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DEA EFFICIENCY APPROACH IN COMPARING MACROECONOMIC PERFORMANCE OF EU AND BALKAN COUNTRIES[3]

The past two decades have witnessed the emergence of various types of crises – financial, economic and even health crises affecting adversely the economic development of countries worldwide. This has highlighted the role of public revenue and public spending as drivers for both economic recovery and the achievement of economic policy goals such as price stability, high economic growth and low unemployment. Despite the potential of fiscal policy to influence economic development, more active use of public spending and hence its increase does not always result in increased well-being and better macroeconomic performance of countries. This study examines the macroeconomic performance of countries from the European Union (EU) and Balkan countries over the period from 2004 to 2019. For the purposes of assessing macroeconomic performance and public spending efficiency, it uses Data Envelopment Analysis (DEA), a non-parametric method for estimating technical efficiency through the use of a single input – public spending as a percentage of GDP, and several macroeconomic indicators as outputs. Our findings indicate a decrease in the efficiency of the countries under examination and larger differences in terms of macroeconomic performance during the crisis years 2009 and 2012. Moreover, countries with more significant public spending in GDP terms tend to be less efficient than others, that have lower public spending levels.
Keywords: efficiency; public sector expenditure; fiscal policy; DEA
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1. Introduction

The past two decades have witnessed the emergence of various types of crises – financial, economic and even health crises affecting adversely the economic development of countries worldwide. This brings the focus of attention on the role of the government and the

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application of measures that are most appropriate for effecting a faster recovery of the economies. To the extent that, in certain countries, the possibilities to implement a monetary policy are limited by the existence of special monetary regimes[4], fiscal policy emerges as a key, yet not as a substitute tool. According to some authors, the role of fiscal policy is determined primarily by the level of a country's economic development: while developed countries focus their efforts on maintaining full employment and stable economic growth, fiscal policies in developing countries set out, by applying an appropriate toolbox, to stimulate investment activity, accelerate growth and minimise the emerging social inequality (Popa, Codreanu, 2010). Despite the potential of fiscal policy to influence economic development, a more active use of public spending and hence its increase do not always result in an increased well-being and better macroeconomic performance of countries (Baciu, Botezat, 2014). For that reason, how efficiently public spending has been used is a very relevant question for researchers today. An analysis of the efficiency of public resources used in the course of the crisis-induced processes observed over the past decades is particularly relevant because a more substantial use of public spending generates substantial public budget deficits and rising government debt. Prior to the global financial crisis, public budget deficits in the EU countries amounted to just 0.9% of GDP and went up to 6.6% of GDP in 2009, dramatically exceeding the convergence threshold of 3% of GDP. Government debt in the EU countries was 58.1% of GDP in 2007, and 73.9% of GDP in 2009. It continued to go up in the years that followed, reaching 86.9% in 2014, on the back of the European debt crisis of 2012-2013.

For the purposes of estimating public spending efficiency, this study uses the non-parametric method of Data Envelopment Analysis (DEA). This method measures the technical efficiency of the countries included in the study, using the relevant inputs and outputs. The study covers all of the EU members states: Austria, Belgium, Bulgaria, Greece, Germany, Denmark, Estonia, Ireland, Spain, Italy, Cyprus, Latvia, Lithuania, Luxembourg, the Netherlands, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Hungary, Finland, France, Croatia, the Czech Republic, Sweden and the United Kingdom[5], and the Balkan countries which are located on the Balkan Peninsula: Bulgaria, Romania, Slovenia, Croatia, Greece, Albania, Serbia, Bosnia and Herzegovina, North Macedonia, Montenegro, Kosovo and Turkey[6]. The period under examination is 2004-2019, and the purpose of choosing a longer time period is to include several years prior to the global financial crisis.

The current research tests two hypotheses. The first hypothesis is that public spending efficiency decreases in the crisis years due to the more substantial use of public sector

[4] For example, under a currency board arrangement, national central banks cannot implement a monetary policy. Currency boards are in place in Bulgaria, Bosnia and Herzegovina, and used to exist in Estonia and Lithuania before the adoption of the euro as a national currency. Another example of an absence of a monetary policy can be seen in countries that have introduced unilaterally the euro, such as Montenegro.

[5] The United Kingdom is included in the study since it was a member of the EU during the analysed time period 2004-2019. As of 2021, the United Kingdom is no longer part of the EU.

[6] Bulgaria, Romania, Slovenia, Croatia and Greece are included in the EU as well as from the date when they joined the EU, i.e. Greece since 1981, Slovenia since 2004, Bulgaria and Romania since 2007, and Croatia since 2013, respectively.

financial resources in economic recovery. The second hypothesis is that countries that have a larger public sector as measured in terms of the share of a country's public spending in GDP, exhibit a lower efficiency compared to countries with a smaller share of public spending in GDP.

With this study, the authors attempt to contribute to economics literature by researching public spending efficiency and the delivery on ultimate economic policy goals by making a comparative analysis of countries in the EU and countries on the Balkan Peninsula. So far, comparative analyses of public spending efficiency have included but a few of the countries in the Balkan Region, mostly those that have become members of the EU. For instance, Bulgaria, Romania, Greece and Slovenia are presented in some of the research on public spending efficiency at the EU level (Baciu, Botezat, 2014; Halaskova et al., 2018). There are also analyses of public spending efficiency that deal only with countries in the Balkan Region for the period 2007-2019. (Nenkova, Mihaylova-Borisova, 2020). This study expands the scope of that analysis both in terms of the time period (as it covers the years from 2004 till 2019), and in terms of the range of countries.

The study is structured in five parts. The second part provides a detailed presentation of achievements in terms of the existing research on public spending efficiency and public sector efficiency. The next chapter presents the methodology used to calculate the technical efficiency of countries included in the study. The fourth part analyses the results, and the last part offers the main conclusions.

2. Literature Review

There is a range of studies on the purposes of the estimation of public spending efficiency and public sector performance and on the assessment of the efficiency of fiscal policy and the macroeconomic indicators achieved by the countries. Since the methods used to measure public spending efficiency differ, the studies can be divided into four groups:

- Using a composite indicator to measure efficiency (Afroso et al., 2003; Afroso et al., 2006; Afroso et al., 2007; Bazin, Botezat, 2014; Hauner, Kyobe, 2008; Todorova, 2004). Some of the research in that group employs a macro approach in calculating the efficiency of general government spending, while other studies use a micro approach, measuring the efficiency of a specific category of public spending (Afonso, 2006).
- Using the non-parametric method of Data Envelopment Analysis (DEA) to estimate public spending efficiency (Bazin, Botezat, 2014; Afonso et al., 2006; Afonso et al., 2019; Halaskova et al., 2018; Raber, 2017; Hauner, Kyobe, 2008; Wang, Alvi, 2011; Lovell et al., 1995; Mohamad, Said, 2011; Montes et al., 2019; Ouertani et al., 2018; Boueri et al., 2014; Herrera, Ouedraogo, 2018; Herrera, Pang, 2005; Mattina, Gunnarsson, 2007; Hu et al., 2020).
- Measuring public spending efficiency by applying the so-called parametric method of the Stochastic Frontier Approach (SFA) (Grigoli et al., 2013).

- Measuring public spending efficiency by applying the non-parametric method of Free Disposal Hull (FDH) analysis[7] (Herrera, Ouedraogo, 2018; Herrera, Pang, 2005; Afroso et al., 2003).

As noted above, the *first group* of studies focus on measuring the efficiency and the performance of public spending in the countries examined by using composite indicators. This method is widely used in the research conducted by Afroso et al. (2006), Afroso et al. (2007), Bazin and Botezat (2014), Hauner, Kyobe (2008), Todorova (2004).

Afonso et al. (2006) study the public sector efficiency of the new member states of the European Union and some of the emerging economies in Asia. To achieve its goal, the study covers the ten new member states of the European Union (EU) which joined in 2004, i.e. Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia; the two countries which joined in 2007, i.e. Bulgaria and Romania; three 'old member states of the EU, i.e. Greece, Ireland and Portugal; and nice countries which are considered emerging economies, i.e. Brazil, Chile, Korea, Mauritius, Mexico, Singapore, North Africa, Thailand and Turkey. Within the scope of the study, considerable differences are observed in respect of the public spending in GDP terms in those countries, with averages ranging from 18% to 50% of GDP in the period 1999-2003. The Baltic countries (Estonia, Lithuania and Latvia) have values for that indicator that is below 40% of GDP and are defined as countries with a small government. Nevertheless, the values of the indicator in those countries is notably higher than the average value for Asian emerging economies such as Thailand, Singapore and Korea. The analysis of the results, obtained by the authors, leads to the conclusion that the countries having a low level of public spending in GDP terms, i.e. countries with a 'small government', or those with public spending of up to 30% of GDP, are most efficient. Moreover, they are twice as efficient in terms of public spending as the worst-performing countries. By using the non-parametric method of Data Envelopment Analysis, Afonso et al. (2006) arrive at the conclusion that the countries do not use their resources efficiently, since they could obtain the same level of output by using only 45% of their inputs. The authors prove that the following factors: security of property rights, GDP per capita, competence of government officials and education level of the people, exhibit a strong correlation to the efficiency of government spending.

Afonso et al. (2007) calculate public sector performance and public sector efficiency for 23 industrial countries, and the scope of the study includes Canada as well. In 2000, Canada ranked 12th among the 23 industrial countries in terms of public sector performance, and the estimated indicator is exactly equal to that for the USA and just below the average for the 23 countries. Based on the calculated indicator for public sector efficiency, it was found that countries with a small government are significantly more efficient in achieving public sector performance levels compared to countries with mid-sized and big governments. A small government public sector is one that has public spending of below 40% in GDP terms, while a public sector having a mid-sized government has public spending equal to 40 to 50% in GDP terms, and a big government refers to public spending larger than 50% of GDP.

[7] The Data Envelopment Analysis (DEA) and the Free Disposal Hull (FDH) analysis belong to the group of non-parametric methods of measuring efficiency that are based on a production frontier (Mihaylova-Borisova, 2015).

Afonso, Schuknecht, Tanzi (2007) studies the extent to which countries use public spending efficiently to achieve the same level of public sector performance. Thus, for instance, they have calculated that Canada could achieve the same level of public sector performance using just 75% of the public spending it has actually used over the analysed period.

Baciu, Botezat (2014) analysed the public sector efficiency and public sector performance in EU countries, and in particular in the new EU member states that jointed in 2004: Cyprus, the Czech Republic, Hungary, Lithuania, Latvia, Malta, Poland, Slovakia and Slovenia, and those that became part of the EU in 2007: Bulgaria and Romania. The analysis of their public sector efficiency was made using two methods: 1) the composite indicator technique; and 2) the Data Envelopment Analysis (DEA). The period under examination is 2000-2009, and it has been defined more broadly in order to capture the periods before the accession and the period of integration, which affect the size and efficiency of the public sector.

The government efficiency in many developed and developing countries in the period from 1980 to 2006 has been studied by Hauner, Kyobe (2008). In calculating efficiency, they include a range of indicators in the area of education and healthcare. They estimate the efficiency of the government sector by calculating the indicators for public sector performance, public sector efficiency and technical efficiency by applying the Data Envelopment Analysis (DEA) approach. Then they regress the obtained technical efficiency coefficients by using a variety of economic, demographic, geographical and institutional indicators. Hauner, Kyobe (2008) also conclude that countries with high levels of public spending in GDP terms achieve lower public sector efficiency.

Todorova (2004) researched public sector performance by means of a composite indicator, using two types of indicators as opportunity indicators exploring the functioning of public administration, education and healthcare, and the traditional Musgravian indicators such as the Gini coefficient, economic efficiency indicator (average inflation rate over the past 10 years and real GDP growth through a coefficient of variation) and an allocation efficiency indicator (unemployment rate – average value for the past 10 years and GDP growth in real terms – average value for the past 10 years). The author takes into account also the public sector efficiency, where the public sector performance is considered as a ratio to public expenditure in GDP terms. The study covers the countries that acceded to the European Union in 2004, namely, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia, as well as Bulgaria and Romania, which acceded at the beginning of 2007. Based on the calculations, it concludes that the efficiency of public spending in each of these countries is generally low and differs quite a lot. The highest public sector efficiency is observed in countries where public spending in DGP terms amounts to around 35%. In the context of a crisis, it is concluded that most of the countries under examination should increase the efficiency of their public spending and reduce the share of public expenditure in GDP.

The review of the cited studies reveals that, notably, most of the researchers use both composite indicators and Data Envelopment Analysis (DEA). The following studies based on the DEA method can be instanced: Afonso et al. (2019), Halaskova et al. (2018), Raber (2017), Hauner, Kyobe (2008), Wang, Alvi (2011), Lovell et al. (1995), Mohamad, Said

(2011), Montes et al. (2019), Ouertani et al. (2018), Boueri et al. (2014), Herrera, Ouedraogo (2018), Herrera, Pang (2005), Mattina, Gunnarsson (2007), Hu et al. (2020).

Afonso et al. (2019) analysed the extent to which the tax system can affect the public spending efficiency. The study is based on data on the 36 advanced OECD countries and covers the 2003-2017 period and is divided into three sub-periods: 2003-2007, 2008-2012 and 2013-2017. The researchers' approach involves computing the efficiency coefficients of each of the countries included in the study using the Data Envelopment Analysis and then regressing the resulting efficiency coefficients with the data on the various types of taxes. The so-called Malmquist Index, on the basis of which the change in the total factor productivity, the change in efficiency and the change in technology are measured, is also calculated. Applying this methodology, the authors conclude that the countries could use less inputs (about 32 to 34%) to achieve the same target level of outputs. The ten-year period exhibited an improvement in efficiency but also a decline in the total factor productivity and in technologies. Regarding the influence of taxes on public spending efficiency, a negative impact of direct taxes and a strong negative impact of social security contributions and indirect taxes on government performance have been found.

Halaskova et al. (2008) estimated public spending efficiency in five areas of public service provision such as healthcare, education, social security, recovery, culture and religion, general public services. The study covers 27 member states of the European Union, excluding Malta, for which no data was available on all of the indicators included in the investigation. The countries included in its scope are Bulgaria, Belgium, the Czech Republic, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, the Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden and the United Kingdom. For the purposes of applying the DEA method, several inputs are defined as follows: expenditure in healthcare, expenditure in education, social security spending, expenditure for recovery, culture and religion and expenditure for general public services. GDP per capita and employment in services are the indicators used for outputs. The outcome of the estimated public spending efficiency in services shows that countries with a small or mid-sized public sector, i.e. those with public spending in the range of 40% of GDP or less, have a higher spending efficiency in services. Conversely, countries where that indicator exceeds 50% of GDP or those with a high standard of living achieve a lower public spending efficiency. The study also highlights the limitations relating to it – mostly limitations in terms of the data used, which are not always of sufficient quality.

Rabar (2017) presents the Data Envelopment Analysis (DEA) method as a key tool in computing and measuring the social and economic efficiency of OECD countries. The study distinguishes three groups of research that use DEA: 1) Research focusing on economic growth and employment; 2) Research using and combining economic indicators with environmental ones; 3) Research dealing with the supply and consumption of electric energy. Rabar (2017) notes that the Data Envelopment Analysis (DEA) method was first used in "researching macroeconomic performance by Fare, Grosskopf, Norris, Zhang (1944)".

Wang, Alvi (2011) measure public spending efficiency using the Data Envelopment Analysis approach. They cover 10 OECD countries (Australia, Canada, France, Germany, Italy, Japan, Korea, New Zealand, the United Kingdom and the USA) and 7 Asian countries (Hong Kong,

Japan, Korea, Malaysia, Singapore, Thailand and Taiwan). The period of investigation for the OECD countries is 1981-2008, while that for the Asian countries is 1986-2007. Wang, Alvi (2011) tested five hypotheses through which they attempted to explain the inefficiency of public spending. The first hypothesis refers to the extent to which private sector activity affects public sector performance. The next hypothesis has to do with corruption, while the third one deals with the link between the increase in money supply and public spending efficiency in stimulating income. The next hypothesis is related to the size of government, and the last one looks at government debt. The results of the study indicate that government sector inefficiency decreases with the increase in the activity of the private sector, which confirms the view of non-interference of the state in the economy, in line with the views upheld by monetarists.

Lovell et al. (1995) also employ the DEA approach for the purposes of policy performance with respect to four macroeconomic indicators such as real GDP per capita, inflation, employment and trade balance. The authors study 19 OECD countries, drawing a comparison between 14 European countries and 5 non-European countries over the period 1970-1990. The researchers arrive at the conclusion that DEA "[...] is fully suited for analysing the macroeconomic performance" of the countries (Lovell et al.,1995).

Mohamad, Said (2011) studied the way in which 54 countries that are members of the Organization of the Islamic Conference use their resources. The macroeconomic performance of the countries is examined using the DEA approach, defining inputs (government spending as a percentage of GDP[8]) and the following outputs: real economic growth, export-to-import ratio, inflation and employment rate.

Montes et al. (2019) explored whether countries are working towards improving their fiscal transparency and whether it affects public spending efficiency. To this end, they analysed 82 countries, of which 68 developing countries and 14 developed countries, over the period 2006-2014. The results prove that fiscal transparency helps reduce public debt and increases public spending efficiency. The method used to calculate public spending efficiency is, again, DEA. Ouertani et al. (2018) measured and analysed public spending efficiency by applying the DEA approach for Saudi Arabia over the period 1988-2013. Boueri et al. (2014) estimated the efficiency of the educational system in Brazil, applying the non-parametric method of DEA. The study proves the existence of a negative link between the cost of education per capita and the efficiency of the educational system in the country.

One of the studies that employ the Stochastic Frontier Approach (SFA) to measure public spending efficiency is that by Grigoli, Kapsoli (2013). The researchers apply the method for the purposes of measuring healthcare spending efficiency in emerging economies and developing economies. The results of the study show that African countries exhibit the lowest efficiency. There are also studies that apply the non-parametric method of Free Disposal Hull (FDH) for the purposes of computing public spending efficiency. Afonso et al. (2003) calculate a composite indicator for public sector performance and public sector efficiency for 23 industrial countries for the years 1990 and 2000. The study also examines the efficiency

[8] This refers to government consumption in the final use of GDP.

of inputs and outputs by applying the non-parametric method of Free Disposal Hull (FDH). It proves that the average public spending inefficiency is 20%.

In some of the research applying the Data Envelopment Analysis (DEA) method, the Free Disposal Hull (FDH) technique is also applied: Herrera, Ouedraogo (2018), Herrera, Pang (2005). The DEA and the FDH) also applied also by Herrera, Ouedraogo (2018) for the purposes of measuring public spending efficiency in the area of education, healthcare and infrastructure. Their study includes 175 countries over a ten-year period, from 2006 to 2016. Herrera, Pang (2005) apply the DEA and the FDH methods to measure public spending efficiency by including 140 countries over the period 1996-2002. The results of the study show that countries that have higher levels of public spending have a lower efficiency.

On the basis of the above review of the economics literature on the topic of the study, certain conclusions can be drawn that determine the next steps in our study as well:

- With regard to the methods applied to examine efficiency, the most widely used one is the Data Envelopment Analysis (DEA), or a combination of methods, where in addition to the specific non-parametric, a composite indicator is used (Afonso et al., 2006). The reason for using mainly the non-parametric DEA method in the economic literature is based on the advantages of this approach in particular its use in relatively small samples of production units. In addition, this method does not need to pre-define the type of production frontier, which eliminates the possibility of errors in this respect.
- Most of the studies also go on to measure the efficiency of specific public sector areas such as, *inter alia,* healthcare and education, which indicates that further research is needed to examine the effects of the applied fiscal policy on the countries' macroeconomic performance.
- The studies use a very limited time period, in the range of just a few years; in this study, we will focus on researching a longer time period that includes the accession of the new EU member states in 2004, and the observed crisis-related developments in the context of the global financial crisis and the European debt crisis.
- Lovell et al. (1995) и Mohamad et al. (2011) apply the Data Envelopment Analysis (DEA) method for the purposes of examining the macroeconomic performance of the countries, defining almost identical outputs and inputs. Considering the stated conclusion that this is a good approach to the measurement of the countries' macroeconomic performance, it will be the approach to be applied in this study as well.

3. Methodology and Data

For the purposes of measuring public spending efficiency and the countries' macroeconomic performance, this study will employ the Data Envelopment Analysis (DEA) technique. That is a non-parametric method of estimating the efficiency of Decision Making Units, based on production frontiers. The advantage of these methods based on production frontiers is that they enable the inclusion of a wide range of activities related to production units. In computing efficiency, all of those activities or outcomes can be translated into a single index

which is a measure of the efficiency of a particular unit in comparison to the rest of the units included in the scope of the study, i.e. what is measured is the so-called "comparative efficiency". To embrace the various activities, the so-called 'inputs' to be used to produce the desired level of outputs also need to be defined.

3.1. Data Envelopment Analysis (DEA)

The founder of the non-parametric method of Data Envelopment Analysis (DEA) is Farrell (1957), who built the model on the basis of defining one output and multiple inputs. The model was developed further by Charnes at al. (1978), to include not only multiple inputs but multiple outputs as well. Data Envelopment Analysis (DEA) is a non-parametric method of linear programming where the efficiency of each unit included in the research is estimated in respect of the most efficient units that make up the production frontier. Initially, it was applied to production units the purpose of which is not profit-making, such as universities, hospitals, etc., but later it was used with respect of units whose activity was aimed at generating a profit, such as banks and business enterprises. In this study, it will be applied with respect of the governments of the EU member states and the countries in the Balkan Region for the purposes of estimating public spending efficiency and the efficiency of fiscal policy as a whole.

The DEA method has a range of *advantages,* as listed below.

- It is not associated with any specific type of production function, unlike other methods require, e.g. the parametric Stochastic Frontier Approach. That reduces the probability of an error in attempting to determine the type of production frontier.
- The model allows for the inclusion of a variety of inputs and outputs without indicating which one is the most important for the production unit (Lin at al., 2009).
- It enables the computation of the overall technical efficiency, which can be disaggregated into pure technical efficiency and scope efficiency (Kumar, Gulati, 2008).
- It can be applied to small samples of production units as well.

One major *shortcoming* of the method that can be noted is that it depends to a large extent on extreme observations. For that reason, it is not possible to distinguish if the deviation from the production frontier is due to inefficiency or is the result of an random error.

The method has two forms: 1) the output-oriented DEA, where what is required is the minimum quantity of inputs that is necessary in order to produce a specific target level of outputs; and 2) the input-oriented DEA, where the aim is to find the maximum quantity of outputs that can be achieved with the inputs that are available to the production unit. The production units (DMUs – Decision Making Units) could operate under constant return to scale (CRS), as well as under variable return to scale (VRS).

The model at a constant return to scale (CRS) could be presented in the following way:

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &-y_I + Q\lambda \geq 0 \\ &\theta x_I - X\lambda \geq 0 \\ &\lambda \geq 0 \end{aligned} \tag{1}$$

The coefficient θ is the so-called efficiency coefficient of the respective production unit i. The respective production unit – i has inputs x_i and outputs y_i. All production units, included in the model, is represented by I. All inputs for production units are presented by inputs matrix X, while all outputs for the included production units are presented by outputs matrix Q. λ is the vector with weights Ix1.

The linear model is solved for each production unit. In such way, the efficiency coefficient is obtained. The coefficient takes values from 0 to 1. When the production unit receives a value of 1, then it lies at the production frontier. Other production units that receive a value below 1 are inefficient and may increase their efficiency.

The model (1) could be transformed and be presented for variable return to scale (VRS). It is necessary to include the restriction $I1'\lambda = 1$, where $Ix1$ is a single vector. The restriction means that the technical efficiency is greater than or equal to that obtained at a constant return on scale (CRS). Thus, the model is presented as follows:

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &-y_I + Q\lambda \geq 0 \\ &\theta x_I - X\lambda \geq 0 \\ &I1'\lambda = 1 \\ &\lambda \geq 0 \end{aligned} \tag{2}$$

By solving the model, it is not possible to defined which production unit (Decision-making unit (DMU)) operates under constant return to scale and which operates under variable return to scale. To achieve this, it is necessary to change the restriction $I1'\lambda = 1$ in the following way: $I1'\lambda \leq 1.$

The following model is solved:

$$\begin{aligned} &\min_{\theta,\lambda} \theta \\ &-y_I + Q\lambda \geq 0 \\ &\theta x_I - X\lambda \geq 0 \\ &I1'\lambda \leq 1 \\ &\lambda \geq 0 \end{aligned} \tag{3}$$

In addition to the calculation of the technical efficiency of a production units, a change in the toral factor productivity could be investigated. For the purpose of calculation of the total factor productivity, a so-called Malmquist productivity index could be used. The Malmquist index is decomposed to the technology change and technical efficiency change.

3.2. Data used

For the purposes of calculating public spending efficiency of the EU countries and the countries from the Balkan Region, or the so-called macroeconomic performance, a number of macroeconomic indicators are used, and those are also main targets of the countries' fiscal and monetary policies. Since there are limitations in respect of the use of monetary policy data[9] about the selected set of countries, the focus is on studying public spending efficiency in GDP terms.

Official statistical data about the countries has been used, which is published by the statistical offices of the countries, Eurostat, the International Monetary Fund and the World Bank. The period under examination is 2004-2019, and the purpose is to capture also the period since the accession to the European Union of the new member states the Czech Republic, Hungary, Poland, Cyprus, Malta, Slovenia, Slovakia, Estonia, Lithuania and Latvia. This is important in view of the existing differences between these countries and the old EU member states.

The countries' macroeconomic performance is described by a number of indicators such as economic growth in real terms, inflation measured in terms of the harmonised index of consumer prices, employment and trade balance. These macroeconomic indicators will be used as outputs for the purposes of studying public spending efficiency and macroeconomic performance of the selected counties, similarly to the methodology applied by Mohamad, Said (2011). A similar approach has been used by Lovell et al. (1995). The indicator of government spending in GDP terms will be applied as an input. Chart 1 presents the inputs and outputs.

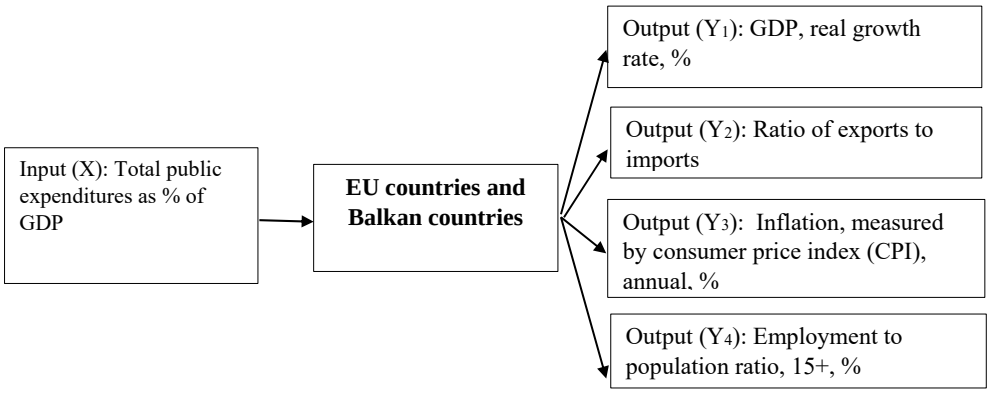
Table 1 shows descriptive statistics of inputs and outputs under the DEA method used.

Notably, there are significant deviations in the standard deviation of most of the indicators used in the model. This is explained by the significant differences among the countries in terms of their economic development and the inclusion of the ten new EU member states. The influence of the global financial crisis of 2008-2009 also leads to more substantial deviations and disparity in the countries' macroeconomic performance. The economic growth of the countries from the Balkan Region went down by 2.9% in real terms in 2009, while EU countries registered an economic downturn of 4.3% in 2009. The larger economic downturn of EU countries also accounts for the slower pace of their recovery from the global financial crisis.

[9] For example, some of the countries apply a specific currency board arrangement: Bulgaria, Bosnia and Herzegovina, Lithuania and Estonia prior to the adoption of the euro. Under a currency board arrangement, there is no monetary policy and hence the key interest rates are not the result of the defined monetary policy, unlike, for example, the interest rates set by the European Central Bank.

Chart 1

Inputs and Outputs of EU countries and Balkan countries



Sources: own presentation.

Table 1

Descriptive statistics of inputs and outputs

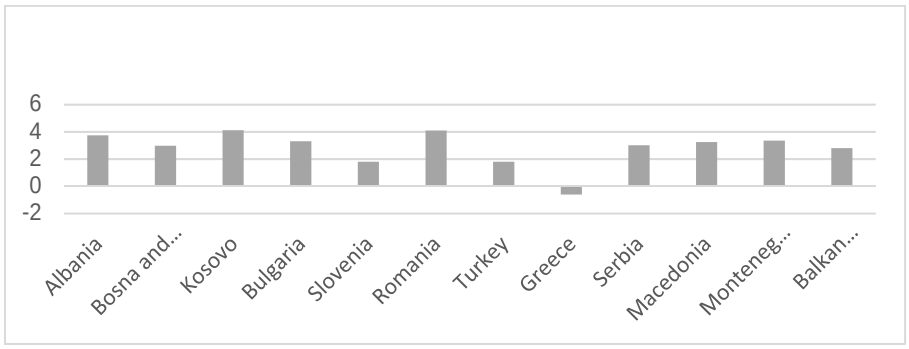
		2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*
Inputs									
Public expenditures to GDP, %	Average	42.10	41.75	41.38	41.05	42.99	46.52	46.14	44.99
	Standard Deviation	7.02	7.31	7.10	6.96	6.29	6.65	7.65	7.30
Outputs									
GDP growth (annual %)	Average	4.60	4.30	5.21	5.20	2.00	-4.55	1.83	1.86
	Standard Deviation	2.36	2.63	2.24	2.56	3.30	4.00	2.98	3.65
Exports to Imports	Average	0.87	0.87	0.87	0.86	0.86	0.91	0.93	0.96
	Standard Deviation	0.25	0.24	0.23	0.24	0.23	0.22	0.19	0.17
Inflation, consumer prices (annual %)	Average	2.92	3.05	3.34	3.58	5.91	1.31	2.24	3.66
	Standard Deviation	2.49	2.75	2.31	2.26	3.26	2.27	1.79	1.70
Employment to population ratio, 15+, total (%)	Average	49.35	49.53	50.24	51.11	51.46	50.09	49.28	49.04
	Standard Deviation	8.26	8.28	8.34	8.52	8.33	7.62	7.66	7.74
		2012	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*
Inputs									
Public expenditures to GDP, %	Average	45.15	45.78	44.85	44.00	42.41	41.70	41.92	41.95
	Standard Deviation	7.68	9.06	7.55	7.73	7.39	7.19	6.95	6.84
Outputs									
GDP growth (annual %)	Average	-0.25	1.02	2.13	3.50	2.68	3.68	3.29	2.72
	Standard Deviation	2.79	2.61	2.10	4.12	1.28	1.93	1.55	1.41
Exports to Imports	Average	0.98	1.00	1.01	1.03	1.03	1.04	1.07	1.09
	Standard Deviation	0.17	0.17	0.18	0.19	0.19	0.21	0.35	0.47
Inflation, consumer prices (annual %)	Average	2.99	1.57	0.41	0.17	0.34	1.99	2.16	1.90
	Standard Deviation	1.51	1.73	1.65	1.53	1.47	1.73	2.49	2.41
Employment to population ratio, 15+, total (%)	Average	48.83	48.77	49.35	49.87	50.61	51.71	52.56	53.10
	Standard Deviation	7.90	7.64	7.58	7.69	7.39	7.20	7.33	7.25

Sources: Own calculations.

Figure 1 shows the economic growth of countries from the Balkan Region, with Albania, Kosovo and Romania as the best-performing countries in the period 2004-2019. The best performers among the EU countries in terms of the same indicator include Ireland, Romania, Malta and Poland (Figure 2). Other countries like Luxembourg, Sweden and the Netherlands, although exhibiting moderate levels of economic growth, in the range of 2-3% over the period as a whole, rank among the best performers in terms of the following indicators: export-to-import ratio (Luxembourg, with 1.28 on the average for the 2004-2019 period; Sweden, with 1.12; and the Netherlands, with 1.14, against an average of 0.96 for all the countries in the selection) and in terms of employment ((Luxembourg, with 54.9 on the average for the 2004-2019 period; Sweden, with 59.5; and the Netherlands, with 61.2, against an average of 50.3 for all the countries in the selection). These EU countries are responsible also for the achievement of moderate inflation rates, in line with the understanding of price stability.

Figure 1

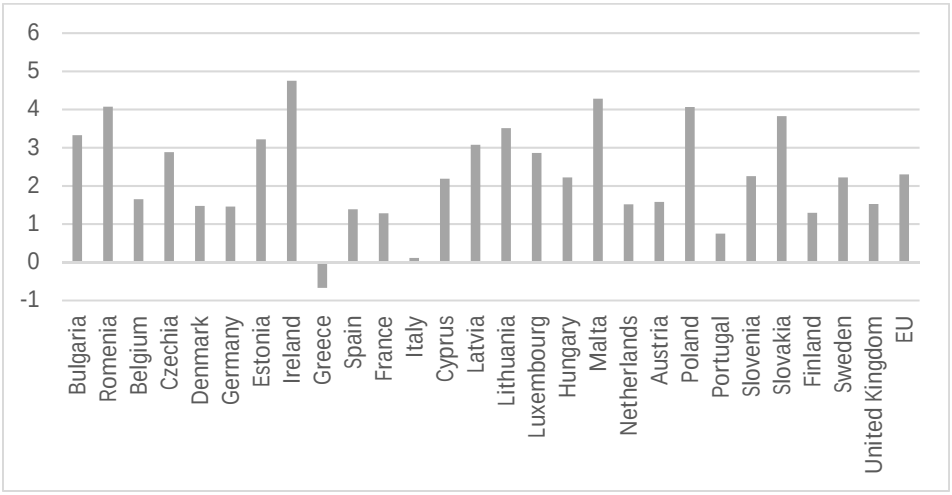
Economic growth of countries from the Balkan Region in the 2004-2019 period



Sources: World bank, authors' calculations

Figure 2

Economic growth of EU countries in the 2004-2019 period



Sources: Eurostat, authors' calculations.

Since the DEA method cannot be used on negative values, which are observed in economic growth and inflation rates for some of the countries, particularly during the global financial crisis in 2009, it is necessary to normalise the indicators. Normalisation on the scale from 1 to 10 is applied, using the approach of Mohamad, Said (2011).

The indicators – the real economic growth rate, the ratio of exports to imports and the employment to population ratio should be transformed. The formula is following:

$$Y_{nor} = \frac{9*(Y_{act}-Y_{min})}{Y_{max}-Y_{min}} + 1, \quad (4)$$

where:

Y_{nor} – is the value of normalised indicator Y;

Y_{act} – is the actual value of the indicator Y;

Y_{max} – is the maximum value of the indicator Y;

Y_{min} – is the minimum value of the indicator Y.

The inflation will be transformed by using the following formula:

$$Y_{nor} = \frac{9*(Y_{max}-Y_{act})}{Y_{max}-Y_{min}}+1, \quad (5)$$

where:

Y_{nor} is the value of normalised indicator Y;

Y_{act} – the actual value of the indicator Y;

Y_{max} – is the maximum value of the indicator Y;

Y_{min} – is the minimum value of the indicator Y.

As a result of transformation, the macroeconomic indicators Y will receive value between 1 and 10.

4. Analysis of the Results

To calculate the technical efficiency of government spending of EU countries and countries from the Balkan Region, the DEAP 2.1 (Coelli, 1996) software was used. The DEA approach was applied both with constant returns to scale (CRS) and with variable returns to scale (VRS). Due to market inefficiencies and market failures, it is not possible for countries to operate at constant returns to scale. That makes it necessary to analyse the results obtained for the countries with variable returns to scale.

Table 2 shows the results obtained for EU member states and for countries from the Balkan Region, where the technical efficiency is with variable returns to scale. In 2009, when the significant negative effects of the global financial crisis were observed in Europe, technical efficiency stands at a level that is the lowest during the whole period under examination. A drop in technical efficiency is observed in 2012 as well, when the European debt crisis

occurred. The data confirm the hypothesis that public spending efficiency decreases in the crisis years due to the more substantial investment of financial resources in economic recovery.

Table 2

Technical efficiency of EU member states and for countries from the Balkan Region

	2004	2005	2006	2007	2008	2009	2010	2011
Number of countries	37	37	37	37	37	37	37	37
Number of countries, being on the production frontier	13	10	13	14	11	8	14	15
Technical efficiency	0.951	0.952	0.961	0.960	0.954	0.919	0.949	0.962
Minimum	0.886	0.827	0.779	0.817	0.861	0.728	0.748	0.763
Maximum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Standard deviation	0.04	0.05	0.05	0.05	0.04	0.08	0.07	0.05
	2012	2013	2014	2015	2016	2017	2018	2019
Number of countries	37	37	37	37	37	37	37	37
Number of countries, being on the production frontier	14	17	14	9	13	5	3	11
Technical efficiency	0.957	0.970	0.976	0.954	0.974	0.951	0.950	0.976
Minimum	0.816	0.850	0.877	0.839	0.871	0.889	0.872	0.912
Maximum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Standard deviation	0.05	0.04	0.03	0.04	0.03	0.03	0.03	0.02

Sources: Eurostat, authors' calculations.

This hypothesis is also supported by the diminishing number of countries which, in crisis years, show a maximum technical efficiency and chart the production frontier. In 2009, only 8 countries were involved in the plotting of the production frontier, against 11 countries in the preceding year. This also reveals the more significant gaps among the countries in terms of public spending efficiency and macroeconomic performance, especially in the crises under examination.

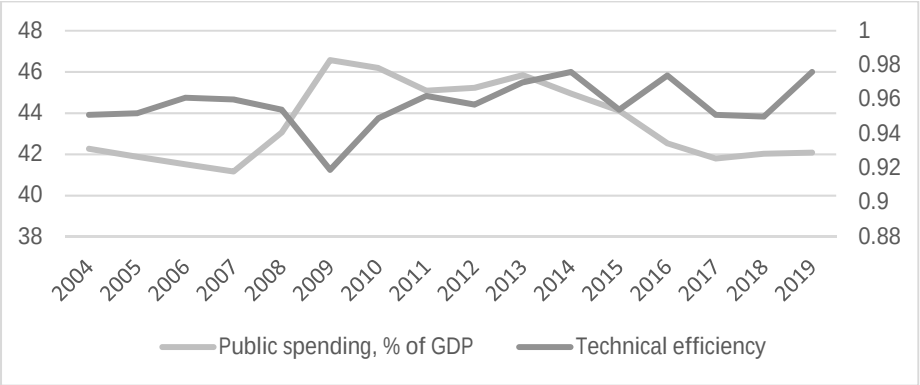
Tracing the dynamics of the countries' technical efficiency and public spending in GDP terms shows an inverse relationship between the variables (Figure 3). That negative correlation is quite pronounced, particularly in 2009, where the average public spending for all of the countries included in the study went up to 46.6% of GDP, against 43% of GDP in 2008. At the same time, there is a dramatic drop in technical efficiency by 3.7% in 2009 compared to the preceding year. The correlation between the change in public spending in GDP terms and the change in the efficiency of all the countries is negative in the period 2004-2019 (-0.48), which also supports the existence of an inverse relationship between public spending and its realised efficiency.

The total factor productivity increased in the analysed period 2004-2019 (Table 3). The productivity rose in the period by 0.6% on average per year due to improvement in technology change by 2.3% on average per year. The productivity had its lowest value of -9.6% and -5.4% in 2008 and 2009 respectively, when the negative effects of the global financial crisis on the economic development of the countries were seen. In 2009 the decline

in the productivity change was related to both factors: a drop in the technology change and decline in the technical efficiency.

Figure 3

Technical efficiency and public spending in GDP terms of EU countries and countries from the Balkan Region in 2004-2019



Sources: Eurostat, authors' calculations

Table 3

Technical efficiency, technology change, pure efficiency, scale efficiency and total factor productivity change index

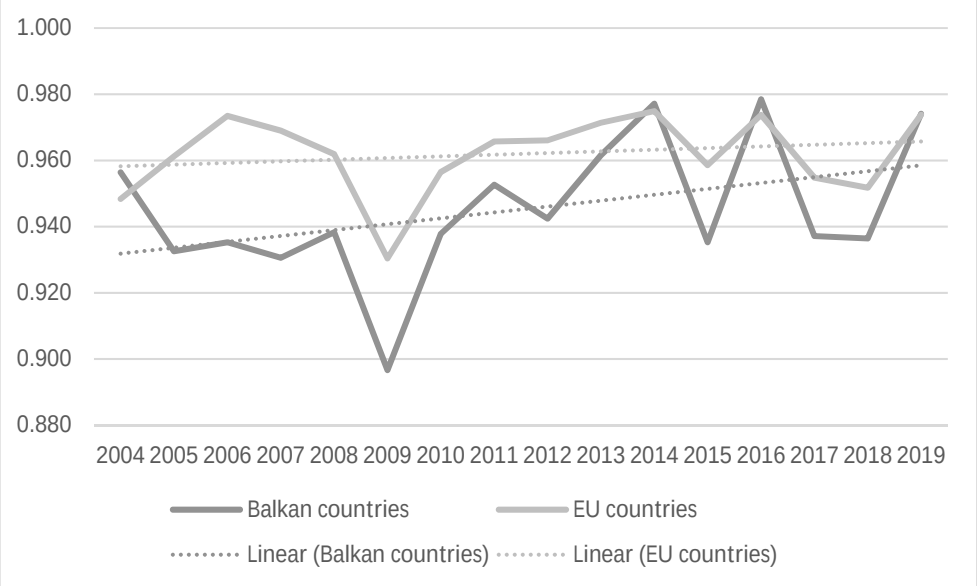
	Technical efficiency change index	Technology change index	Pure efficiency change	Scale efficiency change	Total factor productivity change (Malmquist productivity change index)
2005/2004	0.978	1.030	1.001	0.978	1.008
2006/2005	1.042	0.976	1.010	1.032	1.017
2007/2006	1.020	0.992	0.998	1.022	1.013
2008/2007	1.063	0.851	0.994	1.069	0.904
2009/2008	0.983	0.962	0.961	1.022	0.946
2010/2009	1.000	1.038	1.034	0.968	1.039
2011/2010	0.968	1.047	1.014	0.954	1.014
2012/2011	1.001	1.008	0.996	1.006	1.009
2013/2012	1.007	1.016	1.013	0.993	1.023
2014/2013	0.991	1.052	1.006	0.985	1.042
2015/2014	0.840	1.240	0.977	0.860	1.042
2016/2015	1.044	0.981	1.022	1.022	1.024
2017/2016	0.885	1.134	0.976	0.907	1.004
2018/2017	0.966	1.040	0.999	0.967	1.005
2019/2018	0.993	1.026	1.027	0.966	1.018
	0.984	1.023	1.002	0.982	1.006

Sources: Authors' calculations

When the countries that are included in the scope of the study are divided into EU countries and countries from the Balkan Region, the latter exhibit a lower average efficiency but also a faster increase in efficiency over the years (Figure 4). That trend can be explained by the process of convergence of the countries from the Balkan Region to the EU member states. In the two subgroups, the hypothesis of deterioration in efficiency, during the crisis years is upheld again, as it was for the whole set of the countries.

Figure 4

Technical efficiency of EU countries and countries from the Balkan Region in 2004-2019

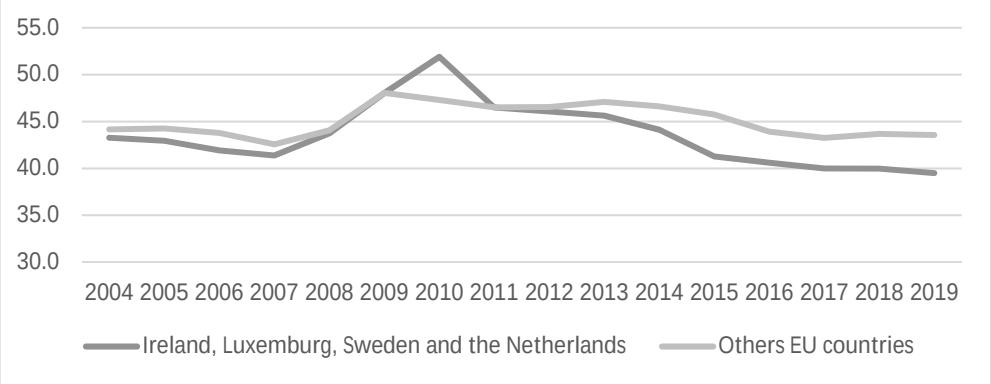


Sources: Authors' calculations

Among the EU member states, the highest average efficiency over the whole of the 2004-2019 period was reported by Ireland, Sweden, Luxembourg and the Netherlands, and it is equal to 1, i.e. the maximum efficiency possible over the entire period. They use their public spending efficiently to achieve their macroeconomic targets. These are also the countries with some of the highest rates of employment and the strongest export orientation, and also with moderate rates of economic growth and have achieved price stability. Their public spending on average in the period amounted to 43.6% (Figure 5). For the rest of the countries, average public spending was 45.1%. The data shows that the countries with the highest public spending efficiency for fiscal policy purposes also report lower public spending in GDP terms. That proves the second hypothesis that countries that have lower public spending are more efficient than EU countries that report high levels of public spending.

Figure 5

Public spending in GDP terms of EU countries in 2004-2019



Sources: Eurostat, authors' calculations

The EU member states reporting the lowest efficiency over the 2004-2019 period include Hungary, Belgium, Italy and Greece[10]. The average public spending efficiency in GDP terms for the analysed period is 0.93, and their public spending in GDP terms amount, on the average, to 50.4 % over the whole period, i.e. according to the existing research, they can be treated as countries with big governments ((Afonso et al. l., 2007; Halaskova et al. l., 2018).

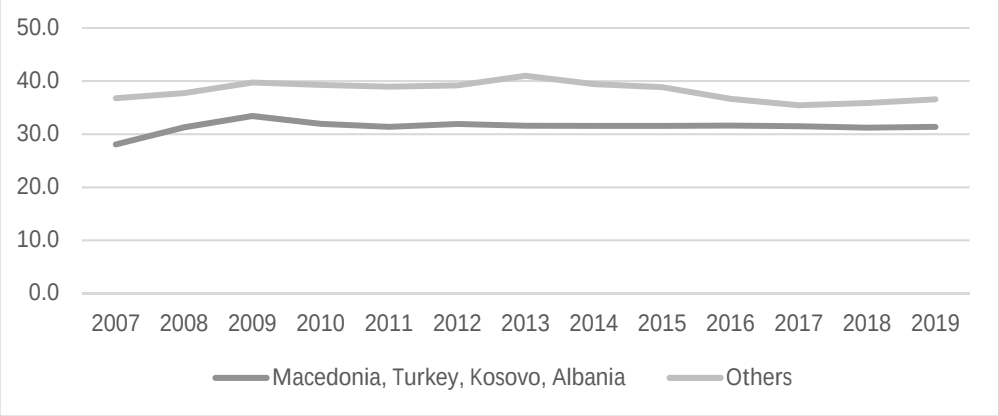
Among the countries from the Balkan Region, the best performers are North Macedonia, Turkey, Albania and Kosovo. Their average efficiency over the 2004-2019 period is 0.98, which means that they use only 2% of their public spending in GDP terms inefficiently. The rest of the Balkan countries have an average efficiency of 0.93. The average public spending efficiency in GDP terms of those countries over the same period is 31.1%, against 43.4% for the rest of the Balkan countries (Figure 6). In the case of the Balkan countries, the higher public spending efficiency and government sector performance of countries having lower public spending in GDP terms were also proven, i.e. they have small or mid-sized governments.

The countries with the lowest public spending efficiency in GDP terms from the Balkan Region are Serbia, Montenegro, Croatia and Greece. Their average efficiency over the whole period is 0.90, while their public spending in GDP terms amount to 46.6 %, which is 3.2 percentage points higher than the average for the Balkan Region. Again, this confirms the hypothesis that countries with big governments have lower efficiency compared to countries with a lower level of public spending in GDP terms.

[10] Greece is included both in the Balkan countries group and in the EU group since it belongs to both subgroups. The same approach has been applied with respect to Bulgaria and Romania, which are included in the EU group from 2007 to 2019.

Figure 6

Public spending in GDP terms of countries from the Balkan Region in 2004-2019



Sources: Eurostat, authors' calculations.

5. Conclusion

Over the past two decades of substantial changes in the economies and imbalances resulting from a series of crisis developments, the role of governments has shifted towards increased involvement in the economies. This involvement is driven by the need to support countries in their efforts to recover more quickly from the downturns they have experienced. This inevitably leads to increased public spending in GDP terms, but that cannot go on for a long time. In that context, the issue of more efficient use of public resources is becoming increasingly relevant. This study examining public spending efficiency and public sector performance in implementing its economic policy goals was also designed to address that topical issue.

The study used an approach based on linear mathematical programming that assesses the efficiency of each of the countries in comparison to the rest of the countries in the set. A comparative analysis of the public spending efficiency of EU member states and the countries in the Balkan Region was conducted.

The results from the computation prove the hypotheses formulated at the start of the research, namely, that in the conditions of the observed crises – the global financial crisis and the European debt crisis, the countries' public spending efficiency and macroeconomic performance deteriorates, due to the more substantial increase in the expenditure incurred by governments for the purposes of supporting the economies. Moreover, it has been proven that countries that have lower levels of public spending in GDP terms have higher efficiency compared to countries with higher levels of public spending, or those with the so-called "big government". These conclusions have been proven both for EU member states and for countries from the Balkan Region. In addition, the Balkan countries exhibit a higher increase

in the efficiency of government spending and of their government sector over the analysed period, which can be explained by their desire to achieve a faster convergence to the EU.

The factors behind the negative relationship between technical efficiency and public spending, especially during the crisis, is not subject to investigation in this study, but it would be a base for future research. The reason for the negative relationship between the efficiency and the level of the public spending could be fiscal multipliers, which takes different values. They can vary from negative to positive values (Yotzov, 2018, p. 1-2). The fiscal multipliers can take different values, depending on the specific characteristics of the economies: exchange rate regimes, level of government debt, phases of business cycles, openness of the economy, size of the government. The study covers a broad range of countries from more developed to less developed; from countries with common monetary policy to countries with strict monetary rules, based on the currency board arrangements; from countries with government debt over 100% of GDP to countries with government debt of about 20% of GDP. The fiscal multipliers for the EU countries and Balkan countries are different in value. Thus, the in-depth research in this respect can be a subject of a subsequent analysis.

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