FISCAL POLICIES AND ECONOMIC GROWTH IN EUROPE: AN EMPIRICAL ANALYSIS

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1. Introduction

Assessing the factors underlying long-run economic growth is undoubtedly one of the most important issues of applied macroeconomics. Among these factors, a firmer understanding of the role of discretionary fiscal policy decisions in shaping growth prospects is of particular importance, given the direct control of governments over these decisions. Stylised facts support the hypothesis that fiscal policies, and notably the size of the government, have a significant effect on long-term economic growth prospects. For instance, in examining the data for the current Member States of the European Union (EU) – excluding Luxembourg over the last three decades, a negative correlation between both government spending and taxation and trend per capita economic growth is evident in most countries (see Table 1). Negative correlations between tax revenue and trend growth are particularly notable for Belgium, France, Italy and Austria, with the same negative correlation for these countries in terms of government expenditure. More generally, some evidence of a negative relationship between government size and trend economic growth in most EU Member States emerges from a purely descriptive analysis of the data, with the noteworthy exceptions of Denmark, Germany, Spain, Portugal and the UK.

In general, the thrust of theoretical evidence and stylised facts for developed countries, as exemplified above by the EU, confirms that fiscal policy, and in particular government size, is of importance, but the evidence on the type and magnitude of its effects has not been definitive to date. Although some clear evidence exists that distortionary taxes and

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generous unemployment benefit schemes can adversely affect the labour supply decision (and thereby hinder growth)[1], the growth impact of an aggregation of somewhat heterogeneous public expenditure items is not clear. For instance, Temple (1999) in a recent survey concludes that existing studies disagree on the relationship between government consumption and growth on the whole. Public investment expenditure – often argued to be the most productive public spending item – represents only a small fraction of overall government spending in developed countries. More generally, the presence of non-linear effects of fiscal policy, such as the non-monotonic relationship between government spending/taxation and economic growth alluded to by Barro (1990), Bertola and Drazen (1993) and Giavazzi *et al.* (2000), among others, can also hamper a clear theoretical prediction for public finance effects on economic growth which applies uniformly to all countries.

Table 1

Correlation with trend GDP growth per capita

Country	Correlation between government expenditure and trend growth	Correlation between government revenue and trend growth	Period
Belgium	–0.79	–0.94	1971-00
Denmark	–0.22	0.01	1972-00
Germany	–0.67	0.20	1971-00
Greece	–0.67	–0.35	1972-00
Spain	–0.10	–0.03	1971-00
France	–0.94	–0.92	1972-00
Ireland	–0.68	–0.46	1971-00
Italy	–0.84	–0.98	1973-00
Netherlands	–0.74	–0.80	1973-00
Austria	–0.87	–0.85	1971-00
Portugal	0.26	0.36	1975-00
Finland	–0.67	–0.54	1972-00
Sweden	–0.55	–0.51	1972-00
United Kingdom	–0.07	0.34	1971-00

Note: The trend growth rate for Germany is corrected for the large structural break associated with reunification in the early 1990s. See the Appendix for a description of the data used in this study.

1 For a detailed review of the channels via which taxation affects economic growth, see van den Noord (2002); for a review of the role of the welfare state in economic performance, see Atkinson (1995) and Slemrod (1995).

Ultimately, a lack of clear theoretical indications for the effects of public finance variables on growth, combined with a need to quantify impacts, contributes to making this an issue which needs to be addressed empirically. Within the empirical literature, however, the role of public finances in affecting economic growth remains somewhat controversial. Recent developments in estimating growth models with public finance elements have contributed to a sizeable body of empirical studies on this subject. However, a clear consensus does not exist regarding the relationship between government spending/taxation and economic growth within this empirical literature. It has even been posited that, in general, although theory predicts that changes in tax rates affect investment and growth in the long-run, in practice tax policy is an ineffective instrument to influence growth (Mendoza *et al.* 1997). This lack of agreement of results can be attributed at least in part to problems that plague existing empirical studies on economic growth, including parameter heterogeneity, the presence of outliers, controlling for the cycle, model uncertainty, endogeneity, measurement error and error correlation.

In this study, we review the methodological issues – and the treatment of econometric problems – surrounding the empirical assessments of the determinants of economic growth. We further work on the role of public finances in accounting for economic growth in the more specific context of current EU Member States, a generally homogeneous panel of countries for which a reasonably good quality data set is available. After reviewing stylised facts for the EU, we empirically evaluate fiscal effects on growth, making use of dynamic panel estimation techniques, along the lines of Caselli *et al*. (1996), which control for the several econometric estimation problems. We use of annual estimates of trend economic growth, rather than period averages.[2] Our findings tend to support the hypothesis that a robust negative relationship between government size and trend growth indeed exists for EU countries. Moreover, it provides some support for the notion that improvements in the government budget balance for the EU in the past have tended to support long-term economic growth.

The paper is organised as follows. Section 2 reviews relevant issues for estimation, and is structured into two subsections. First, we review the

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2 These trend estimates should in principle reflect long-term factors, and in practice do not represent a radical departure from past practice in that these filters used to calculate trend are somewhat akin to a weighted moving average. Hiebert *et al* (2002) also use similar estimators of trend growth.

recent related literature, then assess methodological problems inherent in an empirical assessment of the determinants of economic growth and some potential remedies. Section 3 presents our methodology, proposing some methodological refinements to counteract the most pressing problems inherent in these exercises. Section 4 presents the results of the analysis, then Section 5 concludes.

2. Recent evidence and methodological issues

2.1 Recent empirical evidence on fiscal policy and growth

Ideally, Solow equations for representative economy would be used for evaluating the determinants of long-term economic growth. However, data constraints have meant that multi-country analysis is needed to obtain robust empirical results. In a seminal paper, Barro (1991) examined the determinants of economic growth in a cross-section of countries. He found a positive relationship between the initial level of human capital and the growth rate of real per capita GDP and a negative relationship between the initial level of real per capita GDP and economic growth. Among the determinants of growth, the share of government consumption in GDP – a proxy for government size – was found to be negatively related to growth, whilst public investment was found to have no significant impact on growth. In the wake of Barro, several authors have pursued this line of research, attempting to infer the role of fiscal policies in economic growth by estimating growth equations. These equations, also known as Barro equations, are regressions which relate economic growth to a number of variables, typically the initial levels of income, a number of steady-state variables and *ad hoc* variables (including policy variables like government expenditure, taxes, etc.).

This literature has produced contrasting results and no definitive agreement on the impact of fiscal policies on growth has yet emerged. In earlier empirical investigations, growth regressions were estimated on a cross-section of countries, in line with Barro (1991). In recent years, however, a trend toward the use of panel data and advanced time series methods has emerged, in line with a growing consensus on relatively superior properties of panel data (see for example Bond *et al.,* 2001 and Temple, 1999). Despite similarities in specifications, the findings of these studies have been mixed. Along with peculiarities of the estimation methods and design of estimated equations, this also partially relates to the time span and country coverage of the data themselves. An assessment of some representative studies from the recent literature indicates that dynamic panel estimation is among the most reliable estimation methods currently available, and that the size of government is of importance in determining long-term economic growth.[3]

Cross-country regressions show in general a negative but extremely fragile relationship between government size and growth. In a critical contribution to the growth literature, Levine and Renelt (1992), based on extreme bounds analysis, argue that, though negative, the coefficient of government consumption is not robust in cross-country regressions. Moreover, based on a sensitivity analysis of results to the variables included in regressions, they are unable to find a robust cross-country relationship between a diverse collection of fiscal policy indicators and economic growth. Easterly and Rebelo (1993), however, attribute the failure to obtain significant correlation between tax revenues and growth to potential endogeneity of fiscal policy to the scale of the economy. They note in this respect that Wagner's Law postulates an elasticity of government size and income greater than unity. More generally, Sala-i-Martin (1997) argues that, extreme bound analysis may be an inappropriate way to check for robustness, and finds that a substantial number of variables included in cross-country regressions are strongly related to growth. Nevertheless, his analysis suggests that no measure of government spending (including investment) appears to affect growth significantly.

The most recent empirical literature, mainly based on panel data regressions, show that economic growth is significantly affected by fiscal policies, although there remains some lack of agreement on the sign of the effects. On one hand, Caselli *et al.* (1996) find a robust positive contribution of the government spending ratio (net of military and educational spending) to growth. In a similar way, Kneller *et al*. (1999) find that public expenditure and taxation only affect growth if they are productive and distortionary, respectively; productive government expenditure is found to positively affect growth, whereas distortionary taxation is found to be harmful for growth. With this distinction they argue that both sides of the government budget should be considered in estimating the impact of fiscal policy on growth, as the growth-enhancing

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3 For a recent review of empirical literature examining the role of policies in long-term economic growth, see Bassanini *et al* (2001).

effects of productive expenditure are offset by their financing. On the other hand, Fölster and Henrekson (2001) argue that selecting a relatively homogeneous panel of countries (OECD) and controlling for econometric problems such as heteroscedasticity reveals a robust negative relationship between government size and economic growth. Unlike Kneller *et al*. (1999), however, they do not explicitly control for the entire government budget constraint. Bassanini *et al.* (2001) also find some evidence supporting the hypothesis that government size has an impact on growth. They find that public investment has a positive impact on growth, whilst government size, either proxied by government consumption or total tax burden, affects growth negatively.

2.2 Problems with estimation and potential remedies

Several problems hamper standard estimators in much of the existing empirical literature on fiscal policies and economic growth, and have consequently hindered the capability of researchers to come to firm empirical conclusions. The main problems – heterogeneity, simultaneity bias, omitted variable bias, measurement issues and model uncertainty – are addressed in sequence below.

Heterogeneity

A first key problem involves the heterogeneity of the sample. As noted by Temple (1999), cross-sectional multiple regression analyses rely on the assumption that individual cross-sectional units are drawn from a common surface. The problem of *observed* differences across cross-sectional units, along with the associated problem of outliers unduly affecting estimation results, can be curbed by estimations based on a group of countries with similar characteristics. If the differences are measurable, one could also control for them in the equation specification. Even if heterogeneity across economies is stemmed to some extent by analysing a cluster of countries, however, some *unobservable* variation among countries in the panel is likely to remain. A prominent example in this respect is the initial level of technology in individual countries, which is not directly quantifiable. Nevertheless, one can control for this and any other unobservable heterogeneity fixed through time by introducing a different time-invariant intercept for each country. Estimation can be conducted by expressing the data in terms of deviations from means at the cross-section level or any kind of transformation that eliminates the time-invariant intercept. Also, unobserved panel heterogeneity can also be curbed at the source by the selection of a homogenous grouping of countries in the sample.

Nevertheless, the above correction may be insufficient as country heterogeneity can arise not only in the intercept but also in the slope of the explanatory variables. For example, the effect of fiscal variables on growth could differ across countries. Some relatively recent techniques have been developed by Pesaran and Smith (1995) and Pesaran *et al.* (1999) which allow for heterogeneous slopes, and represent one way to tackle this issue. Pesaran and Smith (1995) and Pesaran *et al.* (1999) give an account of such methods, which include the Mean-Group estimator and the Pooled Mean-Group estimator. Mean Group estimators are based on averaging estimators from individual country equations, and Pooled Mean Group estimators in principle distinguish between short and long term effects, imposing common coefficients for the long-term slopes, while allowing for heterogeneity in the short-term dynamics and country-specific variances. Very few growth studies to date have employed these techniques, with the notable exceptions of Lee, Pesaran and Smith (1997) and Bassanini and Scarpetta (2002).

The incorrect treatment of country specific effects results in inconsistent estimators. The reason is that growth equations are in fact dynamic equations, where the lagged dependent variable is a regressor. In this case individual effects create some specific problems. To illustrate these problems, take a standard growth equation of the following form:

$$g_{it} = \alpha y_{it-1} + \beta_1 x^1_{it} + \beta_2 x^2_{it} + \mu_i + \varepsilon_{it} \tag{1}$$

where g_{it} is the per capita income growth rate, the dependent variable for country i in period t, y_{it-1} is per capita income for country i in period $t-1$ (expressed in logarithm), x^1_{it} is a set of weakly exogenous regressors, while x^2_{it} is a set of strictly exogenous regressors. In addition, μ_i represents the unobserved country-specific effects. Expression (1) can therefore be rewritten as:

$$y_{it} = (1+\alpha) y_{it-1} + \beta_1 x^1_{it} + \beta_2 x^2_{it} + \mu_i + \varepsilon_{it} \tag{2}$$

which clearly is a dynamic equation with a lagged-dependent variable on the right hand side.

The problems of estimation of this equation could be addressed in two ways. First, it could be assumed that the unobserved country-specific effects are a component of the error term – known as the random effects method. In this case, any correlation between the individual effects and the regressors would lead to biased coefficient estimates. Under a dynamic specification, it is clear that the lagged dependent variable would be correlated with the unobserved individual effects, since the current value of the dependent variable would itself be dependent on the individual effects. The alternative would be to use any type of fixed effect technique, eliminating time-independent effects by taking some kind of difference (first differences, within group transformations, etc.). In this case, however, the error term would have some lags and therefore will be correlated with the lagged dependent variable, thus leading to biased estimates. Several solutions have been proposed in the literature. The most popular is to use a Generalised Method of Moments (GMM) as proposed by Arellano and Bond (1991), where all the differences of the regressors correlated with the error term (endogenous and lagged-dependent variable) are instrumented using (all) lags from period $t-2$ of the observed variables in levels. More recently a Maximum-Likelihood (ML) estimator has been proposed by Binder *et al.* (2001) which does not depend on the initial conditions as maximum likelihood estimators usually do in this case (see, for instance, Anderson and Hsiao, 1982).

Furthermore, for the asymptotic validity of the panel estimators, it is necessary to have a sample of countries characterised by the absence of interdependencies and cross-correlations. This in practice hardly holds, since in an increasingly globalised world most countries are subject to similar shocks. This problem is addressed in the literature by including a set of time dummies as regressors.[4] This procedure also controls for the existence of other country-invariant factors omitted from the regression, which could easily drive both the dependent and independent variables over time.

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4 The inclusion of time dummies is equivalent to transforming the variables into deviations from time means. This transformation explicitly controls for common shocks such as trade or technological shocks hitting several economies in a given period. This transformation should correct for a great deal of the unobserved cross-correlation patterns present in the error structures of different countries included in the panel.

Simultaneity

A second and more difficult issue to remedy is that of inconsistent estimators resulting from simultaneity bias. Standard regression analysis using ordinary least squares relies on the assumption that all explanatory variables are exogenously determined and thus not correlated with the error term. In growth regressions, this assumption is often violated, since most of the variables entering the economic system interact and feedback on each other when there are changes in the economy. Failing to account for such feedbacks across variables would inexorably lead to biased estimates. If over the sample there appears to be a positive correlation between government revenues and economic growth rates, a failure to account for such simultaneity in the relationship would lead to upward-biased estimates of the coefficients on tax revenues, what may lead to coefficients close to zero. The issue of simultaneity bias can be addressed either by using instrumental variables or alternatively by estimating a system of simultaneous equations, explicitly allowing for feedbacks across the endogenous variables entering the system. In a panel context, most studies have made use of the former (instrumental variables).

One of the most likely sources of simultaneity is business cycle effects (see, for example, Easterly and Rebelo, 1993, for a discussion) and the tendency of government expenditure to be positively correlated with the level of GDP per capita. As noted by Fölster and Henrekson (2001), a typical business cycle correlation might be associated with the operation of automatic stabilisers in government budgets – implying for instance that a fall in growth is associated with a fall in tax revenue accompanied by a rise in government expenditure (given unemployment-related outlays). To date, this control for the cycle has most often been obtained by taking five or ten-year averages of data, accompanied occasionally by the use of additional variables such as unemployment to control for the cycle. One alternative avenue – not pursued to date as far as we have ascertained – is the use of annual ‘trend’ or ‘potential’ output estimates, which alleviate the need to take period averages. These estimates are readily available from international institutions, and are based on a more formal derivation of long-term output than the relatively crude use of period averages, which implicitly embody a deterministic shift in growth every five years, which clearly might not coincide with the actual length of the business cycle for all cross sectional units of the panel. As a corollary, one is left with a longer time series – allowing for a less binding constraint on degrees of freedom despite a more limited and more homogenous number of cross-sectional units.

Omitted variable bias

A third problem leading to inconsistent estimators relates to the existence of omitted variables correlated with the regressors included in the regression, which is closely related to the issue of multicollinearity across regressors. In practice it is hard to come by all factors that could enter a growth regression without at the same time creating problems of multicollinearity. Most studies, including ours, deal with the issue of omitted variable bias by including country-specific effects, which would capture all time-invariant structural factors characteristic of each country. Moreover, the issue of multicollinearity, though generally recognised, is hardly dealt with in the literature given difficulties in remedying this problem. For instance, Easterly and Rebelo (1993) find that initial per capita income levels are highly correlated with government expenditure shares of GDP. As a result, when both variables are included in the same regression, the latter becomes insignificant. In contrast, when initial income levels are omitted the fiscal policy variable becomes significant. This problem appears to be particularly acute across fiscal policy variables, since both revenues and expenditure figures tend to co-move over time. Regarding the latter issue, as alluded to in Section 2.1, Kneller *et al.* (1999) argue that most growth studies dealing with the link between fiscal policy and growth have rendered conflicting results by failing to control for both sides of the government budget constraint in the regression. As a result, when variables from only one side of the budget constraint are included in the regression, such estimates are likely to be biased , since they would be capturing the indirect effect that the omitted element from the other side of the budget has on growth through its impact on the included fiscal variable. Accordingly, they argue that only neutral fiscal categories such as unproductive expenditure and non-distortionary taxation should be omitted from any regression. However, what they propose may be infeasible in practice if the fiscal categories included in the regression are highly correlated to each other.

Measurement issues

A fourth problem relates to the measurement of variables, particularly those related to policy. In terms of government taxation, the relevant factors affecting long-term growth prospects are marginal tax rates. Given, however, the complexity of tax systems in industrialised countries, often with substantial use of exemptions, deductions and credits, the calculation of a homogeneous marginal tax rate comparable across countries is virtually impossible. This has led some, such as Padovano and Galli (2001), to estimate marginal tax rates from regressions. The estimated marginal tax rates produced by these simple regressions of tax revenues on GDP with some intercept shifts, however, are themselves subject to significant error given econometric problems, not least potentially severe omitted variable bias. Another substitute for actual marginal tax rates is the use of effective tax rates. As these effective tax rates are calculated as the ratios between the tax revenues from particular taxes and the corresponding tax bases obtained from national accounts (see, for instance, Martinez-Mongay, 2000), tax revenues in GDP may represent a viable proxy for them. Moreover, taking into account potential problems of tax compliance, government tax revenues remain a reasonable proxy for marginal tax rates.

Model uncertainty

An additional concern is the issue of the present uncertainty in both the selection of which explanatory variables should enter the regression and the specification of the correct functional form underlying the relationship. When applying simple cross-section techniques, the problem of limited degrees of freedom is well known. In contrast, in a panel framework, we are not bound to a trade-off in terms of gains in explanatory power by including many regressors versus a more parsimonious specification. Common practice in the literature is the choice of an *ad hoc* set of explanatory variables without rigorous theoretical grounds. This runs the risk of leaving out from the regression important growth determinants, while including irrelevant ones. Whilst Levine and Renelt (1992), using extreme bounds analysis, find that most variables are very "fragile" – and the only robust variables in the Barro equations are initial income and investment – the temptation to adopt a very parsimonious specification must be tempered by the potential for the problem of omitted variable bias discussed above.[5]

The uncertainty associated with the functional form underlying the relation between fiscal policy and growth may also lead to incorrect inferences. It is common practice in the literature to assume either a linear

5 An avenue of research may be the use of Bayesian methods to deal with the problem of uncertainty. However, the choice of priors in terms of the choice of regressors and functional form may condition the final outcome.

or log-linear specification, while on theoretical grounds there may be a U-inverted type of relationship between government size and growth as advocated by Barro (1990). This functional form would imply the existence of a threshold level of government spending beyond which a systematic negative relation appears to exist between government size and growth.[6]

3. Method

In this section we first present the variables included in our specification to analyse the long-run effects of fiscal policy instruments on growth for EU countries (excluding Luxembourg) over the last three decades. We then outline the estimation procedures we adopt for our analysis and the way these procedures deal with the problems pointed out in the preceding section.

3.1 Selection of variables

We follow Mankiw *et al.* (1992) for the basic specification to which we add fiscal policy instruments in order to proxy for the long-run effects that fiscal policy may have on growth.[7] The basic specification thus comprises lagged levels of per capita GDP to account for conditional convergence effects along the transitional path. In addition, we include the private physical capital investment share of GDP and the average years of education in the working-age population. These variables should account for the flow of physical capital and the stock of human capital respectively, which both determine the steady state positions of each country. To account for the fact that growing populations as well as a higher rate of technological progress and depreciation of physical and human capital require greater physical and human capital accumulation to keep the level of capital endowment per effective worker constant, we adjust the population data in the same way as Mankiw *et al.* (1992). The resulting data are obtained taking the natural log of the sum of the growth rate of

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6 See Romero de Ávila and Strauch (2001) for an explicit estimation of such threshold effects in the EU over the last 30 years.

7 The descriptive statistics for our data are contained in Table 2, and data sources in Appendix Table 1.

Table 2

Descriptive statistics for dataset

Series	Obs	Mean	Std Deviation	Minimum	Maximum
DLGDP_PPP_HP	420	0.022365	0.015441	–0.194538	0.075411
LPRIVINV_GDP	420	2.937.084	0.166321	2.448.625	3.408.415
SCHOOL	420	9.635.223	1.648.927	5.800.000	13.613.773
LPOPMRW	420	–2.915.334	0.111340	–3.124.079	–1.275.145
TOTALEXP_GDP	407	39.16	7.91	19.31	58.71
TAXREV_GDP	409	32.02	6.24	16.37	46.07
SURPLUS_GDP	407	–4.54	4.36	–23.21	4.39

Note: For a more detailed description of the data and a description of the codes, see the Appendix.

population plus 0.05 as a rough measure of the technological progress and depreciation rates. This is a common assumption given the inherent difficulty in determining the true rates of depreciation and technological progress across countries. We also include a common trend and timedummies that may account for common shocks similarly affecting all EU countries in a given period (e.g. the oil shock in the early 1970s).

The dependent variable, our measure of long-term growth, represents a departure from the measures used in studies to date. Specifically, we employ trend PPP-adjusted growth estimates based on the Hodrick-Prescott filter (the methodology used by the European Commission to calculate estimates of trend output) as an indicator of long-term growth rather than taking period averages. The use of this measure has the benefit that, although it remains based on a largely mechanical derivation, it represents a relatively more analytically grounded measure of the cycle than mechanical period averages. More importantly, basing the analysis on annual figures allows for an extension of the time series for each individual cross-sectional unit as well as for the selection of a more homogeneous sample without the cost of a reduction in overall sample size. Nevertheless, one important peculiarity of the HP-filter methodology is the choice of the smoothing parameter, which is an important determinant of trend output estimates. The smoothing parameter used in this study is that proposed by Bouthevillain *et al.* (2001) in their recent paper examining cyclical adjustment methodology for public finances in EU countries (λ=30).[8]

We augment the basic specification with government expenditure as a measure of the size of the public sector and tax revenue as a proxy for the degree of distortionary taxation. Total government expenditure and total tax revenue are included first individually to capture both of these effects, and then expenditure is included jointly along with the surplus in the spirit of Kneller *et al.* (1999) in order to gauge the importance of the government budget constraint. In addition, the sign and magnitude of the budget balance as an explanatory variable may to some extent capture the role of expectations about fiscal sustainability.

3.2 Estimation procedure

To estimate our dynamic panel equation (2) we rely on GMM estimation along the lines of Caselli *et al.* (1996). As outlined in Section 2.2, this procedure accounts for several of econometric problems, such as endogeneity and correlated individual effects (resting on the assumption that valid instruments are used in estimation).[9]

To start with, we transform our estimation equation by taking first-differences in order to sweep out unobserved individual country effects that are a source of inconsistency in the estimates.

$$\Delta y_{it} = (1+\alpha)\Delta y_{i\,t-1} + \beta_1 \Delta x^1_{it} + \beta_2 \Delta x^2_{it} + (\mu_i - \mu_i) + \varepsilon_{it} - \varepsilon_{i\,t-1} \tag{3}$$

Then, as instruments for the variables that are correlated with the error term (lagged dependent variable and other endogenous variables, x^1_{it}) we use the lagged levels of the observed series, $y_{i\,t-3}$ to nstrument for $y_{i\,t-1}-y_{i\,t-2}$ and $x^1_{i\,t-2}$ to instrument $x^1_{it}-x^1_{i\,t-1}$. The original estimator of

8 In principle, the fact that explanatory variables which could potentially exhibit cyclicality in levels, but are not adjusted for the cycle will not be problematic if they are calculated as ratios to GDP (as long as the cycle in nominal GDP produces a commensurate and identical response in the variable of interest – for public finance variables, this is akin to assuming a unitary elasticity).

9 Rather than taking variables as deviations from period means, as done by Caselli *et al* (1996), we rely on the inclusion of dummy variables for each time series unit in the panel to capture both time-variant and invariant individual effects.

Arellano and Bond (1991) makes use of all possible lags from *t–2*.[10] We limit our instruments to the lags at *t–2* or *t–3* for two reasons. First, the decision to include a large number of instruments must be tempered by the use of a small sample. In this respect, generally these additional instruments may render important gains in efficiency, but may also be infeasible and inappropriate in panels with a small cross-sectional dimension, since the number of instruments would by far exceed the number of observations. Second, as shown by Arellano and Bond (1991) for a given small-sample cross-section dimension, the use of too many instruments might lead to *overfitting bias.* This appears to be corroborated by Judson and Owen (1999) who find that estimators that make use of only a limited number of moment conditions as instruments in levels appear to outperform those by Arellano and Bond (1991) for the small-sized samples in the cross-sectional dimension, such as ours.

In addition, by using levels of the dependent variable lagged by one additional period to instrument for the first-differenced term – the first instrument for $y_{i\,t-1} - y_{i\,t-2}$ is $y_{i\,t-3}$ – we account for the potential presence of measurement errors (see Blundell and Bond 1998).

In our estimation we also correct for the heteroscedasticity that may be present in the error structure by following the two-step procedure proposed by Arellano and Bond (1991).[11] They showed that if the error terms ε_i of the equation in levels are identical and independently distributed across countries and over time, also implying that the errors are homoscedastic in both the cross-section and the time dimensions, the variance-covariance matrix of the moment conditions is a square matrix. This matrix is equal to a matrix consisting of *2*s in the main diagonal, *–1s* in the first sub-diagonals and *0*s elsewhere multiplied by a scalar – the variance of the error of the level equation. For the case in which the errors

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10 Concerning the number of lags, our estimator is closer to that in Anderson and Hsiao (1982), which can be understood as an instrumental variable estimation procedure applied to the dynamic equation in differences. Anderson and Hsiao (1982) propose the use of the lagged observation, say, y_{it-2} or the lagged difference $y_{it-2} - y_{it-3}$, to instrument for $y_{it-1} - y_{it-2}$. Since $x^1_{it} - x^1_{it-1}$ is also correlated with $\varepsilon_{it} - \varepsilon_{it-1}$, they propose the use of $x^1_{i\,t-2}$ as instrument in levels or $x^1_{i\,t-2} - x^1_{i\,t-3}$ as instrument in first differences. Anderson and Hsiao (1982)'s instrumental variable estimators have been shown to be consistent.

11 Fölster and Henrekson (2001) show that the results from the regressions are easily reversed if one does not correct for heteroscedasticity. They make use of Weighted Least Squares to estimate the impact of government size on growth.

are heteroscedastic, this estimator is still consistent but is not efficient. For this purpose, they propose a two-step estimation procedure that accounts for heteroscedasticity. The first step assumes homoscedasticity, then in a second step the residuals obtained in the first step are used to construct a consistent estimate of the variance-covariance of the moment conditions.

In addition, Arellano and Bover (1995) show that when the lagged dependent variable and the endogenous regressors are highly persistent over time, the moment conditions in lagged levels are weak instruments for the variables in first differences.[12] As the persistence increases, the asymptotic variance associated with the difference estimator rises, reducing in turn the precision of the estimates. As a result, they propose a *system estimator*, which combines the regression in first differences in a system with the regression in levels. In effect, the instruments for the regression in first differences are those implied by the *difference estimator*, whereas the instruments for the regression in levels are the lagged differences of the variables involved. They suggest that only the most recent instruments in differences should be used for the specification in levels in order to avoid redundant instruments. The bias from weak instruments seems to be particularly important when the span of time series observations is short (Blundell and Bond, 1998), which is not a major issue in our case. This, together with the fact that our cross-sectional dimension is relatively small, prevented us from estimating a system at this stage.[13]

The consistency of these estimators relies on the validity of the instruments and on the absence of first-order autocorrelation in the errors ε_{it} (second-order autocorrelation in the errors of the first-differenced equation), $E(\Delta\varepsilon_{it},\Delta\varepsilon_{i\,t-2})=0$. Arellano and Bond (1991) present specification tests for the validity of the instruments. The first one is a Sargan test for over-identifying restrictions, which tests for the overall validity of the instruments, implying the absence of correlation between the instruments and the error term. The second one tests for the null hypothesis of the absence of second-order serial correlation in the residuals of the first-differenced equation.

12 Blundell and Bond (1998) extended the system estimator primarily presented by Arellano and Bover (1995) to the case of endogenous regressors.

13 We also based our decision on the study carried out by Ziliak (1997) who finds that *"the downward bias in GMM is quite severe as the number of moment conditions expands, outweighing the gains in efficiency*". Judson and Owen (1999) corroborate these findings.

Furthermore, a downward bias to the standard errors of the two-step difference estimator is well known for the case of panels comprised of a small cross-section. This often can lead to spuriously significant regressors. To correct for this, we apply the bias correction adjustment proposed by Windmeijer (2000). In sum, by using an estimator along the lines of Anderson and Hsiao (1982), computed in a way that is robust to the presence of heteroscedasticity, measurement errors and small-sample biases to standard errors should allow us to make more reliable inferences on the link between fiscal policy and growth.

4. Results[14]

The results from estimating equation (3) using annual data of trend per capita GDP growth are reported in Table 3 for four basic specifications: no policy variables, government expenditure, tax revenue, and expenditure and surplus. Government expenditure and tax revenue are proxies for the size of government and distortionary taxation, and the additional regression containing both expenditure and surplus is included to gauge the importance of fully specifying the government budget constraint along the lines of Kneller *et al.* (1999). In general, the instruments used appear to be valid on the basis of the Sargan test, while the results of the autocorrelation tests do not indicate major problems concerning the existence of second-order correlation that would lead to inconsistent estimates.

We begin with a benchmark regression containing no policy variables. In this regression, the private investment share in GDP, the stock of human capital and population growth consistently enter with the expected signs and generally are significant at the 1% confidence level. The coefficient on private investment share implies that a 10 percent increase in physical investment (measured as a share of GDP) would increase long-term growth by up to nearly two percent. A 10 percent increase in the average number of years of schooling would also increase trend per capita growth by around two percent. Population growth also enters consistently in a significant manner and with the expected negative sign.

[14] All the calculations have been done using the DPD program of Arellano and Bond for OX.

Table 3

Estimation results

	No policy variables	Government expenditure	Tax revenue	Expenditure and surplus
PARAMETER ESTIMATES (AND T-STATS)				
LPRIVINV_GDP	0.00189	0.00152	0.00315	0.00068
	16***	10.9***	22.6***	4.13***
LSCHOOL	0.00220	0.00214	0.00281	0.00217
	29.3***	40.6***	48.2***	35.2***
LPOPMRW	–0.00173	–0.00084	–0.00310	–0.00068
	–5.54***	–6.01***	–19.8***	–5.17***
TREND	0.01997	0.01922	0.02276	0.01869
	129***	102***	113***	100***
LTOTALEXP_GDP		–0.00095		0.00006
		–9.03***		1.47
LTAXREV_GDP			–0.00107	
			–10.3***	
SURPLUS_GDP				0.00146
				2.92***
SPECIFICATION TESTS				
SARGAN TEST	1.17E–10	2.27E–12	–2.68E–13	–1.24E–14
	[1.000]	[1.000]	[1.000]	[1.000]
AR(2) TEST	1.820	1.909	1.916	1.876
	[0.069]*	[0.056]*	[0.055]*	[0.061]*
OBS	392	387	389	385

Notes: The dependent variable is purchasing-power parity adjusted GDP per capita. One, two and three asterisks indicate rejection of the null hypothesis at the 10%, 5% and 1% respectively. All variables are transformed into first differences to remove the country-specific effects. GDP per capita lagged differences are instrumented by the level lagged three periods for robustness in the presence of measurement error. Likewise, the other variables were instrumented by the levels lagged two periods. The AR(2) is a test for the presence of second-order correlation in the error structure. The test is asymptotically distributed as a standard normal distribution. The Sargan test is distributed as χ^2_{J-K}, where J stands for the number of moment restrictions, GMM instruments, and in turn the number of columns of the matrix of instruments while K is the number of regressors.

In the second and third column of the Table, we augment the basic specification by including government expenditure and tax revenue, proxies for government size and distortionary taxation. The estimated coefficients of each policy variable included separately point to a similar negative effect and statistically significant impact of government size on long-term growth. Specifically, a 10 percent increase in either total government expenditure or tax revenue as a share of GDP would decrease growth by about one percentage point. These specifications do not explicitly control for the financing element of the budget constraint, which may result in biased estimates of the coefficient on government expenditure. Specifically, controlling for the financing of government expenditure should reveal a positive relationship, as long as government expenditure is productive on average. Potentially severe problems of multicollinearity would most likely arise from a simultaneous inclusion of both government expenditure and tax revenue in the same regression, as these variables are bound to co-move over the long-term in the absence of explosive behaviour for the deficit. Taking into account this consideration, the budget surplus is included as a control variable for the government budget constraint. This inclusion leads to the result that government expenditure is no longer a significant determinant of long-term growth. Interestingly, improvements in the budget balance ratio have a significant growth-enhancing impact. This suggests a positive effect of EU governments improving their budgetary positions and a limited role for additional government expenditure in boosting the trend growth rate of the economy.

Similar analysis is carried out by using five-year averaged data as an alternative way of controlling for the cycle rather than using annual trend growth. This set of regressions yields insignificant coefficients of explanatory variables accompanied by very high standard errors.[15] Although this is most likely influenced by the relatively small cross sectional dimension when compared with other studies in the literature, it may also cast some doubt on the appropriateness of using five-year averages to analyse the relationship between trend growth and fiscal policy variables, since by averaging we disregard potentially important information in the time dimension. When this information is excluded from the sample, there may not be enough variability in the averaged regressors as to be able to explain even a small part of the variability of growth rates

[15] The results based on five-year averages of all variables are available from the authors upon request.

in the sample. In addition, these results can be partly attributed to the poor performance of the difference estimator for the case when the time dimension is very small as demonstrated by Blundell and Bond (1998).

5. Conclusions

This paper examines the empirical relationship between government size/taxation and economic growth for EU countries and finds a robust negative relationship. Moreover, assessing the joint impact of the government budget balance along with public expenditures yields the result that budgetary improvements tend to enhance long-term economic growth whilst the long-term growth-enhancing impact of additional public expenditure on long-term growth prospects has been limited for EU countries over the period of analysis. The analysis is performed by estimating growth regressions for a panel of EU countries using a generalised method of moments estimator that eliminates standard problems in this literature such as endogeneity of the explanatory variables and correlated individual effects. The analysis in the paper also tackles other problems present in this literature, *e.g.* the presence of cyclical effects which are usually addressed by taking 5-year averages of the data. Instead, we estimate the regressions with annual data and control for the cycle by using trend growth as dependent variable. Our sample selection contributes to better account for the problem of heterogeneity of the coefficients across countries.

Despite the large volume of literature already existing on the subject, further research is still warranted on the assessment of fiscal policy variables on long-term growth. In particular, the problem of weak instruments leaves open scope for further evaluation of other instruments in the GMM analysis and the evaluation of system estimators. Another promising avenue in this respect is the use of a quasi- maximum likelihood (QML) estimators to assess this relationship. In particular, Binder *et al.* (2001) present a QML estimator which has some desirable characteristics. Lastly, an avenue of research which shows promise to further elucidate the role of fiscal policies in influencing long-term growth is a more systematic treatment of heterogeneous slopes, for example through the use of recently developed Pooled Mean Group estimators outlined in Section 2.2 developed by Pesaran and Smith (1995) and Pesaran *et al.* (1999).

APPENDIX

DATA SOURCES

Variable	Definition	Source
GDP_PPP_HP	Trend gross domestic product at 1995 market prices (obtained using HP filter, lambda = 30), 1995 PPP US$ divided by total population	European Commission, AMECO database Autumn 2001 Release
SCHOOL	Average years of education of the working age population	Barro and Lee (2001) and Bassanini and Scarpetta (2001)
LPOPMRW	Total Population, adjusted for technological progress and depreciation of capital (see Mankiw *et al.*, 1992)	European Commission, AMECO database, Autumn 2001 Release
PRIVINV_GDP	Gross fixed capital formation at current prices; total economy less gross fixed capital formation at current market prices, general government, as a percent of GDP at current market prices	European Commission, AMECO database Autumn 2001 Release
TOTALEXP_GDP	Total expenditure, central government (consolidated accounts) as a percent of GDP at current market prices	IMF Government Finance Statistics. Extended chaining Commission Autumn 2001 forecasts in AMECO
TAXREV_GDP	Total tax revenue, central government (consolidated accounts) as a percent of GDP at current market prices	IMF Government Finance Statistics, excludes non-tax revenue. Extended chaining Commission Autumn 2001 forecasts in AMECO
SURPLUS_GDP	Budgetary surplus/deficit, central government (consolidated accounts) as a percent of GDP at current market prices	IMF Government Finance Statistics (code 80), the difference between total revenue and grants minus total expenditure. Extended chaining Commission Autumn 2001 forecasts in AMECO

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