Tax composition and economic growth in OECD countries

by

Norman Gemmell[*]
Richard Kneller[*]
and
Ismael Sanz[**]

([*] University of Nottingham, UK)
([**] Universidad Complutense de Madrid, Spain)

February 2007

ABSTRACT

The literature testing for long-run impacts of fiscal policy on growth at the macro, cross-country level has generally ignored short-run dynamics and treated all counties' fiscal-growth dynamics identically. This paper examines how robust previous 'long-run' results for OECD countries are to new empirical methods that model short-run dynamics explicitly and allow fiscal-growth responses to be heterogeneous both across countries and over time. Our results suggest that most of the so-called 'long-run' growth effects of fiscal policy are typically achieved very quickly (within a few years). We also find that positive growth effects of fiscal changes in OCED countries have often been approximately counteracted by fiscal changes with negative growth effects. We test for the robustness and potential endogeneity of those fiscal-growth effects, and conclude that a more appropriate interpretation of the evidence is that fiscal policy effects on growth are generally *short*-run and significant, but that these are also *persistent*, provided the relevant fiscal policy changes are not reversed.

1. Introduction

Does fiscal policy have sustained impacts on economic growth? Since the mid-to-late 1990s new developments in both theory and empirics have challenged previous answers to this question. In particular, developments in endogenous and 'semi-endogenous' growth models (see, for example, Eicher and Turnovsky, 1999; Howitt, 2000; Dalgaard and Kreiner, 2003) yield results in which economic policy may only have transitional growth impacts, but convergence to equilibrium following policy shocks may be rapid or slow.[1] Turnovsky (2004), on the other hand, develops a neoclassical model in which transitional effects are very long-lasting. Simulations suggest these should be measured in decades not years. This increasing theoretical focus on the transitional dynamics of fiscal-growth responses has not yet been reflected in the empirical literature, which generally continues to look for long-run effects, whilst ignoring (or assuming away) the short-run transitional path, and treating all countries identically. Nevertheless, these studies increasingly find that various fiscal policy variables impact significantly on 'long-run' growth.

This paper provides new evidence on the long-run impact of taxes and public expenditures on growth in OECD countries, whilst allowing for fiscal-growth dynamics explicitly. In particular, updating and extending existing datasets to cover 1970-2004, yields an annual panel with a sufficient time-series dimension to allow both short- and long-run fiscal-growth responses to be heterogeneous across countries. This allows us to address three questions:

(a) How robust are previous estimates of long-run fiscal-growth effects to the inclusion of short-run dynamics and heterogeneous parameters?
(b) How long does it take to reach the long-run equilibrium following a fiscal shock, and does this differ by country?
(c) Does the evidence point to *en*dogenous or *ex*ogenous relationships?

Our results suggest that most of the previously identified 'long-run' growth effects of fiscal policy are typically achieved very quickly (within a few years). A more appropriate interpretation of the evidence would therefore appear to be that fiscal policy does impact on growth; these effects are *short*-run and significant; but they are also persistent *provided the relevant fiscal policy changes persist*.

2. Testing for Fiscal-Growth Effects: Methodological Issues

As noted above, recent developments in both neoclassical and endogenous growth models with a fiscal policy dimension are capable of predicting growth impacts from fiscal policy during transitions of up to several decades. Though a number of hypothesised mechanisms generate such effects, most share the Barro (1990) model's characteristic that growth-affecting fiscal policies arise from distortions to private savings/investment decisions (including human capital investment and technological innovations) or the allocation of public spending between spending which affects social welfare and that affecting private sector production.[2] As a result most models now predict that some aspects of tax *structure* and/or public expenditure *composition* may be important for growth, rather than total tax or expenditure levels.[3]

The Government Budget Constraint

In particular, following Kneller et al. (1999) and Bleaney et al. (2001), it is now recognised that whether taxes are 'distortionary' or 'non-distortionary' (with respect to investment) and whether expenditures are 'productive' or 'unproductive' are important distinctions when testing for growth impacts of fiscal policy. They also argue that interpretation of results from these tests depends critically on recognising the role of the government budget constraint (GBC).[4] Since the government budget, composed of expenditures, revenues and deficits/surpluses, is a 'closed system', any change in one element must be balanced by an equal and opposite change in some other element(s).

---

[1] Recent endogenous growth models in which fiscal policy continues to have long-run effects include Kaas (2003), Kalyvitis (2003), Zagler and Durnecker (2003), Park and Philippopoulos (2003) and Ho and Wang (2005).

[2] Turnovsky (2004), for example, demonstrates growth impacts associated with taxes on (from largest impact to smallest) capital, labour income and consumption respectively. Peretto (2003) shows that, in a semi-endogenous growth model, the level and composition of public expenditures affect transitional growth even though they have no steady-state effects. Capital and corporate income taxes do however have steady-state effects while labour income and consumption taxes do not.

[3] Unfortunately many early empirical studies examining fiscal effects on growth were based only loosely on theoretical models, often testing *ad hoc* hypotheses relating to government size such as government consumption spending or some aggregate measure of tax burden. Not surprisingly, early results were ambiguous or contradictory and frequently non-robust (see Agell et al, 1997, and Myles, 2000 for reviews).

[4] Other empirical models which recognise the role of the government budget constraint for testing (to some extent) include Devarajan et al, 1996; Kocherlakota and Yi, 1997; Miller and Russek, 1997; de la Fuente, 1997. More recently, Wildmalm (2001), Padovano and Galli (2002), Li and Sarte (2004), and Lee and Gordon (2005), Angelopoulos et al. (2007) have each found that tax *structure* and/or public expenditure *composition* are correlated with growth, though the GBC is not always fully specified in these studies. Bose et al. (2003) and Adam and Bevan (2005) apply the Kneller et al (1999) methodology to developing countries; Adam and Bevan extend the analysis to examine different sources of deficit financing.

This has implications for the interpretation of parameters on fiscal variables in growth regressions which include one or more elements of the GBC. Suppose that GDP growth, in each country at time *t*, g_t, is a function of a set of $k= 1\ldots K$ conditioning (non-fiscal) variables, Z_{kt}, and a set of $m = 1\ldots M$ fiscal variables, X_{mt}. A typical growth regression takes the following form:

$$g_t = \alpha + \sum_{k=1}^{K} \beta_k Z_{kt} + \sum_{m=1}^{M} \gamma_m X_{mt} + u_t \tag{1}$$

where u_t is a classical error term. Investigators may be interested, for example, in whether changing a particular tax rate or level of government expenditure impacts beneficially or adversely on growth. However since a change in either fiscal variable requires or induces a compensating change in some other fiscal variable, no single fiscal variable can be considered in isolation. To see this, consider the simple case where a single type of expenditure, *e*, is financed partly by a proportional tax on income, *y*, with revenue from the tax given by $r = \tau y$, where τ is the marginal (= average) tax rate. Expenditure, in excess of (less than) tax revenue, is financed by government borrowing (lending). Defining $E = e/y$, $R = r/y$ (= τ), and $D = d/y$ where *d* is the budget deficit, we might investigate whether each of these impacts on growth such that (1) becomes:

$$g_t = \alpha + \sum_{k=1}^{K} \beta_k Z_{kt} + \gamma_r R_t + \gamma_e E_t + \gamma_d D_t + u_t \tag{2}$$

However, defining the GBC as:

$$D_t = R_t - E_t \tag{3}$$

and using (3) to substitute for D_t in (2) gives:

$$g_t = \alpha + \sum_{k=1}^{K} \beta_k Z_{kt} + (\gamma_r + \gamma_d) R_t + (\gamma_e - \gamma_d) E_t + u_t \tag{4}$$

Combining the parameters on R_t and E_t in (4), yields $(\gamma_r + \gamma_e)$. The individual fiscal parameters, γ_r , γ_e , γ_d , however cannot be separately identified. Indeed, they have no independent meaning since it is not possible to have a growth effect from one variable without a simultaneous effect from at least one other.

For estimation purposes, in order to avoid perfect collinearity, at least one of the fiscal variables in (2) must be omitted, as in equation (4). The omitted variable is effectively the assumed compensating element within the government budget constraint. In other words, the correct interpretation of each estimated fiscal parameter is the effect of a unit change in the relevant fiscal variable *offset by a unit change in the fiscal element or elements omitted from the regression*. In terms of the fiscal categories described above, for example, the parameter on productive expenditure would be expected to be higher if it is implicitly financed by omitting non-distortionary taxation rather than by omitting distortionary taxation – because in the former case γ_r in the expression $(\gamma_r + \gamma_e)$ is expected to be less negative, or zero. The problem is not solved by omitting many elements of the government budget constraint from the regression instead of just one; rather it becomes harder to identify precisely what is the assumed implicit financing.

Allowing for Heterogeneous Fiscal-Growth Effects

Previous empirical tests for fiscal-growth effects in OECD countries have typically relied on cross-section or panel data using 5-year averages to smooth out short-run effects.[5] Partly because of the resulting short time-series dimension, these studies have then applied static or dynamic panel data estimators. Bleaney et al. (2001) is an exception – they use annual data (1972-1995) with up to 8 annual lags, which necessarily restricts the T-dimension in regressions. These methods therefore impose parameter homogeneity across countries and over time, though some do allow for individual country fixed effects.

However, it is known that the results from a dynamic fixed effects (DFE) regression are likely to be biased if, as Pesaran and Smith (1995) suggest, the assumption of homogeneity of the short-run parameter estimates across countries cannot be accepted. They show that this may be a more serious problem than the bias generated by the inclusion of lagged dependent variables and can lead to inconsistent and misleading results even for large T and large N. To overcome this bias they suggest the use of either the pooled mean group (PMG) or mean group (MG) estimators (Pesaran, et al., 1999). The latter allows both short- and long-run parameter heterogeneity, while the former imposes long-run homogeneity. A comparison of the results from these two also allows us to address formally the question of whether the long-run effect of fiscal policy on growth is identical across countries, even if short-run effects

[5] See, for example, Wildmalm (2001), Padovano and Galli (2002), Li and Sarte (2004), and Lee and Gordon (2005), Angelopoulos et al. (2007). Angelopoulos et al. (2007) is closest in spirit to the approach used here but, like most previous papers, they use static (fixed effects) panel techniques applied to 5-yearly averaged data. Their results confirm positive (negative) long-run growth effects from productive expenditures (some taxes).

differ.[6] Acceptance of this restriction implies that the results from the PMG estimator are more efficient than those from the MG estimator (Pesaran, et al., 1999).

The estimated regression for the MG model is of the following error correction form,

$$\Delta g_{it} = \phi_i (g_{it-1} - \beta_i F_{it-1}) + \sum_{j=1}^{J} \gamma_{0ij} \Delta g_{it-j} + \sum_{l=0}^{L} \gamma_{1il} \Delta F_{it-l} + \varepsilon_{it} \tag{5}$$

where i indicates the country, t is time, g is the rate of growth of GDP, F is a matrix of fiscal and control variables, ϕ, β and γ are parameters to be estimated and ε_{it} a classical error term. The test for the long run effect of fiscal policy is made on the parameter vector β_i. The long run effect of fiscal policy across countries is calculated as the (unweighted) average of the estimates from the N individual country regressions. The PMG model differs from these single country time series regressions by imposing homogeneity of the long-run parameter: β_i becomes β. A Hausman test can be used to test the statistical plausibility of this restriction.[7]

The disadvantage of the MG and PMG estimators is of course that unless the available time series is very long a degrees of freedom problem is soon reached. For the dataset available here this requires some restrictions on lag lengths and/or the set of right-hand-side (RHS) variables. For this reason we restrict the RHS variables to include two control variables (the investment rate and employment growth), and up to five of seven possible fiscal variables (budget surplus, distortionary, non-distortionary & 'other' tax revenues and productive, unproductive & 'other' expenditures). To maximise the degrees of freedom (in Section 3) we initially combine distortionary with 'other' taxes and unproductive with 'other' expenditures.[8]

We are also forced to restrict the regression equation to include a maximum of two lags. At first sight this may appear to be an unhelpful limitation, since one objective is to identify how long it takes for any persistent fiscal effects to emerge. This turns out not to be a problem, in part because the inclusion of the lagged dependent variable ensures that the impact of shocks can persist for many periods.

---

[6] The PMG estimator has the additional advantage over the alternative mean-group (MG) estimator in that it performs well even when, as is the case here, N is small (Hsiao et al., 1997). The MG estimator tends to be thought of as providing better information about the short-run and error correction coefficients of the PMG model (Pesaran et al., 1999).

[7] Results reported below were estimated using Pesaran's GAUSS programme, available from the following website: http://www.econ.cam.ac.uk/faculty/pesaran/jasa.exe .

[8] Bleaney et al (2001) found that 'other revenues' (those not readily classified as either distortionary or non-distortionary) also had a significant (negative) effect on growth.

Testing for Endogeneity

Partly because of the 'single snap-shot' nature of much of the evidence, establishing that observed fiscal-growth correlations are not simply the result of endogeneity has proved difficult. Bleaney et al (2001) explored lag structures on both period-averaged and annual data and tried to assess whether endogeneity could account for observed growth effects associated with distortionary taxes and productive public expenditures. Having established new fiscal-growth estimates using MG and PMG methods in Section 3, we also pursue this issue in Section 4. We use methods proposed by Jones (1995) – excluding any contemporaneous correlation – and instrumental variable (IV) methods to examine causation among our fiscal and growth variables.

The Updated Dataset

Bleaney et al. (2001) used GFS fiscal data for 17 OECD countries, available from the early 1970s to 1995, to construct measures of distortionary and non-distortionary taxes, productive and unproductive expenditures, and budget surpluses/deficits. [9] Updating this dataset to 2003 or 2004 is not straightforward because of changes in the GFS methodology, which moved to an accruals accounting (as opposed to cash accounting) basis for fiscal data from the late 1990s onwards. This is described in more detail in Appendix 2. This exercise provides around 30-32 annual time-series observations each for most of the 17 countries in the sample.

Data on GDP growth, and the two control variables – the investment/GDP ratio and employment growth – were obtained for the same period from OECD sources (see Appendix 2). An important difference from previous studies is that we use data on private non-residential investment (PNRI) instead of total investment (gross fixed capital formation). Since all regressions include various public expenditure variables, the use of PNRI avoids the possibility of 'double counting' much public investment which otherwise potentially affects both the investment and public expenditure data.[10]

3. New Estimates

Using a DFE model, Bleaney et al. (2001) found strong support for positive, long-run growth effects associated with productive public expenditures and budget surpluses and negative

[9] The term 'less distortionary' may be more appropriate in this case since the, mainly consumption, taxes in this category can distort investment decisions via labour supply effects in models such as Mendoza et al (1997). The method of aggregating the GFS functional classification into these sub-aggregates is described in Bleaney et al. (2001) and summarised in Appendix Table A1.1.

[10] Using total investment rather than its private component, as a control variable, would also bias results because public investment would appear within the 'control'.

effects for distortionary taxes. To identify these long-run effects appeared to need up to 8 annual lags of data. Later in this section we replicate these DFE regressions on the new dataset, using either 8 or 2 lags. This allows comparisons with the more flexible MG and PMG results reported below.

We begin by estimating equation (5) for the 17 OECD countries using the PMG method, reported as regressions R1 - R4 in Table 1. Each of these regressions omits the budget surplus/deficit, while ‘other’ revenues and expenditures have been combined with distortionary taxes and productive expenditures respectively.[11] In each regression both control variables (investment and employment growth) take the expected positive signs and are statistically significant.[12] Though adjusted-R^2s are not reported for those regressions (they can be obtained as weighted averages of the country-specific adjusted-R^2s), the fit of all regressions reported below is around 55 - 60%.

Table 1 Pooled Mean Group Regressions, 1970-2004

Method:	PMG	PMG	PMG	PMG	PMG		PMG
Regression No.	***R1***	***R2***	***R3***	***R4***	***R5***		***R6***
Budget surplus*	-	-	-	-	0.164 (4.91)	Budget surplus	0.066 (2.23)
Distortionary & Other tax	-0.073 (-3.51)	-0.081 (-3.33)	-0.104 (-3.15)	-0.120 (-3.55)	-0.246 (-7.82)	**Distort Tax only**	-0.139 (-3.87)
Productive & Other expend.	0.119 (4.22)	0.070 (2.24)	0.008 (0.21)	0.016 (0.43)	0.260 (4.92)	**Productive exp only**	0.120 (2.32)
Investment ratio	0.049 (1.75)	0.078 (2.74)	0.086 (2.31)	0.098 (2.78)	0.017 (0.59)	Investment ratio	0.035 (1.10)
Employment	0.220 (4.47)	0.181 (3.47)	0.237 (4.38)	0.240 (4.73)	0.227 (4.58)	Employ -ment	0.170 (3.39)
Non-distort. taxes	0.175 (3.26)	-	0.055 (0.88)	-	-		-
Unproductive expenditure	-0.171 (-6.76)	-0.116 (-4.60)	-	-	-		-
Financed by:	*Bud Surp*	*Bud Surp* *Non-dis tax*	*Bud Surp* *Unprod Exp*	*Bud Surp* *Non-dis tax* *Unprod exp*	-		*Non-dis tax* *Unprod exp* *Other tax & exp*

Note: t-statistics in parentheses below parameters.

[11] The impact of this aggregation is explored below. Note that, the budget surplus is defined as revenue minus expenditure (where expenditure excludes net lending), and net lending = net acquisition of financial assets. This budget surplus measure is referred to as “Net Operating Balance” in the 2001 GFS manual.

[12] Both control variables could be endogenous in these regressions if, for example, faster GDP growth drives up investment and employment. We test later for endogeneity of investment (and possible simultaneous relationships with fiscal variables). We have also examined similar regressions to those in Table 1 but replacing employment with labour force data. Results are broadly similar.

R1 shows that when only the budget deficit is assumed to finance tax and expenditure changes, there are small negative growth effects from distortionary (and other) taxes and small positive effects from productive (and other) expenditures. That is, distortionary & other taxes have more damaging effects on growth than deficits so that simultaneously reducing the latter and raising these taxes is bad for growth in net terms. But deficit-financed increases in productive public spending would appear to be modestly growth-enhancing.

R1 also reports *positive* growth effects for non-distortionary taxes and *negative* effects from non-productive expenditures. These signs are not necessarily counter-intuitive since both parameters include the impact of deficit-financing. That is, replacing a deficit with non-distortionary taxes would be growth-enhancing; but financing increases in unproductive spending with a deficit would be growth-retarding. In terms of growth effects, the following rankings may be inferred from the results in R1:

Growth effects:	**Taxes/Deficits**	**Expenditures/Surpluses**
'best'	non-distortionary	productive/other expenditures
'intermediate'	deficits	surpluses
'worst'	distortionary/other taxes	unproductive expenditures

Notice also in R1 that the parameters on non-distortionary taxes and unproductive expenditures are of similar absolute magnitudes, but opposite signs. From equation (4) it can be shown that this implies that $\gamma_r = -\gamma_e$ for those taxes/expenditures, and hence if only these fiscal variables are both omitted from subsequent regressions (see R5), the implied net financing assumption is approximately zero. Regressions R2 & R3 confirm that when only one of these two fiscal categories is included in the regression, a deficit-reducing increase in non-distortionary taxes is positive for growth (though not significantly so), while a deficit-financed increase in unproductive spending is negative for growth.

Comparing regressions R4 & R5 demonstrates the impact of deficit financing – R5 includes the budget surplus whereas R4 omits it. It can be seen that inclusion of the budget surplus (with the omitted categories now being approximately 'net growth-neutral'), leads to much larger parameters on the included fiscal variables. R6 shows the effect on the distortionary tax and productive spending parameters when 'other' categories are omitted. The included fiscal variables are therefore now counteracted by omitted negative (other tax) and positive (other expenditure) impacts on growth. It can be shown that this is expected to reduce the absolute size of the included fiscal parameters in R6 compared to R5,[13] and regression R6 confirms this.

Testing PMG versus MG Methods

As noted above, MG estimates of fiscal parameters can be obtained as unweighted averages of individual country parameters, where the assumption of homogeneity is relaxed both for the short-run and long-run. The assumption of long-run homogeneity in Table 1, imposed by the PMG, can also be tested using a Hausman test. Table 2 shows the PMG regression (R6, Table 1), and compares this with the equivalent MG regression estimates for the three fiscal variables. It can be seen that the MG estimates are similar but generally larger (in absolute value) and, unsurprisingly, are less precisely estimated.

Table 2 MG and PMG Estimates

	Distortionary taxes	Productive expenditure	Budget Surplus
Pooled Mean Group Estimates	**-0.139 (-3.87)**	**0.120 (2.32)**	**0.066 (2.23)**
Mean Group Estimates	**-0.262 (-1.21)**	**0.162 (0.47)**	**0.014 (0.07)**
Hausman Test: [p-value]	**0.33 [0.56]**	**0.02 [0.90]**	**0.07 [0.79]**

Note: t-statistics in parentheses below parameters.

The Hausman test suggests strongly however that the assumption of long-run homogeneity using the PMG method can be accepted (high p-values on the H-tests). This implies that the estimated long-run fiscal-growth effects in Table 1 can legitimately be treated *as if* they were common across countries. Of course, to the extent that parameter estimates for individual countries are associated with large standard errors, this test will have relatively low power.

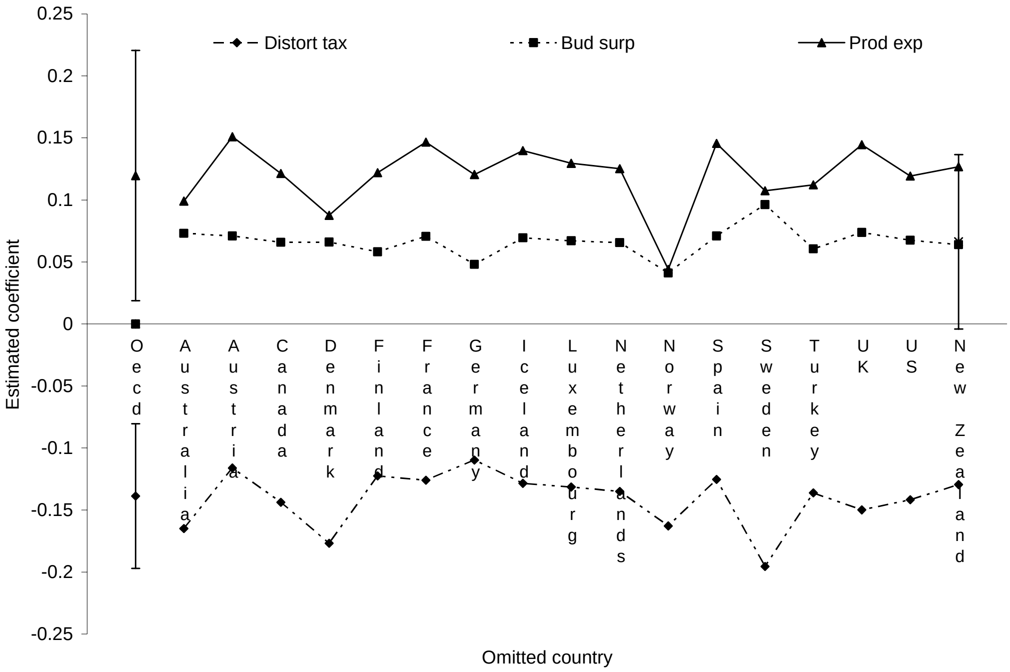
Parameter Stability

Bassanini & Scarpetta (2002) argue that in small country samples the estimated PMG parameters may be sensitive to the inclusion or exclusion of any one country, even when the

[13] For example, where increased distortionary taxes are financed solely by reductions in 'other revenues' the growth effects would be expected to be smaller (less negative) if these other revenues also have negative growth effects, and zero if both types of tax had similarly negative growth effects. If, instead, increased distortionary taxes financed increases in (omitted) other expenditures with positive growth effects, a smaller (less negative) distortionary tax parameter would again be expected.

Hausman tests do not reject the assumption of long-run homogeneity. Following their example, we re-estimate the regression R6 in Table 1 excluding in turn one country from the sample. Figure 1 reports the coefficients for each of the fiscal variables when a single country is omitted, and 95% confidence intervals, based on the standard errors from the full sample. As can be seen the parameter estimates remain stable from such a test and never stray outside of the confidence bands.[14]

Figure 1 Testing Parameter Homogeneity



Comparing PMG and DFE Results

Pesaran and Smith (1995, pp.85-87) show that, in dynamic heterogeneous panels, the imposition of homogeneous parameters in DFE models is expected to yield over-estimates of average long -run parameters and under-estimates of average short-run parameters (for absolute values in each case).[15] Table 2 compares regression R6 from Table 1 with the equivalent DFE regressions using either 8 or 2 lags. The former was found by Bleaney et al. (2001) to be required to capture long-run effects fully in a DFE model; the latter allows direct comparison with the PMG results.

[14] Using regression R5 in Table 1 produces similar results, except that productive-plus-other expenditure displays more sensitivity to the exclusion of Sweden. Other expenditures represent around 5% of GDP on average across the sample, compared to about 35% for total expenditures.

[15] These biases result where the right-hand-side variables follow stationary autoregressive processes and the autoregressive parameter, ρ, is $0 < \rho < 1$, which holds for our fiscal variables.

Table 2 Comparing PMG and DFE Results

Method: Lags:	***PMG (2 lags)***	***DFE (8 lags)***	***DFE (2 lags)***
Regression no.	***R6***	***DFE8***	***DFE2***
Budget surplus	0.066 (2.23)	0.228 (2.50)	0.078 (1.46)
Distortionary tax	-0.139 (-3.87)	-0.213 (1.85)	-0.168 (2.33)
Productive expenditure	0.120 (2.32)	0.184 (1.49)	0.068 (0.88)
Investment ratio	0.035 (1.10)	0.059 (0.84)	0.053 (0.97)
Employment	0.170 (3.39)	0.282 (2.43)	0.157 (2.34)
Observations	480	405	490
Adjusted R^2	0.55*	0.58	0.52
Financed by:	*Non-dist tax;Unprod exp; Other tax & exp*		

* Unweighted average of individual country adjusted-R^2.

It can be seen that the PMG regression generates both more precisely estimated long-run fiscal effects, and lower parameters (in absolute value) that the DFE model when 8 lags are allowed, as predicted when short-run dynamics are heterogeneous. Comparing the 8- and 2-lag DFE results it is clear that 2 lags fail to capture the full long-run effects but, even here, parameters are larger than the PMG case for the budget surplus and distortionary taxes. The DFE model, by imposing short-run homogeneity, also appears generally to identify long-run parameters less precisely, especially for productive expenditures.

Short-Run Dynamics

Theory provides little guidance on how long it might be expected to take for fiscal changes to impact fully on economic growth rates, though periods from several years to several decades have been proposed based on alternative views of the likely speed of convergence towards a new steady state following a fiscal shock. For policy makers it is clearly important to be able to identify how quickly the long-run fiscal-growth effects feed through. For example, does the bulk, or all, of the growth impact of an increase in productive expenditures occur quickly or only after several years? Does growth respond much more quickly in some countries than others?

Because the dynamics in the PMG regressions are allowed to differ across countries, it is possible in principle to answer these questions for each country and fiscal variable. However, the merit of the PMG approach is primarily in delivering more reliable, homogeneous *long-*

run effects, by relaxing the homogeneity assumption for the short-run. With relatively short time-series for each country, the individually-estimated short-run effects are not typically estimated with much precision and should therefore be interpreted cautiously. Nevertheless, for the sample as a whole they might be expected to give some indication of the likely time lags involved in adjusting towards a new long-run equilibrium following a fiscal shock.

The trajectory followed by each country is determined by the estimated lag structure on each fiscal variable for that country together with its error-correction parameter, ϕ_i, in equation (5). Since this is an asymptotic process, (except where $\phi_i = -1$) one way to summarise these trajectories is to consider the number of years taken to reach a given percentage of the long-run equilibrium, following a fiscal shock.[16] Table 3 therefore reports the number of years taken (0, 1-2, 3-4 etc.) for each fiscal-growth effect to reach 90% of its long-run value.[17] The error correction parameter itself, ϕ_i, of course, also provides a measure of the speed of adjustment of growth following an exogenous shock. These are also summarised in Table 3. In all cases results are reported using regression R6 in Table 1, but similar results are obtained based on other regressions.

Table 3 Short-Run Dynamic Adjustments*

No. of years to achieve 90% of long-run effect	**Number of countries**			**Proportion of disequilibrium corrected within 1 year**	**Number of countries**
	Budget surplus	**Distort. taxes**	**Product. expend.**		
0	0	0	0	**> 90%**	7
1 – 2	0	1	2	**50% - 90%**	7
3 – 4	6	4	4	**< 50%**	3
5 - 7	6	8	7		
≥ 8	5	4	4		
Long-run effect (standard error)	0.066 (0.03)	-0.137 (0.04)	0.120 (0.05)		

** using regression R6 in Table 1.*

The table reveals that the adjustment process is relatively rapid in most cases. For example, for productive expenditures, 90% of the estimated long-run effect (of 0.12) is achieved within 4 years by 6 of the 17 sample countries. A further 7 countries achieve this within 7 years and 4 countries take 8 years or more. The adjustment process appears to be similar for both

[16] Half-lives (the more usual indicator of adjustment speeds in such cases) are not very helpful in this case because of the relatively rapid adjustment observed, as shown below.
[17] In those cases where countries oscillate towards the long-run equilibrium, we choose the number of years until the relevant fiscal-growth effect *remains* within 90% of its long-run value. Results are not sensitive to the particular percentages chosen.

productive expenditures and distortionary taxes. The error correction parameters reported on the right-hand-side of the table also suggest a relatively quick adjustment process with 7 countries moving to within 90% of a new equilibrium within one year of an exogenous shock.[18] A further 7 countries adjust more than 50% of the way towards a new equilibrium within a year.

These results suggest that the adjustment process to the long-run is measured in years rather than decades. However, the evidence of short lag lengths and rapid adjustment speeds raises questions concerning the exogeneity of fiscal policy. Could these rapid responses in fact be evidence of familiar short-run macroeconomic behaviour, where fluctuations in growth rates cause 'automatic' and/or discretionary fiscal responses and/or *vice versa*? We turn next to this issue.

4. Endogeneity of Fiscal-Growth Effects

We cannot, so far, discount the possibility that the evidence in the previous section arises from simultaneous relationships between growth and fiscal policy. That is, instead of, or as well as, direct impacts of fiscal variables on GDP growth, changes in GDP growth may be inducing changes in these fiscal variables, albeit that the latter would not be expected to persist over the long-run. This section adopts two procedures to investigate this possibility. First we consider the specific endogeneity arguments in this case.

The hypothesis that faster growth induces changes in *total* government expenditure or taxation is well known: economic downturns reduce taxable capacity and generate demands for additional public expenditure such as unemployment benefits and social insurance payments.[19] These arguments might be expected to apply with equal or greater force to the main tax/expenditure components considered here. Since distortionary taxes are mainly corporate and personal income taxes, these would be expected to be income-elastic and therefore pro-cyclical (both absolutely and relative to non-distortionary taxes). As a result they would be expected to rise, as a share of GDP, when income grows more rapidly and fall (or rise more slowly) when income grows slowly.

[18] This error correction parameter reflects the combined short-run responses of *all* variables in the regression, including control variables.

[19] The argument that *total* expenditures rise during downturns of course hinges on the assumption that increases (or faster growth) in counter-cyclical expenditures are not compensated by reductions (or slower growth) in pro-cyclical expenditures, such as public investment spending. This is likely to hold since short-run contractions of other expenditures are typically more difficult to achieve than increases in social expenditures.

Productive expenditures would also be expected to rise when faster growth generates additional revenues, and demands for unproductive expenditures (such as social insurance) weaken. This would raise the share of productive expenditures in total expenditure and probably also in GDP – public investment can be expected to be pro-cyclical. In addition, budget deficits are well known to be counter-cyclical, which could reflect slower growth *causing* increased deficits (reduced surpluses), and *vice versa*. As a result, endogeneity in our previous regressions could result from effects running from growth to fiscal variables, with predicted effects on our three fiscal variables as follows:

Distortionary taxes:	**positive**	Budget surplus:	**positive**
Productive expenditures:	**positive**		

Endogeneity arguments therefore reinforce the chances of finding positive effects for productive expenditures and budget surpluses, but they *reduce* the likelihood of finding the strong negative effects of distortionary taxes on growth that results thus far indicate. Nevertheless, for all three fiscal variables we pursue two strategies to test for endogeneity effects.

Firstly, in his critique of the investment and growth literature, Jones (1995) suggests that, at one extreme, regressions including contemporaneous investment can be considered as implicitly treating all contemporaneous effects of investment on growth as causal. At the other extreme, omitting current values treats *none* of the observed contemporaneous correlation as causal. Analogously, for our fiscal variables, by repeating earlier regressions but disallowing any contemporaneous correlation between the fiscal variables and growth, the estimated parameters could be considered as representing the minimum causal effect of those fiscal variables on growth. This approach was followed by BGK (2001).

Secondly, where endogenous relationships are suspected, a preferred solution is to instrument as fully as possible for each endogenous variable and test using IV methods. In the present context, finding suitable instruments is difficult. However, using statutory tax rates, population size and age structure, and lagged values of the suspected endogenous variables, we show that, with the exception of budget deficits, these yield relatively strong instruments for potentially endogenous fiscal variables.

Disallowing Contemporaneous Effects

Table 4 shows the effect on the previous PMG growth regressions of omitting contemporaneous effects of the fiscal variables. Three cases are shown, involving three different forms of financing. In each case, the original regression (R1, R4 or R5 from Table 1), involving contemporaneous values of all variables, is reported. The adjacent column reports the equivalent regression but where contemporaneous values of the included fiscal and investment variables have been omitted (E1, E4, & E5). Note that, even if fiscal variables are exogenous, endogeneity of investment would be expected if, as seems likely, fiscal variables affect growth partly through their effect on private investment.

Table 4 Endogeneity Tests: Removing Contemporaneous Correlation

Regression:	R1 (Table 1)	**E1**	R4 (Table 1)	**E4**	R5 (Table 1)	**E5**
Contemporary effects?:	*YES*	***NO***	*YES*	***NO***	*YES*	***NO***
Budget surplus	-	-	-	-	0.164 (4.91)	**-0.066 (-1.36)**
Distortionary & other taxes	-0.073 (-3.51)	**-0.166 (-5.13)**	-0.120 (-3.55)	**-0.106 (-2.54)**	-0.246 (-7.82)	**-0.095 (-1.99)**
Productive & other expenditures	0.119 (4.22)	**0.103 (2.51)**	0.016 (0.43)	**0.052 (1.22)**	0.260 (4.92)	**0.005 (0.081)**
Investment ratio	0.049 (1.75)	**0.169 (4.61)**	0.098 (2.78)	**0.083 (2.00)**	0.017 (0.59)	**0.110 (2.83)**
Employment	0.220 (4.47)	**0.130 (1.91)**	0.240 (4.73)	**0.214 (3.33)**	0.227 (4.58)	**0.206 (3.15)**
Non-distortionary taxes	0.175 (3.26)	**-0.128 (-1.40)**	-	-	-	-
Unproductive expenditure	-0.171 (-6.76)	**0.102 (2.00)**	-	-	-	-
Financed by:	*Budget Surplus*		*Budget Surplus Nondistort. tax Unproduct. exp*		*Nondistort. tax Unproduct. exp*	

Consider first regressions R1 & E1 where the implicit financing element is the budget surplus/deficit. The parameter on productive expenditure remains of similar magnitude in E1, while the distortionary tax parameter becomes more negative.[20] Notice however that the parameters on non-distortionary taxes and unproductive expenditures change signs so that now the so-called 'unproductive' spending appears to have a similar long-run growth impact (around 0.10) to productive spending.

[20] The result for distortionary taxes is consistent with a positive contemporaneous correlation between these taxes and growth (as hypothesised), resulting in a larger negative growth response when only lagged tax values are used.

Taken together, the results in R1 and E1 imply that unproductive spending is negatively correlated with *current* growth (as expected), whereas productive spending is essentially uncorrelated with *current* growth. Both have similar lagged growth effects. These results imply some changes to the ranking of *long-run* growth effects identified earlier, which now become:

Growth effects:	**Taxes/Deficits**	**Expenditures/Surpluses**
'best'	deficits (zero effect)	productive/other expenditures
'intermediate'	non-distortionary	unproductive expenditures
'worst'	distortionary/other taxes	surpluses (zero effect)

Unproductive expenditures have been ranked below 'productive/other' because of the negative association of the former with current growth. Similar comparisons between regressions R4 & E4 confirm smaller growth effects (in absolute value, compared to R1 & E1 respectively) from distortionary taxes and productive spending, when these are now part-financed by non-distortionary taxes and unproductive spending. However, the productive spending parameter in E4 (at 0.052) is both larger and more precisely identified than the equivalent in R4 (0.016), confirming a *larger* growth effect estimate when contemporaneous fiscal values are omitted.

Finally comparing regressions R5 & E5 allows the exogeneity of the budget surplus/deficit to be assessed; and this would appear to be rejected. When contemporaneous values are omitted, the budget deficit takes the opposite (negative) sign in E5 compared to R5. Thus, whereas, when current values are included increases in budget surpluses appear to be growth-enhancing, when only lagged budget surpluses are examined, there is no estimated impact (or possibly a small adverse impact) on long-run growth.[21]

In summary, these results suggest that, *if* we treat all contemporaneous correlations among the fiscal, investment and growth variables as non-causal, then the previous long-run growth effects for productive spending and distortionary taxes appear to be as strong, or stronger, than previously estimated. Now, however, unproductive spending displays a long-run positive growth effect which was previously obscured by the strong negative contemporaneous relationship with growth (when deficit financed). For budget surpluses, the previously identified positive long-run growth effect appears essentially to be dependent on current comovements of surpluses and growth. Larger deficits may be associated with slower growth in the short-run, but they have not been shown to be harmful for growth over the long-run, perhaps in part because fiscal prudence in OECD countries generally ensures that substantial changes in deficits are not allowed to persist for long.

IV Estimation

The instrumental variables used include the population level and age structure, the top statutory tax rate and 2- or 3-period lagged values of our suspected endogenous variables as shown below:

T-TAX	top statutory rate of personal income tax
AGE-Y	proportion of the young (under 16 years) in the population
AGE-O	proportion of the old (over 64 years) in the population
POP	population size
LAG2(3)	*t-2 (t-3)* own-lagged value of the relevant endogenous fiscal variable. (e.g. first stage regression for distortionary tax ($rdis_t$) includes $rdis_{t-2\ (t-3)}$ etc).

Table 5 Endogeneity Tests: IV Estimation

Regression No.:	**IV1**	**IV2**	**IV3**	**IV4**
Budget surplus	-0.135 (-2.15)	0.027 (0.48)	-0.02 (-0.34)	0.005 (0.083)
Distortionary taxes	-0.140 (-2.80)	-0.074 (-1.35)	-0.133 (-2.49)	-0.192 (-3.69)
Productive expenditure	0.104 (1.90)	0.118 (1.80)	0.149 (2.70)	0.062 (0.97)
Investment ratio	0.097 (2.08)	0.041 (0.82)	0.067 (1.40)	0.047 (0.76)
Employment	0.393 (8.53)	0.345 (6.14)	0.414 (8.62)	0.488 (11.62)
	14	18	21	12
Instrument set:	*T-TAX* *LAG2*	*T-TAX* *LAG2; LAG3* *AGE-Y; AGE-O*	*T-TAX* *LAG2; LAG3*	*T-TAX* *LAG2* *AGE-Y; AGE-O* *POP*

Note: Regressions based on R6 in Table 1; i.e. implicit financing is non-distortionary taxes and unproductive spending. Unweighted regression adjusted-R^2s are around 0.45 in all cases.

5. Are the Orders of Magnitude 'Right'?

The results of the previous sections appear to offer strong support to the view that there are persistent effects of fiscal policy on growth. Previous such evidence has been subject to two further criticisms however. Firstly, the magnitudes of some previously estimated effects are

[21] Recall that in both these regressions the estimated growth impacts could also be related to the omitted

too large to be plausible.[22] Secondly, Jones (1995) and Karras (1999) have argued that evidence of non-stationarity in investment/GDP ratios (Jones) and total tax/GDP ratios (Karras) is at odds with evidence of stationarity in GDP growth rates. Thus, the former cannot plausibly explain the latter, unless *"by some astonishing coincidence all of the movements in variables that can have permanent effects on growth rates have been offsetting"* (Jones; 1995; p.496).

In this section we examine the relevance of these arguments for our evidence that changes in *the composition of* expenditures and taxes have persistent effects on growth. Our evidence suggests that changes in fiscal variables have often not been persistent, but where they have been, they have also generated largely offsetting effects on growth during the period studied.[23]

Descriptive Statistics

First, it is worth noting that there is considerable cross-section and time-series variation in the key fiscal variables within the sample. Table 6 summarises the data for three fiscal variables (as shares of GDP) towards the end of the period (2000-02), for OECD, EU and non-EU groupings.[24]

Table 6 OECD Fiscal Categories (as % GDP; average 2000-02)

	Distort. taxes	Product. exp.	Budget surplus	Distort. taxes	Product. exp.	Budget surplus
	Unweighted averages			***Weighted averages***		
OECD Average	20.2	13.0	-0.3	20.4	12.2	-0.1
(Standard dev.)	(5.6)	(4.4)	(4.4)	(3.3)	(3.6)	(2.0)
EU Average	22.9	13.9	0.0	23.4	14.0	-1.1
Non-EU Average	16.3	11.7	-0.7	18.6	11.3	0.5

From Table 6, on average around 20% of GDP in the OECD was collected from distortionary taxes, but varied from almost 30% in the Netherlands to 10% in Turkey. EU governments on average had a substantially greater proportion of distortionary taxes (23%) than Non-EU governments (16%). Productive expenditures were also widely dispersed: from 21% in France

financing – non-distortionary taxes and unproductive spending.

[22] See, for example, Agell et al. (2006) and Folster and Henrekson (2006) for a debate over previous fiscal-growth estimates.

[23] We do not use the term 'permanent' here since our period of analysis does not allow us to discriminate between 'persistent' but nevertheless transitional effects (in the sense used in neoclassical models), and permanent effects.

[24] In these tables, we 'smooth' the data - to avoid any atypical annual values distorting the picture - by averaging over 2000-02 – years for which there are data for all sample countries.

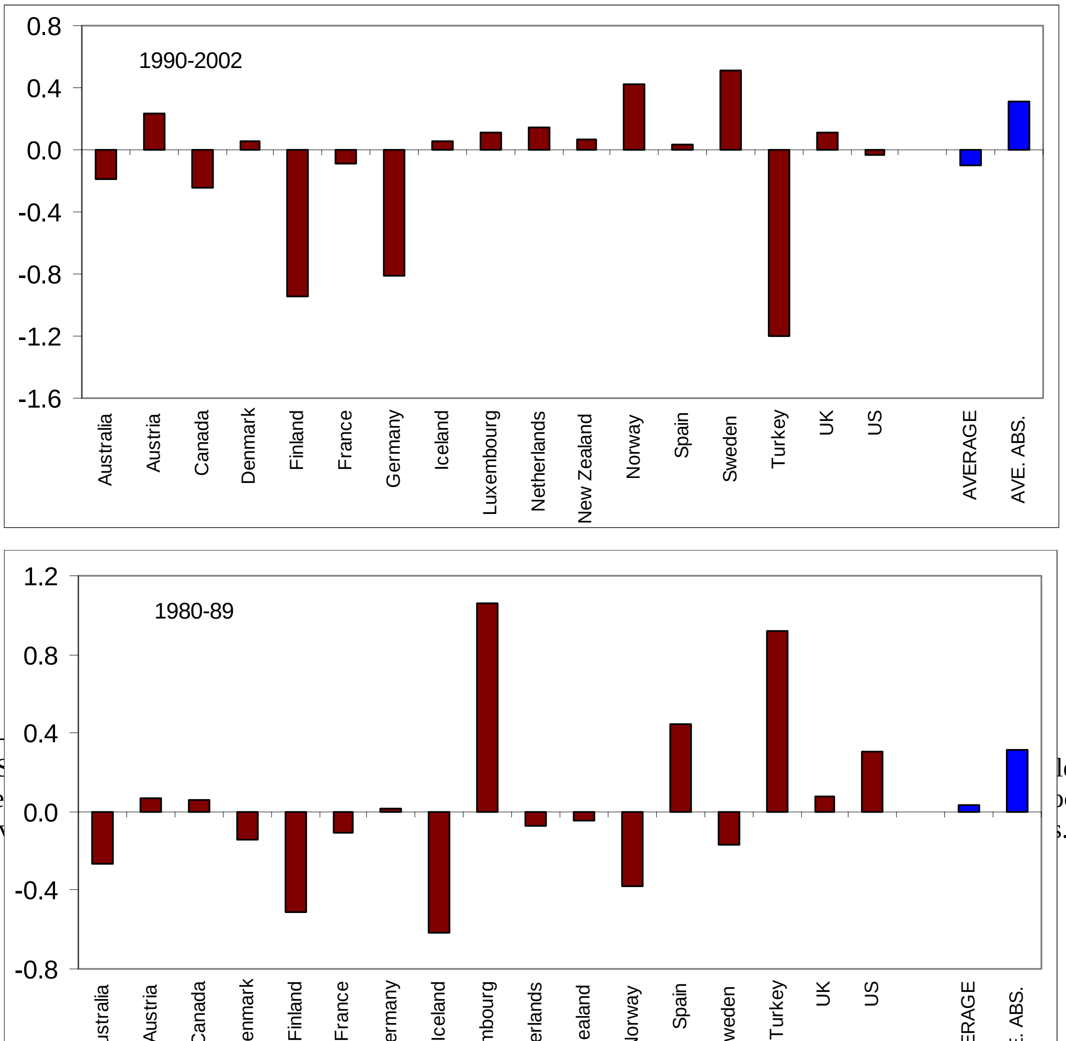
to 4% in Canada, with an OECD average around 13%, which is quite similar across EU and non-EU sub-samples.[25]

For around half the countries, budgets are in deficit (negative surplus) in this period; values range from a 7% surplus in Norway to a 16% deficit in Turkey. Appendix Table A1.2 shows that, there is also considerable variation in country GDP growth rates, even for period averages – from lows of 1.4% p.a. during the 1980s in Denmark to almost 5% in Luxembourg (1990-2004) and Turkey (1970s).

Estimating Overall Fiscal-Growth Effects

Using the (short- and long-run) parameters from the regressions in Section 3, it is possible to identify the contribution to each OECD country's GDP growth rate from their observed annual fiscal changes. These are summarized in Figure 2 (see Appendix Table A1.3 for details of the fiscal components) for the 1980s decade and for 1990-2002, using regression R5 in which all fiscal variables are included except non-distortionary taxes and unproductive spending.[26] Negative values indicate that fiscal choices reduced growth over the period relative to a counter-factual of unchanged fiscal variables.

Figure 2 Net Growth Effects of Fiscal Changes (in % points p.a.), 1980-2002*



[25] S … le, since
the … ocal
gov … s.

Note: * Based on regression R5 (Table 1) which omits non-distortionary taxes and unproductive expenditures

The figure also shows the OECD group average, and average absolute, growth impact (on the right-hand-side). Note that the 'bars' for individual countries will reflect both the actual changes in fiscal variables over the period and the estimated short- and long-run parameters for each country. However, to the (unknown) extent that the assumed homogeneous long-run parameter is inaccurate for an individual country, the estimated fiscal-growth effect will also be inaccurate.

On average across the 17 countries the net fiscal growth effect is small, and the average *absolute* growth impact is also relatively small at around 0.3 percentage points (pps) per annum. For most individual countries the estimated growth effects are in the -0.4pps to +0.4pps range, though for some, such as Finland, Germany and Turkey, growth effects appear unusually (perhaps implausibly?) large, at around -1pps per annum (1990-2002). [27]

These estimated growth effects are the net result of changes in distortionary (and other) taxes, productive (and other) expenditures and budget deficits. They suggest that, with the exception of a few countries, even where growth effects from individual fiscal variables are larger, the net effects from all relevant fiscal changes are relatively small. These represent plausible orders of magnitude on the whole and suggest that the growth effects of fiscal changes have generally been small but not trivial. For example, at 2.5% annual GDP growth, a 0.2pps (0.4pps) improvement via fiscal changes delivers a 4% (8%) higher GDP after 20 years.

Another way of assessing the quantitative significance of fiscal growth effects is to consider the growth impact of a country moving across the inter-quartile range of the relevant fiscal

[26] Regression lag structures limit the length of the period considered.

variables. For example, if a hypothetical country, currently at the 25th percentile of the distribution of distortionary taxes (as a % of GDP), moved to the median, how is this predicted to affect its long-run growth rate. Using two of the regressions in Table 1 (i.e. two alternative financing assumptions), Table 7 shows the predicted growth effects of shifts in the fiscal variables of interest from the 25th percentile to the median, and from the median to the 75th percentile.[28]

As expected, when only non-distortionary taxes and unproductive expenditures are the assumed financing categories (which were estimated to be approximately net growth-neutral), the predicted growth effects are larger than when 'other' revenues and expenditures are included among the financing variables.[29]

Table 7 Inter-Quartile and Median Growth Effects (2000-04 values [+])

Financed by:	*non-dist tax unprod. exp.*			*non-dist & other tax unprod.& other exp.*		
Sample averages: (% of GDP, 2000-04)	Prod. & other exp.	Dist. & other tax	Surplus	Prod. exp.	Dist. tax	Surplus
25th percentile	15.52	18.86	-1.96	10.47	15.34	-1.96
Median	17.97	23.52	0.84	11.97	20.43	0.84
75th percentile	21.53	28.60	2.21	16.52	25.14	2.21
Regression Parameters[*]:	*0.260*	*-0.246*	*0.164*	*0.120*	*-0.139*	*0.066*
Growth Effects (% points p.a.):						
25th percentile to median	**0.64**	**-1.15**	**0.46**	**0.18**	**-0.71**	**0.18**
Median to 75th percentile	**0.93**	**-1.25**	**0.22**	**0.55**	**-0.66**	**0.09**

Note: [+] Distributional statistics based on 71 annual observations (17 countries over 2000 - 2003/04).
[*] Regression parameters from regressions R5 & R6 in Table 1.

In the first case, increases in productive (and other) expenditures are shown to increase growth by around 0.6 - 0.9pps, while increases in distortionary (and other) taxes reduce growth by around 1 - 1¼pps. When 'other' categories are omitted, since these also have growth effects the estimates for productive expenditures are smaller at around 0.2 – 0.5pps, and for distortionary taxes are around -0.7pps. Clearly, in practice for any OECD country, moving across the inter-quartile range would represent a major shift in fiscal policy, and would likely be implemented over several years. The data here suggest that such a move could generate significant growth changes if applied to individual fiscal variables. However,

[27] These countries did, however, have some large changes in key fiscal variables. For example, in Turkey from 1990-2000, both distortionary (and other) taxes and productive (and other) revenues approximately doubled, while the budget deficit worsened dramatically from -3% of GDP in 1990 to -11% in 2000.
[28] For this exercise we use sample averages during the period from 2000 to 2003 or 2004 (depending on available data). This gives 71 observations on the relevant variables.
[29] Given our earlier evidence of possible endogenous responses involving budget deficits, we are not inclined to place much weight on the their estimated growth effects in this table.

as in Figure 2, simultaneous increases in productive spending and distortionary taxes would be expected to have only small net growth impacts, on average.

Applying Stationarity Tests

Having suggested that post-World War II growth rates in the OECD are best characterised as stationary, Jones (1995, p.502) argues that:

"if … permanent movements in some variable X have permanent effects on growth, then either (a) X must exhibit no persistent movements, or
(b) *some other variable (or variables) must also have persistent effects on growth that offset the movements in X".*

Our fiscal data provide *some* evidence of persistence in the "*X*" variables – namely between the early 1970s and 2004, both distortionary taxes and productive expenditures (as % of GDP) show signs of persistent upward movement in *some* OECD countries. For others, changes in fiscal categories appear to have been more transitory. In either case the evidence in Figure 2 is that the net effect of our fiscal variables is largely to *compensate* rather than *reinforce* their individual effects on growth (see Appendix Table A1.3.).

Jones (1995) suggests using formal time-series tests of the properties of individual country time-series: mainly ADF tests for growth and the right-hand-side variables of a growth regression. Given our focus on fiscal variables the available time-series are insufficiently long to permit time-series tests for individual countries. However, we can apply two comparable formal tests in a panel context:

(a) Panel unit root tests of the null hypothesis of non-stationarity of our fiscal variables in all countries against the alternative of stationarity in at least one, or all, countries.
(b) Stationarity tests of the residuals from the PMG regressions.

We first examine whether our three fiscal variables, investment and the growth rate are stationary, using panel unit root tests that test the null of non-stationarity for all countries against the alternative that at least one country/variable is stationary. We use the tests proposed by Maddala and Wu (1999), Im et al. (2003), and Taylor and Sarno (1998). Each has some advantages and drawbacks for the current application. These are discussed in the Appendix 1 and results are given in Appendix Table A1.4. Of most relevance in the current context is the recent panel unit root test proposed by Harris et al. (2005) which involves a simple test of the model's residuals.[30] As Appendix 1 demonstrates, each of these tests provides strong support for rejecting the null hypothesis of non-stationarity for our fiscal and other variables.

6. Conclusions

The last few years have seen important advances in methodologies for testing the long-run impact of fiscal policy on growth, and increasing availability of fiscal data. Previously, the "long-run" in most studies was typically identified using cross-section or panels methods applied to period-averaged data, with assumed common impacts across countries. As a result fiscal impacts were identified rather crudely and estimated, or assumed, to take 5-10 years or more to feed through to growth. However, as Pesaran and Smith (1995) and others have argued, assuming *incorrectly* that such parameters are homogeneous across countries is likely to bias results.

To overcome this, Pesaran et al. (1999) suggested using Pooled Mean Group or Mean Group estimators. This paper has applied these methods to address three key questions.

- Are previous estimates of long-run fiscal-growth effects robust to those new methods?
- Do they differ across countries?
- To the extent there are long-run effects, how quickly are they achieved?

Our results support the following conclusions:

1. The alternative estimators yield statistically significant but generally smaller long-run parameter estimates to those obtained using dynamic fixed effects models, and with much shorter lag structures.
2. The method of financing changes in fiscal policy is crucial to understanding, and interpreting, the growth impact of these changes.
3. The results confirm pervious evidence that distortionary taxes and productive expenditures have, respectively, negative and positive impacts on growth, and these long-run effects can reasonably be treated as homogenous across OECD countries.
4. Fiscal deficits would appear to have only transitory effects on growth.
5. Short-run dynamics are quite different across countries, but in most countries, estimated 'long-run' effects are typically achieved quickly (within 1 – 5 years).

[30] This test can accommodate structural breaks, stationary and non-stationary series, and heterogeneous time-series dynamics.

Overall, a more appropriate interpretation of the evidence is that there are significant effects of fiscal policy on growth over the short-run, but these are also *persistent*, provided fiscal policy changes are not reversed.

The tests for fiscal-growth effects in this paper are based on linear approximations of the relationships among the variables. If, as the Barro model proposes, these relationships are non-linear, this linear approximation may obscure the fact that some countries (with low government spending and taxes) could raise both taxes/expenditures and GDP growth, while the reverse might hold for high taxing countries. Our results generally find that the (linear) parameters on productive spending and distortionary taxes are similarly sized, or the former is smaller. This implies that, on average, the sample countries are estimated to be at, or slightly above, the growth-maximising fiscal combination. As Park and Philippopoulos (2003, p.525) demonstrate, when governments also pursue other objectives via fiscal policy, such as improvements in social welfare, it is to be expected that many chose tax/expenditure combinations above their growth-maximising levels.[31]

We have subjected our results to various tests for endogeneity of our fiscal policy variables. With the likely exception of the budget surplus/deficit, the evidence of persistent effects of fiscal variables on growth would appear not to be due to endogenous fiscal policy responses. We also considered whether our regression results yield plausible growth effects, when applied to the various fiscal policy changes observed across OECD countries. We found that where relevant fiscal changes persist, their effects on growth are generally compensating so that the *net* effect is expected to be small. Our estimates of these net effects confirm that for the OECD as a whole, and for most of the 17 members considered, estimated fiscal-growth effects over the period examined are relatively small, and certainly within the range of plausibility.

We also found that our key fiscal variables (*distortionary* taxes, *productive* expenditures and budget deficits) are often stationary; that is, potentially growth-affecting fiscal changes are often reversed, so growth effects in practice would be expected to be short-lived. Hence Jones's (1995) view that it would be an "astonishing coincidence" if two non-stationary variables that drive growth compensate for each other in such a way as to generate a

[31] By compromising somewhat on the regression specifications in Section 3, future analysis may be able to identify whether there are substantial non-linearities in fiscal-growth relationships. For example, are especially low (high) public spending countries capable of raising their growth rates via additional (lower) spending?

stationary growth process, is not so astonishing in this context. Where governments have chosen to increase their productive expenditures with growth-enhancing consequences, they have simultaneously tended to increase growth-inhibiting distortionary taxes to finance them. In sum, our results largely confirm Dalgaard and Kreiner's (2003; p.83) conjecture, based on *a priori* reasoning, that:

"*it may well be the case that a higher tax rate has a significant negative effect on the growth rate, but that this is roughly offset by a significant positive growth effect of the productive government expenditure that is financed by the higher tax rate, thus resulting in a small overall net effect*".

References

Adam, C.S. and Bevan, D.L. (2005) Fiscal deficits and growth in developing countries, *Journal of Public Economics*, 89, 571-597.

Agell, J., Lindh T., and Ohlsson H. (1997) ‘Growth and the public sector: a critical review essay’, *European Journal of Political Economy,* 13, 33-52.

Agell, J., Lindh T., and Ohlsson H. (1999) ‘Growth and the public sector: a reply’, *European Journal of Political Economy*, 15, 359-366.

Agell, J., Ohlsson, H. and Skogman-Thoursie, P. (2006) Growth effects of government expenditure and taxation in rich countries: a comment, *European Economic Review*, 50, 211-218.

Angelopoulos, K., Economides, G and Kammas, P. (2007) Tax-spending policies and economic growth: theoretical predictions and evidence from the OECD. *European Journal of Political Economy* (forthcoming).

Barro R. (1990) Government spending in a simple model of endogenous growth, *Journal of Political Economy*, 98, s103-117.

Bassanini A., and Scarpetta, S. (2002) Does human capital matter for growth in OECD countries? A pooled mean-group approach. *Economics Letters*, 74, 3,. 399-405.

Bleaney, M, Gemmell, N. and Kneller R. (2001) Testing the endogenous growth model: public expenditure, taxation and growth over the long run, *Canadian Journal of Economics,* 34, 36-57.

Bose, N., Haque, M.E and Osborne, D. (2003) *Public Expenditure and Economic Growth. A Disaggregated Analysis for Developing Countries.* Centre for Growth and Business Cycle Research, Economic Studies, University of Manchester. Discussion Paper No. 30.

Cassou, S.P. and Lansing, K.J. (1999) Fiscal Policy and productivity growth in the OECD, *Canadian Journal of Economics*, 32 (5), 1215-1226.

Dalgaard, C,J. and Kreiner, C.T. (2003) Endogenous growth: a knife edge or the razor’s edge?, *Scandinavian Journal of Economics*, 105 (1), 73-85.

de la Fuente A. (1997) Fiscal policy and growth in the OECD, *CEPR Discussion Paper No. 1755*.

Devarajan S., Swaroop V., and Zou H. (1996) The composition of public expenditure and economic growth, *Journal of Monetary Economics*, 37, 313-344.

Eicher and Turnovsky, S. (1999) Convergence Speeds and Transition Dynamics in Non-Scale Growth Models.” *Journal of Economic Growth* 4, 413–428.

Folster, S. and Henrekson, M. (2001) Growth effects of government expenditure and taxation in rich countries , *European Economic Review*, 45, 1501-1520.

Folster, S. and Henrekson, M. (2006) Growth effects of government expenditure and taxation in rich countries: a reply, *European Economic Review*, 50, 219-221.

Harris, D, Leybourne, S and McCabe, B. (2005) Panel stationarity tests for purchasing power parity with cross-sectional dependence, *Journal of Business Economics and Statistics*, 23, 395-409.

Ho, W.H. and Wang, Y. (2005) Public capital, asymmetric information and economic growth, *Canadian Journal of Economics*, 38 (1), 57-80.

Howitt, P. (2000) Endogenous Growth and Cross-Country Income Differences, *American Economic Review*, 90, 829-846.

Im, K.S., Pesaran, M.H. and Y. Shin (2003): “Testing for unit roots in heterogeneous panels”, *Journal of Econometrics* ,115, 53 –74.

Jones, C. I. (1995): “Time series tests of endogenous growth models”, *Quarterly Journal of Economics*, 110, 495-525.

Kaas, L. (2003) Productive government spending, growth, and sequential voting, *European Journal of Political Economy*, 19, 227-246.

Kalyvitis, S. (2003) Public investment rules and endogenous growth with empirical evidence from Canada, *Scottish Journal of Political Economy*, 50, 90-110.
Karras, G. (1999) Taxes and growth: testing the neoclassical and endogenous growth models, *Contemporary Economic Policy*, 17, 177-188.
Kneller, R., Bleaney, M. and Gemmell, N. (1999) Fiscal policy and growth: evidence from OECD countries, *Journal of Public Economics*, 74, 171-190.
Kocherlakota, N., and Yi, K-M. (1997a) A simple time series test of endogenous vs exogenous growth models: an application to the United States, *Review of Economics and Statistics, 78*, 126-134.
Kocherlakota, N., and Yi, K-M. (1997b) Is there endogenous long-run growth? Evidence from the US and UK, *Journal of Money, Credit and Banking, 29*, 2235-62.
Lee, Y. and Gordon, R.H. (2005) Tax structure and economic growth, *Journal of Public Economics,* 89, 1027-1043.
Levin, A., Lu, C. and Chu, C. (2002) Unit root tests in panel data: asymptotic and finite sample properties, *Journal of Econometrics*,108, 1-24.
Li, W. and Sarte, P-D. (2004) Progressive taxation and long-run growth, *American Economic Review*, 94, 1705-1716.
Maddala, G. and S. Wu (1999): "A comparative study of unit root tests with panel data and a new simple test", *Oxford Bulletin of Economics and Statistics*, 61, 631-652.
Mendoza E., Milesi-Ferretti G., and Asea P. (1997) 'On the ineffectiveness of tax policy in altering long-run growth: Harberger's superneutrality hypothesis', *Journal of Public Economics,* 66, 99-126.
Milesi-Ferretti G., and Roubini, N. (1998) 'On the taxation of human and physical capital in models of endogenous growth', *Journal of Public Economics*, 70, 237-254.
Miller S., and Russek F. (1997) 'Fiscal structures and economic growth: international evidence', *Economic Inquiry,* 35, 603-613.
Myles, D. (2000) Taxation and economic growth, *Fiscal Studies*, 21, 141-168.
Padovano, F. and Galli, E. (2002) Comparing the growth effects of marginal vs average tax rates and progressivity, *European Journal of Political Economy*, 18, 529-544.
Park, H. and Philippopoulos, A. (2003) On the dynamics of growth and fiscal policy with redistributive transfers, *Journal of Public Economics*, 87, 515-538.
Peretto, P.F. (2003) Fiscal policy and long-run growth in R&D-based models with endogenous market structure, *Journal of Economic Growth*, 8, 325-347.
Peretto, P.F. (2004) Corporate taxes, growth and welfare in a Schumpeterian economy, Duke University, (October).
Pesaran M.H., and Smith, R.P. (1995) 'Estimating long-run relationships from dynamic heterogeneous panels', *Journal of Econometrics*, 68, 79-113.
Pesaran M.H., Shin, Y., and Smith, R.P. (1998*) 'Pooled mean group estimation of dynamic heterogeneous panels*', University of Cambridge, DAE Working Paper No. 9721.
Pesaran M.H., Shin Y., Smith R.P, (1999). 'Pooled Mean Group estimation of dynamic heterogeneous panels,' *Journal of the American Statistical Association*, 94, 621-34.
Taylor, M. and Sarno, L. (1998): "The behaviour of real exchange rate during the post-Bretton Woods period", *Journal of International Economics*, 46, 2, 281-312.
Turnovsky, S.J. (1999) Fiscal policy and growth in a small open economy with elastic labour supply, *Canadian Journal of Economics,* 32 (5), 1191-1214.
Turnovsky, S.J. (2004) The transitional dynamics of Fiscal Policy: Long-run capital accumulation and growth, *Journal of Money, Credit and Banking*, 36 (5), 883-910.
Wildmalm, F. (2001) Tax structure and growth: are some taxes better than others? *Public Choice,* 107, 199-219
Zagler, M. and Durnecker, G. (2003) Fiscal Policy and Economic Growth, *Journal of Economic Surveys,* 17 (3), 397-418.

Appendix 1

Classifying Taxes and Expenditures

Table A1.1 Allocation of Functional Classifications to Theory-Based Categories

Theoretical Classification	GFS Functional Classification
Budget surplus	budget surplus (net operating balance)
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 other tax revenues non-tax revenues
Productive expenditures	general public services expenditure* defense 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 expenditure	other expenditure (unclassified)

* mainly administration services. ** mainly sector spending (e.g. agriculture, forestry), often in the form of subsidies, environmental management etc.

GDP Growth Rates for OECD countries

Table A1.2 GDP Growth Rates

	1970-79	1980-89	1990-04		1970-79	1980-89	1990-04
Australia	3.0	3.4	3.3	Netherlands	3.1	2.0	2.4
Austria	3.8	2.0	2.4	New Zealand	1.9	2.0	3.0
Canada	4.4	3.0	2.6	Norway	4.7	2.7	3.1
Denmark	2.2	1.4	2.1	Spain	3.8	2.8	2.9
Finland	3.6	3.6	1.9	Sweden	2.0	2.3	2.0
France	3.5	2.5	2.0	Turkey	4.9	4.1	4.1
Germany	3.0	1.9	2.0	UK	2.4	2.4	2.4
Iceland	6.5	3.2	2.7	US	3.7	3.1	3.0
Luxembourg	2.9	4.6	4.8	**Average**	**3.5**	**2.8**	**2.7**

Table A1.3 Estimated Growth Effects of Fiscal Changes, 1980-2002

	---------- 1980-1989 ----------					----------- 1990-2002 -----------			
	Total	Deficit	Prod Exp	Dist Tax		Total	Deficit	Prod Exp	Dist Tax
Australia	-0.3	-0.1	0.1	-0.3		-0.2	-0.2	-0.1	0.1
Austria	0.1	-0.1	0.2	0.0		0.2	0.0	0.5	-0.3
Canada	0.1	-0.2	0.4	-0.2		-0.2	0.4	-0.7	0.1
Denmark	-0.1	0.4	0.4	-0.9		0.1	0.3	-0.4	0.2
Finland	-0.5	0.2	0.0	-0.7		-0.9	-0.7	0.2	-0.4
France	-0.1	-0.2	0.2	-0.1		-0.1	-0.2	0.2	-0.1
Germany	0.0	0.2	0.0	-0.2		-0.8	-0.1	0.3	-1.0
Iceland	-0.6	-0.1	-0.5	0.0		0.1	0.1	0.0	0.0
Luxembourg	1.1	0.6	-0.1	0.6		0.1	-0.1	0.1	0.1
Netherlands	-0.1	-0.2	0.2	-0.1		0.1	0.2	0.0	0.0
New Z'land	0.0	-0.1	0.3	-0.3		0.1	0.1	-0.8	0.7
Norway	-0.4	0.3	0.1	-0.7		0.4	0.1	-0.1	0.4
Spain	0.4	-0.1	0.6	-0.1		0.0	0.0	0.1	0.0
Sweden	-0.2	1.0	1.1	-2.3		0.5	-2.1	0.6	1.9
Turkey	0.9	-0.1	0.0	0.9		-1.2	-1.5	1.5	-1.2
UK	0.1	0.1	0.1	-0.1		0.1	-0.4	0.1	0.4
US	0.3	-0.2	0.4	0.1		0.0	0.3	-0.2	-0.2

Note: Growth effects are estimated using regression R6, Table 1.

Stationarity Tests

This section provides details of the panel unit root tests discussed in Section 5 and reported in Appendix Table A1.4 below. Five tests are used: those proposed by Maddala and Wu (MW, 1999), Im et al. (2003), Taylor and Sarno (1998), Levin et al. (2002), and Harris et al. (2005).

The MW (1999) test has the advantage here that it does not require a balanced panel, allowing the full sample to be tested. This reveals that the null hypothesis of all countries being non-stationary is rejected at a 1% significant level for all variables except investment. However, the MW (1999) test does not take into account any cross-section dependence, since it combines the p-values from N independent unit root tests. Using the Im et al. (2003) test, consistently with the PMG used previously, allows for individual effects, time trends, autoregressive coefficients and numbers of lags[32]. We find that the null hypothesis of non-stationarity for all series is clearly rejected for distortionary taxes, investment and growth,

[32] This test requires a balanced panel; hence, we reduce the sample to the period 1973-2001 and exclude Germany.

whereas it is not rejected for productive expenditures and the budget surplus. However, like MW (1999), this test does not fully take account of any cross correlation.

Taylor and Sarno (1998) propose a panel unit root test using the SURE method, which takes into account the contemporaneous correlation among the individual-country disturbance terms. Appendix Table A1.3 shows that this test rejects the null hypothesis of non-stationarity for all variables. Finally, Levin et al. (2002) provide a test of the null hypothesis of all countries being non-stationary against the alternative of *all countries* being stationary. This test also allows individual effects, time effects and a time trend, though it does not allow for heterogeneity in the autoregressive coefficient under the null hypothesis of stationarity. Nevertheless, this test rejects the null here at a 1% level for all variables.

More recently, Harris et al. (2005) have proposed a non-parametric panel unit root rest that allows for cross-sectional dependencies, can accommodate structural breaks, stationary and non-stationary series, and heterogeneous time-series dynamics, within the panel. These properties most closely approximate those relevant to the PMG models estimated here. The Harris et al. (2005) approach involves a simple test of the stationarity of the model’s residuals, where the test statistic is distributed as a standard Normal. Testing the residuals from regression R5 in Table 1 easily satisfies the null of stationarity: test statistic, S = 0.242; with 5% (10%) critical values = 1.65 (1.3). A similar conclusion holds when the model is re-estimated for the same balanced panel used above.

.

Table A1.4 Panel Unit Root Tests

Test	Distortionary taxes	Productive expenditures	Investment	Budget Surplus	Growth rate
Maddala and Wu (1999)	χ(34): 66.82 p-value= 0.00	χ(34): 102.61 p-value= 0.00	χ(34): 65.44 p-value= 0.00	χ(34): 86.91 p-value= 0.00	χ(34): 213.09 p-value= 0.00
Im, Pesaran and Shin (2003)	t-bar -2.558 p-value 0.03	t-bar -2.525 p-value 0.04	t-bar -2.737 p-value 0.00	t-bar -2.032 p-value 0.01	t-bar -3.776 p-value 0.00
Levin, Lu and Chu (2002)	t-value -11.139 p-value 0.00	t-value -10.432 p-value 0.00	t-value -11.645 p-value 0.00	t-value -8.555 p-value 0.00	t-value -15.500 p-value 0.00
Taylor and Sarno (1998)	MADF 350.467 CV 28.150	MADF 198.168 CV 29.741	MADF 97.647 CV 25.898	MADF 127.572 CV 28.894	MADF 495.831 CV 25.463

MADF = Multivariate Augmented Dickey-Fuller Statistic; CV = critical value.

Appendix 2: Updating the Dataset

The dataset used in this paper builds on that used by Bleaney et al. (BGK, 2001), who used GFS fiscal data, covering consolidated *central* government functions only, based on the 1986 GFS Manual classification of fiscal variables (labeled "*old*" below. Like much National Accounting at that stage, these variables were measured based on a 'cash', as opposed to 'accruals', accounting method. We refer to this below as the "*old*" classification. The 2001 GFS Manual introduced a "*new*" classification system (mainly involving the reclassifying of public asset sale/acquisition into a separate category, and minor reclassification of some expenditure items). In line with new National Accounting practice, the "new" GFS is based on accruals accounting and so is not directly comparable with the original BGK dataset. In addition GFS data for central government on a cash basis has not generally been updated beyond about 1999 or 2000 for most countries in our sample. The most recent data available (typically up-dated to 2003 or 2004), based on the new classification, is available for central and general (central plus local) government but has only been back-dated to 1990.

Annual differences between fiscal variables measured on cash or accrual bases can be quite substantial. For example, the financial year in which corporation tax (cash) payments are made in many OECD countries can be different by up to 2-3 years from the (accrual) accounting period to which the tax liability relates. As a result, up-dating our dataset beyond around 2000 requires a careful splicing of 'old' and 'new' data streams and is likely to involve a number of inaccuracies of unknown magnitude.

The currently available data is summarized in Table A2.1 below. In general, we use (i) the latest GFS data on a cash basis for central government to up-date BGK (typically to 1999 or 2000) and then (ii) the annual rate of change in 'new' fiscal variables for central government to up-date the series to the latest possible year (typically 2003 or 2004). In some cases, where overlaps in the series suggest that the new and old GFSY do not correspond well, we supplement this with OECD sourced data which is based on a similar definition to the new GFS. Though in principle we would prefer to use a dataset capturing all levels of government, the unavailability of data on this basis prior to 1990 or 1995 would leave us with insufficient time-series observations. The up-dated dataset includes 16 of the previous 17 countries used by BGK plus one new country, New

Zealand (shown in **bold** in Table A2.2 below).[33] In most cases results are reported for a sample of 17 countries, from the early 1970s to 2003 or 2004.

Table A2.1 Summary of Data Sources & Coverage

Source	Classification System	Cash or Accrual?	Government: Central or General?	Approx. Period Coverage
Fiscal Variables:				
IMF GFS	Old	Cash	Central	1970-98
IMF GFS	New	Cash	Central	1990-1998/9
IMF GFS	New	Accrual	Central	1998-2003/4
IMF GFS	New	Accrual	General	1998-2003/4
OECD	New	Accrual	General & Central	1990/95–2003/04
GDP:				
OECD: Economic Outlook	Real GDP growth			1970-2004
Private Investment:				
OECD: Economic Outlook	Private non-residential fixed cap. formation			1970-2004

Table A2.2 Sample Countries

Original Sample	Original Sample	Additional Countries
Australia	**Luxembourg**	Belgium
Austria	**Netherlands**	Ireland
Canada	**Norway**	Italy
Denmark	**Spain**	Japan
Finland	**Sweden**	Mexico
France	**Turkey**	**New Zealand**
Germany	**UK**	Portugal
Iceland	**US**	

[33] BGK included data for Belgium for which some series end in 1990. To keep the country time-series approximately the same for all countries, we omit Belgium from this sample. [33] In addition, some data are available for a further 6 OECD countries. However, in general, for those countries data are only available from around 1990.