PUBLIC EXPENDITURE AND NATIONAL INCOME:

Time series evidence from Greece

by

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Abstract

The paper investigates the existence and nature of long-run relationships between Greek national income and four categories of public expenditure. Our results suggest that there exists a positive long-run relationship between GDP on the one hand; and public expenditure and "productive" public consumption on the other, with causality running both ways. There appears to be no long-run relationship between GDP and public-sector personnel expenditure; and GDP and public-debt service expenditure. From that point of view, it would appear that in terms of output growth, the fiscal policy followed by Greece during the 1975-1990 period has rather been ineffective.

JEL Classification: E0, E6.

Keywords: Fiscal policy; GDP; Public expenditure; Cointegration, Weak exogeneity/causality

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1. INTRODUCTION

The link between public expenditure and economic growth has attracted considerable interest on the part of economic researchers both in the theoretical as well as in the empirical level. Roughly speaking, one may distinguish between two opposing views: On the one hand, there is the Keynesian approach according to which government spending is an important policy tool to be used to ensure a reasonable level of economic activity; correct short-term cyclical fluctuations in aggregate expenditure (Singh and Sahni, 1984); and secure an increase in productive investment, thus providing a socially optimal direction for growth and development (Ram, 1986). The opposite view is that excessive state intervention in economic life affects growth performance in a negative way for two reasons: First, because government operations are often conducted less inefficiently, hence they reduce the overall productivity of the economic system; and second because excessive government expenditure (usually accompanied by high taxation levels) distorts economic incentives and results in sub-optimal economic decisions (see e.g. Barro 1990 and King and Rebelo 1990). On the basis of the above, it is clear that in terms of designing economic policy, the question as to where exactly the truth lies is an important one. Empirical evidence on the subject is mixed. Studies like the one by Ram (1986) conclude that the overall impact of government size on economic growth is positive. On the other hand, studies like the ones by Barro (1990 and 1991) reach the opposite conclusion.

This paper aims to shed some further empirical light on the issue of public expenditure's ability to promote economic growth by focusing on the experience of a small, open economy, namely the one of Greece. The latter is a particularly interesting

case study because it experienced a major increase in public expenditure during the period 1975-1990[1]. The additional spending undertaken by Greek authorities was partly financed through higher taxation revenue but the its main part was financed though increased government borrowing. As a result, Greek budget deficit and public debt (in terms of percentage in GDP) recorded significant increases (see Figures 1 and 2). Figure 3 reveals the nature of the extra government spending. Its biggest part was devoted to higher personnel wages and, as public debt was increasing, expenditure for servicing public debt (i.e. amortization and interest payments). In this paper we aim to acquire insights regarding the output effects of these fiscal developments by means of examining the existence and nature of long-run relationships between Greek national income and the categories of public expenditure represented in Figure 3. The remainder of the paper is organized as follows: Section 2 outlines the theoretical background on which our empirical analysis is based. Section 3 presents the methodology used and our econometric results. Section 4 discusses the post-1975 fiscal policy of Greece in the light of the results obtained in section 3. Section 5 summarises and offers some concluding remarks.

2. THEORETICAL BACKROUND

The long-run relationship between real output and public expenditure has attracted considerable attention in economic research. In particular, the ability of public expenditure to influence national income is questioned in two levels. First, the nature of the causality pattern is disputed: a number of public finance studies adopt the Wagner's law approach which states that national income causes public expenditure,

[1] For an overview of recent fiscal developments in Greece see Christodoulakis, 1994.

mainly through an increase in demand for public services. Within this framework, public expenditure is treated as a behavioural variable, similar to private consumption. On the other hand, a number of macroeconomic models adopt a view closer to the Keynesian doctrine according to which public expenditure is an important policy tool able to influence the level of equilibrium output. As Singh and Sahni (1984 p.630) argue, if the causality pattern were Wagnerian, public expenditure is delegated to a passive role, if Keynesian it acquires the status of an important policy variable.

Second, even if we exclude the possibility of a causality pattern running from national income to public expenditure, it is not quite clear that increased public outlays will have lasting positive output effects. Postulating a fixed level of taxation revenue, authorities have two options to finance a higher level of public expenditure: either to monetize (accommodate) or/and to bond-finance the expansion. Under a medium-term upward-sloping aggregated supply schedule, the output implications of the fiscal expansion would have to be studied within a Barro-Gordon (1983) set-up. Money-financed deficits would cause positive output effects only if they remain unanticipated by the private sector. Repeated and predictable monetary accommodation of deficits would result in a higher inflation rate without any long-run output gain. By resulting in a higher inflation rate, money-financed budget deficits could then imply real costs for the economy through the well-documented real costs of inflation. On the other hand, bond-financed public expenditure may involve expansionary effects of a more lasting nature provided that the anticipation of future interest payments causes positive wealth effects on current and future consumption (see e.g. Blinder and Solow, 1973). However, such outcomes may be mitigated by crowing-out effects which can take place through two channels. First, through portfolio effects: an

increase in the stock of bonds may necessitate a similar increase in interest rates to maintain equilibrium in the bonds' market. Such an increase may imply a shift of the LM curve (to the left), which could reduce the expansionary impact of the bond-financed deficit. Second, through an upwards-sloping aggregate supply curve: given a certain level of nominal money, increasing prices caused by a fiscal expansion would lead to a reduction in real money stock. That would cause an increase in interest rates and negative wealth effects reducing private investment and consumption. By causing an increase in interest rates, bond-financed deficits may actually result in a worse inflation performance than money-financed deficits in the lines suggested by Sargent and Wallace (1981)[2]. Finally, a bond-financed budget deficit would have no expansionary effects at all (not even in the short-run) if the Ricardian Equivalence hypothesis were valid[3].

More recently, the role of public expenditure as an output-promoting control variable has been highlighted in the framework of the endogenous growth literature pioneered by the seminal papers by Romer (1986) and Lucas (1988). Endogenous growth models postulate that the economy's output is conditioned not only on the level of physical capital and labour stock (as it was the case in Solow's (1956) neoclassical growth model) but also on additional production factors which may enter the production function with constant returns to scale *alone*. If this is the case, returns on

[2] A substantial increase in interest rates leads to a violation of the government's solvency condition, in which case the central bank is expected to increase seignorage revenue in the future. The increase in expected inflation may then lead to an increase in actual inflation.

[3] However, empirical evidence in favour of the Ricardian Equivalence hypothesis is at best mixed (see e.g. Poterba and Summers, 1987) and the validity of the views expressed by its supporters have been questioned on various grounds. First, the Ricardian equivalence hypothesis is based on the assumption of a tax system involving lump-sum taxation. Second, in reality, tax-payers have finite life horizons and may not want to leave bequests to future generations. Third, there are agents who face borrowing constraints and, in the event of a reduction in taxation (causing a bond-financed deficit), would prefer to increase their consumption instead of their savings. Finally, agents may not be perfectly rational and may not be able to grasp the future implications of increased pubic borrowing.

investment on such production factors need not diminish as the stock of the latter increases, and growth differences among nations may persist indefinitely if the rate of accumulation of the specific productions factor differs from country to country[4]. A number of variables have been proposed to exhibit constant returns to scale alone with spending on public infrastructure being one of them (see Aschauer, 1989). Public expenditure on education may also improve growth performance by promoting human capital accumulation (see e.g. Mankiw *et al*, 1992). Finally, both public expenditure on education and public expenditure on infrastructure may be responsible for the creation of positive externalities with potentially important output implications. However, the endogenous growth models framework has also been used to highlight possibly harmful effects of excessive government spending. For example, it has been suggested (see King and Rebelo, 1990) that if increased public expenditure is financed through higher taxation the economy may end in a "development trap" and pay a significant welfare cost as a result of distortions affecting economic incentives. A similar result is reached by Barro (1990) who argues that tax-financed increases in "non-productive" public expenditure lowers the economy's saving rate and, ultimately, the economy's equilibrium growth rate.

3. METHODOLOGY, DATA AND EMPIRICAL RESULTS

In this section we investigate the existence of a long-run relationship between real Greek GDP on the one hand; and a set of Greek public expenditure categories expressed in real terms on the other[5]. We consider four categories of budget outlays: public investment expenditure (GI); personnel expenses (W); public debt service

[4] For a review of endogenous growth theory see, among others, Barro and Sala-i-Martin (1995).

expenditure i.e. interest and amortization payments (GC-B); and the remaining part of public expenditure (GC-P). This fourth category roughly corresponds to "productive" public consumption (as opposed to what Barro (1991) defines as "non-productive" public expenditure) and includes agricultural grants; tax rebates; industrial and other corporate subsidies; payments for corporate loans whose repayment the Greek state has guaranteed; "third-parties revenue rebates"; payments to EU; and "remaining expenditure". Our analysis is based on annual data taken from the data bank of the Bank of Greece. Our sample covers the period 1960/1998, a total of 39 observations[6]. Our econometric approach follows a two-step logic: First, we investigate the existence of a long-run relationship between the logarithms of each of the four government expenditure categories and the logarithm of real Greek GDP. Second, for those cases for which the cointegration hypothesis is not rejected, we undertake weak exogeneity analysis in order to get indications regarding the direction of causality in the Granger sense[7].

We start by investigating the stationarity properties of the variables involved in the analysis using the (Augmented) Dickey-Fuller (1979) unit root tests. As far as the logarithms of the variables are concerned, we tested the null hypothesis of non-stationarity against the alternative that the series are trend-stationary. The estimated

[5] We compute real values by means of dividing nominal values by the consumer price index. The data source for the latter is the IFS databank provided by Datastream.

[6] It is clear that since our analysis makes use of a certain number of asymptotic tests (see below), a bigger sample would be preferable. However, we have little choice than to work within the limitations imposed by our data set and interpret our results with the appropriate caution.

[7] A comment regarding the limitations of the Granger causality analysis is due here. Granger's definition of causality suggests that if past and present values of y_t provide useful information to forecast x_{t+1} at time t, then it is said that y_t Granger causes x_t. From that point of view, strictly speaking, a better term for Granger causality would be *precedence*. Hence, the term "Granger causality" should not be used unconditionally to imply causality in the sense the latter is commonly understood (see Maddala and Kim, 1998). In particular, in the framework of bivariate analysis, Granger causality analysis may well lead to spurious causality results as a result of the omission of other variables. However, if Granger causality analysis is undertaken in a bivariate framework supported by theoretical

ADF statistics suggested that all variables include a unit root. In contrast, their first differences appear to be stationary[8]. We proceed by applying Johansen's (1988) cointegration methodology. Since the latter is widely used in empirical research, we will not discuss its technical characteristics here. As a first step, the order of the underlying VAR models to be used in the cointegration analysis has to be specified. For each category of expenditure, we examined three different lag structures, ranging from one to three lagged values for each variable. In all estimated systems (with the exception of those referring to GC-B) we faced mispecification problems of one form of another, particularly residual non-normality. In order to overcome the problem we tested the statistical significance of a number of dummy variables, aiming to capture the impact of shocks which might be responsible for non-normality. Out of the cases examined, two proved statistically significant. The first, D1974, refers to year 1974 when Greece experienced political shocks of various forms and the international economic environment was still very much affected by the first oil shock. The second, D1980, refers to year 1980, a year that the Greek economy faced another recession and the international economic environment was under the influence of the second oil shock. The inclusion of these dummies as unrestricted variables (not entering the cointegration space) allowed the acquisition of Gaussian errors and yielded well-specified systems (see below)[9].

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background, as it is the case between public expenditure and national income (see section 2 above), one can legitimately use the results (in a cautious way of course) for inference purposes.

[8] Due to space limitations, the results of the ADF tests are not presented here. They are available by the author upon request.

[9] Acquiring Gaussian errors by means of adding dummy variables other than centred seasonal ones may sometimes by costly as the extra dummies will affect the underlying distribution of cointegrating rank statistics. In that case the power of the cointegration tests is reduced and the published critical values will only be indicative (see Harris 1995, p. 81). However, in our case there are two factors which make us believe that our results are robust. First, even without these dummies, the nature of the results of the cointegration analysis which follows remained unchanged. Second, even when the dummies are included in the system, the existence of one cointegrating vector for the cases the cointegration hypothesis is not rejected is statistically significant at the 1% level; whereas the values of the trace and maximal eigenvalue testing for different cointegration ranks are way apart the critical values.

The next issue raised in the process of formulation of the underlying VAR system is whether or not determenistic terms like a constant and a trend should enter the short and/or long-run models. To answer the question, we use the Pantula principle (see Johansen 1992)[10], i.e. a number of joint hypotheses tests testing simultaneously both the number of cointegrating relationships among the variables and the existence of determenistic components. More specifically, for each category of public expenditure considered, three models are estimated. The most restrictive (named Model 2) assumes no linear trends in the levels of the data, i.e. an intercept which is restricted to the cointegration space. The second (named Model 3) assumes the existence of linear trends in the levels of the data, implying an intercept both in the long-run model as well as in the short run model. The two intercepts, when combined, leave only a constant in the short-run model. Finally, the least restrictive model (named Model 4), assumes the existence of some long-run linear growth which the model specification cannot account for, i.e. the existence of a trend term restricted to the cointegration space. The Pantula principle involves the estimation of all three models and the presentation of the results from the most restrictive hypothesis (i.e. r = number of cointegrating relations = 0 and Model 2) through the least restrictive hypothesis, i.e. r = number of variables entering the VAR $-1 = n -1$ and Model 4). The model selection procedure comprises of moving across the rows of the upper half of each Table, from the most restrictive model towards the least restrictive one, and stoping when the null hypothesis is not rejected for the first time.

The results referring to public investment (GI) appear in Table 1; to personnel expenditure (W) in Table 2; to public debt service expenditures (GC-B) in Table 3;

[10] See also Harris, 1995, pp. 96-97.

and to the expenditure category defined as GC-P in Table 4. According to the Pantula principle, for public investment (GI) and the category defined as GC-P both the rank ($l_{\max}$) and the trace (l_{trace}) statistics show that the null hypothesis is for the first time not rejected for r =1 in model 2, suggesting the existence of one cointegrating (positive) relationship between each of these variables and real GDP together with the existence of a constant, restricted in the cointegration space. In the case of personnel expenditure (W) and public debt service expenditure (GC-B) the null hypothesis is for the first time not rejectd for r =0 in model 3, suggesting the absence of cointegration between each of these two variables and GDP. All systems and all individual equations pass the necessary mispecification tests. Finally, for the pair of variables for which the hypothesis of cointegration was not rejected (i.e. GI/GDP and GC-P/GDP), we proceed to weak exogeneity analysis using the long-run weak exogeneity LR tests proposed by Johansen and Juselius (1992). These consist of testing zero restrictions on the elements of the alpha matrix (i.e. the matrix of coefficients of the speed of adjustment to long-run equilibrium) embedded in the estimated Vector Error Correction Model. In both cases the LR test statistics show that none of the variables is weakly exogenous to the system. In other words, the results suggest a two-way causality pattern between GDP on the one hand; and public investment and "productive" public consumption on the other.

4. POST-1960 GREEK FISCAL POLICY: AN ASESSMENT

The results reached in the previous section concerning public investment confirm the validity of the importance and the growth-inducing properties attached to this particular kind of public expenditure. Hence, from a long-run perspective, the

stagnation (or even slight reduction) of the share of public investment in Greek GDP which was observed after 1975 (see Figure 3) and the financing of a number of small and medium-sized projects rather than major infrastructure ones (a fact well-documented in the study by Alogoskoufis and Prodromidis, 1995), may not be considered an optimal fiscal policy choice. In the same spirit, the major public infrastructure projects currently under construction may boost future Greek economic performance.

Turning now to the examination of the results referring to what we have termed "productive" public consumption (GC-P), it appears that in the past, categories of expenditure like industrial and agricultural subsidies or tax rebates have been conducive to Greek economic growth (although causality seems to run both ways). This result is not surprising given that our data sample extends back to 1960, i.e. it includes a long period during which the Greek economy was largely dependent on agricultural production and Greek industrial firms were enjoying preferential subsidies treatment relative to their EU counterparts[11]. In the framework of limited international competition both in the domestic and foreign markets, government expenditure on agricultural and industrial subsidies were giving Greek firms a competitive edge and were boosting Greek national income[12]. Having said that, it would be rather hazardous to jump into the conclusion that such a policy, if applied today, would necessarily be conducive to future economic growth. The truth of the

[11] During the period 1961-1980, Greece was linked to the EU with an Association Agreement which on the one hand allowed her to keep its market relatively close to European products competitive to the products of Greek industries and, at the same time, gave Greek products preferential tariff and quota treatment in the EU markets. When Greece joined the EU in 1981 it was given a transition period extending up to 1989 to bring its industrial policy in line with EU regulations. Hence, for almost a decade after its EU accession, Greece was allowed to grant financial assistance to its industrial firms.

[12] Alogoskoufis (1995) shares this opinion. He terms the economic regime established in Greece after World War II "state corporatism" and argues that in the fifties, sixties and the best part of the 1970s this model of economic organization suceeded in delivering economic development.

matter is that the present international economic environment is much more globalised and Greece is much more open to foreign competition than what it used to be in the 1960s or even the 1980s. There exists evidence indicating that since 1981 the competitiveness of Greek agricultural and industrial products relative to those of Greece's main trading partners has been declining (see Arghyrou, 2000), despite the fact that for much of this period Greek producers retained some form of preferential treatment compared to their foreign competitors in the domestic market. There is no guarantee that state financial assistance alone will be enough to restore the observed competitiveness losses. Hence, our results reached in Section 3 are more relevant in answering questions of the form "did state financial support to domestic firms promote Greek economic growth in the past" rather than "will state financial support to domestic supporters promote Greek economic growth in the future".

To turn now to the remaining two categories of public expenditure, the results reported in Tables 2 and 3 reject the cointegration hypothesis, and consequently, the hypothesis that an increase in personnel wages and public debt service expenditure leads to an increase in Greek national income. From that point of view, it would appear that in terms of output growth, the fiscal policy which was followed after 1975 (whose main characteristic was a significant increase in these two categories) has rather been ineffective. There appears to be little evidence in favour of a Ricardian Equivalence explanation to support this conclusion. In contrast, the post-1975 decline in the share of private investment in GDP suggests that crowding-out effects may have taken place (see Figure 4). The historic movements of real interest rates (which assumed low, and some times even negative, values during the 1980s) do not suggest that crowding effects were caused by money market adjustments, at least not before

the beginning of the 1990s[13]. Alternative explanations for the apparent failure of the private sector to increase its investment expenditure in the face of government-led increased aggregate demand include the following:

First, the conditions of credit-rationing in which the private sector had to operate after 1975. The declining saving's ratio of the economy together with increased credit to the public sector (see Figure 5) made possible by the conditions of financial regulation prevailing in Greece before 1990 meant that the private sector was deprived the necessary funds to proceed to the investment needed to expand its production capacity. Second, the well-known "time to build" problem, i.e. the existing lags in the investment process. In the framework of a small, open economy like Greece where the industrial base was rather limited and the propensity to imports quite high (see Arghyrou, 2000) it may suggested that the increased demand was largely directed to imports of goods for which domestic production was either limited or not existent (e.g. durable goods). This argument appears to be particularly relevant during the early 1980s when fiscal expansion was quite pronounced, Greece had just joined the EU and a reduction in trade barriers was gradually taking place (see Figure 5). Third, the possible adverse impact of increasing budget deficits on inflation which may have resulted to the inflation costs mentioned in section 2[14]. Fourth, as suggested by Halikias (1996), the negative impact of increased taxation and government intervention on economic incentives and production efficiency; and the negative

[13] This is not too surprising, given the fact that public securities were not available to the non-bank private sector before 1987; and that financial regulation kept the level of nominal interest rates under the control of the government until the early 1990s.

[14] Of course, the hypothesis that budget deficits have led to a higher rate of actual inflation is a testable one and could well constitute the topic of another paper. However, at this stage it may be useful to note that in a paper dealing with monetary policy in Greece, Alogoskoufis and Philippopoulos (1992) estimate that inflation expectations and actual average inflation rate in Greece during the period 1972-89 was higher than during the period 1958-71.

impact of the widening fiscal imbalances on the private sector's expectations regarding the future macroeconomic performance of the country.

All in all, it would appear that the post-1975 fiscal expansion did not result in any lasting welfare improvement for the Greek economy but created a number of serious fiscal problems whose full significance was realized after 1987, when the process of financial liberalization was initiated and, as a result, interest rates on public securities increased substantially, assuming values exceeding the rate of growth of the economy. This put public debt on an explosive, non-sustainable path which brought Greece on the brink of insolvency at the beginning of the 1990s (see Alogoskoufis and Christodoulakis, 1991). As a result, in the 1990s the Greek authorities were obliged to dedicate to the debt's service a very significant percentage of public revenues (see Figure 3) and take unpopular steps aiming to reverse its dynamics. In short, on the basis the results reached in Section 3, one might say that the fiscal policy applied in Greece between 1975-90 appears to have operated as a mechanism of intertemporal shifting of consumption without any apparent long-run output gains.

5. SUMMARY AND CONCLUDING REMARKS

This paper has attempted to shed some further empirical light on the issue of the link between public expenditure and national income. In particular, we have examined the role of four categories of public expenditure in terms of promoting real GDP in Greece. Our results suggest that increases in "non-productive" Greek public consumption and personnel expenditure are not followed by increases in Greek GDP. On the other hand, public investment spending appears to be linked to Greek GDP with a positive long-run

relationship where causality runs both ways. The same applies for "productive" public consumption, although we argued that given the fundamental changes in the Greek and international economic environment which have occurred over the past decade, this result does not necessarily imply that expenditure like industrial and agricultural subsidies will display in the future the same income-inducing properties they have displayed in the past.

On the basis of our results, we discussed the implications of the major fiscal expansion undertaken by Greece between 1975 and 1990. Given the fact that this was mainly directed to personnel and "non-productive" public consumption purposes, we argued that that in terms of output growth, the expansion has rather been ineffective and may have contributed, through various channels, to the prolonged economic stagnation out of which Greece has started recovering only recently. From that point of view, the fiscal consolidation effort which was initiated in 1990 and intensified since 1995 is a positive development. Having said that, one might argue that there certainly exists scope for further restructuring of the Greek public sector. Elsewhere (see Mourmouras and Arghyrou, 2000), we argue that over the last ten years, the stabilization/convergence effort of Greece in the 1990s attached an excessively high weight to monetary policy and postponed long-overdue adjustments in the field of fiscal policy. In this framework, the consensus which now seems to have emerged in Greece regarding the necessity of restructuring the Greek public sector and the recent implementation of relevant policy measures (e.g. privatization of certain loss-making state-owned firms, opening of markets previously reserved for state monopolies etc.) may be creating conditions for a better growth performance in the future.

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Table 1

JOINT TESTS FOR DETERMENISTIC COMPONENTS AND COINTEGRATING RANK:
THE PANTULA PRINCIPLE

H_0	r	$n-r$	*Model 2*	*Model 3*	*Model 4*
l_{max} *test*	0	2	50.1	22.39	23.07
	1	1	9.00+	6.80	7.352
l_{trace} *test*	0	2	59.11	29.2	28.82
	1	1	9.00+	6.80	6.96

+ indicates the first time the null hypothesis is not rejected

COINTEGRATION ANALYSIS: *Model 2*

VAR estimated: $\mathbf{z_t} = \mathbf{A_1 z_{t-1}} + \Psi \mathbf{D_t}$ $\mathbf{z_t}$ = [*constant GDP GI*] , $\mathbf{D_t}$ = [*D1974 D1980*]

Mispecification tests: individual equations

GDP: Portmanteau 5 lags 8.738
GI: Portmanteau 5 lags 6.852
GDP: AR $_{autocorrelation}$ 1.650
GI: AR $_{autocorrelation}$ 2.448
GDP: Normality c^2 0.725
GI: Normality c^2 0.726
GDP: ARCH 0.423
GI: ARCH 0.678
GDP: c^2 $_{heteroscedasticity}$ 1.089
GI: c^2 $_{heteroscedasticity}$ 0.665

System mispecification tests

Vector portmanteau 20.592
Vector AR $_{autocorrelation}$ 1.354
Vector Normality c^2 1.084
Vector c^2 $_{heteroscedasticity}$ 1.143

DETERMINATION OF COINTEGRATING RANK

H_0	H_1	*LR statistic*	*95% CV*	*Trace statistic*	*95% CV*
r = 0	r = 1	50.01**	15.7	59.11**	20.0
r ≤ 1	r = 2	9.008	9.2	9.008	9.2

Standardized beta¢ eigenvectors

GDP	*GI*	*Constant*
1.000	-0.174	-4.0150
-1.2039	1.000	2.2660

RESTRICTED COINTEGRATION ANALYSIS

H_0: $a_1 = 0$ (*GDP weakly exogenous*)

LR-test, rank =1, $c^2(1) = 41.045$**

H_0: $a_2 = 0$ (*GI weakly exogenous*)

LR-test, rank =1, $c^2(1) = 9.399$**

* Rejects the null hypothesis at the 5% level
** Rejects the null hypothesis at the 1% level

Cointegration analysis: GDP and Public Investment (GI)

Table 2

JOINT TESTS FOR DETERMENISTIC COMPONENTS AND COINTEGRATING RANK:
THE PANTULA PRINCIPLE

H_0	r	$n-r$	*Model 2*	*Model 3*	*Model 4*
l_{max} *test*	0	2	20.48	12.68+	14.75
	1	1	0.463	0.189	1.68
l_{trace} *test*	0	2	20.94	12.87+	16.43
	1	1	0.463	0.189	1.68

+ indicates the first time the null hypothesis is not rejected

COINTEGRATION ANALYSIS: *Model 3*

VAR estimated: $\mathbf{z_t} = \mathbf{A_1 z_{t-1}} + \mathbf{A_2 z_{t-2}} + \Psi \mathbf{D_t}$ $\mathbf{z_t} = [GDP \;\; WI]$, $\mathbf{D_t} = [constant]$

Mispecification tests: individual equations

GDP: Portmanteau 5 lags 9.481
W : Portmanteau 5 lags 4.938
GDP: AR $_{autocorrelation}$ 0.863
W: AR $_{autocorrelation}$ 0.988
GDP: Normality c^2 0.408
W: Normality c^2 0.390
GDP: ARCH 1.528
W: ARCH 0.228
GDP: c^2 $_{heteroscedasticity}$ 0.989
W: c^2 $_{heteroscedasticity}$ 0.957

System mispecification tests

Vector portmanteau 20.782
Vector AR $_{autocorrelation}$ 0.821
Vector Normality c^2 0.516
Vector c^2 $_{heteroscedasticity}$ 0.857

DETERMINATION OF COINTEGRATING RANK

H_0	H_1	*LR statistic*	*95% CV*	*Trace statistic*	*95% CV*
r = 0	r = 1	12.68	14.1	12.87	15.4
r ≤ 1	r = 2	0.169	3.8	0.189	3.8

* Rejects the null hypothesis at the 5% level
** Rejects the null hypothesis at the 1% level

Cointegration analysis: GDP and public expenditure for personnel wages (W)

Table 3

JOINT TESTS FOR DETERMENISTIC COMPONENTS AND COINTEGRATING RANK:
THE PANTULA PRINCIPLE

H_0	r	$n-r$	*Model 2*	*Model 3*	*Model 4*
l_{max} *test*	0	2	19.09	12.31+	12.47
	1	1	2.055	0.737	8.615
l_{trace} *test*	0	2	18.86	13.05+	18.8
	1	1	1.833	0.737	7.684

+ indicates the first time the null hypothesis is not rejected

COINTEGRATION ANALYSIS: *Model 3*

VAR estimated: $\mathbf{z_t} = \mathbf{A_1 z_{t-1}} + \mathbf{A_2 z_{t-2}} + \Upsilon\ \mathbf{D_t}$ $\mathbf{z_t} = [GDP\ \ GC\text{-}B]$, $\mathbf{D_t} = [constant]$

Mispecification tests: individual equations

GDP: Portmanteau 5 lags 6.441
GC-B : Portmanteau 5 lags 0.752
GDP: AR $_{autocorrelation}$ 2.225
GC-B: AR $_{autocorrelation}$ 0.239
GDP: Normality c^2 3.368
GC-B: Normality c^2 2.233
GDP: ARCH 0.999
GC-B: ARCH 0.315
GDP: c^2 $_{heteroscedasticity}$ 0.791
GC-B: c^2 $_{heteroscedasticity}$ 1.372

System mispecification tests

Vector portmanteau 12.27
Vector AR $_{autocorrelation}$ 1.359
Vector Normality c^2 5.570
Vector c^2 $_{heteroscedasticity}$ 0.897

DETERMINATION OF COINTEGRATING RANK

H_0	H_1	*LR statistic*	*95% CV*	*Trace statistic*	*95% CV*
r = 0	r = 1	12.31	14.1	13.05	15.4
r ≤ 1	r = 2	0.737	3.8	0.737	3.8

* Rejects the null hypothesis at the 5% level
** Rejects the null hypothesis at the 1% level

Cointegration analysis: GDP and public-debt service expenditure (GC-B)

Table 4

JOINT TESTS FOR DETERMENISTIC COMPONENTS AND COINTEGRATING RANK:
THE PANTULA PRINCIPLE

H_0	r	$n-r$	*Model 2*	*Model 3*	*Model 4*
l_{max} *test*	0	2	48.5	41.65	41.79
	1	1	1.226+	0.937	1.229
l_{trace} *test*	0	2	49.73	42.59	43.02
	1	1	1.226+	0.937	1.229

+ indicates the first time the null hypothesis is not rejected

COINTEGRATION ANALYSIS: *Model 2*

VAR estimated: $\mathbf{z_t} = \mathbf{A_1 z_{t-1}} + \Psi \mathbf{D_t}$ $\mathbf{z_t}$ = [*constant GDP GI*] , $\mathbf{D_t}$ = [*D1974 D1980*]

Mispecification tests: individual equations

GDP: Portmanteau 5 lags 4.418
GI: Portmanteau 5 lags 2.422
GDP: AR $_{autocorrelation}$ 2.310
GI: AR $_{autocorrelation}$ 1.299
GDP: Normality c^2 0.117
GI: Normality c^2 0.763
GDP: ARCH 2.495
GI: ARCH 0.645
GDP: c^2 $_{heteroscedasticity}$ 0.848
GI: c^2 $_{heteroscedasticity}$ 0.479

System mispecification tests

Vector portmanteau 11.781
Vector AR $_{autocorrelation}$ 0.977
Vector Normality c^2 1.239
Vector c^2 $_{heteroscedasticity}$ 0.588

DETERMINATION OF COINTEGRATING RANK

H_0	H_1	*LR statistic*	*95% CV*	*Trace statistic*	*95% CV*
r = 0	r = 1	48.5**	15.7	49.73**	20.0
r ≤ 1	r = 2	1.226	9.2	1.226	9.2

Standardized beta eigenvectors

GDP	*GI*	*Constant*
1.000	-1.0501	-0.7188
-1.690	1.000	4.042

RESTRICTED COINTEGRATION ANALYSIS

H_0: $a_1 = 0$ (*GDP weakly exogenous*)

LR-test, rank =1, $c^2(1) = 16.76$**

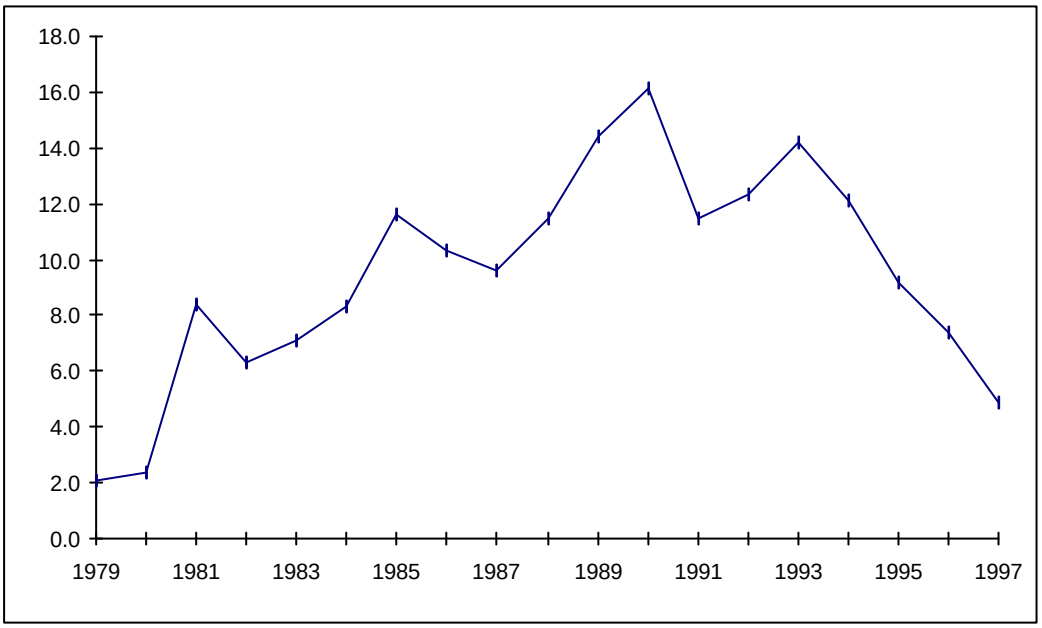
H_0: $a_2 = 0$ (*GC-P weakly exogenous*)

LR-test, rank =1, $c^2(1) = 34.665$**

* Rejects the null hypothesis at the 5% level
** Rejects the null hypothesis at the 1% level

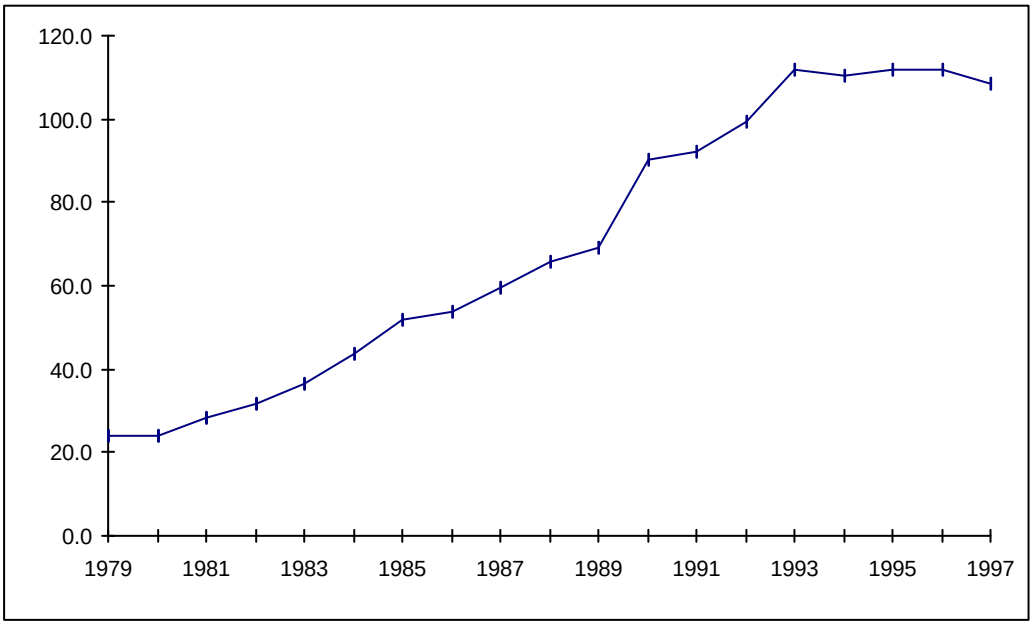
Cointegration analysis: GDP and "productive" public consumption expenditure (GC-P)

Figure 1



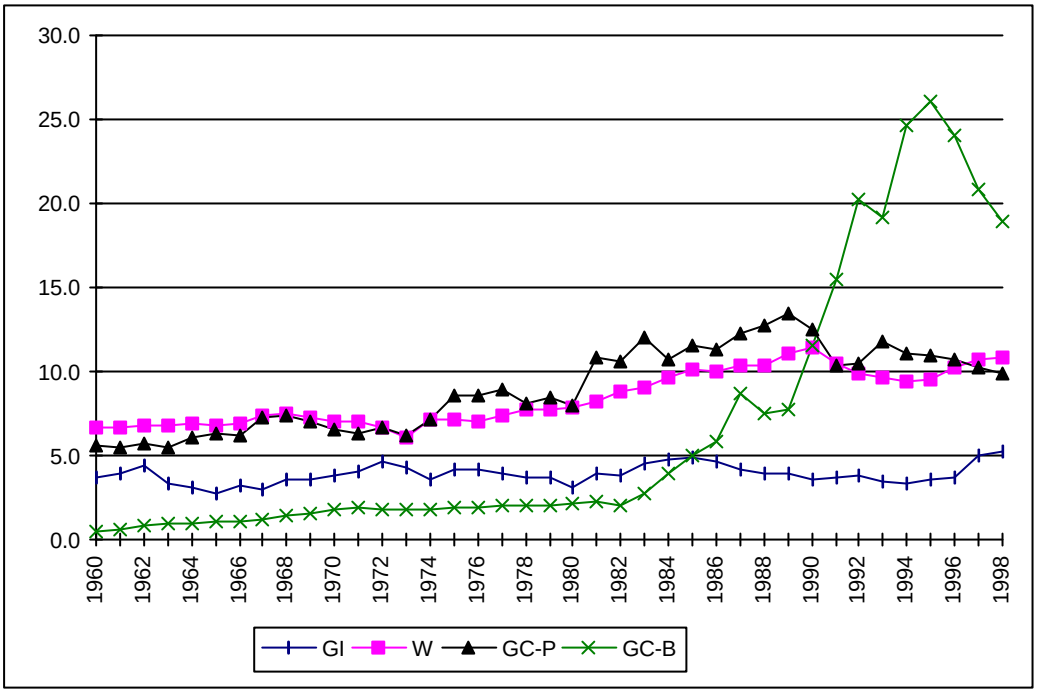
Budget deficit (% in GDP)
Source: European Economy No 64, Statistical Appendix

Figure 2



Public debt (% in GDP)
Source: European Economy No 64, Statistical Appendix

Figure 3

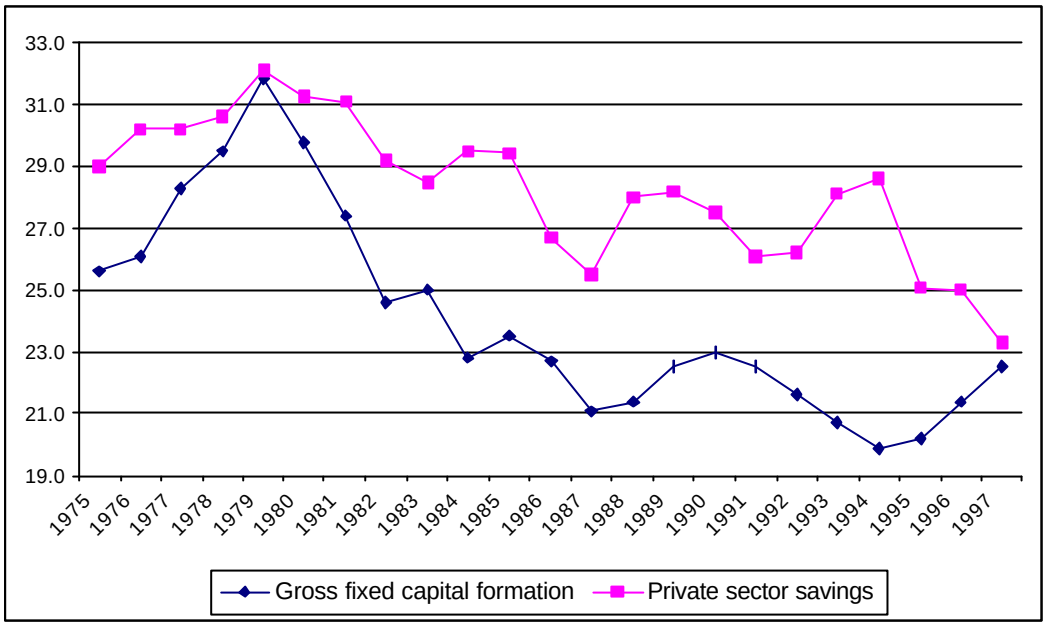


Public expenditure (% in GDP)

GI = Government Investment
W = Personnel Wages
GC-B = Public debt service expenditure
GC-P = Residual spending:"Productive" public consumption

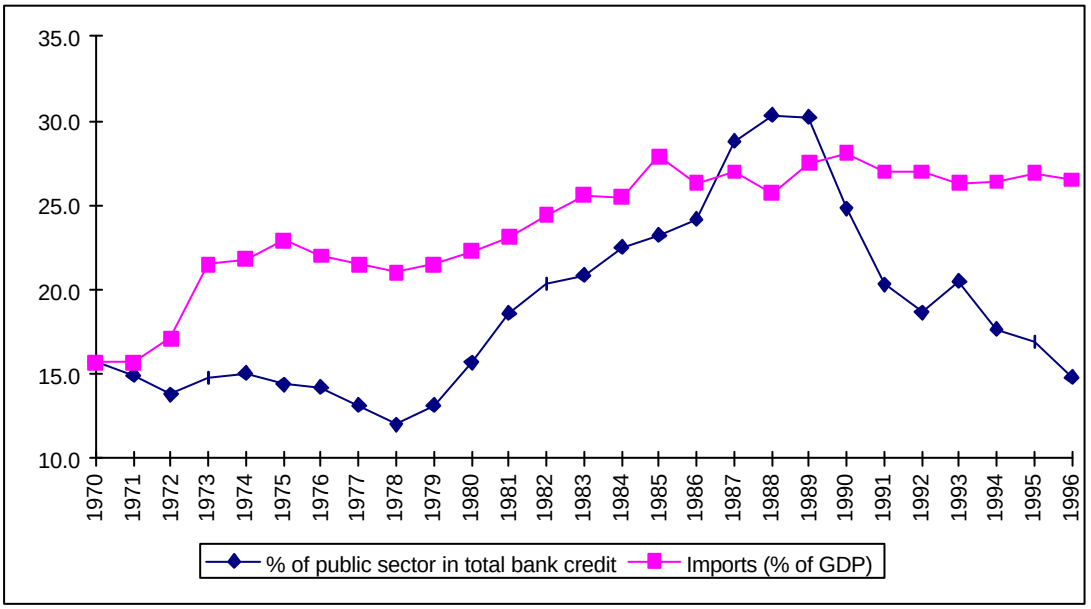
Source: Bank of Greece, The Greek Economy 1960-1997, Long-term macroeconomic time series, Athens 1998 and Report of the Governor for year 1998.

Figure 4



Gross fixed capital formation and private saving (% in GDP)
Source: European Economy No 64, Statistical Appendix

Figure 5



Imports and credit to public sector (% in GDP)
Source: European Economy No 64, Statistical Appendix and Bank of Greece, Monthly Statistical Bulletin (various editions).