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Fiscal policy and growth: evidence from OECD countries

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Abstract

Is the evidence consistent with the predictions of endogenous growth models that the structure of taxation and public expenditure can affect the steady-state growth rate? Much previous research needs to be re-evaluated because it ignores the biases associated with incomplete specification of the government budget constraint. We show these biases to be substantial and, correcting for them, find strong support for the Barro model (1990, Government spending in a simple model of endogenous growth. Journal of Political Economy 98 (1), s103–117, for a panel of 22 OECD countries, 1970–95. Specifically we find that (1) distortionary taxation reduces growth, whilst non-distortionary taxation does not; and (2) productive government expenditure enhances growth, whilst non-productive expenditure does not. © 1999 Elsevier Science S.A. All rights reserved.

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1. Introduction

Does the share of government expenditure in output, or the composition of expenditure and revenue, affect the long-run growth rate? According to the neoclassical growth models of Solow (1956) and Swan (1956), the answer is

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largely 'no'. Even if the government could influence the rate of population growth, for example by reducing infant mortality or encouraging child-bearing, this would not affect the long-run growth rate of per capita income. In these models, tax and expenditure measures that influence the savings rate or the incentive to invest in physical or human capital ultimately affect the equilibrium factor ratios rather than the steady-state growth rate.

In endogenous growth models, by contrast, investment in human and physical capital *does* affect the steady-state growth rate, and consequently there is much more scope in these models for at least some elements of tax and government expenditure to play a role in the growth process. Since the pioneering contributions of Barro (1990), King and Rebelo (1990) and Lucas (1990), several papers have extended the analysis of taxation, public expenditure and growth, demonstrating various conditions under which fiscal variables can affect long-run growth (see, for example, Jones et al., 1993; Stokey and Rebelo, 1995; Mendoza et al., 1997).

If the theory is reasonably clear, however, the empirical evidence is not. As Stokey and Rebelo (1995, p. 519) state, ''recent estimates of the potential growth effects of tax reform vary wildly, ranging from zero to eight percentage points''. In fact, virtually no studies have been designed to test the predictions of endogenous growth models with respect to the *structure* of *both* taxation and expenditure in the way that we do here (Devarajan et al. (1996) do so for the expenditure side only). Moreover, few researchers have recognised that partial studies (e.g. those that focus exclusively on one side of the budget and ignore the other) suffer from systematic biases to the parameter estimates associated with the implicit financing assumptions. This point has been demonstrated by Helms (1985), Mofidi and Stone (1990) and Miller and Russek (1993) for various data sets. We explore the implications of this argument for the regression specification and show that, if this point is ignored, the bias to the estimates of the growth impact of fiscal variables can be substantial. This issue assumes greater importance as theory becomes more refined in its predictions of the impact of various sub-divisions of expenditure and taxation on growth.

In this paper we test specific predictions of recent public policy endogenous growth models such as Barro (1990) and Mendoza et al. (1997), paying careful attention to avoiding the source of bias just mentioned. Using the criteria proposed by these models to classify fiscal data, we examine the growth effects of fiscal policy for a panel of 22 OECD countries during 1970–95. We find: (i) considerable support for the predictions of Barro (1990) with respect to the effects of the structure of taxation and expenditure on growth; (ii) that mis-specification of the government budget constraint leads to widely differing parameter estimates which, in previous studies, have been mistaken for non-robustness; and (iii) that our results are robust to several changes in data classification or regression specification.

The remainder of the paper is organised as follows. In Section 2 we summarise the key predictions of recent public policy endogenous growth models and discuss the implications of the government budget constraint for empirical testing. The relevant empirical literature is outlined in Section 3. Section 4 then discusses our empirical methodology and results for our OECD sample, and Section 5 draws some conclusions.

2. Theoretical predictions

As is well known, public-policy *neoclassical* growth models (see, for example, Judd, 1985; Chamley, 1986) consign the role of fiscal policy to one of determining the level of output rather than the long-run growth rate. The steady-state growth rate is driven by the exogenous factors of population growth and technological progress, while fiscal policy can affect only the transition path to this steady-state. By contrast, the public-policy endogenous growth models of Barro (1990), Barro and Sala-i-Martin (1992), (1995) and Mendoza et al. (1997) provide mechanisms by which fiscal policy can determine both the level of output and the steady-state growth rate.

Predictions from these endogenous growth models are derived by classifying elements of the government budget into one of four categories: distortionary or non-distortionary taxation and productive or non-productive expenditures. Distortionary taxes in this context are those which affect the investment decisions of agents (with respect to physical and/or human capital), creating tax wedges and hence distorting the steady-state rate of growth. Non-distortionary taxation does not affect saving/investment decisions because of the assumed nature of the preference function, and hence has no effect on the rate of growth. Government expenditures are differentiated according to whether they are included as arguments in the private production function or not. If they are, then they are classified as productive and hence have a direct effect upon the rate of growth. If they are not then they are classified as unproductive expenditures and do not affect the steady-state rate of growth (see Barro and Sala-i-Martin, 1995, for a clear theoretical exposition).

These results can be extended in various ways, for example by allowing for government-provided goods to be productive in stock rather than flow form (Glomm and Ravikumar, 1994, 1997) or for different forms of taxation to be distortionary (or different forms of expenditure to be productive) to different degrees (Devarajan et al., 1996; Mendoza et al., 1997)[1]. There may of course be some debate over the classification of particular expenditures as productive or

[1] In the Mendoza et al. (1997) model for example, consumption taxation (which is non-distortionary in the Barro (1990) model and thus has no effect on the growth rate) becomes distortionary, with a (negative) effect on growth if leisure is included in the utility function, affecting education/labour-leisure choices and thus capital/labour ratios in production.

non-productive, or of particular taxes as distortionary or non-distortionary, and this is a point to which we return in the empirical section.

These models predict that shifting the revenue stance away from distortionary forms of taxation and towards non-distortionary forms has a growth-enhancing effect, whereas switching expenditure from productive, and towards unproductive, forms is growth-retarding. Non-distortionary tax-financed increases in productive expenditures are predicted to have a positive impact upon the growth rate, whereas with distortionary-tax financing the predicted growth effect is ambiguous. Finally non-productive expenditures financed by a distortionary tax have an unambiguously negative growth effect, but a zero effect is predicted if non-distortionary tax finance is used (see Barro, 1990).

In the empirical literature a specification issue of some importance—and one that has been all too frequently overlooked—is that the explicit or implicit financing of a unit change in an element of the government budget will affect the estimated coefficient. To put the point formally, suppose that growth, g_{it}, in country i at time t is a function of conditioning (non-fiscal) variables, Y_{it}, and a vector of fiscal variables, X_{jt}.

$$g_{it} = \alpha + \sum_{i=1}^{k} \beta_i Y_{it} + \sum_{j=1}^{m} \gamma_j X_{jt} + u_{it} \tag{1}$$

Assuming that all elements of the budget (including the deficit/surplus) are included, so that

$$\sum_{j=1}^{m} X_{jt} = 0,$$

one element of X must be omitted in the estimation of Eq. (1) in order to avoid perfect collinearity. The omitted variable is effectively the assumed compensating element within the government's budget constraint. Thus, if we rewrite Eq. (1) as:

$$g_{it} = \alpha + \sum_{i=1}^{k} \beta_i Y_{it} + \sum_{i=1}^{m-1} \gamma_j X_{jt} + \gamma_m X_{mt} + u_{it} \tag{2}$$

and then omit X_{mt} to avoid multicollinearity, the identity:

$$\sum_{j=1}^{m} X_{jt} = 0$$

implies that the equation actually being estimated is:

$$g_{it} = \alpha + \sum_{i=1}^{k} \beta_i Y_{it} + \sum_{j=1}^{m-1} (\gamma_j - \gamma_m) X_{jt} + u_{it} \tag{3}$$

The standard hypothesis test of a zero coefficient of X_{jt} is in fact testing the null hypothesis that $(\gamma_j - \gamma_m) = 0$ rather than $\gamma_j = 0$. It follows that the correct interpretation of the coefficient on each fiscal category is as the effect of a unit change in the relevant variable *offset by a unit change in the omitted category*, which is the implicit financing element. If the category chosen to be omitted is altered, the estimated coefficients of the included categories will change. This implies that the investigator must be careful to choose a 'neutral' omitted category (i.e. one where theory suggests that $\gamma_m = 0$).

The implication that it is possible to test only the difference between two γ values, and not each γ individually, does not exclude the possibility of testing whether two γ values are equal. This is appropriate when theory suggests that there is more than one neutral category (in this case, non-distortionary taxation and non-productive expenditure), in which case both γ values are expected to be zero. If the hypothesis of equality cannot be rejected, then more precise parameter estimates can be obtained by omitting *both* categories. In other words, the appropriate procedure is to test down from the most complete specification of the government budget constraint to less complete specifications, taking care to omit only those elements which theory suggests will have negligible growth effects. If this is not done, and (for example) expenditure variables are omitted from the regression and only tax variables are included (as in Mendoza et al., 1997)[2], then the results will be biased because of the implicit partial financing by non-neutral elements of the government budget. In the case cited, since a unit tax increase will partially finance productive expenditure, the estimated (negative) impact will be biased towards zero (we present evidence of this later).

3. Existing empirical evidence

Much of the empirical literature examining relationships between economic growth rates and fiscal variables pre-dates the public policy endogenous growth models referred to above, and varies in terms of data set, econometric technique and quality. The ad hoc nature of much of the pre-1990 literature means that it provides, at best, only crude tests of the empirical validity of the endogenous growth models (as well as being subject to the biases mentioned earlier), and the results are extremely variable.

In Kneller et al. (1998) we tabulate the main studies and their key results, classifying them according to the fiscal variables included within regressions (tax, government consumption expenditures, transfers/welfare expenditures, government investment). There is widespread non-robustness of coefficient sign and significance, even, in some cases, for apparently similar variables within similarly

[2]In some of their regressions Mendoza et al. include aggregate government (consumption) expenditure. This assumes implicitly that (a) all included expenditures are equally (un)productive; and (b) all omitted expenditures (e.g. capital expenditures) and the budget surplus/deficit are 'neutral' with respect to growth.

specified regressions, a point also demonstrated by Levine and Renelt (1992). Easterly and Rebelo (1993) provide further evidence of the non-robustness of fiscal variables by demonstrating their dependence upon the set of conditioning variables and initial conditions.

This non-robustness may in part reflect the widespread tendency to add fiscal variables to regressions in a relatively ad hoc manner without paying attention to the linear restriction implied by the government budget constraint. Only Helms (1985), Mofidi and Stone (1990) and Miller and Russek (1993) have addressed the issue. Miller and Russek, for example, find (for a panel of annual data for 39 countries, 1975–84) that the growth effect of a change in expenditure depends crucially upon the way in which the change in expenditure is financed. In general their results suggest that changes in expenditure financed by taxation produce insignificant growth effects, and that, where they occur, negative effects tend to be associated with budget deficit-financed changes in taxes or expenditures. They do not, however, distinguish between different categories of expenditures and revenues in the way suggested by endogenous growth models.

The importance of a complete specification of the government budget constraint is brought out by recent empirical results. Mendoza et al. (1997) conclude that the tax mix has no significant effect on growth (although it does significantly affect private investment), but since their regressions include no expenditure variables, their estimates are biased by the implicit partial financing of productive expenditures. This is borne out by the Kocherlakota and Yi (1997) finding that tax measures significantly affect growth only if public capital expenditures are included in regressions. Our review of evidence in Kneller et al. (1998) also highlights the wide range of estimates of growth effects for government expenditures. Most of those studies, however, include no (or few) tax variables. There is some support for the view that government investment in the form of transport and communications spending produces positive effects on growth, whilst income taxation also tends to have a significantly negative coefficient, but otherwise there is little consistency of findings across studies.

4. Empirical methodology and results

4.1. Data and methodology

As noted above, within the class of endogenous growth models relevant to this study, results are driven by the classification of fiscal variables into one of four types. To these we add the government budget surplus and revenues and expenditures whose classification is ambiguous (we label these ‘other revenues’ and ‘other expenditures’). We aggregate the IMF’s functional classifications of

Table 1
Theoretical aggregation of functional classifications

Theoretical classification	Functional classification
Distortionary taxation	Taxation on income and profit
	Social security contributions
	Taxation on payroll and manpower
	Taxation on property
Non-distortionary taxation	Taxation on domestic goods and services
Other revenues	Taxation on international trade
	Non-tax revenues
	Other tax revenues
Productive expenditures	General public services expenditure
	Defence expenditure
	Educational expenditure
	Health expenditure
	Housing expenditure
	Transport and communication expenditure
Unproductive expenditures	Social security and welfare expenditure
	Expenditure on recreation
	Expenditure on economic services
Other expenditures	Other expenditure (unclassified)

Note: functional classifications refer to the classifications given in the data source.

fiscal data into seven main categories, as described in Table 1[3] and later test the sensitivity of our results to this classification of the data.

A key issue is the allocation of taxes and expenditures, respectively, to distortionary/non-distortionary and productive/non-productive categories. Whilst all major taxes used in OECD countries are distortionary in some respect, in testing endogenous growth models the relevant distortion is that to the incentive to invest (in physical and/or human capital). Following Barro (1990), we treat income and property taxes as 'distortionary'[4] and consumption (expenditure-based) taxes as 'non-distortionary', on the grounds that the latter do not reduce the returns to investment, even though they may affect the labour/leisure choice. Of course, in more sophisticated models (such as Mendoza et al., 1997) consumption taxes do distort the decision to invest (indirectly) to the extent that they affect the labour–education–leisure choices of agents. Note however, that our treatment of

[3]The GFSY includes the category 'lending minus repayments'. This item, typically very small (see Table 2), is included in regressions as a separate variable (*elmr*) but is not discussed further.

[4]In some endogenous growth models capital and labour income taxes have different impacts on growth. In the absence of suitably disaggregated data we are unable to examine these two tax types separately and hence estimate an 'average' effect. For similar reasons, we are unable to separate profit taxation into taxes on 'pure' profits (which are non-distortionary) and taxes on returns to capital (which are distortionary)—see Atkinson and Stiglitz, 1980 (pp. 464–468). Also some taxes on property may best be treated as non-distortionary to the extent that they represent lump-sum taxes on land.

consumption taxes as 'non-distortionary' is a hypothesis (which we later test), rather than an assumption, of our empirical model[5]. In allocating expenditures to productive/non-productive categories we generally follow Barro and Sala-i-Martin (1995); Devarajan et al. (1996) and treat expenditures with a substantial (physical or human) capital component as 'productive'. The major 'unproductive' expenditure category is social security expenditures[6].

Our data set covers 22 developed countries for the period 1970–95, from two sources. Government budget data come from the GFSY; remaining data are from the World Bank Tables (see Appendix A). These data are annual, but we follow the standard practice of taking 5-year averages to remove the effects of the business cycle, and we then apply static panel econometric techniques. Adopting the standard approach makes it easier to compare our results with those published elsewhere. At a later stage we consider the sensitivity of our findings to different time aggregations of the data[7].

Table 2 lays out some descriptive statistics for the data set. The set of conditioning variables includes the investment ratio, the labour force growth rate and initial GDP[8]. It can be seen that our sample countries grew, on average, around 2.8% per capita per annum, with investment ratios in excess of 20% and labour force growth around 1% p.a. Among the fiscal variables, our distortionary tax category yields about twice as much revenue (18% of GDP on average), as non-distortionary taxes, while the two main expenditure categories each account for about 15%of GDP.

Our regression equations follow the form of Eq. (3) above. We initially considered five different forms of panel data estimator for each regression: pooled OLS, one-way (country dummies) fixed (by OLS) and random (by GLS) and two-way (country and time effects) fixed and random effects models. Model

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[5]Additional distortions from consumption taxes in practice may arise from the common practice of setting those at a variety of rates for different goods and services. This may affect investment incentives to the extent that these different consumption tax rates fall on goods which are substitutes or complements with respect to investment goods (including educational investments).

[6]Note that in Barro (1990) social security expenditures are predicted to have a zero impact on growth (because they are hypothesised to enter the utility function but not the production function). Some overlapping generations models however can predict a negative impact of social security expenditures (such as old age pensions) on long-run growth if these reduce the current level of private savings. Our tax re-classification in Section 4.3 examines the effects of social security expenditures separately, where (when regressions are appropriately specified) we find no evidence of negative growth effects.

[7]In order to maintain balance across the government budget constraint after averaging the data, it was necessary to classify one of the seven available fiscal variables as the balancing item. Two methods were used for this: the first was to balance the budget through the deficit term and the second through the other expenditure and other revenue terms. The empirical results suggest there was no difference between the two methods and only those where the deficit term is the balancing item are discussed here.

[8]The conditioning variables are those found in the usual Barro-type regression. In addition, human capital measures (from Nehru et al., 1995) were investigated but these yielded negative, statistically insignificant parameters.

Table 2
Descriptive statistics

Variable	Mean	Standard deviation	Minimum (country)	Maximum (country)
GDP p.c. growth (% p.a.)	2.79	1.66	1.54 (Switzerland)	5.09 (Turkey)
Initial p.c. GDP (thousands of 1970 US$)	10.710	3.38	2.966 (Turkey)	15.313 (US)
Investment	22.06	3.61	18.11 (UK)	29.43 (Portugal)
Labour force growth (% p.a.)	1.06	0.80	−0.06 (Germany)	2.06 (Iceland)
Budget surplus	−3.08	3.39	−11.76 (Portugal)	1.65 (Luxembourg)
Lending minus repayments	1.22	1.39	0.11 (Ireland)	4.49 (Norway)
Distortionary taxation	18.76	7.25	7.10 (Iceland)	33.47 (The Netherlands)
Non-distortionary taxation	9.15	4.22	0.96 (US)	16.77 (Norway)
Other revenues	4.56	2.96	1.51 (Germany)	16.72 (Ireland)
Productive expenditures	14.69	4.57	7.35 (Canada)	23.74 (Italy)
Non-productive expenditures	15.24	6.05	4.96 (Turkey)	24.31 (Luxembourg)
Other expenditures	4.44	3.07	0.98 (Finland)	9.16 (Ireland)

Note: the table gives descriptive statistics for the variables used in the regressions. Figures are in percentages of GDP except where stated. The data set includes 5-year averages for 1970–95 (Australia, Austria, Canada, Denmark, Finland, Germany, Iceland, Luxembourg, The Netherlands, Norway, Spain, Sweden, Turkey, UK, USA); 1975-95 (France); 1970-90 (Belgium); 1970-85 (Greece, Switzerland); 1975–90 (Italy, Portugal); and 1980–95 (Ireland).

selection is based on the log-likelihood and the adjusted R^2 for the pooled OLS and the fixed effects models (both one-way and two-way error models). Since the Hausman test rejects the null hypothesis of no correlation amongst the individual effects and the error term, we only report the results from the fixed effects models. In all cases the two-way form of the regression equation (which allows for both a time-specific and a country-specific intercept) receives greatest support from the diagnostics (with the highest adjusted R^2), and these are the results reported here.

4.2. Empirical results

Table 3 summarises the basic results. The first column of the table uses non-distortionary taxation as the implicit financing element, and the second column uses non-productive expenditure. Each of these items should have a zero

Table 3
Regression results

Estimation technique: 5-year averages, two-way FE
Dependent variable: Per capita growth

Omitted Fiscal Variable:	Non-distortionary taxation	Non-productive expenditures	Non-dis. taxation and non-prod. expenditures
Initial GDP p.c.	−0.490	−0.490	−0.483
	(2.79)	(2.79)	(2.82)
Investment	−0.020	−0.020	−0.020
	(0.33)	(0.33)	(0.34)
Labour force growth	−0.327	−0.327	−0.336
	(1.09)	(1.09)	(1.14)
Lending minus repayments	0.417	0.380	0.384
	(1.82)	(2.13)	(2.18)
Other revenues	−0.154	−0.117	−0.118
	(0.81)	(1.12)	(1.13)
Other expenditures	0.315	0.279	0.289
	(2.00)	(2.42)	(2.75)
Budget surplus	0.446	0.410	0.416
	(2.79)	(4.60)	(4.93)
Distortionary taxation	−0.446	−0.410	−0.410
	(2.79)	(4.21)	(4.37)
Non-distortionary taxation	–	0.037	–
		(0.23)	
Productive expenditures	0.290	0.253	0.268
	(1.98)	(1.95)	(2.43)
Non-productive expenditures	0.037	–	–
	(0.23)		
Adjusted R^2	0.602	0.602	0.621
No. of observations	98	98	98

Note: *t*-statistics in parentheses. For definitions of variables see Table 2. Observations are 5-year averages 1970–95. Country and time intercepts are included in the regression.

coefficient according to the Barro (1990) model, so that the results should be similar with either specification. Finally, the third column omits both of these variables, imposing a common coefficient for these two elements of the budget. The hypothesis of a common coefficient is not rejected by the data, so our interpretation is based on the results shown in the final column of Table 3.

We begin by discussing the conditioning variables. Unlike Easterly and Rebelo (1993), we find that initial GDP enters the regression with a significant negative coefficient, indicating conditional convergence of growth rates over the period. Neither of the other two conditioning variables, the investment ratio and the labour force growth rate, is significant (indeed the investment coefficient is negative) but both the time and country dummies are collectively significant.

The budget variables in the Table 3 regressions mostly have the expected sign. Productive expenditures have a significant positive coefficient, and the point estimate suggests that an increase by one percentage point of GDP raises the growth rate by 0.27 percentage points. Other expenditures also have a significant positive coefficient, which is slightly larger than that of productive expenditures (0.29)[9]. Distortionary taxation, on the other hand, significantly reduces growth: its estimated coefficient is −0.41. This number is perhaps unrealistically large, but, as we shall see below, altering the start-years of the 5-year periods somewhat reduces the point estimate of this coefficient. Other revenues also have a negative (but much smaller and statistically insignificant) effect. A notable feature of the results is the large and positive coefficient for the budget surplus. Even under the assumption of Ricardian equivalence we would expect the surplus to have a positive coefficient, since we have constrained it to finance a neutral element of the budget in the current period, but have not similarly constrained the compensating future deficits. These future deficits will partially finance additional productive expenditure or cuts in distortionary taxation which raise the anticipated returns to current investment and should therefore be reflected in a positive growth impact of the current surplus. This argument would, however, imply a somewhat smaller positive coefficient for the surplus than for productive expenditure or for cuts in distortionary taxation.

4.2.1. Mis-specifying the budget constraint

We argued above that to specify the government budget constraint fully was, in principle, important for interpretation of fiscal parameters. But how serious *in practice* are the errors from omitting or mis-specifying the budget constraint? Table 4 shows that the bias to the parameter estimates is often important. In columns 1 and 2 the three tax and expenditure variables are omitted, respectively, from the regression; while in columns 3–6 only one expenditure or tax variable is *included*. Comparing those results with those in Table 3 reveals substantial

[9] In fact, 'other expenditures' appear throughout our results to behave like productive expenditures.

Table 4
Mis-specifying the budget constraint

Estimation technique: 5-year averages, two-way FE
Dependent variable: Per capita growth

	Omitted fiscal variable(s):		*Included* fiscal variable:			
	All revenues	All expenditures	Distortionary taxation	Productive expenditure	Non-prod. exp.	Dis. and non-dis. taxation
Initial GDP p.c.	−0.501	−0.576	−0.389	−0.478	−0.386	−0.408
	(2.72)	(3.25)	(2.08)	(2.46)	(2.21)	(2.18)
Investment	−0.027	0.007	0.064	0.072	−0.024	0.060
	(0.42)	(0.11)	(1.01)	(1.09)	(0.38)	(0.94)
Labour force growth	−0.522	−0.342	−0.363	−0.463	−0.522	−0.311
	(1.69)	(1.12)	(1.10)	(1.34)	(1.71)	(0.94)
Lending minus repayments	0.150	0.280	–	–	–	–
	(0.83)	(1.56)				
Other revenues	–	09.055	–	–	–	–
	(0.53)					
Other expenditures	0.025	–	–	–	–	–
	(0.27)					
Budget surplus	0.165	0.269	–	–	–	–
	(1.85)	(3.88)				
Distortionary taxation	–	−0.260	−0.245	–	–	−0.269
		(3.43)	(3.06)			(3.28)
Non-distortionary taxation	–	0.222	–	–	–	0.190
		(1.56)				(1.23)
Productive expenditures	−0.009	–	–	−0.147	–	—
	(0.10)			(1.61)		
Non-productive expenditures	−0.229	–	–	–	−0.301	–
	(3.01)				(4.49)	
Adjusted R^2	0.572	0.591	0.512	0.465	0.571	0.515
No. of observations	98	98	98	98	98	98

Note: *t*-statistics in parentheses. For definitions of variables see Table 2. Observations are five-year averages 1970–95. Country and time intercepts are included in the regression.

changes in coefficient sign, magnitude and significance when some elements are omitted from the budget constraint.

In column 1, for example, when taxes are omitted, expenditures appear to have negative growth effects, significantly so in the case of unproductive expenditures. Since expenditures are (implicitly) partially financed by distortionary taxation, it is not surprising that omitting the latter variable imparts a negative bias to the expenditure coefficients. Similarly, when expenditures are omitted (column 2), non-distortionary taxes appear to have (marginally significant) positive growth effects (compared with the zero effect in Table 3). Again, since taxes are (implicitly) partially financing productive expenditures, omitting the latter imparts the expected positive bias to the tax coefficients. The results in Table 4 demonstrate how easy it is to reach incorrect conclusions by mis-specifying the regression equation. Since most empirical studies have failed to recognise this point and omit important elements of the government budget, it is not surprising that previous results offer a somewhat confused picture.

4.3. Robustness testing

In this section we test the robustness of the above results to four changes in the specification of the data and regression equation. Firstly we omit initial GDP from the regression to identify whether the coefficients on fiscal variables are sensitive to the inclusion of the initial GDP term, as reported by Easterly and Rebelo (1993). Secondly we consider whether our results are sensitive to the choice of time period. We begin by shifting the 5-year periods so that the start-years are those ending in (for example) one and six rather than zero and five. We then use instrumental variables to examine the possibility of simultaneity between fiscal variables and growth. Finally we consider alternative classifications of the fiscal data.

4.3.1. Initial GDP

Easterly and Rebelo (1993) find that the significance of fiscal variables in their regressions is sensitive to the inclusion or otherwise of initial GDP. The removal of this term collapses Eq. (1) to a simple form of growth accounting equation. Since initial GDP is a significant regressor in Table 3 above, it would not be surprising if our results were sensitive to its exclusion. Table 5 presents the regression equations with this variable excluded. The coefficients of all the fiscal variables are fairly close to those shown in Table 3, which indicates that in our data set the significance of fiscal variables in the growth regression is *not* sensitive to this change in specification.

4.3.2. Alternative 5-year periods

Table 3 is based on 5-year averages of years with the final digits 0–4 and 5–9. This choice was made simply in order to maximise the number of data points and

Table 5
Initial income omitted from the regression

Estimation technique: 5-year averages, two-way FE
Dependent variable: Per capita growth

Omitted Fiscal Variable(s):	Non-distortionary taxation	Non-productive expenditures	Non-dis. taxes and non-prod. expenditures
Investment	0.020	0.020	0.021
	(0.32)	(0.32)	(0.35)
Labour force growth	−0.015	−0.015	0.001
	(0.05)	(0.05)	(0.00)
Lending minus repayments	0.314	0.353	0.349
	(1.32)	(1.89)	(1.89)
Other revenues	−0.101	−0.140	−0.140
	(0.51)	(1.27)	(1.28)
Other expenditures	0.301	0.340	0.329
	(1.82)	(2.86)	(3.01)
Budget surplus	0.357	0.400	0.389
	(2.17)	(4.32)	(4.41)
Distortionary taxation	−0.427	−0.467	−0.463
	(2.36)	(4.66)	(4.72)
Non-distortionary taxation	–	--0.039	–
		(0.23)	
Productive expenditures	0.273	0.312	0.296
	(1.77)	(2.31)	(2.56)
Non-productive expenditures	−0.039	–	–
	(0.23)		
Adjusted R^2	0.574	0.574	0.581
No. of observations	98	98	98

Note: *t*-statistics in parentheses. For definitions of variables see Table 2. Observations are 5-year averages 1970–95. Country and time intercepts are included in the regression.

generally follows convention. In Kneller et al. (1998) we explore the consequences of changing the time periods to years with final digits 1–5 and 6–0; 2–6 and 7–1; and 3–7 and 8–2 (which reduces the number of observations from 98 to 86). The results (not shown here, but available from the authors on request) are broadly similar, although the point estimates of the coefficients tend to be somewhat smaller (averaging −0.3 for distortionary taxation and +0.2 for productive expenditures) and the evidence of equality between the coefficients of non-distortionary taxation and non-productive expenditures is not quite so convincing in two of the three cases.

4.3.3. Instrumental variable estimation

The estimation of regression (1) assumes that all of the right-hand side variables are exogenously determined. As Easterly and Rebelo (1993) and Hsieh and Lai (1994) discuss, the most likely sources of simultaneity in the regression are business cycle effects and Wagner's law (the tendency for government expenditure to be higher at higher levels of per capita GDP). Period averaging attempts to control for the former, but perhaps imperfectly, so some endogeneity may remain. Wagner's law is less of a concern here, since it suggests an association between GDP growth and the growth rate, rather than the level, of government expenditure and taxation.

To address these concerns about endogeneity requires estimation by instrumental variables (IV), but the selection of instruments is a problem in this sort of regression. The most common choice is the first lag of the fiscal variables, but lagged values cannot be used as instruments in fixed effects models because of potential biases from the presence of fixed effects. We therefore follow Folster and Henrekson (1997) and estimate the regression in first differences. As instruments we use country intercepts, the lagged levels of all fiscal variables, and the level and first difference of labour force growth and initial GDP. The growth equation is run in first difference form and the results, displayed in Table 6, should be interpreted accordingly.

Comparing the IV results in Table 6 with those in Table 3, it is clear that the fiscal effects identified earlier are not simply the result of endogeneity. Coefficient signs are unchanged and of similar magnitude to their Table 3 values. Though standard errors are somewhat larger (and adjusted R^2 values correspondingly lower) than previously (not surprising because the regression is in first differences), the interpretation of the key fiscal variables is substantially unaffected: the estimated effects of distortionary taxation and productive expenditures remain sizeable.

4.3.4. Reclassifying fiscal variables

The next change we make to the regression equation is to reclassify the variables included within the fiscal matrix. The aggregation of the functional classifications in the data source into theory-based categories in Table 1 is not uncontroversial. To address this point, we now separate out personal income taxes from taxation of other factor incomes, expenditures on health from other productive expenditures and expenditures on social security expenditures from other non-productive expenditures. This allows us to focus on variables commonly used in previous studies (or previously found to produce consistently strong results), and to determine the robustness of our theoretical aggregations.

The table in Appendix A shows how the data have been reclassified. Distortionary taxation is now sub-divided into income taxes and remaining distortionary taxes (property, payroll and social security taxes). Social security expenditures have been separated from other non-productive expenditures (on recreation and economic services), which are now included within the other expenditure category. As noted earlier, theory suggests that growth may depend on the *stocks* of some types of public goods (e.g. infrastructure) and the *flows* of others. We use this criterion to separate productive expenditures into those categories where the stock effect seems likely to be more important (transport and communications, housing, education) and the rest.

Results for the new classifications are displayed in Table 7. The first two

Table 6
Estimation by instrumental variables

Estimation technique: 5-year averages, two-way FE Dependent variable: Per capita growth			
Omitted fiscal Variable:	Non-distortionary taxation	Non-productive expenditures	Non-dis. taxation and non-prod. Expenditures
Initial GDP p.c.	−0.125	−0.125	−0.124
	(3.95)	(4.23)	(4.19)
Investment	0.129	0.129	0.127
	(1.41)	(1.51)	(1.48)
Labour force growth	−0.244	−0.244	−0.295
	(0.45)	(0.48)	(0.60)
Lending minus repayents	0.389	0.270	0.278
	(0.75)	(0.74)	(0.76)
Other revenues	−0.204	−0.084	−0.086
	(0.45)	(0.34)	(0.35)
Other expenditures	0.266	0.147	0.178
	(0.73)	(0.59)	(0.77)
Budget surplus	0.630	0.511	0.521
	(1.68)	(3.17)	(3.27)
Distortionary taxation	−0.575	−0.455	−0.460
	(1.47)	(2.90)	(2.92)
Non-distortionary taxation	–	0.119	–
		(0.35)	
Productive expenditures	0.284	0.165	0.201
	(0.83)	(0.69)	(0.93)
Non-productive expenditures	0.119	–	–
	(0.33)		
Adjusted R^2	0.339	0.442	0.416
No. of observations	76	76	76

Note: *t*-statistics in parentheses. For definitions of variables see Table 2. Observations are 5-year averages 1970–95. Country and time intercepts are included in the regression.

columns of the table omit those elements of the budget constraint predicted to be neutral with respect to growth. The table shows that the further disaggregation of the budgetary data does not improve the fit of the model. The reallocation of recreation and economic services from non-productive to other expenditures has a negligible effect. Both distortionary tax components (income and 'factor' taxes) are still estimated to have a negative impact on growth, with the point estimates slightly larger for the former, while non-distortionary taxes have small, statistically insignificant effects. The decomposition of productive expenditures results in somewhat lower individual *t*-statistics, but very similar estimated coefficients for the two categories[10].

[10] In one sense this is surprising, since for those categories where growth depends on the stock rather the flow, current expenditures can have only a limited effect on the stock, which would seem to imply a smaller coefficient.

Table 7
Reclassifying fiscal aggregates

Estimation technique: 5-year averages, two-way FE
Dependent variable: Per capita growth

Omitted Fiscal variable:	Non-dis. taxation	Social security exp.	Income taxes	Other distortionary taxes	Exp. on prod. flows	Exp. on prod. stocks	Health exp.
Initial	−0.529	−0.529	−0.529	−0.529	−0.529	−0.529	−0.529
GDP p.c.	(2.92)	(2.92)	(2.92)	(2.92)	(2.92)	(2.92)	(2.92)
Investment	−0.058	−0.058	−0.058	−0.058	−0.058	−0.058	−0.058
	(0.87)	(0.87)	(0.87)	(0.87)	(0.87)	(0.87)	(0.87)
Labour	−0.210	−0.210	−0.210	−0.210	−0.210	−0.210	−0.210
force growth	(0.64)	(0.64)	(0.64)	(0.64)	(0.64)	(0.64)	(0.64)
Lending	0.546	0.509	0.022	0.188	0.178	0.175	0.270
minus rep.	(2.20)	(2.49)	(0.12)	(0.75)	(0.66)	(0.70)	(1.00)
Other	−0.325	−0.289	0.199	0.032	0.042	0.046	−0.049
revenues	(1.65)	(2.00)	(1.44)	(0.16)	(0.21)	(0.23)	(0.20)
Other exp.	0.387	0.350	−0.137	0.029	0.019	0.016	0.111
	(2.37)	(2.67)	(1.22)	(0.20)	(0.11)	(0.09)	(0.52)
Budget	0.559	0.523	0.035	0.202	0.192	0.188	0.283
surplus	(3.31)	(4.53)	(0.33)	(0.16)	(1.03)	(1.20)	(0.13)
Income tax	−0.524	−0.488	–	−0.166	−0.157	−0.153	−0.248
revenues	(2.74)	(3.62)		(1.02)	(0.81)	(0.92)	(1.13)
Other dis.	−0.358	−0.321	0.166	–	0.010	0.014	−0.081
taxation	(1.73)	(2.25)	(1.02)		(0.04)	(0.07)	(0.35)
Non-dis.	–	0.036	0.524	0.357	0.367	0.371	0.276
taxation		(0.20)	(2.74)	(1.73)	(1.57)	(1.99)	(1.15)
Exp. on	0.367	0.331	−0.157	0.010	–	−0.004	0.091
prod. flows	(1.57)	(1.53)	(0.81)	(0.04)		(0.02)	(0.31)
Exp. on	0.371	0.335	−0.153	0.014	0.004	–	0.095
prod. stocks	(1.99)	(1.59)	(0.97)	(0.07)	(0.02)		(0.34)
Health	0.276	0.240	−0.248	−0.081	−0.091	−0.095-	–
exp.	(1.15)	(1.18)	(1.13)	(0.35)	(0.31)	(0.34)	
Soc. sec.	0.036	–	−0.488	−0.321	−0.331	−0.335	−0.240
exp.	(0.20)		(3.62)	(2.25)	(1.56)	(1.59)	(1.18)
Adjusted R^2	0.a582	0.582	0.582	0.582	0.582	0.582	0.582
No. of obs.	98	98	98	98	98	98	98

Note: *t*-statistics in parentheses. For definitions of variables see Table 2. Observations are five-year averages 1970–95. Country and time intercepts are included in the regression.

Columns 3–7 of Table 7 once again demonstrate the importance of selecting for omission those budget constraint elements which are predicted to be neutral in their effects on growth. The estimated coefficients of distortionary taxes and productive expenditures are insignificantly different from zero in these columns, because they are financed by cuts in similar taxes or expenditures. Income tax effects, for example, appear small and statistically weak when financing productive rather than non-productive expenditures. For the same reason social security expenditures now appear to have a negative effect.

5. Conclusions

Theory predicts that the impact of fiscal policy on growth depends on the structure as well as the level of taxation and expenditure. We have attempted to test this systematically using a panel data set for 22 OECD countries over the period 1970–95, aggregating the data into 5-year averages to take out short-run factors. An important feature of our methodology is that we have taken full account of the implicit financing assumptions associated with the government budget constraint. Few previous studies have done this, and none for such a comprehensive data set. Failure to take account of the government budget constraint introduces a bias into the regression coefficients which has been ignored in most previous research, and we have shown that this bias can be substantial.

The government budget constraint implies that the estimated coefficient of each fiscal element within a growth regression will depend on how it is financed. The effect of an individual element cannot be isolated, since it is only possible to estimate the difference between the coefficients associated with a pair of elements of the government budget. Where theory predicts the coefficients to be zero, however, it is possible to test the equality of these coefficients in a growth regression. We find expenditures classified as non-productive and tax revenues classified as non-distortionary to have equal coefficients, and consequently we cannot reject the hypothesis that these variables have a zero impact on growth, consistent with the predictions of Barro (1990). When financed by some combination of non-distortionary taxation and non-productive expenditure, an increase in productive expenditures significantly enhances growth, and an increase in distortionary taxation significantly reduces growth. Both of these results are consistent with the Barro (1990) model. We have tested the robustness of our results to various changes in specification, and found them to be robust. We have found, however, that the *magnitudes* of the estimated impacts of (productive) expenditures and (distortionary) taxation are sensitive to the process of 5-year averaging of the data. This suggests that considerable caution should be exercised in predicting the precise growth effects of fiscal changes; further work should seek to identify those magnitudes more reliably. Nevertheless, even our lowest estimates suggest that increasing productive expenditure or reducing distortionary taxes by 1% of GDP can modestly increase the growth rate (by between 0.1 and 0.2% per year).

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Appendix A

Data sources and characteristics

Data are available for 22 OECD countries. The fiscal data used in this paper are collated from IMF, *Government Financial Statistics Yearbook*. The data are consolidated and cover all levels of government. All fiscal variables are expressed as percentages of GDP. In accordance with usual practice the growth rate is taken as the log difference between annual per capita GDP figures taken from the World Bank CD ROM. The investment rate and the labour force growth rates were taken from the same source. Initial income is taken from the Penn World Tables.

Reclassifying fiscal data

New fiscal variables	Functional classification
Income taxation	Taxation of income and profit
Other distortionary taxation	Social security contributions
	Taxation on payroll and manpower
	Taxation on property
Consumption taxation	Taxation on domestic goods and services
Other revenues	Taxation on international trade
	Non-tax revenues
	Other tax revenues
Productive flows	General public services expenditure
	Defence expenditure
Productive stocks	Educational expenditure
	Housing expenditure
	Transport and communication expenditure
Health expenditure	Health expenditure
Social security and welfare expenditure	Social security and welfare expenditure
Other expenditure	Expenditure on recreation
	Expenditure on economic services
	Other expenditure

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