

EFFICIENCY OF PUBLIC EXPENDITURE ON EDUCATION: COMPARING CROATIA WITH OTHER NMS

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Abstract

Modern economies are becoming more knowledge-intensive and service-oriented, which makes human capital more important than ever for mid-term and long-term growth. Therefore, education, the main channel of governments' influence on human capital formation, became important research subject in the field of economic growth. This paper examines efficiency of public expenditure on secondary and tertiary education in the New Member States (NMS) in EU; only efficient government spending can generate adequate returns in terms of contribution to economic growth. Data Envelopment Analysis (DEA) is applied to assess relative technical efficiency of public expenditure on secondary and tertiary education in NMS, with a particular focus on Croatia. Input variables are public expenditure on education per student and as % of total education expenditure, while output variables for secondary education are PISA results and for tertiary education share of unemployed with a tertiary education and Shanghai ranking of leading national universities. The results show high inefficiency of public spending on education in Croatia.

Keywords: education, technical efficiency, public expenditure on education, Data Envelopment Analysis, New Member States EU.

1 INTRODUCTION

Growing literature on efficiency of education systems identified educational attainment as a key factor of employment and earnings [1]. Findings were in line with economic theory and research of determinants of economic growth. This line of research pointed at education as an important source of human capital formation and economic growth. Growth is related to technological progress which requires more skilled and qualified labor. Investment in education also delivers other benefits for society such as higher life expectancy for better educated citizens and greater participation in social and civic life [2]. Also, public expenditure on education is one of the most sizeable functional government expenditures so it has substantial impact on allocation of resources.

Developed societies need more educated people to contribute to further technological advancement. On the other hand, sizeable fiscal deficits and public debts call for higher fiscal responsibility and increased efficiency of public expenditures. The policy attitudes regarding this trade-off are different across the EU member states.

According to Eurostat public expenditure on education in EU-28 in 2015 amounted to 4.9 percentage of GDP on average, of which secondary and tertiary education accounted for 1.9 and 0.7 percentages respectively. In 2007-2015 period, government expenditure on education as a ratio to GDP remained relatively stable at around 5.1 percent. However, the amount of public money devoted to education differs across member states. The highest amounts of overall public expenditure on education were reported by Iceland (7.5 percent of GDP) and the lowest by Romania (3.1 percent of GDP). Croatia is close to EU average with 4.7 percent of GDP. Notwithstanding such differences, the question remains: how efficient is use of these resources?

Research on educational performance is organized in two parallel streams of economic literature. One is related to literature on endogenous economic growth. Growth theory suggests that education is a key to sustained economic growth (e.g. [3]; [4]; [5]; etc.). Empirical studies often provide mixed results on the influence of human capital formation on growth (e.g. [6]; [7]). Afonso and St. Aubyn [8] found that education contributes to growth positively, but it is not always statistically significant. However, most of cross-country growths regressions tend to find a significant positive correlation between quantity of schooling (measured by the average numbers of years of education) and economic growth (e.g. [9]; [10]; [11]).

Some researchers argue that education quality is more important than quantity. Barro ([12]; [13]) and Hanushek and Kimko [14] showed that PISA international score for science, math and reading matter more than years of schooling for economic growth. In his recent work, Trabelsi [15] examined the existence of a quality education threshold effect on the relationship between public expenditure on education and economic growth. His results imply that public expenditures promote growth only after quality of education exceeds a certain threshold.

Another stream of literature is focused on direct measurement of educational efficiency. The 'efficiency literature' examines the transformation of various inputs (e.g. student-related, family-related, community-related inputs or institutional variables such as public expenditures) into outputs (e.g. number of graduates, students' test scores, attendance rate, enrollment, employability). Provision of public education is considered efficient if it makes the best possible use of available inputs. The toolbox to assess the efficiency in education can be classified into two groups: non-parametric methods based on mathematical optimization (such as Data Envelopment Analysis, Free Disposal Hull, Order-m frontiers, meta-frontier, etc.) and parametric approaches such as the Stochastic Frontier Analysis SFA [16]. Data Envelopment Analysis (DEA) in its various forms is popular among researchers because it can be used as input or output-oriented model and can operate with multi-input and multi-output variables [17].

Research of efficiency in education focuses either on different teaching levels (primary, high-school or university-tertiary level) or county/district level. A smaller group of research focuses on the national level and cross-country analysis [18]. It is surprising that cross-country studies are so rare because they can provide useful information on efficiency benchmarks which are particularly important since education competes with other areas of public expenditure in the budgetary resources allocation process.

Lack of international comparative studies on 'spending efficiency' on education prompted us to contribute to the literature by analyzing public education services in NMS of EU. The group of new EU member states includes Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia (Cyprus and Malta are not included due to lack of data). What follows is a brief overview of the relevant literature that supports this research.

Studies of efficiency of government spending on education in a cross-country perspective (e.g. [19]; [20]; [21]; [22]; [23]; [24]; [26]; [27]; [28]; [29]; [30]; [31]; [32]; [33]; [33]) mainly used DEA method to assess educational performance in a sample of European and/or OECD countries. Availability of internationally standardized data (PISA) allowed for analysis of quality of the secondary education. Research of higher educational systems in the EU and OECD countries is still largely missing due to lack of comparable data.

Clements [19] applied a frontier technique called Free Disposable Hull (FDH) on OECD data. He analyzed relative performance of EU countries in terms of expenditures per student and student-teacher ratio as proxies for financial and human resources employed on the input side and attainment in international standardized tests TIMSS (Trends in International Mathematics and Science Study) as outputs. Results indicated that observed countries could achieve educational output with 25% fewer resources on average. Afonso and St. Aubyn [21] measured educational performance in 25 OECD countries 2000-2002 by comparing country's average PISA test results as output, and student-teacher ratio and time spent at school as inputs. This research showed that countries should improve their educational performance by 11.6 percent using the same resources. Improvements were found to be closely related to country's level of development as measured by GDP per capita and educational attainment of adult population. Gimenez et al. [23] used similar non-parametric DEA model to assess efficiency scores of educational systems for 31 countries, by applying various measures of students' socioeconomic background on the input side and TIMSS 1999 test scores as output. Authors found that the most efficient educational systems can be found in post-communist countries. A large number of developed countries could increase students' performance by using fewer resources than those actually allocated to education.

Aristovnik [27] examined technical efficiency of education systems in 37 EU and OECD countries including Croatia 1999-2007. Author used DEA approach separately for primary, secondary and tertiary education. Expenditures per pupil/student in % of GDP per capita in three educational sub-systems were used as inputs. Outputs/outcomes' variables were PISA 2006 average scores, enrolment and completion rates. For output measures of tertiary education author used % of labor force with tertiary education and tertiary unemployment rate. Results revealed high inefficiency of Croatian education system. Similar findings were found by Aristovnik and Obadić [28] who focused on

technical efficiency of secondary education in 31 countries of EU and OECD 1999.-2007. In four models that they employed when results are combined, Croatia is ranked in the fourth quartile.

Agasisti [29] measured spending efficiency on education in the group of 20 European countries. He extended analysis to two subsequent periods using PISA test scores in 2006 and 2009 as outputs, and expenditure per student and student-teacher ratio as input variables. The results showed that groups of efficient and inefficient countries remained quite similar in 2006 and 2009. Switzerland and Finland appear as benchmark for efficient group, while Greece and Portugal hold the position at the bottom. Also, the same educational performance could be achieved by 10% savings of resources. In the second stage, the efficiency scores are regressed against socio-economic variables such as unemployment rate and GDP per capita as well as against structural features of educational system such as internet usage (as a proxy for technical literacy) and teachers' salaries. Unlike GDP p.c. structural variables have a positive impact on educational performance.

Gavurova et.al [33] applied output-oriented DEA model in the cross-country perspective to assess the efficiency of public expenditure on secondary education in selected European countries in 2015 using PISA test scores in math, reading and science as outputs and public expenditure on the secondary education as % of GDP in 2014 as inputs. The results showed relatively high educational performance in selected countries. In terms of usage of public resources on the secondary education the highest efficiency scores among NMS were observed in Estonia and Slovakia along with Finland, Ireland, Sweden, Norway and Switzerland. However, most of NMS countries were found in a group of inefficient countries with efficiency scores under the average. Three of NMS countries, Poland, Slovenia and Croatia, have efficiency scores higher than average but were not included in the efficient group of countries. Gavurova et. al. [33] conclusions on Croatian educational system differ somewhat from earlier studies of Aristovnik [27] and Aristovnik and Obadić [28] which calls for further research presented in this paper.

The next section contains an overview of methodology and data with brief descriptive analysis. In the third section the results are presented and compared with previous ones, showing high degree of inefficiency in line with Aristovnik [27] and Aristovnik and Obadić [28]. Fourth section contains policy discussion and presents conclusions.

2 METHODOLOGY AND DATA

This section describes Data Envelopment Analysis (DEA) and provides an overview of input and output data.

2.1 Data Envelopment Analysis (DEA)

DEA is a deterministic, non-parametric, linear programming technique that provides a piecewise frontier by enveloping the observed data points, and yields a convex production possibilities set. It was popularized by Charnes et al. [34] and developed to measure relative efficiency of decision making units (DMU). Although this method was mostly used in microeconomic research on firm efficiency, later research expanded its application to various macroeconomic topics including efficiency of public expenditure (see literature review).

DEA score reflects the distance between the respective data point, in this paper a country, and the best practice point which lies at the frontier. The countries (data points) on the frontier are given score of 1 while those inside the frontier are given a score between 0 and 1. DEA provides a measure of relative efficiency, meaning that it indicates that a country is the more efficient relative to the other countries in the sample. It does not provide absolute, theoretically founded efficiency criteria.

Input-oriented DEA with variable returns to scale (VRS) is used in this research. For detailed discussion on the differences between input and output approach and variable and constant returns to scale see Coelli [35]. For the public sector, it is reasonable to assume that it is easier to control the inputs rather than the outputs which are also hardly measurable. VRS assumption is applied to eliminate the scale effect, in case some countries are not operating at optimal scale.

Following Adam et al. [36], our model supposes M inputs and S outputs for N countries. Each country uses a vector of nonnegative inputs to produce a vector of nonnegative outputs. The efficiency scores are obtained by solving the optimization problem of the following form for a given country where the inputs are minimized while the outputs remain at their current levels:

$$\theta^* = \min \theta \quad (1)$$

subject to

$$\sum_{j=1}^n \lambda_j X_{ji} \leq \theta x_{i0} \quad i = 1, 2, \dots, m; \quad (2)$$

$$\sum_{j=1}^n \lambda_j y_{rj} \geq Y_{r0} \quad r = 1, 2, \dots, s; \quad (3)$$

$$\sum_{j=1}^n \lambda_j = 1 \quad (4)$$

$$\lambda_j \geq 0 \quad j = 1, 2, \dots, n; \quad (5)$$

where country N_0 represents one of the N countries under evaluation, x_{i0} and y_{i0} stand for the i -th input and r -th output of the country N_0 . Symbol θ is a scalar which represents the efficiency score of the country N_0 . It measures the distance between each country and the efficiency frontier, which is the linear combination of best performing countries. If θ equals 1 it means that it is not possible to proportionally reduce the input quantities for the selected country, indicating that it is on the efficiency frontier. If θ is lower than 1, it indicates an inefficient country inside the frontier. Vector λ represents weights in a linear combination of positions of efficient countries which projects inefficient country N_0 from its real position below the efficient frontier (we can mark this position as A) to the "artificial" position on the frontier (we can mark this position as A'). Difference between position A and position A' is θ . The restriction $\sum_{j=1}^n \lambda_j = 1$ imposes a convexity assumption, indicating variable returns to scale. The problem has to be solved for each of the N countries in order to obtain the efficiency coefficients.

2.2 Data

Research is based on publicly available secondary data obtained from the web sites of international institutions. Data on PISA results were obtained from OECD database. Data on expenditure on secondary education were obtained from UNESCO database on education and data on expenditure for tertiary education are from the World Bank database on education.

2.2.1 Secondary education

Input is expenditure on secondary education as a percentage of government expenditure on education. PISA results (averages for three dimensions) are output variables. Input variables are constructed in a way that they represent the average of expenditures four years before, and a year of PISA test (due to the lack of data, expenditures for PISA test 2015 are averaged for the period 2010-2013 or 2014, depending on the availability; also, it is important to point out that UNESCO dataset does not contain data for Croatia for every year - data is available for 2007, 2011, 2012 and 2013).

For example, for PISA results in 2009 we use average data on expenditures from 2005-2009. Quality of education cannot improve within a one-year period as it takes time for positive effects of increased spending (e.g. higher wages for teachers, digitalization etc.) to materialize.

Fig.1 (a) - (c) shows the "efficient frontier" by connecting the (efficient) countries on "edges" of the sample. Those countries are in DEA analysis called "benchmarks" and it is clear that Lithuania, Estonia and Poland lie at the efficiency frontier or very close to it in all three PISA years.

These figures suggest that most countries are not using their inputs efficiently. Most of them are positioned relatively far from the efficiency frontier. From 2009 to 2015 positions of the countries below the efficient frontier became more condensed and most of the countries drifted away from the frontier which is in line with the well-known finding that average PISA scores did not improve recently. Probability of these observations will be analytically tested in the next section of the paper.

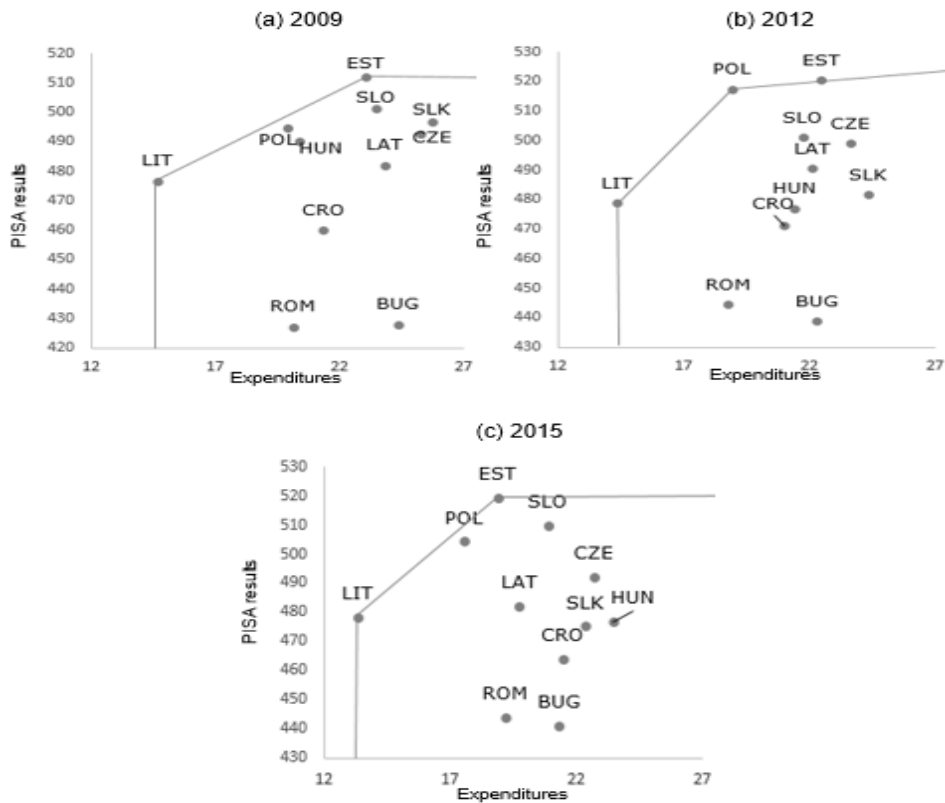


Figure 1. Expenditure on secondary education vs PISA results

2.2.2 Tertiary education

Input in the analysis of the efficiency of expenditures on tertiary education is expenditure on tertiary education per pupil in percentage of GDP per capita. Output is the share of unemployed with tertiary education in the total number of unemployed. Inputs and outputs are based on 2005-2013 averages.

It is impossible to distinguish between labor market characteristics and quality of educational output when tertiary unemployment is used as a measure of output. Therefore results' robustness check is provided by using the World University Ranking list as an alternative output measure. As unemployment is "undesirable output" (see Adam et al. [36]) output data had to be adjusted by subtracting the shares from 10 in order to calculate "inverted tertiary unemployment rate" with higher figures indicating lower shares of tertiary unemployment in total employment. Fig. 2 shows that most NMS are relatively close to the efficient frontier except Croatia.

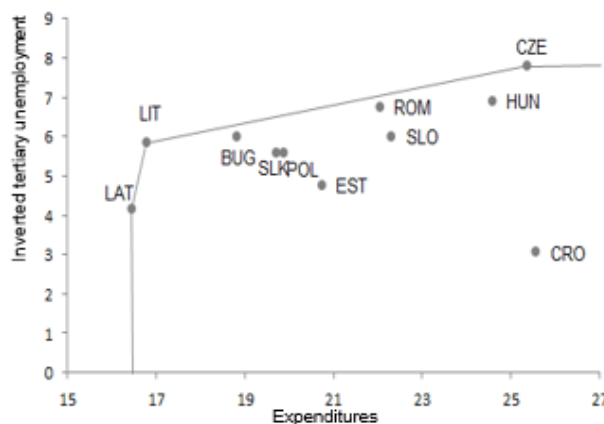


Figure 2. Expenditure on tertiary education vs inverted tertiary unemployment rate

3 RESULTS

Tables below contain efficiency scores, data on real inputs, optimal inputs, i.e. level of inputs which countries could use to keep the outputs at the same level, and a column with possible reduction of inputs which can be seen as a measure of “resource wastefulness”.

3.1 Secondary education

Results for efficiency of expenditure on secondary education in relation with PISA results in 2009, 2012 and 2015 are presented in Tab.1.

Table 1. DEA results for expenditure on secondary education

2009	Efficiency score	Real input	Optimal input	Possible reduction	2012	Efficiency score	Real input	Optimal input	Possible reduction
Estonia	1	23.1	23.1	0	Estonia	1	22.5	22.5	0
Lithuania	1	14.7	14.7	0	Lithuania	1	14.4	14.4	0
Poland	0.95	19.9	19	0.9	Poland	1	18.9	18.9	0
Hungary	0.87	20.4	17.8	2.6	Slovenia	0.78	21.7	16.9	4.8
Slovenia	0.87	23.4	20.4	3	Romania	0.77	18.8	14.4	4.4
Slovakia	0.76	25.8	19.5	6.3	Latvia	0.71	22.1	15.8	6.3
Czechia	0.73	25.3	18.5	6.8	Czechia	0.71	23.6	16.7	6.9
Romania	0.73	20.2	14.7	5.5	Croatia	0.69	21	14.4	6.6
Croatia	0.69	21.4	14.7	6.7	Hungary	0.67	21.4	14.4	7
Latvia	0.67	23.8	15.9	7.9	Bulgaria	0.65	22.3	14.4	7.9
Bulgaria	0.6	24.4	14.7	9.7	Slovakia	0.61	24.3	14.7	9.6

2015	Efficiency score	Real input	Optimal input	Possible reduction
Estonia	1	18.9	18.9	0
Lithuania	1	13.3	13.3	0
Poland	0.96	17.6	16.8	0.8
Slovenia	0.84	20.9	17.6	3.3
Latvia	0.7	19.8	13.9	5.9
Romania	0.7	19.2	13.3	5.9
Czechia	0.67	22.7	15.2	7.5
Bulgaria	0.63	21.3	13.3	8
Croatia	0.62	21.4	13.3	8.1
Slovakia	0.6	22.3	13.3	9
Hungary	0.57	23.4	13.3	10.1

Source: authors

Two Baltic countries were on the efficient frontier in 2009 - Estonia and Lithuania, while Poland was near the efficient frontier. Croatia ranked among bottom three countries, with the efficiency score of 0.62. In 2012 Estonia and Lithuania kept their position at the efficient frontier and Poland joined efficient group. Croatian position changed to the fourth place from the bottom of the scale as more countries recorded weaker scores. Finally, in 2015 Poland drifted away from the efficient frontier, which made only Estonia and Lithuania benchmark countries. Croatia worsened its position, moving back to the group of three weakest performers. Croatia could reduce share of expenditures on secondary education by 6.6-8.1 percentage points, while keeping its PISA results unchanged. Results for Croatia are mostly in line with conclusion of Aristovnik [27] and Aristovnik and Obadić [28].

3.2 Tertiary education

Efficiency scores presented in Tab.2 are based on the relationship between expenditures on tertiary education per pupil in percentage of GDP per capita and “inverted tertiary unemployment rate”.

Table 2. DEA results for expenditure on tertiary education

	Efficiency score	Real input	Optimal input	Possible reduction
Czechia	1	25.4	25.4	0
Latvia	1	16.5	16.5	0
Lithuania	1	16.8	16.8	0
Romania	0.95	22.1	20.9	1.2
Bulgaria	0.92	18.8	17.3	1.5
Hungary	0.87	24.6	21.3	3.3
Poland	0.85	19.7	16.7	3
Slovakia	0.84	19.8	16.7	3.1
Slovenia	0.8	20.7	16.6	4.1
Estonia	0.77	22.3	17.3	5
Croatia	0.65	25.6	16.5	9.1

Source: authors

Czech Republic, Latvia and Lithuania represent benchmarks. Most countries are close to the frontier as their scores move in 0.8-0.95 region, indicating similarity of tertiary education systems. Estonia and Croatia are found to be exceptions. Croatia is the weakest performer in the sample with efficiency score of modest 0.65, which translates into the possible reduction of inputs of high 9.1 percentage points of GDP per capita. This result closely resembles findings of Obadić and Aristovnik [37] who found that Croatia could significantly reduce its average expenditures on higher education per student by around 10 percentage points.

3.2.1 Tertiary education - robustness check

Although share of unemployed with tertiary education in total unemployment can give some insights in the quality of education, this indicator is also strongly dependent on the structural characteristics and dynamics in the labor market.

Thus, in this subsection we provide a robustness check by replacing this output with new one - best ranked universities from observed countries in the World University Ranking list. Countries with best rankings of universities are attached value of 6 and worst ranked of 1. The results of this robustness test are presented in Tab. 3.

Table 3. DEA results for expenditure on tertiary education – robustness test

	Efficiency score	Real input	Optimal input	Possible reduction
Czechia	1	25.4	25.4	0
Latvia	1	16.5	16.5	0
Lithuania	1	16.8	16.8	0
Poland	1	19.7	19.7	0
Estonia	0.95	20.7	19.7	1
Bulgaria	0.88	18.8	16.5	2.3
Slovakia	0.84	19.9	16.8	3.1
Slovenia	0.75	22.3	16.8	5.5
Romania	0.75	22	16.5	5.5
Hungary	0.74	24.6	18.3	6.3
Croatia	0.71	25.6	18.3	7.3

Source: authors

The results have not changed notably compared to Tab. 2. In Tab. 3 Czech Republic, Latvia and Lithuania are still on the efficient frontier, which now also includes Poland. Croatia is again the worst performer. Results indicate that Croatia could decrease input by 7.3 percentage points to keep the ranking of its university unchanged (vs 9.1 in previous model) which indicates robust findings.

4 DISCUSSION AND CONCLUSIONS

Input-oriented DEA approach used in this research showed that Croatian educational system is a laggard among NMS. Problem is especially pronounced in tertiary education. The result is robust and in line with the most of previous empirical tests. In general, the finding is that there is a room for substantial reduction of inputs, up to 10%, and the results suggest that such savings of public funds might be attainable without significant deteriorations of educational outputs.

This is controversial, of course. The final discussion presents two arguments for interpreting the conclusion with a grain of salt and one argument which speaks strongly in its favor. Presentation of these arguments sets the stage for further research.

Firstly, measuring output in secondary education by average PISA scores of three dimensions involves significant error when there are large variations in results across dimensions. Indeed, this is the case in Croatia. According to PISA scores 2015, Croatian results for reading (close to OECD average and improved since 2006) are better than for math and science (not close to OECD average and stable and declining since 2006). Ideally, research should be conducted on mezzo level with inputs allocated to three dimensions in order to obtain credible results that might provide more specific guidance to policy makers. In general, mezzo and micro research in this field is highly recommended in order to raise credibility, attention and usefulness for policy makers and practitioners. Research on primary education should be included as well.

Secondly, DEA's strict separation of inputs from outputs in a complex system such as education is artificial. There are links between inputs and outputs within individual education systems, and most of these links are probably not reflected in the data used in the type of research presented here. It is precisely the nature of these missing links which limits the relevance of conclusions of the type "it is possible to reduce input by x% without affecting output". DEA in general provides very useful detection of problems and performance, but it is weak in providing the basis for normative and prescriptive policy recommendations. One way to (partly) overcome this problem is to be more confident about what is actually measured. For example, finding the stable relationship between educational outcomes and economic growth would indirectly imply finding the relationships between inputs and growth in a more complete model; and the more complete the model, the more confident one may be that manipulating inputs won't affect growth negatively. This is especially important because time lags in materialization of policy effects (of effects both on output-performance and on input-output relationships) limit our knowledge of cause and effect in managing government functions.

Thirdly, and this is the argument in favor of policy relevance of findings presented in this paper, allocative inefficiency of use of public resources is always a cause of concern. It should be of special concern at times of fiscal strain. Croatia has the highest public debt and the interest payments to GDP ratio among NMS. It is the only one in this group of countries with output still below 2008 level. Prolonged recession (that lasted until late 2014) was coupled with fiscal deficits and accumulation of public debt which will remain very high for years to come. In a situation like this, usual trade-offs and conflicts about tight fiscal resources escalate. This is a situation which substantially differs from the more comfortable fiscal situations, when policy makers can exploit luxury of demanding highly reliable analytical results on efficiency of allocation of public resources before undertaking any decisions. In tight fiscal situations, any indication on inefficiency can be useful as it may help avoid linear budget cuts. Linear budget cuts hit useful public expenditures invested in efficient programs and worsen overall public sector performance. While policies based on DEA and similar analytical findings should be based on comparison of results across functional areas of the government, even macro findings at level presented in this paper are superior to alternative political allocation mechanisms, such as relative political strength of individual ministers and their public relations abilities.

This paper represents the first part of our broader analysis. In future research we will combine these results of technical efficiency of public expenditures on education with growth regressions in order to estimate both narrower productivity of educational systems and their impact on economic growth.

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