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Growth, Public Policy and the Government Budget Constraint: Evidence from OECD Countries

by

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Abstract

This paper examines whether the evidence from OECD countries is consistent with the predictions of endogenous growth models that the structure of taxation and public expenditure can affect the steady-state growth rate. We find strong support for the Barro (1990) public policy endogenous growth model for a panel of 22 OECD countries over the period 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. Our results are robust to different time aggregations of the data, and the estimates are free from biases associated with incomplete specification of the government budget constraint.

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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 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; and Mendoza et al., 1997).

If the theory is reasonably clear, however, the empirical evidence is not. As Stokey and Rebelo note (1995, p.519), “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) is a notable exception). 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. In general, 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; or 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 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 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).

[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 .

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}.

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

Assuming 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 equation (1) in order to avoid perfect collinearity. The omitted variable is effectively the assumed compensating element within the government's budget constraint. Thus, rewriting (1) as:

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

where X_{mt} is the omitted fiscal category, the condition: $\sum_{j=1}^{m} X_{jt} = 0$ allows (2) to be rearranged to give:

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

Clearly the standard hypothesis test that the coefficient of X_{jt} is zero is 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. Adjusting the omitted category changes the estimated coefficients of the included categories. This implies that the investigator must be careful to choose a "neutral" omitted category (i.e. one where theory suggests that $g_m = 0$).

Although it is only possible to test the difference between two g's, and not each g individually, this does not exclude the possibility of testing whether two g's 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 g's 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 procedure should be 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.

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

[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

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 the Appendix we list 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). This demonstrates the non-robustness of coefficient sign and significance, even, in some cases, for apparently similar variables within similarly 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.

Evidence from Appendix Table A1, for studies including tax variables, suggests fairly consistent negative growth effects for *income* tax variables but mixed evidence regarding other forms of taxation. Perhaps the most rigorous investigation to date is that by Mendoza et al. (1997), who conclude that the tax mix has no significant effect upon the rate of growth but does significantly affect the rate of private investment. Yi and Kocherlakota (1996), however, using a different sample and a different econometric technique, find that tax measures significantly affect growth provided that public capital expenditures are included in regressions.[3] Results in Appendix Tables A2-A4 highlight the wide range of estimates of growth effects for government expenditures. Note however that most of those studies include no (or few) tax

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omitted expenditures (e.g. capital expenditures) and the budget surplus/deficit are ‘neutral’ with respect to growth.

variables. There is some support for the view that government investment in the form of transport and communications spending produces positive effects on growth. However, overall the significance of fiscal variables appears to be sensitive to econometric specification.

As mentioned earlier, a specification issue of particular importance is the incorporation of the government budget constraint (crucial within theoretical models) into estimating equations. Most studies have ignored this, adding fiscal variables to regressions in a relatively *ad hoc* manner. 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.

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 deficit/surplus *(sur)* and revenues and expenditures whose classification is ambiguous (we label these “other revenues”

[3] This is an example of the bias effect mentioned earlier.

(roth) and "other expenditures" *(eoth)*). We later test the sensitivity of our results to this classification of the data. We aggregate the functional classifications of fiscal data (from IMF, *Government Finance Statistics Yearbook* (GFSY)) into seven main categories, as described in Table 1 below.[4] We follow Barro (1990) and treat consumption taxation as 'non-distortionary', although in some models it might better be described as 'less distortionary', since consumption taxation may still distort the labour-leisure choice, even though it does not affect the trade-off between present and future consumption.

Our dataset covers 22 developed countries for the period 1970-94, from two sources. Government budget data come from the GFSY; remaining data are from the World Bank Tables (see the Appendix). These data are annual, but we follow the standard practice of taking five-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.[5]

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.[6]

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[4] 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.

[5] In order to maintain balance across the government budget constraint after averaging the data, it was necessary to classify one of the 7 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.

[6] The conditioning variables are those found in the usual Barro-type regression. Given our sample political instability measures are irrelevant and are excluded from the *Y* matrix. In addition, human capital measures (from Nehru *et al*., 1995) were investigated but these yielded negative, statistically

It can be seen that our sample countries grew, on average, around 2.8 per cent per capita per annum, with investment ratios in excess of 20% and labour force growth around 1% p.a. Among the fiscal variables, distortionary taxation (*rdis*) yields about twice as much revenue (18% of GDP on average), as nondistortionary taxes (*rndis*), while the two main expenditure categories each account for about 15%of GDP.

Our regression equations follow the form of equation (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 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 (*rndis*) as the implicit financing element, and the second column uses non-productive expenditure (*enprd*). Each of these items should have a zero 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,

insignificant parameters in growth regressions. We discuss these results briefly below but otherwise all 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, suggesting that the latter may be capturing some omitted conditioning variables.[7]

The budget variables in the Table 3 regressions mostly have the expected sign. Productive expenditures *(eprd)* 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 *(eoth)* also have a significant positive coefficient, which is slightly larger than that of *eprd* (0.29).[8] Distortionary taxation *(rdis)*, 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 five-year periods somewhat reduces the point estimate of this coefficient. Other revenues *(roth)* also have a negative (but much

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our reported results exclude human capital variables.

[7] We also investigated regressions including human capital measures from Nehru et al. (1995). In the resulting regression human capital (measured as secondary or a combination of all levels of education) entered the regressions with negative, though insignificant, coefficients; initial GDP was rendered insignificant and the investment ratio also became negative (though insignificant). Of the fiscal variables the main relationships do not appear to alter, although some evidence that non-productive expenditures have a positive effect on the growth rate is found.

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, which may partially finance additional productive expenditure or cuts in distortionary taxation. This argument would, however, imply a somewhat smaller positive coefficient for the surplus than for productive expenditure or for cuts in distortionary taxation.

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 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

[8] In fact, 'other expenditures' appear throughout our results to behave like productive expenditures with significant parameters of similar, or slightly larger, magnitude to those for *eprd*.

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 five-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.

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 equation (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.

Alternative five-year periods

Table 3 is based on five-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 generally follows convention. Table 6 presents the results 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 (labelled respectively "1971", "1972" and "1973" in the Table).

Table 6 shows results with *rndis* as the omitted fiscal variable, and then with both *rndis* and *enprd* omitted, for the alternative five-year classifications of the data. In all cases we cannot reject the hypothesis that *rndis* and *enprd* have the same coefficient, which theory predicts to be zero, although *enprd* has a t-statistic of greater than one in the "1972" and "1973" regressions. Among the conditioning variables, investment now has a positive rather than a negative coefficient, although still insignificant; initial GDP continues to have a significant negative coefficient, with labour force growth insignificantly negative.

The higher t-statistic for *enprd* in the "1972" and "1973" regressions means that there is quite a difference in these cases between the coefficients with just *rndis* omitted, and those with both *rndis* and *enprd* omitted. We concentrate on the latter, since theory predicts that these two variables should have the same coefficient. We see that the coefficient of distortionary taxation falls from its value of –0.41 in Table 3 to -0.33, -0.26 and finally –0.17 for the “1973” regression. The coefficient of productive expenditure is 0.30, 0.17 and 0.12 respectively, compared with its Table 3 value of 0.27. These results suggest that the true values of these coefficients are probably below those shown in Table 3, which appear to be somewhat inflated by the particular way in which the annual data have been aggregated.

Instrumental variable estimation

The estimation of regression (1) assumes that all of the right hand side variables are exogenously determined. Easterly & Rebelo (1993) and Hsieh & Lai (1994) both discuss the simultaneity problem between fiscal variables and the level of GDP and the rate of growth and find it to be a problem. The most likely sources of simultaneity in the regression are business cycle effects and Wagner’s law (the positive income effect attached to some categories of government expenditure). Period averaging attempts to control for the former, but since period averages may not coincide with the business cycle, some cyclical effects may remain within the data.

The choice of instruments is a problem in this sort of regression. The most common form is the first lag of the fiscal variables, but lagged values cannot be used as instruments in fixed effects models due to potential biases from the presence of fixed effects. We therefore follow Folster & Henrekson (1997) and estimate the regression in first differences. The first differences of all fiscal variables are instrumented by their lagged levels, the level and first difference of the population and initial GDP variables and country-specific effects. The growth equation is run in first difference form and the results, displayed in Table 7, should be interpreted as such.[9]

Comparing the IV results in Table 7 with those in Table 3, it is clear that the fiscal effects identified earlier are not due to simultaneity. Coefficient signs are unchanged and of similar magnitude to their Table 3 values. Though standard errors are somewhat larger (and adjusted R^2s correspondingly lower) than previously (as may be expected using the first difference form) the interpretation of the key fiscal variables is substantially unaffected: distortionary taxation and productive expenditures continue to display sizeable negative and positive effects on growth respectively.[10]

Reclassifying fiscal variables

The next change we make to the regression equation is to reclassify the variables included within the fiscal matrix. In creating the theory-based classifications, the allocation of the data from the GFSY is obviously imprecise. We further disaggregate by separating out income taxation (*rinc*), health expenditures (*ehlth*) and social security expenditures (*ess*). This allows us to focus on variables commonly used in previous studies (or previously found to produce consistently strong results),[11] and to determine the robustness of our theoretical aggregations.

Appendix Table A5 shows how the data from the GFSY has been reclassified. Distortionary taxation is now sub-divided into income and remaining distortionary taxes (property, payroll and social security taxes), which we label ‘factor income

[9]. To ensure that the government budget remains an identity the surplus term is generated as a balancing item between revenues and expenditures, and is not therefore an instrumented variable.
[10] Additional evidence against simultaneity caused by Wagner’s law is the robustness of the results to the exclusion of initial income from the regressions.

taxation' (*rfact*). Non-productive expenditures are now confined to social security, as expenditures on recreation and economic services have instead been included within the other expenditure category. As noted earlier, theory suggests there may be a difference between the nature of public goods as either stocks or flows such as its subjection to the forces of congestion which may have a bearing upon our results. We therefore also separate out those expenditures which are perceived to be productive as a *flow* of goods and services (*epf*), such as defence, and those arguably productive as a *stock* (*eps*), such as transport and communication infrastructure.

Results for the new classifications are displayed in Table 8. The first two columns of the table again omit those elements of the budget constraint predicted to be neutral with respect to growth (*rndis* and *enprd*). Theoretical predictions are again supported. Both distortionary tax components (income and 'factor' taxes) have negative effects 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 the results again suggest relatively large positive effects from productive expenditures and no discernible effects from non-productive expenditures (*ess*). The results also do not suggest any difference between the positive growth effects of productive expenditures in 'stock' or 'flow' form.[12]

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[11] These categories also often constitute large proportions of total revenues or expenditures and may therefore swamp the effects of other categories in our results.

[12] This last result is rather different from those of Barro (1989, 1991), Easterly and Rebelo (1993) and Devarajan et al (1996) who tend to find greater positive effects from 'capital' expenditures. However this may well arise from the incomplete specification of the budget constraint in these cases and because 'flow' expenditures often include unproductive (consumption) expenditures which are expected to impact *negatively* on growth (which we also find).

Columns 3-7 of Table 8 again emphasise the consequences of selecting for omission those budget constraint elements which are predicted to be *non*-neutral in their effects on growth. Income tax effects, for example, appear small and statistically weak when financing productive rather than non-productive expenditures. The effects of productive expenditures of various types (*epf*, *eps*, *ehlth*) are also biased towards zero, while non-productive expenditures (*ess*) now display negative growth effects. Finally, the sign and significance of conditioning variables is unaffected by the alternative fiscal aggregations. These results suggest that our earlier evidence in support of the theoretical predictions of endogenous growth models is not sensitive to data aggregations, and confirm the importance of choosing carefully the appropriate omitted category (or categories) from the government budget constraint in growth regressions.

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 five-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 (e.g. Miller and Russek (1993) use annual data for the period 1975-84, although they do have a larger sample of (39) countries). Failure to take account of the government budget constraint will in general introduce a bias into the regression coefficients, 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 each element 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 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 *magnitude* of the estimated impacts of (productive) expenditures and (distortionary) taxation is sensitive to the process of five-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 of a percent per year).

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Table 1 Functional/Theoretical Classifications

Theoretical Classification	Functional Classification
budget surplus (*sur*)	budget surplus
distortionary taxation *(rdis)*	taxation on income and profit social security contributions taxation on payroll and manpower taxation on property
non-distortionary taxation *(rndis)*	taxation on domestic goods and services
other revenues *(roth)*	taxation on international trade non-tax revenues other tax revenues
productive expenditures *(eprd)*	general public services expenditure defence expenditure educational expenditure health expenditure housing expenditure transport and communication expenditure
unproductive expenditures *(enprd)*	social security and welfare expenditure expenditure on recreation expenditure on economic services
other expenditure *(eoth)*	other expenditure (unclassified)

Table 2 Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum (country)	Maximum (country)
GDPp.c. growth (% p.a.)	2.79	1.66	1.54 - Switzerland	5.09 - Turkey
initial GDP	10710	3378.78	2966 - Turkey	15313 - US
invest. (% of GDP)	22.06	3.61	18.11 - UK	29.43 - Portugal
lab. force growth	1.06	0.80	-0.06 - Germany	2.06 - Iceland
surplus (% of GDP)	-3.08	3.39	-11.76 - Portugal	1.65 - Luxembourg
elmr (% of GDP)	1.22	1.39	0.11 - Ireland	4.49 - Norway
rdis (% of GDP)	18.76	7.25	7.10 - Iceland	33.47 - Netherlands
rndis (% of GDP)	9.15	4.22	0.96 - US	16.77 - Norway
roth (% of GDP)	4.56	2.96	1.51 - Germany	16.72 - Ireland
eprd (% of GDP)	14.69	4.57	7.35 - Canada	23.74 - Italy
enprd (% of GDP)	15.24	6.05	4.96 - Turkey	24.31 - Luxembourg
eoth (% of GDP)	4.44	3.07	0.98 - Finland	9.16 - Ireland

Table 3 Regression Results

Estimation Technique	5-year aves, 2 way FE		
Dependent variable	Per capita growth	n= 98	
	Omitted Fiscal Variable:		
	rndis	enprd	rndis,enprd
Initial GDP	-0.490 (2.79)	-0.490 (2.79)	-0.483 (2.82)
Investment / GDP	-0.020 (0.33)	-0.020 (0.33)	-0.020 (0.34)
Lab. force growth (lbfg)	-0.327 (1.09)	-0.327 (1.09)	-0.336 (1.14)
elmr	0.417 (1.82)	0.380 (2.13)	0.384 (2.18)
roth	-0.154 (0.81)	-0.117 (1.12)	-0.118 (1.13)
eoth	0.315 (2.00)	0.279 (2.42)	0.289 (2.75)
sur	0.446 (2.79)	0.410 (4.60)	0.416 (4.93)
rdis	-0.446 (2.79)	-0.410 (4.21)	-0.410 (4.37)
rndis		0.037 (0.23)	
eprd	0.290 (1.98)	0.253 (1.95)	0.268 (2.43)
enprd	0.037 (0.23)		
adj R^2	**0.602**	**0.602**	**0.621**
log likelihood	**-0.118**	**-0.118**	**-0.118**

Note: *t*-statistics in parentheses.

Table 4 Mis-specifying the Budget Constraint

Estimation Technique			5-year aves, 2 way FE			
Dependent variable			Per capita growth		n= 98	
	Omitted Fiscal Variable:		*Included* Fiscal Variable			
	rdis, rndis, roth.	eprd, enprd, eoth.	rdis	eprd	enprd	rdis, rndis
GDP70x10^{-3}	-0.501 (2.72)	-0.576 (3.25)	-0.389 (2.08)	-0.478 (2.46)	-0.386 (2.21)	-0.408 (2.18)
inv	-0.027 (0.42)	0.007 (0.11)	0.064 (1.01)	0.072 (1.09)	-0.024 (0.38)	0.060 (0.94)
lbfg	-0.522 (1.69)	-0.342 (1.12)	-0.363 (1.10)	-0.463 (1.34)	-0.522 (1.71)	-0.311 (0.94)
elmr	0.150 (0.83)	0.280 (1.56)	-	-	-	-
roth	-	-0.055 (0.53)	-	-	-	-
eoth	0.025 (0.27)	-	-	-	-	-
sur	0.165 (1.85)	0.269 (3.88)	-	-	-	-
rdis	-	-0.260 (3.43)	-0.245 (3.06)	-	-	-0.269 (3.28)
rndis	-	0.222 (1.56)	-	-	-	0.190 (1.23)
eprd	-0.009 (0.10)	-	-	-0.147 (1.61)	-	-
enprd	-0.229 (3.01)	-	-	-	-0.301 (4.49)	-
adj R^2	**0.572**	**0.591**	**0.512**	**0.465**	**0.571**	**0.515**

Table 5 Initial Income Omitted from the Regression

Estimation Technique	5-year aves, 2 way FE		
Dependent variable	Per capita growth	n= 98	
	Omitted Fiscal Variable:		
	rndis	enprd	rndis,enprd
inv	0.020 (0.32)	0.020 (0.32)	0.021 (0.35)
lbfg	-0.015 (0.05)	-0.015 (0.05)	0.001 (0.00)
elmr	0.314 (1.32)	0.353 (1.89)	0.349 (1.89)
roth	-0.101 (0.51)	-0.140 (1.27)	-0.140 (1.28)
eoth	0.301 (1.82)	0.340 (2.86)	0.329 (3.01)
sur	0.357 (2.17)	0.400 (4.23)	0.389 (4.41)
rdis	-0.427 (2.36)	-0.467 (4.66)	-0.463 (4.72)
rndis		-0.039 (0.23)	
eprd	0.273 (1.77)	0.312 (2.31)	0.296 (2.56)
enprd	-0.039 (0.23)		
adj R^2	**0.574**	**0.574**	**0.581**
log likelihood	**-123**	**-123**	**-124**

Table 6 Adjusting the Start-Year of 5-Year Panels

Estimation Technique	5-year aves, 2 or 1way FE					
Dependent variable	Per capita growth			n= 86		
	Omitted Fiscal Variable:					
	1971 2-way	1971 2-way	1972 1-way	1972 1-way	1973 2-way	1973 2-way
	rndis	enprd/rndis	rndis	enprd/rndis	rndis	enprd/rndis
GDP70x10^{-3}	-0.599 (2.78)	-0.599 (2.82)	-0.402 (2.40)	-0.430 (1.77)	-0.524 (2.65)	0.502 (2.52)
inv	0.016 (0.19)	0.015 (0.19)	0.013 (0.15)	0.014 (0.10)	0.156 (1.87)	0.147 (1.75)
lbfg	-0.133 (0.34)	-0.136 (0.36)	-0.430 (1.13)	-0.543 (0.21)	-0.320 (0.79)	-0.405 (1.00)
elmr	0.188 (0.73)	0.181 (0.93)	0.269 (0.79)	0.011 (0.03)	0.559 (1.92)	0.285 (1.24)
roth	-0.251 (1.15)	-0.243 (1.91)	-0.456 (-1.90)	-0.245 (1.48)	-0.227 (0.91)	-0.087 (0.61)
eoth	0.316 (1.73)	0.310 (2.71)	0.414 (1.97)	0.232 (1.05)	0.349 (1.83)	0.131 (1.03)
sur	0.387 (2.08)	0.380 (4.31)	0.527 (2.40)	0.322 (2.07)	0.547 (2.83)	0.307 (2.75)
rdis	-0.332 (1.64)	-0.325 (3.06)	-0.511 (-1.97)	-0.256 (1.05)	-0.457 (2.10)	-0.172 (1.56)
eprd	0.301 (1.66)	0.295 (2.44)	0.331 (1.52)	0.171 (0.48)	0.304 (1.69)	0.122 (0.90)
enprd	0.007 (0.04)		0.245 (1.12)		0.310 (1.52)	
adj R^2	**0.587**	**0.596**	**0.339**	**0.335**	**0.441**	**0.434**
log likelihood	**-102**	**-102**	**-99**	**-100**	**-108**	**-110**

Table 7 Estimation by Instrumental Variables

Estimation Technique	5-year aves, 2-way FE		
Dependent variable	Per capita growth	n= 76	
	Omitted Fiscal Variable:		
	rndis	enprd	rndis,enprd
GDP70x10^{-3}	-0.125 (3.95)	-0.125 (4.23)	-0.124 (4.19)
inv	0.129 (1.41)	0.129 (1.51)	0.127 (1.48)
lbfg	-0.244 (0.45)	-0.244 (0.48)	-0.295 (0.60)
elmr	0.389 (0.75)	0.270 (0.74)	0.278 (0.76)
roth	-0.204 (0.45)	-0.084 (0.34)	-0.086 (0.35)
eoth	0.266 (0.73)	0.147 (0.59)	0.178 (0.77)
sur	0.630 (1.68)	0.511 (3.17)	0.521 (3.27)
rdis	-0.575 (1.47)	-0.455 (2.90)	-0.460 (2.92)
rndis		0.119 (0.35)	
eprd	0.284 (0.83)	0.165 (0.69)	0.201 (0.93)
enprd	0.119 (0.33)		
adj R^2	**0.339**	**0.442**	**0.416**

Table 8 Reclassifying Fiscal Aggregates

Estimation Technique			5-year aves, 2 way FE				
Dependent variable			Growth		n= 98		
	Omitted Fiscal Variable:						
	rndis	enprd	rdis		eprd		
		(ess)	rinc	rfact	epf	eps	ehlth
GDP70x10^{-3}	-0.529 (2.92)	-0.529 (2.92)	-0.529 (2.92)	-0.529 (2.92)	-0.529 (2.92)	-0.529 (2.92)	-0.529 (2.92)
inv	-0.058 (0.87)	-0.058 (0.87)	-0.058 (0.87)	-0.058 (0.87)	-0.058 (0.87)	-0.058 (0.87)	-0.058 (0.87)
lbfg	-0.210 (0.64)	-0.210 (0.64)	-0.210 (0.64)	-0.210 (0.64)	-0.210 (0.64)	-0.210 (0.64)	-0.210 (0.64)
elmr	0.546 (2.20)	0.509 (2.49)	0.022 (0.12)	0.188 (0.75)	0.178 (0.66)	0.175 (0.70)	0.270 (1.00)
roth	-0.325 (1.65))	-0.289 (2.00)	0.199 (1.44)	0.032 (0.16)	0.042 (0.21)	0.046 (0.23)	-0.049 (0.20)
eoth	0.387 (2.37)	0.350 (2.67)	-0.137 (1.22)	0.029 (0.20)	0.019 (0.11)	0.016 (0.09)	0.111 (0.52)
sur	0.559 (3.31)	0.523 (4.53)	0.035 (0.33)	0.202 (0.16)	0.192 (1.03)	0.188 (1.20)	0.283 (0.13)
rinc	-0.524 (2.74)	-0.488 (3.62)		-0.166 (1.02)	-0.157 (0.81)	-0.153 (0.97)	-0.248 (1.13)
rfact	-0.358 (1.73)	-0.321 (2.25)	0.166 (1.02)		0.010 (0.04)	0.014 (0.07)	-0.081 (0.35)
rndis		0.036 (0.20)	0.524 (2.74)	0.357 (1.73)	0.367 (1.57)	0.371 (1.99)	0.276 (1.15)
epf	0.367 (1.57)	0.331 (1.53)	-0.157 (0.81)	0.010 (0.04)		-0.004 (0.02)	0.091 (0.31)
eps	0.371 (1.99)	0.335 (1.59)	-0.153 (0.97)	0.014 (0.07)	0.004 (0.02)		0.095 (0.34)
ehlth	0.276 (1.15)	0.240 (1.18)	-0.248 (1.13)	-0.081 (0.35)	-0.091 (0.31)	-0.095 (0.34)	
ess	0.036 (0.20)		-0.488 (3.62)	-0.321 (2.25)	-0.331 (1.56)	-0.335 (1.59)	-0.240 (1.18)
adj R^2	**0.582**	**0.582**	**0.582**	**0.582**	**0.582**	**0.582**	**0.582**

APPENDIX
Data Sources and Characteristics

Data are available for 22 OECD across a time span of 1970 (or 1972) to 1992 (or 1994). This time span is not consistent across countries; for example, data for Switzerland exits only for 1970-84. The fiscal data used in this paper are collated from IMF, *Government Financial Statistics Yearbook*. The level of government used in the study is the consolidated level and therefore includes local, national and supranational 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 (Summers & Heston (1991)).

Summary of Empirical Studies

Table A1: Tax and Growth Studies

Author	Countries	years	econometric method	length of average	main results
Marsden (1983)	10 pairs of matched GDP	1970s	pair comparisons		low tax countries grew quicker than high tax countries
Koester, Kormendi (1989)	63	1970-79	cross-section	10-years	marginal tax and average tax rates have no significant negative effect
Skinner (1987)	African countries		cross-section		income, corporation and import taxes are significant and negative. Export and sales taxes insignificant
Engen, Skinner (1992)	107	1970-85	cross-section	16 years	taxes have significant and negative effects in short and long-run
Dowrick (1992)	OECD	1960-85	cross-section	26 years	income taxes significant negative. Corporation taxes not significant
Easterly, Rebelo (1993)	100	1970-88	cross-section	19 years	income taxes significant and negative, others types of taxation non-robust
Cashin (1995)	23 OECD	1971-88	panel	5-years	total taxation significant negative
Mendoza, Milesi-Ferretti, Asea (1996)	11 OECD	1965-91	panel	annual, 5-year	effective capital, consumption and labour tax rates are insignificant in 5-year averages, non-robustly significant in annual data regressions
Yi, Kocherlakota (1996)	US, UK	US 1891-1991, UK 1831-1991	time-series	annual (10 lags)	tax measures insignificant individually, significant when put with public capital term

Table A2: Government Consumption Expenditure and Growth Studies

Author	Countries	years	econometric method	length of average	main results
Landau (1983)	104	1961-76	cross-section	16 years	government consumption expenditure has a significant negative effect
Kormendi, Meguire (1985)	47		cross-section	28 years	government consumption expenditure has a no significant effect
Ram (1986)	115	1960-80	cross-section, time series	10	size of government produces significant positive coefficients
Landau (1986)	LDCs		cross-section		government consumption expenditure has a significant negative effect
Grier, Tullock (1989)	115	1950-81	panel data	5-years	government consumption expenditure has a significant negative effect
Romer (1989a)	94	1960-85	cross-section	16 years	government consumption expenditure has a significant positive effect
Romer (1989b)	112	1960-85	cross-section	16 years	government consumption expenditure has a significant positive effect
Romer (1990)	90	1960-85	cross-section	16 years	government consumption expenditure has a significant positive effect
Alexander (1990)	13 OECD	1959-84	panel	annual	government consumption expenditure has a significant negative effect
Barro (1991)	98	1960-85	cross-section	16 years	government consumption expenditure has a significant negative effect

Table A3: Transfer Payments/Welfare Expenditure and Growth Studies

Author	Countries	years	econometric method	length of average	main results
Landau (1983)					transfer payment expenditure has no significant effect
Korpi (1985)	OECD	1970-87	panel	18 years	transfer payment expenditure has a significant negative effect
Landau (1985)	16 OECD	1952-76	panel/ cross-section	annual	transfer payment expenditure has no significant effect
Weede (1986)	19 OECD	1960-82	panel/ cross-section	7-years	transfer payment expenditure has a significant positive effect
McCallum, Blais (1987)	17 OECD	1960-83	panel/ cross-section	7-years	transfer payment expenditure has a significant negative effect
Castles, Dowrick (1990)	18 OECD	1960-85	panel	6 years	transfer payment expenditure has a significant negative effect
Weede (1991)	19 OECD	1960-85	panel	7-years	transfer payment expenditure has a significant positive effect
Nordstrum (1992)	14 OECD	1970-89	cross-section	20 years	transfer payment expenditure has a significant positive effect
Sala-i-Martin (1992)	75		cross-section		transfer payment expenditure has a significant positive effect
Persson, Tabellini (1994)	14 OECD	1960-85	cross-section	16 years	transfer payment expenditure has a significant positive effect
Hanson, Henrekson (1994)	OECD	1970-87	cross-section	18 years	transfer payment expenditure has no significant effect
Cashin (1995)	23 OECD	1971-88	panel	5-years	transfer payment expenditure has a significant positive effect
Nazmi, Ramirez (1997)	Mexico	1950-90	time-series	annual	transfer payment expenditure has a significant positive effect

Table A4: Public Investment Expenditure and Growth Studies

Author	Countries	years	econometric method	length of average	main results
Landau (1986)	LDCs				education, defence, capital expenditure insignificant
Barth, Bradley (1988)	16 OECD	1971-83	cross-section	13 years	total public investment insignificant
Barro (1989)	72	1960-85	cross-section	16 years	total investment significant
Barro (1991)	98	1960-85	cross-section	16 years	transport & communication significant, total public investment insignificant
Easterly, Rebelo (1993)	100	1970-88	cross-section	19 years	transport & communication significant, total investment, education, health insignificant
Devarajan, Swaroop, Zou (1996)	14 developed countries	1970-1990	panel	5-year moving average	health, transport & communication significant positive, defence, education significant negative
Yi, Kocherlakota (1996)	US, UK	US 1891-1991 UK 1831-1991	time-series	annual, (10 lags)	public investment insignificant when included individually, significant when included with tax variables

Table A5: Reclassifying Fiscal Data

New Fiscal Variables	Functional Classification
deficit/surplus *(sur)*	deficit/surplus
income taxation *(rinc)*	taxation and income and profit
factor income taxation *(rfact)*	social security contributions taxation on payroll and manpower taxation on property
consumption taxation (*rndis)*	taxation on domestic goods and services
other revenues *(roth)*	taxation on international trade non-tax revenues other tax revenues
productive flows *(epf)*	general public services expenditure defence expenditure
productive stocks *(eps)*	educational expenditure housing expenditure transport and communication expenditure
health expenditure (*ehlth)*	health expenditure
social security and welfare expenditure *(ess)*	social security and welfare expenditure
other expenditure *(eoth)*	expenditure on recreation expenditure on economic services other expenditure