BANK OF GREECE

EUROSYSTEM

WAGNER'S LAW IN 19th CENTURY GREECE: A COINTEGRATION AND CAUSALITY ANALYSIS

Dimitrios Sideris

Working Paper

No. 64 December 2007

BANK OF GREECE
Economic Research Department – Special Studies Division
21, E. Venizelos Avenue
GR-102 50 Athens
Tel: +30210-320 3610
Fax: +30210-320 2432

www.bankofgreece.gr

Printed in Athens, Greece
at the Bank of Greece Printing Works.

ISSN 1109-6691

WAGNER'S LAW IN 19TH CENTURY GREECE: A COINTEGRATION AND CAUSALITY ANALYSIS

Dimitrios Sideris
Bank of Greece and University of Ioaninna

ABSTRACT

The validity of Wagner's law, which states that the growth of public expenditure can be explained as a result of the increase in economic activity, is tested for Greece during the period 1833-1938. This represents a period of growth, industrialisation and modernisation of the economy, conditions which should be conducive to Wagner's law. In addition, the long data sample ensures the reliability of the results in terms of economic significance and statistical inference. Cointegration analysis provides positive evidence for the existence of a long-run relationship between government expenditure and national income, and Granger causality tests indicate that causality runs from income to government expenditure. The results support Wagner's hypothesis, in line with other empirical studies examining the validity of the hypothesis in 19th century economies.

Keywords: Public expenditure; Wagner's law; cointegration.
JEL classification: H1; H5; N43; N44

Acknowledgements: Comments from Heather Gibson are gratefully acknowledged. All remaining errors are entirely my responsibility. The views expressed in this paper are the author's own and do not necessarily represent those of the institutions to which he is affiliated.

Correspondence:
Dimitrios Sideris
Economic Research Department
Bank of Greece, 21 El. Venizelou St.,
10250 Athens, Greece,
Tel. +30210-3203607, Fax +30210-3233302
e-mail: dsideris@bankofgreece.gr

1. Introduction

The notion that there is a long-run tendency for government activities to grow relative to economic activity was proposed by Wagner as back as in the late 19th century (Wagner, 1890). Wagner stated that during the industrialisation process, as the real income *per capita* of a nation increases, the share of public expenditures in total expenditure increases. According to him, there are three main reasons, which support this hypothesis: first, during industrialisation, the administrative and regulatory functions of the state would substitute public for private activity; second, economic growth would lead to an increase in cultural and welfare services, which are assumed to be income elastic; third, state participation would be required to provide the capital funds to finance large-scale projects made to satisfy the technological needs of an industrialised society, not met by the private sector. In other words, Wagner's law states that government grows because there is an increasing demand for public goods and for the control of externalities. Based on these arguments, the law also implies causality running from national income to public sector expenditure. Hence, public expenditure is considered as endogenous to the growth of national income, in contrast to the Keynesian view, which considers public spending as an exogenous policy ins ument which can affect growth in national product.

Modern versions of the law use the notion of individual utility maximisation as a necessary component of their explanation. Niskanen (1971) states that government spending may rise disproportionately with growth as a result of the utility maximising behaviour of the bureaucrats, who may be able to expand the size of their bureaus at the expense of efficiency. Meltzer and Richard (1981) and Persson and Tabellini (1990) consider public choice motivations: assuming that government activity has a redistributive element, they explain the growth of the government sector as a result of the spread of the franchise in the 19th and 20th centuries, which increased the number of low income voters who push for more and more redistributive expenditures. Tridimas (2001) emphasises the role of interest groups able to capture government through the majority rule.

Due to its important policy implications, the relationship between government expenditure and economic growth as postulated by Wagner has been one of the most extensively investigated relationships in public economics over the last three decades. The validity of the law has been assessed empirically for a large number of developing and developed countries using both time series and cross sectional data sets. The studies cover country-specific analyses as well as analyses of groups of economies, mainly for the post -Second World War period.[1]

The empirical works on the law can be categorised in two groups, based on the different types of the econometric methodology they apply: a) The early studies which are performed until the mid 1990s, assume stationary data series and apply simple OLS regressions to test alternative versions of the law (see *inter alia* Ram, 1987; Courakis *et al*., 1993 and references therein). b) The cointegration - based studies, which are performed from the mid 1990s and on, test for cointegration between government expenditure and national income (and occasionally population); early studies of this group use the Engle and Granger methodology, whereas more recent works apply the Johansen technique. Most of the recent studies also perform Granger causality tests to indicate the direction of causality between the variables (see *inter alia*, Henrekson, 1993; Murthy, 1993; Ahsan *et al*., 1996; Biswal *et al*., 1999; Kolluri *et al*., 2000; Islam, 2001; Al-Faris, 2002; Burney, 2002; Wahab, 2004). However, the empirical studies have produced mixed and sometimes contradictory results. These conflicting findings (which are well documented in *inter alia* Bohl 1996), have been attributed to the different econometric methodologies used, and to the different features characterising different economies during alternative time periods.

A number of economists state that the law is expected to be valid in developing economies; after all, Wagner's proposition was conceived as applicable to countries in their early stages of development. Thus: (a) In a number of studies, evidence for the hypothesis is investigated in currently emerging industrialised economies, or developing economies with relatively small public sectors, which have strong social and economic roles, using time series data for recent periods (e.g. Ansari *et al*., 1997; Iyare and Lorde, 2004). (b) A different strand of the literature examines the validity of the postulate for currently developed economies using historical time series, so that the examined period covers mainly the industrialisation phases (Oxley, 1994; Thornton, 1999; Florio and Colautti, 2005).[2] In particular: Oxley (1994) uses data for the British economy for the period 1870-1913 and provides evidence consistent with the hypothesis. Thornton (1999) analyses the experience of six presently developed economies (Denmark, Germany, Italy, Norway, Sweden and the

[1] For a recent literature review see *inter alia* Chang *et al*., 2004, for a more critical discussion of the literature Peacock and Scott, 2000.

[2] The importance of state intervention for the development and industrialisation of western economies in the 19th century is acknowledged by a number of economists (see *inter alia* North and Wallis, 1982).

UK) for the period beginning around the mid 19th century and ending in 1913, and reports results in favour of the law. Florio and Colautti (2005) analyse the experience of five economies (US, UK, France, Germany and Italy) for the period 1870-1990. They observe that the increase in the public expenditure to national income ratio is faster for the period until the mid 20th century and develop a model -based on Wagner's law and the Pigou's conjecture that the excess burden of taxation constraints the growth of public expenditures- to analyse the growth process of the ratio for the whole period.

In the present paper, we extend this strand of the literature by testing for the validity of Wagner's hypothesis for the case of the Greek economy in the 19th century. We use data for the period 1833-1938, which have been registered and released only recently (Kostelenos *et al*., 2007; Dertilis, 2005). The development of state activities in Greece share all the features assumed by Wagner during the examined period. The Greek economy is characterised by an initially small but expanding public sector which played an important administrative role for economic development and growth of the economy in the 19th century. The state's importance, initially a result of its administrative and bureaucratic functions -Greece became an independent country in 1827- was later re-enforced by the increased demand for social and educational services, which followed the urbanization of the country, in the late 19th century; its role was further enhanced by government activities to form the institutional framework and monitor the industrialisation of the economy in the period 1860-1920 (see Dertilis, 2005).

An additional advantage of the present study is the long span of the historical time series used. While studies examining recent experiences, including those which refer to Greece, (see the more recent Hondroyiannis and Papapetrou, 1995; Chletsos and Kollias, 1997; Vamvoukas, 2000; Dritsakis and Adamopoulos, 2004; Loizides and Vamvoukas, 2005) use at most 55 annual observations covering the post- Second World War period, in the present study we use annual observations covering more than a century. If Wagner's law is to be regarded as a long-run phenomenon, the longer the time series used, the more reliable the results become in terms of both economic interpretation and statistical inference. In this, we follow the suggestion of *inter alia* Henrekson (1992), Legrenzi (2000) and Florio and Collautti (2005) who propose the use of long time series, as they consider them to be more revealing compared to cross-country analyses.[3]

The empirical work is performed following the methodological suggestions in the recent studies of the relevant literature. An initial investigation of the time series properties of the data is followed by the examination of the existence of any possible long-run relationship between government spending and national income, by applying the multivariate cointegration methodology suggested by Johansen (1988, 1995). To test the direction of causality, we make use of the concept of Granger causality (Granger, 1986) and apply the relevant causality tests as adapted in cointegrating systems.

The rest of the paper is organised as follows: Section 2 presents briefly the theoretical and mathematical formulations of Wagner's hypothesis and outlines the econometric methodology performed in the testing. Section 3 presents the applied work and results. The final section summarises and concludes.

2. Theoretical and methodological issues

2.1 The theoretical relationship

The general nature of Wagner's notion makes it difficult to define uniquely the relationship between 'economic progress' and 'the growth of state activity'. Alternative strands of the literature test several different specifications of Wagner's hypothesis, using various variables to approximate the theoretical variables of 'state activity' and 'economic progress'. Five specifications are predominant in the literature, since most authors test for the validity of one or more of them.[4] These can be expressed mathematically in a log-linear functional form, as follows:

Model 1: $\ln G_t = a_1 + b_1 \ln Y_t + u_{1t}$ (1)

Model 2: $\ln G_t = a_2 + b_2 \ln (Y_t / N_t) + u_{2t}$ (2)

Model 3: $\ln (G_t / Y_t) = a_3 + b_3 \ln (Y_t / N_t) + u_{3t}$ (3)

Model 4: $\ln (G_t / N_t) = a_4 + b_4 \ln (Y_t / N_t) + u_{4t}$ (4)

Model 5: $\ln (G_t / Y_t) = a_5 + b_5 \ln Y_t + u_{5t}$ (5)

where ln denotes natural logarithms and u_{jt}, j=1,…5, are serially uncorrelated random disturbance terms. G stands for real government expenditure, Y for real gross

[3] In particular, Henrekson (1993) examines the expansion of government expenditure in Sweden, for the period 1861-1988, whereas Legrenzi (2000) analyses the pattern of the Italian government expenditure for 1861-1998.

[4] Including more recently Folster and Henrekson, 2001; Chang, 2002; Chang *et al.*, 2004; Iyare and Lord, 2004.

domestic product (GDP) and N for the population size; thus, Y/N stands for real GDP *per capita*, G/Y for the share of real government expenditure in real GDP and G/N for real government expenditure *per capita*. Wagner's law implies that the real income elasticity coefficient should exceed unity in Models 1, 2 and 4 ($b_1>1$, $b_2>1$, $b_4>1$) and should be greater than zero in Models 3 and 5 ($b_3>0$, $b_5>0$).

Model 1 expresses the most general version of the law, Model 3 is known as the share of income formulation and Model 4 is the *per capita* formulation of the law. Models 1 and 5 are equivalent for a monotonic transformation (with $b_5 = b_1-1$); so are Model 3 and Model 4 (for $b_3 = b_4-1$). Model 2 is conceptually different and the interpretation of the elasticity b_2 is also more loosely related to Wagner's law. A more general variation, which nests both models 3 and 4, has also been considered in the literature (see Courakis *et al*., 1993); it takes the form:

Model 6: $\ln G_t = a_6 + b_6 \ln Y_t + c \ln N_t + u_{6t}$ (6)

with the implied restriction $c = 1- b_6$.

The above models imply causality running from income to public sector expenditure. This is how Wagner seemed to view the basis of the law. It is then important that this uni-directional causality is tested and established formally, if unambiguous support for the law is to be inferred.

2.2 The econometric methodology

The present applied work follows a three step procedure. In the first step, the stationarity properties of the data series are examined to determine the order of integration of the series. To this end, tests for unit roots are carried out, using the by now well-known Augmented Dickey-Fuller (ADF) tests (Dickey and Fuller, 1979). Tests for unit roots in the levels of the series are followed by tests for unit roots in the first difference of the series.

In the second step, we test for cointegration among the variables involved in the six specifications, in the event that they are identified as I(1) in the first step, using the Johansen (1988, 1995) maximum likelihood methodology. We define the number of the cointegrating vectors and report the estimated relationships.

In the third step, we examine the causality dynamics between the variables by carrying out Granger causality tests (Granger, 1986). The well-known procedure is to regress past values of a stationary series Z_{1t}, on current values of some other stationary process Z_{2t}. If Z_{1t} contains information which helps to model Z_{2t}, then in the Granger sense, Z_{1t} causes Z_{2t}. The reverse procedure allows testing whether Z_{2t} causes

Z_{1t}. If both regressions provide positive evidence for causality, then a bidirectional relationship exists between Z_{1t} and Z_{2t}.[5]

3. Empirical results and analysis

The data used in the study relate to Greece 1832-1938 and are taken from Dertilis (2005) and Kostelenos, *et al*. (2007). The analysis employs annual data on real GDP (Y), real total government spending (G) and population (N). All variables are measured as natural logarithms. First, univariate time series analysis is performed. The idea is to define the order of integration of the variables involved in the six models under consideration (lnY, lnG, lnN, ln(Y/N), ln(G/N), ln(G/Y)). To this end, the variables are tested for unit roots in levels and in differences applying ADF tests. Table 1 reports the results. On the basis of the results, all time series appear to be I(1) at a 1% level of significance.

In the second step, cointegration between the series involved in Models 1 – 6 is investigated using the Johansen approach. Initially, five two-dimensional VARs (Models 1-5) and one three-dimensional VAR (Model 6) are estimated using one lag of the variables to obtain non-correlated residuals; hence, effective estimation periods are reduced so as to accommodate the lag structure of the models. In all systems, the deterministic variable sets include a constant and impulse dummies to account for specific structural breaks that affected the performance of the Greek economy during the estimation period. The dummies which have been used are reported in the second column of Table 2. D1913 and D1914, which take the value 1 in 1913 and 1914, respectively, are included in all systems. They account for the effects of the participation of Greece in the First World War. D1864 and D1922, which take the value one in 1864 and 1922 respectively, are included in VAR 6. D1864 accounts for

[5] Assuming that the series are I(1) and that there is evidence for one cointegrating vector, which can be used as an error correction term (EC_{jt}) for each model j, the Granger causality tests for model j, can be defined based on the following formulation:

$$\Delta \ln X_{1jt} = \lambda_{j0} + \sum_{t=1}^{k} \lambda_{j1i} \Delta \ln(X_{1j})_{t-i} + \sum_{t=1}^{k} \lambda_{j2i} \Delta \ln(X_{2j})_{t-i} + \lambda_{j4}(EC_j)_{t-1} + u_{j1t} \quad \text{(A1)}$$

$$\Delta \ln X_{2jt} = \mu_{j0} + \sum_{t=1}^{k} \mu_{j1i} \Delta \ln(X_{1j})_{t-i} + \sum_{t=1}^{k} \mu_{j2i} \Delta \ln(X_{2j})_{t-i} + \mu_{j4}(EC_j)_{t-1} + u_{j2t} \quad \text{(A2)}$$

where u_{j1t} and u_{j2t} are zero-mean, uncorrelated and homoscedastic random error terms. On the basis of (A1) and (A2), unidirectional causality from $\Delta \ln X_{2j}$ to $\Delta \ln X_{1j}$, is implied if the estimated λ_{j2i}'s and λ_{j4} are statistically different from zero as a group (based on standard F statistics) in (A1), and the estimated μ_{j1i} 's and μ_{j4} are not statistically different from zero as a group in (A2). Equivalently, unidirectional causality from $\Delta \ln X_{1j}$ to $\Delta \ln X_{2j}$, is implied if not only the estimated λ_{j2i}'s and λ_{j4} are not statistically different from zero as a group in (A1), but also the estimated μ_{j1i} 's and μ_{j4} are statistically different from zero as a group in (A2).

the large population increase caused by the annexation of two new peripheries in the Greek territory in 1864; D1922 accounts for the population increase due to a big wave of refugees of Greek origin coming from Asia Minor in 1922. All reported dummies are kept in the respective VARs as they turned out to be significant, whereas their absence would mean non normal residuals for the relevant VARs.

Thus specified, the VARs satisfy the statistical assumptions required for the Johansen technique and we can go on with the cointegration analysis.[6] The outcomes of the maximum eigenvalue and trace statistics are reported in columns 3 - 8 of Table 2. According to both likelihood ratio tests, there is strong evidence for one cointegrating vector for all six models.

In addition, the estimated coefficients of the cointegrating vectors, which are reported in Table 3, indicate that all vectors imply relationships as postulated by the theory.[7] All income elasticities obtain values which are consistent with the hypotheses as expressed in the theoretical models. The estimated b_1 and b_4 obtain values which exceed unity, whereas the estimated b_3 and b_5 exceed zero. As expected, the estimated coefficient parameters satisfy the restrictions $b_5 = b_1-1$ (0.0887 = 1.0887 -1) and $b_3 = b_4-1$ (0.357=1.357-1), associating models 1 and 3 to models 5 and 4, respectively. In versions 1 and 5 which express the hypothesis in absolute terms, the estimated income elasticity implies that an increase in income would lead to an almost equal government expenditure rise; in the *per capita* formulations 3 and 4, government expenditure turns out to be clearly output elastic; finally, the estimated version 2 implies that a 1% growth of *per capita* income would lead to an increase of total public expenses by 5.2%.

The estimated parameters of Model 6 are also in line with the theory. The Johansen technique permits testing for the joint hypothesis H_1: $-c = 0.357$; $b_6=1.357$. H_1 tests for $c=1- b_6$ (so that the estimated model is consistent with the theoretical hypothesis of model 6) and for $b_6 =b_4$ (that the estimated income elasticity of model 6 equals the estimated elasticity in version 4), thus implying that Model 6 is an alternative formulation of Model 4. The test statistic, which is asymptotically $\chi^2(2)$ distributed, takes the value 3.75; thus H_1 cannot be rejected at conventional levels of significance.

---

[6] Their diagnostic tests do not indicate any serious mis-specification (serial correlation and/or non-normality) problem. They are not reported here for space reasons but are available on request.

[7] Most of the studies which use cointegration analysis interpret the existence of cointegration between the variables in models 1-6 as evidence in favour of the hypothesis and do not report the estimated coefficients, in contrast to the present work.

Then, Granger causality tests are conducted for models 1-5.[8] All models are estimated using two lags for the variables, based on diagnostic tests which ensure uncorrelated residuals. Given the existence of cointegration for all five examined versions, Granger causality tests are defined as joint tests (F-tests) for the significance of the lagged values of the assumed exogenous variable and for the significance of the error correction term. The results are reported in Table 4. According to them, Granger causality is running from income to spending, in Models 1 and 3-5.[9] For Model 2 the tests do not support any form of causality between the two variables.

4. Conclusions

In the present study, the long-run tendency for government expenditure to grow relative to national income, Wagner's law, is investigated empirically using Greek data from the 19th and the beginning of the 20th century. A basic advantage of the study is that the data span covers a period of more than a century; the long data sample thus ensures the reliability of the results, in terms of economic interpretation and statistical inference. In addition, the period refers to the early phase in the development of the Greek economy, during which, the growth of state activities share all the features assumed by Wagner.

In the paper, the methodological suggestions proposed in recent studies of the relevant literature are followed. After a thorough examination of the time dependence properties of the series, cointegration analysis validates the existence of long-run relationship between the variables, as expressed by the six most popular versions of the law. In addition, the estimated signs and magnitudes of the parameters support Wagner's conception. Then, Granger causality tests indicate causality running from the variables approximating income to the government expenditure variable, in most cases. The results provide support for the validity of the law, and are in line with other studies examining the relationship between government spending and national income in other economies during the 19th century. The findings probably indicate that Wagner's law is valid for economies which are in their early phase of development.

---

[8] Granger causality is not investigated for model 6, as it is an alternative formulation of 3 and 4 which, though, involves three variables.

[9] Note that, given that models 5 and 4 are alternative formulations of 1 and 3 respectively, the test statistics obtain similar values.

References

Ahsan, S.M., Kwan, A.C.C., B.S. Sahni, 1996, "Cointegration and Wagner's Hypothesis: Time Series Evidence for Canada", Applied Economics, 28, 1055-58.

Ansari, M.I., D.V. Gordon and C. Akuamoah, 1997, "Keynes versus Wagner: Public Expenditure and National Income for Three African Countries", Applied Economics, 29, 543-550.

Al-Faris,A.F., 2002, "Public Expenditure and Economic Growth in the Gulf Cooperation Council Countries", Applied Economics, 34, 1187-93.

Biswal, B., U. Dhawan and H.Y. Lee, 1999, "Testing Wagner versus Keynes Using Disaggregated Public Expenditure Data for Canada", Applied Economics, 31, 1283-91.

Bohl, M., 1996, "Some International Evidence on Wagner's Law", Public Finance, 51, 185-200.

Burney, N.A., 2002, "Wagner's Hypothesis: Evidence from Kuwait Using Cointegration Tests", Applied Economics, 34, 49-57.

Chang, T., 2002, "An Econometric Test of Wagner's Law for Six Countries Based on Cointegration and Error-Correction Modelling Techniques", Applied Economics, 34, 1157-69.

Chang, T., W. Liu and S.B.Caudill, 2004, "A Re-examination of Wagner's Law for Ten Countries Based on Cointegration and Error-Correction Modelling Techniques", Applied Financial Economics, 14, 577-89.

Chletsos, M. and C. Kollias, 1997, "Testing Wagner's Law Using Disaggregated Public Expenditure Data in the Case of Greece: 1958-93", Applied Economics, 29, 371-77.

Courakis, A.S., F. Moura-Roque and G. Tridimas, 1993, "Public Expenditure Growth in Greece and Portugal: Wagner's Law and Beyond", Applied Economics, 25, 125-34.

Dertilis, G.V., 2005, "History of the Greek State: 1830-1920", Hestia, Athens (in Greek).

Dickey, D.A. and W.A. Fuller, 1981, "The Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", Econometrica, 49, 1057-72.

Dritsakis, N. and A. Adamopoulos, 2004, "A Causal Relationship between Government Spending and Economic Development: An Empirical Examination of the Greek Economy", Applied Economics, 36, 457-64.

Florio, M. and S. Colautti, 2005, "A Logistic Growth Theory of Public Expenditures: A Study of Five Countries over 100 Years", Public Choice, 122, 355-93.

Folster, S. and M. Henrekson, 2001, "Growth Effects of Government Expenditure and Taxation in Rich Countries", European Economic Review, 45, 1501-20.

Granger, C.W.J., 1986, "Developments in the Study of Cointegrated Economics Variables", Oxford Bulletin of Economics and Statistics, 48, 213-28.

Henrekson, M., 1993, "Wagner's Law: A Spurious Relationship?", Public Finance, 48, 406-15.

Henrekson, M., 1992, "An Economic Analysis of Swedish Government Expenditure", Aldershot, U.K., Brookfield, Vt. and Sydney: Ashgate, Avebury.

Hondroyiannis, G. and E. Papapetrou, 1995, “An Examination of Wagner’s Law for Greece: A Cointegration Analysis”, Public Finance, 50, 60-79.

Islam, A.M., 2001, “Wagner's Law Revisited: Cointegration and Exogeneity Tests for the USA”, Applied Economics Letters, 8, 509-15.

Iyare, S. O. and T. Lorde, 2004, "Co-integration, Causality and Wagner's Law: Tests for Selected Caribbean Countries", Applied Economics Letters, 11, 815-25.

Johansen, S., 1988, “Statistical Analysis of Cointegration Vectors”, Journal of Economic Dynamics and Control, 12, 231-54.

Johansen, S., 1995, “Likelihood-Based Inference in Cointegrated Vector Autoregressive Models”, Oxford: Oxford University Press.

Kolluri, B.R., M.J.Panik and M.S. Wahab, 2000, “Government Expenditure and Economic Growth: Evidence from G7 Countries”, Applied-Economics, 32, 1059-68.

Kostelenos, G., D. Vasiliou, E. Kounaris, S. Petmezas and M. Sfakianakis, 2007, “Gross Domestic Product 1830-1939. Sources of Economic History of Modern Greece, Quantitative Data and Statistical Series 1830-1939”, Athens: Historical Archive of the National Bank of Greece and Centre for Planning and Economic Research (in Greek).

Legrenzi, G., 2000, “The Long-Run Relationship between Public Sector Size and Economic Growth: Income Elasticity and Causality of the Italian General Government Expenditure (1861-1998)”, International Review of Economics and Business, 47, 415-37.

Loizides, J. and G. Vamvoukas, 2005, “Government Expenditure and Economic Growth: Evidence from Trivariate Causality Testing”, Journal of Applied Economics, 8, 125-52.

Meltzer, A.H. and S.F. Richard, 1981, “A Rational Theory of the Size of Government”, Journal of Political Economy, 89, 914-27.

Murthy, N.R.V., 1993, “Further Evidence of Wagner's Law for Mexico: An Application of Cointegration Analysis”, Public Finance, 48, 92-96.

Niskanen, W.A., 1971, “Bureaucracy and Representative Government”, Aldine-Atherton, Chicago.

North, D.C. and J.J. Wallis, 1982, “Longer-Run Determinants of the Economic Role of the US Government”, American Economic Review (Papers and Proceedings), 72, 336-340.

Oxley, L., 1994, “Cointegration, Causality and Wagner's Law: A Test for Britain 1870-1913”, Scottish Journal of Political Economy, 41, 286-98.

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

Persson, T. and G. Tabellini, 1990, “Macroeconomic Policy, Credibility and Politics”, Harwood Academic, London.

Ram, R., 1987, “Wagner's Hypothesis in Time-Series and Cross-section Perspectives: Evidence from Real Data for 115 Countries”, Review of Economics and Statistics, 69, 194-204.

Thornton, J., 1999, “Cointegration, Causality and Wagner's Law in 19th Century Europe”, Applied Economics Letters, 6, 413-16.

Tridimas, G., 2001, “The Economics and Politics of the Structure of Public Expenditure”, Public Choice, 106, 299-316.

Vamvoukas, G., 2000, “Government Spending and Economic Growth: Time Series Evidence for Greece”, Archives of Economic History, 11, 167-77.

Wagner, A., 1890, “Finanzwissenschaft”, Winter, C.F., Leipzig.

Wahab, M., 2004, "Economic Growth and Government Expenditure: Evidence from a New Test Specification", Applied Economics, 36, 2125-35.

Table 1: ADF unit root tests

Variables	t(ADF)	lags, trend	Variables	t(ADF)	Lags
ln G	-0.110	(3)	Δ ln G	-7.735**	(3)
ln Y	1.213	(4)	Δ ln Y	-4.872**	(4)
ln N	2.562	(1, trend)	Δ ln P	-7.621**	(1)
ln (G/Y)	3.371*	(4)	Δ ln (G/Y)	-7.384**	(4)
ln (G/N)	2.648	(3)	Δ ln (G/N)	-7.723**	(3)
ln (Y/N)	0.965	(4)	Δ ln (Y/N)	-5.862**	(4)

Note: * and ** indicate rejection of the null hypothesis at the 5% and 1% level of significance, respectively.

Table 2: The Johansen procedure results: Testing for the cointegration rank

Model	Dummies	Maximal Eigenvalue			Trace statistic		
		r = 0	r = 1	r =2	r = 0	r = 1	r =2
1	D1913, D1914	38.53**	0.049		38.58**	0.049	
2	D1913, D1914	17.22**	2.018		19.23**	2.018	
3	D1913, D1914	36.92**	1.076		37.99**	1.076	
4	D1913, D1914	36.92**	1.076		37.99**	1.076	
5	D1913, D1914	38.53**	0.049		38.58**	0.049	
6	D1913, D1914, D1922, D1864	43.98**	10.15	0.667	54.8*	10.82	0.667
	Critical values at 95% level	21.0	14.1	3.8	29.7	15.4	3.8

Note: * and ** indicate rejection of the null hypothesis at the 5% and 1% level of significance, respectively.

Table 3: Estimated beta coefficients

Model 1	ln G	ln Y	
	1	-1.0887	
Model 2	ln G	ln (Y/N)	
	1	-5.219	
Model 3	ln (G/Y)	ln (Y/N)	
	1	-0.357	
Model 4	ln (G/N)	ln (Y/N)	
	1	-1.357	
Model 5	ln (G/Y)	ln Y	
	1	-0.0887	
Model 6	ln G	ln Y	ln N
	1	-0.991	-0.29

Table 4: Granger Causality tests

Model		F (3,97)	p-value		F (3,97)	p-value
1	lnY causes lnG	8.075**	(0.000)	lnG causes lnY	0.540	(0.655)
2	ln(Y/N) causes lnG	1.0236	(0.385)	lnG causes ln(Y/N)	1.938	(0.128)
3	ln(Y/N) causes ln(G/Y)	7.912**	(0.000)	ln(G/Y) causes ln(Y/N)	0.525	(0.666)
4	ln(Y/N) causes ln(G/N)	7.403**	(0.000)	ln(G/N) causes ln(Y/N)	0.524	(0.666)
5	lnY causes ln(G/Y)	8.967**	(0.000)	ln(G/Y) causes lnY	0.540	(0.655)

Note: * and ** indicate rejection of the null hypothesis at the 5% and 1% level of significance, respectively.

BANK OF GREECE WORKING PAPERS

41. Genberg, H., "Exchange-Rate Arrangements and Financial Integration in East Asia: On a Collision Course?", including comments by James A. Dorn and Eiji Ogawa, May 2006.

42. Christl, J., "Regional Currency Arrangements: Insights from Europe", including comments by Lars Jonung and the concluding remarks and main findings of the workshop by Eduard Hochreiter and George Tavlas, June 2006.

43. Edwards, S., "Monetary Unions, External Shocks and Economic Performance: A Latin American Perspective", including comments by Enrique Alberola, June 2006.

44. Cooper, R. N., "Proposal for a Common Currency Among Rich Democracies" and Bordo, M. and H. James, "One World Money, Then and Now", including comments by Sergio L. Schmukler, June 2006.

45. Williamson, J., "A Worldwide System of Reference Rates", including comments by Marc Flandreau, August 2006.

46. Brissimis, S. N., M. D. Delis and E. G. Tsionas, "Technical and Allocative Efficiency in European Banking", September 2006.

47. Athanasoglou, P. P., M. D. Delis and C. K. Staikouras, "Determinants of Bank Profitability in the South Eastern European Region", September 2006.

48. Petroulas, P., "The Effect of the Euro on Foreign Direct Investment", October 2006.

49. Andreou, A. S. and G. A. Zombanakis, "Computational Intelligence in Exchange-Rate Forecasting", November 2006.

50. Milionis, A. E., "An Alternative Definition of Market Efficiency and Some Comments on its Empirical Testing", November 2006.

51. Brissimis, S. N. and T. S. Kosma, "Market Conduct, Price Interdependence and Exchange Rate Pass-Through", December 2006.

52. Anastasatos, T. G. and I. R. Davidson, "How Homogenous are Currency Crises? A Panel Study Using Multiple Response Models", December, 2006.

53. Angelopoulou, E. and H. D. Gibson, "The Balance Sheet Channel of Monetary Policy Transmission: Evidence from the UK", January, 2007.

54. Brissimis, S. N. and M. D. Delis, "Identification of a Loan Supply Function: A Cross-Country Test for the Existence of a Bank Lending Channel", January, 2007.

55. Angelopoulou, E., "The Narrative Approach for the Identification of Monetary Policy Shocks in a Small Open Economy", February, 2007.

56.Sideris, D. A., “Foreign Exchange Intervention and Equilibrium Real Exchange Rates”, February 2007.

57.Hondroyiannis, G., P.A.V.B. Swamy and G. S. Tavlas, “The New Keynesian Phillips Curve and Lagged Inflation: A Case of Spurious Correlation?”, March 2007.

58.Brissimis, S. N. and T. Vlassopoulos, “The Interaction between Mortgage Financing and Housing Prices in Greece”, March 2007.

59.Mylonidis, N. and D. Sideris, “Home Bias and Purchasing Power Parity: Evidence from the G-7 Countries”, April 2007.

60. Petroulas, P., “Short-Term Capital Flows and Growth in Developed and Emerging Markets”, May 2007.

61.Hall, S. G., G. Hondroyiannis, P.A.V.B. Swamy and G. S. Tavlas, “A Portfolio Balance Approach to Euro-area Money Demand in a Time-Varying Environment”, October 2007.

62. Brissimis, S. N. and I. Skotida, “Optimal Monetary Policy in the Euro Area in the Presence of Heterogeneity”, November 2007.

63.Gibson, H. D. and J. Malley, “The Contribution of Sector Productivity Differentials to Inflation in Greece”, November 2007.