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ANALYSIS OF THE EFFICIENCY OF TERTIARY EDUCATION EXPENDITURE IN EUROPEAN UNION MEMBER STATES FROM CENTRAL AND EASTERN EUROPE: AN EFFICIENCY FRONTIER APPROACH

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Abstract

The main purpose of this paper is to test the efficiency of tertiary education expenditure in European Union Member States from Central and Eastern Europe, in comparative terms, through the application of an efficiency frontier approach (Data Envelopment Analysis). The results from the study conducted show that the most efficient country with respect to tertiary education expenditure is Romania, followed by the Czech Republic, Lithuania and Slovenia. Estonia and Bulgaria are classified as the most inefficient countries in terms of tertiary education expenditure, with the largest deviation from the efficiency frontier, even though investment in the field is relatively high.

JEL Classification: C14, H52, I21, I23, O52
Keywords: Efficiency frontier approach, Data Envelopment Analysis, Tertiary education, Expenditure efficiency, CEE countries, EU, Comparative analysis

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Introduction

The development of the scope and quality of tertiary education is important for every country, as it is considered to be an investment in human capital, leading to many positive effects for both individual recipients of the service and the economy as a whole. On the one hand, tertiary education has a positive effect on labour market placement and the welfare of the individual. On the other hand, according to endogenous growth theories (e.g. Romer, 1986), human capital is a factor that has a positive effect on long-term economic growth. In view of the above, it is important to increase investments in the field from both public and private sources and to improve the efficiency of the expenditure incurred.

Unlike secondary education, which advocates the principle of equal access and equal opportunity to a greater extent, tertiary education is not compulsory, and, in most European countries, it is funded from mixed sources.

Table 1. Differences between secondary and tertiary education in EU member states from Central and Eastern Europe (CEE) on average

	Population with secondary education	**Population with tertiary education**
Unemployment rates - age group 25-29 (%), 2018[1]	6.7	6.3
Employment rates - age group 25-29 (%), 2018	77.7	82.9
Monthly earnings - age group 20-64 (euro), 2014	731	1066
People at risk of poverty or social exclusion -,age group 25-49 (%)[2], 2018	18.8	6.4

Source: Authors' calculations based on Eurostat data.

1. The value of the indicator is calculated as an average value for CEE countries from the EU except for Estonia and Lithuania, due to the lack of data on Eurostat.
2. Except for Slovakia and Lithuania, due to the lack of data for 2018 on Eurostat.

The acquisition of a tertiary education degree provides an advantage and implies a more successful labour market realization. Table 1 shows that the employment rate (age group 25-29) among the population with secondary education in the member states of the European Union from Central and Eastern Europe (CEE), in 2018, is on average 77.7 percent, while for the population with tertiary education it is 82.9 percent. The same trend is observed for youth unemployment (6.7 percent for the population with secondary education vs. 6.3 percent for the population with tertiary education in CEE Member States, in 2018) and income (the average monthly earnings of a person with secondary education in the CEE member states, in 2014, was 731 euro, while for a person with tertiary education it was 1066 euro). In addition, in 2018, in CEE, a significantly smaller proportion of the population with tertiary education was at risk of poverty or social exclusion.

The positive effects on individuals with tertiary education, as well as the external effects that tertiary education generates, are an incentive for public policy in this field. One goal is for most of the population to acquire a tertiary education degree. In this way, more people will benefit from better opportunities to enter the labour market, thereby also affecting inequality in society. Increasing tertiary educational attainment is precisely one of the goals of the Europe 2020 Strategy to achieve smart growth. In 2018, according to Eurostat data, the EU average goal was reached (tertiary education attainment for age group 30-34 was 40.7 percent with a target of 40 percent by 2020).

The data in Figure 1 show that the achievement of the national target is also characteristic of the Czech Republic, Estonia, Latvia, Lithuania, Poland and Slovenia. The other CEE countries studied are close but have not yet achieved the national target set in the Europe 2020 Strategy in this area. The highest value for tertiary education attainment (age group 30-34) is characteristic of Lithuania (57.6 percent for 2018). Other countries in Central and Eastern Europe (Estonia, Poland, Latvia and Slovenia) also present higher values in tertiary education than the 2018 EU-28 average.

Obtaining a tertiary education degree influences labour market integration and welfare, but what is more important is the skills acquired during training. Exploring the relationship between education and economic growth, Barro (2013) points out that "quality and quantity of schooling both matter for growth but that quality is much more important" (Barro, 2013, p. 228). For this reason, the second area in which efforts in tertiary education should focus on is achieving quality of service.

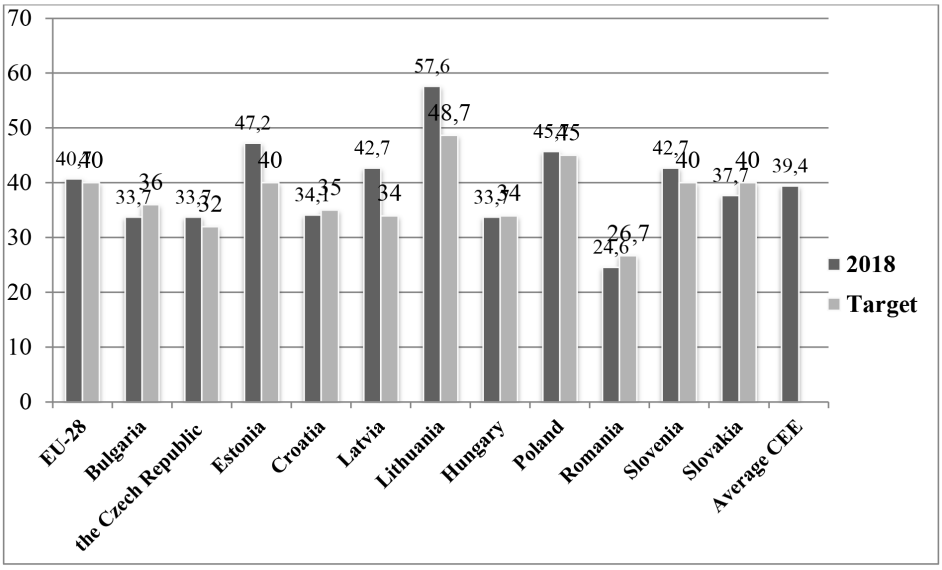

Figure 1. Tertiary educational attainment age group 30-34 (%)

Source: Authors' calculations based on Eurostat data.

Increasing the positive effects of tertiary education in both directions can be achieved by increasing investment in the field or improving the efficiency of the expenditure incurred. Interestingly, against the background of an increase in the proportion of the population with tertiary education, in the period 2008 - 2017, public expenditure on tertiary education, as a share of total public expenditure, decreased, on average, in the EU-28, on average in the CEE Member States, and, also, in all CEE countries except Hungary (see Figure 2). Tertiary education, however, can be a quasi-public good (training at public universities), with a way of excluding consumers, due to the fee charged, or a pure private good (training at private universities). In this regard, tertiary education expenditure has a public as well as a private source, even though in all CEE Member States public exceeds private expenditure[3].

3. For a more detailed analysis of higher education funding in CEE Member States, see Yotova and Stefanova (2017).

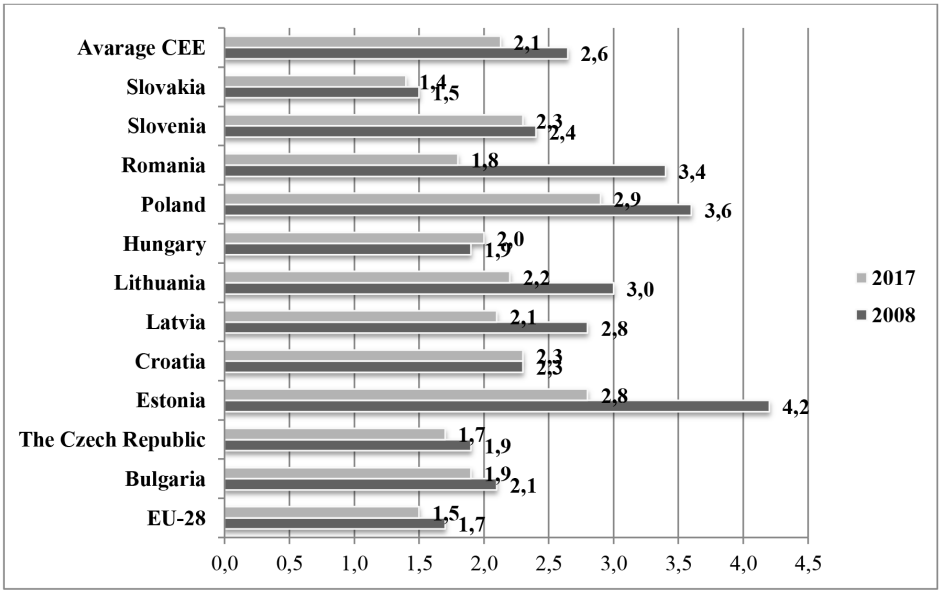

Figure 2. Share of tertiary education public expenditure in total public expenditure (%)

Source: Authors' calculations based on Eurostat data.

Increasing expenditure in tertiary education is important but ensuring that the investment is spent efficiently is even more important. The concept of efficiency is associated with the theory of the firm, but is also increasingly being applied to public policy evaluations. Expenditure efficiency for tertiary education is achieved when the resources given produce the maximum possible results or when the results given are achieved with minimal resources.

The purpose of this study is to carry out a comparative analysis of the expenditure efficiency of tertiary education in the EU Member States of Central and Eastern Europe. To achieve this, the approach adopted is one that aims to increase the validity of conclusions. It differs from those used in relevant literature in the field of combining several methodological decisions: First, it accounts for mixed higher education funding when choosing an input resource indicator (the sum of public and private expenditure on tertiary education per student as a percentage of GDP per capita). Second, it takes account of the time lag between costs spent on higher education and results manifested. Third, it uses three separate models with a common indicator for input and different indicators for output, which is a kind of robustness test concerning the results. Fourth, it takes account of both the direct quantitative effects of expenditure spent on tertiary education and some of the indirect costs related to the labour market realization and welfare.

The paper is structured as follows: The next section provides a brief summary of existing relevant literature in the field. The second part describes the methodology adopted. The third part presents the main results of the study conducted, identifying the most efficient and comparatively inefficient countries, in terms of expenditure on tertiary education. The last part presents the main conclusions drawn from the analysis.

Literature Review

Studies on efficiency of educational expenditure of countries, in comparative terms, predominantly apply non-parametric methods. The most used method of this type is DEA (Data Envelopment Analysis). Existing research studies in the field adopt various methodological approaches that determine the scope, nature and validity of results and conclusions, as well as the contributions made to relevant literature.

Despite the important role of tertiary education in building human capital and placement on the labour market, many of the research studies conducted have not independently examined this important issue. They consider the efficiency of education expenditure as a whole or at different levels (e.g., Afonso and S. Aubyn, 2005; Herrera and Pang, 2005; Jafarov and Gunnarsson, 2008; Aristovnik, 2013; Fonchamnyo and Sama, 2016; Dutu and Sicari, 2016). Fewer studies (e.g., St. Aubyn et al., 2009; Toth, 2009; Yotova and Stefanova, 2017; Jelic and Kedzo, 2018; Stefanova, 2019) trace the specifics of tertiary education, in particular.

Another major feature of much of the research in this field is the use of public tertiary education expenditure as an input resource indicator (e.g., Jafarov and Gunnarsson, 2008; Herrera and Pang, 2005, Fonchamnyo and Sama, 2016; Dutu and Sicari, 2016; Ahec Sonje *et al.*, 2018; St. Aubyn *et al.*, 2009), without taking into account the fact that both public and private funding is available in the sphere in most European countries, including Central and Eastern European countries. Fewer studies (e.g., Toth, 2009; Yotova and Stefanova, 2017; Stefanova, 2019), including this one, consider the mixed nature of higher education funding and use the sum of public and private expenditure as an input resource indicator.

The diversity of methodological approaches in the specialized literature examining the efficiency of higher education expenditure in comparative terms is also largely determined by the choice of output indicators. Existing approaches include indicators for the direct effects of education, such as, for example, labour force with tertiary education (% of total), school enrolment, tertiary educational attainment, ratio of people with diploma to total population (e.g., Aristovnik, 2013; Yotova and Stefanova, 2017; Toth, 2009) and indicators reflecting the quality of education received but having an indirect effect, such as unemployment in the tertiary education population (e.g., Aristovnik, 2013; Ahec Sonje *et al.*, 2018; Jelic and Kedzo, 2018; Stefanova, 2019), the employment rate of tertiary education population (e.g., Toth, 2009; Yotova and Stefanova, 2017; Stefanova, 2019), etc.

In addition to the use of output indicators, the range of countries included in the study is the other major parameter that has a significant impact on the results obtained for the efficiency of using DEA. This is because the method evaluates comparative efficiency and the inclusion or exclusion of a country affects the efficiency frontier calculated and the classification of individual countries as efficient or inefficient. There are also different approaches in this area. Some studies (Herrera and Pang, 2005; Afonso and S. Aubyn, 2005; St. Aubyn *et al.*, 2009; Toth, 2009; Aristovnik 2013; Dutu and Sicari, 2016; Jelic and Kedzo, 2018) examine a broader range of countries that are, however, not homogeneous in terms of economic development, historical features, etc. Others (Jafarov and Gunnarsson, 2008; Yotova and Stefanova, 2017; Ahec Sonje *et al.*, 2018), as well as the current study, focus on a smaller and relatively homogeneous group, such as the EU member states from Central and Eastern Europe.

Due to different methodological approaches, and, especially, due to different country choices, the conclusions from the studies are not identical, making it difficult to define a common conclusion about the countries that show the highest efficiency of tertiary education expenditure. However, some common features of the results of studies on the countries of Central and Eastern Europe can be indicated. For example, Aristovnik (2013) and AhecSonje *et al.* (2018) classify the Czech Republic, Latvia and Lithuania as efficient countries. These countries are also efficient in at least one of the models implemented by Yotova and Stefanova (2017). Lithuania and the Czech Republic are among the most efficient countries in the EU, according to Jelic and Kedzo (2018). As to Romania's place in terms of efficiency of expenditure on tertiary education, there are also some similarities in the results of the studies, with the country being in second place according to Ahec Sonje *et al.* (2018), Aristovnik (2013) and Yotova and Stefanova (2017). Slovakia, on the other hand, is classified as an efficient country by Jelic and Kedzo (2018) and Toth (2009), and Bulgaria is among the most inefficient countries, according to Jafarov and Gunnarsson, Yotova and Stefanova (2017) and Jelic and Kedzo (2018).

Methodology

The evaluation of the efficiency of tertiary education expenditure in this study is done through the application of an efficiency frontier approach. In particular, the method applied is DEA (Data Envelopment Analysis)[4]. The method has been increasingly applied in research on public sector efficiency, and especially for comparative analysis of the efficiency of education and health expenditure. It can also be used in more extensive analyses (e.g., Alfonso *et al.*, 2006).

4. For a more detailed analysis of DEA (Data EnvelopmentAnalysis), see Cooper *et al.* (2011).

The widespread application of the method is a consequence of its advantages as a non-parametric method, in which the form of the efficiency frontier or the functional relationship between inputs and outputs need not be defined in advance, but determined on the basis of specific empirical data on inputs and outputs, through mathematical programming. It is precisely for this reason that the method is particularly suitable for use in the field of tertiary education expenditure efficiency, since it is difficult to determine in advance a specific relationship between input resource and output result, because the effects of higher education are predominantly indirect. Furthermore, according to Mihaiu (2010), the DEA recognises a complex nonlinear relationship between results and inputs, while parametric methods typically limit this relationship, based on a linear relationship or simple forms of a nonlinear one.

The DEA uses linear programming and other forms of mathematical programming methods in order to calculate the efficiency frontier and to derive efficiency coefficients. The DEA classifies countries as efficient (with efficiency coefficient one and situated on the efficiency frontier) and inefficient (with efficiency coefficient under one and situated below the efficiency frontier).

Applying DEA assesses the efficiency of certain units in a comparative way. This means that the method does not provide a theoretical criterion for efficiency, but, rather, indicates which countries are more efficient than others included in the study. For this reason, the choice of countries is essential. In this regard, the current study covers a relatively homogeneous group of countries with similar characteristics, in terms of historical features and economic development, that are relevant to the area under study.

DEA can be used to analyse the efficiency of input resources or output results. If there is inefficiency, with respect to input resources in one country, this means that such input resources must be reduced until the efficiency frontier is reached. In the case of inefficiency with respect to the output result, it must be increased in order to achieve efficiency. In this study, DEA is used to analyse the efficiency of input resources, since these are easier to model and can be directly affected. The influence on output results is more complicated since it cannot be directly addressed and influenced. For this reason, the input-resource DEA model provides a better opportunity to make recommendations to policy makers. The model is applied at variable returns of scale, as this takes account of the different scales of the individual units and allows different input-output ratios to be defined as efficient. In other words, the choice of the variable returns of scale removes the scale effect if some units are not functioning at optimal scale. When studying efficiency in a comparative aspect, under constant returns of scale, only one correlation between input resources – output result is assumed as efficient, and all other units have to be compared against it without taking into account the scale at which individual units, subject to classification, act.

This study employs three models that use one input resource indicator and different output indicators drawing data from the Eurostat database. This approach aims at increasing the validity of results, while also serving as a robustness test of results.

The input indicator selected is Total expenditure on tertiary education per student, as a percentage of GDP per capita. Despite the preponderance of studies on the efficiency of public expenditure on tertiary education in relevant literature, the methodological approach here is different. Because of the mixed funding system, it is impossible to clearly distinguish what part of the results is due to public and what to private sources. In this regard it is more appropriate to use the total tertiary education expenditure, which, in this study, is calculated as the sum of public expenditure and private household expenditure and presented in relative terms.

A critical question of the methodology of this study is how the outputs of tertiary education expenditure incurred should be defined and measured. The first area in which results can be explored reflects the quality of the education received, which, in turn, affects labour market realisation and the welfare of the population with tertiary education. The indicators employment rate of population with tertiary education and population with tertiary education not at risk of poverty and social exclusion were selected to reflect the qualitative aspect in this study[5]. Although the indirect effects of higher education are more important, they can clearly be also influenced by other factors not necessarily related to educational attainment, such as IQ, personal qualities, talents, etc. For this reason, in order to carry out the robustness test of results, as already indicated, an additional third model has been applied. It reflects the direct quantitative effects of the degree obtained using tertiary education attainment as an output indicator.

In particular, the following indicators are used as outputs for the three models. The first model uses Tertiary education attainment (age group 25-34 years). The second model applies Employment rate of population with tertiary education (age group 25-29 years), and the third model uses Population with tertiary education not at risk of poverty and social exclusion (age group 25-49 years). The choice of output indicators is predetermined by the existence of a strong direct theoretical relationship between the input resource and the output that is required for the application of DEA, since the purpose of the method is not to calculate the coefficient of significance of the relationship and verify that it exists, but to determine, through comparative analysis, which countries achieve the greatest resource efficiency (achieving the highest result with a given resource or achieving a given result using the least amount of resources).

5. The indicator population with tertiary education not oatrisk of poverty and social exclusion is obtained by subtracting the percentage of the population with higher education at risk of poverty and social exclusion from 100%.

DEA works with data for a given year or averaged data for a specific period. The study uses averaged data over two years, the purpose being to prevent any extreme values to affect results. Due to the time lag between the time when the expenditure is incurred and the effects it has (about four years, given the average duration of a Bachelor's degree course), input and output data are taken over different periods. Input resource data for the year 2013-2014 on average is used. Averaged data for the 2017-2018 period[6] is used for output results since these are the latest data available for the indicators.

The three indicators are defined for a specific age group. The lowest limit is determined by the age at which it is generally considered that genuine integration into the labour market has begun, and at least a Bachelor's degree has been attained. The highest limit is the lowest possible, according to available Eurostat data. Data on tertiary education population indicators are at levels 5 to 8 according to ISCED 2011. All methodological decisions described aim at increasing the reliability of study results.

Results

The results of applying Data Envelopment Analysis to the group of ten EU Member States[6] from Central and Eastern Europe show that the only country classified as efficient in all three models applied is Romania. The Czech Republic has an efficiency coefficient equal to one, according to the first and third models, and according to the second model, it is the closest to the efficiency frontier among the countries studied. Lithuania is defined as efficient, according to the first and second models, but according to the third model, it is ranked eighth in terms of efficiency coefficient. In this regard, the Czech Republic and Lithuania can be described as relatively efficient, according to this study. Slovenia shows an efficiency coefficient equal to one, according to the first model, while according to the second and third ones, it is ranked fourth and third, respectively. All other countries are classified as inefficient with different deviations from the efficiency frontier according to the three models since their efficiency coefficients are under one (see Table 2).

It is important to note that, according to the three models, the ranking of countries (except Lithuania) is relatively similar, which increases the validity of the conclusions, since the application of the three models also serves as a robustness test. In addition to the similar results of the three models, the validity of the findings of this study is also supported by the validation of their more important part, not only

6. For the indicator Population with higher education not at risk of poverty and social exclusion for Lithuania and Slovakia, only data for 2017 are used, as data for 2018 were missing on Eurostat at the time of the study.

by other authors applying similar methodologies, but also in studies using different output indicators, different time intervals and a much more diverse and comprehensive choice of countries studied. For example, Lithuania and the Czech Republic are classified as efficient countries by Aristovnik (2013), Yotova and Stefanova (2017), Jelic and Kedzo (2018) and Ahec Sonje *et al.* (2018). Romania is classified as efficient by Stefanova (2019) and it is in second place in studies by Ahec Sonje *et al.* (2018), Aristovnik (2013) and Yotova and Stefanova (2017).

Table 2. Efficiency Coefficients

	First Model		Second Model		Third Model	
	Efficiency Coefficient	**Rank**	**Efficiency Coefficient**	**Rank**	**Efficiency Coefficient**	**Rank**
Bulgaria	0.7823	6	0.7760	8	0.7760	7
Czech Republic	1.0000	1	0.9938	2	1.0000	1
Estonia	0.7638	7	0.6741	9	0.6741	9
Latvia	0.8626	5	0.7791	7	0.7791	6
Lithuania	1.0000	1	1.0000	1	0.7487	8
Hungary	0.9826	2	0.9788	3	0.9788	2
Poland	0.9659	3	0.8507	5	0.8507	4
Romania	1.0000	1	1.0000	1	1.0000	1
Slovenia	1.0000	1	0.8931	4	0.8931	3
Slovakia	0.8776	4	0.8448	6	0.8448	5
Average	**0.9235**		**0.8790**		**0.8545**	

Source: Authors' calculations through applying DEA on Eurostat data.

The most inefficient country, according to the efficiency coefficients obtained from the three models, is Estonia. It should be noted that the highest percentage of expenditure per student, as a percentage of GDP per capita (see Figure 3), is observed in Estonia, but the results from costs incurred in the areas studied are not satisfactory. At the same time, in Romania and the Czech Republic there is a relatively low value for the input resource indicator. From these observations, a relationship between the expenditure on tertiary education and the efficiency coefficient can be assumed. However, there are also exceptions, since one of the most efficient coun-

tries (Lithuania) ranks second according to the input indicator used. It cannot, therefore, be determined unequivocally that there is an inverse relationship between the magnitude of tertiary education expenditure and the efficiency coefficient. Both countries that spend less and invest more in the field can be efficient. The process of providing the service is more important.

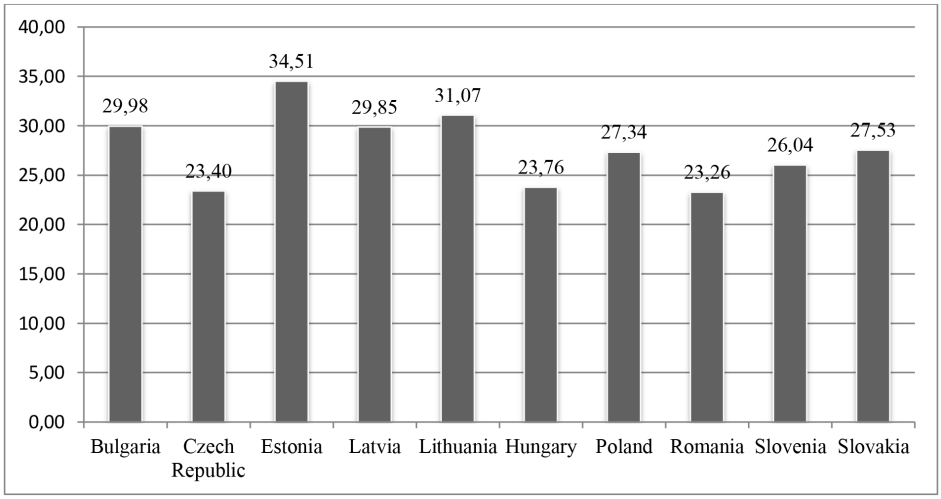

Figure 3. Total expenditure on tertiary education per student, as a percentage of GDP per capita 2013-2014 (%)

Source: Authors' calculations based on Eurostat data.

Results show that Bulgaria is one of the most inefficient in all three models (in the first and second models, it is in the penultimate place before Estonia, and in the third less efficient than Estonia and Lithuania), while, at the same time, it is second in terms of the input indicator used. This indicates that, comparatively, the country presenting a high value of total expenditure on tertiary education per student, as a percentage of GDP per capita, which, however, is not spent in the most efficient way. It should be noted that the poor performance of Bulgaria in terms of efficiency of tertiary education expenditure, is confirmed, by other studies (Jafarov and Gunnarsson, 2008; Yotova and Stefanova, 2017; Jelic and Kedzo, 2018; Stefanova, 2019). The first model has the greatest number of efficient countries (four). For this reason, the average efficiency coefficient is also the highest (0.9235) as compared to the other two models. This indicates that more countries are achieving performance that reflects the quantitative results of the expenditure incurred. The average coefficient obtained shows that, for the same amount of expenditure, one CEE country on average provides 7.65 percent less output than if it had been efficient.

According to the second and third models, reflecting the quality of tertiary education, two countries are classified as efficient, with an average efficiency coefficient of 0.8790 and 0.8545, respectively. The efficiency coefficient of the second (third) model (s) means that for the same amount of input, a country provides 12.1 percent (14.55 percent) less output than if it had been efficient.

Conclusion

The study conducted shows that, despite the use of different output indicators in the three models, the ranking of the counties (except Lithuania) is relatively close. Romania is classified as efficient in all three models applied. Lithuania and the Czech Republic have an efficiency coefficient equal to one, according to two of the models, while Slovenia has an efficiency coefficient equal to one according to the first model. According to the three models, the most inefficient country is Estonia, followed by Bulgaria. The study results are also consistent with the results of other researchers in this field.

All EU Member States from CEE included in the study show the highest efficiency coefficients in the first model. At the same time, the average efficiency coefficient, according to this model, is the highest and the number of efficient countries is the greatest. This indicates that the quantitative aspects of the results of the tertiary education expenditure incurred are higher than those related to the quality of the service provided and the labour market realisation and welfare. The existence of a supranational objective, in terms of the quantitative aspects of the results of investment in tertiary education, is one of the reasons for the results observed. However, given the ultimate goal of investing in human capital, it is necessary to strengthen the pursuit of quality in tertiary education in the Member States of Central and Eastern Europe. Increasing the positive results in these areas will favour the countries' economic development in the long run.

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