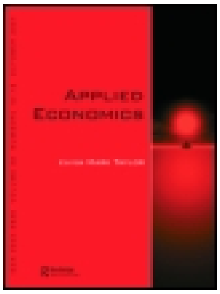

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Public sector and economic growth: the Greek experience

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Public sector and economic growth: the Greek experience

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Over the past two decades there has been an increase in the relative size of the public sector, accompanied by a decline in the growth performance of the Greek economy. In an attempt to highlight the contribution of the government size to growth, an analytical framework is developed, incorporating the possibility that marginal factor productivities are not equal in the public and private sectors. Econometric analysis utilizing this framework points to a negative relationship between government size and economic growth. This seems to derive, in part, from intersectoral diseconomies generated by the growing share of deft-financed government activities.

I. INTRODUCTION

The relation between economic growth and the size and/or efficiency of the public sector has been a subject of considerable interest to development economists in recent years. Given that government expenditures are a component of GDP, one would expect a positive association in terms of the correlation coefficient. However, several studies have demonstrated, on conceptual or empirical grounds, that the contribution of the public sector to growth may exceed or fall short of the change in the government size, proxied by the share of government consumption in GDP.

The literature on the impact of government activities on overall economic growth tends to differentiate those aspects of government intervention which accelerate growth from those which retard it.

On the one hand, public sector activity may increase GDP indirectly through its interaction with the private sector. Grossman (1988) underscores some of the main features of government decision-making that facilitate growth: provision of legal and social framework, defence, police services, judiciary, enforcement of property rights, correction for the inadequacies of an unrestrained marketplace, development of the economic infrastructure, regulation of externalities and transfer payments for maintaining social harmony and improving the productivity of the labour force.

On the other hand, government activity may give rise to excess burdens and disincentive effects associated with the revenue raising and transfer mechanisms. Tax and expenditure programmes may lead to serious misallocation of resources, thus mitigating or even offsetting the positive effects of government intervention. The potential for inefficiencies in the provision of government output is enhanced by the bureaucratic structure of the decision-making process in the public sector, the logrolling practices of the political system which tend to promote the interests of small, cohesive minorities at the expense of the general public, and the behavioural tactics of special interest groups who press for diverting resources into rent-seeking activities (monopolies, tariffs and quotas etc.) with a purpose towards redistributing income to their benefit.

Since beneficial and adverse effects are invariably fixed together in any form of government activity, an evaluation of the net impact of the public sector on the growth performance cannot safely be made without empirical investigation. Recent contributions to the relative literature include a number of empirical studies. For example, Kormendi and Meguire (1985) find no significant relation between average growth rates of real GDP and average growth rates or levels of the share of government consumption spending in GDP; Grier and Tullock (1987), Landau (1983), Barro (1990) and Grossman (1988) find a significantly negative relation between the growth of real GDP and the growth of the government share in GDP, whereas Ram (1986) and Rubinson (1977) contend that the overall impact of government size on growth is generally positive.[1]

The common features of the above papers are the following:

(1) Their conclusions are predominantly derived from cross-country comparisons. In such comparisons, the level of aggregation is of necessity quite high and both the reliability and the range of variables for which data are available is limited.
(2) The derivation of the growth function is based on two distinct approaches. The first is an *ad hoc* approach in which economic growth is specified as a linear function of a set of variables, such as human and physical capital, the level of per capita product, the structure of production, historical–political factors, geo-climatic factors, indicators of international economic conditions and government spending (see, for instance, Landau (1983) and Kormendi and Meguire (1985)). The second approach has a better theoretical foundation as the growth/government spending relationship is explicitly derived from a general production function (see, for example, Ram (1986) and Grossman (1988)). However, no reliable conclusions on the contributions of public sector to growth can be drawn on the basis of the above relationship, since the relevant variable (usually the ratio of the change in government spending to GDP, dG/Y) is not a representative measure of government size.
(3) The impact of public spending on growth is examined in terms of the sign and significance of the relevant coefficient. Statistically high and negative (positive) values are interpreted as yielding sufficient ground on which to argue that a larger government size depresses (accelerates) economic growth. Hence all previous studies seem to overlook the fact that the methods of financing a given stream of government expenditures may crucially affect the growth process. For instance, a growing share of public spending in GDP may affect economic growth in diametrically opposite ways, depending on whether a debt-financed or a tax-financed expansionary fiscal policy is followed. Ignoring the financing aspects of government activities means in essence that government size *per se* may be wrongly awarded a key role in the design and implementation of fiscal policy with consequential effects on the overall economic performance.

This study will address the issue of whether the growth in government size affects economic growth, in a framework that avoids the major criticisms levelled against the aforementioned studies. The approach to be followed has four advantages over the extant empirical research on this issue. First, a specific production equation is derived which establishes an explicit, clear-cut relationship between the growth rate of GDP and the growth rate of government size. Second, an important case study is considered – that of Greece in the postwar period. Most of the previous studies have used cross-sectional data and thus have implicitly assumed that the regression parameters are constant across countries. Moreover, when Granger causality between the public sector size and output has been tested, only bivariate models are considered and thus the result may be biased due to the omission of relevant variables. In particular, omitting labour, capital, money balances, exports and imports may have given spurious correlations. In the present text, the investigation of this relationship is undertaken within a multivariate framework, encompassing all the above variables. Third, the differential effects of the alternative means of financing government spending are examined and the distortionary impact of an increasing debt/GDP ratio is evaluated. Fourth, an attempt is made to account for the fact that some of the estimated coefficients in the production equation may not be the same over the entire sample period, a factor that seems to have been overlooked in previous formulations of the model.

The empirical study carried out here is undertaken with the intention of capturing some of the specificities of the country studied and the policies adopted during the period, and attempts to trace the mechanisms through which fiscal policies and variables interact in affecting the growth process. We find that the increase in government size has adversely affected economic growth, as a result of the overwhelming importance of debt accumulation as a means of financing government spending. Thus, the results of the present study are consistent with the findings of Grier and Tullock (1987), Grossman (1988) and Barro (1990) and lend support to the traditional (crowding out) view.

II. FRAMEWORK OF ANALYSIS

The model to be developed is a modified version of the one first presented by Feder (1982) and then adapted by Ram (1986) and Grossman (1988). It is assumed that the economy consists of two sectors, the government sector (G) and the private sector (C). Output in each sector depends on the sectoral inputs of labour (L) and capital (K) but, in addition, private sector output is a function of the government

[1] Other studies that bear directly or indirectly on the issue are summarized by Afxentiou (1982).

sector output, as the latter is supposed to exercise an externality effect on the former. Thus the production functions for the two sectors are:

$$C = C(L_c, K_c, G) \quad (1)$$

$$G = G(L_g, K_g) \quad (2)$$

where subscripts denote sectoral inputs. The government sector output is defined as government consumption (Ram) or a vector including government consumption, government transfers and proxy variables to account for the misallocation of resources created by government intervention (Grossman). The total inputs are given by:

$$L_c + L_g = L \quad (3)$$

$$K_c + K_g = K \quad (4)$$

and the total output by:

$$C + G = Y \quad (5)$$

A further assumption is that the relative factor productivity in the two sectors differs by a constant amount δ:

$$G_L/C_L = G_K/C_K = 1 + \delta \quad (6)$$

where uppercase subscripts stand for the partial derivatives of the functions with respect to subscripted input. It is obvious that a positive (negative) value of δ implies higher (lower) input productivity in the government sector. By manipulating the production functions and using Equations 3–6, the following growth equations are derived:

$$\mathrm{d}Y/Y = a_0(\mathrm{d}L/Y) + a_1(\mathrm{d}K/Y) + a_2(\mathrm{d}G/Y) \quad \text{(Grossman)} \quad (7)$$

$$\mathrm{d}Y/Y = b_0(\mathrm{d}L/L) + b_1(I/Y) + b_2(\mathrm{d}G/G)(G/Y) + b_3(\mathrm{d}G/G) \quad \text{(Ram)} \quad (8)$$

where $\mathrm{d}K = I =$ total investment.

It is worth noting that in none of the last two specifications does the ratio G/Y appear as an independent variable by itself, even though the inclusion of such a variable is necessary for assessing the pure impact of government size on development. An *ad hoc* addition of G/Y to the growth equation tends to raise serious questions about the adequacy of the theoretical foundation of the model.

In the present text, the appropriate functional form of Equation 2 is determined on the basis of the Box–Cox model,

$$(G^\lambda - 1)/\lambda = A + \alpha[(L_g^\lambda - 1)/\lambda] + \beta[(K_g^\lambda - 1)/\lambda]$$

with the elasticity of substitution between capital and labour being equal to: $\sigma = 1/(1-\lambda)$. If the estimated λ is not significantly different from zero, the elasticity of substitution is equal to one and Equation 2 reduces to the Cobb–Douglas production function,

$$G = BL_g^{\alpha'} K_g^{\beta'} \quad (9)$$

The appropriate functional form of Equation 1 is determined in a similar fashion. Again, if $\lambda = 0$, Equation 1 reduces to

$$C = AL_c^{\alpha} K_c^{\beta} G^{\gamma} \quad (10)$$

where $\alpha\,(\alpha')$ and $\beta\,(\beta')$ represent the elasticities of private (government) output with respect to the sectoral inputs of labour and capital, respectively, γ is the elasticity of private output with respect to government output – i.e., the marginal externality effect of government size on the rest of the economy and, hence, on economic performance – and $A(B)$ stands for the index of economic efficiency. An additional term, $e^{\phi t}$, may also be included to account for the rate (ϕ) of disembodied or neutral technological change.

In testing for the hypothesis H_0: $\lambda = 0$, the maximum likelihood estimates of the parameters of both the Box–Cox model and Equations 9 and 10 are obtained for Greece over the period 1956–1994 and the appropriate likelihood ratio tests are performed.[2] We find that the values of the test statistic are below their critical values [$\chi^2(1, 0.05) = 3.84$], indicating that we can accept the hypothesis of a Cobb–Douglas production function. The same qualitative results are obtained when we carry out likelihood ratio tests for the hypothesis that Equations 9 and 10 do not impose significant constraints on an unconstrained CES production function.[3]

By applying Equation 6 to the production Equations 9 and 10, the relative factor productivity is estimated as follows:

$$(\alpha' G/L_g)/(\alpha C/L_c) = (\beta' G/K_g)/(\beta C/K_c) = 1 + \delta$$

or

$$G/C = \lambda(1+\delta)$$

or

$$Y/C = \lambda(1+\delta) + 1 \quad (11)$$

where

$$\lambda = \frac{G}{C(1+\delta)} = \alpha L_g/\alpha' L_c = \beta K_g/\beta' K_c \quad (12)$$

[2] Let $L(\mathrm{H}_0)$ be the value of the likelihood function under the assumption that the more restricted model (Cobb–Douglas) is correct and let $L(\mathrm{H}_1)$ be the likelihood function value under the alternative hypothesis. The test statistic $-2\ln[L(\mathrm{H}_0)/L(\mathrm{H}_1)]$ follows a chi-square distribution with one degree of freedom.

[3] In the CES production function, $G = A[\omega L_g^{-\rho} + (1-\omega)K_g^{-\rho}]^{-v/\rho}$, the elasticity of substitution is $\sigma = 1/(1+\rho)$. Thus, if the estimated substitution parameter ρ is not significantly different from zero, then the elasticity of substitution equals one and the CES production function reduces to the Cobb–Douglas production function.

From Equation 12 one obtains the following relationships:

$$L_g/L_c = \lambda(\alpha'/\alpha) \qquad K_g/K_c = \lambda(\beta'/\beta) \tag{13}$$

$$\begin{aligned} L_g &= (\lambda\alpha' L)/(\alpha + \lambda\alpha') \quad & L_c &= (\alpha L)/(\alpha + \lambda\alpha') \\ K_g &= (\lambda\beta' K)/(\beta + \lambda\beta') \quad & K_c &= (\beta K)/\beta + \lambda\beta') \end{aligned} \tag{14}$$

By substituting the private-sector production function (10) into Equation 11 and using Equation 14, the following approximation for an aggregate output equation can be derived:

$$Y = A' L^{\alpha} K^{\beta} G^{\gamma} \tag{15}$$

where

$$A' = (\lambda + \delta\lambda + 1) A[\alpha/(\alpha/(\alpha + \lambda\alpha')]^{\alpha}[\beta/(\beta + \lambda\beta')]^{\beta}$$

Dividing Equation 15 through by Y^{γ} and taking the total differential of the corresponding log linear form yields:

$$d\ln Y = a_0 + a_1 d\ln L + a_2 d\ln K + a_3 d\ln(G/Y) \tag{16}$$

where

$$\left.\begin{aligned} a_0 &= (d\ln A')/(1-\gamma), \quad & a_1 &= \alpha/(1-\gamma) \\ a_2 &= \beta/(1-\gamma), & a_3 &= \gamma/(1-\gamma) \end{aligned}\right\} \tag{17}$$

The formulation in Equation 16 will be the basis of the empirical work to be reported in the next sections. This model differs from previous formulations in two respects. First, a direct link between the rate of economic growth and the growth rate of government size – defined as the ratio of government expenditures to GDP – is structured on purely theoretical grounds. Second, what has been treated in previous empirical studies as a constant term does not seem to be valid, at least in a Cobb–Douglas environment. Indeed, the intercept in Equation 16 includes, among other arguments, the term λ which, according to Equation 12, represents the ratio of government output to private-sector output (after allowing for differences in factor productivity). Thus a contradiction seems to exist in previous studies, when estimating equations similar to Equation 16, as the ratio of government output to total output enters into the production function as an explanatory variable, while the ratio of government output to private output is assigned the status of a constant in the intercept. To evaluate better the effects of government size on economic growth, the present study re-examines the validity of the empirical findings by adopting a parameter-value flexibility formula.

III. CAUSALITY, INTEGRATION AND COINTEGRATION

In concentrating on the empirical investigation of the relationship between government size and aggregate output, a positive (negative) correlation is hypothesized, depending on whether an expansion in the government size is considered to cause an improvement (deterioration) in resource allocation and/or an increase (decrease) in productivity growth. In this context, the direction of causality is posited to be from government size to economic growth. An alternative view of causal reactions may well consider the other way around: the causality running from economic growth to government, in accordance with the basic principles of the Wagner hypothesis.[4]

So far, the nature of the causal relationship between government expenditure and growth has not been examined in the context of a specific production function.[5] To fill the gap, the investigation of this relationship is undertaken here within a multivariate framework using time series data on Greece over the postwar period (from 1948 to 1994). Besides government size and output the conventional sources of growth (labour and capital), real money balances, exports and imports are also included in the model. The causal relationships are examined by using the vector autoregressive (VAR) technique which accounts for all the possible bivariate influences among the variables, aside from those of principal interest. In a seven-variable model, there are 42 bivariate relationships (excluding the own-variable relationships).

The role of money in economic performance has been emphasized by many writers – see, for example, Sinai and Stokes (1972, 1975) and Niccoli (1975) – who argue that real money balances are a factor of production and enter significantly in production functions. The rationale for including money in the production function relates to the increased productive efficiency of a monetary economy as capital and labour are released from the special task of insuring whatever trade is necessary in a barter economy.

The empirical framework that provides a formal rationalization for the incorporation of the export variable in the production function has been developed by Feder (1982), whereas the beneficial aspects of exports on growth (greater capacity utilization, competitive pressures from abroad, incentives for technological improvements, economies of scale, etc.) have been stressed by a number of economists, such as Balassa (1978) and Tyler (1981).

Imports are also included by some economists (see, for example, Serletis, 1992) in the production function in order to examine whether the export externality effects can be

[4] There are several versions of the Wagner hypothesis; for a concise statement see, for example, Singh and Sahni (1986).
[5] A number of studies have considered only bivariate models and thus their results may be biased due to the omission of relevant variables.

attributed to the role of exports in relieving a foreign borrowing constraint. Thus a finding that the impact of exports on GDP weakens when imports are included in the growth equation would substantiate the argument that the foreign exchange provision effect is important.

The theoretical grounds for supporting the view that there are possible interrelationships between the dependent variable and each of the independent variables, as well as among the independent variables, in the growth equation are discussed by a number of writers. For instance, Subhush *et al.* (1991) divide the prima-facie causal relationships into two sets: the first set includes the relationships which are consistent with the neoclassical growth model where labour, capital and export–import growth are assumed to cause output growth. The second set consists of those relationships which are consistent with demand-led growth where causality runs from output to labour, capital and exports–imports. Hsiao (1981) briefly discusses the opposing views over the relationship between money and income, while the Wagner hypothesis is capable of explaining why causality may run from output to government spending.

The lag length of each polynomial in the seven-variable VAR model is determined using Hsiao's (1981) sequential procedure which is based on the Granger definition of causality and Akaike's minimum final prediction error criterion. Moreover, the specific gravity criterion of Caines *et al.* (1981) is used to determine the order in which the variables are added at each stage. After determining the lag lengths, the VAR model is estimated by Zellner's iterative seemingly unrelated regression procedure. The variables are expressed in terms of first differences of logarithms. To test the prima-facie cause (or no cause) from one variable to the other, the likelihood ratio test is conducted.

The direct and indirect prima-facie causal implications are reported below:

- Government size, labour and money prima-facie cause income directly.
- There is a prima-facie feedback relationship between income and capital stock.
- The government share in GDP prima-facie causes the capital stock, given that public-sector investment accounts for a significant portion of the total investment effort in Greece. Given the feedback relationship between capital and income, it becomes evident that government size influences income both directly and indirectly through capital.
- Money and exports prima-facie cause imports, which in turn weakly affect income (at the 8% significance level).

Thus the data is in general supportive of the neoclassical growth hypothesis, according to which the conventional sources of growth should cause output growth, even though the impact of government size seems to be particularly strong. It remains to be seen whether this impact is in the positive or in the negative direction.

Table 1. (*Augmented*) *Dickey–Fuller unit root test results*

Variable	Level (a)	(First) differences
Y	– 0.62*	– 3.6
L	– 1.13*	– 4.3
K	– 1.18*	– 3.9
G/Y	– 1.73*	– 5.2
$M2$	– 0.83*	– 4.0
X	– 1.98*	– 4.8
M	– 0.65*	– 3.7

(a) $\Delta X_t = a_0 + a_1 t + a_2 X_{t-1} + \sum_{i=1}^{k} b_i \Delta X_{t-i}$. Optimal number of lags is chosen by Akaike's final prediction error criterion. The values shown in the Table denote the t-statistics of X_{t-1} ($X_t = \ln Y, \ln K, \ln L, \ln G/Y, \ln M2, \ln M, \ln X$).
* The null hypothesis of the unit root is not rejected at 5% level of significance.

Hsiao's criterion requires stationarity. Evaluating empirically the time series properties of the variables means in essence that: (i) we examine whether the variables involved are integrated of order one, $I(1)$, so that their changes are stationary, and (ii) we test for cointegration, as regressions involving integrated variables are spurious in the absence of cointegration.

To test the level of integration of the variables that appear in the growth equation, the Dickey–Fuller (DF) and the augmented Dickey–Fuller (ADF) tests are used. They are t tests and rely on rejecting the hypothesis that the series is a random walk in favour of stationarity. A negative and significant test statistic points towards a stationary series. For the variables contained in the growth equation, $(\ln Y, \ln K, \ln G/Y, \ln M2, \ln M, \ln X)$, we are unable to reject the unit root hypothesis at even the 10% level. On taking, however, first differences, these series strongly reject the unit root at the 5% level, thus confirming that the data set contains seven $I(1)$ variables (the results are reported in Table 1).

IV. THE MAIN RESULTS

The estimates based on time-series data for Greece cover the full 1948–94 period. Since, however, the first nine observations of total investment were used to compute the capital stock, regressions were run for the period 1956–94. Annual rates of growth are approximated by first differences of the logarithms of the corresponding variable values for successive years. All variables have been deflated by the GDP deflator and are expressed in constant 1985 drachmas. The computation of the capital stock, the nature of the variables and sources of data are reported in the appendix.

Table 2. *Regression results (dependent variable: rate of growth of real GDP)*

	Estimated coefficient (t-statistic)	
Variable	Equation 1	Equation 2
Constant	–	0.01 (1.18)
Labour	0.72 (2.10)	0.86 (1.98)
Capital	0.39 (2.02)	0.30 (2.13)
Total government size	– 0.18 (2.95)	–
Nonproductive government size	–	– 0.27 (2.41)
Real money balances	0.24 (3.84)	0.21 (2.86)
Exports	0.04 (1.52)	0.02 (1.28)
Imports	0.17 (5.70)	0.17 (4.36)
$\bar{R}^2$	0.83	0.87
$Q(15)$ – (significance level)	13.80 (0.54)	10.90 (0.76)
DW	1.77	1.83
F (6, 26)	14.30	13.10
RESET, $F(1, 25)$	2.60	2.40
$LM_N, \chi^2(2)$	1.50	1.50
$LM_H, \chi^2(1)$	0.70	0.50

Notes: White heteroscedasticity consistent t-statistics are shown in parentheses. $\bar{R}^2$ is the coefficient of multiple determination adjusted for the degrees of freedom; DW is the Durbin–Watson statistic; F is the regression F-statistic. Ramsey's RESET tests of the functional form were carried out by including the square of the predicted values of each regression as additional explanatory variables. F values are reported above for the tests of the (joint) significance of the additional regressors. In no cases are the additional regressors significant at the 5% level.

The Lagrange multiplier statistics for normality, LM_N, and homoscedasticity, LM_H, proposed by Jarque and Bera, are distributed as χ^2 under the null hypothesis of normality and homoscedasticity. It is shown that LM_N is below its critical value, $\chi^2(2, 0.1) = 4.61$, indicating that we cannot reject the hypothesis that the residuals are normally distributed. Similarly, LM_H is below its critical value, $\chi^2(1, 0.1) = 2.71$, indicating that we cannot reject the hypothesis of homoscedasticity. The sum of the two Lagrange multiplier statistics is also below its critical value, $\chi^2(3, 0.1) = 6.25$, indicating that we cannot reject the joint hypothesis of normality and homoscedasticity.

Q-statistic is the Ljung–Box Q statistic, which is treated as a chi-square and provides a test for general serial correlation of the residuals.

The general idea of including government spending as a separate argument in the production function – see Equations 1, 10 and 16 – is that private inputs (capital, labour) are not a close substitute for public inputs. The proxy usually employed for public inputs is government consumption expenditures which exclude public investment and transfers but include expenditures on defence and education. Barro (1990) criticizes the inclusion of any category of government consumption spending in the production function, except for spending on defence and education, on the grounds that it is only the last two items that affect investment and growth. He draws a line between productive government spending (on defence and education) and nonproductive government spending (on the remaining items) and adduces empirical evidence that an increase in resources devoted to nonproductive (but possibly utility-enhancing) government services is associated with lower per capita growth.

At the preliminary stages of analysis, we shall deal with both forms of government expenditures. Estimations will be done with ordinary least squares (OLS) and also on the premise of a first-order autoregressive disturbance term (AR1). However, the AR1 estimates will not be reported since the autoregressive parameters were found statistically insignificant at the 10% level. All the standard errors were computed using White's heteroscedasticity-robust procedure.

The most important points that emerge from the estimates, as reported in Table 2, are the following:

Labour, capital, government size, money and imports appear to be the most important determinants of growth. In both regressions, the coefficients of these variables were found statistically significant, regardless of the definition of government size employed. The only variable that turned out to be insignificant is exports. Government size appeared to be negatively correlated with growth and this result is insensitive to the specification. The overall fit of the regression is quite good and the regressions explain up to 87% of the variability of the growth rate. The rest of this section describes with greater detail the results obtained for the main variables.

Estimates of the coefficient of government size are negative and statistically significant at least at the 2% level in every case. Accordingly, it is fair to conclude that the externality effect of government size on private-sector output, and hence on economic growth, is negative, irrespective of whether nonproductive or total government consumption spending is contemplated: a 10% increase in the growth rate of the government consumption/GDP ratio leads to a slowdown in economic growth by 1.8–2.7%. This result is consistent with a pro-free market view that an expansion of public-sector activities hinders growth. It is not, however, a solid foundation for strong conclusions because government investment and transfers are not included in the definition of government size, whereas government consumption *per se* might help increase economic welfare even when it retards economic growth.

There are a number of channels through which government size affects growth negatively in Greece. An increase in government consumption tends to increase the amount of distortionary taxation, and hence to reduce growth. The distortions in resource allocations associated with the excess burdens and disincentive effects generated by rising taxation are likely to offset the positive effects of the government sector growth. Moreover, government consumption does not seem to be complementary to private sector investment; it rather induces a crowding out of the latter because a higher government share in GDP, in addition to being detrimental to efficiency – economic regulation, bureaucracy, rent-seeking activity, problems in eliminating inefficiency and rewarding productivity in the production of collective goods, and so on – does lead to a higher income tax rate. Since individuals retain a smaller fraction of their returns from investment, they have less incentive to save and invest.

The contribution of labour and capital to the total for both of them was about two-thirds and one-third, respectively, which is what we have come to expect on the basis of a number of studies that have assumed constant returns to scale. For example, in the first equation (Table 2), labour's share of the total returns to scale was 65% while, in the second equation, it was 74%. In considering production under constant returns to scale, we assume that the sum of the elasticities with respect to all inputs is equal to unity, and hence the value-shares of inputs in the value of output sum to unity. In strictly interpreting the Cobb–Douglas production function, labour and capital are the main inputs that are allowed to enter the growth equation. Therefore, testing in such a context for the assumption of constant returns to scale is equivalent to re-estimating the growth equation, under the restriction that: (i) the sum of the coefficients on labour and capital equals unity, and (ii) the sum of the coefficients on the remaining variables equals zero. The corresponding $\chi^2(1)$ test-statistic is 0.04 (0.12) for the first (second) equation, indicating that the null hypothesis of constant returns to scale cannot be rejected – with one degree of freedom, the critical value of the 5% level is 3.84.

Should, however, real money balances be classed as one of the factor inputs in the production function, a modest degree of increasing returns to scale is exhibited in both equations. Therefore, assuming that money is a producer's good, it can be plausibly maintained that the Greek economy functions under increasing returns to scale.

Lastly, the weak – though positive – relation between exports and growth does not seem to substantiate the argument of export externality effects. Since, however, it has been found that: (i) exports cause imports, which in turn cause income, and (ii) the impact of exports on growth weakens when imports are included in the growth equation, there is a strong reason to believe that the foreign exchange constraint may have been binding; that is, the growth of exports lessens the foreign exchange constraint, thereby facilitating imports of capital goods and faster growth.

Before embarking on a more detailed analysis of the growth determinants, it would be advisable to evaluate the validity of our assumed functional form against one possible alternative, the CES production function, by applying Kmenta's (1967) test. The result of the test indicated the appropriateness of the Cobb–Douglas hypothesis for our data. The results were:

$$\ln Y = -6.8 + 1.04 \ln L + 1.11 \ln(K/L) - 0.02 \ln(K/L)^2$$
$$\quad\ \ (0.9) \qquad (13.2) \qquad\qquad (4.4) \qquad\qquad\qquad (1.1)$$
$$\bar{R}^2 = 0.997, \mathrm{DW} = 1.85, Q(15) = 7.1$$

The coefficient of the last term is statistically insignificant and equal to $-0.5\rho\gamma\delta$, where ρ is a substitution parameter, γ a scale parameter and δ a distribution coefficient. The coefficient of $\ln(K/L)$ – defined as $\gamma\delta$ – is significant. Therefore, $\rho = 0$ and the elasticity of substitution $\sigma = 1/(1+\rho) = 1$. Interestingly, $\gamma = 1.04$ which indicates constant returns to scale.

V. SOME EMPIRICAL IMPLICATIONS

The estimated coefficients of the augmented growth equation can easily be used to compute, on the basis of the relations of Equation 17, the elasticities of labour, capital and government spending with respect to the private-sector output. The values of these coefficients, however, are not sufficient to yield estimates of δ and λ, which indicate the intersectoral factor productivity difference and the ratio of government-sector output to private-sector output, respectively.

As is evident from the relationships (11) and (12), estimates of δ and λ can only be obtained after the determination of the elasticities of capital and labour with respect to the government output – i.e., values of α' and β' in Equation 9 – probably through a process similar to the one employed for the estimation of the parameters α and β in Equation 10. A meaningful replication of such a process, however, must be based on an argument at least as strong as the one, that justified the inclusion of government spending in the private sector production function. In other words, it should be assumed that positive externalities are derived for the government sector from the growth of the private sector.

Various explanations can be put forth to justify inclusion of the private-sector output as an explanatory variable in the government-output production function. For instance, incentives for technological improvements and efficient management techniques of the private sector can be diffused into the public sector; productivity increases made possible through the realization of economies of scale in the private sector exert pressures on public officials for adopting methods and practices capable of inducing the government sector to keep pace with innovations in the private sector; experienced personnel of the private enterprises can be properly utilized by the government to transplant advanced pricing strategies, asset administration systems and modern organizational models into the public sector; and a faster private-output growth results in a broader tax base, and hence increased tax revenue for financing public spending programmes.

Should the hypothesis of externalities running from the private sector to the government sector be accepted, Equations 9 and 10 would take the following form:

$$G = BL_g^{\alpha'} K_g^{\beta'} C^{\gamma'} \qquad (9')$$

$$C = AL_c^{\alpha} K_c^{\beta} \qquad (10')$$

From Equation 11 we get

$$\frac{C}{G} = \frac{1}{\lambda(1+\delta)} \qquad (11')$$

or

$$Y/G = \frac{1+\lambda(1+\delta)}{\lambda(1+\delta)}$$

By substituting the government-sector production function (9′) into (11′) and using Equation 14, the following approximation for an aggregate output equation can be derived:

$$Y = B' L^{\alpha'} L^{\alpha'} K^{\beta'} C^{\gamma'} \qquad (15')$$

where

$$B' = B[1+\lambda(1+\delta)/\lambda(1+\delta)] \times [\lambda\alpha'/(\alpha+\lambda\alpha')]^{\alpha'} [\lambda\beta'/(\beta+\lambda\beta')]^{\beta'}$$

Dividing Equation 15′ through by $Y^{\gamma'}$ and taking the total differential of the corresponding log linear form yields:

$$d\ln Y = \beta_0 + \beta_1 d\ln L + \beta_2 d\ln K + \beta_3 d\ln(C/Y) \qquad (16')$$

where

$$\beta_0 = \frac{d\ln B'}{1-\gamma'} \quad \beta_1 = \frac{\alpha'}{1-\gamma'} \quad \beta_2 = \frac{\beta'}{1-\gamma'} \quad \beta_3 = \frac{\gamma'}{1-\gamma'} \qquad (17')$$

To maintain comparability with the estimates reported in Table 2, three additional variables (growth rates of real money balances, exports and imports) are also included in Equation 16. Furthermore, to simplify matters, the private size, C/Y, is estimated as the difference of the nonproductive government size from unity. Thus, from now on, the results of the second equation in Table 2 will be used as the basis of the analysis.[6]

The augmented form of Equation 16′ is estimated using the same data set and the same period and methodology as those used in estimating the augmented form of Equation 16. The results are:

$$\begin{aligned} d\ln Y = {} & \underset{(0.34)}{0.01} + \underset{(1.92)}{0.28} d\ln L + \underset{(2.34)}{0.36} d\ln K + \underset{(2.18)}{0.43} d\ln(C/Y) \\ & + \underset{(2.89)}{0.26} d\ln M2 + \underset{(3.85)}{0.18} d\ln M + \underset{(1.26)}{0.06} d\ln X \end{aligned} \qquad (18)$$

$$\bar{R}^2 = 0.84, \quad DW = 2.01, \quad Q(15) = 8.7, \quad SEE = 0.02$$

The OLS regression results for Equations 16 and 16′ could, at a first approximation, be used for assessing the values of the intersectoral factor productivity difference (δ), the marginal externality effect of government size (α_3) on economic growth and the ratio of government-sector output to private-sector output (λ). These results, however, will not be useful in making broad judgements on the overall pattern of the interrelationships because λ enters, along with other parameters, into the constant term of Equations 16 and 16′ – see relations 17 and 17′ – even though the government output/private output ratio varies over time. Indeed, this ratio was 24% in 1950, but climbed up to 40% in 1985 (36% in 1993), showing an impressive 67% increase in a 25-year period. As standard regression methods fail to account for this kind of intercept, the Kalman filter will be used in the rest of the analysis to give more reliable estimates of the coefficients of Equations 16 and 16′.

[6] The simplest criterion for a comparison of the models in a statistical sense is the 'goodness of fit' of the two equations to the data. It is easy to see from Table 2 that this criterion favours Equation 2 over Equation 1, as adjusted R^2 for Equation 1 is lower than for Equation 2.

Table 3. *Kalman-filtered coefficient estimates of the growth equations*

Variance	Intercept	$d\ln K$	$d\ln L$	$d\ln(G/Y)$	$d\ln M2$	$d\ln M$	$d\ln X$	$d\ln(P/Y)$
Constant	0.33	0.27	0.55	– 0.17	0.15	0.11	0.02	–
Increasing at 2%	0.38	0.32	0.61	– 0.23	0.05	0.17	0.06	–
Increasing at 5%	0.49	0.35	0.69	– 0.30	0.01	0.25	0.14	–
Declining at 2%	0.31	0.25	0.52	– 0.10	0.25	0.03	0.05	–
Declining at 5%	0.16	0.22	0.48	– 0.08	0.39	0.03	0.10	–
Constant	0.33	0.31	0.17	–	0.18	0.12	0.01	0.28

VI. THE MAIN KALMAN-FILTERED RESULTS

To initialize the Kalman filter, we need to start out at the beginning of the sample providing presample values for the initial state vector (and the initial covariance matrix of the states). In the present context, this amounts to setting a prior mean of one for the intercept and zero for all other variables in each of the two augmented growth equations. Furthermore, a random walk assumption for time variation is adopted throughout. The covariance matrices of the state variables and the state transition covariance matrices (covariance matrices of the changes in the coefficients) are set to initial values, both based upon covariance matrices from the corresponding OLS regressions. A key factor in the Kalman-filtering process is the values assigned to:

(i) The variance of the change in the state vector; if, for example, it is equal to zero, then there is no time variation.
(ii) The variance of the observation equation.

To broaden the scope of analysis and account for a wide range of possible parameter estimates, the following alternative assumptions will be made with respect to the variance of the observation Equation 16: (i) it remains constant; (ii) it increases at the rates of 2% and 5%; and (iii) it declines by 2% and 5%.[7] The estimation results are given in Table 3.

It is worth recalling that each step of the Kalman filter algorithm does sequential updating of coefficient estimates, so that estimates at each step should be interpreted as full coefficient vectors at each point in time. Given that we have applied the Kalman filter to the full sample period, ending in 1994, the coefficient estimates that appear in Table 3 correspond to the parameter values of the growth equations in the last year of the sample period.

Table 3 displays a pattern which is quite similar to that in Table 2, except that:

(1) The intercept takes on a much higher value, as a result of the hypothesis that one of its constituent components – the ratio of government output to private output – rises through time.
(2) The externality effect of government size on economic growth remains negative in all cases but its magnitude varies, depending on the assumption underlying the behaviour of the variance. In particular, the negative impact becomes stronger (weaker) as the variance increases (declines), following an expanding (contracting) public sector. Furthermore, the larger (lower) the rate of growth of the variance, the stronger (weaker) will be the negative impact of government size on economic performance.

The coefficient estimates of Equations 16 and 16′ for 1994, as reported in Table 3 and derived under the assumption of a constant positive variance, along with the ratio of government output to private output in 1994, $G/C = 0.362$, will be used to evaluate the intersectoral factor productivity difference and a number of other crucial determinants of the growth process in Greece.

When economic growth is made a function of government size – augmented form of Equation 16 – the elasticities of output with respect to labour, capital and government spending are derived from the set of relationships (17) and are equal to: $\alpha = 0.67$, $\beta = 0.33$ and $\gamma = -0.21$, respectively. On the other hand, if economic growth is made a function of the private sector size – augmented form of Equation 16′ – the corresponding elasticities are estimated on the basis of the relationships (17′) and are equal to: $\alpha' = 0.13$, $\beta' = 0.24$ and $\gamma' = 0.22$

From Equation 12, $\lambda = \beta K_g/\beta' K_c$, the value of λ can be easily assessed, provided that the total capital stock can split up into its constituent parts: capital used in the production of private output and government output. The National Accounts data for government investment and private investment are utilized to produce estimates of government capital and private capital. To this end, the procedure described in the appendix for estimating total capital is employed. The ratio of government-sector capital to private-sector capital is found to be 0.70 for the last year of the sample period. Therefore, $\lambda = 0.96$ and, consequently, the value of the intersectoral factor

[7] For simplicity, the assumption of a constant variance will be adopted for the observation Equation 16′.

Table 4. *Regression results for the augmented form of Equation 19*

	Constant	$d\ln L$	$d\ln K$	$d\ln(T/Y)$	$d\ln(DEF/Y)$	$d\ln M2$	$d\ln M$	$d\ln X$
OLS estimates	0.01	0.65	0.28	− 0.004	− 0.04	0.27	0.20	0.009
(t-ratios)	(0.49)	(1.89)	(2.21)	(0.82)	(2.47)	(2.86)	(3.49)	(0.46)
Kalman-filtered estimates	0.33	0.53	0.26	− 0.003	− 0.03	0.19	0.13	0.003
$\bar{R}^2$ 0.813,		DW 2.02,		$Q(15)$ 8.20				

productivity difference, estimated on the basis of Equation 11 − $G/C = \lambda(1+\delta)$ − is equal to $\delta = -0.62$ in 1994. This is equivalent to saying that the marginal product of the factors of production employed in the government sector accounts for only 38% of their marginal product in the private sector. On the other hand, the ratio of the government-sector employment to the private-sector employment is found to be 0.19, according to Equation 13. This means that a portion equal to 16% of the total labour force is employed in the public sector.

The main focus of all previous studies, dealing with the potential role of the government in the growth process, has been on obtaining an estimate of the overall effect of government size on growth. The broad strategy, therefore, has been to consider the estimated coefficient of some measure of government size to assess directly the overall effect. In none of the specifications developed so far does the budget constraint appear as a binding factor in formulating government behaviour. In other words, the methods of financing a given stream of government expenditure are not taken into consideration when trying to highlight the contribution of the public sector to the dynamics of growth. The hypothesis advanced is that government expenditures financed by tax revenue affect growth in exactly the same way as government expenditures financed by bond issuance.

There is a voluminous theoretical literature on the controversy over whether demand, income and other important macrovariables are sensitive to the choice of tax versus debt financing of government spending; see, for example, Leiderman and Blejer (1988), Kormendi and Meguire (1990) and Dalamagas (1992). The two competing views (known as Ricardian equivalence proposition and traditional view) on this issue have been adequately analysed and tested in previous studies and will not be reported here. However, the question remains open of whether it is the tax collection mechanism or the debt accumulation policy that should bear the blame for the distortionary effects of an expanding public sector on economic growth in some countries. The brief empirical investigation that follows will attempt to distinguish those features of fiscal policy and decison-making that facilitate (or are neutral to) growth from those features that serve to hinder growth.

Starting with the flow budget constraint of the government sector, $G = T + DEF$, where T = tax revenue and DEF = budget deficit, and substituting the last identity into Equation 10, we end up with a relationship, showing the growth rate of GDP as a function, *inter alia*, of the growth rates of the shares of both tax revenue and budget deficit in GDP:[8]

$$d\ln Y = \gamma_0 + \gamma_1 d\ln L + \gamma_2 d\ln K + \gamma_3 d\ln(T/Y) + \gamma_4 d\ln(DEF/Y) \qquad (19)$$

Table 4 contains OLS estimates and Kalman-filtered estimates for the augmented form of this equation.

As shown in Table 4, the coefficient of the tax/GDP ratio, though negative, is not significantly different from zero in any of the two formulations. In contrast, estimates of the coefficient of the deficit/GDP ratio are negative and statistically significant. It thus seems fair to conclude that the government-induced adverse effects on economic performance should not be attributed to the size of the public sector *per se*, but to the fiscal authorities' practice of financing a continuously increasing portion of public outlays by debt, rather than by taxation (especially in the post-1979 period).

A full investigation of the channels through which a debt-financed expansionary fiscal policy may adversely affect growth, is not pursued here, but a negative externality effect can be explained along the lines suggested by the traditional and probably still predominant view: the growth and persistence of fiscal deficits tend to stimulate consumption demand (especially for imported goods in the case of Greece), trigger off inflationary pressures in the market place, raise interest rates and crowd out private investment.

To corroborate the argument that a debt-financed fiscal expansion may seriously damage the growth potential, we make the coefficients on the right-hand side variables of (the augmented form of) Equation 16 interactive with the ratio of government debt to GDP. Following Burdekin

[8] In our estimation, we used the first-order term of the approximation $\ln(x+y) = \ln 2 + 0.5(\ln x + \ln y) + 0.125(\ln x - \ln y)^2 + , \ldots,$ where $x = T/Y$ and $y = DEF/Y$.

Table 5. *Estimates of the coefficient on government size with assigned values for the debt/GDP ratio*

	Ratio of government debt to GDP		
	At one standard deviation below the mean $B/Y = 0.037$	At its mean level $B/Y = 0.250$	At one standard deviation above the mean $B/Y = 0.462$
Effect of government size on economic growth	0.045	– 0.206	– 0.457

(1988), the response of economic growth to its main determinants is taken to be interactive with the above ratio. Accordingly, each explanatory variable of the growth equation is placed alongside a corresponding interaction term in the estimation giving a compound variable. Equation 16 then takes the form:

$$d\ln Y = a_0 + a_{11} d\ln L + a_{12}(B/Y) d\ln L + a_{21} d\ln K + a_{22}(B/Y) d\ln K + a_{31} d\ln(G/Y) + a_{32}(B/Y) d\ln(G/Y) \quad (20)$$

Since the results obtained from estimating Equation 20 consist of a large array of coefficients (that are available on request), interpretation is necessarily complicated. To simplify matters, we consider the case in which the debt/GDP ratio is assigned values of one standard deviation above and below the mean, together with that of the mean itself. As the main interest lies in the overall response to government size, the coefficient on the interaction term $(B/Y) d\ln(G/Y)$ is muliplied by the given level of the debt/GDP ratio and then added to the simple $d\ln(G/Y)$ coefficient, to obtain the figure for the overall response to government size. The results of these calculations are given in Table 5.

Table 5 conveys, although in a different form, the same message as Table 4: at one standard deviation below the mean for the debt/GDP ratio, there is a positive (though limited) response of economic growth to the increase in government size. As, however, public indebtedness rises, an expanding government output will increasingly lead to misallocation of resources, serving to offset totally the positive aspects of government.

VII. CONCLUDING REMARKS

The main objective of this study has been to investigate the relationship between output and government size using time-series data on Greece. Capital and labour – along with money balances, exports and imports – were also included in the analysis to capture other likely sources of growth. The estimated equations, based on a Cobb–Douglas production function, suggest that an increase in government size has adverse effects one economic growth, due mainly to the increasing importance of debt accumulation as a means of financing government activities. In particular, the overall impact of government size on growth – and hence the externality effect – is negative and marginal factor productivity in the government sector is lower than the productivity in the rest of the economy.

In exploring the role of government size in order to identify possible channels, through which macroeconomic policy influences growth, it seems clear that the conventional engines of development (investment, human capital, exports, technological progress etc.) are not sufficient for achieving sustained growth. The debt crisis, reinforced by macroeconomic mismanagement and the subsequent stabilization attempts in Greece, shows that restoring a normal growth pace goes beyond modernizing the private sector. In particular, the distortionary effects attendant on government provision of goods and services must be first eliminated via a process of decreasing the public sector's component of GDP and revising the methods of financing government expenditure.

It should be emphasized that the intention in this paper was not to derive a growth model of the Greek economy. The thrust of the objective was rather to study the long-run properties of the main growth-generating forces and to focus primarily on the crucial role played by government intervention. Incorporating the results in recent theories of endogenous growth is an attractive feature on which to build.

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APPENDIX

The sources of the variables used in this study are as follows:

(i) Gross domestic product, government consumption, total investment, exports, imports, fiscal deficit, GDP deflator, money balances (M2), population, unit value of exports and unit value of imports are from IMF, *International Financial Statistics*. As in several other studies, the rate of population growth is used in place of the rate of increase in labour input. Although not really a good proxy in some cases, use of population growth does have some advantages. Good time-series data on labour force, covering the whole sample period, do not exist for Greece but data on population are fairly good.

(ii) Government investment and government consumption on defence and education are obtained from the National Accounts of Greece, National Statistical Service of Greece (NSSG).

(iii) Goverment debt comes from the Macroeconomic Series of the Greek Economy, Bank of Greece.

(iv) The calculation of the aggregate capital-stock series is based on the solution to the difference equation

$$K_t = (1-\rho)K_{t-1} + I_t \qquad (A1)$$

where ρ is the rate of depreciation.

Following Haque *et al.* (1990), Equation A1 is rewritten in log form:

$$\ln K_t = \ln\left[\sum_{i=0}^{t-1}(1-\rho)^i I_{t-i} + (1-\rho)^t K_0\right]$$
$$\approx \ln 2 + 0.5\ln\sum_{i=0}^{t-1}(1-\rho)^i I_{t-i} + \frac{t}{2}\ln(1-\rho) + 0.5\ln K_0 \qquad (A2)$$

where K_0 is the initial capital stock.

The approximation used was

$$\ln(x+y) \approx \ln 2 + 0.5(\ln x + \ln y) + 0.125(\ln x - \ln y)^2 + \ldots, \qquad (A3)$$

where $x = \sum_{i=0}^{t-1}(1-\rho)^i I_{t-i}$ and $y = (1-\rho)^t K_0$.

In the estimation process:

- the first order term of Equation A3 was found to be adequate,
- the term $0.5\ln K_0$ of Equation A2 was added to the intercept of the growth Equation 16,
- the growth equation was estimated for different values of ρ over the interval (0,1). The optimal value of ρ is the one which maximizes $\bar{R}^2$ in the growth equation. The optimal rate of depreciation was found to be 3%, which is close to the figure calculated by other researchers.