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Education, public expenditure and economic
growth under the prism of performance

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Declarations of interest

None

Abstract

Recursively in the literature, public spending on education is found to have an ambiguous impact on economic growth. Using World Development Indicators from the World Bank, we revisit an endogenous growth model from [Blankenau et al. \(2007\)](#), over the last thirty years. Considering the fiscal effect, we analyse the empirical relationship between public spending on education and economic development.

Despite having a positive and significant impact on the overall group of 65 countries belonging to upper-middle and high-income countries, our main results are not robust to sub-groups, focusing on the economic development. Once we control for the performance of public expenditure, to effectively generate human capital, we find a positive and significant impact from increasing expenditure on education, in what we call "performing countries". Our results demonstrate that increasing spending on education cannot be growth enhancing without considering the prism of performance.

Keywords:

Education; Endogenous growth; Fiscal policy; Performance

JEL codes:

H52, O11, O47,

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1 Introduction

In the recent report from the European Commission, education and skill-related reforms and investments are expected to account for about 13 percent of the Recovery and Resilience Facility launched as part of the NextGenerationEU post-Coronavirus recovery assistance (Commission et al., 2021). According to the EU-level targets for 2030, EU member states plan to foster their engagement in education. To respond to a more inclusive society, four main objectives are designed, decreasing underachievement, increasing early childhood education and care, reducing early leavers from education and training and increasing tertiary level attainment.

In the context of the EU-2020 strategy, smart growth objectives already included an increase in the share of the population aged 30-34 with tertiary education to at least 40 percent. The new target of 45 percent has been defined to meet the increasing demand for a more skilled labour force (Falk and Biagi, 2017). In 2019, the EU-2020 objective was reached (40.7% on average) but with some international disparities according to the national specific targets. For example, Hungary and Romania did not get their target by 2020 while Poland over-performs. During the last 20 years, the tertiary-educated population increased in all countries inside the EU. The highest changes are observed in the Czech Republic and Slovakia.¹

Investment in education is correlated to the role of well-being and human capital in economic growth. According to Commission et al. (2018), a better-educated labour force leads to an efficient labour demand-supply matching process, increasing intersectoral flexibility, and inducing better economic performance and growth.

1. Source: Eurostat, tertiary educational attainment by sex, age group 30-34, code [t2020_4]

One may wonder whether increasing the educational attainment has been useful to increase human capital and generate smarter economic growth.

In the growth literature theory and more specifically looking at the role of the government, we try to put some new insights to understand the impact of increasing human capital on economic growth. The main purpose of this paper is to clarify the interactions between economic development and public spending on education, under the assumption that to increase human capital, education funding may have a detrimental effect.

Our paper contributes to the literature from an empirical view. Using the endogenous growth literature, we update [Blankenau and Simpson \(2004\)](#) and [Blankenau et al. \(2007\)](#) to dig deeper into the contemporaneous relationship between public spending and human capital formation. The literature highlights the human capital measure issue [Krueger and Lindahl \(2001\)](#). We choose a recent work from [Lim et al. \(2018\)](#) who computed a multidimensional index, considering education and health to transcript the human capital evolution.

Finally, by introducing a performance measure, using data envelopment analysis, à la [Ji and Lee \(2010\)](#), we complete recent research from [Neycheva \(2010, 2019\)](#) on public education expenditure and human capital quality. Our performance measure captures the public spending's ability to generate human capital, such that we can explain the lack of a significant impact, from public spending on education to GDP.

We estimate our growth equation, using an LSDV estimator, over a sample of 65 countries belonging to upper-middle and high-income economies. We revisit the equation from [Blankenau et al. \(2007\)](#), with World Development Indicators from

the World Bank, over the last thirty years, with five-year periods of average data. We consider public spending and its inherent fiscal counterpart plus a proxy for the human capital level. We first find an overall positive and significant impact of education expenditure on economic growth. However, looking at income subgroups, the results are more mitigated. We omit the 1990s as most countries in upper-middle income are countries in transition, suffering transitional structural shocks.

The introduction of performance in the model restores the positive and significant relationship between public spending and GDP only in countries with a relatively high-performance level. Our results support the idea that increasing public spending on education, per se, is not sufficient to generate the human capital inherent to observing the GDP increase. A coherent education policy should come with public spending, to avoid any disconnection between human capital and budgetary policy. We provide some statistics on European countries to put forward some common characteristics observable in performing countries. Tertiary education expenditure, to a lesser, extend secondary education, seems to be relatively higher in those countries once controlled for GDP, students and demographic evolution.

The section 2 of the paper presents the related literature. In sections 3, 4 and 5 we present the empirical approach, the data and our results. Section 6 develop the role of performance in public spending on education and section 7 concludes.

2 Literature review

Since the seminal contributions from [Lucas \(1988\)](#) or [Mankiw et al. \(1992\)](#), the literature agrees on the role of human capital as a production factor, to gener-

ate economic growth (Tsamadias and Prontzas, 2012). A better educated labour force is expected to foster innovation (Nelson and Phelps, 1966; Benhabib and Spiegel, 1994). Benhabib and Spiegel (2005) highlight the double role of education, increasing human capital, as an inherent component of innovation but also increasing knowledge flows among economies. Recently, with an original dataset from UNESCO, Valero and Van Reenen (2019) confirms the spillovers effect through innovation, associated with the higher supply of human capital.

Education is highly correlated with higher resilience in the labour market and is a significant component of economic growth and employment (Riddell and Song, 2011; Woessmann, 2016).

However, the way education is financed generates a deeper debate, depending on education funding issue (Cashin, 1995; Kneller et al., 1999; Benos, 2010) and on its composition (Acemoglu et al., 2006; Zhang and Zhuang, 2011; Agénor and Canuto, 2015).

The public intervention is mostly justified by market imperfections in terms of access to education (high private costs) and by human capital spillovers with global social impacts not considered at the individual level with possible underinvestment into education.² Increasing public education expenditure, at the expense of less productive expenditures improves school attainment (Gupta et al., 2002). Besides the justification of the state intervention, financing education, particularly through public spending may dampen the long-run economic impact of increasing human capital (Glomm and Ravikumar, 1992; Kaganovich and Zilcha, 1999; Dissou et al., 2016). Annabi (2017) find a negative impact of public spending on the generation

2. See Plank and Davis (2020) for a comprehensive analysis of the state intervention in education.

supporting the higher share of the policy shock. [Gamlath and Lahiri \(2018\)](#) deal with the substitution effect between public and private spending to apprehend heterogeneity in the overall education funding economic impact.

[Blankenau et al. \(2007\)](#) reconcile the theory of endogenous growth and the link between education expenditure and economic growth with empirical data. They use the overlapping generation model from [Glomm and Ravikumar \(1997\)](#) and [Blankenau and Simpson \(2004\)](#) with adjustments through taxation to conclude the positive interactions between education and growth, at least in high-income countries. [Bose et al. \(2007\)](#) and [Afonso and Jalles \(2014\)](#), considering the state budget constraint and the fiscal composition, find that education spending is significantly associated with growth. [Gemmell et al. \(2016\)](#), looking at OECD countries, examine the long-run GDP impacts of changes in the shares of different government spending categories and converge to the idea that investment into infrastructure and education boost the GDP.

Behind the public spending on education lies in the assumption that PSE effectively generates human capital (output) and that we observe a global economic impact (outcome) ([Canton et al., 2018](#)). From [Mandl et al. \(2008\)](#), the performance of overall public spending may be decomposed into "technical efficiency" where spending generates the designed output and then "effectiveness" by observing the general outcome.

[Lu \(2018\)](#) and [Gamlath and Lahiri \(2018\)](#) detail the importance of public schooling quality. These two studies suggest that if the share of unproductive public education spending is too high, then private schooling may increase. This asset high-jacking hampers more productive private investment (e.g. toward tertiary

education). Moreover, an incoherent education investment policy will not stimulate "knowledge network externalities" (Agénor and Canuto, 2015), leading to a low-growth trap issue, characterized by a misallocation of talents. This relatively high level of over(under)education mismatch has consequences on wages and the labour market in general (Leuven and Oosterbeek, 2011; Neycheva, 2019).

The empirical literature tries to highlight how efficient public spending is (Agasisti, 2014; Dutu and Sicari, 2016). Using efficiency scores, within a two-stage approach, Antonelli and De Bonis (2019) highlight structural factors explaining higher efficiency in public social expenditure such as GDP, population, and corruption level. In terms of public spending on education efficiency, Canton et al. (2018) use three dimensions of efficiency, meaning quantity effect (tertiary educational attainment), quality effect (PISA science scores) and inclusiveness through total PSE and NEETs (Neither in employment education nor training young population rate). Within the European Union, they find ways for improvements in almost every country (compared to the common EU frontier and/or to the country-specific frontiers).

3 Empirical approach

3.1 The model

In this section we revisit Blankenau and Simpson (2004) and Blankenau et al. (2007) and estimate a structural equation derived from Blankenau et al. (2007).³

3. You may find a detailed description of the model on appendix A

$$y_{nt} = \beta_0 y_{nt-1} + \beta_1 e_{nt} + \beta_2 p_{n,t} + \beta_3 \tau_{n,t} + \beta_4 b_{n,t} + \beta_5 h_{n,t} + \eta_n + \delta_t + \mu_{n,t} \quad (3.1)$$

While y refers to the GDP per capita, the main interest variable is e and corresponds to the government expenditure on education (PSE). To avoid any misinterpretation in the PSE coefficient, we control for global government expenditure, p , measured as the government's final total expenditure, excluding education expenditure. The introduction of total government expenditure isolates the education expenditure impact on economic development. Moreover, it considers the possible implicit increase in overall expenditures following an increase in education expenditure. According to [Blankenau and Simpson \(2004\)](#), countries tend to have a higher level of non-education per capita expenditure when they face larger per capita education spending. As another control variable, we introduce the stock of human capital measured by h .

As suggested by the literature, the introduction to the model, of the government expenditure, implies looking at the way they are financed. Indeed, the way public education expenditures are financed may have a direct impact on growth. While we expect public spending to positively affect economic growth, required taxes to finance such expenditures may be detrimental, such that the overall impact is mitigated, at least ambiguous ([Blankenau and Simpson, 2004](#)). The fiscal part of this equation considers either fiscal revenue (denoted by τ) and the government budget surplus (denoted by b).

A country (η) and a time (δ) fixed effects allow individual and temporal heterogeneity. An error term (μ), following the usual characteristics, closes our empirical specification.

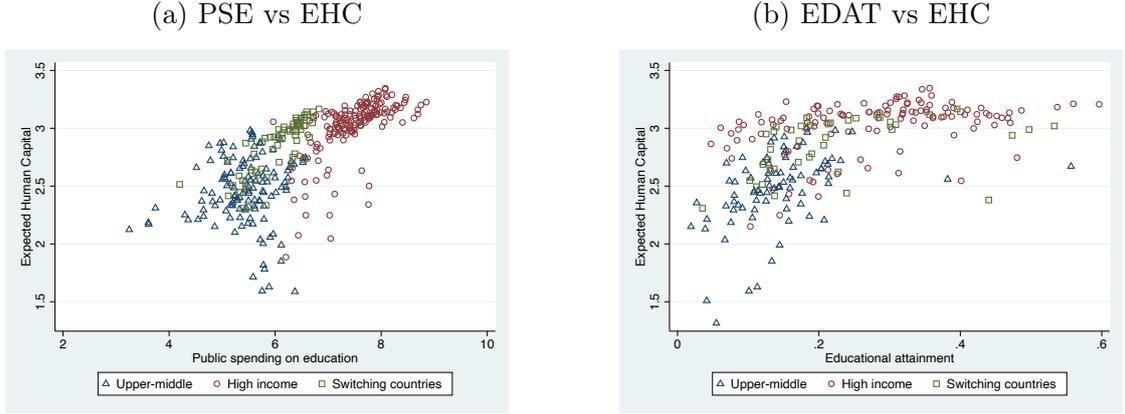


Figure 1 – Human capital in the light of public spending and educational attainment

Notes: The left-hand side figure presents public spending on education versus the Expected Human Capital index from [Lim et al. \(2018\)](#) by income countries level. On the right-hand side switch PSE to tertiary educational attainment (population aged 25 and over with at least upper secondary education). Three groups of countries are considered: upper-middle-income countries and high income (back to 1990) and countries that, over the period, switched from upper-middle to high income (World Bank ranking).

3.2 Performance

From equation [A.1](#) in [Blankenau et al. \(2007\)](#), the agent is endowed with public education and the human capital of the previous generation to explain human capital accumulation. From figures [1a](#) and [1b](#), no clear pattern emerges in the relationship that may exist between increasing PSE or educational attainment with the Expected Human Capital index (EHC) from [Lim et al. \(2018\)](#). The EHC index is a convenient multidimensional measure of human capital as it considers a large panel of countries over the 1990-2016 period.⁴

Back to Eq. [A.6](#), we could think about an efficient investment toward human capital such that a share of $\tilde{e}Y$ is actually transferred into g i.e., non-productive

4. See Appendix [D](#) to get details about the expected human capital index.

expenditures. From now, $\tilde{e}Y$ refers to *efficient* education expenditure.

To capture this *efficiency* in public education expenditure, we use Data Envelopment Analysis (DEA) technique from [Ji and Lee \(2010\)](#), to generate a new variable. The DEA process, commonly used in the literature ([Waldo, 2007](#); [Agasisti, 2011](#)) by comparison with the best producer, measures the efficiency of the decision-making unit (DMU). We focus on the input-oriented model, to minimize our input with a given output level. This makes sense if we consider that the government strategy is to reach a certain level of human capital and wish to minimize public spending to attain this goal.⁵ We use the public spending on education and health as the input and the measure from [Lim et al. \(2018\)](#) for the output.⁶

Table 1 – Efficiency statistics

	Mean	Std. Dev.	Min	Max	Countries	Periods
Upper-middle income	0.43	0.12	0.15	0.81	41	13.4
High income	0.70	0.14	0.21	1	48	17.8

To allow for the best estimation of PSE performance, we run our DEA process on the overall sample of countries belonging to lower middle, upper-middle- and high-income countries.

We obtain a new variable, named performance, which orders every country-year

5. Another strategy would be to get the maximal human capital level, with public spending as given. This is the output-oriented strategy. As described in the introduction, in the EU context, the EU-2020 strategy determines the human capital target such that we consider the input-oriented model. We tried the output-oriented model and the results remain unchanged; our DEA output is coherent with the use of the Malmquist index in technical efficiency, considering the panel dimension.

6. We introduce health expenditure as an additional input because the Expected Human Capital index from [Lim et al. \(2018\)](#) is constructed on health and education.

observation. Statistical details of this new variable are available in table 1. We use this proxy for performance to construct two sub-groups of countries. Countries with an average public expenditure performance, from 2010 to 2015, below the median, are considered as non-performing countries; performing otherwise.⁷

4 Data and descriptive statistics

Like in Blankenau et al. (2007), we use World Development Indicators (WDI) from the World Bank database.⁸ We focus on the 1990-2018 period. Despite being interested in the European context, our empirical approach, for the evident reason of getting more robust results, handles with a worldwide sample.

To reduce the panel heterogeneity bias, we restrict our panel to upper-middle-income and high-income countries as defined by the World Bank (last ranking available). This last point gives some credibility as the theoretical model is built upon a deviation from the steady state which is a strong assumption in the case of lower-income countries. We perform the performance dichotomy, using the efficiency variable defined as before. The exact list of countries considered in our sample is available in appendix B.

The table 2 presents the main statistics of our variables. The real GDP per capita is higher in performing countries (on average 33653 dollars a year against almost 10746 in the non-performing group). If we focus on the period from 2000 to 2018, the real GDP per capita growth rate is relatively higher in the non-performing

7. We do not refer here to efficient countries as we've seen before that efficiency consider the output; as we want to disentangle the overall outcome, we prefer the terms "performance" and/or "effectiveness" as used in Mandl et al. (2008)

8. The exact definition of the variables is available in appendix D, using World Bank definition.

Table 2 – Descriptive statistics

Non-performing countries				
	Mean	Std. Dev.	Min	Max
GDP	10746	12754	866	107638
Gov. Cons. X	11.03	4.17	1.82	28.37
Gov. Cons. Educ	4.06	1.21	0.70	7.23
Taxation	5.44	3.68	0	41.14
Gov. Budget	-2.01	3.96	-12.71	19.56
Human Capital	13.24	3.87	4.36	26.3
Performing Countries				
	Mean	Std. Dev.	Min	Max
GDP	33653	18026	2075	92077
Gov. Cons. X	14.58	3.22	5.74	24.94
Gov. Cons. Educ	5.26	1.08	2.04	7.97
Taxation	7.84	3.49	1.01	23.08
Gov. Budget	-1.38	4.43	-13.02	19.67
Human Capital	21.80	2.29	16.82	28.4

The table presents each variable by sub-group of countries. GDP represents the real per capita GDP in constant \$ in 2010; Government consumption, tax revenue and budget variables are expressed in percent of GDP. The human capital is the index from [Lim et al. \(2018\)](#), it considers both education and health in its construction.

group (respectively 2.7% and 1.95% per year) which supports the convergence process that postulates a higher GDP growth rate in relatively poorer countries. The government expenditure considers the general final consumption government expenditures by function. For this study, we mostly focus on total expenditure and education expenditure. We only look at general government statistics. First, the level of decentralization is heterogeneous among countries and looking at a sub-sector like the central or local government may capture political organization heterogeneity more than fiscal policy concern. Second, multiple breaks in time series were observed during the period, mainly due to reclassification or reorganisation.⁹

In the overall period, government final consumption (excluding education) is 4pp. higher in performing countries. The ratio of public expenditure to GDP remains relatively constant over time, even at the country level. Public education expenditure respectively counts for 4.07% and 5.26% of GDP in non-performing and performing countries; in performing countries, the public effort put toward education seems to be relatively higher (1.5pp). The share of education expenditure in total government expenditure is rather similar around 27 per cent, suggesting that public strategy toward education in both groups is not different. However, over the 2000-2018 period, the distribution of the share of education expenditure over total public expenditure is more heterogeneous, with a higher standard deviation both in the between and within dimensions. Drawing a comparison between the pre-2008 and post-2008 period, in both groups of countries, standard deviation doubled, particularly in the within dimension. This introduces some interesting

9. It is the case for example in Europe, in Estonia in 2004-2005 at the local government sector level; in Hungary in 2012 for a specific reorganisation in the fields of education and health between the central and local government or in Romania in 2011 for the social contributions.

volatility that should be captured in our model.

Fiscal revenue

Following [Blankenau et al. \(2007\)](#), taxation (τ) controls for the importance of the crowding out effect of financing government expenditure, implicitly through non-distortionary taxation. The measure follows Eq. [A.14](#) in appendix [A.5](#)

$$\tau_i = \frac{g + e + b}{1 + \phi}$$

where $\phi = \frac{\tau_c \bar{C}_t}{\tau_i Y_t}$.

To construct this variable, we refer to $(e + g)$ as total general government expenditure and b as the budget surplus. Last, the ϕ component is computed with the World Bank dataset on taxation where $\tau_c \bar{C}_t$ is the taxes on goods and services and $\tau_i Y_t$ taxes on income profits and capital gains.

Taxes on income, in GDP terms, is relatively lower in not-performing economies (respectively 4.17% and 6.1%). The gap, between the two groups of countries, seems to have slightly decreased over the years. However, the share of income taxation among total government revenue has remained constant, around 24% and 28% respectively in not-performing and performing countries, in line with the assumption stated in the model from [Blankenau et al. \(2007\)](#).

The budget surplus variable equals government revenue minus expenditure, minus net investment in non-financial assets, in GDP percentage, and appears in the literature to be a significant determinant of economic growth as it captures the international lending position. On average, the budget surplus is negative in both groups and is relatively similar, close to -2% of GDP, slightly lower in performing

countries.

Educational attainment

Our last variable concerns the measure of the stock of human capital. The school enrolment, à la [Zhang and Zhuang \(2011\)](#) suffers from a high level of inertia, as it comes close to a stable level. This is particularly true in high-income countries. The more recent literature focus on the educational attainment ([Barro, 2001](#); [Faggian and McCann, 2019](#); [Neycheva, 2019](#)) or on years of schooling à la [Barro and Lee \(2013\)](#).

In non-performing countries, from 2010 to the last data available, tertiary educational attainment represents on average 20% of the population while this ratio hikes to 33% in the other group of countries. According to [Barro and Lee \(2013\)](#), in 2010, years of schooling, in upper-middle economies remain below high-income (respectively 8.5 and 10.7 years); completed tertiary education is half lower in the first group while the rate of the population with no education is twice bigger.

These variables implicitly consider a homogeneous level of education quality among countries. Such an assumption has been partly tackled by [Hanushek and Woessmann \(2020\)](#) with an increasing gap between *education quality* and *education quantity*.

Following [Hanushek and Kimko \(2000\)](#), human capital in the growth equation should be apprehended through the prism of cognitive skills.¹⁰ The role of education quality has been largely studied to trace a more realistic role of human capital upon economic growth ([Barro, 2001](#)). The impact of cognitive skills is

10. The literature refers to test scores such as the PISA OECD tests to measure such cognitive skills.

an important driver to understand the role of education on economic development (Hanushek and Woessmann, 2008). Using PISA-scores tests from OECD, Hanushek and Woessmann (2010) highlight the positive growth impact of improving the labour force skills. Despite an increasing number of countries attending the PISA tests every three years, using PISA scores will drastically decrease the dimension of our panel.

We refer to recent work from Lim et al. (2018), using both education and health to apprehend the human capital level. They construct a yearly index for 195 countries from 1990 to 2016 using census, health, learning and household surveys from multiple sources.¹¹ This globalizing approach gets rid of many issues concerning human capital measures. In our panel of countries, the index belongs to the [3;29] interval. The lowest values are observed in Namibia and Botswana. Finland, Iceland, Denmark and Netherlands are the better ranked. In both groups of countries, the index increased over the period. In non-performing countries, the *between* volatility is relatively high compared to the within dimension and to the performing group suggesting more heterogeneous countries regarding their human capital level.

Empirical issues

As we introduce the GDP in per capita terms on both sides of the equation, we transform our variables of interest (public expenditure and taxation) in per capita terms. To disentangle the long-term relationship between government ex-

11. Lim et al. (2018) "generate a period measure of expected human capital, defined for each birth cohort as the expected years lived from age 20 to 64 years and adjusted for educational attainment, learning or education quality, and functional health status using rates specific to each period, age, and sex for 195 countries from 1990 to 2016."

penditure and economic growth, we use five years average period. In doing so, we omit short-term variation in the data that would introduce noise in our specification. All variables in the model are expressed in log terms except for the budget surplus.

Since the seminal paper from [Nickell \(1981\)](#) who described the inconsistency of the OLS estimator under dynamic panel data with individual fixed effects, the literature provides a bias correction using least square dummy variables (LSDV) estimator ([Kiviet, 1995](#); [Bun and Kiviet, 2003](#)). More recent works from [Bruno \(2005a,b\)](#) allow estimating such autoregressive models, with N (moderately) large and finite T , using a bias-corrected LSDV estimator, even in the presence of an unbalanced panel, which is our case. Such an approach also provides a bootstrap variance-covariance matrix. We impose the initial estimates to follow the Blundell-Bond estimator. Our results are robust to other initial approaches like Anderson-Hsiao (first difference with variables lagged twice).

5 Results

In [table 3](#), we present the results following the estimation of [equation 3.1](#). In every specification, the dependent variable is the real GDP per capita as previously described. In columns 1 to 3, we detail results in line with the strategy adopted in [Blankenau et al. \(2007\)](#), focusing on upper-middle and high-income economies. The overall group counts 65 countries.

As expected, the lagged dependant variable has a positive and highly significant coefficient, below unity which summarises part of the convergence hypothesis of the growth equation.

Table 3 – Main results

	(1)	(2)	(3)	(4)	(5)
	Overall	High income	Upper- middle income	Performing	Non- -performing
L.GDP per capita	0.704*** (0.049)	0.814*** (0.066)	0.731*** (0.083)	0.451*** (0.076)	0.733*** (0.096)
Other Pub. Spend.	0.068** (0.034)	0.027 (0.060)	0.053 (0.048)	0.375*** (0.076)	0.074 (0.079)
Pub. Spend. Educ	0.112*** (0.042)	0.086 (0.062)	0.005 (0.039)	0.247*** (0.049)	0.058 (0.075)
Taxes	0.047* (0.028)	-0.008 (0.066)	0.087** (0.034)	-0.134*** (0.047)	0.034 (0.070)
Gov. budget	0.017*** (0.004)	0.011** (0.005)	0.011* (0.006)	0.020*** (0.004)	0.031*** (0.010)
Expected HC	-0.013 (0.129)	-0.110 (0.261)	-0.153 (0.157)	0.514** (0.249)	-0.066 (0.167)
Nb observations	293.00	120.00	149.00	151.00	121.00
Nb countries	65.00	24.00	35.00	32.00	31.00

Notes: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable for all regressions is the five-years average of annual per capita GDP (in log terms); We use a LSDVC estimator; Standard errors are obtained thanks to a bootstrap variance-covariance matrix using 50 repetitions. Regression 1-3 considers the overall group of countries, high income and upper-middle income respectively. Column 4-5 split the sample of countries according to their performance in PSE as defined in section 3.

Public expenditure positively impacts GDP as does spending on education. An increase of one percent in PSE leads to a 0.11% increase in GDP per capita. Our coefficient attached to public spending on education is slightly lower than what is found in the literature. In [Blankenau et al. \(2007\)](#) the impact from PSE to GDP was at 0.2% while [Neycheva \(2010\)](#) found a coefficient equal to 0.3 in the Central and Eastern European Countries.

The taxation variable highlights a positive (and even significant) sign. This counter-intuitive positive sign remains when we only look at income tax revenues or more global government revenue. We suppose some taxation purpose heterogeneity to blur the effective relationship. We deal with this issue later on.

The government budget, as expected has a significant positive impact on GDP. This last point comes closed to [Blankenau et al. \(2007\)](#). We do not find a significant impact of human capital on economic growth. Looking at other measures of human capital neither improves the model nor leads to a significant human capital coefficient.¹²

Columns 2 and 3 of table 3 split the sample of countries according to their level of economic development back to the nineties. We look first at high-income economies and then at upper-middle-income countries. We prefer here the use of an older ranking to consider that some transition economies switched from upper-middle to high income over the period. We end up with respectively 24 and 35 countries. This sub-sample analysis refers to [Blankenau et al. \(2007\)](#). In these two new specifications, we find no significant results concerning public spending;

12. As robustness, we replace [Lim et al. \(2018\)](#) index by commonly used variables i.e., primary school enrolment à la [Blankenau et al. \(2007\)](#), educational attainment à la [Neycheva \(2019\)](#) or years of schooling à la [Barro and Lee \(2013\)](#); we never get a significant impact of the stock of human capital on GDP.

as is the case for human capital. The counter-intuitive result found on taxation only persists in upper-middle-income countries. The coefficient attached to the government budget loses some robustness but remains constant.

Before going further, we consider a GMM alternative estimator to test for the robustness of our approach. Despite it having been proven that LSDV estimators are more efficient than GMM in the case of relatively small N dimension, GMM is a good alternative to tackle the endogeneity bias usually found in the growth equation model. The GMM estimator, à la [Blundell and Bond \(1998\)](#) considers each variable as potentially endogenous while the LSDVC from [Bruno \(2005b\)](#) considers instruments as exogenous. In column 1 of table 4, in appendix C, we implement a system GMM estimator using previous work from [Roodman \(2009\)](#). The results of the GMM estimator are in line with our main set of regressions. We both find a positive and significant impact from public spending and PSE on GDP; as well as from the government budget surplus. Neither taxation nor human capital stock appears to be significant.

In columns 4 and 5 of table 3, we present the results, using our performance measure. While countries are not ranked thanks to their level of economic development but according to their performance to generate human capital through their public spending on education, we find highly improved results when a country belongs to the performing group (column 4). Indeed, coefficients attached to public spending and PSE are significantly positive. PSE coefficient is closer to what has been previously found in the literature. Taxes and the government budget variables also highlight significant coefficients (respectively negative and positive, as

expected). Last, the Expected Human Capital index also ends up with a positive and significant coefficient. This supposes that the impact of education on economic growth is not only a matter of human capital flows but also considers the importance of the stock.

In this estimation, with 32 economies, the results tend to prove that performance in public spending is of primo interest to disentangle the impact on economic development. These first conclusions are corroborated by the absence of significant results in non-performing economies (fifth column).

The literature converges on the idea that performance in public spending is a key element to increase human capital. Our results support the idea and confront the importance of efficiency in more global output, looking at the performance of public spending on education in a growth equation model. We now go back to the European context to explore and analyse in deeper detail some of the potential leverage effects on the performance.

6 Performance of public education expenditure

The interesting point with EU countries is visible in figure 1. We isolate (green squares) countries that have switched from upper-middle to high income over the period. Switching countries correspond to Central and Eastern European countries. Unsurprisingly they also belong, except for Bulgaria and Romania to countries with a relatively high level of performance in public spending on education to generate human capital. In other words, the Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia and Slovakia are classified as upper-middle-income but high performers.

Back to the EU context, we define a new level of performance as the median of the average performance, as previously done, but only among the EU-27. The purpose is to disentangle whether we observe heterogeneous common behaviours between the best performers and the lower group.¹³ We focus on the 2012-2020 period to have detailed and comparable data across EU member states.¹⁴

Public spending on education (in GDP terms) is relatively higher in countries classified as "performing countries" (5.6% against 4.3% in non-performing on average over the period). The mean difference is highly significant. Disaggregating the data by level of education highlights that the difference is mainly driven by tertiary education expenditure while in primary and secondary education, the difference, between the two groups does not seem to be significant.

Per student direct public expenditure, expressed in purchasing power standard, is significantly higher in performing countries, valid for all levels of education. Once controlled for the GDP per capita, the mean difference still holds at the overall level, for secondary and tertiary education. At the secondary education level, the distribution is relatively homogeneous comparing the two groups (similar coefficient of variation). Nonetheless, secondary education institutions tend to be more "private institutions dependant from the general government".¹⁵ At the tertiary education level, we observe larger heterogeneities in the performing group with a relatively high level of public expenditure per student (in GDP per capita terms) in Sweden, Denmark and Finland (low in Latvia and Ireland). The variable is

13. According to our classification, the best performers in terms of PSE to generate human capital inside the EU-27 are Austria, Belgium, Cyprus, Germany, Estonia, Finland, France, Ireland, Latvia, the Netherlands and Sweden.

14. Detailed figures are available in table 5 on appendix E

15. This last point is to be considered with caution with a high level of missing data. Two other statuses prevail i.e. public institutions and private independent institutions (confined to non-performing countries).

positively skewed. The countries where we observe the highest level of per-student direct public expenditure in tertiary education belong to the group with the highest score obtained in the previous DEA analysis.

This is also in performing countries that we observe the highest level of financial aid to households and/or student loan facilities. Those elements tend to converge on the importance of tertiary education in generating human capital. To some extent, it supports the EU-2030 target of at least 45% of the 30-34 yo population with tertiary educational attainment.

7 Conclusion

Given the EU-2020 and EU-2030 strategies, for providing a more inclusive education system, we question the role of public spending on education to generate economic growth. Revisiting the [Blankenau et al. \(2007\)](#) model, we draw an empirical estimation of the interactions between human capital and economic growth. We use the WDI of the World Bank for 65 countries over the last thirty years. We mostly focus on upper-middle- and high-income countries.

Our equation controls for other public spending and the way governments have financed expenditure thanks to the fiscal measure à la [Blankenau et al. \(2007\)](#). To proxy the human capital stock, we introduce the index from [Lim et al. \(2018\)](#), using a multidimensional approach based on education and health.

We find positive impacts from public spending on education and other public spending on GDP. However, when we focus on upper-middle-income countries, the relationship becomes not significant. A recent paper from [Neycheva \(2019\)](#) explained the lack of significant results between education expenditure and eco-

conomic growth thanks to labour mismatching, underlying the role of human capital quality, in Eastern Europe.

To disentangle this insignificant outcome and restore the impact of human capital quality, we estimate a performance measure of public expenditure, to generate human capital, using a data envelopment analysis process.

Upon a subgroup of 32 countries, classified as "high-performing", we fully restore the significant impact of PSE on economic growth. In this case, the marginal impact of PSE on GDP, depending on the average performance, increases (twice as high). Providing education expenditure statistical details in the EU context, we observe a positive link between public spending on tertiary education per student (in GDP per capita terms) and the highest level of performance. This relative importance of public tertiary education spending corroborates the EU-2020 strategy goal.

We review the role of human capital on economic growth and more importantly, the importance of implementing a performing education strategy to minimize inefficient public education expenditure. By introducing the concept of performance into expenditure, we allow PSE to positively impact economic development and to a lesser extent to confirm the important role of public spending in generating human capital. Further research may dig deeper into the effective channels that link human capital to public expenditure to promote and enhance the employability of the European labour supply.

An interesting strategy is based on the need for lifelong learning programs to increase labour supply inter-sectoral flexibility even after "education" is over. Amongst the different paths, we could follow to understand performance in tertiary education strategy we could think about financial aid to households relatively

higher in performing countries and/or the role of student loans.

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Appendices

A Model of growth: [Blankenau et al. \(2007\)](#)

A.1 The agent's problem

The model consists of a simple overlapping generations model of growth, derived from models of [Glomm and Ravikumar \(1997\)](#) and [Blankenau and Simpson \(2004\)](#). Homogeneous agents live three periods and a single good is produced by a representative firm. A government and the technology parameters allow to produce human capital.

Normalized to one, a continuum of agents born each period and refers to the 'learners'. The 'learners' receive an endowment of public education inputs which is combined with the prior generation human capital to form the level of human capital in the next period such that, like in [Glomm and Ravikumar \(1997\)](#):

$$h_{t+1} = \xi E_t^\mu h_t^{1-\mu}; \mu \in [0, 1], \xi > 0 \quad (\text{A.1})$$

where μ captures both government expenditure on education and the human capital level of the prior generation relative importance in generating actual human capital. Following [Blankenau and Simpson \(2004\)](#), public and private education expenditures are imperfect substitutes as government expenditures are usually more focus on primary and secondary education while private investment in human capital are more turned toward tertiary education.¹⁶

In $t + 1$, the agent becomes an 'earner' as she supplies her labour endowment to receive after-tax income, in line with her human capital stock.

$$w_{t+1} h_{t+1} (1 - \tau_i)$$

where w is the corresponding wage and τ_i is the income tax rate. The net wage income is used to consume and save for old age. Through capital accumulation, at the end of period $t + 1$, the agent is endowed with $K_{t,t+2}$. Once 'old' the agent consumes the net income from savings as a unit of capital in period t returns $r_{t+1}(1 - \tau_i)$ where r_{t+1} is the rental rate in period $t + 1$, assuming a fully depreciation of capital. Last, define consumption in period $t + 1$ and $t + 2$ with β , the discount

16. [Blankenau and Simpson \(2004\)](#) keep the Cobb Douglas specification despite elasticity of substitution between private and public inputs in tertiary education are found to be relatively higher ([Houtenville and Conway, 2008](#)).

rate and τ_c the consumption tax rate to get the agent's problem:

$$\max_{C_{t+1}, C_{t+2}, K_{t+2}} \ln(C_{t+1}) + \beta \ln(C_{t+2}) \quad (\text{A.2})$$

subject to

$$\begin{aligned} C_{t+1}(1 + \tau_c) + K_{t+2} &\leq w_{t+1}h_{t+1}(1 - \tau_l) \\ C_{t+2}(1 + \tau_c) &\leq (r_{t+2}(1 - \tau_i))K_{t+2} \\ C_{t+j} &\geq 0, j = 1, 2. \end{aligned}$$

The agent's problem is solved, under optimal savings when:

$$K_{t+2} = \frac{\beta}{1 + \beta} (w_{t+1}h_{t+1}(1 - \tau_i)) \quad (\text{A.3})$$

A.2 Firms

A single final good is generated by the representative firm on a competitive market¹⁷, using a particular combination of human (L_t) and physical capital (K_t). A usual Cobb-Douglas function is assumed with $k_t \equiv \frac{K_t}{L_t}$:

$$Y_t = AK_t^\alpha L_t^{1-\alpha} \quad (\text{A.4})$$

$$y_t \equiv \frac{Y_t}{L_t} = Ak_t^\alpha$$

where $\alpha \in [0, 1]$ et $A > 0$. The firms hire until $r_t = A\alpha k_t^{\alpha-1}$ and

$$w_t = A(1 - \alpha)k_t^\alpha. \quad (\text{A.5})$$

A.3 Gouvernement

Public expenditures are divided in two categories. A share e of output is dedicated to government expenditure on education:

$$E_t = \tilde{e}Y \quad (\text{A.6})$$

Another share g is spent by the government but is seen as non-productive. We allow the government to finance part of the public expenditure through deficit spending, denoted by b , defined as e and g i.e., as a share of output.¹⁸

17. An individual firm is considered as a price taker

18. We strictly follow Blankenau et al. (2007) and assume that g and b implicitly integrate the interest payments.

Taxes on labour & capital income (τ_i), consumption taxes (τ_c) plus borrowing (b) represent the three instruments used to finance public expenditures. Each period, the government budget must balance such that the government policy may be described as:

$$w_t h_t \tau_l + r_t \tau_k K_t + \tau_c (c_{t-1,t} + c_{t-2,t}) + \tau_p Y_t = (G + e) Y_t \quad (\text{A.7})$$

A.4 Equilibrium and balanced growth

Definition 1 Given these different elements, a competitive equilibrium may be defined through consumption and portfolio holdings trade off by the representative agent $\{C_{t,t+1} + C_{t,t+2} K_{t,t+2}\}_{t=0}^{\infty}$; the firm chooses a specific set of inputs to end up with a given level of output $\{Y_t, K_t, L_t\}_{t=0}^{\infty}$; the government policy is set by the sequence $\{\tau_{i,t}, \tau_{c,t}, e_t, g_t, b_t\}_{t=0}^{\infty}$. Last, prices and initial conditions are respectively set by $\{w_t, r_t, \}_{t=0}^{\infty}$ and (K_0, h_0) such that:

- (i) the agent's problem is solved, under the assumption of 'price taker' and a given government policy, when a period t learner chooses $C_{t,t+1}, C_{t,t+2}$ and $K_{t,t+2}$,
- (ii) from the firm perspective, the profit maximisation issue, in period t, ends up with a level of Y_t, K_t and L_t constraint by a given set of prices, government policy and production possibilities (Eq. A.4),
- (iii) the government policy, under the balanced budget constraint, chooses $\{\tau_{i,t}, \tau_{c,t}, e_t, g_t, b_t\}$,
- (iv) the stock of human capital, in each period evolves according to Eq. A.1 and Eq. A.6,
- (v) the good market clears: $Y_t = (e_t + g_t + b_t) Y_t + C_{t-1,t} + C_{t-2,t} + K_{t-1,t+1}$
- (vi) the capital market clears, and
- (vii) the labour market clears: $L_t = h_t$

Definition 2 Additional to definition 1, a balanced growth path satisfies the following properties:

- (i) government policy is time invariant $\tau_i, \tau_c, e, g, b = \tau_{i,t}, \tau_{c,t}, e_t, g_t, b_t$;
- (ii) the same and constant rate, γ defines the evolution of output, human and physical capital, consumption by both 'earners' and 'old'.

Thanks to definition 2, k_t, y_t, w_t and r_t are stationary (no need for time subscript). Using Eq. A.1 and Eq. A.6:

$$1 + \gamma = \xi(\tilde{e} A k^\alpha)^\mu \quad (\text{A.8})$$

Equation A.8 highlights the direct positive effect, on growth, of an increase in government education expenditure and by the same time, the ambiguous final

impact given by the general equilibrium adjustments to k . From Eq. A.8, it is possible to get γ as a function of τ_i :¹⁹

$$\gamma \approx \bar{\beta}_0 + \beta_1 e + \beta_2 \tau_i \quad (\text{A.9})$$

where τ_i assumes a constant relationship on the balanced growth path between consumption and income tax revenue. By this way, introducing τ_i , in the growth equation, considers expenditure funding under distortionary taxation (Blankenau and Simpson, 2004; Blankenau et al., 2007)

A.5 Balanced growth

From Eq. A.10, solving k as a function of policy instruments and the model parameters allow to understand the general equilibrium adjustments. Substituting Eq. A.1, Eq. A.5 and Eq. A.6 into Eq. A.3 yields:

$$K_{t+2} = \tilde{\beta}(A(1 - \alpha)k_{t+1}^\alpha \xi(\tilde{e}y_t)^\mu h_t^{1-\mu} L_t^\mu (1 - \tau_i))$$

. Labour market clearing requires $L_t = h_t$ giving

$$k_{t+2} = \tilde{\beta}(A(1 - \alpha)k_{t+1}^\alpha \xi(\tilde{e}y_t)^\mu (1 - \tau_i))$$

At the steady state, solving for k :

$$k = [\tilde{\beta}A^{1-\mu}(1 - \alpha)\xi\tilde{e}^\mu(1 - \tau_i)]^{\frac{1}{1-\alpha-\alpha\mu}}$$

Using Eq. A.8:

$$1 + \gamma = A^\mu [\tilde{\beta}A^{1-\mu}(1 - \alpha)]^{\frac{\alpha\mu}{1-\alpha(1+\mu)}} \xi^{\frac{1-\alpha}{1-\alpha(1+\mu)}} \tilde{e}^{\frac{\mu(1-\alpha)}{1-\alpha(1+\mu)}} (1 - \tau_i)^{\frac{\alpha\mu}{1-\alpha(1+\mu)}} \quad (\text{A.10})$$

taking the natural logarithm:

$$\gamma \approx \bar{\beta}_0 + \beta_1 e + \beta_2 \tau_i \quad (\text{A.11})$$

where

$$\beta_1 = \frac{\mu(1 - \alpha)}{1 - \alpha(1 + \mu)}, \beta_2 = -\frac{\alpha\mu}{1 - \alpha(1 + \mu)} \quad (\text{A.12})$$

and $\bar{\beta}_0 = \ln A^\mu [\tilde{\beta}A^{1-\mu}(1 - \alpha)]^{\frac{\alpha\mu}{1-\alpha(1+\mu)}} \xi^{\frac{1-\alpha}{1-\alpha(1+\mu)}}$.

To find the relationship between e and τ_i , we use the government budget constraint

19. Details from Eq. A.8 to Eq. A.9 are available in appendix A.5.

Eq. A.7:

$$\tau_i Y_t + \tau_c (C_{t-1,t} + C_{t-2,t}) = (e + g + b) Y_t$$

rewritten as

$$\tau_i + \tau_c \frac{\tilde{C}_t}{Y_t} = (e + g + b) \quad (\text{A.13})$$

Let define $\phi = \frac{\tau_c \tilde{C}_t}{\tau_i Y_t}$ as the ratio of consumption to income tax revenue (constant in balanced growth):

$$\tau_i = \frac{e + g + b}{1 + \phi} \quad (\text{A.14})$$

substituting Eq. A.14 in Eq. A.11:

$$\gamma \approx \bar{\beta}_0 + \beta_1 e + \beta_2 \frac{e + g + b}{1 + \phi} \quad (\text{A.15})$$

B List of countries

Non-performing PSE :

Albania, Argentina, Armenia, Azerbaijan, Bulgaria, Bahrain, Belize, Brazil, Barbados, Chile, Colombia, Costa Rica, Ecuador, Fiji, Gabon, Guatemala, Guyana, Iran, Islamic Rep., Jamaica, Lebanon, Maldives, Mexico, Mauritius, Malaysia, Oman, Panama, Peru, Paraguay, Qatar, Romania, Russian Federation, Thailand, Turkmenistan, Uruguay, South Africa.

Performing PSE :

Australia, Austria, Belgium, Belarus, Brunei Darussalam, Canada, Switzerland, Czech Republic, Germany, Denmark, Spain, Estonia, Finland, France, United Kingdom, Croatia, Hungary, Ireland, Iceland, Israel, Italy, Japan, Lithuania, Latvia, Netherlands, Norway, New Zealand, Poland, Portugal, Singapore, Serbia, Slovak Republic, Slovenia, Sweden, United States.

C Other regressions results

Table 4 – Robustness results

	(1)	(2)	(3)	(4)	(5)
	GMM	Anderson Hsiao	Schooling	10-yrs	GFCF
L.GDP per capita	0.484*** (0.110)	0.665*** (0.070)	0.568*** (0.075)	0.766*** (0.135)	0.334*** (0.053)
Other Pub. Spend.	0.211* (0.119)	0.249** (0.116)	0.226** (0.101)	0.221* (0.120)	0.236*** (0.072)
Pub. Spend. Educ	0.127** (0.062)	0.196** (0.087)	0.157** (0.066)	0.247* (0.128)	0.100* (0.056)
Taxes	0.043 (0.036)	-0.053 (0.064)	-0.015 (0.059)	-0.140*** (0.049)	-0.087** (0.034)
Gov. budget	0.017*** (0.006)	0.016*** (0.006)	0.011** (0.005)	0.026*** (0.006)	0.013*** (0.003)
Expected HC	0.027 (0.145)	0.176 (0.324)		-0.232 (0.579)	0.629*** (0.202)
Years of Schooling			0.005 (0.013)		
GFCF					0.282*** (0.029)
Nb observations	293.00	157.00	111.00	77.00	150.00
Nb countries	65.00	33.00	32.00	34.00	32.00

Notes: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Dependent variable is the five-years average of annual per capita GDP in log terms (except for column 4 which considers the 10-years average); Column 1 uses a GMM estimator to control for endogeneity. Regressions 2 to 5 test the robustness for effective countries. In column 2, we change the initial first stage of LSDVC, with AH method. Standard errors are obtained thanks to a bootstrap variance-covariance matrix using 50 repetitions. Column 3 controls for the HC stock with years of schooling instead of the EHC Column 4 looks for long term impact of public spending on growth. Column 5 controls for the inclusion of private investment, proxied by the gross fixed capital formation.

D Variables definition: World Bank

Gross Domestic Product per capita: GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. Data are in constant 2010 U.S. dollars. Source World Bank national accounts data and OECD National Accounts data files.

Government expenditure (% of GDP): General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defence and security but excludes government military expenditures that are part of government capital formation. Source World Bank national accounts data and OECD National Accounts data files.

Government expenditure on education, total (% of GDP): Government expenditure on education is calculated by dividing total government expenditure for all levels of education by the GDP and multiplying by 100. Aggregate data are based on World Bank estimates. Data on education are collected by the UNESCO Institute for Statistics from official responses to its annual education survey. All the data are mapped to the International Standard Classification of Education (ISCED) to ensure the comparability of education programs at the international level. The current version was formally adopted by the UNESCO Member States in 2011. GDP data come from the World Bank. The reference years reflect the school year for which the data are presented. In some countries the school year spans two calendar years (for example, from September 2010 to June 2011); in these cases, the reference year refers to the year in which the school year ended (2011 in the example).

Budget (% of GDP): Net lending (+) / net borrowing (−) equals government revenue minus expense, minus net investment in nonfinancial assets. It is also equal to the net result of transactions in financial assets and liabilities. Net lending/net borrowing is a summary measure indicating the extent to which the government is either putting financial resources at the disposal of other sectors in the economy or abroad, or utilizing the financial resources generated by other sectors in the economy or from abroad. Source International Monetary Fund, Government Finance Statistics Yearbook and data files.

Taxes on income, profits and capital gains (% of revenue): Taxes on income, profits, and capital gains are levied on the actual or presumptive net income of individuals, on the profits of corporations and enterprises, and capital gains, whether realized or not, on land, securities, and other assets. Intragovernmental payments are eliminated in consolidation. Source International Monetary Fund, Government Finance Statistics Yearbook and data files.

Human Capital Index The Human Capital Index (HCI) database provides data at the country level for each of the components of the Human Capital Index as well as for the overall index, disaggregated by gender. The index measures the amount of human capital that a child born today can expect to attain by age 18, given the risks to poor health and poor education that prevail in the country where the child lives. It is designed to highlight how improvements in current health and education outcomes shape the productivity of the next generation of workers, assuming that children born today experience over the next 18 years the educational opportunities and health risks that children in this age range currently face. Source World Bank

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Table 5 – Financial analysis

Country	Pub. Exp.	Dir. Exp.	Fin. support	Stu. Loan	Pub. Inst. .
AT	0,96	0,94	0,08	0	0,91
BE	0,96	0,94	0,15	0	0,46
BG	0,83	0,80	0,15	0	0,99
CY	0,82	0,95	0,24	0,28	0,96
CZ	0,92	0,97	0,02	0	0,96
DE		0,90	0,19	0,17	
DK	0,95	0,83	0,34	0,17	0,91
EE	0,93	0,96	0,08	0,49	0,83
EL	0,91	0,99	0,01	0	
ES	0,83	0,96	0,11	0	0,85
EU-27	0,91	0,93	0,17	0,17	0,90
FI	0,98	0,94	0,13	0	0,88
FR	0,91	0,96	0,09	0	0,89
HR	0,94	1,00	0,01	0	0,99
HU	0,83	0,96	0,13	0	0,85
IE	0,89	0,91	0,31	0	0,97
IT	0,89	0,93	0,25	0	0,97
LT	0,90	0,96	0,09	0,05	0,98
LU	0,98	0,98	0,07	0	0,95
LV	0,91	0,96	0,09	0	0,81
MT	0,91	0,91	0,14	0	0,84
NL	0,91	0,86	0,30	0,58	0,99
PL	0,88	0,96	0,12	0,02	0,91
PT	0,81	0,95	0,15	0	0,92
RO	0,99	0,96	0,09	0	0,97
SE	0,99	0,90	0,26	0,65	0,86
SI	0,89	0,95	0,12	0	0,98
SK	0,91	0,93	0,12	0,04	0,93

Sources: Eurostat - Educational expenditure by education level, programme orientation, type of source and expenditure category.

Notes: Figures, per country, detail from column 2 to 5, respectively, public expenditure in education, direct expenditure in education and financial support to households, as a share of GDP and concern all education elvels (ISCED02-8). Student loans, still as a share of GDP, only look at tertiary education level (ISCED 5-8). Zero should not be interpreted as "missing data" but as almost null. Eventually, public institution look ak the share of public institutions over total institutions at all level of education levels.