Determinants of Public Health Care, Education and Administration Efficiency in Central, Eastern and South Eastern Europe

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This paper explores determinants of public sector efficiency in 15 Central, Eastern and South Eastern European (CESEE) countries and identifies areas for improvement.

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Using Data Envelopment Analysis (DEA) and panel Tobit regressions, we analyse the efficiency of public expenditures on health care, education, and public administration. Empirical results indicate that the level of economic development, economic activity, demographics, level of education, and quality of institutions act as important determinants of public sector efficiency.

Keywords: public expenditure efficiency, Central, Eastern and South Eastern European countries, Data Envelopment Analysis, panel Tobit

1. Introduction

Recent demographic and economic trends present a substantial challenge for public finance sustainability and management in most European countries. An ageing population is exerting pressure on public health and social protection expenditure, whilst globalisation is opening up borders to the free movement of capital and tax competition, causing the erosion of the public revenue base. Space for further increase in public expenditure is limited and the need for a more efficient use of existing resources is becoming inevitable. Public expenditure efficiency is thus becoming an increasingly popular area of research.

Efficiency analyses can be conducted for overall public expenditure or for individual expenditure categories. As the literature has shown, the growth effects of different expenditure items are different and so is the structure between countries. With this in mind, greater attention is directed at larger public functions because efficiency improvements in those areas could have a more significant effect on overall expenditure efficiency. Smaller functions that have important growth implications, however, should not be neglected.

The aim of this paper is to investigate the efficiency of public expenditure in the Central, Eastern and South Eastern European (CESEE) region. As available data show, this sample has not previously been investigated, most likely due to a lack of data availability, which has also been a challenge in the case of this analysis. Special attention will be given to the efficiency of individual large public expenditure categories: education, health care, and public administration. These are large and important public activities and their efficiency is key to public finance sustainability. In that respect, a Data Envelopment Analysis (DEA) will be carried out to obtain mea-

sures of relative efficiency and Tobit regression will be used to analyse the effects of efficiency determinants. This paper is organised as follows: the second section provides a brief literature review, the third section presents the methodology used in the paper, the fourth section describes the data, and the fifth section presents the results of the efficiency analysis. The paper ends with a conclusion and policy recommendations.

2. Literature Review

Interest in research on public expenditure efficiency has risen substantially over the last decade. Education and health care efficiency analyses are the most common in the literature, due to their important growth effects through labour productivity, human capital accumulation, and their large share in total public expenditure. On the other hand, public administration is not a frequent subject of analysis. Usually it is part of a broader analysis of public sector performance indicators (PSP), including overall efficiency analysis. Regarding CESEE countries, literature on public sector efficiency is relatively scarce. This is why the literature review is based on available literature on health care, education, public administration, and overall efficiency, with an emphasis on CESEE countries where results are available.

Efficiency is a concept used to explain the relationship between input and output in order to objectively measure the performance of public activities. For an overall efficiency analysis, the most common input variable is total government expenditure (% of GDP), whilst the most common outputs are the per capita GDP growth rate and the public sector performance indicator (PSP). Some researchers also use the Human Development Index (HDI) as the output (Prasetyo, 2013). Regarding empirical analysis, the prevailing opinion in the literature is that there is significant potential for expenditure savings in many countries. Afonso, Schuknecht and Tanzi (2005) show that, on average, countries could attain the same output using only 80% of their resources. They conducted a free disposal hull (FDH) analysis on a sample of 23 industrialised countries in 1990 and 2000. Interestingly, small governments turned out to be the most efficient amongst industrialised countries, implying diminishing marginal returns of higher public spending. In a later paper, Afonso, Schuknecht and Tanzi (2010) confirmed the results for 12 EU countries, this time using Data Envelopment Analysis (DEA)/Tobit regression, and found that countries could attain the same output with 45% fewer resources. Ac-

cording to public sector performance (PSP) and public sector efficiency (PSE) indices, countries with public expenditure of around 30% of GDP tend to be the most efficient. Bađun, Pribičević and Deskar-Škrbić (2014) found the average optimal government size for old EU member states to be larger than the size for new EU member states. They applied a DEA/Tobit input-oriented methodology to a sample of EU member states plus Iceland and Norway, and found that countries should, on average, reduce their general government expenditure (% of GDP) by 3.54 p. p. to reach the optimal government size, which was 39.21% for the sample.

In education efficiency analyses, monetary measures such as expenditures on education (% of GDP), (public) expenditure per student, or quantitative measures such as hours per year at school are often used as input. Frequent measures of education output are test results (PISA), secondary or tertiary school enrolment, or teacher–pupil ratio. Regarding health care, common monetary inputs in the literature are average public spending on health (% of GDP) or health care spending per capita (private and public), whilst quantitative inputs include the number of doctors, nurses, hospital beds, and the like. The most common health care outputs are infant mortality rate and life expectancy at birth.

Extensive literature on education and health care efficiency has found opportunities for efficiency improvement. Hauner and Kyobe (2010) found that countries can attain the existing educational output with only 70% of resources. They conducted a DEA analysis on 114 developed and developing countries in the health and education sector. European countries were found to be efficient in education but achieved low efficiency scores in the health care sector. Aristovnik (2009) conducted a DEA and an FDH analysis on new EU member states, only to find that there was room to reduce education and health spending whilst retaining the same output. Health care inefficiencies are related to high public expenditures, while education efficiency disappears in the transformation of intermediate output into real outcome. In a subsequent paper, Aristovnik (2011) applied an output-oriented DEA to a sample of 37 EU/OECD countries to analyse efficiency in primary, secondary, and tertiary education, as well as overall education efficiency. The results showed that CEE countries had the potential to improve their efficiency in education. New EU member states showed relatively high efficiency in tertiary education, with the Czech Republic, Latvia, Lithuania, Poland, Slovakia, and Slovenia in the first quartile. Only Romania and Slovakia remained in the first quartile with regard to secondary education. As regards overall education, the lowest scores were recorded in Bulgaria, Romania, and Portugal. Croatia was

shown to have low efficiency, located in the fourth quartile as regards primary education and in the third as regards secondary and tertiary education. Non-EU member states achieved significantly lower efficiency in tertiary education and would need to increase their outputs/outcomes by more than 13% to become efficient. In a similar paper, Obadić and Aristovnik (2011) applied a DEA-VRS output-oriented method to analyse the efficiency of government spending on higher education. The results suggested that Slovenia was more efficient than Croatia and that Croatia should decrease its level of government expenditure per student by up to 10% to become efficient or improve its output. Jafarov and Gunnarsson (2008) ran an output-oriented DEA (variable returns to scale) on EU-12 and OECD countries, paying particular attention to Croatia. They found inefficiencies in the health care and education sectors in Croatia, which scored the lowest in tertiary education and found itself in the last quartile, together with Bulgaria, the Czech Republic, Romania, and Slovakia. Regarding primary and secondary education, the results were not favourable either. Croatia was in the third quartile together with Estonia, Hungary, Latvia, Poland, and Slovenia as regards primary education and in the third quartile along with the Czech Republic as regards secondary education. Romania ranked the highest in primary education; Romania, Poland, Bulgaria, and Lithuania in secondary education; whilst Latvia ranked the highest in tertiary education. Regarding public spending on health care again, Croatia ranked in the third quartile together with Estonia, Poland Slovakia, Slovenia, and Romania. Bulgaria, the Czech Republic, and Latvia ranked in the second quartile, whilst Hungary and Lithuania were in the last quartile. Another paper investigating health care and education expenditure efficiency for 30 OECD countries, authored by Afonso and Aubyn (2005), found that the average input efficiency varied between 0.859 and 0.886 in the education sector, whilst in health care sector it ranged between 0.832 and 0.946. The FDH results for education showed that, on a scale of 1 to 17, Poland and Hungary were fully efficient, whereas the Czech Republic was ranked 6th for input efficiency. The results of the DEA were the same for Poland, whilst Hungary ranked 6th and the Czech Republic 5th. A new approach to measuring the efficiency of the institutes of public health services in Croatia was proposed by Vitezić, Cankar and Janković (2017). The authors used the combination of DEA and BSC methods, thus identifying opportunities to improve the effectiveness of health care. The findings showed a weak and inadequate efficiency measurement system and low effectiveness measurement of Croatian health care services.

Some papers go a step further in analysing the efficiency of public expenditure by identifying the exogenous drivers of efficiency that are out of control of policy-makers. In the health care sector, several studies found that GDP per capita positively affected health efficiency (Samut & Cafrı, 2016; Lionel, 2015; Afonso & Aubyn, 2006a) as well as the level of education (Afonso & Aubyn, 2006a; Samut & Cafrı, 2016). Certain lifestyle factors were found to have a negative effect, such as obesity, smoking habits, alcohol consumption, and consumption of fat or sugar (Afonso & Aubyn, 2006a; Joumard, André, Nicq & Chatal, 2008). Other socioeconomic factors used in the literature have been population density, CO2 emissions, percentage of the population aged 65 and above, poverty, urbanisation, income distribution, unemployment, ethnic origin and/or religion, and occupational status. Institutional factors such as corruption, political stability, and government effectiveness are also frequently included in analyses (Lionel, 2015; Joumard et al., 2008). On the other hand, GDP per capita and parental education are also correlated with a higher level of education efficiency (Afonso & Aubyn 2006b).

When it comes to public administration expenditure efficiency, it was found to be higher in old than in new EU member states (Bađun, Pribičević & Deskar-Škrbić, 2014). Estonia was found to be highly efficient in several studies, whilst Romania and Bulgaria repeatedly achieved poor results, followed by the Czech Republic. Adam, Delis and Kammas (2011) conducted a DEA/SFA analysis on a sample of 19 OECD countries in the period 1980–2000 to analyse the efficiency of public administration, with expenditures on general public services as the input variable and corruption in government followed by bureaucratic quality measures as the output variables. The results showed Switzerland to be the only efficient country in this regard. The first to develop a public administration performance indicator using data for corruption, red tape, quality of the judiciary, and size of the shadow economy were Afonso et al. (2005). They calculated PSP and PSE indicators for a sample of 23 industrialised countries in 1990 and 2000. The results showed that smaller governments were more efficient than medium and large governments. In a later paper, Afonso et al. (2010) computed PSE indicators for 24 countries. Romania, Bulgaria, and the Czech Republic had the lowest efficiency score for the public administration subindicator, whilst Estonia and Slovenia showed the highest efficiency among new member states. In their paper Bađun et al. (2014) conducted a DEA/Tobit analysis on EU/OECD countries and found that among new member states Bulgaria, Romania, and Croatia were the worst performers, whereas Estonia achieved the highest score.

They used the share of expenditure on general government employees' salaries in GDP as the input variable and government effectiveness, regulatory quality, rule of law, efficiency of the legal framework in settling disputes, and the number of days required to start a business as the output variables. Hribernik and Kierzenkowski (2013) conducted a DEA analysis on a sample of 29 OECD countries with a particular focus on Slovenia. They constructed a composite public administration outcome indicator, using data on the quality of justice, level of corruption, government inefficiency, bureaucracy, and the level of administrative burden. The input variable was total government expenditure on general public services per capita. According to input-oriented results, Estonia scored the highest, while Slovakia and the Czech Republic scored the lowest among new member states. Slovenia achieved poor results, indicating it could reduce its expenditure by 50% if it were fully efficient.

3. Methodology: DEA-Tobit Approach

Methods used to measure government efficiency usually rely on the formulation of a production possibility frontier. The most common methods can be divided into parametric and non-parametric ones. The main difference between them is that non-parametric methods do not require a predetermined form of the production function, while parametric ones do. Non-parametric methods use input–output data from a sample to form a production possibility frontier, which links the best performing units in the sample following a mathematical linear programming method. Once formed, the best practice frontier is used to calculate efficiency scores based on the distance of each unit from the frontier.

The most common method used to evaluate efficiency is the Data Envelopment Analysis (DEA). It is a non-parametric linear programming method popularised by Charnes, Cooper, and Rhodes (1978), developed to measure the relative efficiency of decision-making units (DMUs). Its main advantage is that it does not require a predetermined form of the production function. It uses input–output data from the sample to form a production possibility frontier as a linear combination of the best performing units. Efficiency scores are then calculated based on the relative distance of each unit from the frontier. The units on the frontier are given a score of 1, while the units inside the frontier are given a score between 0 and 1. The DEA gives a measure of relative efficiency; therefore, the fact that a unit has an efficiency score of 1 does not imply it is fully efficient.

It only indicates that the unit is more efficient relative to other units in the sample.

The DEA can be either input- or output-oriented. Input-oriented DEA gives information on whether the current level of output could have been attained with less input and if so, to what extent. Output-oriented DEA shows whether greater output could have been produced with the current level of input and if so, to what extent. The literature suggests that orientation should be chosen depending on which of the two the DMU has more control over: the input or the output. With regard to the public sector, it is reasonable to assume that it is easier to control the input rather than the output. In addition, significant attention has been focused on the reduction of government size in some European countries in recent years, so input orientation results would be more useful to interpret in that regard. For that reason, an input-oriented DEA will be conducted in this paper, using DEAP version 2.1. software (Coelli, 1996).

The DEA can assume either constant returns to scale (CRS) or variable returns to scale (VRS). CRS assumption is suitable only when all units are operating at an optimal scale, assuming there is no information asymmetry or market imperfections. In this paper, VRS assumption is applied to eliminate the scale effect in case some countries are not operating at an optimal scale. The VRS model includes the convexity assumption, so efficiency coefficients are calculated by comparing them with coefficients of countries of a similar size.

Our model supposes M inputs and S outputs for N countries. Each unit uses a vector of non-negative inputs to produce a vector of non-negative outputs. The efficiency scores are obtained by solving the optimisation problem of the following form for a given DMU_0, where the inputs are minimised whilst the outputs remain at their current levels (Adam et al., 2011):

$$\min\theta \tag{1}$$

subject to

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

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

$$\sum_{j=1}^{n} \lambda_j = 1 \tag{4}$$

$$\lambda_j \geq 0 j = 1,2,\ldots,n; \tag{5}$$

where, for DMU_0 in the sample, x_{i0} and y_{r0} stand for the i-th input and r-th output of the DMU_0. θ is a scalar, which represents the efficiency score of DMU_0. It measures the distance between DMU and the efficiency frontier, which is a linear combination of best performing units. If θ equals 1, this means it is not possible to proportionally reduce input quantities for the selected DMU, indicating that the unit is on the efficiency frontier. If θ is lower than 1, this indicates an inefficient unit inside the frontier. λ is a vector of constants, which represents weights used to calculate the position of DMU_0 as if it were on the frontier. The DMU_0 would be projected on the frontier as a linear combination of efficient units (peers), where λ represents respective weights. The peers are other efficient DMUs which are used as a benchmark for the inefficient DMUs. The restriction imposes a convexity assumption, indicating variable returns to scale. The problem has to be solved for each of the N DMUs in order to obtain the efficiency coefficients.

The efficiency coefficients obtained from DEA models can be biased because the efficiency of the public sector in a country depends on various socioeconomic characteristics. To capture the effects of these determinants of efficiency and to achieve comparability among the countries in the sample, we employed panel Tobit regressions, following De Witte and Moesen (2010). A Tobit regression is used when the dependent variable is censored, whilst in this paper it is appropriate due to the censored nature of efficiency coefficients. Dependent variables in these regressions are calculated gross efficiency scores, whilst independent variables reflect country specifics. The maximum likelihood estimation was used for parameter estimations. The Tobit regression employed in this study is expressed as follows (Lionel, 2015):

$$y_{it}^{*} = \beta X_{it} + \varepsilon_{it} \tag{6}$$

$$y_{it} = \begin{cases} 0 \; if \; y_{it}^{*} \leq 0 \\ 1 \; if \; y_{it}^{*} \geq 1 \\ y_{it}^{*} \; if \; 0 < y_{it}^{*} < 1 \end{cases} \quad i = 1, \ldots, and \; t = 1, \ldots, T \tag{7}$$

The dependent variableis censored between 0 and 1. is an unobservable latent variable, X_{it} is a vector of explanatory environmental variables, β is a vector of estimated coefficients, whileis the error term. The subscript i indicates the country, while the subscript t indicates time. All negative values of are censored at 0, while all the values of greater than 1 are censored at 1.

4. Data

The sample contains fifteen CESEE countries that share a similar background with regard to the transition process. This sample provides data homogeneity, yet enough variety to ensure the discriminatory power of the efficiency analysis in detecting efficient and inefficient units. Due to a high sensitivity to measurement errors, average data over 5-year periods were used to eliminate the effect of short-term oscillations (Afonso & Aubyn, 2006b). Regarding the sample size, we observed the general rule that the number of decision-making units should be at least 3 times the number of inputs and outputs (Cooper, Seiford & Tone, 2000). Selection of input and output data was highly dependent on data availability. General government expenditure for each area of research was used for the input variable, which is common in public sector expenditure efficiency analyses (Adam et al., 2011; Afonso et al., 2005). The output variables vary, depending on the public function that is being studied.

For the health care sector efficiency analysis, public expenditure on health (% of GDP) is used for the input and life expectancy at birth for the output variable, following Adam et al. (2011) and Afonso et al. (2005). Data on the input and the output were obtained from the Health Nutrition and Population Statistics Database of the World Bank. Using the most recent data available, the output is averaged over the 2010–2014 period, while the input is averaged over the 2005–2009 period to account for the delayed effect on the output.

In order to obtain a larger data set for the efficiency determinants analysis, DEA efficiency coefficients were calculated for each year from 2002 to 2014, using life expectancy for that year as the output and public expenditure on health from the previous year as the input. These coefficients were regressed on efficiency determinants, GDP per capita PPP, share of 65+ in the total population, and tertiary education share (see Table 1). As was noted in the literature review, GDP per capita was found to positively affect health efficiency (Samut & Cafrı, 2016; Lionel, 2015; Afonso & Aubyn, 2006a) as well as the education level given by the share of the population that received a tertiary education (Afonso & Aubyn, 2006a; Samut & Cafrı, 2016), while the share of 65+ in the total population may have both a positive (Lionel, 2015) and negative effect on efficiency. According to Samut and Cafrı (2015), the better educated and wealthier population is more aware of their health and leads a healthier lifestyle, including being able to afford healthier nutrition. According to the "wealthier is healthier" hypothesis, wealthier and better educated in-

dividuals live in healthier countries. Because the share of 65+ in the total population correlates positively with life expectancy, it may positively affect efficiency through higher output (Lionel, 2015). On the other hand, it may result in higher health care expenditure because the senior population is a more frequent user of health care services.

For the education sector efficiency analysis, the average scores of 15-year-old students on the PISA reading, science, and mathematics tests in 2012 were used as the output variable, which are the most recent available data for the selected countries. The average public expenditure on education (% of GDP) between 2007 and 2011 was used for the input. The input variable is taken with a lag to account for the delayed impact of PISA results on changes to the education system and the variable is averaged to prevent expenditure outliers from biasing the overall results. The sample is reduced for this part of the analysis due to lack of data availability, so it contains 12 countries (Czech Republic, Estonia, Poland, Romania, Slovak Republic, Bulgaria, Croatia, Hungary, Serbia, Slovenia, Lithuania, and Latvia). Both input and output data were obtained from the World Bank Education Statistics Database.

For the efficiency determinants analysis, Serbia was excluded from the sample due to an insufficient data time span. Because PISA testing is conducted every 3 years, DEA coefficients for this purpose were estimated for each year of available PISA results (2003, 2006, 2009, 2012) using the average public expenditure on education in the 3-year period prior to each test as the input (again to account for the delayed response of the output). Multiple DEA coefficients were estimated in order to obtain a larger data set to be used as a variable in the Tobit regression. The estimated coefficients were regressed on efficiency determinants, GDP per capita PPP, and unemployment rate (see Table 1). Such socioeconomic factors have been shown to be the key determinants of student performance (Coco & Lagravinese, 2014). Children from families of low socioeconomic status may be less motivated to study, as education is not emphasized as important as it is in families of higher socioeconomic status. Additionally, these children may have limited access to books, reading materials, or tutoring lessons and possibly need to combine work and school. Unemployment is an indicator of low socioeconomic status. The loss of a parent's job may reflect on the child's lower school performance and attendance, and can have long-lasting consequences in terms of lower tertiary education enrolment. In addition to financial factors, psychological ones may be even more pronounced because parents who lose their jobs may be depressed and unsupportive; thus their children tend to be less motivated and optimistic about their future careers.

For public administration we used general government final consumption expenditure (% of GDP) as input and government effectiveness (WGI) as output, following Bađun et al. (2014). In accordance with the time frame of the health care analysis, the output data is averaged over the period 2010–2014, whilst the input data is taken with a lag and averaged over the period 2005–2009 to account for the delayed effect on the output. Input data were obtained from the WDI database, whilst the output was obtained from Worldwide Governance Indicators Database (WGI) of the World Bank. The government effectiveness variable contained negative values, which is not appropriate for a DEA analysis. To solve this problem a value of 0.53 was added to all the observations to ensure they were all positive. This procedure was performed following Sarkis (2002).

In order to obtain a large data set for the efficiency determinants analysis, DEA coefficients for each year from 2004 to the most recent available (2015) were calculated with government final expenditure from the previous year as the input. These coefficients were regressed on efficiency determinants, GDP per capita, and institutional quality index (see Table 1). According to Chong and Gradstein (2007), the higher the level of institutional quality, the more positive the perception of the quality of public services in a certain country. La Porta, Lopez-de-Silanes, Shleifer and Vishny (1999) found that poor countries have lower government performance compared to rich countries, emphasizing GDP per capita as an important determinant of public administration efficiency.

Table 1. *Efficiency determinants – variables and data sources*

Variable	Source	Expected effect
Health care		
GDP per capita PPP (EU28=100)	Eurostat	+
Share of 65+ in total population	Eurostat	+/-
Tertiary education share	World Bank	+
Education		
GDP per capita PPP (EU28=100)	Eurostat	+
Unemployment rate	Eurostat	-
Public administration		
GDP per capita PPP (EU28=100)	Eurostat	+
Institutional quality index	World Bank (WGI)	+

Source: authors

5. Results

In this section, we provide the analysis results for each expenditure category and point out some methodological limitations of our approach. Results of the DEA analysis are presented in terms of efficiency scores , ranks, and the so-called "waste of resources" indicator, which is calculated as , whilst the results of the panel Tobit regressions are interpreted in terms of estimated coefficients and standard errors, with corresponding z-statistics and p-statistics.

5.1. Public Expenditure Efficiency in the Health Care Sector

In the model with life expectancy as the output and public expenditure on health (% of GDP) as the input, the average input efficiency score amounts to 0.87. This indicates that countries could attain the same output with an average of 13% fewer resources (see Table 2). Results show that Bulgaria, Estonia, and Slovenia are the most efficient countries in the sample (Figure 1). Slovenia has the highest life expectancy in the sample (80.2 years). On the other hand, Serbia, Croatia, and Bosnia and Herzegovina are at the bottom of the sample. Serbia could attain the same output using 33% fewer resources, whilst Croatia could do so using 29% fewer resources. Croatia's inefficiency can be explained with the highest public expenditure on health in the entire sample (6.39% of GDP), while its life expectancy is 76.96 years, which is slightly above average. The source of Croatia's inefficiency is its enormous public health expenditure.

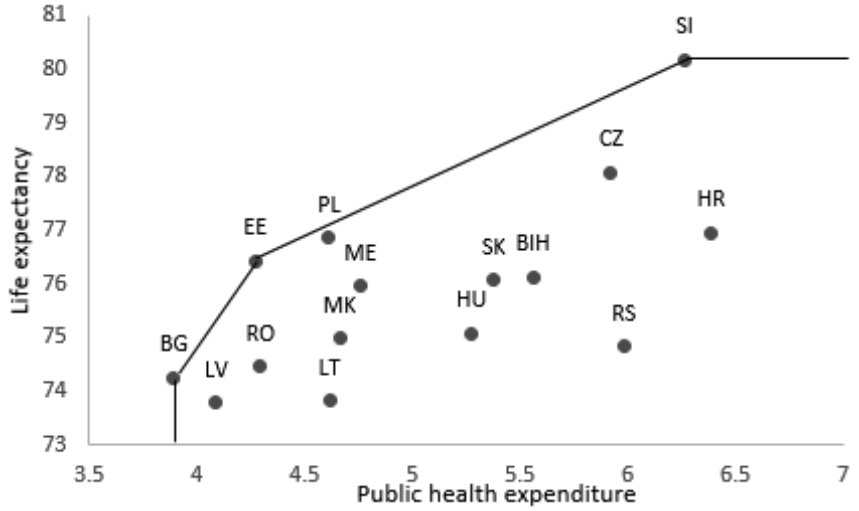
Table 2. *DEA results – Public expenditure efficiency in the health care sector*

Country	DEA	Rank	Waste of resources (1-DEA)
Bulgaria	1.00	1.00	0.00
Estonia	1.00	1.00	0.00
Slovenia	1.00	1.00	0.00
Poland	0.98	2.00	0.03
Latvia	0.95	3.00	0.05
Romania	0.91	4.00	0.09

Montenegro	0.88	5.00	0.12
Czech Republic	0.87	6.00	0.13
Macedonia, FYR	0.86	7.00	0.14
Lithuania	0.84	8.00	0.16
Slovak Republic	0.78	9.00	0.22
Hungary	0.77	10.00	0.24
Bosnia and Herzegovina	0.76	11.00	0.24
Croatia	0.71	12.00	0.29
Serbia	0.67	13.00	0.33
Average	0.87		0.13

Source: authors' calculations

Figure 1. *Efficiency frontier – Health care*



Source: authors' calculations

As for the determinants of efficiency scores, following Afonso and Aubyn (2006a), we analyse the effects of GDP per capita, the share of the elderly population, and the share of tertiary education as the main determinants of efficiency in the health care sector. The results of the panel Tobit regression are presented in Table 3.

Table 3. *Determinants of efficiency in the health care sector*

	Coefficient		Std. Error	z-Statistic	Prob.	
Efficiency =	Constant	0.59	0.07	8.13	0.00	****
	GDP per capita	0.0026	0.00	4.33	0.00	***
	Share of 65+	-0.0055	0.00	-2.66	0.09	*
	Tertiary education	0.0036	0.00	4.50	0.00	***

Source: authors' calculations

Results indicate that GDP per capita has a positive effect on efficiency in the health care sector as life expectancy is strongly correlated with the level of development. The rising share of the elderly population reduces the efficiency coefficient because they are more frequent users of health care services, resulting in higher health care expenditure. Finally, a higher level of education has a positive effect on the efficiency score as better educated societies are expected to take better care of adults, children, and the elderly.

5.2. Public Expenditure Efficiency in the Education Sector

Results suggest that countries waste an average 10% of their resources. The Czech Republic, Estonia, Poland, Romania, and the Slovak Republic represent the frontier (see Figure 2 or Table 4). The worst performers are Slovenia, Lithuania, and Latvia. Slovenia could attain the same output using 25% fewer resources, whilst Lithuania could do so using 22% fewer resources. Slovenia has the highest public expenditure on education in the sample (5.38% of GDP), whilst its average PISA score amounts to 498.86, slightly above average, which explains its low efficiency score.

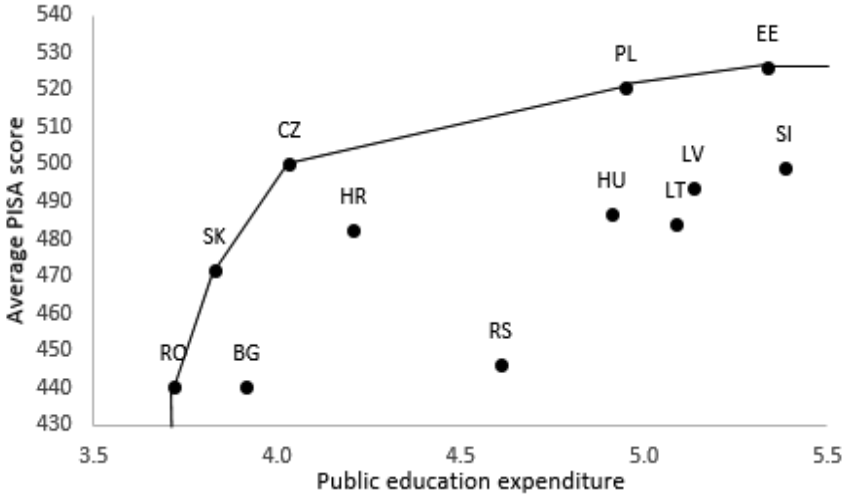
Table 4. *DEA results – Public expenditure efficiency in the education sector*

Country	DEA	Rank	Waste of resources (1-DEA)
Czech Republic	1.00	1.00	0.00
Estonia	1.00	1.00	0.00
Poland	1.00	1.00	0.00

Romania	1.00	1.00	0.00
Slovak Republic	1.00	1.00	0.00
Bulgaria	0.95	2.00	0.05
Croatia	0.93	3.00	0.07
Serbia	0.81	4.00	0.19
Hungary	0.80	5.00	0.20
Latvia	0.78	6.00	0.22
Lithuania	0.78	6.00	0.22
Slovenia	0.75	7.00	0.25
Average	0.90		0.10

Source: authors' calculations

Figure 2: Efficiency frontier – Education



Source: authors' calculations

Literature on determinants of efficiency in the education sector is relatively scarce and data availability for CESEE countries is limited, so in this paper we analyse the effects of two determinants of efficiency in education sector: GDP per capita as a proxy for the level of development and the unemployment rate as a proxy for socioeconomic status in the sample. The results of the panel Tobit regression are presented in Table 5.

Table 5. *Determinants of efficiency in the education sector*

	Coefficient		Std. Error	z-Statistic	Prob.	
Efficiency =	Constant	0.681	0.05	7.19	0.00	***
	GDP per capita	0.012	0.00	7.31	0.00	***
	Unemployment rate	-0.02	0.01	2.06	0.04	**

Source: authors' calculations

The results show that GDP per capita has a positive effect on efficiency in the education sector as the quality of schooling systems is higher in more developed countries. On the other hand, a higher unemployment rate leads to lower efficiency scores as the weaker socioeconomic status of a country's population may have a negative effect on learning and educational outcomes (Hattori, 2014).

5.3. Efficiency of Public Administration

The average efficiency score of the countries in the sample is 0.9, which indicates that countries are wasting an average 10% of their resources. Estonia and Romania are fully efficient, whilst Montenegro, Bosnia and Herzegovina, and Hungary are the most inefficient countries in the sample (see Table 6). Efficiency of public administration was measured with effectiveness of government as the output variable.

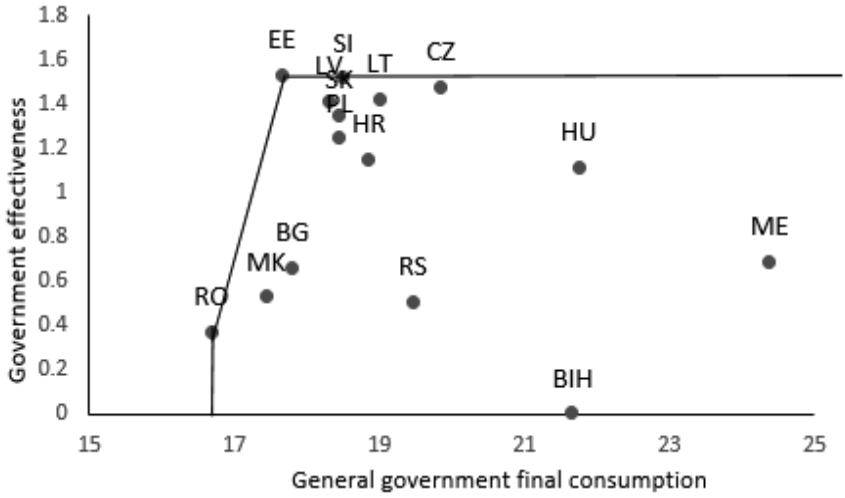
Table 6. *DEA results – Efficiency of public administration expenditure*

Country	DEA	Rank	Waste of resources (1-DEA)
Estonia	1	1	0
Romania	1	1	0
Macedonia, FYR	0.96	2	0.04
Latvia	0.96	3	0.04
Slovenia	0.95	4	0.05
Bulgaria	0.95	5	0.05
Slovak Republic	0.95	6	0.05

Poland	0.94	7	0.06
Lithuania	0.92	8	0.08
Croatia	0.92	9	0.08
Czech Republic	0.89	10	0.11
Serbia	0.86	11	0.14
Hungary	0.80	12	0.20
Bosnia and Herzegovina	0.77	13	0.23
Montenegro	0.70	14	0.31
Average	0.90		0.10

Source: authors' calculations

Figure 3. *Efficiency frontier – Public administration*



Source: authors' calculations

As the main determinants of the efficiency of public administration, we use GDP per capita and the institutional quality index, which is constructed as a weighted sum of selected WGI indicators: voice and accountability, political stability, regulatory quality, rule of law, and control of corruption. Government effectiveness is not used in the calculation of the index, as this indicator is used as an output in the DEA analysis. Institutional quality indicators are included in most analyses of public administration

efficiency (for example Bađun et al., 2014). The results of the panel Tobit regression are presented in Table 7.

Table 7. *Determinants of efficiency of public administration*

	Coefficient		Std. Error	z-Statistic	Prob.	
Efficiency =	Constant	0.604	0.05	13.27	0.00	***
	GDP per capita	0.002	0.00	2.25	0.02	**
	Institutional quality	0.003	0.00	4.93	0.00	***

Source: authors' calculations

As expected, GDP per capita has a positive effect on the efficiency of public administration as more developed countries also have better developed public administration services. Institutional quality has a positive effect on the efficiency score because a solid institutional framework, which implies compliance with regulations, lack of corruption and the like, is beneficial for the efficiency of public administration.

5.4. Robustness Check

Because the DEA is highly sensitive to data selection, we performed a robustness check using different output measures. In the health care analysis, we used the crude death rate (per 1,000 people) as the output variable instead of life expectancy. Data on input and outputs were obtained from the Health Nutrition and Population Statistics Database of the World Bank. The death rate data were inverted to obtain variables where a higher value indicated a better result. The results did not change significantly; the most and the least efficient countries remained the same as in the previous estimates (see Table 8).

Table 8. *DEA results – Public expenditure efficiency in the health care sector (robustness check)*

Country	DEA	Rank	Waste of resources (1-DEA)
Bulgaria	1.00	1	0.00
Estonia	1.00	1	0.00

Poland	1.00	1	0.00
Slovenia	1.00	1	0.00
Macedonia, FYR	0.99	2	0.01
Montenegro	0.97	3	0.03
Latvia	0.95	4	0.05
Romania	0.95	4	0.05
Slovak Republic	0.86	5	0.14
Lithuania	0.84	6	0.16
Bosnia and Herzegovina	0.83	7	0.17
Czech Republic	0.78	8	0.22
Hungary	0.77	9	0.23
Serbia	0.65	10	0.35
Croatia	0.64	11	0.36
Average	0.88		0.12

Source: authors' calculations

In the education efficiency analysis, we used a model with all three outputs for PISA results (reading, mathematics, and science) instead of the average. The results remained quite similar to the original coefficients (see Table 9).

Table 9. *DEA results – Public expenditure efficiency in the education sector (robustness check)*

Country	DEA	Rank	Waste of resources (1-DEA)
Czech Republic	1.00	1	0.00
Estonia	1.00	1	0.00
Poland	1.00	1	0.00
Romania	1.00	1	0.00
Slovak Republic	1.00	1	0.00
Bulgaria	0.96	2	0.04
Croatia	0.94	3	0.06

Hungary	0.82	4	0.19
Serbia	0.82	4	0.19
Slovenia	0.79	5	0.21
Latvia	0.78	6	0.22
Lithuania	0.78	6	0.22
Average	0.91		0.09

Source: authors' calculations

In the public administration efficiency analysis, rule of law (WGI) was used as the output variable in the robustness check. A value of 0.25 was added to all observations to ensure they were all positive. A model specification with rule of law as the output variable gave similar results to the previous estimate (see Table 10).

Table 10. *DEA results – Efficiency of public administration expenditure (robustness check)*

Country	DEA	Rank	Waste of resources (1-DEA)
Estonia	1.00	1	0.00
Romania	1.00	1	0.00
Latvia	0.96	2	0.05
Slovenia	0.95	3	0.05
Bulgaria	0.95	4	0.05
Poland	0.94	5	0.06
Lithuania	0.92	6	0.08
Macedonia, FYR	0.92	7	0.08
Slovak Republic	0.91	8	0.09
Czech Republic	0.91	9	0.09
Croatia	0.87	10	0.13
Serbia	0.85	11	0.15
Hungary	0.79	12	0.21
Bosnia and Herzegovina	0.75	13	0.25

Montenegro	0.72	14	0.28
Average	0.9		0.1

Source: authors' calculations

5.5. Methodological Limitations

Even though the DEA analysis has numerous advantages, it also has several drawbacks regarding its sensitivity to the data used. The DEA analysis is strongly sensitive to sample selection. This sample was chosen to compare the efficiency of countries that have similar historical backgrounds and are thus more homogenous. The analysis shows their efficiency scores relative to the other countries in the sample. A broader sample including western European countries would have more discriminatory power and the efficiency scores would most likely be different with fewer countries forming the frontier. However, the goal of this analysis was to compare countries that have similar starting positions. Furthermore, the DEA is highly sensitive to measurement errors, which were accounted for by taking the 5-year averages of the variables as explained in the data section. Different variables were used as outputs for robustness analysis whenever the data were available to account for the sensitivity of the method to the variables used.

6. Concluding Remarks

In this paper we used an input-oriented DEA analysis on a sample of 15 CESEE countries to provide efficiency measures of public expenditure on health care, education, and public administration. Furthermore, we applied Tobit regressions to identify the determinants of public expenditure efficiency for each category. This is the first analysis of this type for CESEE countries. Several countries from the sample were included in previous research at the EU level, specifically new EU member states. These countries were generally shown to be less efficient than the old member states, implying the level of economic development is a significant determinant of efficiency. This paper is unique as it affords an insight into the similarities and differences between CESEE transition economies and shows that there is heterogeneity among them. The order of the

most efficient and the least efficient countries is robust to different output measures. Once detected, these efficient countries can serve as a realistic benchmark for the others, given their similar historical background. The order of the countries is dependent on the expenditure category investigated, meaning that a country may be efficient in one area but inefficient in another. This is why it is important to investigate and interpret the efficiency of different expenditure categories separately.

In the health care sector the average input efficiency score amounts to 0.87 and indicates that countries could attain the same output with an average of 13% fewer resources. The results show that Bulgaria, Estonia, and Slovenia are the most efficient countries in the sample, whilst Serbia, Croatia, and Bosnia and Herzegovina are at the bottom. In accordance with earlier research, the results indicate that GDP per capita has a positive effect on efficiency in the health care sector, whilst a higher level of education has a positive effect on efficiency. The rising share of the elderly population reduces the efficiency coefficient, unlike the findings of Lionel (2015).

In education, the results suggest that countries waste an average 10% of their resources. The Czech Republic, Estonia, Poland, Romania, and the Slovak Republic form the frontier, whilst the worst performers are Slovenia, Lithuania, and Latvia. In accordance with previous research, the results show that GDP per capita has a positive effect on efficiency in the education sector, whilst a higher unemployment rate leads to lower efficiency scores. Regarding public administration, the average efficiency score is 0.9, which indicates that countries are wasting an average 10% of their resources. Estonia and Romania are fully efficient, whilst Montenegro, Bosnia and Herzegovina, and Hungary are the most inefficient countries in the sample. As was expected, GDP per capita and institutional quality have positive effects on the efficiency of public administration.

In future research, it would be beneficial to investigate more public functions to obtain better insight into the sources of inefficiency. However, data availability still remains a serious constraint in that regard. Large resources savings can be achieved in the health sector, which shows the lowest average efficiency score out of the three public spending areas investigated in the paper. The paper shows there is significant potential to reduce government size without hampering economic growth in most countries, which is an optimistic outcome for the challenging times we are currently witnessing.

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DETERMINANTS OF PUBLIC HEALTH CARE, EDUCATION AND ADMINISTRATION EFFICIENCY IN CENTRAL, EASTERN AND SOUTH EASTERN EUROPE

Summary

This paper analyses determinants of public sector efficiency in 15 Central Eastern and South Eastern European (CESEE) countries. Using Data Envelopment Analysis (DEA) and panel Tobit regressions we analyse the efficiency of public expenditure on health care, education, and public administration. This paper represents the first analysis of public expenditure efficiency for this region. The countries in the sample share a similar economic transition background and transition related challenges in terms of government size and efficiency. In this paper we use input-oriented DEA to calculate efficiency scores and apply Tobit regressions to identify the determinants of public expenditure efficiency for each category. According to our results, the health care sector shows the most room for improvement. With an average input efficiency score of 0.87, the analysed countries could attain the same output with an average 13% fewer resources. The results show that Bulgaria, Estonia, and Slovenia are the most efficient, whilst Serbia, Croatia, and Bosnia and Herzegovina are the worst performers. GDP per capita has a positive effect on efficiency in the health care sector, the rising share of the elderly population reduces the efficiency coefficient, whilst a higher level of education has a positive effect on the efficiency score, as recorded in earlier studies. In education, our results suggest that countries waste an average 10% of their resources. The Czech Republic, Estonia, Poland, Romania, and the Slovak Republic represent the frontier, while the worst performers are Slovenia, Lithuania, and Latvia. The results show that GDP per capita has a positive effect on efficiency in the education sector, whilst a higher unemployment rate leads to lower efficiency scores. Regarding public administration, the average efficiency score of the analysed countries is 0.9, which indicates that countries are wasting an average 10% of their resources. Estonia and Romania are fully efficient, whilst Montenegro, Bosnia and Herzegovina, and Hungary are the most inefficient countries in the sample. As expected, GDP per capita and institutional quality have positive effects on the efficiency of public administration.

Keywords: *public expenditure efficiency, Central Eastern and South Eastern European countries, Data Envelopment Analysis, panel Tobit*

DETERMINANTE UČINKOVITOSTI ZDRAVSTVENOG I OBRAZOVNOG SUSTAVA TE SUSTAVA JAVNE UPRAVE U DRŽAVAMA SREDIŠNJE, ISTOČNE I JUGOISTOČNE EUROPE

Sažetak

Rad se bavi analizom determinanata učinkovitosti javnoga sektora u 15 zemalja središnje i jugoistočne Europe. Analizom omeđivanja podataka (AOMP) i Tobitovom regresijom ocjenjuje se učinkovitost javnih rashoda u sustavu zdravstva, javne uprave i obrazovanja. To je prva znanstvena analiza učinkovitosti javnih rashoda u navedenim državama koje dijele iskustvo ekonomske tranzicije te slične izazove u vezi s veličinom i učinkovitosti javnog sektora. AOMP usmjeren na inpute korišten je za izračun koeficijenata učinkovitosti, dok se Tobitovom regresijom identificiraju determinante učinkovitosti javnih rashoda za svaku od analiziranih kategorija.Prema dobivenim rezultatima, u zdravstvenom sektoru postoji najviše prostora za poboljšanje. Prosječna vrijednost učinkovitosti inputa od 0,87 upućuje na to da bi analizirane države mogle ostvariti isti output uz prosječno 13 % manje resursa. Najučinkovitije su države Bugarska, Estonija i Slovenija, dok su Srbija, Hrvatska i Bosna i Hercegovina ostvarile najlošije rezultate. BDP po stanovniku pozitivno utječe na učinkovitost u zdravstvenom sektoru, dok rastući udio starije populacije umanjuje koeficijent učinkovitosti. Viša razina obrazovanja također pozitivno utječe na učinkovitost, što je u skladu s prethodnim istraživanjima. Rezultati pokazuju prosječan gubitak resursa od 10 % u obrazovnom sektoru. Češka, Estonija, Poljska, Rumunjska i Slovačka nalaze se na granici učinkovitosti, dok su najlošije rezultate ostvarile Slovenija, Latvija i Litva. BDP po stanovniku ima pozitivan učinak na učinkovitost obrazovnog sektora, dok veća stopa nezaposlenosti umanjuje njegovu učinkovitost. U sektoru javne uprave prosječna vrijednost učinkovitosti iznosi 0,9, što znači da analizirane države gube u prosjeku 10 % svojih resursa. Estonija i Rumunjska potpuno su učinkovite, dok su Crna Gora, Bosna i Hercegovina i Mađarska ostvarile najnižu razinu učinkovitosti. U skladu s očekivanjima, BDP po stanovniku i kvaliteta institucija pozitivno utječu na učinkovitost javne uprave.

Ključne riječi: *učinkovitost javnih rashoda, države središnje i jugoistočne Europe, analiza omeđivanja podataka (AOMP), Tobitova regresija*