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Angel de la Fuente

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Centre for Economic Policy Research
90–98 Goswell Rd
London EC1V 7DB
Tel: (44 171) 878 2900
Fax: (44 171) 878 2999
Email: cepr@cepr.org

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ABSTRACT

Fiscal Policy and Growth in the OECD*

This paper investigates the impact of public expenditures and taxation on economic growth using panel data for a sample of OECD countries. The empirical results suggest that fiscal policy influences growth through three main channels. First, the government contributes directly to factor accumulation through public investment in infrastructure and other assets. Second, public expenditure tends to crowd out private investment by reducing disposable income and the incentive to save. Third, there is evidence of a sizeable negative 'externality' effect of government on the level of productivity. According to the estimates, the effective cost of $1 of public expenditure is around $1.3 once the relevant distortions are taken into account. While this figure is viewed as an upper bound, it does suggest that taxes and public expenditures generate significant efficiency costs which should be taken into account when making budget decisions.

JEL Classification: E62, O40
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Angel de la Fuente
Instituto de Análisis Económico (CSIC)
Campus UAB
08193 Bellaterra
Barcelona
SPAIN
Tel: (34 3) 580 6612
Fax: (34 3) 580 1452
Email: delafuente@cc.uab.es

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NON-TECHNICAL SUMMARY

It is widely recognized that a myriad of public sector activities can have an important impact on economic performance. Modern governments provide a large number of services to households and firms, ranging from transport infrastructure to police protection, raise large amounts of revenue through taxes and fees, manage large social insurance and redistribution schemes and actively intervene in markets, both as buyers and sellers and as regulators. The net impact of all these activities on economic growth and welfare has attracted a considerable amount of attention and has generated an ongoing controversy among policy-makers as well as a rich academic literature on the subject.

Although we are very far from having reached a consensus on the issue, it is probably fair to say that the 'liberal' view that large governments are typically inefficient and generally have an adverse effect on economic growth has been gaining ground in recent years. Proponents of this view typically advocate tax cuts, reductions in social benefits and various liberalization and deregulation measures as a way to promote growth through the elimination of disincentives to work and save and the strengthening of competition. At the same time, it is often held that government expenditures should be restructured in order to direct scarce public resources away from 'unproductive' or consumption activities and towards productive investment.

This paper investigates the extent to which these views are supported by the empirical evidence. It includes an econometric study of the impact of government expenditures and taxation on economic growth and private investment using panel data for a sample of OECD countries. Following Mankiw, Romer and Weil (1992), it uses a 'structural' specification derived from an approximation to a descriptive growth model. This allows us to recover the parameters of a reduced-form aggregate production function that includes public capital as an input and allows the level of productivity to be a function of the relative size of government in order to capture the effects of various types of distortions.

The paper reports clear support for the view that, on the whole, government expenditures have a negative impact on income levels and growth rates, both directly and through their effect on private investment. Hence, many public programmes have a non-negligible efficiency cost in terms of forgone output and slower growth. Our estimates suggest that this indirect cost can be quite significant and that it should be taken into account in making budgetary decisions. This analysis does not necessarily imply that tax and expenditure reductions would necessarily increase welfare, however. The economic benefits of such measures must be carefully balanced against the costs of reduced social protection or an increase in income inequality. While extremely difficult to quantify, these 'social costs' are undoubtedly substantial.

Our empirical results suggest that fiscal policy influences growth through three main channels. First, the government contributes directly to factor accumulation through public investment. Second, public expenditure tends to crowd out private investment by reducing private disposable income and the incentive to save. Third, there is evidence that increases in the overall size of government, as measured by the share of total government expenditures in GDP, are associated with a sizeable reduction in the level of productivity through an 'externality effect' arising from various types of distortions.

Public infrastructure investment seems to present sharply diminishing returns. While its marginal contribution to productivity growth is very large at low expenditure levels, it declines rapidly and becomes essentially zero for values of the public investment ratio within the range observed in our sample. Taking as a reference the levels of public investment observed during the period 1990–95, we estimate that an increase in the public investment rate by half a point of GDP would have a significant positive effect in Belgium, Denmark, the Netherlands and the United Kingdom. For the remaining EU countries the effect of such a policy change is found to be small and even negative in some cases. Allowance should be made, however, for the fact that these estimates will tend to underestimate the return on public investment in countries where the stock of infrastructure is low in relation to the endowment of other productive factors.

The effect of fiscal policy on private capital formation seems to be quite important. According to our estimates, each $1 increase in government expenditures reduces private investment by about $0.32. This crowding out effect is smaller (by about one-half) for transfers to households than for other expenditures, presumably because this item does not represent a net withdrawal of resources from the private sector. The net impact of current subsidies to enterprises and public investment on private capital formation is positive, but it should be noted that the induced investment seems to be smaller than the amount of the subsidy.

Perhaps our most striking finding is that an increase in the size of government tends to reduce output for given stocks of productive factors. This negative 'externality' effect is quite significant: according to our estimates, a 1%

increase in the share of government expenditures in GDP (i.e. an increase in expenditure of around one-half a point of GDP) reduces national income by 0.17% in the short run. This figure is too large to be due primarily to the mismeasurement of public output and, as far as we can tell, is not due to reverse causation.

Our empirical model predicts that a reduction of total government expenditures by five points of GDP (holding constant public investment and the share of transfers to households in total expenditure) would increase the annual growth rate of the average EU country by two-thirds of a point in the medium term, and raise its long-term income level by almost 10%. It may be dangerous, however, to interpret these estimates too literally as an indication of the expected effect of a reduction of public expenditures on national income. In addition to various measurement and econometric problems, it must be kept in mind that the distortions our estimates presumably capture probably relate more to the extent to which government interferes with private incentives and the efficient functioning of firms and markets than with the size of the public sector *per se*. Although it is likely that the two things will go roughly hand in hand, expenditure cuts will not necessarily translate into an automatic and proportional reduction of the relevant distortions.

Subject to this qualification and the inevitable doubts about whether our estimates are in fact capturing a causal relationship running from government to growth, our results do suggest that limiting the size of the public sector and the extent of government intervention in the economy may bring substantial benefits in terms of output gains. It does not necessarily follow that the same policies will increase welfare, however.

In conclusion, our results on the negative growth effects of government activities are both sharper and more 'pessimistic' than those found in most of the previous literature. Although we have made every possible effort to use econometric techniques which should help correct for the sources of bias we are likely to encounter in an exercise of this nature, it must be said that some of our estimates seem unreasonably large and should be interpreted with caution. In the light of previous work in the area, our view is that these figures should probably be regarded as an upper bound on the efficiency cost of public spending. The findings would nevertheless seem to confirm pre-existing evidence pointing to the conclusion that such costs are non-negligible.

1.- Introduction

It is widely recognized that a myriad of public sector activities can have an important impact on economic performance. Modern governments provide a large number of services to households and firms, ranging from transport infrastructure to police protection, raise large amounts of revenue through taxes and fees, manage large social insurance and redistribution schemes and actively intervene in markets, both as buyers and sellers and as regulators. The net impact of all these activities on economic growth and welfare has attracted a considerable amount of attention and has generated an ongoing controversy among policy-makers as well as a rich academic literature on the subject.

Although we are very far from having reached a consensus on the issue, it is probably fair to say that the "liberal" view that large governments are typically inefficient and generally have an adverse effect on economic growth has been gaining ground in recent years. Proponents of this view typically advocate tax cuts, reductions in social benefits and various liberalization and deregulation measures as a way to promote growth through the elimination of disincentives to work and save and the strengthening of competition. At the same time, it is often held that government expenditures should be restructured in order to direct scarce public resources away from "unproductive" or consumption activities and towards productive investment.

This paper investigates the extent to which these views are supported by the empirical evidence. To this end we undertake an econometric study of the impact of government expenditures and taxation on economic growth and private investment in a sample of OECD countries. We use a "structural" specification derived from an approximation to a descriptive growth model following the procedure developed by Barro and Sala (1992) and Mankiw, Romer and Weil (1992). This allows us to recover the parameters of a reduced-form aggregate production function which includes public capital as an input and allows the level of productivity to be a function of the relative size of the public sector in order to capture the effects of government-induced distortions.

Our results provide clear support for the view that, on the whole, government expenditures have a negative impact on income levels and growth rates, both directly and through their effect on private investment. Hence, many public programmes have a non-negligible efficiency cost in terms of foregone output and slower growth. Our estimates suggest that this indirect cost can be quite significant and that it should be taken into account in making budget decisions. Our analysis, however, does not necessarily imply that tax and expenditure reductions would necessarily increase welfare. The economic benefits of such measures must be carefully balanced against the costs of reduced social protection or an increase in income inequality. While extremely difficult to quantify, these "social costs" are undoubtedly substantial.

On the issue of public investment, our results indicate that this component of government expenditures has a positive impact on productivity growth but is subject to sharply diminishing returns. Starting from the situation prevailing during the period 1990-95, only a handful of OECD members would benefit significantly from an increase in this expenditure item.

The paper is organized as follows. Section 2 briefly reviews some previous work on government and growth and relates this paper to the literature. Building on Barro (1990), in Section 3 we discuss how tax and expenditure parameters would enter a simple growth model as a way to highlight the main channels through which fiscal policies can affect the growth process. The remainder of the paper summarizes the findings of an empirical investigation of the effects of fiscal policy on output growth and private investment using panel data for a sample of OECD countries. Section 4 discusses the data and presents some preliminary results from exploratory growth equations. In Section 5 we develop and estimate a structural specification derived from an extension of the augmented Solow model proposed by Mankiw, Romer and Weil (1992). Sections 6 and 7 discuss our main results and explore their implications by simulating the effects of various policy changes in a subsample of European countries. The Appendices contain a formal analysis of the model sketched in Section 3 as well as a more detailed description of the data and some further details on the empirical results.

2.- A brief review of the literature

The existing evidence on the growth effects of fiscal policy is surprisingly inconclusive and is far from providing unqualified support for the hypotheses that large governments are necessarily harmful for growth or that the economic return on public investment is substantial.

Perhaps the most robust result in the literature is the finding of a negative partial correlation between output growth and the share of government consumption in GDP.[1] Due to the scarcity of comprehensive data on government expenditures, many of the existing studies use this variable as a proxy for the overall size of government and interpret this negative correlation as evidence of an adverse effect of the public sector on income growth. Some

[1] See for example Landau (1983, 1985, 1986), Grier and Tullock (1989), Barro (1991a,b) and Easterly and Rebelo (1993). The main exception to this result is a paper by Ram (1986), who finds a positive effect of government size on growth. Dowrick (1993), however, argues that this result probably reflects an endogeneity bias and shows that it disappears when the model is estimated using instrumental variables techniques.

authors, however, have questioned the robustness of this result. Levine and Renelt (1992), Levine and Zervos (1993), Easterly and Rebelo (1993) and Andrés et al (1996) have documented the statistical "fragility" of this correlation, which often disappears with plausible changes in the set of conditioning variables included in the exploratory growth regressions used in most of the literature.

Results concerning the growth effects of other types of "non-productive" government expenditures and various types of taxes are rather inconclusive and typically point to small growth effects. Landau (1985, 1986) finds that the partial correlation between growth and the share of transfer payments in GDP is positive and significant or close to significant when we control for private investment and total government expenditures. Hence, transfers seem to be at least less harmful for growth than other types of public expenditures. Omitting these variables, the net growth effect of transfers seems to be slightly positive although not significant. Barro (1991) reports a similar finding but argues that this result may reflect the endogeneity of the share of transfers, which is highly correlated with income per capita.

One of the clearest predictions of most growth models is that increases in tax rates will have an adverse effect on growth by discouraging private investment. Empirical evidence in this respect, however, has been rather difficult to find. The growth effects of various tax measures seem to be small and the coefficients are not robust to the specification (eg. Koester and Kormendi (1989), Easterly and Rebelo (1993), Mendoza et al (1995)).

The situation is quite similar in the literature which analyzes the relationship between productivity and public investment. Early production function studies by Aschauer (1989) and Munnell (1990) implied exceedingly high rates of return on infrastructure investment. This work, however, has been criticized for relying on inadequate econometric specifications.[2] More recent research shows mixed results. Some of these studies (e.g. García Milà, McGuire and Porter (1993), Holtz-Eakin (1994) and Evans and Karras (1994a,b)) conclude that the contribution of public investment to productivity is practically non-existent, or at least cannot be detected within the traditional framework of an aggregate production function. Other researchers, however, continue to report sizable public capital elasticities (although typically smaller than those found by Aschauer), using estimation techniques which should in principle avoid the problems detected in the early specifications (e.g. Bajo and Sosvilla (1993), Argimón et al (1993), Mas et al (1993), Argimón et al (1996) and González-Páramo and Argimón (1997)).

The evidence available from growth regressions is also mixed. Landau finds a small positive productivity effect of public investment in a sample of LDCs (Landau, 1986) and a negative and significant coefficient for the OECD countries (Landau, 1985). Devarajan et al

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[2] See for example Aaron (1990) and Tatom (1991).

(1993) report a non-linear effect but find that most countries are on the downward-sloping branch of an inverted U curve. Barro (1991a, b) finds a generally positive growth effect but the public investment variable loses its significance in some specifications. The most positive results are obtained by Easterly and Rebelo (1993) using fairly disaggregated data on public investment in a sample of LDCs. These authors find a significant and robust positive partial correlation between both growth and private investment on the one hand and general government investment on the other. When they disaggregate, public investment in transport and communications is robustly correlated with growth (but not with private investment), while investment in education, housing and urban infrastructure display positive coefficients but lose their significance when additional regressors are included in the equation.

In both branches of the literature, the lack of precision of the estimates may reflect (in addition to the usual problems in empirical growth studies) important limitations of the data (such as the lack of consistent and disaggregated data on government expenditures or public capital stocks and the difficulty of measuring public output) in addition to severe endogeneity and multicollinearity problems. As Easterly and Rebelo (1993) emphasize, the effects of fiscal policy may be difficult to disentangle from the well-known convergence effect due to the high correlation between fiscal structure and income per capita. In addition, it is hard to determine to what extent the estimated coefficients may be capturing a spurious correlation arising from "reverse causation," running from income levels or growth rates to fiscal variables (Dowrick, 1993).

Noting the inconclusiveness of the existing results and the numerous data and estimation problems involved, some authors have argued that cross-country studies at the aggregate level have not in the past, and probably cannot as a matter of principle, shed much light on the connection between government and growth. Atkinson (1995), Slemrod (1995) and Agell et al (1997) propose as an alternative a "bottom-up" approach to the quantification of the costs and benefits of government involvement in the economy. Such a microeconomic approach, it is argued, will allow the analyst to take into account the institutional structure and the "fine print" of the relevant programmes, which is often crucial for understanding their effects on the decisions of private agents and the size of the induced distortions.

While such a detailed cost-benefit analysis is certainly necessary for the evaluation of specific government programmes, even rough estimates of the aggregate growth effects of the public sector would be of considerable interest for policy formulation. Since we lack a sufficiently detailed set of microeconomic analyses and, in any event, adding up their partial-equilibrium results would be an arduous and uncertain task, macroeconomic cross-country studies appear to provide an attractive shortcut. If the adverse effects of public sector activities on economic performance are as important as it is sometimes held, moreover, it seems reasonable to expect that we should be able to find at least traces of them at the aggregate level. Our results suggest that this is indeed the case.

While our overall approach to the quantification of the growth effects of fiscal policy is quite similar to the one followed in numerous other studies, we have sought to improve on previous work in a number of ways. First, we have attempted to systematically account for the effects of both revenue and expenditure decisions rather than rely on some rough proxy for the size of government. This has been possible because we have had access to a fairly complete data set on total government revenues and expenditures and the breakdown of the latter into public consumption and investment, transfers to households, subsidies to firms and interest payments. Secondly, we have tried to base the empirical analysis as closely as possible on a coherent and explicit model of the growth process. This is particularly useful when it comes to interpreting the results or using them for policy analysis. An additional advantage of this procedure is that it imposes a certain amount of discipline on the choice of regressors and other aspects of the empirical specification. While we do not conduct a sensitivity analysis along the lines of Levine and Renelt (1992), our results are robust to a number of alternative specifications and are derived within a model which tries to account explicitly for the main immediate determinants of growth. Within such a framework, including additional regressors in an ad-hoc fashion does not seem the best way to proceed. Third, we have been particularly careful in trying to make sure that our results are not vitiated by an endogeneity bias. We report instrumental variables estimates of the relevant coefficients using alternative sets of instruments and different specifications which may be helpful in detecting reverse causation. Finally, the fact that we have restricted ourselves to a sample of industrial countries has two potentially important advantages. The first one is that the data are, presumably, fairly homogeneous and reliable. The second one is that multicollinearity problems arising from the correlation between income per capita and government size are likely to be somewhat less severe than in broader samples.

3.- Government and growth: a theoretical framework

This section sketches an extension of Barro's (1990) model of government and growth which will serve as a theoretical framework for our analysis of fiscal policy. The discussion will highlight the main channels through which tax and expenditure policies may affect growth and welfare, summarize the main predictions of the relevant theory and sketch a workable approach to empirical testing. A more formal analysis of the model is contained in Appendix 1.

The model is built around two key relationships: an aggregate production function which relates national output to the stocks of private and public inputs and the overall size of government, and a utility function which describes the preferences of a representative individual over private consumption and public expenditures. Both functions must be interpreted as reduced forms which attempt to capture in a simple way the effects of government policy on social welfare and aggregate productivity.

We will assume that the instantaneous utility function of the representative agent is of the form

$$(1)\ U(C, E) = \mu \ln C + (1-\mu) \ln E$$

where C is private per capita consumption and E total government expenditures per capita, including transfers. Hence, private agents are assumed to benefit directly from government expenditures on infrastructure, health, police protection and other public services and to place a positive value of income redistribution. To simplify the exposition, we do not disaggregate these items and simply assume that, other things equal, utility increases with total expenditure.

To describe the production side of the economy we will rely on a reduced-form aggregate production function of the form

$$(2)\ Y = \theta^{\gamma} K^{\alpha} G^{\beta} (AL)^{1-\alpha-\beta}$$

where Y is national output, K the stock of private capital, G government-provided productive services, L employment, A an index of labour-augmenting technical efficiency which grows over time at an exogenous rate g, and θ the share of total government expenditures in GDP, including directly productive expenditures (θ_p), transfer payments (θ_T) and "unproductive" public consumtion (θ_c).

This formulation is completely standard except in that it allows national output to be a function of the relative size of government. The additional "government externality" term we have introduced in the aggregate production function (θ^{γ}) is meant to capture in the simplest possible way the fact that public activities may affect productivity in a variety of ways other than through infrastructure investment. Some of the relevant effects are certainly positive: Many government activities which are generally classified as public consumption, from health services to police protection and the court system, can be expected to increase private sector productivity through various channels. But there are also forces operating in the opposite direction. As it has been emphasized in the literature, government regulations which interfere with the efficient operation of markets and firms may increase costs and distort resource allocation, thus reducing the level of output. Similarly, income and other taxes and social insurance programmes may have an adverse effect on labour supply and work effort. On the other hand, social programmes aimed at promoting "social cohesion" are probably vital in maintaining a stable political and social climate and avoiding labour unrest. As a result, social expenditures may have a positive effect on investment and even on worker motivation and productivity. Since the net effect of these conflicting forces is unclear ex ante, the government externality coefficient, γ, could be either positive or negative in principle, or even vary with the level of expenditure.

Given these two relations, the government chooses the various expenditure shares and a representative household or dynasty maximizes the present value of its utility stream taking as given factor prices, the time path of government expenditures and other policy parameters. We will assume that the government finances its operations through a flat-rate tax on income. Tax proceeds are used to finance the provision of productive services (p), to finance public consumption (c) and to make lump-sum transfers to the population (T). We will further assume that the government runs a balanced budget each period, and that expenditure on each of these categories is a fixed fraction of GDP (e.g. $G = \theta_p Y$). Hence, the government budget constraint can be written in the simple form

(3) $\tau = \theta_c + \theta_T + \theta_p \equiv \theta$

where τ is the tax rate and θ_i denotes the fraction of GDP devoted to each of the three types of public expenditure we consider.

As shown in Appendix 1, the behaviour of the economy under these assumptions can be summarized by a system of differential equations which describes the evolution of private consumption (and hence investment) and the capital stock. Fiscal policy parameters enter this system in a number of ways. First, the different types of government expenditures have a direct effect on productivity through the aggregate production function. Second, fiscal parameters influence private factor accumulation decisions through three channels. To discuss them, notice that total private investment (I_p) can be written as the product of disposable (after taxes and transfers) private income ($(1-\theta_c-\theta_p)Y$) and the average propensity to save and invest out of it, s, which is itself a function of the after-tax rate of return on private capital, ($(1-\theta)R$),

(4) $I_p = s[(1-\theta)R(\theta)]*(1-\theta_c-\theta_p)Y(\theta)$,

where we emphasize that both Y and R are themselves functions of the level (and composition) of government expenditures. Equation (4) shows that the direct productivity effects of public expenditures feed back into factor accumulation because, other things equal, savings and investment will tend to rise roughly in proportion with income. Fiscal policy instruments, moreover, also influence the first two terms in the right-hand side of equation (4). With the partial exception of redistributive transfer payments, government expenditures tend to "crowd out" private investment because they represent net transfers of resources to the public sector. Finally, public policies will also influence the private investment ratio to the extent that they modify the net return to private factor accumulation. Taxes directly reduce the incentive to save but this negative effect may be offset (or reinforced) by the net impact of public expenditures on the marginal product of private capital, working again through the production function.

The model we have just sketched yields a number of potentially testable predictions about the effects of different types of fiscal variables on income levels and growth rates and provides a useful framework both for the empirical analysis and for policy evaluation. The predictions are quite straightforward: Taxes will reduce growth by discouraging factor accumulation. Productive government expenditures will have a positive effect on both income levels and growth rates until some level of expenditure is reached beyond which the opportunity cost of the resources used and the distortions induced by their financing exceed their positive direct effects. The same will be true of transfer payments and public consumption if the associated externality effects are positive on balance. Otherwise --and as we will see the evidence points in this direction-- the contribution of an increase in either of these variables to medium-term growth and long-term incomes will be unambiguously negative. In either case, aggregate welfare may either go up or down depending on the initial tax and expenditure levels and on the relative weight of public expeditures in the representative agent's utility function.

The previous discussion suggests a two-pronged approach to empirical testing. First, we can attempt to measure the direct contribution of public expenditures to productivity (including the possible externalities) by estimating some version of, or convenient approximation to, the aggregate production function. We can then deal with the indirect, factor accumulation effects by estimating an investment function which can be seen as an approximation to the "policy function" of the theoretical model. In Sections 4 and 5 below we will follow this approach to obtain estimates of the parameters of an empirical model which tries to approximate the one we have sketched in this section. This model will then be used in Sections 6 and 7 to produce quantitative estimates of the effects of hypothetical policies involving changes in the level and composition of expenditures in a sample of European countries.

Although we will not be able to carry the analysis much further, thinking about these results with an explicit social welfare function in mind may help us put them in the proper perspective in at least two ways. The first point to keep in mind is that net welfare effects will generally be considerably smaller than the estimated change in long-term income. The main reason is that most of these output gains (or losses) build up slowly over time as a result of induced changes in private investment behaviour. Policies which increase investment eventually bring higher income levels; but since the resulting output increase must be financed by a reduction in current consumption, the net gain may be rather small once we properly discount everything. Secondly, our estimates refer only to expected changes in aggregate output and will therefore capture only one part of the relevant costs and benefits-- those which would eventually show up in the national accounts as they are currently constructed. The other part of the balance sheet -- the welfare gains or losses associated with increases or decreases in social protection levels and the degree of redistribution among other things-- are much harder to measure. Although we will not be able to factor such considerations explicitly into the analysis except in a very informal way, it is important to keep them in mind when assessing the desirability of alternative expenditure policies.

4.- Fiscal policy and growth in the OECD, 1965-95

The remainder of the paper presents an empirical analysis of the relationship between growth and fiscal policy using panel data for a sample of OECD countries and discusses the policy implications of the results. This section discusses the data and presents some preliminary results based on a set of exploratory growth and investment regressions. In Section 5 we develop and estimate a "quasi-structural" model of fiscal policy and growth. Finally, Sections 6 and 7 present some estimates of the effects of alternative policy scenarios involving changes in total government expenditures and in public investment from their average levels during the period 1990-95.

a.- Sources and construction of the data on fiscal aggregates

Our data on national income and other macroeconomic aggregates are taken primarily from Doménech and Boscá (D&B, 1996), who essentially replicate Summers and Heston's Penn World Table for the OECD countries using OECD-specific purchasing power parities. Most of our data on tax revenues and government expenditures comes from the *OECD Statistical Compendium* and the European Commission's compilation of General Government data (1996). Both of these sources provide a breakdown of general government receipts and expenditures according to "economic" classifications which are roughly compatible with each other. The EEC data cover the period 1970-95 (plus projections for 1996-98) for the current members of the EU, the US, Japan and Canada. Since these figures are presumably the most accurate data available, we have relied on them whenever possible. The OECD data has been used to extend the sample to countries and periods not covered by the EEC series. For each country in the EEC sample we have checked the consistency of the two data sources over common observations. When the differences are minor (at least close to 1970), we have used the OECD data to extend the EEC series backwards to the period prior to 1970 (see Appendix 2.1 for details). In cases where the differences between the two sources were important, the OECD data has been disregarded.

We have also compared the data constructed in this manner with alternative estimates of the share of government consumption in GDP and the budget surplus taken from Doménech and Boscá (1996) and a series on the average tax rate provided by Boscá and Fernández (1996). For some variables, there are systematic differences across sources which suggest that the definitions of various budget items may vary somewhat. In these cases, we have kept the two series but without "mixing" them. In particular, we have two different estimates of the average tax rate, the government surplus and the share of government consumption in GDP.

Table 1: Available fiscal variables

TAX = total tax receipts as a share of GDP in nominal terms. Source: EEC (1996) and OECD Statistical Compendium (1996).

TAXBF = total receipts from taxes on capital and labour income and consumption as a share of GDP. Source: Boscá and Fernández (B&F, 1996).

GTOT = (nominal) share of total government expenditure in GDP at current prices. Source: EEC (1996) and OECD (1996).

SURPEU = net government lending as a fraction of GDP. Source: EEC (1996).

SURPBD = government surplus as a fraction of GDP. Source = Doménech and Boscá (D&B, 1996) from IMF.

ASGR = share of (general) government consumption in GDP measured in real terms (at constant international prices). Source: D&B (1996).

GCONSR = share of (general) government consumption in GDP measured in real terms. The nominal share, taken from EEC (1996) and OECD (1996), is adjusted using the deflator for government consumption provided by D&B (1996).

SKG = (real) share of government final capital expenditure in GDP. The nominal share, taken from EEC (1996) and OECD (1996), is adjusted using the deflator for (total) investment provided by D&B (1996).

TRHH = current transfers to households as a share of GDP in nominal terms. Source: EEC (1996) and OECD (1996).

SUBSID = current subsidies to enterprises as a fraction of GDP in nominal terms. Source: EEC (1996) and OECD (1996).

INTER = interest payments, nominal share in GDP. Source: EEC (1996) and OECD (1996).

Table 1 gives the definition and source of the fiscal variables we have used. The number of available observations varies from 83 to 126, depending on the indicator. Five of our variables can be used as indicators of the global amount of resources absorbed by the public sector. These include two alternative measures of the share of (direct and indirect) taxes on national income (TAX and TAXBF), the (nominal) share of total government expenditures in GDP (GTOT) and two measures of the general government surplus (SURPEU and

SURPBD). As for the composition of government expenditures, we have data on government consumption (ASGR and GCONSR), investment (SKG), transfers to households (TRHH), current subsidies to enterprises (SUBSID) and interest payments (INTER). All variables are measured as shares of GDP, with the shares of government consumption and investment measured in real terms (at international prices of the base year, using the corresponding price deflators supplied by Doménech and Boscá (1996)) and those of the remaining variables measured in nominal terms (i.e. at current prices in national currencies). All fiscal variables are either averages of annual observations over the relevant five-year subperiod (including both endpoints) or growth rates between the beginning and end of the period.

b.- A first look at the data

This section briefly reviews some of the main features of the data, focusing on the evolution of growth rates and on the behaviour of fiscal aggregates. Figure 1 summarizes the evolution of the main fiscal aggregates in a hypothetical average OECD country. Total government expenditures (GTOT) and taxes (TAX) increase at a rapid pace throughout the period 1965-95. Government consumption (GCONSR) remains relatively stable at around 20% of GDP and public investment (SKG) decreases by around 30% (from 4.4% to 3% of GDP). The main sources of the increase in expenditures are transfers to households (TRHH), which double (going from 8.7 to 18.1% of GDP), and interest payments (INTER), which increase threefold (from 1.67 to 5.8%).

By contrast, output growth shows a marked decline over the period. Average growth rates of output per capita (GYPC) and per employed worker (GYPE) fell from around 4% in 1965-70 to less than 2% in 1990-95. This dramatic decrease is difficult to explain in terms of the behaviour of investment. Private (SKPR) and public investment (SKG) in physical capital declined during the sample period, but not enough to explain the slowdown, and investment in human capital (proxied by the ratio of secondary and university enrollment to the labour force, SH2) and R&D expenditures (CASRD) increased at a rapid pace.

The contrast between Figures 1 and 2 suggests that the expansion of the public sector may be one of the main culprits of the growth slowdown experienced by most industrial economies starting after the mid 1970s. Things are less clear, however, if we take a longer perspective or focus on the cross-section profile of the post-1965 data. The rapid expansion of the public sector during the early post-WWII decades came at a time of unprecedented growth. Over the period 1965-95 as a whole, moreover, the cross-country correlation between growth of output and growth of government is essentially zero.

A more careful look at the cross-section evidence, on the other hand, does reveal a significantly negative partial correlation between the growth of output and the growth of total government expenditures during the last three decades. Table 2 summarizes the results of a

Figure 1: Evolution of the main fiscal aggregates in the OECD

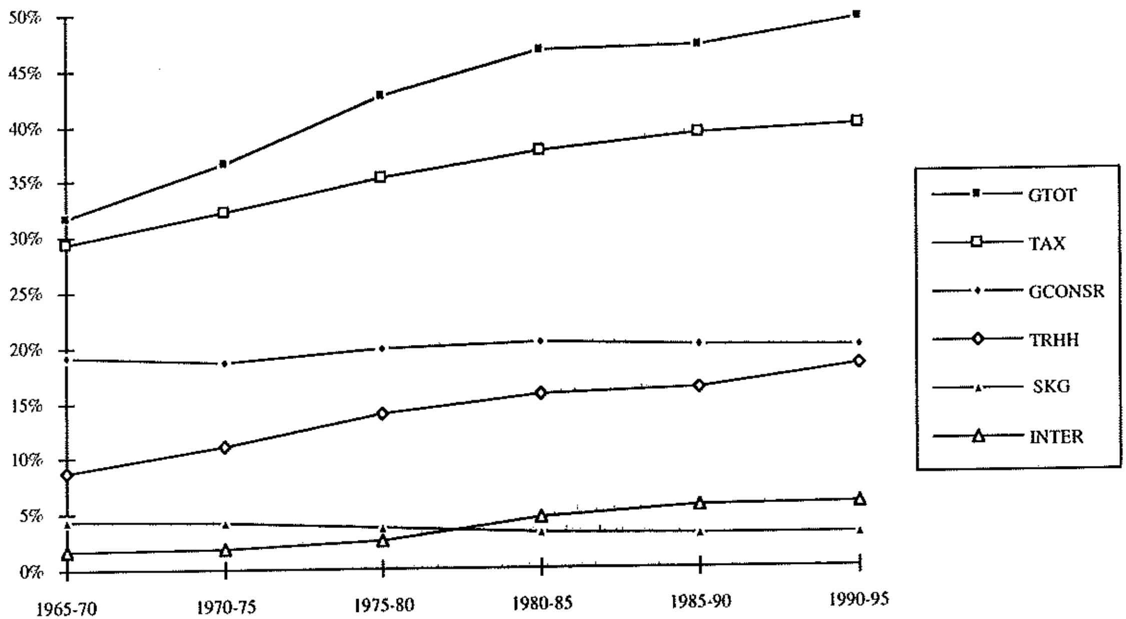


Figure 2: Average growth rate of output per capita and per employed worker in the OECD

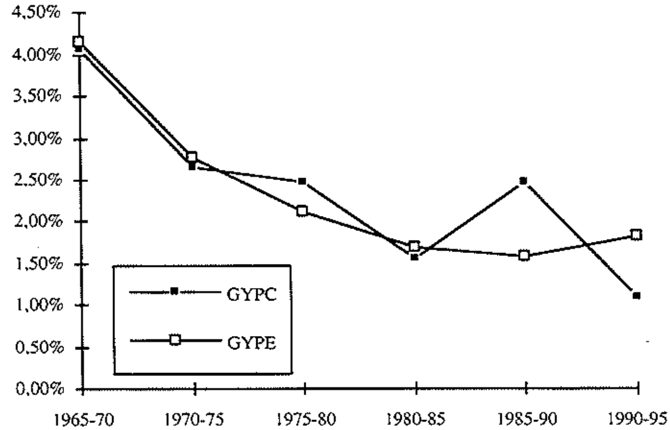
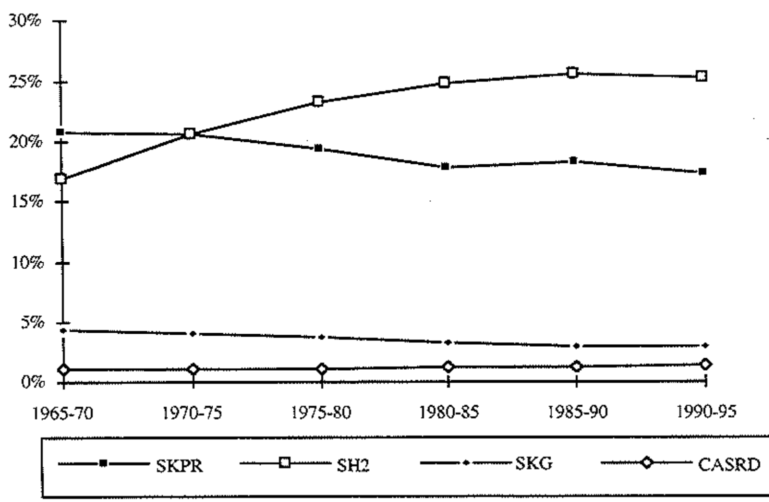


Figure 3: Average investment rates in the OECD



series of cross-section regressions of average growth of income per capita, GYPC, (over the period 1960-95 or 1970-95, depending on the country) on four variables: the average share of total government expenditures in GDP over the sample period (GTOT), the average annual increase in the same variable (DGTOT) and the logs of initial income per capita (LYPC) and the average investment rate over the period (LSK).

Table 2: Cross-section growth regressions

	Dep. var	*LYPC*	*GTOT*	*DGTOT*	*LSK*	R^2
[1]	*GYPC*	-0.0187 (7.58)				0.7823
[2]	*GYPC*		-0.052 (2.94)			0.3513
[3]	*GYPC*			-0.044 (0.07)		0.0003
[4]	*GYPC*	-0.0189 (5.45)	0.0115 (0.10)			0.7824
[5]	*GYPC*	-0.0196 (8.35)		-0.517 (1.86)		0.8230
[6]	*GYPC*	-0.021 (6.21)	0.008 (0.59)	-0.561 (1.91)		0.8273
[7]	*GYPC*	-0.0160 (4.39)	-0.004 (0.29)		0.0095 (1.78)	0.8227
[8]	*GYPC*	-0.0173 (8.06)		-0.649 (2.71)	0.0116 (2.68)	0.8830
[9]	*GYPC*	-0.0178 (5.66)	0.0027 (0.23)	-0.662 (2.60)	0.0114 (2.50)	0.8835
[10]	*GTOTBEG*	0.1906 (4.81)				0.5910

Notes:
- The initial year of the sample period is 1960 for Australia, Canada, Finland, France, Germany, Japan, Norway, Austria, Spain, Sweden, UK and US, and 1970 for Belgium, Denmark, France, Ireland, Italy, Netherlands and Portugal.
- In equation [10], GTOTBEG is total government expenditure as a fraction of GDP at the begining of the sample period (i.e. in the same year as LYPC).
- The average annual increase of the share of government expenditures is computed as the difference between the average value of this variable in the last and in the first five-year subperiod in the sample, divided by the duration of the sample period minus five years.

When the expenditure variables are included alone in the equation, the correlation between government size and growth is negative and significant, while the coefficient of the growth of government variable is not significantly different from zero (equations [2] and [3]). Government size (GTOT), however, is strongly correlated with initial income per capita (equation [10]), a variable which is itself negatively correlated with growth (equation [1]). Hence, GTOT could be capturing part of the effect of initial income when we omit this variable from the equation. When we control for initial income, the pattern of results is reversed. The coefficient of DGTOT now becomes negative and significant (equation [5]) while that of GTOT is zero (equation [4]). The results remain unchanged when we include both variables simultaneously and/or add the investment rate to the list of control variables (equations [6]-[9]).

On the whole, then, our first look at the data seems to indicate that it is the expansion of government, rather than its absolute size, which may slow down growth. The size of the effect appears to have been quite large. In the average country in our sample, the share of government expenditures in GDP increased by an average of 0.66 points per year. With a coefficient of 0.66 for DGTOT as in equation [9], the induced reduction in the average annual growth rate would have been of around four tenths of a percentage point.

It must be noted that part of this effect may be spurious, reflecting nothing more than the difficulty of measuring public sector output and productivity growth. Since most government services are not sold through the market, they are typically valued at cost in the national accounts. When we deflate these figures using a price index which reflects mostly the evolution of wages, productivity growth appears to be very low in the government sector and, as a result, the measured difference between private and public productivity will tend to increase over time.[3]

A rough check, however, suggests that correcting for this effect still leaves us with a rather large negative externality effect from government. Using the limited data we have been able to collect on public employment, we find that on average (across countries and subperiods) output per employed worker in the public sector was around 15% below private sector productivity. As a first approximation, then, an increase in public output by 1% of GDP would reduce the growth rate by 0.15 percentage points. Hence, the correction would account at best for one fourth of the estimated effect. In fact, this figure is likely to grossly overestimate the size of the required adjustment since public output, which is included in government consumption, typically accounts for less than half of total government expenditure.

c.- Some preliminary results

In the remainder of this section we will undertake a more detailed analysis of the growth effects of fiscal policy using panel data for a sample of 19 OECD countries. Exploiting the time dimension of the data in addition to its cross-sectional variation will considerably increase the number of available observations, thus allowing us to disaggregate government expenditures and to control for a richer set of variables. For a first pass at the data, we will follow a variation of the growth equation methodology which has become standard in the

[3] On the other hand, since public output is valued at cost rather than at market prices, even "useless" output will increase measured GDP. Hence, it is also possible that public sector productivity may be overstated in the national accounts. If this effect is sufficiently strong, it might generate a spurious positive correlation between government consumption and growth.

literature. We will run a series of regressions of the growth rate of income per capita and the private investment rate on different combinations of government revenue and expenditure indicators and a set of non-fiscal control variables, relying on changes in the set of conditioning variables to attempt to separate the different effects which are potentially associated with a given fiscal indicator.

To break down the "total" growth effect of a given set of fiscal variables (F) into its "productivity" and "investment" components, we will estimate three different equations. The first one will be a regression of the growth rate of income per capita (GYPC) on the vector F and a basic set of control variables (BC1) which includes initial income per capita and the rate of population growth among other things:

[G.1] $GYPC = \beta_{b1} BC1 + \Gamma_{f1} F.$

The second specification is similar to the first one except in that the set of control variables is augmented with a vector of investment rates (I),

[G.2] $GYPC = \beta_{b2} BC1 + \Gamma_{f2} F + \Gamma_i I.$

Finally, the third equation is a regression of the private rate of investment in physical capital (SKPR), which is one of the components of the vector I, on the vector of fiscal variables and a (different) set of conditioning variables (BC2),

[I] $SKPR = \beta_{b3} BC2 + \gamma_f F.$

The pattern of coefficients in these three equations can potentially give us a fair amount of information about the growth effects of a given F variable. The coefficient of the variable of interest in the first equation (Γ_{f1}) should measure its "total" growth effect, including both its direct impact on productivity and its indirect effect through induced investment. To isolate the first of these effects we can use the coefficients of equation [G.2], where we control for factor accumulation. Finally, the second effect can be recovered using equation [I] and the coefficient of investment in equation [G.2].

Working with each of these equations in turn, we can also attempt to decompose the "net" effect of each type of expenditure into a "direct" and an indirect or "revenue" effect by controlling (or not controlling) for total government expenditures or taxes and deficits. When we include the expenditure variables alone in the equation, the estimated coefficients should (ideally) reflect the net contribution of the different budget items to growth or investment, including the distortionary or crowding-out effects of the taxes and deficits required to finance them. When we control for total expenditures, on the other hand, this last variable should in principle pick up the distortionary costs of taxation or the reduction in private disposable income, and the coefficient of the different expenditure items should capture only their direct effects on growth or investment.

i.-Benchmark estimates

Our starting point will be a set of three *benchmark* equations which try to capture the main determinants of output growth and private investment other than fiscal variables. Table 3 presents these benchmark estimates, which have been chosen after some experimentation with various specifications (see Appendix 2.2).

The first growth equation [G.1] regresses the growth rate of real income per capita (GYPC) on the log of initial real income per capita (LYPC), a trend (T), a squared trend (T^2) and a set of demographic and labour market variables: the growth rate of the labour force participation rate (GTAC), the average increase in the unemployment rate (DU) and (a simple transformation of) the growth rate of population (LDGNPOB).[4] The demographic and labour market variables have the expected signs and are generally significant and the coefficient of initial income is negative and very significant, suggesting a strong tendency for convergence within our sample. Controlling for these factors, the growth rate of income per capita decreases over time, although at a decreasing rate. The equation also tries to control in a simple way for a technological catch-up effect. As discussed in de la Fuente (1995), if technology diffuses across countries at a sufficiently rapid pace, those economies which are technically less advanced at the beginning of the period should grow faster than the rest. This effect, however, should gradually exhaust itself as each country approaches an equilibrium level of relative technical efficiency which is determined by its own R&D effort and the speed of diffusion. To try to capture this effect we include a dummy for initially backwards countries (Spain, Ireland, Greece, Portugal and Japan) and the product of this variable and a trend. These variables are significant and have the expected sign.

Equation [G.2] extends the previous specification by adding three indicators of investment in physical, human and technological capital. The new variables are the (log of the) real share of private investment in GDP (LSKPR), the (log of the) ratio of secondary and university enrollment to the labour force (averaged over the current five-year subperiod and the previous one, LSH2) and the (log of the) cumulative average share of total R&D expenditure in GDP over the current and all preceding subperiods (LCASRD). The last two variables are averaged over several subperiods because it is expected that investment in education and R&D will affect output only with relatively long lags. The coefficients of the investment shares are all positive and significant and do not alter the signs of the coefficients of the other regressors.

Equation [I] in Table 3 is our benchmark investment specification. The dependent variable is the (real) share of private investment in physical capital in GDP (SKPR), and the regressors

[4] LDGNPOB is the log of sum of the rate of population growth and an estimate of the rates of depreciation and technical progress. This variable is the one that would enter a "structural" specification along the lines of MRW (1992) together with the logarithms of initial income per capita and the investment rates in various types of capital. We use the variables in this form here so that our preliminary estimates will give us some information about whether such a specification will fit the data.

are the log of initial income per capita (LYPC), the ratio of total population to employment (DEP, for dependency ratio), the fraction of the population aged 15 to 64 (AF1564), the growth rate of population (GPOB), and an inverse index of the relative price of investment goods (1/PI). The estimated coefficients are all significant and have the expected sign. Investment seems to be quite sensitive to demographic variables and to the relative price of capital goods, and tends to fall with income per capita, possibly reflecting a tendency for the rate of return on capital to fall with accumulation as a result of the operation of decreasing returns.

Table 3: Benchmark growth and investment equations

	[G.1]	[G.2]		[I]
depend. var =	*GYPC*	*GYPC*		*SKPR*
constant	0.0205 (0.56)	0.052 (1.20)	*constant*	-0.1508 (1.49)
T	-0.00014 (2.57)	-0.002 (3.16)	*T*	0.00583 (3.41)
T^2	0.00003 (2.31)	0.00005 (3.34)	T^2	-0.00016 (3.67)
GTAC	0.453 (3.19)	0.535 (3.74)	*AF1564*	0.5095 (3.89)
DU	-1.068 (6.59)	-0.974 (6.57)	*1/PI*	0.2492 (10.76)
LDGNPOB	-0.0247 (2.26)	-0.043 (3.79)	*GPOB*	2.334 (4.13)
LYPC	-0.0202 (3.58)	-0.028 (3.41)	*LYPC*	-0.091 (7.25)
ZLAG5	0.0148 (2.47)	0.0255 (3.87)	*DEP*	-0.0205 (2.30)
ZLAG5T	-0.00065 (2.71)	-0.00106 (4.05)		
LSKPR		0.0134 (3.14)		
LSH2		0.013 (3.55)		
LCASRD		0.00425 (2.34)		
R^2	0.6731	0.7374		0.6531
N	126	103		103

Notes:
- Pooled data for 21 OECD countries covering the period 1965-95 at five-year subintervals. Switzerland and New Zealand are excluded in equations [G.2] and [I] due to the lack of data on the breakdown of investment into its private and public components.
- t-statistics in parentheses below each coefficient; N is the number of observations.
- The dependent variable in the first two equations is GYPC = avge. growth rate of real income per capita during the current five-year subperiod.

Note: Explanatory variables in Table 3

T = trend, TSQ = T^2.

GTAC = growth rate of the labour force participation rate.

DU = annual average change in the unemployment rate.

LDGNPOB = LOG(0.05+GPOB), where GPOB = growth rate of population.

LYPC = log real output per capita at the beginning of the subperiod.

ZLAG5 = dummy variable, = 1 for countries which were technologically less advanced at the beginning of the sample period (Greece, Portugal, Spain, Ireland and Japan). ZLAG5T = ZLAG5*T.

SKPR = (real) share of private investment in GDP, constructed by subtracting the real share of public investment (SKG) from the total investment rate. LSKPR = Log (SKPR)

LSH2 = logarithm of the ratio of total secondary and university enrollment to the labour force, averaged over the current and previous subperiod.

LCASRD = logarithm of the share of total R&D expenditures in GDP, cumulative average over the current and all previous subperiods.

DEP = dependency ratio = total population/employment.

AF1564 = fraction of the population with ages between 15 and 64.

1/PI = inverse index of the relative price of capital goods. PI is the ratio of the price deflators used by Doménech and Boscá to transform nominal GDP and nominal investment (in current national prices) into base-year international prices.

GPOB = population growth rate.

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ii.- Growth and investment effects of fiscal variables:

The next step is to introduce various fiscal indicators into the benchmark equations. Table 4 shows the estimated coefficients of each of the available fiscal variables when added one at a time to the growth and investment equations. When we do not control for investment (equation [G.1]), only the real share of government consumption in GDP (GCONSR and ASGR) and the growth rates of this variable (GGCONSR), total government expenditures (GGTOT) and transfers to households (GTRHH) are significantly (negatively) correlated with growth. When we control for investment (equation [G.2]), the consumption shares lose their significance but not their growth rates. In the investment equation [I] the pattern is roughly the opposite: the share of government consumption in GDP enters with a significant negative coefficient, as do total government expenditures (GTOT), interest payments (INTER) and one measure of the average tax rate (TAXBF). The effects of the government surplus (SURPLUS) and public investment (SKG) are positive and the remaining variables are not significant.

Public investment is close to significance in the growth equations and its impact seems to be non-linear, with a negative coefficient for the quadratic term.

Table 4: Coefficients of various fiscal variables when introduced one at a time in the benchmark equations

equation =	*[G.1]*	*t*	*[G.2]*	*t*	*[I]*	*t*
GTOT	-0.019	(1.25)	-0.021	(1.57)	**-0.114**	(3.12)
TAXBF	0.002	(0.12)	**-0.030**	(1.85)	**-0.121**	(2.64)
TAX	0.0004	(0.03)	-0.023	(1.45)	-0.024	(0.51)
SURPBD	0.034	(1.20)	0.024	(0.85)	0.106	(1.22)
SURPEU	0.020	(0.74)	0.015	(0.52)	**0.197**	(2.51)
GCONSR	**-0.047**	(2.21)	-0.031	(1.40)	**-0.300**	(4.92)
ASGR	**-0.043**	(1.91)	-0.022	(0.93)	**-0.321**	(4.70)
TRHH	0.010	(0.43)	-0.023	(0.97)	-0.033	(0.50)
SUBSID	0.085	(1.38)	0.000	(0.00)	0.258	(1.05)
INTER	-0.035	(0.86)	-0.015	(0.35)	**-0.364**	(3.16)
SKG	**0.160**	(1.75)	-0.055	(0.50)	**0.884**	(3.77)
SKG	**0.726**	(1.71)	**0.647**	**(1.64)**	-1.19	(1.08)
SKGSQ	**-7.31**	(1.36)	**-9.56**	**(1.85)**	26.4	(1.93)
GGTOT	**-0.197**	(3.98)	**-0.163**	(3.35)	0.160	(1.23)
GGCONSR	**-0.086**	(3.12)	**-0.067**	(2.52)	-0.006	(0.08)
GTRHH	**-0.109**	(3.76)	**-0.099**	(3.34)	0.033	(0.38)

Notes:
- Each column gives the coefficients of the given fiscal variables when introduced by itself in the corresponding benchmark equation. The only exception is SKG, which is included both alone and with a square term (SKGSQ).
- t statistics in parenthesis next to each coefficient.
- Definition of the fiscal variables:

GTOT = total government expenditures as a fraction of GDP (average over a five-year subperiod, including both endpoints).
GGTOT = average annual growth rate of GTOT between the beginning and end of the subperiod.
SKG = public investment as a fraction of GDP; SKGSQ = SKG^2.
TRHH = transfers to households as a fraction of GDP; GTRHH = growth rate of TRHH.
GCONSR = real share of government consumption in GDP from EU (1996) and OECD (1996); GGCONSR = growth rate of GCONSR.
ASGR = real share of government consumption in GDP from B&D (1996).
SUBSID = current subsidies to enterprises as a fraction of GDP.
SURPEU = government surplus as a share of GDP from EU (1996).
SURPBD = government surplus as a share of GDP from Boscá and Doménech (1996).
TAX = tax revenue as a share of GDP from EU (1996) and OECD (1996).
TAXBF = tax revenue as a share of GDP from B&F (1996).

Next we introduce different combinations of fiscal variables jointly into the benchmark specifications. Table 5 shows the results obtained starting from equation [G.1] (i.e. without controlling for investment). Equations [1] and [2] include all the main expenditure shares as regressors (using a different estimate of government consumption in each case) together with the growth rate of the share of total government expenditures in GDP. In the remaining equations shown in the table we try to control for the overall amount of resources absorved by the public sector by conditioning on either i) total government expenditures (GTOT) or ii) the share of tax revenue in GDP and the (corresponding estimate of) the public sector surplus. On the expenditure side, we include the share of government investment (SKG) and its square (SKGSQ), the share of government consumption (GCONSR or ASGR), transfers to households (TRHH) and current subsidies to enterprises (SUBSID), omitting interest payments to avoid strong multicollinearity problems (the different expenditure shares roughly add up to GTOT). Thus, the coefficients of equations [1] and [2] should reflect the net effect of each type of expenditure, taking into account the distortionary effects of its financing. In the remaining equations, this last effect should be picked up by the total expenditure or tax and deficit terms. Hence, the coefficients of the expenditure variables should reflect only their direct effects -- or the impact on growth of a change in each type of expenditure financed by a reduction in interest payments.

Table 5: Estimated coefficients of the fiscal variables in the benchmark growth equation without controlling for investment (equation [G.1])

	[1]	*[2]*	*[3]*	*[4]*	*[5]*	*[6]*	*[7]*	*[8]*
GTOT			-0.057	-0.079				
			(1.77)	(3.46)				
TAXBF					-0.011	-0.079		
					(0.28)	(3.02)		
SURPBD					0.0637	0.066		
					(2.41)	(2.45)		
TAX							-0.052	-0.097
							(1.09)	(3.11)
SURPEU							0.061	0.081
							(1.76)	(2.58)
SKG	0.767	0.775	0.864	0.845	0.923	0.725	0.588	0.568
	(2.01)	(2.03)	(2.29)	(2.25)	(2.42)	(1.92)	(1.48)	(1.43)
SKGSQ	-8.55	-8.57	-9.68	-9.54	-9.89	-7.06	-6.52	-6.25
	(1.79)	(1.79)	(2.04)	(2.01)	(2.05)	(1.50)	(1.26)	(1.21)
GCONSR	-0.070		-0.032				-0.047	
	(3.00)		(0.98)				(1.28)	
ASGR		-0.076			-0.087			
		(2.99)			(2.09)			
TRHH	-0.034	-0.035	0.031	0.063	-0.020	0.059	0.019	0.078
	(1.39)	(1.42)	(0.68)	(2.11)	(0.41)	(1.98)	(0.35)	(2.36)
SUBSID	0.089	0.086	0.129	0.127	0.084	0.087	0.179	0.174
	(1.18)	(1.15)	(1.63)	(1.60)	(1.08)	(1.11)	(1.78)	(1.72)
INTER	-0.046	-0.042						
	(1.12)	(1.03)						
GGTOT	-0.209	-0.226	-0.203	-0.210	-0.222	-0.221	-0.143	-0.152
	(4.28)	(4.70)	(4.29)	(4.49)	(4.82)	(4.69)	(2.61)	(2.80)
N	98	98	98	98	98	98	83	83
R^2	0.7818	0.7816	0.7866	0.7841	0.7939	0.7827	0.7396	0.7331

- *Note:* each column gives the coefficients of the given fiscal variables when introduced simultaneously in the benchmark growth equation without controlling for investment variables (equation [G.1]).

The results are roughly consistent with this interpretation and display a fairly reasonable pattern. According to the estimates in equations [1] and [2], the net effect on growth of government consumption (GCONSR) and transfer and interest payments (TRHH and INTER) is negative although only the coefficient of the first variable is statistically significant. The effect of subsidies is positive but not significant and that of public investment displays an inverted U shape. When we control for total expenditures (equations [3] and [4]), the negative coefficient of public consumption becomes smaller and loses its significance, the effect of transfers becomes positive, the positive coefficient of subsidies increases and the coefficients of the investment terms become more precise. When we replace total expenditures by the combination of tax receipts and the budget surplus (equations [5]-[8]), taxes are generally insignificant when government consumption is included. Since these two variables are highly correlated and total tax revenue should provide a better measure of the gross size of the government sector and the induced distortions, we omit public consumption. Taxes then become significant, with a coefficient similar to that of total expenditures and only slightly

Table 6: Estimated coefficients of the fiscal variables in the benchmark private investment equation

	[1]	*[2]*	*[3]*	*[4]*	*[5]*	*[6]*	*[7]*	*[8]*
GTOT			-0.287 (3.40)	-0.314 (5.51)				
TAXBF					-0.211 (1.98)	-0.319 (4.58)		
SURPBD					0.218 (2.92)	0.234 (3.16)		
TAX							-0.017 (0.13)	-0.185 (2.23)
SURPEU							0.186 (2.03)	0.263 (3.28)
SKG	0.573 (2.48)	0.561 (2.43)	0.602 (2.73)	0.613 (2.81)	0.766 (3.40)	0.834 (3.79)	0.608 (2.85)	0.625 (2.90)
GCONSR	-0.268 (3.77)		-0.043 (0.43)				-0.191 (1.63)	
ASGR		-0.280 (3.86)			-0.142 (1.29)			
TRHH	-0.065 (1.00)	-0.0713 (1.09)	0.27 (2.33)	0.30 (3.42)	0.146 (1.22)	0.254 (2.92)	0.038 (0.25)	0.227 (2.24)
SUBSID	0.671 (2.64)	0.667 (2.64)	0.863 (3.37)	0.868 (3.41)	0.78 (3.10)	0.782 (3.10)	0.20 (0.66)	0.21 (0.68)
INTER	-0.236 (2.21)	-0.215 (2.00)						

- *Note:* each column gives the coefficients of the given fiscal variables when introduced simultaneously in the benchmark private investment equation (equation [I]).

larger in absolute value than the coefficient of the government surplus -- a result which is roughly consistent with the hypothesis of Ricardian equivalence. When public consumption is omitted, the coefficients of the remaining variables are fairly similar in the different specifications. The coefficient of the growth rate of the share of total government expenditures in GDP (GGTOT) is negative and significant in all specifications, a result which suggests that government size has a strong negative effect on the level of output.

Table 7: Estimated coefficients of the fiscal variables in the benchmark growth equation controlling for investment rates

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
GTOT		-0.0352 (1.03)	-0.053 (2.01)	-0.029 (2.23)				
TAXBF					-0.0335 (0.78)	-0.0615 (2.20)	-0.035 (2.26)	
SURPBD					0.0486 (1.57)	0.045 (1.48)	0.030 (1.12)	
TAX								-0.029 (1.83)
SURPEU								0.023 (0.78)
SKG	0.768 (1.96)	0.809 (2.09)	0.767 (2.01)	0.633 (1.70)	0.796 (1.97)	0.675 (1.79)	0.579 (1.57)	0.590 (1.45)
SKGSQ	-10.21 (2.01)	-10.49 (2.10)	-10.01 (2.02)	-8.34 (1.73)	-9.47 (1.82)	-8.13 (1.64)	-7.17 (1.49)	-8.28 (1.48)
GCONSR	-0.049 (1.90)	-0.027 (0.81)						
ASGR					-0.0425 (0.86)			
TRHH	-0.034 (1.39)	0.005 (0.11)	0.030 (0.90)		-0.0005 (0.01)	0.031 (0.99)		
SUBSID	0.030 (0.38)	0.064 (0.73)	0.061 (0.70)		0.059 (0.71)	0.051 (0.63)		
INTER	-0.021 (0.50)							
GGTOT	-0.173 (3.41)	-0.171 (3.46)	-0.176 (3.61)	-0.166 (3.47)	-0.185 (3.74)	-0.179 (3.66)	-0.166 (3.48)	-0.149 (2.70)
N	98	98	98	102	98	98	102	83
R^2	0.8003	0.8023	0.8007	0.7936	0.8052	0.8033	0.7952	0.737

- *Note:* each column gives the coefficients of the given fiscal variables when introduced simultaneously in the benchmark growth equation controlling for investment variables (equation [G.2]).

Tables 6 and 7 repeat the experiment starting from equations [I] and [G.2]. The pattern of coefficients in the investment equation is as follows. When we do not control for taxes or total public expenditures, the coefficients of government consumption, transfers to households and interest payments are negative, and those of public investment and subsidies to enterprises are positive. Controlling for total expenditures or taxes and the deficit, government consumption typically becomes non-significant and the coefficient of transfers becomes positive while those of subsidies and public investment increase. Turning to the second growth equation (i.e. controlling for factor accumulation), public investment again displays an inverted U pattern and the significance of the remaining expenditure items typically disappears when we control for total expenditures. This last variable and its growth rate, however, maintain both their negative coefficient and their significance when we control for investment.

The estimates we have just reviewed present some econometric problems that must be dealt with as we seek to improve upon the previous specifications. In particular, there are clear indications that the error term is serially correlated in the investment equation, and we must consider the possibility of reverse causation arising from the endogeneity of some our regressors. The second problem will be discussed in greater detail below. As for the first, autocorrelation seems to be due to the fact that the omission of relevant characteristics makes the prediction error for some countries either systematically positive or systematically negative. To correct this problem, we have added to the investment equation a limited number of country dummies, following the selection procedure discussed in Appendix 2.3. This corrected specification of the investment equation will be the one we will use in the following section. The same Appendix also provides some preliminary evidence that our estimates of the externality effects of government are not seriously affected by an endogeneity bias.

5.- Towards a structural model of government and growth

The results of the previous section suggest that a fairly sparse two-equation specification describes rather well the growth effects of fiscal policy. We have seen that once we control for private factor accumulation, the only fiscal variables which affect output growth are public investment and some indicator of the overall size of the public sector and its growth rate. Private investment, on the other hand, is sensitive both to the overall level of public spending and to its composition. Hence, fiscal policies seem to influence growth mostly through three channels: their direct contribution to factor accumulation through public investment, the crowding out (or crowding in) of private investment, and a direct "externality" effect of government size on productivity.

In this section we will explore further the impact of fiscal policies on productivity growth using a "quasi-structural" specification of the growth equation which will allow us to obtain direct estimates of the coefficients of a reduced-form aggregate production function. The resulting estimates will be easier to interpret and more directly comparable with others in the recent literature than the coefficients obtained in the previous section and can be used to provide estimates of long-term effects. The growth equation we will estimate is derived in Subsection a. Subsection b discusses its empirical implementation and presents the main results, and subsection c investigates the possibility of an endogeneity bias.

a.- Derivation of the growth equation

The model we will develop in this section is an extension of the structural convergence equation derived by Makiw, Romer and Weil (1992) from an extended Solow model. As these authors, we will start out from a reduced-form aggregate production function which displays constant returns to scale in aggregate employment and factor stocks. We will, however, modify this function to allow for the possibility that the level of output may depend on the size of the public sector. As in Section 3, we will assume that the aggregate production function is of the form

$$(1)\ Y = \Theta^{\gamma}K^{\alpha}(AL)^{1-\alpha} = \Theta^{\gamma}ALZ^{\alpha}$$

where Y is national output, K the stock of capital, L employment, and A an index of total factor productivity (TFP) which summarizes the current state of technical knowledge. The variable Z = K/AL measures the stock of physical capital per efficiency unit of labour and Θ is some indicator of the weight of government in the economy.

Let s be the observed investment ratio during a given period and δ the depreciation rate. Then, the instantaneous rate of growth of the capital stock during the period can be approximated by

$$(2)\ \frac{\dot{K}}{K} = \frac{sY - \delta K}{K} = \frac{s\Theta^{\gamma}ALZ^{\alpha}}{K} - \delta = s\Theta^{\gamma}Z^{\alpha-1} - \delta.$$

Let $\dot{L}/L = n$ and $\dot{A}/A = g$ be the observed growth rates of the labour force and TFP during the period. Observing that

$$\frac{\dot{Z}}{Z} = \frac{\dot{K}}{K} - \frac{\dot{L}}{L} - \frac{\dot{A}}{A} = \frac{\dot{K}}{K} - (n+g),$$

and using equation (2), we obtain a differential equation in Z which describes the evolution of the capital-labour ratio in efficiency units during the period:

$$(3)\ \frac{\dot{Z}}{Z} = s\Theta^{\gamma}Z^{\alpha-1} - (\delta+n+g).$$

Setting $\dot{Z} = 0$ we can solve (3) for the steady-state value of Z, which we will denote by $\bar{Z}$,

$$\bar{Z} = \left(\frac{s\Theta^{\gamma}}{\delta+n+g}\right)^{1/(1-\alpha)}$$

or, using lower-case letters to denote logarithms,

$$(4)\ \bar{z} = \frac{1}{1-\alpha}\ln\frac{s}{\delta+g+n} + \frac{\gamma}{1-\alpha}\theta.$$

If the variables s, Θ, n and g remained constant forever at their current values, the capital/labour ratio in efficiency units would gradually approach the equilibrium value given by $\bar{Z}$. Since these variables do, of course, change over time, $\bar{Z}$ must be interpreted as a moving target but it is still true that during the current period the economy will behave approximately as if it were approaching the long-run equilibrium described by $\bar{Z}$.

Equation (4), moreover, allows us to make predictions about the long-term effects of various parameter changes (conditional on the values of the remaining variables). Dividing both sides of (1) by L and taking logarithms, log output per worker along a steady-state path, $\bar{q}_t$, is given by

$$\bar{q}_t = \ln A_t + \gamma\theta + \alpha\bar{z}.$$

Substituting (4) into this expression and simplifying,

$$(5)\ \bar{q}_t = \ln A_t + \frac{\gamma}{1-\alpha}\theta + \frac{\alpha}{1-\alpha}\ln\frac{s}{\delta+g+n},$$

we see that changes in s and θ induce parallel shifts in the long-term trajectory of output per worker.

Following Mankiw, Romer and Weil (1992), we will use a log-linear approximation to equation (3) to derive an empirical specification which can be used to recover the parameters of the reduced-form aggregate production function given in (1). Letting $z = \ln Z$ and observing that

$$\dot{z} = \frac{\dot{Z}}{Z} \quad \text{and} \quad Z = e^z,$$

we can rewrite equation (3) in terms of z,

$$(6)\ \dot{z} = s\Theta^{\gamma}e^{z(\alpha-1)} - (\delta+g+n) \equiv \phi(z),$$

and linearize it around the steady state, obtaining

$$(7)\ \dot{z} = -\lambda(z - \bar{z}) \quad \text{where} \quad \lambda = \phi'(\bar{z}) = (1-\alpha)(\delta+g+n).$$

Using equation (7) we will now derive an equation describing the evolution of output per worker ($Q = Y/L$). Log output per worker is given by

$$(8)\ q = a + \gamma\theta + \alpha z.$$

Differentiating this expression with respect to time and using (7),

$$(9)\ \dot{q} = \dot{a} + \gamma\dot{\theta} + \alpha\dot{z} = g + \gamma\dot{\theta} + \lambda(\alpha z - \alpha\bar{z}),$$

where $\dot{a} = g$ by definition and $\dot{\theta}$ is the growth rate of Θ. Using (4) and (8) and grouping terms, we arrive finally at

$$(10)\ \dot{q} = g + \lambda a + \lambda\frac{\alpha}{1-\alpha}\ln\frac{s}{\delta+g+n} - \lambda q + \gamma\left(\dot{\theta} + \frac{\lambda}{1-\alpha}\theta\right)$$

This *convergence equation* relates the growth of output per worker over a given period to the initial value of the same variable, the determinants of the steady state, the rate of technical progress, and the inital value of the technological index. Controlling for the level and growth rate of technical efficiency, the growth rate of productivity ($\dot{q}$) will be a decreasing function of initial output per worker (q) and the rate of population growth (n) and an increasing function of the investment rate (s). Notice that both the level and the growth rate of the government size variable enter the equation. The second variable enters directly in equation (9), and the first comes in through the steady-state value of z, which is a function of θ.

Using cross-section or panel data for a sample of countries, equation (10) yields direct estimates of the coefficients of the production function and the convergence parameter λ. The specification is easily extended to accommodate various types of capital assets. It is easy to show that if the depreciation rate is the same for all types of capital, these enter the equation in a symmetric manner. For example, if we distinguish between physical (K) and human capital (H), with exponentes α_k and α_h in the production function and investment rates s_k and s_h, the preceding equation becomes

$$(11)\quad \dot{q} = g + \lambda a + \lambda\left(\frac{\alpha_k}{1-\alpha_k-\alpha_h}\ln\frac{s_k}{\delta+g+n} + \frac{\alpha_h}{1-\alpha_k-\alpha_h}\ln\frac{s_h}{\delta+g+n}\right) - \lambda q + \gamma\left(\dot{\theta} + \frac{\lambda}{1-\alpha_k-\alpha_h}\theta\right)$$

with $\lambda = (1-\alpha_k-\alpha_h)(\delta+g+n)$.

b.- Empirical specification and main results

The empirical specifications of the growth equation we will estimate in this section are based (somewhat loosely) on the model developed above. In light of our previous results, we will allow for non-linearities in the effects of public investment by assuming that the relevant term is of the form

$$(\alpha_{kg} + \alpha_{kg2}{*}SKG) * \ln SKG$$

where SKG is the share of public investment in GDP. Hence, we are allowing the elasticity of output with respect to the public capital stock to be a function of the public investment rate.[5] As in the previous section, we will control for two labour market variables (the increase in the labour force participation and unemployment rates), and introduce a dummy for the technologically backwards countries and its product with a time trend as well as a trend and a trend squared. These last four variables are intented to approximate the term

$$g_{it} + \lambda a_{it}$$

in equation (10) while allowing for some country heterogeneity.

With these changes, our basic equation will be of the form

[5] Although this specification seems to be the most natural way to allow for non-linearities while treating public capital in the same way as other factors, it also has some unattractive features. First, it would be more natural to write the coefficient of the public investment rate as a function of the stock of public capital, rather than SKG itself, but we lack data on this variable. Secondly, since we are still assuming constant returns to scale, we are implicitly assuming that labour's coefficient is also a function of SKG and adjusts as required so that the relevant parameters of the production function always add up to one. In fact, equation (12) implies that the impact on the growth rate of a change in any of the investment ratios will depend on the value of SKG.

$$\text{(12) } GYPC = \Gamma_o + \Gamma_1*T + \Gamma_2*T^2 + \Gamma_3*ZLAG5 + \Gamma_4*ZLAG5*T + \Gamma_5*GTAC + \Gamma_6*DU$$
$$- \lambda*LYPC + \frac{\lambda}{1-\alpha_{kp} - \alpha_h - \alpha_r - \alpha_{kg} - \alpha_{kg2}*SKG} * [\alpha_{kp} * LSKPR + \alpha_h * LSH2 +$$
$$\alpha_r * LCASRD + (\alpha_{kg} + \alpha_{kg2} * SKG) * LSKG$$
$$- (\alpha_{kp} + \alpha_h + \alpha_r + \alpha_{kg} + \alpha_{kg2}*SKG) * LDGNPOB]$$
$$+ \gamma\left(GGOV + \frac{\lambda}{1-\alpha_{kp} - \alpha_h - \alpha_r - \alpha_{kg} - \alpha_{kg2}*SKG} GOV\right)$$

where GOV ($= \theta$) stands for an indicator of government size and GGOV ($= \dot{\theta}$) for its growth rate. The parameter λ measures the speed of convergence toward a hypothetical steady state, and the coefficient α_i is the exponent of the i-th type of capital in the (Cobb-Douglas) aggregate production function, with i = kp, h, r, kg for, respectively, private physical capital, human capital, R&D capital and publicly-owned physical capital. Aside from these changes, the notation is the same as in Section 4.

Table 8 presents several estimates of the key parameters of the structural growth equation we have just derived and the same investment equation used above (after introducing selected country dummies to correct the autocorrelation problem noted at the end of Section 4). Equations [G.1], [G.2] and [I.1] are OLS estimates of each individual equation, and equations [G.3] and [I.3] are estimated jointly using a SUR procedure. After some experimentation, we have chosen to use the share of total government expenditures in GDP as our indicator of the size of government (that is, Θ = GTOT). Appendix 2.4 reports the results obtained with alternative specifications.

Our results indicate that the effect of fiscal policy variables on private capital formation is quite important. According to our estimate of the investment equation, each $1 increase in government expenditures reduces private investment by about $0.32. This crowding out effect is smaller (by about one half) for transfers to households than for other expenditures, presumably because this item does not represent a net withdrawal of resources from the private sector. The net impact of current subsidies to enterprises and public investment on private capital formation is positive, but it should be noted that the induced investment seems to be smaller than the amount of the subsidy. The "crowding in" effect of public investment probably reflects a combination of supply and demand factors: public capital expenditures may increase the return to private factors and induce investment on the part of government suppliers.

Turning now to the growth equation, we observe that its coefficients have the expected sign and are generally significant, and that the theoretical restriction on the coefficients of the level and growth rate of the government size variable is easily accepted by the data. In [G.1] we estimate equation (12) after imposing this restriction -- that is, we estimate a single externality coefficient, γ, which enters multiplying a weigthed sum of these two variables as in equation (12). In equation [G.2], on the other hand, we estimate separate coefficients for LGTOT and GGTOT, rewriting the relevant term of equation (12) in the form

$$(13)\ \gamma_1 \, GGTOT + \gamma_2 \frac{\lambda}{1-\alpha_{kp} - \alpha_h - \alpha_r - \alpha_{kg} - \alpha_{kg2}*SKG} LGTOT.$$

As can be seen in the table, the hypothesis that the two coefficients are the same ($\gamma_1 = \gamma_2$) cannot be rejected.

Table 8: Various estimates of the growth and investment equations

regressor	*dep. var. =* *param.*	*GYPC* *[G.1]*	*GYPC* *[G.2]*	*GYPC* *[G.3]*		*SKPR* *[I.1]*	*SKPR* *[I.3]*
LYPC	λ	0.02965 (3.73)	0.0301 (3.71)	0.0298 (4.05)	*LYPC*	-0.0447 (3.98)	-0.0420 (4.19)
LSKPR	α_k	0.2472 (3.43)	0.2401 (3.17)	0.287 (4.53)	*GTOT*	-0.316 (7.36)	-0.321 (8.40)
LSH2	α_h	0.1612 (3.50)	0.161 (3.50)	0.155 (3.81)	*SKG*	0.545 (3.46)	0.525 (3.70)
LCASRD	α_r	0.0532 (2.35)	0.0534 (2.36)	0.060 (3.07)	*TRHH*	0.142 (2.31)	0.145 (2.64)
LSKG	α_{kg}	0.1952 (2.06)	0.199 (2.11)	0.170 (1.99)	*SUBSID*	0.858 (3.46)	0.856 (3.90)
*SKG*LSKG*	α_{kg2}	-2.98 (1.70)	-2.97 (1.71)	-2.76 (1.88)			
GGTOT&LGTOT	γ	-0.1779 (4.16)		-0.168 (4.37)			
LGTOT	γ_1		-0.197 (2.65)				
GGTOT	γ_2		-0.172 (3.60)				
R^2		0.7915	0.7918		R^2	0.917	0.9167
s.e.		0.00706	0.00710		s.e.	0.0125	0.0125
N		102	102	102	*N*	99	99
specification		OLS	OLS	SUR		OLS	SUR

The parameters of this new specification of the growth equation can be compared with other estimates available in the literature. The coefficient of the stock of technological capital in the production function (0.060) is similar to the one obtained by Lichtenberg (1992), and those of physical and human capital (0.287 and 0.155 respectively) and the convergence rate (0.0298) are within the usual range in the literature.[6] As for the effects of public investment, we continue to detect non-linearities which suggest some sort of saturation effect as the level of expenditure rises. Although our estimates of the relevant parameters are not very precise.

[6] See Barro and Sala (1992) and Mankiw, Romer and Weil (1992) among others.

they suggest that the marginal contribution to growth of public investment is substantial at low expenditure levels but falls sharply as the level of expenditure rises. Finally, the coefficient of the government size variable (γ) is negative, significant and quite large. Our estimate of this parameter implies that, holding factor stocks and employment constant, a 1% increase in the relative size of government (i.e. an increase in public expenditures of about half a percentage point of GDP) would reduce national output by about 0.17%. Hence, the real cost of each dollar of public expenditure would be around $1.3 once we take into account the relevant distortions.

While the sign of this coefficient is not surprising in view of the previous literature, its size is considerably larger than we expected -- particularly because, since we are controlling for factor accumulation and the level of employment, the distortionary effects we are picking up exclude crowding out and (part of the) adverse labour supply responses. One possible explanation for this finding is that the externality coefficient may be biased upward due to an endogeneity problem.

c.- Checking for endogeneity

The possibility of an endogeneity bias is an issue which deserves a careful investigation. Intuitively, the problem is that government size and growth may be correlated for reasons which have nothing to do with the existence of a direct effect of the first variable on productivity. This correlation may reflect either "reverse causation" from growth to public expenditures or the joint response of both variables to a third external factor.[7] The "full model" would then involve (at least) two equations with their corresponding disturbances and it will generally be true that the solution values of both variables will be a function of both the error terms. If we ignore this and estimate only one of these equations by itself, the resulting coefficients may not accurately describe the relationship we are trying to capture because the correlations between the relevant variables will be "contaminated" to some extent by the relation described by the missing equation. Technically, the assumptions underlying the ordinary least squares estimation procedure will be violated (because one of the regressors will not be independent of the error term) and the resulting estimates will not be consistent.

The standard way to deal with this problem is to estimate the equation using an instrumental variables technique (two-stage or three-stage least squares). The basic idea is to

[7] For example, if government consumption is relatively insensitive to the cycle, its share in GDP will fall in periods of rapid growth simply because the denominator is increasing at an above-average rate. Likewise, unemployment insurance payments and other social transfers tend to increase rapidly in recessions. These factors may generate a negative correlation between the share of government expenditures in GDP or its growth rate and the growth rate of income which has nothing to do with a negative externality effect from government spending on productivity, and will bias the estimates of the size of the latter effect when the equation is estimated without taking into account the endogeneity problem. A bias of the opposite sign may arise if government services are a superior good, as the share of public expenditures in GDP would then be positively correlated with income growth.

select a set of variables, called "instruments," which are correlated with the regressors of interest and uncorrelated with the error term, and to replace the suspicious regressors by their predicted value using a set of first-stage regressions of these variables on the instruments (and other exogenous variables included in the original model). This procedure should "clean" the explanatory variables of their correlation with the error term, thereby allowing us to obtain consistent estimates. If these are significantly different from the original OLS estimates we should probably conclude that the latter were vitiated by an endogeneity bias.

In this paper we will rely on this technique to try to assess the extent to which endogeneity may be a problem. It must be kept in mind, however, that the fact that we will be able to produce reasonable-looking instrumental variables estimates, while reassuring, does not constitute foolproof evidence of the absence of an endogeneity bias. The problem is that it is not easy to find adequate instruments, as truly exogenous variables which are correlated with fiscal indicators but not with the error term are scarce. In practice, the usual procedure is to "instrument" the suspicious variables by their lagged values but this is often far from satisfactory as it involves a high cost in terms of lost degress of freedom (especially when we work with panel data with few observations per country) and, to the extent that the relevant variables are relatively stable over time, the correlation with the error term may not disappear completely.

Since most of the explanatory variables we consider are determined simultaneously with the growth rate, endogeneity problems may in principle arise in connection with practically all of our regressors. The problem, however, can be expected to be particularly acute in the case of the growth rates of the expenditure shares in GDP. The main reason is that the most likely source of endogeneity problems is the sensitivity of many of our variables to cyclical factors. Since most of our variables are either averages or growth rates computed over six-year periods, cyclical effects should not be very strong but (except in the unlikely case that the subperiod coincides exactly with the business cycle) some cyclical noise will remain. Since this cyclical variation should be more pronounced in variables measured in growth rates than in levels, we should be particularly careful in controlling for endogeneity when estimating the coefficients of the first set of variables. An additional reason for focusing on the growth of government variable is that its coefficient is a direct measure of the externality effect of the public sector and our OLS estimates indicate that the size of this effect is substantial. Before concluding that this is in fact the case, and drawing the obvious policy implications, it is important to be reasonably sure that these results are not driven by a spurious correlation.

Table 9 presents several estimates of the system formed by the growth and investment equations. Equations [1] and [2] are OLS and SUR estimates reproduced from Table 8 for convenience. The remaining columns contain joint instrumental variables estimates of the two

Table 9: Joint estimates of the growth and investment equations.

		[1]	[2]	[3]	[4]	[5]	[6]	[7]
dep. var. =		*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*
LYPC	λ	0.02965	0.0298	0.0278	0.0278	0.0266	0.0259	0.0172
		(3.73)	(4.05)	(3.40)	(3.66)	(3.22)	(3.43)	(2.09)
LSKPR	α_{kp}	0.2472	0.287	0.266	0.310	0.307	0.356	0.399
		(3.43)	(4.53)	(3.62)	(5.00)	(4.01)	(5.60)	(8.21)
LSH2	α_h	0.1612	0.155	0.149	0.141	0.140	0.133	0.096
		(3.50)	(3.81)	(3.24)	(3.52)	(3.00)	(3.28)	(2.52)
LCASRD	α_r	0.0532	0.060	0.058	0.066	0.052	0.060	0.056
		(2.35)	(3.07)	(2.49)	(3.34)	(2.15)	(2.92)	(2.57)
LSKG	α_{kg1}	0.1952	0.170	0.245	0.225	0.254	0.232	0.411
		(2.06)	(1.99)	(2.44)	(2.52)	(2.45)	(2.50)	(4.08)
*SKG*LSKG*	α_{kg2}	-2.98	-2.76	-4.07	-3.89	-4.45	-4.15	-5.45
		(1.70)	(1.88)	(2.14)	(2.49)	(2.33)	(2.71)	(2.60)
GGTOT&	γ	**-0.178**	**-0.168**	**-0.176**	**-0.164**	**-0.152**	**-0.137**	**-0.171**
LGTOT		(4.16)	(4.37)	(3.68)	(3.83)	(2.77)	(2.84)	(2.73)
R^2		0.7915		0.7908	0.7877	0.8054	0.8020	0.7918
s.e.		0.00706		0.0071	0.0071	0.0071	0.0071	0.0075
N		102	102	98	98	90	90	85
dep. var. =		*SKPR*	*SKPR*	*SKPR*	*SKPR*	*SKPR*	*SKPR*	*SKPR*
LYPC		-0.0447	-0.0420	-0.0447	-0.0424	-0.0423	-0.0406	-0.0422
		(3.98)	(4.19)	(3.98)	(4.23)	(3.33)	(3.64)	(3.27)
GTOT		-0.316	-0.321	-0.316	-0.321	-0.319	-0.328	-0.310
		(7.36)	(8.40)	(7.36)	(8.42)	(6.74)	(7.90)	(5.68)
SKG		0.545	0.525	0.545	0.534	0.556	0.543	0.557
		(3.46)	(3.70)	(3.46)	(3.75)	(3.33)	(3.64)	(3.03)
TRHH		0.142	0.145	0.142	0.146	0.117	0.120	0.111
		(2.31)	(2.64)	(2.31)	(2.67)	(1.77)	(2.08)	(1.74)
SUBSID		0.858	0.856	0.858	0.862	1.00	1.00	1.08
		(3.46)	(3.90)	(3.46)	(3.93)	(3.49)	(4.02)	(2.59)
R^2		0.917	0.9167	0.917	0.917	0.921	0.917	0.922
s.e.		0.0125	0.0125	0.0125	0.0125	0.0127	0.0071	0.0126
N		99	99	99	99	91	90	86
INSTRUM				[A]	[A]	[B]	[B]	[C]
specific.		OLS	SUR	2SLS	3SLS	2SLS	3SLS	3SLS

Notes:
- The table displays only the coefficients of the regressors of direct interest but both equations contain additional variables (see equation (12) for the growth equationand Appendix 3.3 for the investment equation).
- *INSTRUM:* In [A] and [B] we instrument only GGTOT; in [C] we instrument DU, SKG, LSKPR, GTOT, GGTOT, TRHH and SUBSID with their lagged values plus AU, Z3, AF65, G65 and LEFT (plus all the "exogenous" regressors in the original system). The "outside" instruments used in the other specifications are: for [A]GF65, AF65, Z3, and GTOTBEG; for [B]: the same, replacing GTOTBEG by GTOT(-1) and GGTOT(-1).

Notes to Table 9 (continued)

- *Variable definitions:*
AU = average unemployment rate during the current subperiod.
Z3 = dummy for the period 1970-75.
AF65 = fraction of the population aged sixty five or over (average value during thesubperiod); GF65 = growth rate of this variable between the beginning and the end of the subperiod.
LEFT = years of government by socialist, communist or social-democractic parties during the subperiod, except in the US where "left-leaning" means that the presidency was held by a democrat. Years of government by a leftist party in coalition with center or conservative parties are counted as one half.
GTOTBEG = share of public expenditures in GDP in the first year of the subperiod
X(-1) = value of the variable X lagged one period.

equations. The outside instruments used for the growth rate of the government share (GGTOT) always include the fraction of the population aged sixty five and over (AF65), the growth rate of this variable (G65), a dummy for the period 1970-75 (characterized by the rapid growth of government expenditures), and the number of years in which the government was held by left-of-center parties (LEFT), which may a priori be expected to adopt policies involving an increase in public expenditure. In the equations labeled [A] at the bottom of the table we also use as an instrument the total expenditure share in the first year of the subperiod (GTOTBEG), while in those labeled [B] we replace this variable by the lagged values of the government share and its growth rate (LGTOT(-1) and GGTOT(-1)), a change which involves the loss of some observations. In equations [3]-[6] we instrument only the growth rate of the expenditure shares (GGTOT), while in equation [7] the list is expanded to comprise most of the potentially endogenous regressors.

The results suggest that endogeneity is not a serious problem. Although the size of some of the coefficients varies somewhat across specifications, instrumenting does not qualitatively alter the results. The coefficient of total government expenditures, in particular, is always negative and significant and its size remains quite stable across specifications, ranging from -0.137 (with a t value of 2.84) to -0.178 (with t = 4.16). The coefficients of other variables are also fairly robust to the use of instrumental variables techniques. In the last equation of each table we instrument all the fiscal variables (including the levels of the various expenditure shares as well as their growth rates) together with the unemployment rate and the log of the private investment rate using their lagged values as instruments.[8] The results do not change qualitatively. The main difference relative to the previous specifications is that the coefficient of public investment now becomes implausibly large, that of subsidies (SUBSID) increases above one, and transfers (TRHH) becomes borderline significant in the investment equation.

[8] We do not instrument for LSH2 or LCASRD since these variables are cumulative averages over several subperiods and are therefore less likely to be subject to endogeneity problems

As an additional check on endogeneity, we will present various estimates of an alternative specification of the growth equation which, in the absence of econometric problems, should be equivalent to the one we have used until now (equation (12) in the text). Notice that the growth rate of the share of total government expenditures in GDP (GGTOT) is equal to the difference between the growth rate of total government expenditures per capita (GGTOTPC) and the growth rate of income per capita (GYPC), which is the dependent variable in the growth equation,

(14) GGTOT = GGTOTPC - GYPC.

It may be argued that the growth rate of public expenditure per capita is more likely to be exogenous to the growth equation than the growth rate of government's share of GDP since the latter depends directly on the left-hand side variable of the equation. If this is so, a better OLS estimate of the externality coefficient may be obtained by reformulating the original equation in terms of GTOTPC rather than GGTOT. On the other hand, if this last variable is "more endogenous" than GGTOT, the OLS estimate of the second equation is more likely to be biased than that of the original specification.

To compare these two estimates we will rewrite the growth equation in terms of GGTOTPC. Notice that the original equation is of the form

(15) $GYPC = A + \gamma GGTOT$

or, using equation (3),

$GYPC = A + \gamma(GGTOTPC - GYPC)$.

Solving for GYPC in this last expression, the growth equation may be rewritten in the form

(16) $GYPC = \frac{1}{1+\gamma}(A + \gamma GGTOTPC)$.

Table 10: An alternative specification of the growth equation in terms of the growth rate of government expenditures per capita

		[1]	*(t)*	*[2]*	*(t)*	*[3]*	*(t)*
LYPC	λ	0.0289	(3.41)	0.0287	(3.61)	0.0281	(3.49)
LSKPR	α_{kp}	0.2765	(3.29)	0.264	(3.71)	0.300	(4.02)
LSH2	α_h	0.1854	(3.51)	0.161	(3.53)	0.153	(3.35)
LCASRD	α_r	0.077	(3.18)	0.056	(2.45)	0.053	(2.28)
LSKG	α_{kg}	0.1229	(1.08)	0.214	(2.17)	0.210	(2.06)
*SKG*LSKG*	α_{kg2}	-2.90	(1.22)	-3.46	(1.90)	-3.72	(2.01)
GGTOTPC	γ	**0.0106**	(0.21)	**-0.160**	(2.96)	**-0.129**	(2.11)
R^2		0.7489		0.7037		0.7420	
s.e.		0.00775		0.00842		0.00812	
N		102		102		94	
specification		OLS		2SLS		2SLS	
instruments				[A]		[B]	

- *Note*: See the notes to Table 9 for the list of instruments.

Table 10 presents three different estimates of equation (16). Notice that the externality coefficient obtained by OLS in equation [1] is positive, although not significant. In the other two equations, however, instrumental variables estimation yields a negative externality coefficient of roughly the same magnitude as our previous estimates. This reinforces our previous conclusion that our estimate of this parameter in not seriously flawed by an endogeneity problem.

6.- Public investment and productivity

Previous analyses of the contribution of public investment to productivity growth have produced very different results, with existing estimates of the relevant output elasticity ranging from essentially zero to around 0.40. Our estimates fall somewhere in the middle of this range. According to our results, the elasticity of aggregate output with respect to the stock of public capital is around 0.20 at very low investment levels. Our non-linear specification, however, reveals that this elasticity decreases rapidly as the volume of investment increases, suggesting that investment in infrastructure is subject to sharply diminishing returns. If we take our results at face value, they imply that there is some threshold level beyond which public investment becomes completely unproductive. As we will see below, moreover, this value is well within the range of investment rates observed in our sample. This implies that, starting from current levels, increases in investment expenditures would only be expected to generate significant increases in the growth rate in those countries which currently devote less than 2% of their GDP to public investment. It must be emphasized, however, that data limitations have forced us to work with a specification which does not take into account the fact that the degree of "saturation" in public investment is likely to depend on the existing stock of infrastructure as well as on the size of the current expenditure flow. As a result, our estimates will tend to underestimate the growth effects of public investment in the poorer countries of the OECD, where there is still an important deficit of basic infrastructures.

To examine in greater detail the policy implications of our results, we will rely on the structural model estimated in the previous section. This model can be used to simulate the effects of alternative fiscal policies on growth and private investment. While such an exercise must be interpreted with great precaution for many reasons, it may give us some idea of the order of magnitude of the relevant effects. In this section we will analyze the growth effects of a change in the public investment ratio, and in the next one we will explore the implications of a change in the level of overall government expenditures. In each case, we will focus on a subsample of EU countries and, taking as a baseline the "average" situation in each of them during the period 1990-95 (which may be quite different from the current one in some respects), we will estimate the induced changes in growth rates and long-run levels of income per capita under the assumption that the new expenditure levels are maintained indefinitely and that there are no changes in other "exogenous" variables of the model. All calculations are based on equations [G.3] and [I.3] in Table 8, i.e. on a SUR specification with government size measured by the share of total public expenditure in GDP.

The specific policy experiment we will consider involves an increase in public investment by half a percentage point of GDP. Table 11 summarizes the expected medium and long-term effects of such a policy change under two alternative assumptions as to its financing. Column [1] of the table shows the average rate of public investment (SKG) in each EU country during the period 1990-95. Columns [2] and [3] (Scenario 1), show the direct impact of the additional investment on the growth rate of income per capita during the five-year period in which the new policy is adopted (DGYPC1) and on the steady-state or long-run equilibrium level of income per capita (DYPCSS1). These figures are calculated under the assumption that both private investment and total government expenditures remain constant. These assumptions are relaxed in Scenarios 2 and 3. In Columns [4]-[6] we take into account the increase in private investment induced by the additional public capital expenditure (DSKPR2) but continue to assume that total public spending remains constant (i.e. that new public investment is financed by an offsetting reduction in "non-productive" consumption expenditure). Finally, Scenario 3 allows for induced changes in private investment but assumes that the additional investment represents a net increase in government expenditures.

The direct growth effect is positive in most countries but rather small with the exception of the top four countries in the table. It ranges from an increase in the growth rate of a third of a percentage point per year in the case of Belgium to a small decrease in the case of Spain. The corrections for indirect effects through induced private investment and additional taxation are very small and do not alter the results significantly. Our estimates suggest that further cuts in public investment would significantly reduce growth in Belgium, the Netherlands, the UK and Denmark but would probably be harmless or even beneficial in the remaining members of the EU. This conclusion, however, may need some qualification. The rate of return on public investment will depend on the relative scarcity of infrastructure capital relative to other types of assets.[9] Hence, a high public investment rate may be temporarily justified in countries with low infrastructure stocks.

Lacking data on the stocks of public capital and other productive factors, precise estimates of relative rates of return cannot be obtained. It is possible, however, to get some idea of at least the direction of the necessary correction to our first-round estimates by accumulating investment flows over the entire sample period and making some reasonable guess as to each

9 The specification we have used does not capture this effect. It relies on income per capita as a summary measure of the per capita stocks of all productive factors and implicitly assumes that relative factor endowments are the same in all countries. To a large extent, this shortcoming is also an important advantage, as it allows us to estimate the coefficients of the production function without direct data on factor stocks. It is important, however, to keep this in mind when drawing policy conclusions.

Table 11: Estimated effects of a half a point increase in the public investment rate

		Scenario 1		Scenario 2			Scenario 3					
	[1] SKG 1990-95	[2] DGYPC1	[3] DYPCSS1	[4] DSKPR2	[5] DGYPC2	[6] DYPCSS2	[7] DSKPR3	[8] DGYPC3	[9] DYPCSS3	[10] SKG 1970-95	[11] SKPR 1970-95	[12] SKG/ SPKPR
Belgium	1.44%	0.29%	9.64%	0.26	0.32%	10.73%	0.10	0.26%	9.67%	2.87%	15.98%	0.18
Netherlands	1.93%	0.17%	5.56%	0.26	0.20%	6.70%	0.10	0.14%	5.62%	2.81%	19.07%	0.147
Denmark	2.04%	0.15%	5.03%	0.26	0.18%	6.18%	0.10	0.12%	5.13%	3.38%	20.19%	0.167
UK	1.99%	0.15%	4.93%	0.26	0.19%	6.26%	0.10	0.11%	4.96%	2.08%	13.83%	0.150
W. Germany	2.25%	0.09%	3.10%	0.26	0.12%	4.14%	0.10	0.06%	3.08%	2.81%	17.98%	0.156
Ireland	2.35%	0.08%	2.69%	0.26	0.12%	3.92%	0.10	0.04%	2.65%	3.65%	17.65%	0.206
Sweden	2.99%	0.04%	1.44%	0.26	0.08%	2.60%	0.10	0.02%	1.60%	3.34%	15.07%	0.222
Italy	2.99%	0.01%	0.25%	0.26	0.04%	1.33%	0.10	-0.02%	0.30%	3.18%	17.58%	0.181
Portugal	3.21%	0.00%	-0.03%	0.26	0.03%	0.90%	0.10	-0.04%	-0.11%	2.40%	18.13%	0.133
Austria	3.27%	-0.01%	-0.29%	0.26	0.01%	0.49%	0.10	-0.04%	-0.36%	3.85%	20.30%	0.190
France	3.48%	-0.03%	-1.09%	0.26	0.00%	-0.07%	0.10	-0.06%	-1.05%	3.45%	18.34%	0.188
Finland	3.86%	-0.04%	-1.34%	0.26	-0.01%	-0.42%	0.10	-0.07%	-1.31%	4.29%	23.03%	0.186
Spain	4.15%	-0.07%	-2.41%	0.26	-0.04%	-1.42%	0.10	-0.11%	-2.42%	3.30%	16.69%	0.198
Average	*2.77%*	*0.06%*	*2.11%*	*0.26*	*0.09%*	*3.18%*	*0.10*	*0.03%*	*2.14%*	*3.19%*	*17.99%*	*0.177*

- *Notes:*
DGYPC = change in the growth rate relative to the base scenario during the five-year subperiod in which the policy takes effect.
GYPCSS = change in the steady-state or long-run equilibrium level of income per capita
DSKPR = induced change in private investment (measured in points of GDP)
Scenario 1 = direct effects, holding constant private investment and total government expenditures.
Scenario 2 = holding total government expenditures constant but allowing for induced changes in private investment
Scenario 3 = allowing for the distortionary and crowding out effects of additional government expenditure as well as for induced investment.
Reported effects are calculated as the difference between the predictioins of the estimated model with the old and new parameter values.

country's initial relative position. Columns [10] to [12] of Table 11 show the average investment rate in public and private capital in each country over the period 1970-95 and the ratio of these two variables. A country's final capital stock will be approximately equal to some weighted average of its (unknown) initial stock plus a term proportional to its cumulative investment ratio. If we assume an annual depreciation rate of 3% for both types of capital, 47% of the 1970 capital stock would still be around in 1995. Hence, the weight of the first term is likely to be non-negligible.

With this in mind, the ranking in column [2] may be somewhat misleading. Consider for example the cases of Sweden and Portugal. According to our estimates, a reduction of public investment would have roughly the same effect in both countries. The figures in columns [10] to [12], however, suggest that this is unlikely to be the case in the short or medium run because 1995 factor stocks are quite different in the two countries, both in absolute and in relative terms. Sweden's 1970 stock of public capital per worker was certainly much larger than Portugal's, and since the first country devoted to public investment a larger fraction of GDP than the second one, the difference between the two can only have increased. On the other hand, since Portugal's private investment rate was higher than Sweden, the gap between the two countries in terms of private capital has probably narrowed over time (in percentage terms). On the whole, since the ratio of public to private capital was probably much higher in Sweden than in Portugal (already in 1970 and more so in 1995) the immediate return on public investment is likely to be higher in Portugal than in Sweden.

7.- Government size and economic growth

As we have seen in Section 2, the available evidence on the growth effects of taxation and various types of government expenditures is rather inconclusive, although there are some indications that an increase in the overall size of the government sector tends to have an adverse effect on economic performance. Our results in this respect are considerably "sharper" and more pessimistic than previous ones in the literature and seem to indicate that the efficiency cost of government-induced distortions is quite considerable. Although we have made every possible effort to ensure that our results are not due to a spurious correlation between fiscal variables and economic growth, our estimates should probably be interpreted with considerable caution pending additional evidence in this respect. In particular, while the sign of the relevant coefficient is not unexpected, its size seems unreasonably large. This may be an indication that we have not fully succeeded in avoiding an endogeneity bias or, perhaps more likely, that our sample may be biased in some way by the exclusion of certain countries or earlier periods in which the rapid expansion of public spending went hand in hand with rapid growth.

With all this in mind, it may still be of some interest to use our empirical results to provide a rough estimate of the potential benefits of reducing the overall size of government. The experiment we will consider is the following. Holding constant a country's initial income per capita and other relevant variables, we will calculate the impact of a reduction in its total government expenditures by 5 percentage points of GDP spread over five years, assuming that the ratio of transfers to total spending and the public investment rate remain constant. The new expenditure level will then be assumed to remain constant forever thereafter. As we know, such a policy change will affect the time path of income in several ways. First, there will be an "impact effect" as the reduction of the government-induced externality increases output with given factor stocks. Part of the resulting increase in output will be saved and invested (holding the private investment rate constant), giving rise to a second "induced growth" effect. Finally, the private investment rate will also increase, reinforcing the two previous "direct" effects of the expenditure cut. Over time, the accumulation of the induced changes in the growth rate (which become progressively smaller as time passes) will bring the economy to a new steady state with a permanently higher income level.

Table 12 presents quantitative estimates of the size of these effects. The figures in Columns [2]-[5] are obtained under the assumption that the private investment rate remains constant. The medium-term effect (on the average growth rate during the period in which the policy change takes place), DGYPC1, is decomposed into an "impact" effect which reflects the direct operation of the relevant externality, and an "induced growth" effect which works through induced factor accumulation holding the private investment rate constant. The combination of the impact and the accumulated induced effects asymptotically yields an increase in steady-state income measured by DYPCSS1. Columns [6]-[8] show the induced increase in the private investment rate (DSKPR2, measured in percentage points of GDP) and the medium and long-term impact of the policy when we consider this indirect effect (DGYPC2 and DYPCSS2).

The estimates in Table 12 vary across countries in a way which is not entirely plausible, with the expected benefits of expenditure cuts being larger in those countries where the initial size of the public sector is smaller.[10] Hence, it is probably best to focus on the cross-country average given in the bottom row of the table. In any event, the predicted growth effects of the proposed policy are sizable. In the average EU country, the growth rate would go up by around two thirds of a point in the medium term, and long-run income levels would rise by

[10] The main reason for this result is that in our specification the externality effect is proportional to the change in the relative size of government, rather than to the absolute size of the expenditure cut. Since this generates rather counterintuitive results, we have introduced a non-linear term in the specification which would allow the externality coefficient to vary with the share of government. This non-linear term, however, is not significantly different from zero and has therefore not been reported in earlier sections.

Table 12: Estimated effects of a five-point reduction in total government expenditures

		direct effects only				including induced investment					
	[1] GTOT 1990-95	[2] DGYPC1	[3] IMPACT	[4] INDUCED	[5] DYPCSS1	[6] DGYPC2	[7] DYPCSS2	[8] DSKPR2	[9] TRHH 95	[10] recipients/pop.	[11] tr. per cap/ YPC
Sweden	67.17%	0.36%	0.26%	0.09%	3.17%	0.53%	9.14%	1.35	24.30%	21.30%	114.20%
Denmark	59.88%	0.41%	0.29%	0.11%	3.81%	0.59%	9.81%	1.36	21.70%	21.20%	102.50%
Finland	57.45%	0.41%	0.31%	0.11%	3.52%	0.55%	8.19%	1.33	23.70%	22.30%	106.10%
Belgium	55.18%	0.45%	0.32%	0.13%	4.34%	0.61%	9.71%	1.28	25.00%	20.80%	120.40%
Netherlands	55.00%	0.45%	0.32%	0.13%	4.20%	0.61%	9.65%	1.25	26.50%	16.40%	161.70%
Italy	53.98%	0.45%	0.33%	0.12%	3.98%	0.61%	9.54%	1.35	19.30%	19.40%	99.60%
France	53.03%	0.45%	0.33%	0.12%	3.93%	0.60%	8.97%	1.30	23.20%	19.70%	117.80%
Austria	51.62%	0.47%	0.34%	0.12%	4.09%	0.58%	8.07%	1.31	21.80%	17.00%	128.20%
Germany	48.50%	0.51%	0.37%	0.14%	4.69%	0.67%	10.01%	1.34	19.40%	18.80%	103.30%
Spain	46.52%	0.51%	0.38%	0.13%	4.32%	0.66%	9.40%	1.36	15.80%	23.60%	66.90%
Portugal	43.55%	0.56%	0.41%	0.15%	4.92%	0.70%	9.81%	1.37	16.20%	17.70%	91.40%
UK	42.50%	0.59%	0.42%	0.16%	5.49%	0.79%	12.47%	1.38	13.80%	19.80%	69.80%
Ireland	39.58%	0.63%	0.45%	0.17%	5.78%	0.81%	12.02%	1.34	14.00%	16.40%	85.30%
Average	*51.84%*	*0.48%*	*0.35%*	*0.13%*	*4.33%*	*0.64%*	*9.75%*	*1.33*	*20.10%*	*19.50%*	*103.80%*

Notes:
- Colum [10] = transfers to households as a fraction of GDP in 1995.
- Column [11] = transfer recipients (= pop. over 65 + unemployed) as a fraction of the total population.
- Column [12] = average transfers per recipient as a fraction of GDP per capita.

close to 10%, with more than half of this gain coming from the induced increase in the private investment rate.

The net welfare gains derived from such a policy, however, are difficult to assess and may even be negative in at least some of the countries. First, it must be recognized that the direct welfare gain arising from the proposed policy would be considerably smaller than the long-run output increase. The reason is that most of the long-run output gain comes from investment financed by the deferral of consumption. Secondly, these benefits must be compared with the costs of the expenditure cuts, including a lower level of social protection and a lower degree of redistribution.

While these costs are extremely difficult to quantify, a first indication of the scope for expenditure reductions may be obtained by comparing the existing levels of social protection in the different countries in our sample. Columns [9]-[11] of Table 12 give us three rough indicators: the share of transfers to households in GDP in 1995, the weight of the "recipient population" in the total (computed as the ratio of the sum of the number of unemployed and the population over sixty five to the total population) and the level of transfer payments per recipient, expressed as a fraction of GDP per capita. There are large differences across countries in benefit levels per recipient, and smaller but still significant ones in the size of the recipient population. Average transfers per recipient are about equal to income per capita in the EU as a whole, and fall signficantly below this level only in the three poorest countries in our sample and in the UK. Since these four countries also present the lowest levels of public spending relative to GDP, it may be difficult to argue that further expenditure cuts should be implemented, and in fact there may be some room for tax increases and a rise in social protection levels. In the richer members of the Union, where both benefit and overall expenditure levels are higher, the case for expenditure cuts is probably clearer.

8.- Summary and conclusions

This paper has investigated the impact of taxes and public expenditures on economic growth. After a brief review of the literature, we have sketched an extension of Barro's (1990) model which describes the main channels thorugh which fiscal policy variables may influence aggregate income and social welfare. The central sections of the paper report the results of an empirical investigation of growth and fiscal policy using panel data for a sample of OECD countries. The results of the exercise are then used to provide quantitative estimates of the likely effects of expenditure cuts and investment increases in the member countries of the European Union, taking as a reference their observed policy stand in the period 1990-95.

Our empirical results suggest that fiscal policy influences growth through three main channels. First, the government contributes directly to factor accumulation through public investment in infrastructure and other assets. Second, public expenditure tends to crowd out private investment by reducing private disposable income and the incentive to save. Third, we find evidence of a sizable negative externality effect of government on the level of productivity.

Public infrastructure investment seems to present sharply diminishing returns. While its marginal contribution to productivity growth is very large at low expenditure levels, it declines rapidly and it may even become negative for values of the public investment ratio within the range observed in our sample. Taking as a reference the levels of public investment observed during the period 1990-95, we estimate that an increase in the public investment rate by half a point of GDP would have a significant positive effect on medium-term growth and long-term income in Belgium, the Netherlands, Denmark and the UK. For the remaining EU countries we find that the effect of such a policy change would be small and even negative in some cases. Some allowance should be made, however, for the fact that estimates will tend to underestimate the return on public investment in countries where the stock of infrastructure is low in relation to the endowment of other productive factors.

The effect of fiscal policy variables on private capital formation seems to be quite important. According to our estimates, each $1 increase in government expenditures reduces private investment by about $0.32. This crowding out effect is smaller (by about one half) for transfers to households than for other expenditures, presumably because this item does not represent a net withdrawal of resources from the private sector. The net impact of current subsidies to enterprises and public investment on private capital formation is positive, but it should be noted that the induced investment seems to be smaller than the amount of the subsidy.

Perhaps our most striking finding is that an increase in the size of government tends to reduce output for given stocks of productive factors. This negative "externality" effect is quite significant: according to our estimates, an increase in public expenditure by a point of GDP reduces national income by 0.33% in the short run. This figure is too large to be due primarily to the mismeasurement of public output and, as far as we can tell, is not due to reverse causation.

Our empirical model predicts that a reduction of total government expenditures by five points of GDP (holding constant public investment and the share of transfers to households in total expenditure) would increase the annual growth rate of the average EU country by two thirds of a point in the medium term, and raise its long-term income level by almost 10%. It may be dangerous, however, to interpret these estimates too literally as an indication of the expected effect of a reduction of public expenditures on national income. In addition to the measurement problems already mentioned, it must be kept in mind that the distortions that our estimates presumably capture probably have more to do with the extent to which government interferes with private incentives and the efficient functioning of markets and firms than with the size of the public sector per se. Although it is likely that the two things will go roughly hand in hand, expenditure cuts will not necessarily translate into an automatic and proportional reduction of the relevant distortions.

Subject to this qualification and the inevitable doubts about whether our estimates are in fact capturing a causal relationship running from government to growth, our results do suggest that limiting the size of the public sector and the extent of government intervention in the economy may bring substantial benefits in terms of output gains. It does not necessarily follow, however, that the same policies will increase welfare. If our estimates are correct, the cost in terms of foregone output of social protection, income redistribution, market regulation and other public activities is substantial, but there is little doubt that so are their benefits, although these are harder to measure because they are seldom reflected in the national accounts.

APPENDIX 1: FISCAL POLICY IN A SIMPLE GROWTH MODEL

This Appendix contains a more formal analysis of the model sketched in Section 3 of the text. We extend Barro's (1990) model to allow for productive and unproductive government expenditures and transfer payments and examine the impact of government decisions on the equilibrium path of a competitive economy.

As in the text, we assume an aggregate production function of the form

(1) $Y = \theta^{\gamma} K^{\alpha} G^{\beta} (AL)^{1-\alpha-\beta}$

where Y is national output, K the stock of private capital, G government-provided productive services, L employment and A an index of labour-augmenting technical efficiency which grows over time at an exogenous rate g. The term θ^{γ} captures an externality associated with the share of government in the economy, and the coefficient γ may be either positive or negative in principle, depending on the size of the relevant effects.

We will assume that the government finances its operations through a flat-rate tax on income. Tax proceeds are used to finance the provision of productive services (p), to finance public consumption (c) and to make lump-sum transfers to the population (T). We will further assume that the government runs a balanced budget each period, and that expenditure on each of these categories is a fixed fraction of GDP (e.g. $G = \theta_p Y$). Hence, the government budget constraint can be written in the simple form

(2) $\tau = \theta_c + \theta_T + \theta_p \equiv \theta$

where τ is the tax rate and θ_i denotes the fraction of GDP devoted to each of the three types of public expenditure we consider.

1.- Household behaviour

A representative household or dynasty maximizes utility taking as given factor prices, the time path of government expenditures and other policy parameters. We will assume that the instantaneous utility function of each member of the household is of the form

(3) $U(C, E) = \mu \ln C + (1-\mu) \ln E$

where C is private per capita consumption and E total government expenditures per capita. The problem faced by the agent is of the form

(P.H) Max $\int_0^{\infty} [\mu \ln C_t + (1-\mu) \ln E_t] L_t e^{-\rho t} dt$

s.t (4) $\dot{K}_t = (1-\tau)\theta^{\gamma} K_t^{\alpha} G_t^{\beta} (A_t L_t)^{1-\alpha-\beta} + L_t T_t - L_t C_t - \delta K_t$

where L_t is the "size of the household" (i.e. population), which is assumed to grow at a constant rate n, and δ the rate of depreciation.

Differentiating the current value Hamiltonian,

$H^c = \mu L \ln C + (1-\mu) \ln E + \lambda [(1-\tau)\theta^{\gamma} K^{\alpha} G^{\beta} (AL)^{1-\alpha-\beta} + LT - LC - \delta K]$, with respect to the control (C) and state (K) variables we obtain the following necessary conditions for an optimum:

(5) $\frac{\partial H^c}{\partial C} = \frac{\mu L}{C} - \lambda L = 0$ and

(6) $-\frac{\partial H^c}{\partial K} = -\lambda[(1-\tau)\theta^\gamma \alpha K^{\alpha-1} G^\beta (AL)^{1-\alpha-\beta} - \delta] = \dot{\lambda} - \rho\lambda$

or, rearranging this last expression

(6') $\frac{\dot{\lambda}}{\lambda} = \rho + \delta - (1-\tau)\alpha\theta^\gamma K^{\alpha-1} G^\beta (AL)^{1-\alpha-\beta}$,

where the costate variable, λ, can be interpreted as the shadow price of wealth (in utility units).

Equations (5) and (6) can be consolidated into a single differential equation describing the time path of private consumption. Taking logs of both sides of (5) and differentiating with respect to time, we have

$$\ln C = \ln \mu - \ln \lambda \Rightarrow \frac{\dot{C}}{C} = -\frac{\dot{\lambda}}{\lambda}.$$

and substituting (6') into this expression

(7) $\frac{\dot{C}}{C} = (1-\tau)\alpha\theta^\gamma K^{\alpha-1} G^\beta (AL)^{1-\alpha-\beta} - \rho - \delta.$

Using the government budget constraint and the homogeneity of the production function we can rewrite equations (4) and (7) in a way which will be more convenient below. First, notice that since public transfers are a constant fraction of income, we have

(8) $(1-\tau)Y_t + L_t T_t = (1-\tau+\theta_T)Y_t = (1-\theta_c-\theta_p)Y_t$

where $\theta_c + \theta_p$ measures the net transfer of resources from the private to the public sector.

Next, define the following normalized variables

(9) $c = \frac{C}{A}$, $Z = \frac{K}{AL}$ and $P = \frac{G}{AL}$

and observe that

$$Y = \theta^\gamma K^\alpha G^\beta (AL)^{1-\alpha-\beta} = AL\theta^\gamma \left(\frac{K}{AL}\right)^\alpha \left(\frac{G}{AL}\right)^\beta = AL\theta^\gamma Z^\alpha P^\beta.$$

Hence, output per capita, Q, is given by

(10) $Q \equiv \frac{Y}{L} = A\theta^\gamma Z^\alpha P^\beta$

and the marginal product of capital (R) can be written

(11) $R \equiv \alpha\theta^\gamma K^{\alpha-1} G^\beta (AL)^{1-\alpha-\beta} = \alpha\theta^\gamma Z^{\alpha-1} P^\beta.$

Substituting (8) and (10) into (4), the law of motion of the capital stock can be written

$$\dot{K}_t = (1-\tau)\theta^\gamma K^\alpha G^\beta (AL)^{1-\alpha-\beta} + LT - LC - \delta K$$
$$= (1-\theta_c-\theta_p)\theta^\gamma ALZ^\alpha P^\beta - LC - \delta K$$

and, using this expression and noting that $\dot{Z}/Z = \dot{K}/K - g - n$,

$$(12)\ \frac{\dot{Z}}{Z} = (1-\theta_c-\theta_p)\,\theta^{\gamma}Z^{\alpha-1}P^{\beta} - \frac{c}{Z} - (g+n+\delta).$$

Similarly, observing that

$$\frac{\dot{c}}{c} = \frac{\dot{C}}{C} - g$$

and using (11) in (7), we have

$$(13)\ \frac{\dot{c}}{c} = (1-\tau)\alpha\theta^{\gamma}Z^{\alpha-1}P^{\beta} - (\rho+\delta+g).$$

2.- Equilibrium and dynamics

So far we have not discussed how G (or P) is determined. Let us consider the simplest alternative. Suppose G is not a stock of capital but a flow of productive services financed by current taxes. In particular, suppose $G = \theta_p Y$. Then

$$ALP = G = \theta_p Y = \theta_p AL\theta^{\gamma}Z^{\alpha}P^{\beta}$$

and, solving for P,

$$(14)\ P = \theta^{\gamma}\theta_p^{1/(1-\beta)}Z^{\alpha/(1-\beta)}.$$

Using this expression in (10) and (11), output per capita and the interest factor are given by

$$(15)\ Q = A\theta^{\gamma}Z^{\alpha}P^{\beta} = A\,\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)}$$

and

$$(16)\ R = \theta^{\gamma}Z^{\alpha-1}P^{\beta} = \theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{[\alpha/(1-\beta)]-1}.$$

Substituting these expressions into (12) and (13) and noting that $\tau = \theta$ we arrive finally at a system of differential equations in c and Z parameterized by the different expenditure shares, θ_i,

$$(17)\ \dot{c} = [(1-\theta)\alpha\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{[\alpha/(1-\beta)]-1} - (\rho+\delta+g)]\,c \equiv \phi(c, Z; \theta_p, \theta)$$

$$(18)\ \dot{Z} = (1-\theta_c-\theta_p)\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)} - c - (g+n+\delta)Z \equiv \varphi(c, Z; \theta_c, \theta_p, \theta)$$

Equation (18) is a resource constraint. It simply says that the increase in the capital stock is equal to household disposable income minus consumption and depreciation. Equation (17) characterizes the optimal path of private consumption over time. Household optimization implies that the growth rate of per capita consumption is equal to the difference between the net of tax interest rate and the rate of intertemporal discount.

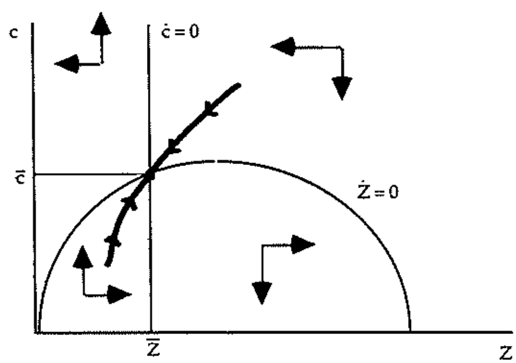
Fiscal policy parameters enter equations (17) and (18) in a number of ways. Productive expenditures (θ_p) directly affect the level of productivity because they enter the production function as an input. Total expenditures will have a similar (positive or negative) effect through the government externality term. Through the same channels, these expenditure shares affect the marginal productivity of private capital and through it the return on investment and the intertemporal allocation of consumption. With the exception of transfers, public expenditures also reduce the amount of resources available for private sector consumption and factor accumulation, as shown in equation (18). Income taxation, moreover, interferes with the efficient allocation of consumption over time, reducing the payoff to investment and discouraging private factor accumulation. Equation (17) shows that this incentive effect depends on the overall tax rate. Hence, the effects of changes in productive expenditure policies will depend in part on whether they are financed by offsetting changes in "non-productive" expenditures or through changes in taxation.

Using these equations we can analyze the dynamics of consumption and capital accumulation. From (17) and (18) we see that

$$(19)\ \dot{Z} \geq 0 \Leftrightarrow c \leq (1-\theta_c-\theta_p)\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)} - (g+n+\delta)Z \equiv c_s(Z),$$

$$(20)\ \dot{c} \geq 0 \Leftrightarrow R(Z) \equiv (1-\tau)\alpha\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{[\alpha/(1-\beta)]-1} \geq g+\rho+\delta.$$

Figure 1: Phase diagram and convergent trajectory



The phase diagram is shown in Figure 1. The direction of the arrows of motion suggests that the steady state is a saddle point. To verify this, we compute the determinant of Jacobian matrix of the system evaluated at the steady state:

$$(21)\ J = \begin{bmatrix} \phi_c & \phi_z \\ \varphi_c & \varphi_z \end{bmatrix} = \begin{bmatrix} 0 & \phi_z \\ -1, & \varphi_z \end{bmatrix}.$$

Since

$$\det J = \lambda_1 \lambda_2 = \phi_z = (1-\tau)\alpha\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}\frac{\alpha+\beta-1}{1-\beta} Z^{[\alpha/(1-\beta)]-2}\,\bar{c} < 0,$$

the eigenvalues of the system, λ_1 and λ_2, are real numbers of opposite sign and the steady state is indeed a saddle. Using the transversality condition for the household problem, it can be shown that the equilibrium path for this economy is the unique solution to the system (17)-

(18) which satisfies the initial condition $Z(0) = Z_o$ (a given constant) and converges to the steady state.

The graph of the convergent solution of the system implicitly defines a policy function giving the optimal value of normalized consumption (and implicitly the equilibrium level of investment) as a function of the current value of the state variable, Z, and the different policy parameters. It can be shown that this function may be rewritten as a savings function relating the optimal investment ratio, s*, to the rate of return on private capital and the policy parameters,

$$s^* = \phi(R; \theta_c, \theta_T, \theta_r, \theta_p).$$

The empirical investment function we will estimate later on can be interpreted as an approximation to this policy function.

3.- Steady state and long-term effects of policy changes

We will now analyze the effects of a change in the various components of government expenditures. In accordance with our empirical results, we will assume that the parameter γ, which captures the externality effect of government, is negative.

The first step is to determine the effect of the policy change on the steady-state values of consumption and the capital/labour ratio, given by the solution of the system:

$$(19') \quad \dot{Z} = 0 \iff c = (1-\theta_c-\theta_p)\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)} - (g+n+\delta)Z$$

$$(20') \quad \dot{c} = 0 \iff R(Z) \equiv (1-\theta)\alpha\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{[\alpha/(1-\beta)]-1} = g+\rho+\delta.$$

It is easy to check that increases in the shares of public consumption and transfer expenditures in GDP (θ_c and θ_T) shift the $\dot{c} = 0$ line to to the left, reducing the steady-state capital/labour ratio. Since these parameter changes also shift the $\dot{Z} = 0$ line downward, the net effect of an increase in "non-productive" government expenditures is to reduce the steady-state level of private consumption. In the case of productive expenditures, things are somewhat more complicated since an increase in θ_p has a direct positive effect on output and on the rate of return on private investment. It can be shown that these positive effects prevail at low expenditure levels but are eventually overcome by the negative effects of the additional expenditure through increased taxes, the negative externality effect of government and the reduction of private disposable income. Hence, both the level of consumption and the capital-labour ratio increase at first with θ_p until a maximum is reached and decline thereafter.

The short-run effects of these various policy changes will involve a discrete change in consumption with a constant capital/labour ratio which will put the economy on the convergent path corresponding to the new parameter values. If the new long-run equilibrium involves a higher income level, the rate of factor accumulation will increase, inducing a temporary rise in the growth rate of income which will gradually exhaust itself as a new long-run equilibrium is approached.

To explore the welfare implications of a hypothetical policy change, notice that the instantaneous utility of the representative agent can be written in terms of the logarithms of income per capita, the average consumption ratio ($\eta = C/Q$) and the share of government in GDP:

$$(22)\ U(C_t, E_t) = \mu \ln C_t + (1-\mu) \ln E_t = \mu \ln \eta_t Q_t + (1-\mu) \ln \theta Q_t$$
$$= \ln Q_t + \mu \ln \eta_t + (1-\mu) \ln \theta.$$

As we have seen, increases in many expenditure categories will tend to reduce both Q and η but will also have a direct positive effect on utility through the last term in this expression. Hence, their net welfare effect will depend on the initial policy stance and the weight of public expenditures in the representative agent's utility function. In general, the optimal policy (i.e. the one which mazimizes the integral of (22)) will involve strictly positive values of all expenditure shares.

If we restrict ourselves to the steady state, equation (22) can be written as a relatively simple function of the relevant expenditure shares. Solving equation (20') for Z, the steady-state capital/labour ratio is given by

$$(23)\ \bar{Z} = \left(\frac{(1-\theta)\alpha\theta_p^{\frac{\beta}{1-\beta}}\theta^{\frac{\gamma}{1-\beta}}}{g+\delta+\rho}\right)^{\frac{1-\beta}{1-\alpha-\beta}}.$$

Substituting this expression into (15), steady-state output per efficiency unit of labour is given by

$$(24)\ \frac{\bar{Q}_t}{A_t} = \theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)} = \theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}\left(\frac{(1-\theta)\alpha\theta_p^{\frac{\beta}{1-\beta}}\theta^{\frac{\gamma}{1-\beta}}}{g+\delta+\rho}\right)^{\frac{\alpha}{1-\alpha-\beta}}$$
$$= \theta_p^{\beta/(1-\alpha-\beta)}\theta^{\gamma/(1-\alpha-\beta)}(1-\theta)^{\alpha/(1-\alpha-\beta)}\left(\frac{\alpha}{g+\delta+\rho}\right)^{\frac{\alpha}{1-\alpha-\beta}}.$$

Next, we compute the steady-state consumption ratio, $\bar{\eta}$. Using equations (19') and (20') we have

$$(25)\ \bar{\eta} = \frac{\bar{c}}{(\bar{Q}_t / A_t)} = \frac{(1-\theta_c-\theta_p)\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)} - (g+n+\delta)Z}{\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{\alpha/(1-\beta)}}$$
$$= (1-\theta_c-\theta_p) - \frac{g+n+\delta}{\theta_p^{\beta/(1-\beta)}\theta^{\gamma/(1-\beta)}Z^{[\alpha/(1-\beta)]-1}} = (1-\theta_c-\theta_p) - \frac{(1-\theta)\alpha(g+n+\delta)}{g+\rho+\delta}.$$

Hence, the steady-state propensity to invest out of disposable income, given by the last term in this expression, is a decreasing function of the average tax rate, θ.

Substituting (24) and (25) into (22), steady-state instantaneous utility can be written

$$(26)\ U(C_t, E_t) = \ln A_t + \ln \frac{\overline{Q}_t}{A_t} + \mu \ln \overline{\eta} + (1-\mu) \ln \theta$$

$$= \ln A_o + gt + \ln\left(\theta_p^{\beta/(1-\alpha-\beta)} \theta^{\gamma/(1-\alpha-\beta)} (1-\theta)^{\alpha/(1-\alpha-\beta)} \left(\frac{\alpha}{g+\delta+\rho}\right)^{\frac{\alpha}{1-\alpha-\beta}} \right) +$$

$$+ \mu \ln\left((1-\theta_c-\theta_p) - \frac{(1-\theta)\alpha(g+n+\delta)}{g+\rho+\delta} \right) + (1-\mu) \ln \theta.$$

Differentiating this expression with respect to each expenditure share we can calculate its impact on steady-state utility. Total welfare effects, taking into account the transition, will generally be of the same sign as steady-state effects but smaller in magnitude because output changes build up slowly over time and are partially offset by temporary changes in the consumption rate in the opposite direction.

APPENDIX 2: DATA AND DETAILED RESULTS

1.- Data

The data used in this study have been assembled from a variety of sources. Basic macroeconomic aggregates corrected for differences in purchasing power (output, total investment, private and public consumption and the current account) are available in the latest update (PWT5.6) of the Summers and Heston data set (S-H 1991) and in the data base constructed by Doménech and Boscá (D&B, 1996) for the OECD countries. Where possible we rely on this second source, since it provides data up to 1995 (whereas S-H typically stops in 1992) and it uses OECD-specific purchasing power parities which should provide a more accurate picture of the relative performance of the countries in our sample than those used by S-H (constructed for a much larger set of countries). This data base also provides some data on the age structure of the population (the fraction of the population aged 15 to 64) and on the evolution of employment and the labour force. Data on human capital investment are taken from UNESCO Yearbooks. The series on R&D expenditures have been constructed by combining information from the OECD's Basic Science and Technology Statistics and UNESCO Yearbooks (see de la Fuente (1997) for details).

Table 1: Economic classifications of public expenditure, OECD (1996) vs. EEC (1996)

OECD (1996)		*EEC (1996)*
1.- Current expenditure:		
a.- Consumption: purchases of goods and services and salaries of public employees	=	*8.- Government consumption*
b.- Subsidies: mainly subsidies to enterprises	=	*6a.- Current transfers to enterprises*
c.- Other current transfers: mostly social security benefits and social assistance grants	=	*6b.- Current transfers to households* *6c.- Current transfers to the rest of the world*
d.- Property income: mostly interest payments on the national debt.	=	*7.- Actual interest payments*
2.- Capital expenditures:		
a.- Gross capital formation: gross public investment	=	*12.- Final capital expenditure*
b.- Other capital expenditure: capital transfers to enterprises, purchases of land and intangible assets.		*11.- Net capital transfers paid*

Most of our data on government expenditures and tax revenues have been constructed by combining information from the OECD (1996) Statistical Compendium and the European Commission's (1996) compilation of government finance data. Both sources provide "economic" breakdowns of expenditures which are roughly compatible with each other (see Table 1) and data on consolidated government tax revenue and other receipts. The EEC data cover the period 1970-95 (plus projections until 1988), while the OECD series start (at best) in 1960 and typically end in 1993.

Table 2: Main differences between EEC (1996) and OECD (1996)

- *Largest discrepancies between the two sources:* (figures inside parenthesis are the largest % difference between the two series in the same year; we report only differences over 10%)

GCONS: Po (9%), Gr (over 40%), Sp: around 15% with national sources for years prior to 1980.

SKG: Be (16%), Dk (23%), Gr (31%), Ir (29%), Sp (12%), US (50%).

TRHH: Dk (11%), Fr (12%), Ge (12%, up to 27% after unification), Gr (29%), Ir (27%), Sp (31%), UK (22%).

INTER: Gr (23%), Nl (24%).

GTOT: Po in mid 80's (23% in 1985).

SUBSID: Fr (32%), Ge (13%), Gr (100%), Ir (80%), Nl (60%), Po (21%), Sp (60%), Swe (45%).

TAX: Gr (20%).

- *Other notes:*

SKG: In the case of Germany we take the OECD data for the period after unification since this series refers to West Germany, as do our output figures. For Japan and Austria the two sources coincide almost exactly when we add the OECD figures for 'gross capital formation' and 'other capital expenditure' (transfers to enterprises, purchases of land and intangible asssets included), otherwise the OECD figures are significantly lower than EEC ones (unlike for other countries). For the years prior to 1970 we have used the OECD data after adding these two concepts. It should be noted, however, that it is possible that the EEC data may overstate public capital formation for these two countries.

INTER: For Germany and Japan we used OECD data until 1978 and 1974 respectively. The two sets of figures were quite similar, but the evolution of the OECD series seemed more reasonable. (Rounding to one decimal in the EEC case may distort things when the numbers are small).

GTOT: The OECD does not report 'other capital expenditure' for Norway. Since this expenditure category is generally rather small, we summed the remaining expenditures to compute GTOT.

SUBSID: The differences between the two sources do not diminish when we combine current and capital transfers to enterprises.

- *Note:* See Table 1 in the text for a definition of the variables.

To maximize the number of available observations we have pooled the two series using the following procedure. For each variable (measured as a share of GDP at current prices), we compare the figures provided by the two sources over common years. If the differences are relatively small (under 10%) at least in the first part of the 1970's, we use the OECD data to extend the EEC series backwards; otherwise the OECD data are disregarded. For countries not included in the EEC report, we use the OECD series except where noted below.

The match between the two sources is rather uneven. The differences are minor for most countries in the case of total government expenditures (GTOT), tax receipts (TAX), public consumption (GCONS) and interest payments (INTER), and quite sizable for government investment (SKG), transfers to households (TRHH) and current subsidies to enterprises (SUBSID). Finally, the two sets of figures bear almost no resemblance to each other in the case of the government surplus (SURP) and other transfers, so we have made no attempt to "collate" these series.

Table 2 lists the major discrepancies between our two main sources and notes a few anomalies we have discovered in the data. Greece is by far the most problematic case but there also rather large differences between the two sources for a number of other countries. In some cases these differences are large enough to give a very different picture of a country's relative position in the sample. Public investment figures for the US, for example, differ by around 50% throughout the sample period.

Table 3: Sample averages by subperiod

	1965-70	*1970-75*	*1975-80*	*1980-85*	*1985-90*	*1990-95*
GYPE	0.0415	0.0277	0.0211	0.017	0.0158	0.0182
GYPC	0.0407	0.0265	0.02486	0.0156	0.0247	0.0109
SK	0.2428	0.2461	0.2265	0.2103	0.2139	0.2071
SKPR	0.2073	0.2067	0.1935	0.1792	0.1834	0.1744
SH2	0.1694	0.2063	0.2324	0.2488	0.2559	0.2529
CASRD	0.0107	0.0114	0.01185	0.01217	0.01287	0.01364
GTOT	0.3181	0.3663	0.4266	0.4671	0.4706	0.4936
TAX	0.2934	0.3222	0.3523	0.3754	0.3918	0.3978
TAXBF	0.2651	0.2936	0.3208	0.3433	0.361	0.3653
SURPBD	-0.0144	-0.0202	-0.0456	-0.0559	-0.034	-0.0293
SURPEU	n.a.	-0.0048	-0.031	-0.0514	-0.035	-0.0482
GINVR	0.04426	0.04147	0.03718	0.0324	0.0297	0.0305
ASGR	0.1871	0.1869	0.1977	0.2034	0.1985	0.1641
GCONSR	0.191	0.187	0.198	0.204	0.199	0.198
TRHH	0.087	0.111	0.139	0.157	0.162	0.181
SUBSID	0.0173	0.0209	0.0292	0.0304	0.0278	0.0254
INTER	0.01669	0.01842	0.02615	0.04517	0.05474	0.05775

- *Notes:* Averages over available observations in each subperiod. See Table 1 in Section 4c of the text for a definition of the variables.

The data used in the empirical analysis are overlapping six-year averages (over five-year subperiods, including both endpoints) of the different tax and expenditure shares in GDP. For total government expenditures, tax receipts, government surplus, transfers to households and subsidies to enterprises we use nominal shares (i.e. measured at current prices in the national currency). In the case of government consumption and public investment, we compute real shares (i.e. measured in constant international prices of the base year) by using the PPP indices provided by Doménech and Boscá (D&B 1996) for government consumption and total investment.

Table 3 shows the sample averages of various growth, investment and fiscal indicators in each of the five-year subperiods in which we have divided the sample.

2.- Benchmark growth and investment equations

The benchmark growth equations used in the text have been selected after some experimenta-tion with various specifications loosely based on recent work on the empirics of growth.[11] All our estimates of the basic growth equation [G.1] control for initial income per capita to capture the well-documented tendency of poorer countries in our sample to grow faster than richer ones -- presumably due to the operation of decreasing returns and the diffusion of technology. We also include a set of demographic and labour market indicators to capture the impact of these variables on the growth of income per capita. Finally, our preferred specification (equation [A.2] in Table 4 = [G.1] in the text) includes also a dummy for the less technologically advanced countries at the beginning of the sample period and the product of this variable and a trend. These two variabls attempt to control in a simple way for technological diffusion. Comparison of equations [A.1] and [A.2] in Table 4 shows that controlling for technological catch-up improves somewhat the fit of the equation and does not significantly alter most of the remaining coefficients.

Equations [B] and [C] in Table 4 extend the previous specifications by adding three indicators of investment in physical, human and technological capital. Equations [B.1] and [B.2] include the (log of) the real share of investment in GDP and differ only in that [B.2] controls for catch-up while [B.1] does not. Our results are qualitatively similar to those of Mankiw, Romer and Weil (1992) and Lichtenberg (1992). All the investment variables are significant and their coefficients have the expected signs. Once more, the catch-up variables are significant but their inclusion does not significantly affect the coefficients of the other regressors. Since we will want to introduce public investment as a separate regressor, we reestimate these last two equations after replacing the total investment ratio with the private

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[11] See Barro (1991a), Barro and Sala (1992) and Mankiw, Romer and Weil (1992). De la Fuente (1997a) contains a survey of the relevant literature.

investment ratio. Although we lose 23 observations in the process, the results (equations [C.1] and [C.2] = [G.2]) are very similar to those of the previous specifications.

Table 5 contains several specifications of the investment equation. In equations [D.1] and [D.2] the dependent variable is the (real) share of total investment in physical capital in GDP (SK), and in [D.3] and [D.4] this variable is replaced by the private investment ratio. Two of the specifications contain a trend and a square trend and the other two do not. Since both these variables are highly significant and we want to focus on the behaviour of private investment, our preferred equation is [D.4].

Table 4: Benchmark growth regressions

	[A.1]	*[A.2] = [G.1]*	*[B.1]*	*[B.2]*	*[C.1]*	*[C.2]=[G.2]*
depend. var =	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*
constant	0.05613	0.0205	0.1485	0.1092	0.1388	0.052
	(1.77)	(0.56)	(4.45)	(2.84)	(3.77)	(1.20)
T	-0.001213	-0.00014	-0.000924	-0.001265	-0.00121	-0.002
	(2.33)	(2.57)	(1.83)	(2.31)	(2.01)	(3.16)
T^2	0.000027	0.00003	0.000026	0.000035	0.000033	0.00005
	(1.91)	(2.31)	(2.02)	(2.60)	(2.08)	(3.34)
GTAC	0.38475	0.453	0.36	0.4083	0.4146	0.535
	(2.69)	(3.19)	(2.79)	(3.21)	(2.76)	(3.74)
DU	-1.087	-1.068	-1.034	-1.035	-0.9788	-0.974
	(6.56)	(6.59)	(6.93)	(7.11)	(6.15)	(6.57)
LDGNPOB	-0.01747	-0.0247	-0.0193	-0.02764	-0.0226	-0.043
	(1.63)	(2.26)	(1.98)	(2.73)	(2.07)	(3.79)
LYPC	-0.02589	-0.0202	-0.04015	-0.0341	-0.0386	-0.028
	(7.71)	(3.58)	(8.53)	(5.29)	(6.30)	(3.41)
ZLAG5		0.0148		0.0137		0.0255
		(2.47)		(2.42)		(3.87)
ZLAG5T		-0.00065		-0.00064		-0.00106
		(2.71)		(2.82)		(4.05)
LSK			0.016377	0.01574		
			(4.08)	(3.99)		
LSKPR					0.0147	0.0134
					(3.20)	(3.14)
LSH2			0.00768	0.01025	0.0097	0.013
			(2.28)	(2.99)	(2.54)	(3.55)
LCASRD			0.006	0.0051	0.0056	0.00425
			(3.75)	(3.20)	(2.92)	(2.34)
R^2	0.6522	0.6731	0.7313	0.7489	0.6886	0.7374
N	126	126	126	126	103	103

Notes:
- Pooled data for 21 OECD countries covering the period 1965-95 at five-year subintervals.
- t-statistics in parentheses below each coefficient.
- N = number of observations
- The dependent variable is GYPC = avge. growth rate of real output per capita during the period.
- LDGNPOB = LOG (0.05 + GPOB) where GPOB = growth rate of population growth. This variable is similar to the one used by MRW (1992).

Table 5: Benchmark investment regressions

dep. var =	SK [D.1]	SK [D.2]	SKPR [D.3]	SKPR [D.4] = [I]
constant	0.01587	-0.1628	-0.0503	-0.1508
	(0.17)	(1.61)	(0.52)	(1.49)
LYPC	-0.0791	-0.0707	-0.0836	-0.091
	(7.95)	(6.17)	(7.95)	(7.25)
DEP	-0.03413	-0.0291	-0.01979	-0.0205
	(3.51)	(3.03)	(2.19)	(2.30)
AF1564	0.4046	0.5653	0.4271	0.5095
	(2.98)	(4.15)	(3.25)	(3.89)
1/PI	0.233	0.253	0.227	0.249
	(10.38)	(11.55)	(9.65)	(10.76)
GPOB	1.80	2.10	1.81	2.33
	(2.90)	(3.48)	(3.20)	(4.13)
T		0.00445		0.00583
		(2.68)		(3.41)
T^2		-0.000156		-0.00016
		(3.55)		(3.67)
R^2	0.5832	0.6445	0.6027	0.6531
N	126	126	103	103

3.- Some econometric issues and preferred linear specification

The low value of the Durbin-Watson statistic in all the specifications of the investment equation presented in Section 4.c of the text is a clear symptom of the existence of positive serial correlation of the residuals. In the present context, this result suggests that the omission of relevant variables is causing the error terms for certain countries to be systematically positive or negative. One possible solution for this problem is to include in the equation a set of country dummies in order to pick up any unobserved country effects which may account for the residual pattern. This procedure, however, can also have an adverse effect on the quality of the estimates. Since adding a full set of country dummies to the equation amounts essentially to disregarding the cross-section variation of the data (i.e. wiping out the differences between country averages), it may make it difficult to identify the coefficients of those explanatory variables which do not change very much over time within a given country. Seeking a compromise between these two problems, we have used an iterative procedure to select the lowest possible number of country dummies which will solve the autocorrelation problem.

The selection procedure was the following. 1) We estimated the investment equation adding one country dummy at a time. All those country dummies which were significant in this first round were then included together in the equation. Those which were not significant were dropped, leaving us with a first group of candidates. 2) A second group of candidates was chosen as follows. First, we estimated a model with a different intercept for each country (including a full set of country dummies and no regression constant), computed the average of the intercepts and selected as a reference the country closest to this average. Then, we run a series of regressions with different combinations of country dummies, starting with the full set (except for the reference country) and dropping at each stage those variables which were not significantly different from zero. The resulting candidate group was similar but not identical to the previous one. 3) Finally, we ran a regression including the union of the two candidate sets and dropped the insignificant variables.

Table 6: Various linear specifications of the growth and investment equations

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
specific. =	*[I]*	*[I]*	*[G.1]*	*[G.2]*	*[I]*	*[G.1]*	*[G.2]*	*[I]*
dep. var =	*SKPR*	*SKPR*	*GYPC*	*GYPC*	*SKPR*	*GYPC*	*GYPC*	*SKPR*
GTOT	-0.314	-0.316	-0.079	-0.0272	-0.319	-0.079	-0.027	-0.320
	(5.51)	(7.36)	(3.46)	(2.26)	(8.28)	(3.48)	(2.24)	(8.34)
SKG	0.613	0.545	0.845	0.578	0.533	0.847	0.655	0.534
	(2.81)	(3.45)	(2.25)	(1.71)	(3.75)	(2.25)	(1.94)	(3.75)
SKGSQ			-9.55	-8.08		-9.59	-9.46	
			(2.01)	(1.85)		(2.02)	(2.14)	
TRHH	0.302	0.142	0.063		0.144	0.064		0.144
	(3.42)	(2.31)	(2.11)		(2.61)	(2.12)		(2.62)
SUBSID	0.868	0.858	0.127		0.854	0.130		0.853
	(3.41)	(3.46)	(1.60)		(3.86)	(1.64)		(3.88)
GGTOT			-0.210	-0.162		-0.198	-0.156	
			(4.49)	(3.73)		(3.72)	(3.20)	
LSKPR				0.0176			0.0176	
				(3.50)			(3.34)	
LSH2				0.0105			0.0094	
				(3.34)			(2.87)	
LCASRD				0.0040			0.0047	
				(2.39)			(2.67)	
N	99	99	98	102	99	98	98	99
R^2	0.7903	0.9171	0.7841	0.7926	0.9170	0.7839	0.7959	0.9169
specification	OLS	OLS	OLS	SUR	SUR	2SLS	3SLS	3SLS
DW	0.931	2.01	2.31	2.23	2.00	2.30	2.32	1.99
country dummies	no	yes	no	no	yes	no	no	yes

Notes:
- Equations [G2] and [I] are estimated jointly either as a SUR or by 3SLS.
- The instruments used in the two and three-stage least squares estimates are all the variables in the equation except the growth rate of the share of government expenditures in GDP (GGTOT) plus the share of total government expenditures in GDP in the first year of the subperiod (GTOTBEG), the level and growth rate of the fraction of the population aged 65 or more (AF65 and GF65), the growth rate of population (GPOB), a dummy for the subperiod 1970-75 (Z3) and the number of years of left-leaning government during the subperiod (LEFT).

This left us with a final group of six significant country dummies, namely those for Ireland (-), Norway (+) the US (-), the UK (-), Spain (-) and Austria (+). (The symbol in parenthesis is the sign of the corresponding coefficient). A comparison of equations [1] and [2] in Table 6 shows that the inclusion of this group of dummies in the investment equation is sufficient to bring the Durbin-Watson statistic to a value close to two. The coefficients of the fiscal variables are not significantly affected by the change (with the exception of transfers (TRHH), whose coefficient falls by one half), but some of the demographic variables lose their signficance with the addition of the country effects.

Table 6 also shows the results of estimating the system formed by the productivity and investment equations ([G.1] and [I]) using two alternative techniques. Equations [4] and [5] are estimated jointly as a system of seemingly unrelated regressions (i.e. allowing for the possible correlation between the error terms of both equations) in order to increase the precision of the estimates. As a preliminary check on the possible endogeneity of the growth rate of the share of government expenditures in GDP, the same system is estimated by three-stage least squares (3SLS), using the same instruments as in Section 5 of the text. As can be seen in the table, instrumenting GGTOT has virtually no effect on its coefficient. This result suggests that the negative correlation between the expansion of the public sector and output growth is not spurious.

4.- The source of the externality effect

We would like to know whether it is possible to identify the negative externality effect of the public sector with any specific items of the government budget. So far we have relied on total government expenditures as an indicator of government size, but it may be argued that any negative effects of the public sector on productivity should arise mainly from the disincentives generated by distortionary taxes and transfer payments. Another possibility is that the externality effect may be associated with government consumption, as this variable provides a more direct measure of the actual size of the government bureaucracy (and hence of its capacity to do either good or harm by interfering with private activities) than total expenditures.

Table 7 presents OLS estimates of different versions of the growth equation (12) which differ in the indicator of government size. Somewhat surprisingly, we find that taxes do poorly as a proxy for government-induced distortions (equations [2] and [3]). The best results are obtained by working either with the share of total government expenditures in GDP (equation [1]) or with a combination of government consumption and transfer payments (equation [6]). Hence, both of these expenditure items may be responsible for some of the distortions which are presumably driving our results.

Finally, it is worth noting that the choice of a specific indicator of government size does not have too much of an effect on the estimated coefficients of other variables. We continue to detect a significant convergence effect (measured by the coeficient of initial income per capita, LYPC), and obtain reasonable estimates of the elasticity of output with respect to the stocks of private capital (between 0.25 and 0.30) and human (0.14-0.16) and R&D capital (0.05-0.07). Public capital is generally but not always significant and there is still evidence of non-linearities.

Table 7: Possible sources of the externality effect in the growth equation

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
LYPC	0.02965 (3.73)	0.0302 (3.43)	0.0306 (3.55)	0.0326 (3.72)	0.0241 (2.98)	0.0299 (3.56)	0.0293 (3.42)	0.0307 (3.64)
LSKPR	0.2472 (3.43)	0.2723 (3.58)	0.2692 (3.49)	0.2357 (2.90)	0.3052 (4.37)	0.2662 (3.74)	0.2707 (3.68)	0.2428 (3.19)
LSH2	0.1612 (3.50)	0.1744 (3.58)	0.181 (3.63)	0.1549 (3.05)	0.162 (3.44)	0.1413 (3.09)	0.1412 (3.01)	0.1403 (3.00)
LCASRD	0.0532 (2.35)	0.0678 (2.99)	0.0727 (3.30)	0.060 (2.53)	0.069 (3.13)	0.636 (2.99)	0.0657 (2.96)	0.0575 (2.52)
LSKG	0.1952 (2.06)	0.1684 (1.63)	0.1503 (1.40)	0.1652 (1.65)	0.217 (2.05)	0.2081 (2.13)	0.2075 (2.06)	0.2131 (2.21)
*SKG*LSKG*	-2.98 (1.70)	-3.07 (1.52)	-3.06 (1.43)	-2.90 (1.33)	-3.26 (2.11)	-3.26 (1.97)	-3.37 (1.93)	-3.28 (1.85)
GTOT	-0.1779 (4.16)							-0.099 (1.39)
TAX		-0.063 (1.28)					0.026 (0.53)	
TAXBF			-0.042 (1.01)					
GCONSR				-0.0609 (2.69)		-0.052 (2.36)	-0.0525 (2.35)	-0.039 (1.61)
TRHH					-0.106 (3.81)	-0.086 (3.07)	-0.092 (3.04)	-0.043 (1.04)
R^2	0.7915	0.7347	0.7492	0.7517	0.782	0.7953	0.7950	0.8002
s.e.	0.00706	0.00787	0.00776	0.00759	0.00720	0.00702	0.00709	0.00698

- *Note:* OLS estimates of equation (12) with different variables in the place of θ. We impose the restriction on the coefficients of GGOV and GOV implied by the theoretical model prior to estimation.

5.- Checking for endogeneity with an alternative measure of government size

In Section 5b of the text we have presented instrumental variables estimates of the growth and investment equations using a specification in which government size is measured by the share of total public expenditures in GDP. Table 8 repeats the experiment after replacing total government expenditures by the combination of government consumption (GCONSR) and transfers to households (TRHH) as measures of the size of the public sector. The estimates in

Table 8: Joint estimates of the growth and investment equations, government consumption and transfers to households are included as separate regressors

	[1]	[2]	[3]	[4]	[5]	[6]	[7]
dep. var. =	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*	*GYPC*
LYPC	0.0299	0.0305	0.0287	0.0293	0.032	0.0320	0.0234
	(3.56)	(3.94)	(3.35)	(3.73)	(3.38)	(3.70)	(2.65)
LSKPR	0.2662	0.305	0.279	0.318	0.270	0.312	0.348
	(3.74)	(5.00)	(4.04)	(5.47)	(3.37)	(4.65)	(5.58)
LSH2	0.1413	0.136	0.135	0.128	0.125	0.119	0.118
	(3.09)	(3.43)	(2.97)	(3.28)	(2.75)	(3.04)	(2.83)
LCASRD	0.0636	0.070	0.061	0.068	0.074	0.079	0.070
	(2.99)	(3.87)	(2.85)	(3.78)	(3.30)	(4.17)	(3.51)
LSKG	0.2081	0.181	0.243	0.219	0.235	0.215	0.320
	(2.13)	(2.11)	(2.43)	(2.52)	(2.36)	(2.46)	(3.04)
*SKG*LSKG*	-3.26	-2.98	-3.79	-3.55	-4.13	-3.94	-4.52
	(1.97)	(2.24)	(2.25)	(2.61)	(2.14)	(2.52)	(2.44)
GGCONSR	-0.052	-0.050	-0.061	-0.059	-0.048	-0.046	-0.021
	(2.36)	(2.55)	(2.59)	(2.85)	(1.93)	(2.13)	(0.71)
GTRHH	-0.086	-0.082	-0.081	-0.075	-0.076	-0.070	-0.100
	(3.07)	(3.31)	(2.49)	(2.64)	(1.98)	(2.11)	(2.18)
R^2	0.7950	0.7931	0.7934	0.7907	0.8021	0.7990	0.8025
s.e.	0.00709	0.0071	0.0071	0.0071	0.0072	0.0073	0.0073
N	99	99	98	98	88	88	85
dep. var. =	*SKPR*	*SKPR*	*SKPR*	*SKPR*	*SKPR*	*SKPR*	*SKPR*
LYPC	-0.0447	-0.0419	-0.0447	-0.0420	-0.0412	-0.0391	-0.0390
	(3.98)	(4.18)	(3.98)	(4.19)	(3.26)	(3.51)	(3.07)
GTOT	-0.316	-0.325	-0.316	-0.324	-0.306	-0.315	-0.319
	(7.36)	(8.54)	(7.36)	(8.52)	(6.54)	(7.68)	(5.93)
SKG	0.545	0.518	0.545	0.527	0.640	0.612	0.569
	(3.46)	(3.65)	(3.46)	(3.71)	(3.71)	(3.99)	(3.08)
TRHH	0.142	0.148	0.142	0.147	0.095	0.101	0.096
	(2.31)	(2.70)	(2.31)	(2.67)	(1.43)	(1.72)	(1.52)
SUBSID	0.858	0.846	0.858	0.852	1.09	1.08	1.20
	(3.46)	(3.87)	(3.46)	(3.90)	(3.77)	(4.26)	(3.07)
R^2	0.917	0.9166	0.917	0.9167	0.9218	0.9215	0.9222
s.e.	0.0125	0.0125	0.0125	0.0125	0.0125	0.0126	0.0126
N	99	99	99	99	89	89	86
INSTRUM			[A]	[A]	[B]	[B]	[C]
specific.	OLS	SUR	2SLS	3SLS	2SLS	3SLS	3SLS

- INSTRUM: In [A] and [B] we instrument only GTRHH AND GGCONSR; in [C] we instrument DU, SKG, LSKPR, GTOT, GGTOT, SUBSID, TRHH, GTRHH, GCONSR and GGCONSR with their lagged values plus AU, Z3, AF65, G65 and LEFT (plus all the "exogenous" regressors in the original system). The "outside" instruments used in the other specifications are: for [A], GF65, AF65, Z3, GCONSRBEG, TRHHBEG where the last two variables are the values of GCONSR and TRHH in the first year of the subperiod; for [B]: the same, replacing GCONSRBEG and TRHHBEG by GTRHH(-1), GGCONSR(-1), TRHH(-1) and GCONSR(-1).

the first column of this table are obtained by ordinary least squares and those in the second by an iterative SUR (seemingly unrelated regressions) procedure which exploits the cross-equation correlation of the error terms to improve the precision of the estimates. The remaining columns contain joint instrumental variables estimates of the two equations. As in the text, the "outside" instruments include the fraction of the population aged sixty five or over and the growth rate of this variable, the years of left-leaning government and either the lagged level and growth rate of each potentially endogenous variable or (in the case of the growth rate of the expenditure shares), the level of the variable at the beginning of the subperiod. (See the notes to the tables for a more precise list of instruments).

The results are now slightly worse than when we work with total government expenditures, with one of the variables losing its significance in some of the instrumental variables specifications. This finding suggests that it is safer to work with a single indicator of the overall size of government than to try to fine-tune the specification. When we proceed in this way, however, there is no reason to believe that our estimates of the externality coefficient are biased.

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