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Economic growth and budgetary components: a panel assessment for the EU

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Abstract In this article, we test to determine whether a reallocation of government budgetary components can enhance long-term GDP growth in a set of 15 EU countries. We apply panel data techniques to the period 1971–2006, and use three alternative dependent variables in a growth regression: economic growth, total factor productivity and labour productivity. Our results also identify the distortions induced by public expenditure in the private factors allocation. In particular, we detect a strong crowding-in effect associated to public investment, which has enhanced economic growth by boosting private investment. We also associate a dependence of productivity on public expenditure on social security.

The opinions expressed herein are those of the authors and do not necessarily reflect those of the ECB or the Eurosystem.

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1 Introduction

The traditional neoclassical growth model did not allow for fiscal policies to affect the long-term growth rate of the economy. However, several extensions of neoclassical growth theory have considered public expenditure and taxation as playing a crucial role in long-term economic growth.[1] Indeed, under the denomination of endogenous growth models, a large strand of the literature includes a variety of possibilities to model economic growth.[2]

The shortcomings of poor data availability (Barro 1991) and sensitiveness of the results to small variations in the model specification (Levine and Renelt 1991; Easterly and Rebelo 1993) affected the first attempts to use panel data models to relate growth and fiscal variables. Recently, data quality has improved, and the large number of empirical studies on the determinants of economic growth provides valuable information about the variables that should be used in such a model (Devarajan et al. 1996; Odedokun 2001; Bose et al. 2003).[3]

The actual debate includes the selection of the estimation method and the definition of the long-term coefficients. Bassanini and Scarpetta (2001) rely on the Pooled Mean Group Estimator, developed by Pesaran et al. (1999), constraining the long-term relationship of the explanatory variables with economic growth to be identical across countries while allowing for heterogeneous short-term effects, which are estimated separately. Romero de Avila and Strauch (2008) estimate short- and long-term effects of the fiscal variables on growth in the same equation, using an approach based on Jones (1995), relying on the specification of an endogenous growth model with non-stationary fiscal variables.[4] In addition, Gupta et al. (2005) consider the possibility of an autoregressive term to account for the dynamic behaviour of growth, rather than using year averaging data.

For instance, Kneller et al. (1999) address two usual critics to growth regressions: the possible endogeneity of the fiscal variables and the consequences of the averaging usually applied to control for the business cycle effects. They find that results are sensitive to 5-year averaging of GDP growth, which is confirmed by Bleaney et al. (2001).

More interestingly, the analysis of the disaggregated government budget may offer useful insights about the suitability of the budgetary components to promote growth.

[1] Aschauer (1989), Barro and Sala i Martín (1997), Mendoza et al. (1997).

[2] Acemoglu (2006) includes a detailed explanation of the evolution of endogenous growth models.

[3] Kneller et al. (1999) argue that the estimated coefficients attached to the fiscal variables have to be interpreted by using some financing assumption. The elements of the public budget that are not included in the regression represent the implicit financing assumptions of the effects of the included variables. See also Miller and Russek (1997).

[4] Tomljanovich (2004) uses a similar analysis for the U.S.

Therefore, by regressing economic growth on budgetary economic categories and on a set of other relevant variables,[5] we evaluate whether the allocation of taxes and public expenditures has been useful to promote growth in a panel of European countries for the period 1971–2006.

Based on the analysis of previous results and the developments of econometric theory (Arellano and Bover 1995; Blundell and Bond 1998; Woolridge 2002), we propose a dynamic model estimated by GMM methods that has not previously been applied in this particular context. From the estimated dynamic coefficients, we determine long-term relations using the assumption that the economy is in its steady state. In addition, we also propose a broader framework that explains more accurately the relationship between the composition of the public budget and economic growth. The results of many empirical and theoretical studies[6] suggest that the public budget has an impact on economic growth, not only through an effect on productivity, but also by altering the conditions in the production factor markets, labour and productivity. Unlike previous studies, we further analyse the mechanisms through which public budget compositions alter long-term growth. Therefore, we also assess the relevance of fiscal variables for labour and total factor productivity. Such an approach allows us to discriminate between the impact on growth via productivity, and the effects induced in the labour and capital markets by distortionary taxation and public expenditure policies.

The analysis yields interesting results about the channels through which the composition of the public budget affects economic growth. A result of particular relevance regards the effects induced by public investment in the capital markets, the so-called crowding-in effect. Moreover, public consumption can be detrimental to growth because it reduces the incentives for private investment, while public employment retards productivity growth. On the revenue-side, contributions to social security do not seem to be growth enhancing.

The remainder of the article is organised as follows. Section 2 addresses the theoretical underpinnings. Section 3 presents our empirical specification. Section 4 reports the empirical analysis. Finally, Sect. 5 contains concluding remarks.

2 Theoretical underpinnings

We assume an economy with four types of public expenditure and three types of taxation in an extended version of the AK (productivity-capital) endogenous growth model. The four expenditure categories are: a type of public expenditure assumed to be an input in the production function, (G_1); a capital-enhancing type of public expenditure, (G_2); a labour-enhancing type of public expenditure (G_3); and a publicly provided

[5] Such variables typically include an indicator of population growth, private investment and trade openness. Other studies also use time-independent variables, such as the initial levels of GDP per capita or human capital (Barro 1991; Devarajan et al. 1996) although that is not strictly necessary in a panel data framework.

[6] See, for instance, Ramirez (2006) and Bojnec and Kosi (2006) on the empirical side, and Corsetti and Roubini (1996) and Liu and Turnovski (2005) on the theoretical side.

consumption good (G_4). Taxation is distributed among taxes on consumption (τ_c), taxes on corporate profits (τ_π) and on labour income (τ_l).[7]

Subsequent to the proposals made by Aschauer (1989) and Barro and Sala-i-Martín (1992), public expenditure has often been modelled as a separate input in the production function.[8] In our Cobb-Douglas' framework, considering public expenditure as a separate input in the production function is equivalent to incorporate it as a part of the technological constraint that determines total factor productivity:

$$Y_t = AK_t^{\alpha} L_t^{\gamma} G_{1,t}^{\delta} \tag{1}$$

where K and L are the private capital and labour supply, respectively.

The capital-enhancing type of public expenditure (G_2) responds to the cost–function approach of public expenditure proposed by several authors.[9] We will make use of the simplest way of affecting the price of public capital, by considering G_2 to be a subsidy to its purchase, as proposed by Devarajan et al. (1998). Being s a parameter in the interval (0,1), representing the non-subsidized share of private capital, the subsidised private capital paid through the capital-enhancing type of public expenditure will be

$$G_{2,t} = (1 - s_t)K_t. \tag{2}$$

G_3 is the labour-enhancing type of expenditure and is modelled following Agenor (2007).[10] It represents public expenditure that may induce the entry of more labour force in the market, or increase human capital, such as public expenditure on education or social programmes. The labour supply depends on the level of public expenditure G_3, the level of population, N, and the real wage:

$$L_t = \tilde{w}_t^{\mu} G_{3,t}^{\nu} N_t^{\eta} \tag{3}$$

where $\tilde{w}$ is the equilibrium real wage of labour supply, net of income taxes. The parameters μ and η are assumed[11] to lie in the interval (0,1).

[7] We will not consider taxation on capital income since its share in public revenues is insignificant and there is a relative consensus in the literature about its perverse effects (cf. Chamley 1986). This result has been also questioned, for example, by Huffman (2001).

[8] Tanzi and Zee (1997) provide a useful literature review on the fiscal policy determinants of long-run growth.

[9] For the introduction of this type of public expenditure Moreno et al. (2003) assume short-term rigidities and Devarajan et al. (1998) instead introduce it as a response to the existence of a positive externality attached to the subsidised capital. See Romp and De Haan (2007) for a survey of the literature.

[10] It could also have the opposite effect, raising equilibrium wages as proposed by Lane and Perotti (2003) in what they call the 'cost channel'.

[11] However, we do also have to accept the possibility of negative values of ν, since public policies that create disincentives to the entry of additional labour supply on the labour market can exist. Those policies could be unemployment subsidies or wage pressures induced by the public salaries. Dhont and Heylen (2007) present theoretical and empirical evidence of the negative impact of subsidies, productive government expenditures and income taxes on labour supply in Europe in contrast to the US.

Finally, we consider a type of public expenditure that is directly consumed by the households (G_4). We assume a Cobb-Douglas' utility function for the representative infinitely lived agent, as in Turnovsky (1996), although we do not consider congestion:

$$U_j = \sum_{t=j}^{\infty} \beta^t C_t^{\theta} G_{4,t}^{(1-\theta)}. \tag{4}$$

The households own the capital and the firms and provide labour supply. They get revenues from all those three activities, since in our economy with a publicly provided input, firms obtain positive profits. Households have to choose the shares of income they want to consume or invest in additional capital for the next period. In addition, they pay taxes on labour income, corporate profits, and on consumption. In all the three cases, we assume constant tax rates, respectively, of τ_l, τ_π and τ_c. Moreover, if we assume a linear tax rate in every case, the household's budget constraint would be

$$(1+\tau_c)C_t + s_{t+1}K_{t+1} = (1-\tau_l)w_t L_t + (1-\tau_\pi)\pi_t + r_t K_t. \tag{5}$$

Assuming total depreciation of the physical capital, K, π_t represents corporate profits and r is the equilibrium price of private capital paid by firms to its owners. The representative agent takes the decisions of the government about taxes and public expenditure as exogenous. She or he maximises her or his utility function (4) subject to the budget constraint (5). Wages and the cost of capital are determined by the market.

From Eqs. 1 to 5, one can derive the effect of a permanent increase in the fiscal variables on the three alternative measures of economic growth: production growth, labour productivity growth and total factor productivity growth. Table 1 summarizes the main relationships of the fiscal variables with the growth measures.

A permanent increase in public consumption only produces a short-term effect in the economic growth rate. In contrast, the effects of a change in the growth rates of the public production factor, G_1, the capital-enhancing public expenditure, G_2, and the labour-enhancing public expenditure, G_3, are permanent and depend on the respective elasticities of substitution.

If we consider the effects on labour productivity (defined as production per worker), the effects of G_1, G_2 and G_4 would remain practically unaltered. However, G_3 will have an opposite impact on labour productivity.[12] Finally, if we consider Total Factor Productivity (TFP), defined as the Solow residual, the expenditure categories G_2 and G_3 would have no effect on multifactor productivity while expenditure category G_1 still has an effect, given by $\partial TFP_t/\partial G_{1,t} = \delta$.

In addition, permanent changes in the tax rates on consumption, labour income and corporate profits, would induce changes in economic growth, which are symmetrical, respectively, to changes in the G_4, G_3, and G_2 spending categories (see Table 1).

[12] This result explains how a determined type of public expenditure that boosts (or diminishes) production growth by increasing (decreasing) labour supply, should have an opposite effect on labour productivity because of the decreasing returns to scale to a single factor of the Cobb-Douglas' production function.

Table 1 The relation of public expenditures and taxation types with alternative measures of economic growth

	Public expenditure				Taxation		
	Productivity-enhancing (G_1)	Capital-enhancing (G_2)	Labour-enhancing (G_3)	Consumption good (G_4)	Consumption tax (τ_c)	Labour Income Tax (τ_l)	Corporate profits (τ_π)
GDP growth	+	+	+	Only short term effect	Only short term effect	−	−
Lab. Prod. growth	+	+	−	Only short term effect	Only short term effect	+	−
TFP growth	+	No effect	No effect	Only short term effect	Only short term effect	No effect	No effect

Those relationships are computed assuming values for the parameters as in the underlying model. In particular:$\alpha > 0, 0 > s > 1$ and $\nu > 0$ guarantee that the effect of the categories of public expenditure on GDP growth is positive

3 Empirical specification

Traditionally, the relationship of economic growth to fiscal variables has been estimated under the form of a static model in which the use of variables expressed in long-frequency periods—usually 5 years—accounts for the long-term relationship.[13] However, and as discussed above, some studies exposed the sensitivity of the results due to the averaging process of the variables (Levine and Renelt 1992; Kneller et al. 1999). Two main weaknesses have been identified as the source of the lack of robustness of the results: the endogeneity of the fiscal variables and the definition of the long-term relationship under the data averaging.

The endogeneity issue has been addressed in several studies with the use of IV techniques (Bleaney et al. 2001; Gupta et al. 2005). The use of yearly data to estimate long-term relationships implies setting up a new framework yielding more reliable estimates. Our view is that the relationship of fiscal variables to growth is dynamic by nature, and the lack of precision of previous estimates could be related to the omission of these dynamics. In addition to the autoregressive behaviour of economic growth, fiscal variables may induce an impact on growth distributed across several periods. That may be particularly relevant for some categories of public expenditure, which might induce a certain impact in the economy in the period in which they are actually realised, and a different impact subsequently.

Therefore, such rational motivates our proposal to model the growth equation as an Autoregressive Distributed Lag (ARDL) specification, including lags of dependent and fiscal variables:

$$y_{i,t} = \mu_i + \nu_t + \sum_{j=1}^{p} \lambda_j y_{i,t-j} + \sum_{s=0}^{q} \delta_s fiscal_{i,t-s} + \tau_i other_{i,t} + \varepsilon_{i,t} \qquad (6)$$

where the index $i (i = 1, \ldots, N)$ denotes the country, and the index $t (t = 1, \ldots, T)$ indicates the period. μ_i and ν_t are the unit- and time-specific effects, respectively.

In (6), $y_{i,t}$ indicates the growth rate of per capita output of country i during year t $(y_{i,t} = \Delta lnGDP_{i,t})$, *fiscal* is a set of fiscal variables expressed as a percentage of GDP and *other* is a set of non-fiscal variables to be included in the growth regression.

We propose to estimate Eq. 6 using the GMM estimator developed by Arellano and Bond (1991). The GMM estimate controls for endogeneity by using the lagged values of the levels of the endogenous and of the predetermined variables as instruments. It is necessary to test for the validity of the instruments as well as for the presence of serial correlation in the residual once the specification has been estimated.[14] The estimates are obtained using the one-step procedure, since the two-step procedure has been found to yield biased downward standard errors for small samples. Actually, in

[13] While some studies use 5-year averages for all variables (Kneller et al. 1999; Bleaney et al. 2001), others regress 5-year forward-looking moving averages of GDP growth on yearly fiscal variables to account for endogeneity (Devarajan et al. 1996; Odedokun 2001).

[14] Although Arellano and Bover (1995) and Blundell and Bond (1998) improve the efficiency of the 'difference GMM' estimator by introducing additional assumptions of no correlation between the fixed-effects and the first differences of the instrumenting variables, a hypothesis which we do not assume.

our sample the Sargan test cannot reject the null hypothesis that the over-identifying restrictions are valid. Therefore, there is no need to use the one-step robust estimator.

However, the estimated coefficients from Eq. 6 are still difficult to interpret. We cannot asses with certainty whether one variable has a relevant impact on growth, particularly if we estimate coefficients with opposite signs for several lags of the same fiscal variable. For that reason, we want to derive a unique coefficient that includes all the lags of every explanatory variable as well as the autoregressive terms.

Therefore, we assume an economy in its steady state in which all variables grow at a constant rate to get a unique long-run coefficient for each fiscal variable. If we impose identical values for the variables over time, then we can work out the long-run coefficients as

$$\text{long-run} = \sum_{s=0}^{q} \delta_s / \left(1 - \sum_{j=1}^{p} \lambda_j\right). \tag{7}$$

The standard errors for the coefficients obtained with this procedure may be computed applying a delta method, which consists of expanding a function of a variable about its mean, with a one-step Taylor approximation, and then taking the variance.[15]

4 Empirical analysis

4.1 Data

Our dataset, sourced from the European Commission Ameco database, covers the period 1971–2006 for 15 EU Member States.[16] The fiscal variables refer to the consolidated general government and are expressed as ratios of GDP. Regarding public expenditure, we focus our analysis on the economic classification. Our analysis excludes those variables that have a residual importance on the public budget or whose interpretation is less clear.

In addition, we have included four control variables: labour force (as a growth rate), private investment (as a percentage of GDP); terms of trade (as a growth rate constructed from an index series in which the year 2000 takes the value 100) and population (growth rate). The inclusion of the production factors related to capital increase (proxied by private investment) and labour force growth follows from the theoretical model presented above and is in line with the related literature. Population growth may determine the growth of the dependent variables as long as it is expressed in per capita terms. Several studies have suggested the relevance of terms of trade or the presence of a similar variable representing economic openness (Odedokun 2001; Bose et al. 2003; Gupta et al. 2005).

[15] A discussion of this method can be found in Woolridge (2002) and Papke and Woolridge (2004).

[16] The EU-15 countries are: Belgium, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, Netherlands, Austria, Portugal, Finland, Denmark, Sweden and United Kingdom.

The unit-specific term in our panel model, μ_i in (6), takes into account the effect of time-invariant idiosyncratic characteristics of each country,[17] whose impact has been suggested by previous analysis, such as the initial levels of GDP or human capital, natural resources, etc.[18] Based on preliminary estimations, we have not included time dummies in our model. These would show no statistical significance and would induce no relevant changes in the estimations, apart from slightly larger values for the standard errors in general.

4.2 Initial results for growth specifications

Table 2 reports the results for the EU15 data set for the period 1971–2006. A key point to make a correct interpretation of the estimated coefficients is the importance of the omitted variable in each regression, as described in Kneller et al. (1999). Therefore, in columns 1–4 in Table 2, we compute the impact of an increase of several categories of public expenditure on economic growth. The omitted variables represent the underlying assumption about how to finance the additional expenditure in the particular type of public spending item. In all cases, the omitted variables are the remainder of the public expenditures. For example, the interpretation of the coefficient associated with public consumption reflects the increase in growth that would induce an increase[19] in public expenditure in consumption, financed with an equivalent decrease in the remainder of public spending.

In columns 5 and 6 of Table 2, we assess the effect on growth of different kinds of taxes. The omitted variables are the remaining public revenues. Therefore, the estimated coefficients reflect the impact on economic growth induced by an increase of one percentage point in the particular type of revenue, financed by an equivalent reduction in the remaining (omitted) sources of revenues. The interpretation of the other fiscal variables (deficit, total public expenditure) follows a similar argument and the estimated coefficients assume that the alterations of the variables would imply the fulfilment of the budgetary identity, by modifying the elements of the budget that are not present in the estimation.

The coefficients shown in Table 2 are the long-term coefficients computed through Eq. 7 from the coefficients estimated in Eq. 6 using the Arellano and Bond (1991) GMM estimator. Column 1 reveals a clear negative relationship of public consumption with economic growth. A statistically significant and negative coefficient has also been estimated for social transfers, while for the other determinants of current public expenditure, compensation of employees and subsidies, we cannot find a statistically significant relation with growth.

[17] The time-specific effect has been removed from the estimations. The results including time-dummies (available upon request) do not reveal significant time effects in our sample period. The selection of the order on the lagged variables, p and q, has been made based on preliminary experiments with several options, and it varies between one and two lags of both the dependent and explanatory variables. In all cases, the inclusion of additional lags yields statistically insignificant coefficients.

[18] As proposed by Kneller et al. (1999); Bose et al. (2003) and Reed (2006) among others.

[19] That is, the increase in the logarithmic growth rate of per capita GDP induced by a one point increase in public expenditure, expressed as a percentage of GDP.

Table 2 EU15 1971–2006 (Long-term coefficients, dependent variable: per capita GDP growth, *log-rpcGDP*)

	(1)	(2)	(3)	(4)	(5)	(6)
PE consumption	−0.7522***					
	(.225)					
PE compensation of employees		−0.1961				
		(.297)				
PE social transfers			−0.2976**			
			(.154)			
PE subsidies			.3222			
			(.240)			
PE Investment				0.6464**		
				(.327)		
PE total					−0.3262**	−0.5675***
					(.133)	(.075)
PR direct taxation					−0.0481	
					(.219)	
PR social contributions					−0.5853**	
					(.254)	
PR Indirect taxation						0.2896
						(.225)
PR total	−0.3913***	−0.5048***	−0.3089***	−0.6091***		
	(.086)	(.104)	(.078)	(.075)		
Public deficit	0.2540***	0.0942	0.1166	0.1103	0.5222***	0.7047***
	(.095)	(.089)	(.103)	(.076)	(.159)	(.114)
Private Investment	0.0030**	0.0028**	0.0037***	0.0020	0.0041***	0.0033***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Terms of trade	−0.0011***	−0.0011***	−0.0012***	−0.0013***	−0.0014***	−0.0013***
	(.0003)	(.0003)	(.0002)	(.0003)	(.0003)	(.0003)
Labour force growth	0.4698***	0.4842***	0.1525	0.3733**	0.3681**	0.4285**
	(.159)	(.170)	(.169)	(.162)	(.176)	(.167)
Population growth	−1.2606***	−1.2803***	−0.9215***	−1.1706***	−1.1787***	−1.256***
	(.216)	(.230)	(.222)	(.219)	(.235)	(.229)
Observations	432	432	432	432	432	432

Notes: GMM Arellano-Bond dynamic panel-data estimation. The standard deviations are in parentheses. *, **, ***—statistically significant at the 10, 5, and 1%. *PE* public expenditure, *PR* public revenue

Public investment enhances economic growth in the long-term, as revealed by the estimated coefficient of around 0.65 (see column 4). That means that an increase in public investment of a percentage point of GDP, financed by an equivalent decrease in current public expenditure (omitted variables), would induce an increase in the growth rate of per capita GDP of around 0.65 percentage points.

The overall effect of public revenues is estimated to be negative as shown by the coefficients attached to that variable in columns 1–4. The estimated coefficient is relative to the omitted variables of public expenditure. Therefore, it is not surprising that the coefficient estimated in column 4 is larger in absolute value since the omitted variables include all public expenditure except public investment.

In columns 5 and 6, we disaggregate the implications of public taxation in economic growth. The estimated coefficients are not extremely significant, which could be an indicator that governments properly accommodated tax distribution. Nevertheless, the significantly negative coefficient attached to social contributions could reveal that a slight decrease in this revenue item reallocated to higher indirect taxation could have helped to promote economic growth in our sample (although the estimated coefficient for indirect taxes is not statistically significant).

The negative coefficient attached to total public expenditure in columns 5 and 6 is not a surprise, taking into account the results described in columns 1–4. Therefore, in our sample economic growth may have been undermined by some excessive spending.

Concerning the control variables, their respective estimated coefficients are in line with previous studies. The budget deficit has a positive effect on long-term growth, even if it is not always statistically significant.[20]

The positive coefficient attached to private investment follows from standard economic theory, in which an increase in the production factors will naturally induce an increase in production. The same reasoning can be applied to the variable labour force, although a negative coefficient has been estimated by previous studies with data from developing countries (Odedokun 2001; Bose et al. 2003), this may be a consequence of the definition of the dependent variable in per capita terms.

The coefficient attached to the terms of trade is usually positive for developing countries since trade is assumed to be growth-enhancing. However, in our sample of European countries, international trade is largely developed and the estimated negative coefficient may stem from the perverse impact of faster capital accumulation on the relevance of trade as mentioned by Acemoglu and Ventura (2001).[21]

Some of our results are in line with previous studies.[22] Of course, we also expect different results from studies including diverse panel samples, particularly when we compare developed and developing countries. For example, Devarajan et al. (1996) find a negative coefficient associated to public capital expenditure in their panel of 43 developing countries, for the period 1970–1990, revealing a possible situation of overspending in public capital during this period. Odedokun (2001) also finds a negative coefficient attached to public capital expenditure on his sub-sample of developed countries. On the other hand, Bassanini and Scarpetta (2001), and Romero de Avila and Strauch (2008), using data very similar to ours, estimate a positive coefficient for EU and OECD countries. In addition, Gupta et al. (2005) also report a

[20] For instance, Kneller et al. (1999), also find a positive coefficient attached to the budget deficit for a panel of OECD countries, while Bose et al. (2003) and Gupta et al. (2005) find the opposite result in their panels of developing countries. We have to bear in mind the financing assumptions leading to this result: increasing public deficits could foster growth if the increase is devoted to increase public investment (column 2) or to decrease taxes (columns 5 and 6).

[21] Miller and Russek (1997) estimate a positive coefficient associated to their openness variable while Gupta et al. (2005) find a negative coefficient attached to the terms of trade.

[22] As a robustness check, we have repeated the estimation splitting the sample into two subsamples (1971–1989 and 1990–2006) to control for the time consistency of the results. We checked that the essence of the results does note change. We do not report these estimations for the sake of brevity, but they are available in Afonso and González Alegre (2008), an earlier working article version.

positive coefficient for public capital expenditure in their sample of 39 low-income economies.

Regarding the compensation of employees, Odedokun (2001) estimates a positive coefficient attached to public expenditure in wages while Gupta et al. (2005) estimate a negative coefficient attached to wages and salaries. However, our study shows no significant coefficients attached to this variable.

Our negative coefficient attached to social transfers can be related to the results of Kneller et al. (1999), who estimate a negative coefficient associated to their variable 'non-productive expenditures', whose main component is spending on social security and welfare policies. For this budgetary item, our results are also in line with the ones reported by Romero de Avila and Strauch (2008). However, Cashin (1994) estimates a positive coefficient associated to this variable for a panel of 23 developed countries, using fixed- and random-effect estimations.

Regarding the composition of public revenues, several studies find a negative impact of general taxation on growth, notably Bose et al. (2003) for developing countries, and Reed (2006) and Bassanini and Scarpetta (2001) for developed economies.

Kneller et al. (1999) estimate a negative effect of 'distortionary taxation', which included direct taxes and social security contributions, for OECD countries. They find no significant effect for non-distortionary (indirect) taxation. Their results are in line with our estimations while we do not uncover the positive coefficient estimated for direct taxation by Romero de Avila and Strauch (2008).

4.3 Labour and total factor productivity

Tables 3 and 4 report the results of estimating Eq. 6 using, respectively, labour productivity and multifactor productivity as dependent variables. The objective is to identify which types of public expenditures and revenues enhance economic growth by boosting labour supply, private capital or factor productivity. Our methodology also allows identifying fiscal variables that may have an impact on economic growth in the short-term, but have no long-term effect, as it happened to G_4 (publicly provided consumption good) or τ_c (consumption tax) in our theoretical model.

In Table 1, we summarised the links that we established between the types of public expenditure and the growth measures. However, we have to consider the possibility that some fiscal variables may simultaneously affect economic growth through several channels.[23] Our tables report the long-term coefficients computed according to Eq. 7. Therefore, they do not reflect the short-term dynamics that could appear in the direct estimations of Eq. 6 and that could serve to identify which fiscal variables could behave like G_4 and τ_c.[24]

[23] For the sake of simplicity, our theoretical framework only includes one channel of impact for every type of public expenditure and taxation. Public expenditure on wages, for example, could simultaneously behave as the productivity-enhancing and the capital-enhancing types of public expenditure. Social contributions may have a short-term effect similar to the one described in the case of consumption taxes, in addition to the long-term effect attached to the profit-tax described in our theoretical model.

[24] The estimations of the long-term coefficients are available on request.

Table 3 EU15 1971–2006 (Long-term coefficients, dependent variable: labour productivity)

	(1)	(2)	(3)	(4)	(5)	(6)
PE consumption	−0.7524***					
	(.201)					
PE compensation of employees		−0.0465				
		(.261)				
PE social transfers			−0.4112***			
			(.126)			
PE subsidies			0.3116			
			(.196)			
PE investment				0.9010***		
				(.296)		
PE total					−0.3130***	−0.5904***
					(.098)	(.070)
PR direct taxation					0.0286	
					(.158)	
PR social contributions					−0.5006***	
					(.184)	
PR indirect taxation						0.2916
						(.199)
PR total	−0.3850***	−0.5205***	−0.2450***	−0.5949***		
	(.077)	(.091)	(.061)	(.064)		
Public deficit	0.2590***	0.0500	0.1103	0.0985	0.5322***	0.6914***
	(.085)	(.079)	(.084)	(.067)	(.117)	(.104)
Private investment	0.0033***	0.0028**	0.0033***	0.0027**	0.0049***	0.0028**
	(.001)	(.001)	(.001)	(.001)	(.0009)	(.001)
Terms of trade	−0.0009***	−0.0009***	−0.0009***	−0.0009***	−0.0012***	−0.0011***
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
Labour force growth	−0.8727***	−0.8858***	−1.1722***	−0.9503***	-0.9933***	−0.9712***
	(.147)	(.152)	(.147)	(.149)	(.141)	(.170)
Population growth	0.1726	0.2014	0.5321***	0.2737	0.3637**	0.2231
	(.179)	(.184)	(.175)	(.180)	(.171)	(.194)
Observations	429	429	429	429	443	443

Notes: GMM Arellano-Bond dynamic panel-data estimation. The standard deviations are in parentheses. *, **, ***—statistically significant at the 10, 5, and 1%. *PE* public expenditure, *PR* public revenue

The comparison of Tables 2 and 3 should allow us identifying which categories of public expenditures and taxation have an impact on production through alterations in the labour market, similar to the one described for G_3 and τ_l in Sect. 2. Those fiscal variables would be the ones for which the estimated coefficients are significantly different in both tables. Still, we observe no big differences between both estimations. Indeed, we are only able to identify some changes in the estimates for social transfers, public investment and slightly in social contributions.

The capital-enhancing type of public expenditure (G_2) and the corporate profit taxation (τ_π), in contrast to G_3 and τ_l, should appear with similar coefficients in Tables 2 and 3, since their effect on GDP and labour productivity is almost identical. As we can see, none of them (G_2, τ_π, G_3 and τ_l) has any effect on TFP.

Table 4 EU15 1971–2006 (Long-term coefficients, dependent variable: total factor productivity growth)

	(1)	(2)	(3)	(4)	(5)	(6)
PE consumption	−0.3382***					
	(.122)					
PE compensation of employees		−0.4225***				
		(.132)				
PE social transfers			0.1227			
			(.077)			
PE subsidies			0.0901			
			(.148)			
PE Investment				−0.3840***		
				(.147)		
PE total					0.0687	0.0281
					(.064)	(.033)
PR direct taxation					−0.1706	
					(.103)	
PR social contributions					0.0837	
					(.122)	
PR Indirect taxation						0.0347
						(.094)
PR total	0.1257***	0.1475***	−0.0082	0.0435		
	(.045)	(.047)	(.041)	(.030)		
Public deficit	0.1016**	0.0676*	−0.0235	0.0598	−0.0677	0.0036
	(.048)	(.038)	(.058)	(.037)	(.076)	(.052)
Private Investment	0.0014**	0.0013**	0.0014**	0.0016***	0.0013**	0.0013**
	(.0005)	(.0005)	(.0007)	(.0005)	(.0005)	(.0005)
Terms of trade	0.0006***	0.0006***	0.0005***	0.0006***	0.0006***	0.0005***
	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)	(.0001)
Labor force growth	0.0784	0.0841	0.0739	0.0934	0.0400	0.0656
	(.086)	(.086)	(.093)	(.089)	(.093)	(.091)
Population growth	0.2179	0.1863	0.0300	0.0432	0.0899	0.1552
	(.255)	(.247)	(.284)	(.254)	(.261)	(.264)
Observations	336	336	336	336	336	336

Notes: GMM Arellano-Bond dynamic panel-data estimation. The standard deviations are in parentheses. *, **, ***—statistically significant at the 10, 5, and 1%. *PE* public expenditure, *PR* public revenue

Table 4 presents the estimations using TFP growth as dependent variable and any variable showing a significant coefficient behaves as the productivity-enhancing type of public expenditure (G_1) described in Sect. 2. In addition, those types of public expenditure should yield a similar result when used as regressors in estimating GDP or labour productivity growth. If this is not the case, the underlying variable may impact economic growth through another channel in addition to the effect on multi-factor productivity.

Interestingly, this seems to be the case for public consumption, public wages and public investment. The absolute estimated coefficient attached to public consumption is clearly smaller than the one estimated in Tables 2 and 3, while public wages appear

with a negative coefficient only in Table 4. According to our model, this would mean that both variables should have a simultaneous impact on growth, through multifactor productivity. The sign of the capital-enhancing effect would be positive in the case of public wages and negative in the case of public consumption.

The effect of public investment should also be examined carefully. It seems as if the level of public capital is too high and additional investment affects negatively multifactor productivity. However, this negative impact would be counterbalanced by both a higher propensity to invest in the private sector (crowding-in effect) and an increase in the labour supply induced by public investment.[25]

Finally, and as expected, taxes have no relevant effect on multifactor productivity. Moreover, it also seems that they do not have a visible impact on labour supply either, according to the estimates for labour productivity growth, even for labour tax. Therefore, the main effect would be caused by alterations in the pattern of consumption and private investment. Table 5 summarises the link of the findings from the estimations in this sub-section with the theoretical framework developed in Sect. 2.

4.4 Using 5-year growth averages

As mentioned before, we have used a new approach in our article. The standard approach of static modelling previously used to estimate the effects of fiscal variables in economic growth, under the argument that the omission of the dynamic in the relationships between the variables, may lead to biased estimates. Therefore, it is important to assess to what extent our methodology produces different results, under a static specification, and using a 5-year forward-looking moving average of per capita GDP growth as dependent variable, as done, for example, by Devarajan et al. (1996) or Odedokun (2001).

Table 6 presents the results, and we can observe relevant differences in some coefficients. In particular, the smaller absolute value for public consumption, the level of significance of public wages, public subsidies and public investment, and the sign attached to indirect taxation. In terms of the control variables, we can also see some variations in the signs and levels of significance.

As mentioned before, our argument is that the averaging process is not able to capture the dynamics that we can show that exist in the impact of the fiscal variables on growth. Therefore, this causes the estimated coefficients under the traditional static models to present a significant bias.

5 Conclusion

The link between the composition of the expenditure and revenue sides of the budget and economic growth has been the focus of recent developments in endogenous growth theory. Several studies have proposed different channels through which public

[25] Afonso and St Aubyn (2009) compute macroeconomic rates of return that also uncover crowding-in effects for several EU countries.

Table 5 Classification of public expenditure according to its impact on alternative measures of economic growth

Public expenditure				Taxation		
Productivity-enhancing (G_1)	Capital-enhancing (G_2)	Labour-enhancing (G_3)	Consumption good (G_4)	Consumption (τ_c)	Labour Income (τ_l)	Corporate profits (τ_π)
PE cons (−) PE emp (−) PE inv (−)	PE cons (−) PE emp (+) PE inv (+)	PE soc trans.(−) PE inv (−)	PE emp PE soc transf.	PR social contr. PR Ind. tax		PR social contr.(−)

Note: We have taken into account the 5to elaborate this table. Short-run relationships are not reported in Tables 2 to 4 since they are not visible in the long-term coefficients. *PE* public expenditure, *PR* public revenue

Table 6 Five-year moving averages, dependent variable: 5-year forward-looking moving average of per capita GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)
PE consumption	−0.2016***					
	(.055)					
PE compensation of employees		−0.2864***				
		(.063)				
PE social transfers			0.0348			
			(.043)			
PE subsidies			−0.2832***			
			(.062)			
PE Investment				−0.0346		
				(.074)		
PE total					−0.0765**	−0.0082
					(.035)	(.016)
PR direct taxation					0.0489	
					(.057)	
PR social contributions					0.1266*	
					(.065)	
PR Indirect taxation						−0.1180**
						(.053)
PR total	0.0273	0.0281	−0.0387**	−0.0248*		
	(.020)	(.018)	(.019)	(.014)		
Public deficit	−0.0034	0.0076	0.0057	−0.0428**	0.0270	−0.0393
	(.022)	(.022)	(.026)	(.020)	(.041)	(.024)
Private investment	−0.0025***	−0.0023***	−0.0019***	−0.0025***	−0.0026***	−0.0025***
	(.0002)	(.0002)	(.0003)	(.0003)	(.0002)	(.0002)
Terms of trade	0.00008	0.00007	0.00001	0.00005	0.00009	0.0001
	(.00007)	(.00007)	(.00007)	(.00008)	(.00008)	(.00008)
Labor force growth	0.0317	0.0233	0.0167	0.0289	0.0227	0.0259
	(.047)	(.046)	(.047)	(.048)	(.047)	(.047)
Population growth	−0.0303	−0.0312	−0.0218	−0.0312	−0.0253	−0.0283
	(.061)	(.061)	(.061)	(.062)	(.062)	(.062)
F-test joint significance (probability)	8.10	11.23	10.75	9.03	8.03	9.53
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Observations	458	458	458	458	458	458

Notes: GMM Arellano-Bond dynamic panel-data estimation. The standard deviations are in parentheses. *, **, ***—statistically significant at the 10, 5, and 1%. *PE* public expenditure, *PR* public revenue

expenditure and taxation could affect economic growth and productivity. In particular, it has been assumed that fiscal policy is able to affect production by altering the pattern of consumption and investment of the economy, by introducing incentives and disincentives in the utility and productivity of the individuals that affect the equilibrium in the labour market, and, in the case of public expenditure, also as a separate input that enters the production function.

We wanted to bring this debate also into the empirical literature. In this article, we argue that we can identify the channels through which the components of the

public budget affect economic growth, by comparing the results of estimating three alternative dependent variables in a growth regression.

This article also proposes innovations regarding the econometric modelling of the growth regression. Therefore, we estimate a dynamic panel data model with lags of the explanatory variables (ARDL) from which we are able to compute long-term relationships. This methodology allows us to deal with the main critics done to previous studies: the presence of endogeneity, the dynamic behaviour of the relations and the omitted variable issue.

Our estimations yield interesting results with respect to fiscal policy in the European Union. Using data for 15 EU countries for the period 1971–2006, we are able to identify a negative impact of public consumption and social security contributions on economic growth, and a positive impact of public investment. The budget deficit has a positive effect on long-term growth, even if it is not always statistically significant. Regarding the control variables, their respective estimated coefficients are in line with previous studies.

Unlike previous studies, we try to better accommodate our results to the developments of economic theory by identifying the channels through which each budgetary category may impact on production growth. Our regressions for labour productivity and TFP reveal that the main impact of fiscal variables comes through changes in the pattern of investment of the economy. We are able to identify the existence of a crowding-in effect of public investment into private investment that provokes an overall positive effect of public investment on economic growth, despite its negative impact on multifactor productivity. Social expenditures and public investment also seem to affect the labour market while public consumption and public wages have a significant impact in multifactor productivity.

This analysis can be improved in several ways. The impact of public expenditure on private investment and the labour market may be addressed in a more specific context. The definition of public expenditure may be extended to include other transfers from supranational levels of government. More specifically, one could address the impact of direct transfers from the European Commission to the private sector through agricultural and regional policies. Finally, the decomposition of public expenditure attending to the level of government could also yield interesting results, since fiscal decentralisation and structures are still very heterogeneous in our set of European countries.

Appendix

See Table 7.

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Table 7 Definition of variables and data sources

GDP data		
MArpcGDP	Five-year forward-looking moving-average of per capita GDP	Moving average from data at current prices
logpcGDP	Log of real per capita GDP growth rate	Growth rate from data at current prices
logLAB	Log of Labor productivity growth rate	Growth rate from data at current prices
TFP	TFP growth rate	Growth rate from data at current prices
General government public spending		
PEtot	Total expenditure; general government	Share on GDP from data at current prices
PEcons	Final consumption expenditure of general government	Share on GDP from data at current prices
PEemp	Compensation of employees; general government	Share on GDP from data at current prices
PEsoc	Social benefits other than social transfers in kind; general government	Share on GDP from data at current prices
PEsub	Subsidies; general government	Share on GDP from data at current prices
PEinv	Gross fixed capital formation; general government	Share on GDP from data at current prices
General government public revenue		
PRtot	Total revenue; general government	Share on GDP from data at current prices
PRdirtax	Current taxes on income and wealth (direct taxes); general government	Share on GDP from data at current prices
PRsoc	Social contributions received; general government	Share on GDP from data at current prices
PRindtax	Taxes linked to imports and production (indirect taxes); general government	Share on GDP from data at current prices
Control variables		
PrivInv	Private sector investment	% GDP
Labfrgr	Total labour force growth rate (Labour force statistics)	Growth rate constructed from data in 1000 persons
Tot	Terms of trade goods and services (National accounts)	Growth rate constructed from series 2000=100
Popgr	Total population growth rate	Growth rate from series of total population

Data source is the EC AMECO database

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