The impact of government education expenditures on growth in EU28 – are there spatial spillovers?

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Abstract
This paper analyses the impact of government spending on education (as a share of overall government spending) on GDP growth in EU28 countries during the period 2004-2013. It extends previous literature on the topic in that it uses a novel econometrics technique that accounts for spatial effects. Our results indicate that firstly, government spending on education significantly and positively influences GDP growth. Moreover, indirect i.e. spillover effects are quite large and account for 40 to 60 percent of the total effect.

JEL: C33, H1, H5, I2, O4
Key words: government spending on education, GDP growth, spatial panel analysis

1. Introduction and motivation

The Maastricht Treaty and the Stability and Growth Pact (SGP) require national fiscal policies in the euro zone and in candidate countries to keep their fiscal deficits below 3% of GDP and their public debts below 60% of GDP. In spite of that, the recent global financial and economic crisis has led to fiscal expansions though various fiscal stimulus packages resulting in mounting government deficits and debts worldwide. In order to ensure the long-term sustainability of public finances, policy makers are now forced to curb the size of the government sector. In such a situation the structure of government spending becomes increasingly important. Namely, provided that different types of government expenditures have different growth effects, the analysis of the composition of government expenditures in relation to the long-run economic growth offers an important basis for relevant policy proposals. There is nowadays a developing consensus among economists about the positive effect of productive public expenditures and the negative effect of unproductive public expenditures on economic growth (Barro, 1990). As noted by Colombier (2011), although governments make spending cuts in order to improve public finances, an attempt to cut down the expenditures linearly might lead into a public-savings paradox whereby non growth-enhancing expenditures crowd out those expenditures that would potentially increase economic growth. In order to avoid this 'budget crowding out' effect, policy makers should have a clear guidance on the growth effects of different expenditure types. This papers, therefore, adds to the literature by investigating the impact on growth of one particular type of productive government spending – education spending.

Namely, modern economies are being progressively more based on knowledge and information, since knowledge and human capital are recognised as key drivers of productivity, growth and prosperity of these countries. Most governments have, therefore, traditionally been involved in the formation of human capital. The necessity of investing in knowledge has also been recognised by the European Commission, who's 2020 strategy (European Commission, 2010) has put forward EU targets in the following five areas: employment, research and innovation, climate change and energy, education and poverty reduction. In light of this, an investigation of the impact of education spending on growth seems particularly timely.

Government spending on education influences growth through human capital and research and development (R&D). As noted by Afonso et al. (2005), government involvement is needed as it can compensate for market failure due to network-externalities, non-linearities and monopolistic competition, and government spending on education can lead to education and R&D being on a higher level than would be the case in a pure market scenario. However, as noted by a number of authors (Kneller, Bleaney and Gemmell, 1999; Blankenau and Simpson, 2004; Blankenau et al., 2007, to name a few), in spite of a relatively straightforward theoretical relationship between government education expenditures and growth, the empirical support of this link is mixed. Even though theory postulates that government spending on education leads to human capital accumulation and an increase in steady state growth, because of general equilibrium adjustments in other factors, which may lead to a decrease in growth, the overall effect can be ambiguous.

The main objective of this paper is, therefore, to empirically investigate the impact of government expenditures on education on growth in EU28 countries during the period of 10 years (2004-2013). This set of countries and the time period have rarely been analysed in the literature on the topic, as will become apparent in Section 3. Additionally, our approach is novel in that we will take into account possible spatial dependencies among these countries. Namely, in economically integrated economies most economic policies are spatially dependent. The policy choice of one country, region, state or municipality depends partly on policy choices of other countries, regions, states or municipalities. Most empirical studies that investigate government spending (at its aggregate and disaggregate level) and growth nexus, however, ignore spatial aspect of the growth process and the possibility of spatial autocorrelation is rarely acknowledged (Nijkamp and Poot, 2004). Ignoring these issues can lead to mis-estimation of standard errors (Anselin and Griffith, 1988); hence, in the presence of spatial dependence traditional (a-spatial) econometric techniques are no longer appropriate.

The paper is organised as follows: Section 2 gives theoretical background for the link between government spending on education and growth; Section 3 reviews empirical literature on the topic; Section 4 presents methodological approach undertaken in this paper and introduces spatial aspect of the analysis; Section 5 gives the results as well as robustness tests, while Section 6 concludes.

2. Theoretical background

Since the seminal contributions of Lucas (1988), Romer (1990) and Mankiw et al. (1992), human capital has been identified as an important determinant of economic growth.

In Mankiw et al.'s (1992) model, which is, in effect, Solow's (1956) model augmented with human capital as a separate input in the production function, human capital is assumed to be accumulated in the same way physical capital is: by investing a fraction of income in its production. An increase in the rate of investment in human capital in this model does not affect the long run growth rate of output per worker in this model, but it does have a level effect.

Endogenous growth literature offers two approaches to incorporating human capital into growth models. In Lucas's (1988) model the main source of growth is accumulation of human capital. In this model human capital enters the production function in labour-augmenting form. Agents are assumed to allocate their time between work (which determines physical capital accumulation) and skill acquisition (which determines human capital accumulation i.e. future productivity). The growth rate of human capital and consequently growth rate of output per worker in Lucas's (1988) model depends on the fraction of time allocated to skill acquisition and productivity of schooling process. Such a formulation implies that the growth rate of human capital does not depend on its level. A one-off increase in the stock of human capital has no effect on the long run growth rate of output per worker, but it does have a level effect.

Finally, in Romer's (1990) model it is the stock (not the accumulation) of human capital that matters for growth, via its role in the process of research, development and adoption of new technologies. In this model human capital is not treated as an independent source of long run growth; rather it is a medium through which technological change affects growth. The growth rate of the stock of knowledge, and consequently growth rate of output per worker, in Romer's (1990) model depends on human capital employed in research the productivity of research. Therefore, unlike the Lucas's (1988) model, a one-off increase in the stock of human capital in this model does have a rate effect.

To the extent that government spending on education facilitates human capital accumulation (since most governments are involved in the formation of human capital by providing funds for education) there is scope for governments to influence long-run growth. A number of papers have developed endogenous growth models that describe particular mechanisms by which government expenditures on education influence human capital and long-run growth (see, for example, Glomm and Ravikumar, 1992, 1997, 1998; Eckstein and Zilcha, 1994; Kaganovich and Zilcha, 1999;

Beauchemin, 2001; Blankenau and Simpson, 2004; Blankenu et al., 2007). Glomm and Ravikumar (1997), for example, assume that human capital accumulation in period *t* depends on public education expenditures in the previous period. Kaganovich and Zilcha (1999) take human capital of an individual in one generation to be a faction of, among other things, government investment in education in the preceding period. Beauchemin (2001) also assumes that human capital accumulation is a linear function of total public education expenditures per pupil in the previous period. Blankenau and Simpson's (2004) model, similarly, relies on the assumption that public and private education inputs combine with the human capital of the prior generation to create human capital of the next generation.

As noted by Gemmell (1996), it is difficult to distinguish between exogenous and endogenous growth models in empirical work. Namely, as pointed out by Bleaney et al. (2001), it is questionable whether empirical methodology employed in majority of papers on the topic has the ability to separate the effects of fiscal policy (government spending on education) on the transition path from those on the steady state. If a chosen empirical approach captures short-run behaviour only, it cannot discriminate between neoclassical and endogenous models, which differ only in their long-run predictions. Overall, therefore, the issue of the impact of government education spending on growth, therefore, remains largely an empirical question.

3. Empirical literature review

In what follows we review only those empirical papers that analyse the relationship between government spending on education and growth.

Nijkamp and Poot (2004) undertake meta-analysis to investigate the effect of fiscal policies on long-run growth. Their sample includes 93 papers that have been published between 1983 and 1998 in refereed journals, and pay special attention to five areas of government policy: general government consumption, tax rates, defence, education expenditures and public infrastructure. Their analysis is thorough and employs several meta-analytical techniques; however, here we focus on their main findings regarding education expenditures as our main variable of interest. Public expenditures on education are analysed in 12 papers, i.e. 9.8 percent of studies used in their sample. Of these studies 92 percent find a positive impact on growth, while the remaining 8 percent are inconclusive. Overall, the frequently identified importance of education for growth is confirmed. This is one of the rare robust findings.

Baldacci et al. (2004) use a system of equations and investigate direct and indirect channels between social spending, human capital and economic growth. In their empirical specification they analyse 120 developing countries during the period 1975-2000, and focus primarily on the impact of education and health spending by the government on growth. They argue that since education and health (as key pillars of human capital) are interlinked they should be analysed together, taking into account feedback effects. They find that both types of spending have a significant and positive direct impact on economic growth; more precisely, a one percentage point increase in education spending is associated with an increase in growth of 1.4 percentage points in 15 years, while the same increase in health spending raises annual per capita GDP growth by 0.5 percentage points.

Bose et al. (2007) explore the impact of disaggregated government expenditures on growth in 30 developing economies over the two decades: 1970-1979, and 1980-1989. They find that education is the key sector for growth; whereby a one percentage point increase in central government investment in education (as percentage of GDP) is found to be associated with an increase in real

GDP per capita of 1.5 percentage points. This finding is robust to inclusion of additional variables to the main regression, taking into account government budget constraint and endogeneity issues. Moreover, they find that aggregate current expenditures do not influence growth, whereas aggregate capital expenditures do.

Afonso and Gonzalez Alegre (2008) analyse a set of 27 EU countries during the period 1970-2006 and test whether government budget items reallocation influences long-term economic growth, total factor productivity and labour productivity, in turn. Using a dynamic panel data model with lags of explanatory variables they find that public consumption and social security contributions influence long-term growth negatively and while the impact of public investment is positive. Public expenditures in education are found to be growth-enhancing.

Sanz (2011) explores the link between 10 components of government spending and government size during the period 1970-2007 in 25 OECD countries. Starting from a premise that a government size reduction does not necessarily lead to a proportionate reduction in all its components Sanz (2011) sets out to investigate which components are cut first. Using a pooled mean group (PMG) approach he finds that reductions in overall government expenditures increase the share of education and transport and communication. On the other hand, social welfare spending reduces its share in aggregate government spending in times of budgetary cuts. Finally, economic affairs, defence, housing and cultural affairs are affected the most when faced with fiscal adjustments.

Acosta-Ormaechea and Morozumi (2013) investigate how government expenditures compositional changes affect long-run growth. They differ between economic and functional classification of expenditures. As far as economic classification in concerned, they find that an increase in capital expenditures, offset by a reduction in current spending, leads to an increase in long-run growth; *albeit* this finding is not robust. As for the functional distribution, their analysis of 56 low-, medium- and high-income countries during the period 1970-2010 reveals that only education has statistically significant growth-enhancing effects. This is quantitatively important mainly in the case a rise in spending on education is financed by a proportionate fall in spending on health or social protection. More precisely, a one percentage point increase in education spending is found to lead to 0.22 percentage points increase in annual growth if it is offset by a one percentage point fall in social protection spending, and 0.31 increase in annual growth if it is offset by a one percentage point fall in health spending. These findings are robust with respect to delayed fiscal policy effects, sample composition, addition of other explanatory variables and institutional coverage level of government.

Gemmell et al. (2014) investigate the influence of total government expenditures as well as of government expenditures composition on long-run GDP levels in (17) OECD countries. They emphasise that much of the existing literature on the topic does not take into account government budget constraint (GBC), i.e. the fact that expenditures have to be financed by revenues and deficits/surpluses, thus omitting an important variable with potential output effects. Using a pooled mean group (PMG) approach, and analysing the period 1972-2008, they find that, firstly, total government expenditures affect GDP negatively when financed by budget deficits. As for expenditures composition, they find that, under the assumption that total spending remains unchanged, increases in the share of transport and communication and education in GDP (offset by pro-rata reduction in other types of spending) lead to increases in GDP per capita in the long-run. Precisely, a one percentage point increase in the share of transport and communication in GDP is associated with an increase in GDP per capita of 2.2%. Similarly, a one percentage point increase in the share of education in GDP is associated with an increase in GDP per capita of 2%.

Afonso and Jalles (2014) analyse fiscal composition-growth nexus in a set of 155 developed and developing countries during the period 1970-2008. They find that total government expenditures have statistically significant negative effect on growth, while the impact of revenues is insignificant. As far as economic decomposition of expenditures is concerned, taxes on income, public wages, interest payments, subsidies and government consumption are found to be detrimental for growth. Finally, as regards functional decomposition, government spending on education and health are found to be growth enhancing, while expenditures on social security and welfare growth retarding.

4. Methodological approach and data

In estimating the relationship between government expenditure on education and growth we use a static panel model given that our sample consists of 28 (EU) countries and 10 years (2004-2013). The number of years is dictated by the fact that the empirical approach that will be used (spatial panel models) requires panels to be balanced, and the data for years prior to 2004 proved to be unobtainable in some cases. The variables included in the model comprise of typical growth regression variables: enrolment rates (Enrolment), investment (Investment) and population growth (Population)[1]. Additionally, the share of government revenues in GDP (Revenues (% GDP)) and the share of education spending in government expenditures (Education (% gov. exp.)) are included as our main variables of interest. Table 1 gives an overview of the variables used in terms of definition and data sources, while Table 2 presents their descriptive statistics.

Table 1 Definitions and sources of the variables

Variable	Indicator(s)	Source
GDP growth	GDP per capita growth (annual %)	World Bank
Enrolment	School enrolment, secondary (% gross)	World Bank
Population	Population growth (annual %)	World Bank
Investment	Gross fixed capital formation (% of GDP)	World Bank
Revenues (% GDP)	Total nominal general government revenue (% of GDP)	Eurostat
Education (% gov. exp.)	Government expenditure on education (% of total government expenditure)	Eurostat

Table 2 Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP growth	280	1.72	4.09	-17.95	12.23
Enrolment	280	103.54	10.70	79.95	165.58
Population	280	0.23	0.84	-3.10	2.89
Investment	280	22.28	4.19	11.21	36.75
Revenues (% GDP)	280	41.96	6.07	31.70	56.20
Education (% gov. exp.)	280	11.96	2.30	7.30	18.40

In order to get a preliminary idea of the differences in the average share of education spending among EU28 countries, Figure 1 depicts these shares divided into quartiles.

[1] It should be noted that initial GDP is also typically included in these regressions. However, given that the methodology that will be applied in this work is static (spatial) panel, inclusion of such a variable (that does not vary over years) is unfeasible (as it would act as a fixed effect).

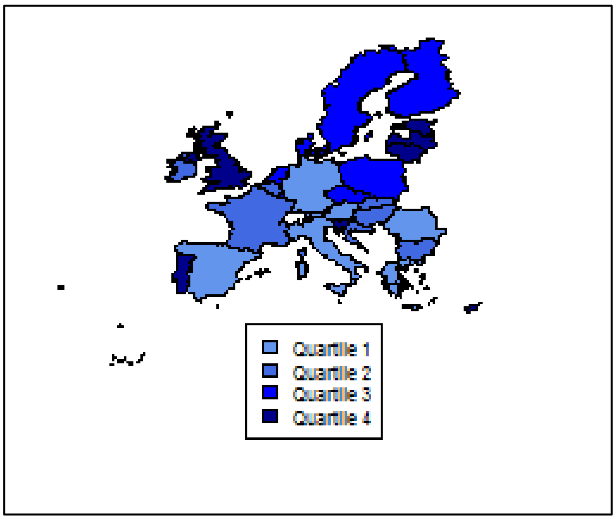

Figure 1 Average share of education spending in overall government expenditures during the period 2004-2013 in EU28

Source: Eurostat and author's calculations

Spatial issues

Recent years have seen a growing interest of mainstream econometrics on spatial statistical methods. As noted by Woolridge (2002), spatial dependence can occur in situations when cross section units are large relative to the population, such as when data are collected at the county, state, province or country level. In that case the outcomes from neighbouring units/countries are likely to be correlated. It is, therefore, reasonable to expect that growth rates and policy variables in one country in EU28 are correlated with growth rates and policy variables in neighbouring countries. As Elhorst (2014) highlights, in both the theoretical and the empirical literature on economic growth and convergence among countries or regions, the economic growth variable is expected to depend not only on the initial income level and the rates of saving, population growth, technological change and depreciation in their own economy, but also on those variables in neighbouring economies.

From the theoretical perspective, researchers have identified externalities, learning and coercion as the main causal mechanisms for spatial policy dependence. Furthermore, they have pointed to issues of heterogeneity in exposure and responsiveness to spatial effects (Neumayer and Plümper, 2012). However, recent advances in the field of spatial econometrics can hardly accommodate the need to empirically investigate the causal mechanisms through which policy choices become spatially dependent. Nonetheless, the spatial econometrics literature has exhibited a growing interest in the specification and estimation of econometric relationships based on spatial panels since the turn of this century (Elhorst, 2014).

Even though incorporating spatial effects into econometric modelling is gaining more and more attention in empirical literature, applications regarding government spending composition and growth nexus are practically inexistent, to the best of our knowledge. The main goal of this study is, therefore, to analyse the impact of government spending on education on growth paying special attention to the issue of possible spatial dependencies. The presence of spatial dependence renders traditional econometric techniques no longer appropriate for spatial data analysis, given that the assumption of independent and identically distributed observations is no longer valid. It is therefore crucial to use appropriate econometric techniques that deal with spatial interactions among geographical units. In this paper we apply spatial panel models that contain time-series observations of a number of geographical units (countries).

There are several possible specifications that take into account spatial dependence in the data. A general specification of spatial panel model is given as follows (Belotti et al., 2013):

$$y_{it} = \alpha + \tau y_{t-1} + \rho \sum_{j=1}^{n} w_{ij} y_{jt} + \sum_{k=1}^{K} x_{itk}\beta_k + \sum_{k=1}^{K} \sum_{j=1}^{n} w_{ij} x_{jtk}\theta_k + \mu_i + \gamma_t + \nu_{it} \qquad (1)$$

$$\nu_{it} = \lambda \sum_{j=1}^{n} m_{ij} \nu_{it} + \epsilon_{it},\ i=1,\ldots,N;\ t=1,\ldots,T$$

Where y_{it} is the dependent variable (GDP growth), x_{it} a set of independent variables (Enrolment, Population, Investment, Revenues (% GDP) and Education (% gov.exp.)), w_{ij} is a spatial weights matrix, μ_i is the individual fixed or random effect, γ_t is the time effect and ϵ_{it} is a normally distributed error term.

If $\tau = 0$ the model is static, while for $\tau \neq 0$ it is dynamic. If $\theta = 0$ the model is Spatial Autoregressive Model with Auto Regressive disturbances (SAC), if $\lambda = 0$ it is Spatial Durbin Model (SDM); if $\lambda = 0$ and $\theta = 0$ the model is Spatial Autoregressive Model (SAR); if $\rho = 0$ and $\theta = 0$ it is Spatial Error model (SEM), while if $\rho = 0$, $\theta = 0$ and $\mu_i = \phi \sum_{j=1}^{n} w_{ij}\mu_i + \eta_i$ it is Generalised Spatial Panel Random Effects Model (GSPRE).

One of the key issues in spatial econometrics literature is the shape i.e. definition of the spatial weights matrix. In general, it is a *N* by *N* positive and symmetric matrix which expresses for each observation (row) those locations (columns) that belong to its neighbourhood, set as nonzero elements (Anselin and Bera, 1998). There are various options regarding the shape of this matrix, some of which take into account only geographical proximity of the units under investigation, while some other account also for social, economic and similar linkages. Since the majority of the literature assumes that geographic measures are decisive in determining the degree of interaction across countries, in our baseline specification we use 1-nearest neighbour spatial weights matrix. Later on we test the robustness of our results by changing the definition of this matrix.

5. Results

Before embarking upon estimation of equation (1) we undertake the Pesaran's test for cross-sectional dependence. Namely, it is to be expected that countries are cross-correlated due to the economic and financial integration of countries and financial entities and/or common macroeconomic shocks. Ignoring these cross-correlations results in inefficient parameter estimates and is likely to lead to size distortions of conventional tests of significance. As can be seen from Table 3, in all the cases, except for population growth variable, the null of cross-sectional independence is rejected.

Table 3 Test for cross-sectional dependence

Variable	CD-test	p-value
GDP growth	47.53	0.000
Enrolment	18.07	0.000
Population	0.15	0.879
Investment	35.72	0.000
Revenues (% GDP)	9.55	0.000
Education (% gov. exp.)	6.45	0.000

Spatial dependence is a special case of cross-sectional dependence in the sense that spatial dependence occurs when cross-sectional correlations follow a certain type of spatial ordering which characterises the neighbour relation. We, therefore, test for the existence of this dependence and find (results are unreported but available upon request) that there is, indeed, spatial autocorrelation in both error and spatial lagged dependent variable. Application of spatial econometric techniques is, therefore, justifiable.

Table 4 provides an estimation of all the mentioned types of spatial models as given by equation (1), with w_{ij} created as a row-standardized 1-nearest neighbour spatial weights matrix of the size (28x28). It should be stressed that columns (5) and (6) both refer to SDM model, whereby in column (5) all the regressors are spatially lagged whereas in column (6) only the share of government spending on education in total expenditures is assumed to be spatially lagged. The main estimation results are given in the first part of Table 4, while direct and indirect spillover effects are given in the lower part of the table.

As noted by LeSage and Page (2009), interpretation of the obtained coefficients is not as straightforward as in linear regressions, since spatial regression models additionally include information from neighbouring regions/observations. In these models one can differentiate between “direct” and “indirect” effects, while the “total “ average effect of a change in an independent variable on the dependent variable is the combination of the two (LeSage and Pace, 2009). The indirect effect measures the influence on GDP growth of a certain country of changes in other countries’ explanatory variables. The general pattern that arises from Table 4 is as follows. Firstly, the differences between direct effects and the coefficient estimates are relatively small. This is not an uncommon finding (see Elhorst, 2014). Secondly, the differences between direct effects of different models are relatively small (we comment only statistically significant results); however, the differences between indirect or spillover effects are larger and differ in terms of sizes, signs and significances. More precisely, the direct average effect of enrolment rates is negative and significant (in SDM and SAR models), and so is the indirect average effect (in SAR), suggesting a negative spillover effect on GDP growth from higher enrolment rates in neighbouring countries. Population is found to be mostly insignificant, while Investment is found to have a significant direct as well as indirect effect on growth, and this effect is positive.

The share of revenues in GDP is found to have significant direct and indirect effect on growth, and this impact is negative. Finally, the share of education in government expenditures (our main variable of interest) is found to have a significant positive effect; both direct and indirect.

Overall, indirect effects have a large impact accounting for, on average, 40 percent of the total effect. This finding indicates that fundamentals in other (neighbouring) countries have significant spatial spillover effects.

Table 4 Estimation results

	(1)	(2)	(3)	(4)	(5)	(6)
W=Knn(1)	**SAC**	**SDM (all)**	**SDM(edu)**	**SAR**	**SEM**	**GSPRE**
Main						
Enrolment	-0.00577	-0.0365*	-0.0219	-0.0315*	-0.0333*	-0.0391*
	(0.0184)	(0.0189)	(0.0179)	(0.0169)	(0.0183)	(0.0159)
Population	-0.216	0.199	0.376*	0.465**	0.134	0.183
	(0.263)	(0.235)	(0.227)	(0.218)	(0.227)	(0.196)
Investment	0.365***	0.251***	0.204***	0.178***	0.283***	0.243***
	(0.0582)	(0.0535)	(0.0450)	(0.0415)	(0.0521)	(0.0413)
Revenues (% GDP)	-0.137**	-0.0984***	-0.0606*	-0.0621*	-0.0936**	-0.123***
	(0.0616)	(0.0360)	(0.0338)	(0.0333)	(0.0383)	(0.0362)
Education (% gov. exp.)	0.153	0.238***	0.244***	0.231***	0.195**	0.182***
	(0.147)	(0.0840)	(0.0822)	(0.0808)	(0.0847)	(0.0701)
_cons		-1.649	-0.230	-0.252	0.449	3.301
		(2.755)	(2.467)	(2.469)	(2.999)	(2.487)
Spatial						
ρ	-0.284***	0.592***	0.554***	0.550***		
	(0.0680)	(0.0287)	(0.0291)	(0.0293)		
λ	0.747***				0.604***	0.597***
	(0.0323)				(0.0281)	(0.0286)
φ						-2.735
						(1.839)
Variance						
lgt_θ	3.309***				4.514***	
	(0.352)				(0.432)	
sigma_e		1.115	0.948*	1.040*		
		(0.684)	(0.554)	(0.592)		
sigma2_e		4.637***	5.083***	5.169***		2.203***
		(0.448)	(0.482)	(0.490)		(0.101)
ln_φ					-2.398***	
					(0.661)	
sigma_mu						0.184
						(0.120)
Direct						
Enrolment	-0.00632	-0.0420**	-0.0278	-0.0397**		
	(0.0163)	(0.0197)	(0.0191)	(0.0178)		

Population	-0.206	0.219	0.495	0.603**		
	(0.303)	(0.327)	(0.321)	(0.302)		
Investment	0.383***	0.263***	0.258***	0.224***		
	(0.0617)	(0.0688)	(0.0601)	(0.0525)		
Revenues (% GDP)	-0.144**	-0.0760*	-0.0763*	-0.0776*		
	(0.0615)	(0.0397)	(0.0404)	(0.0390)		
Education (% gov. exp.)	0.187	0.275**	0.248**	0.308***		
	(0.149)	(0.122)	(0.111)	(0.100)		
Indirect						
Enrolment	0.00146	-0.0189	-0.0218	-0.0311**		
	(0.00420)	(0.0327)	(0.0153)	(0.0142)		
Population	0.0512	0.00978	0.394	0.472**		
	(0.0783)	(0.391)	(0.263)	(0.240)		
Investment	-0.0925***	0.0388	0.203***	0.174***		
	(0.0243)	(0.0769)	(0.0510)	(0.0387)		
Revenues (% GDP)	0.0348*	0.0807	-0.0604*	-0.0606*		
	(0.0177)	(0.0653)	(0.0334)	(0.0309)		
Education (% gov. exp.)	-0.0468	0.0763	-0.0471	0.242***		
	(0.0409)	(0.219)	(0.196)	(0.0854)		
Total						
Enrolment	-0.00486	-0.0609	-0.0496	-0.0708**		
	(0.0123)	(0.0472)	(0.0343)	(0.0318)		
Population	-0.155	0.229	0.888	1.074**		
	(0.229)	(0.667)	(0.583)	(0.540)		
Investment	0.291***	0.302**	0.460***	0.398***		
	(0.0572)	(0.133)	(0.110)	(0.0894)		
Revenues (% GDP)	-0.109**	0.00472	-0.137*	-0.138*		
	(0.0479)	(0.0918)	(0.0736)	(0.0695)		
Education (% gov. exp.)	0.140	0.351	0.201	0.549***		
	(0.112)	(0.326)	(0.289)	(0.184)		
Wx						
Enrolment		0.0146				
		(0.0180)				
Population		-0.121				
		(0.206)				
Investment		-0.120***				
		(0.0452)				
Revenues (% GDP)		0.102***				
		(0.0388)				
Education (% gov. exp.)		-0.108	-0.151			
		(0.0909)	(0.0980)			
N	280	280	280	280	280	280

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Stata command *xsmle* is used for all computations.

Robustness checks

As a robustness check we use different weights matrices. In Table 5 we provide the results of using row-standardized 3-nearest neighbour spatial weight matrix, while in Table 6 inverse distance squared spatial weights matrix is used. For space preservation reasons we provide the results of direct and indirect effects only (and hence do not report the results of SEM and GSPRE models, as these do not differentiate between these effects).

Table 5 Robustness check with row-standardized 3-nearest neighbour spatial weights matrix

	(1)	(2)	(3)	(4)
W=Knn(3)	**SAC**	**SDM (all)**	**SDM(edu)**	**SAR**
Direct				
Enrolment	-0.0232	-0.0500***	-0.0335**	-0.0365**
	(0.0186)	(0.0193)	(0.0171)	(0.0165)
Investment	0.442***	0.295***	0.259***	0.249***
	(0.0634)	(0.0651)	(0.0544)	(0.0508)
Population	-0.224	0.238	0.328	0.375
	(0.316)	(0.308)	(0.278)	(0.262)
Revenues (% GDP)	-0.111	-0.0595	-0.0645*	-0.0689*
	(0.0745)	(0.0390)	(0.0392)	(0.0373)
Education (% gov. exp.)	0.0693	0.132	0.168*	0.172**
	(0.180)	(0.110)	(0.0894)	(0.0863)
Indirect				
Enrolment	0.00807	0.00993	-0.0569*	-0.0615**
	(0.00690)	(0.0929)	(0.0304)	(0.0290)
Investment	-0.155***	0.0569	0.443***	0.416***
	(0.0335)	(0.210)	(0.109)	(0.0947)
Population	0.0777	-0.113	0.573	0.620
	(0.114)	(1.249)	(0.509)	(0.440)
Revenues (% GDP)	0.0394	-0.212	-0.111	-0.115*
	(0.0287)	(0.254)	(0.0721)	(0.0639)
Education (% gov. exp.)	-0.0247	0.185	0.0186	0.290*
	(0.0651)	(0.438)	(0.330)	(0.149)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Stata command *xsmle* is used for all computations.

Table 6 Robustness check with inverse distance squared spatial weights matrix using projected latitudes and longitudes

	(1)	(2)	(3)	(4)
W=inv_sq	**SAC**	**SDM (all)**	**SDM(edu)**	**SAR**
Direct				
Enrolment	-0.0131	-0.0437*	-0.0392**	-0.0302
	(0.0233)	(0.0251)	(0.0190)	(0.0192)
Investment	0.496***	0.347***	0.335***	0.320***
	(0.0733)	(0.0677)	(0.0623)	(0.0604)
Population	-0.319	0.208	0.361	0.492
	(0.433)	(0.420)	(0.320)	(0.317)
Revenues (% GDP)	-0.0750	-0.0369	-0.0538	-0.0625
	(0.105)	(0.0564)	(0.0451)	(0.0467)
Education (% gov. exp.)	0.238	0.221	0.198*	0.226**
	(0.235)	(0.146)	(0.102)	(0.108)
Indirect				
Enrolment	-0.0121	-0.0780	-0.0756*	-0.0558
	(0.0245)	(0.174)	(0.0436)	(0.0383)
Investment	0.425	0.365	0.654***	0.590***
	(0.306)	(0.285)	(0.213)	(0.201)
Population	-0.272	0.256	0.740	0.886
	(0.461)	(2.696)	(0.747)	(0.621)
Revenues (% GDP)	-0.0734	0.0833	-0.107	-0.113
	(0.182)	(0.382)	(0.103)	(0.0892)
Education (% gov. exp.)	0.213	0.154	0.103	0.418*
	(0.337)	(0.885)	(0.233)	(0.231)

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Stata command *xsmle* is used for all computations.

The results from Tables 5 and 6 are relatively similar to those of Table 4. In SAR model indirect effects of education share in overall expenditures is found to be quite large, and amounts to over 60 percent of total effect.

Overall, our results regarding fiscal policy variables indicate that an increase in government revenues share in GDP by 1 percentage point lowers annual growth by 10.9 to 18.39 basis points, depending on model specification. This negative impact is in line with the findings of relevant studies investigating the impact of government size on growth (see, for example, Fölster and Henrekson, 2001; Romero-Ávila and Strauch, 2008; Afonso and Furceri, 2010 and Berg and Karlsson, 2010, to name a few). The size of this effect, however, is larger in our study, as indirect effects are additionally taken into account. As for our main variable of interest, our results indicate that an increase in the share of government expenditures on education in overall expenditures by 1 percentage point increases annual GDP growth by 46.2 to 64.4 basis points. Within this, 24.2 to 41.8 basis points can be attributed to indirect effects. Overall, therefore, the results show significant spillovers across EU28, and these spillovers are especially important when it comes to fiscal policy variables and investment.

6. Conclusion

This paper analyses the impact of government spending on education (i.e. a productive type of government spending) on GDP growth in EU28 countries during the period 2004-2013. It extends previous literature on the topic in that it uses a novel econometrics technique that allows for spatial effects. Namely, it is possible that GDP growth in one country depends not only on independent variables within that country but also on variables from neighbouring countries. If this is the case, traditional (a-spatial) econometric techniques are not appropriate, as the assumption of independent and identically distributed observations is no longer valid. In spite of the fact that spatial econometric techniques are developing fast and gaining more importance, such approach has not been applied to the relationship between government education spending and growth as yet.

Studies investigating the relationship between total government size and growth typically find this relationship to be negative. Indeed, this is confirmed by our results whereby the impact of government revenues is found to be negative. More precisely, an increase in government revenues share in GDP by 1 percentage point is found to be associated with a fall in annual growth of 10.9 to 18.39 basis points. From this point of view, and having in mind the fact that policy makers are trying to restrain the growth of overall government expenditures, the only solution seems to be re-structuring of the given size of the government. Theory posits that government spending on education has a positive impact on growth, and should, as such, be stimulated. The main goal of this paper, therefore, was to investigate whether this part of overall spending is indeed growth-enhancing in EU28 countries, especially after spatial correlations among the countries in the sample are taken into account. Our results confirm this, i.e. we find that government spending on education significantly and positively influence GDP growth. An increase in the share of government expenditures on education in overall expenditures by 1 percentage point is found to increase GDP growth by 46.2 to 64.4 basis points. Moreover, indirect effects are quite large and account for 40 to 60 percent of the total effect. The omission of spatial spillovers on neighbouring countries, therefore, drastically underestimates the impact of changes in fundamentals.

References

Acosta-Ormaechea, S. and Morozumi, A. 2013. Can a Government Enhance Long-run Growth by Changing the Composition of Public Expenditure? *IMF Working Paper* WP/13/162

Afonso, A., Ebert, W., Schuknecht, L. and Thone, M. 2005. Quality of Public Finances and Growth. *ECB Working Paper* No. 438

Afonso, A. and Gonzalez Alegre, J. 2008. Economic growth and budgetary components. A panel assessment for the EU. *ECB Working Paper* 848.

Afonso, A. and Jalles, J. 2014. Fiscal composition and long-term growth. Applied Economics, Vol. 46 (3), 349-358.

Afonso, A., Furceri, D. 2010. Government Size, Composition, Volatility and Growth. *European Journal of Political Economy*, 26, 517-532.

Anselin, L. and Bera, J. 1998. Spatial dependence n linear regression models with an introduction to spatial econometrics in Ullah A. and D. Giles (eds) Handbook of Applied Economic Statistics New York: Marcel Dekker, 237-289.

Anselin, L., and Griffith D. 1988. Do Spatial Effects Really Matter in Regression Analysis? *Papers of the Regional Science Association*, Vol. 65, 11-34

Baldacci, E., Clements, B., Gupta, S. and Qiang, C. 2004. Social Spending, Human Capital, and Growth in Developing Countries: Implications for Achieving MDGs. *IMF Working Paper* WP/04/217

Barro, R. 1990. Government spending in a simple model of endogenous growth. *Journal of Political Economy*, Vol. 98, S103-S117.

Beauchemin, K. 2001. Growth or stagnation? The role of public education. *Journal of Development Economics*, Vol. 64, 389-416.

Belotti F., Hughes G. and Piano Mortari A. 2013. XSMLE - A Command to Estimate Spatial Panel Models in Stata. 2013 German Stata Users Group Meeting, Potsdam, June 7th

Berg, A. and Karlsson, M. 2010. Government Size and Growth: Accounting for Economic Freedom and Globalization. *Public Choice*, Vol. 142, 195–213.

Blankenau, W. and Simpson, N. 2004. Public education expenditures and growth. *Journal of Development Economics*, Vol. 73, 583-605

Blankenau, W., Simpson, N. and Tomljanovich, M. 2007. Public education expenditures, taxation and growth: Linking data to theory. *American Economic Review*, Vol. 97(2), 393-397

Bleaney, M., Gemmell, N. and Kneller, R. 2001. Testing the endogenous growth model: public expenditure, taxation, and growth over the long run. *Canadian Journal of Economics*, Vol. 34(1), 36-57.

Bose, N., Haque, E. and Osborn, D. 2007. Public expenditure and economic growth: a disaggregated analysis for developing countries. *The Manchester School*, Vol. 75 (5), 533-556.

Colombier, C. 2011. Does the composition of public expenditure affect economic growth? Evidence from the Swiss case. *Applied Economics Letters*. Vol. 18, 1583-1589.

Eckstein, Z. and Zilcha, I., 1994. The effects of compulsory schooling on growth, income distribution and welfare. *Journal of Public Economics,* Vol. 53, 339–359.

Elhorst, P. 2014. Spatial Econometrics. From Cross-Sectional Dana to Spatial Panels. Springer, London.

European Commission. 2010. "*Europe 2020 - A European strategy for smart, sustainable and inclusive growth". Communication from the Commission, European Commission, Brussels (http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%2 0-%20Europe%202020%20-%20EN%20version.pdf).

Fölster, S. and Henrekson, M. 2001. Growth Effects of Government Expenditure and Taxation in Rich Countries. *European Economic Review*, Vol. 45 (8), 1501–1520.

Gemmell, N. 1996. Evaluating the impacts of human capital stocks and accumulation on economic growth: some new evidence. *Oxford Bulletin of Economics and Statistics*, Vol. 58 (1), 9-28.

Gemmell, N., Kneller, R. and Sanz, I. 2014. Does the Composition of Government Expenditure Matter for Long-run GDP Levels? University of Wellington, *Victoria Business School Working Paper* 10/2014.

Glomm, G. and Ravikumar, B., 1992. Public versus private investment in human capital: endogenous growth and income inequality. *Journal of Political Economy,* Vol. 100, 818– 834.

Glomm, G. and Ravikumar, B., 1997. Productive government expenditures and long-run growth. *Journal of Economic Dynamics and Control,* Vol. 21, 183–204.

Glomm, G., Ravikumar, B., 1998. Flat-rate taxes, government spending on education, and growth. *Review of Economic Dynamics,* Vol. 1, 306–325.

Kaganovich, M. and Zilcha, I., 1999. Education, social security and growth. *Journal of Public Economics,* Vol. 71, 289– 309.

Kneller, R., Bleaney, M. and Gemmell, N. 1999. Fiscal policy and growth: evidence from OECD countries. *Journal of Public Economics*, Vol. 74, 171-190.

LeSage J.P. and Pace R.K., 2009. Introduction to Spatial Econometrics. Chapman and Hall/CRC

Lucas, R., 1988. On the mechanics of economic development. *Journal of Monetary Economics,* Vol. 22, 3–42.

Mankiw, G., Romer, D. and Weil, D. 1992. A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics*, Vol. 107, 407–37.

Neumayer, E. and Plümper, T. 2012. Conditional Spatial Policy Dependence: Theory and Model Specification. *Comparative Political Studies*, Vol. 45 (7), 819-849.

Nijkamp, P. and Poot, J. 2004. Meta-analysis of the effect of fiscal policies on long-run growth. *European Journal of Political Economy*, Vol. 20 (2004), 91-124.

Romer, P. 1990. Endogenous technological change. *Journal of Political Economy*, Vol. 98 (5), S71-S102.

Romero-Ávila, D. and Strauch, R. 2008. Public finances and long-term growth in Europe: Evidence from a panel data analysis. *European Journal of Political Economy,* Vol. 24, 172-191.

Sanz, I. 2011. What Do OECD Countries Cut First When Faced with Fiscal Adjustments?. *Southern Economic Journal*, Vol. 77 (3), 753-775.

Solow, R. 1956. A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, Vol. 70, 65-94.

Wooldridge, J. 2002. Econometric Analysis of Cross Section and Panel Dana, MIT Press