

## EFFICIENCY OF EDUCATION EXPENDITURE IN OECD COUNTRIES

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### Abstract

*Based on data published in world educational databases, we study public education expenditure in OECD countries. First, we analyse the development of education expenditure from different viewpoints. For this purpose, we use three indicators, namely government expenditure on education as % of gross domestic product, education expenditure as % of gross national income, and expenditure on education as % of total government expenditure. Second, we apply data envelopment analysis to assess the efficiency of education systems in selected OECD countries with regard to socio-economic outcomes. We design two alternative DEA models in which the roles of teachers and students are different in the sense of inputs and outputs to reflect the ambiguous character of the students/teacher ratio. Significant differences among observed countries are identified in the development of selected indicators as well as in efficiency of national education systems.*

**Key words:** *OECD countries, government education expenditure, Data Envelopment Analysis (DEA).*

### 1. Introduction

Education is widely recognized as one of the key drivers of economic and social development. Attainment of education is necessary for individuals to prepare for their professional careers, but it also has a positive impact on the whole society. In spite of natural diversity in national education systems (e.g., in the share of private resources allocated to education), public expenditure is crucial to assure the access to education for all citizens as well as the freedom of education. Therefore, providing a quality education is one of the most important public services. However, it is also necessary to spend public resources efficiently from economic point of view.

Evaluation of quality and economic efficiency of a national education system is a hard task which cannot be performed without a comparison with other countries. Nowadays, world educational databases provide data on inputs and outcomes of education systems which may be used for benchmarking to bring valuable information for national education policies.

DEA is considered a suitable methodology for benchmarking of decision-making units in public sector based on evaluation of their performance efficiency. It may evaluate efficiency in education from different perspectives relating to the educational level (primary, secondary or tertiary), organization structures (faculties, departments), performed activities (teaching, research, study programmes), provided services (administration of study, libraries) or with regard to geographic aspects (regional, national, international comparisons). DEA has been most frequently applied to assess the efficiency of education institutions within countries. A

nice survey of these studies is given by Fuentes et al. (2016). First applications of DEA to cross-country comparisons appeared in 2005. Table 1 shows a brief overview of studies using DEA to assess the efficiency of education systems or institutions among countries.

Table 1: Characteristics of previous cross-country studies

Authors	Countries	Educational level	Inputs	Outputs	Explanatory variables	Methodology
Agasisti (2014)	20 EU countries	students at age 15	expenditure/student (PPP\$), students/teacher ratio	average of OECD-PISA tests scores (Math)	GDP per capita, average teachers' salary (PPP\$), internet usage (number of students in %), public expenditure on education (in %), instructional hours/year, unemployment rate	2-stage analysis Model 1: bootstrap DEA (O-oriented, VRTS) Model 2: Malmquist index (2006, and 2009), OLS regression
Aristovnik (2013)	30 EU and OECD countries	primary	public expenditures/student (% of GDP per capita)	school enrolment in primary (% gross), teacher/pupil ratio, primary completion rate (% of relevant age group)		
Verhoeven et al. (2007)	G7 and OECD countries	secondary and tertiary	Model 1: total spending/student in secondary education Model 2: total spending/student in tertiary education	Model 1: average PISA Math test score, secondary graduation rate Model 2: tertiary graduation rate	GDP per capita	2 stage analysis: DEA, regression analysis
Afonso and St. Aubyn (2005)	17 OECD countries	secondary	hours/year at school, teacher/100 students	PISA results (average of the 3 scores)		FDH, DEA (I/O oriented, VRTS)
Joumady and Ris (2005)	8 EU countries, 210 higher education institutions	tertiary	Model 1: 2 indicators of "Students entry characteristics", 6 indicators of "Study provision" Model 2: 2 indicators of "Intensity of job search", 2 indicators of "Study provision" Model 3 (Overall): all input indicators from Models 1-2	Model 1: level of -vocational, - generic competencies acquired Model 2: vertical -vocational, -generic competencies match, horizontal competencies match Model 3 (Overall): all output indicators from Models 1-2		DEA (output-oriented models, VRTS)

Source: the authors.

In Section 2 we analyse the development of public education expenditure in OECD countries in years 2000 – 2011. We focus on the share of education expenditure on the total government expenditure as well as on the traditional indicators of macroeconomic performance (GDP, GNI). In Section 3, we use a DEA approach to assess the relative efficiency of education systems in selected OECD countries. In Section 4, we draw conclusions from both analyses.

## 2. Development of Public Education Expenditure in OECD Countries

In this section we analyse the structure and development of education expenditure in OECD countries. This group consists of the most developed economies in the world. A substantial part of their economic output is formed by products and services with a high added value whose production requires a highly qualified workforce. This fact naturally increases the importance of their education systems.

OECD includes 34 countries, but in our study we do not consider Greece and Republic of Korea, due to missing values of most indicators that we take into account. The list of observed OECD countries is given in Table 2. Note that there are significant differences among countries in the ratio of students on the total population. In this ratio we consider the number of all students from primary to tertiary education. Depending on the demographic characteristics of the country, the ratio of students varies from less than 15 % in Japan to more than 25% in Turkey, New Zealand, Australia, and Iceland.

In world education databases (World Bank, UNESCO) and in annual reports Education at a Glance (e.g. OECD, 2015) one can find several ways of expressing education expenditure with respect to the total public expenditure and other macroeconomic indicators, e.g., Gross domestic product (GDP) or Gross national income (GNI). Current and capital expenditures are reported for individual educational levels from primary to tertiary. Personal expenditures which form a part of current expenditures are separately indicated.

In our study we focus on the development of three ratio indicators during the period of 2000 – 2011 for which data on majority OECD countries is available. Due to missing values, we do not include Luxembourg and Turkey into consideration for the rest of this section. The data were obtained from the World Bank<sup>1</sup>, the OECD<sup>2</sup> and the UNESCO<sup>3</sup>.

First, we consider government expenditure on education as % of GDP which covers total local, regional, and central government expenditure on education (current, capital, and transfers), expressed as a percentage of GDP. It includes expenditure funded by transfers from international sources to government. A higher percentage of GDP spent on education shows a higher government priority for education, but also a higher capacity of the government to raise revenues for public spending, in relation to the size of the country's economy. However, we must keep in mind that the private sector and/or households in some countries may fund a higher proportion of total funding for education, thus making government expenditure appear lower than in other countries.

The indicator shows how big portion of the wealth produced in the country is allocated to education system through public budgets.

Figure 1 compares the government expenditure on education as % of GDP in OECD countries. The stock chart shows intervals between minimum and maximum values and highlights the values reached in year 2011.

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<sup>1</sup> World Bank data included data on Economy & Growth and Education available at <http://data.worldbank.org/> (accessed April 20, 2016).

<sup>2</sup> Data from OECD.Stat available at <http://stats.oecd.org/> (accessed April 20, 2016).

<sup>3</sup> Data from UIS.Stat available at <http://data.uis.unesco.org/> (accessed April 20, 2016).

Table 2: Observed OECD countries

Country	Shortened name	Population	Students (% of population)
Australia	AUS	22 728 254	25.63%
Austria	AUT	8 429 991	16.77%
Belgium	BEL	11 128 246	18.11%
Canada	CAN	34 751 476	*14.15%
Chile	CHL	17 388 437	23.38%
Czech Republic	CZE	10 510 785	16.12%
Denmark	DNK	5 591 572	22.78%
Estonia	EST	1 322 696	17.16%
Finland	FIN	5 413 971	19.79%
France	FRA	65 639 975	18.85%
Germany	DEU	80 425 823	*12.84%
Hungary	HUN	9 920 362	16.43%
Iceland	ISL	320 716	26.38%
Ireland	IRL	4 586 897	22.93%
Israel	ISR	7 910 500	24.71%
Italy	ITA	59 539 717	15.65%
Japan	JPN	127 561 489	14.19%
Luxembourg	LUX	530 946	16.14%
Mexico	MEX	122 070 963	24.79%
Netherlands	NLD	16 754 962	21.61%
New Zealand	NZL	4 408 100	25.15%
Norway	NOR	5 018 573	21.80%
Poland	POL	38 063 164	17.88%
Portugal	PRT	10 514 844	17.38%
Slovak Republic	SVK	5 407 579	17.39%
Slovenia	SVN	2 057 159	16.73%
Spain	ESP	46 773 055	17.27%
Sweden	SWE	9 519 374	18.19%
Switzerland	CHE	7 996 861	17.00%
Turkey	TUR	74 099 255	25.02%
United Kingdom	GBR	63 700 300	18.63%
United States	USA	314 112 078	22.13%

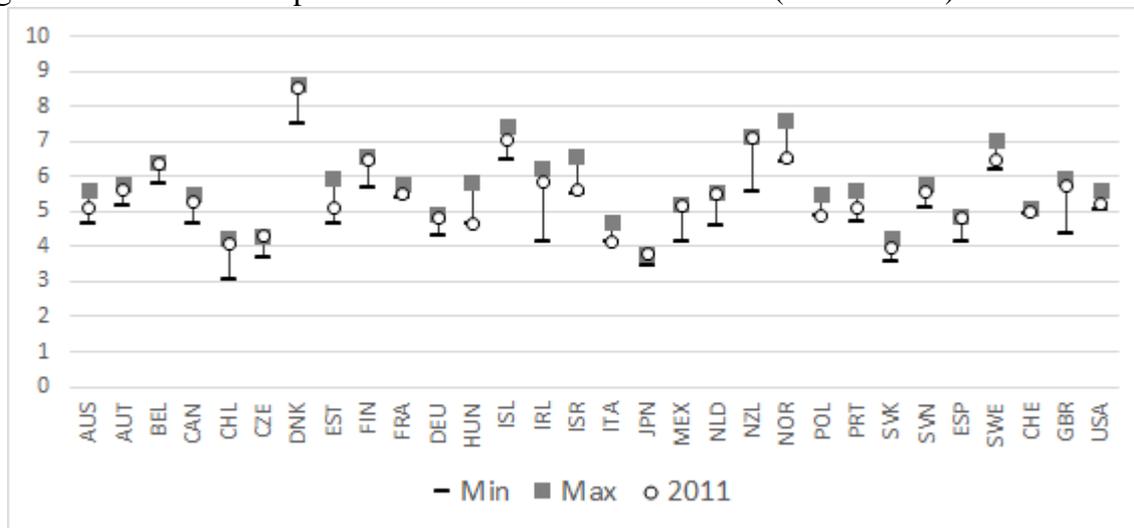
Note: \*Excluding students of tertiary education because of missing values

Source: the authors based on data from the World Bank and UNESCO.

We see that government expenditure on education varies from 3% to 8.6% of GDP. During the whole period, the highest values are observed in Denmark, with the ratio of at least 8.5% in latest three years. Only four other countries - Norway, Iceland, New Zealand and Sweden - reach more than 7% in some years. On the other side, the lowest values are reported by Chile, but they increase at the end of the period. Japan shows very stable values of the indicator, but always below 4% of GDP. Czech Republic and Slovakia exhibit low values of the share, too. Majority of OECD countries show a progress in this indicator, with the highest increase in

Ireland, New Zealand, and UK. A reverse trend can be observed in Estonia, Hungary, Israel, Italy, Norway and Poland.

Figure 1: Government expenditure on education as % of GDP (2000 – 2011)

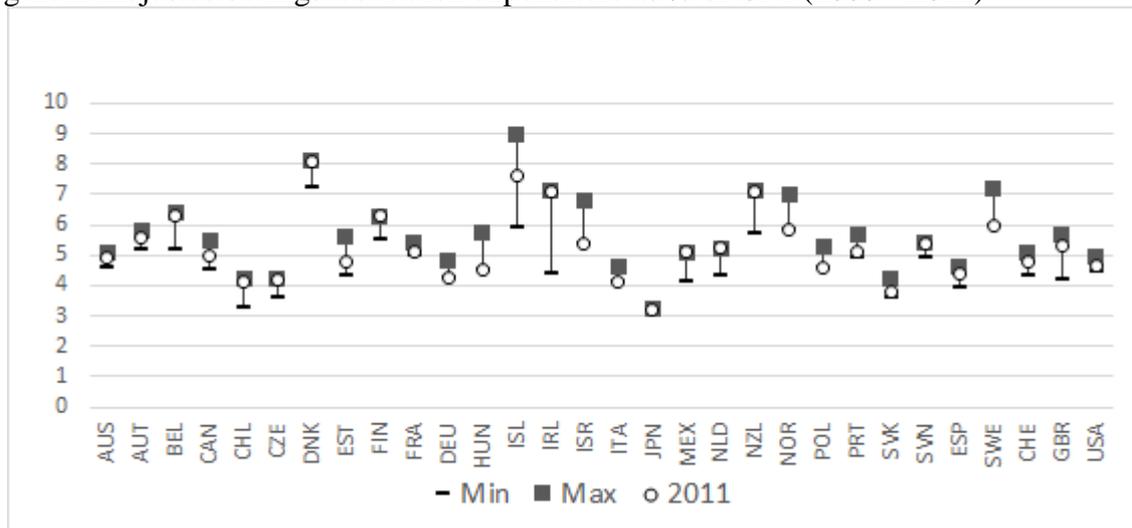


Source: the authors based on World Bank data.

Second, we deal with education expenditure as % of GNI which refers to the current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment. The indicator shows how big portion of all incomes received by the citizens is allocated to the current expenditures on education.

As shown in Figure 2, the education expenditure forms from 3% to 9% of GNI. During the whole period, the highest values are observed in Iceland and Denmark. The lowest values are reached by Japan, Chile, Czech Republic, and Slovakia. The trends in all countries are similar as for the previous indicator.

Figure 2: Adjusted savings: education expenditure as % of GNI (2000 – 2011)



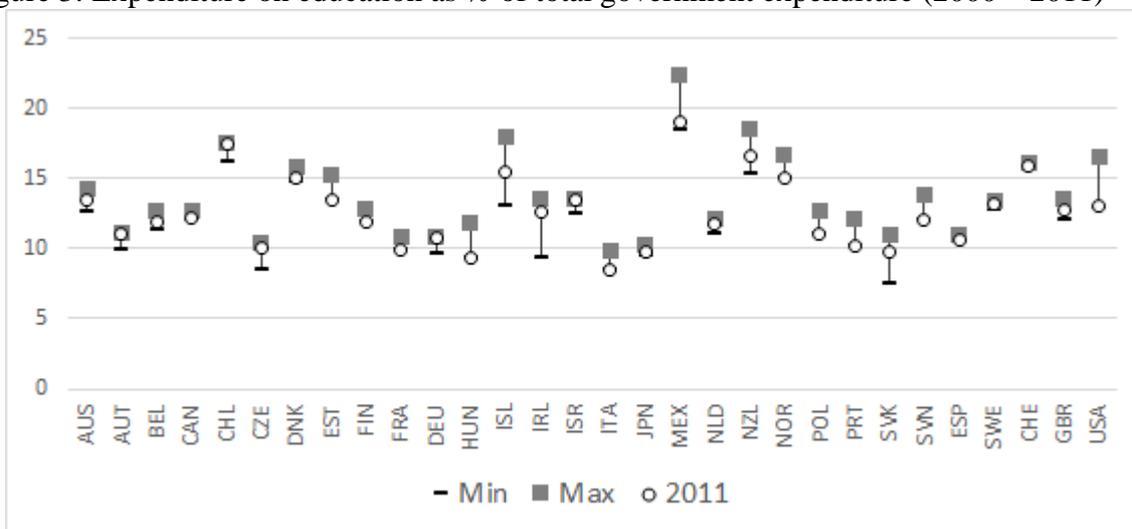
Source: the authors based on World Bank data.

Third, we take into account expenditure on education as % of total government expenditures which covers total local, regional and central government expenditure on

education (current, capital, and transfers), expressed as a percentage of total general government expenditure on all sectors (including health, education, social services, etc.). It includes expenditure funded by transfers from international sources to government. Public education expenditure includes spending by local/municipal, regional and national governments (excluding household contributions) on educational institutions (both public and private), education administration, and subsidies for private entities (students/households and other private entities). In some instances data on total public expenditure on education refers only to the ministry of education and can exclude other ministries that spend a part of their budget on educational activities. The indicator reveals the relative importance of the education among other public services that the governments of all levels reflect in the allocation of public sources.

Figure 3 shows that the shares of education expenditure on total government expenditure are relatively stable, with the differences between maximum and minimum values less than 2% in almost all countries. In the contrast with the shares of education expenditure on GDP or GNI, the values of this indicator tend to decrease in more countries. Mexico reaches the highest share during the whole period, having more than 20% in several years, with a slight decrease at the end of the period. Slovakia started with the lowest share of 7.5% in 2000, but rapidly increased the share in the following years. In spite of the progress, it still belongs to countries with the lowest share of education expenditure which forms only around 10% of the total government expenditure. The lowest share at the end of observed period is reached by Italy which is below 10% in all years, and by Hungary which exhibits a significant decrease in the share during the period.

Figure 3: Expenditure on education as % of total government expenditure (2000 – 2011)



Source: the authors based on World Bank data.

### 3. Efficiency of Education Systems – a DEA Approach

Public expenditure is required to be efficiently spent. This is the reason why appropriate measures for efficiency assessment should be developed. We apply DEA for this purpose. DEA is a non-parametric method that allows us to calculate the relative efficiency of national education systems based on multiple inputs and outputs that may be expressed in different units. The selection of proper inputs and outputs is a key step in the analysis.

### 3.1 Data and Methodology

In our analysis, we use the indicators listed and described in Table 3.

Table 3: Indicators for efficiency assessment of education systems

Indicator	Meaning
Teachers	Number of teachers in primary, secondary and tertiary education (in year 2012)
Students	Number of full time students in primary, secondary and tertiary education (in year 2012)
Youth employment rate	Number of employed 15 – 24 years old people as a percentage of the youth labour force (in year 2012)
GDP per capita, (PPP)	Gross domestic product per capita converted to international dollars using purchasing power parity rates (in year 2012)

Source: the authors.

We take into account the values of given indicators from the year 2012 since it is the latest year for which data is available for sufficient number of OECD countries.

We apply two DEA models in which the roles of teachers and students will be different in the sense of inputs and outputs. Teachers are considered as input and students as output in Model 1, and vice versa in Model 2.

The number of teachers taken as a unique input in Model 1 represents the labour costs which form a substantial part of education expenditure in OECD countries. World Bank database reports the share of all staff compensation on total expenditure in public education institutions in year 2011 varies from 49.5% in the Czech Republic up to 85.5% in Mexico. Students as an output indicator estimate the total range of services provided by the education system.

Besides that, we include other two outputs, youth employment rate and GDP per capita, as external measures of the quality of education systems. Youth employment rate is considered as a quality indicator since the preparation of young people for the labour market is one of the key functions of the education system. Also, the system is expected to positively influence the GDP of the country. However, GDP cannot be considered as directly controlled by the education system since it may be strongly influenced by other factors (e.g., by the use of natural resources of a country). That is why we incorporate GDP per capita as a non-controllable variable, and we apply Non-controllable Variable DEA model (NCN). For a comprehensive review of DEA including NCN see Cooper et al. (2007).

The number of students is a unique input in Model 2 and represents the estimation of total education expenditure since a high correlation between the number of students and the amount of education expenditure is observed. Teachers as an output in Model 2 are considered as a quality indicator since a higher number of teachers for given number of students is expected to provide better education services. The other two output indicators are taken the same as in Model 1.

Table 4 introduces input and output data for selected 20 OECD countries to be assessed by DEA models. The other OECD countries were excluded due to missing data for chosen indicators in year 2012.

Table 5 summarizes the main characteristics of applied DEA models. In Model 1 we focus on the teaching staff from economic perspective, i.e., a country is considered more efficient if it is capable to provide education for given number of students with a smaller teaching staff

and thus with a smaller amount of expenditure. Therefore, Model 1 is input-oriented. On the contrary, Model 2 is centred on the quality of education which is provided by the teaching staff and externally verified by labour market (via youth employment rate) and by the economic performance of a country (measured by GDP per capita). A country is more efficient by this model if it manages to serve the given number of students with a larger teaching staff. That is why Model 2 is output-oriented.

Table 4: Input and output data for DEA models

Country	Teachers	Students	Youth employment rate	GDP per capita, (PPP)
AUT	155 061	1 413 363	90.6	44 850
CHL	216 005	4 066 225	83.7	21 183
CZE	112 085	1 694 859	80.5	28 632
FIN	86 616	1 071 674	82.2	40 209
FRA	810 101	12 372 118	76.1	37 256
HUN	147 096	1 629 982	71.8	22 556
JPN	1 566 112	18 097 023	92.1	35 598
LUX	11 460	85 719	81.2	91 351
MEX	1 560 384	30 257 423	90.7	16 117
NLD	282 340	3 621 052	90.5	46 379
NZL	73 250	1 108 648	82.0	*33 498
POL	617 618	6 805 465	73.5	23 340
PRT	186 934	1 827 801	62.1	27 000
SVK	71 833	940 343	66.0	25 802
SVN	28 634	344 189	79.4	28 436
ESP	669 456	8 078 542	47.1	32 388
SWE	165 808	1 731 405	76.3	43 869
CHE	156 124	1 359 201	91.6	55 857
TUR	870 505	18 540 971	82.5	18 196
USA	4 859 244	69 498 473	83.8	51 457

Note: \*Estimated using linear regression, based on previous 10 years

Source: the authors based on data from UNESCO, OECD and World Bank.

Although these two viewpoints are in contradiction, both they are relevant and it is necessary to find a balance between them when building a really efficient and effective education system.

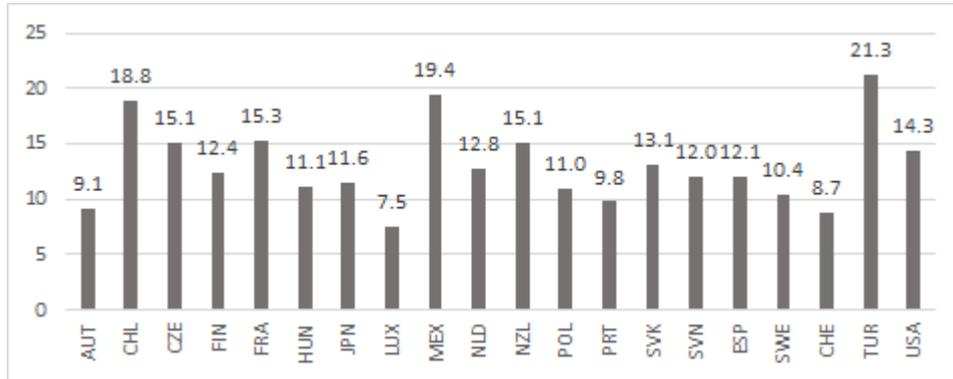
Table 5: Characteristics of applied DEA models

	Model 1	Model 2
Input	Teachers	Students
Outputs	Students Youth employment rate GDP per capita (PPP)	Teachers Youth employment rate GDP per capita (PPP)
Orientation	input	output
Returns to scale	variable	variable
DEA model	NCN-I-V	NCN-O-V

Source: the authors.

Thus, our DEA models touch the question of optimal setting for students/teacher ratio. Figure 4 illustrates differences across countries in the students/teacher ratio. The ratio is highest in Turkey, Mexico and Chile which belong to the countries with the highest share of students on the total population (see Table 2). This coincides with a high correlation between students/teacher ratio and the share of students on the total population of a country.

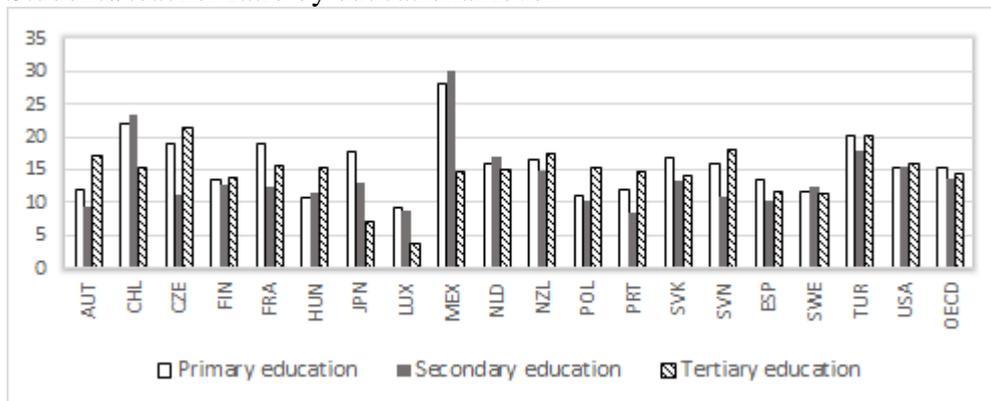
Figure 4: Students/teacher ratio



Source: the authors, based on UNESCO data.

In Figure 5 we see interesting differences in students/teacher ratio by educational level (excluding Switzerland because of missing data). The OECD average is around 15 students per teacher, with only slight differences between the educational levels. However, the ratios in educational levels are rather different in some countries. In Chile, Japan, Luxembourg, and Mexico, the ratio is significantly higher in primary and secondary education than in tertiary education. On the contrary, Austria, Czech Republic, Hungary, Poland, Portugal, and Slovenia show much higher ratio in tertiary education than in the lower levels.

Figure 5: Students/teacher ratio by educational level



Source: the authors, based on OECD data.

### 3.2 Results

Table 6 compares the results of both designed models.

Ten OECD countries are efficient by both models. Since we assume variable returns to scale, two of them are efficient by default due to the minimum value in some input or the maximum value in some output among selected countries. Luxembourg has the lowest number of students and teachers, and the highest GDP per capita, and Japan has the best value of youth employment rate. Technical efficiency is reached by countries with the highest values of the students/teacher ratio (Turkey, Mexico, Chile) as well as by countries with the

lowest values of the ratio (Luxembourg, Austria, Switzerland). The group of efficient countries by both models is completed by Hungary, Slovenia, and USA. All these countries seem to have the students/teacher ratio well balanced with respect to considered socio-economic indicators.

Table 6: Results of DEA models

Country	Model 1		Model 2		Peers
	Efficiency	Rank	Efficiency	Rank	Model 1 / Model 2
AUT	1	1	1	1	AUT / AUT
CHL	1	1	1	1	CHL / CHL
CZE	0.840	14	0.981	14	CHL, LUX, SVN, TUR / AUT, CHL, JPN, SVN
FIN	0.827	15	0.944	16	CHL, LUX, NZL, CHE / AUT, SVN, CHE
FRA	0.721	16	0.834	20	LUX, SVN, TUR / AUT, CHL, JPN, MEX
HUN	1	1	1	1	HUN / HUN
JPN	1	1	1	1	JPN / JPN
LUX	1	1	1	1	LUX / LUX
MEX	1	1	1	1	MEX / MEX
NLD	0.912	13	0.994	13	AUT, MEX, CHE, TUR / AUT, JPN, CHE
NZL	1	1	0.978	15	NZL / AUT, CHL, SVN
POL	0.537	19	1	1	CHL, SVN, TUR / POL
PRT	0.530	20	1	1	CHL, SVN, TUR / PRT
SVK	1	1	0.867	19	SVK / CHL, HUN, POL, SVN
SVN	1	1	1	1	SVN / SVN
ESP	0.576	17	0.925	17	LUX, SVN, TUR / JPN, POL, CHE
SWE	0.552	18	0.904	18	LUX, TUR, USA / AUT, POL, PRT, CHE
CHE	1	1	1	1	CHE / CHE
TUR	1	1	1	1	TUR / TUR
USA	1	1	1	1	USA / USA
Average	0.875		0.971		
Std. Dev.	0.179		0.049		
Minimum	0.530		0.834		

Source: the authors.

New Zealand and Slovakia are efficient only by Model 1. On the other hand, Poland and Portugal are efficient by Model 2, but they reach the lowest efficiency scores by Model 1. Both these countries belong to those with the lowest students/teacher ratio.

Much higher differences in efficiency scores among countries are identified by Model 1 than by Model 2. Four countries (Finland, France, Spain, and Sweden) are assigned efficiency scores below average in both models.

#### 4. Conclusion

We analysed the development of education expenditure in OECD countries in years 2000 – 2011. The expenditure was considered as % of GDP, GNI, or total government expenditure. Significant differences among the highly developed countries were observed not only in the absolute values of the indicators, but also in their trends. While the majority of OECD countries increased the shares of education expenditure or kept them stable, some countries (Estonia, Hungary, Italy, Norway, and Poland) showed a reverse trend. Mexico and USA also significantly decreased education expenditure compared to the total government expenditure, but kept stable or even increased the share on GDP and GNI. Denmark, Iceland, and New Zealand show the highest share of education expenditure on both GDP and GNI, and along with Chile, Mexico, Norway, and Switzerland spend the highest portion of government

expenditure on education. On the contrary, Czech Republic, Italy, Japan, and Slovakia attain low values in all three indicators.

In the second part of our study we dealt with the students/teacher ratio which may be differently interpreted from different efficiency viewpoints, depending on whether we focus on the quality or on the economy of education systems. The ratio also exhibits surprisingly large differences among OECD countries as well as between primary, secondary and tertiary educational levels within the countries. We designed two DEA models which reflect the ambiguous character of students/teacher ratio and its different interpretations by alternating the roles of students and teachers as inputs and outputs of education systems. In both models, we considered youth employment rate as a controllable output and GDP per capita as a non-controllable output of education systems to provide external measures of their quality. We conclude that countries which are efficient by both models manage to have the students/teacher ratio well balanced regarding to their socio-economic environment.

A further research of the specific production process performed by education systems during a longer time period is needed to enhance the designed simple models and to identify key factors influencing the success of nations in using public and private expenditure to build systems which are capable to provide education of high quality and in economically efficient manner.

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