EVALUATING THE PRODUCTIVE EFFICIENCY OF PUBLIC TRANSPORT COMPANIES USING ADDITIVE APPROACH

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Abstract:
Research background: The effectiveness of public transport is currently a very significant topic, which is also influencing the total efficiency of the public budget (state or regional). Public transport companies (bus, rail) are usually providing their services under the public contract with the state or regional authority responsible for the ordering of these services, and they are receiving subsidies form the public budget. It is in the interest of all inhabitants that these funds will be used properly, and they will receive the corresponding quality of public transport services.
Purpose of the article: The main aim of the article is to evaluate the productive effectiveness of chosen public transport companies operating in the suburban bus transport in Slovakia and Czech Republic.
Methods: For evaluating the effectiveness of specific groups of specific groups oi public transport companies, an additive (weighted) approach of Data envelopment analysis (DEA), so-called slack-based model is used. Based on the results from SBM model, individual hypotheses about the significance of efficiency rate are tested using non-parametric Wilcoxon tests for one sample and Mann-Whitney test for independent samples.
Findings & Value added: From the results of the efficiency evaluation using SBM DEA model it is obvious that the average productive effectiveness of public transport companies operating under PSO contracts is in general low, with two or three DMU´s achieving maximum efficiency within the given group. The significance of the difference in efficiency rate between two compared countries is also negligible. The main advantage of using the additive approach for this evaluation consists in considering the weights of inputs and outputs in the model. Suggested methodology can also be used by public authorities responsible for ordering transport services which are supported from the public budget.

Keywords: public transport; economic efficiency; additive model; data envelopment analysis

JEL Classification: C44; L91; R40

1. Introduction

Public transport forms an important part of the state public sector and economy. For the purpose of this study, by the public transport company we understand every enterprise or undertaking, which main activity consists in the provision of passenger transport services (e.g., bus, rail) for general public, in general to satisfy the transport requirements of inhabitants and ensuring the transport accessibility of the specific territory (state or region). This sector of the public economy is also known as low-profitable, due to the cost burden in combination with price regulation of public transport services, which leads to lower revenues. This begs the question how to evaluate the economic efficiency of these companies, which requires special approach considering that net profit is not the key indicator of company performance. Companies operating the passenger public transport are generally depended on subsidies from public authority (state or regional), which cover the difference between economically justified costs related to the operation of transport services, and real revenues from passenger's fares. The amount of this subsidy is usually referred to as a key indicator of efficiency when considering the public budget. For the company, it is more important to look at the operational costs, which optimization could result in the reduction of subsidy required from the state budget, and thereby to the satisfaction of all subjects on the public transport market.

In this paper, we are focusing on the specific approach for evaluating the productive efficiency of a specific sector of the economy, which is represented by companies or group of companies within a regional authority, operating public transport services under public interest. The evaluation of efficiency will be performed on the sample of chosen suburban bus public transport companies from Slovakia and Czech Republic, which are depended on subsidies from state or regional budget, using the additive (weighted) approach of Data envelopment analysis (DEA). One of the main aims is to compare the economic efficiency both within and between the individual countries and set the methodology of outputs and inputs to the model for this "unusual" sector of public economy.

2. Literature review

In the literature we can find several authors, who were dealing with the issues of measuring the performance or efficiency of individual sectors of public or private economy, including the transport sector (both freight and passenger). Anguita Rodriguez et al. (2014) focused in their study on 12 urban transport operating companies, considering different variables related to the management and financing of these companies. Bagatska et al. (2023) clarify the local authority approach to determining the efficiency of municipal-owned enterprises in the capital of Ukraine, including the public transport enterprises. In their research, the dynamic and distribution of budget funds between the municipal-owned enterprises were studied, including the dynamics of their return on assets. Authors came to the conclusion, that availability and level of budget financing of investments of municipal-owned enterprises do not have a significant impact on their profitability. Lukasik et al. (2022) analysed end evaluated the planning process in a transport company. Wurtz and Sandkuhl (2023) have oriented their study on new mobility services in the urban areas (car sharing, urban bikes) in comparison with the traditional modes of transport, and investigates the changes implied by new mobility services for the enterprise architecture of public transport operators. This paper also includes a case study for illustrating the challenges and requirements of this integration. Intermodal transport service optimisation based on passenger demand on the example from metro and urban cableways network was topic of the study by Martinod et al. (2022). With the issue of performance control in the governance of local transport companies dealt Tampieri and

Canonico (2018). This was achieved based on the network-analysis approach to the performance control of integrated built-environment systems considering the efficiency and adequacy, applied to the governance of systems of local transport companies in built environments.

A non-parametric efficiency analysis of public transport companies in Germany was performed by von Hirschhausen and Cullmann (2010) on the sample of 179 communal bus operators. Authors applied data envelopment analysis (DEA) method and bootstrapping to test the robustness of the estimates. Main result of their study is that the average technical efficiency of German bus companies is relatively low. Evaluation of efficiency of a transport company was also a main aim of the paper by Miskic et al. (2022), where authors suggested an objective-subjective model based on a PCA, DEA and MCDM approach. Another paper from the field of bus transport was published by Barabino et al. (2023), focusing mainly on the fare evasion risk evaluation. Cambini et al. (2007) viewed on the evidence on cost properties from medium and large-sized companies, which was performed on the sample of local public transport companies in Italy. The results show the presence of short-run and long-run economies of scale, as well as of economies of network density. Various measures to increase the extra-transport effectiveness have been reviewed by Vakulenko et al. (2022), with the focus on railway transport segment in Russia. With the determination of operating costs and their impact on the economic profitability of urban passenger transport companies in Peru dealt Flores and Blanco (2021), using the descriptive approach. Rykala and Rykala (2021) performed an economic analysis of transport company in the aspect of car vehicle operation, considering the balance between costs and quality of services. Taran et al. (2023) used for the efficiency evaluation a Fuzzy-logic approach. Authors estimated the fleet efficiency of a road transport company on the case study of the delivery of agricultural products. The impact of the organisation of transport processes on the efficiency of vehicle usability was analysed by Lukasik et al. (2021). Bueno-Pascual et al. (2021) determined in their paper main factors influencing the transport productivity of freight transport company using advanced methods of statistics. With the freight transport sector in terms of price competitiveness dealt Poliak et al. (2021), focusing on the international road freight transport.

Another important and current topic is related to the term of sustainability and sustainable transport systems. Several authors dealt with the question of how to find the balance between the sustainability and economic efficiency of the system. Daimi and Rebai (2023) focused on the sustainability performance assessment of Tunisian public transport companies, using the AHP and ANP approaches. Authors created a 29-indicator based transport sustainability governance index of eight regional operators in Tunisia. Another paper by Daimi and Rebai (2022) dealt with the sustainability governance indicator-based framework for public transport companies, considering the developing countries. Authors suggested four key performance indicators areas, which are economic, environmental, institutional and social. Assessment of performance and operational criteria in urban transport companies on the example of Czech Republic was also a topic for Konecna and Lenert (2021a) and for Konecna and Lenert (2021b). Voznakova and Janovska (2019) focused their study on the "greening" of the public transport as an important part of the public economy. The aim was to carry out an environmental analysis of the possibilities of using alternative propulsion in urban transport. Fabianova and Janekova (2022) compared in their study the economic assessment of investment in electric and CNG buses. The result is that with a higher level of financial support, investments in electric buses are more profitable, due to lower operating costs. Another view on the sustainability issue, taking into account the previous and possible future pandemics (as COVID-19) brought Naveen and Gurtoo (2022), focusing on the strategy and epidemic prevention framework in public transport. Their frameworks use three tenets of mobility - agility, integrated movement, and public based partnership.

3. Methodology

Considering the main aim of this paper, the quantitative methods for evaluating the economic efficiency of decision-making units (DMU's) will be used. Economic efficiency can be in general defined as an economic state, in which every resource is optimally allocated to serve each individual or entity in the best way. The term "Productive efficiency", which is for us the most important, based on the assumption that no additional output of one good or service can be obtained without decreasing the output of another good or service, and the production proceeds at the lowest possible costs. According to Cherchye et al. (2023), in the simplest case represented by one input and one output, the efficiency of DMU can be measured by the proportional indicator (1):

$$Efficiency = \frac{output}{input} \tag{1}$$

In the real conditions, it is necessary to consider several inputs and outputs, which requires different approaches for the efficiency evaluation. This can be solved by using weighted sum of individual inputs and outputs, and one of the ways how to determine the optimal weights is by using the linear programming method. For this purpose, a non-parametric Data envelopment analysis (DEA) method has been developed in the late 90s. In this paper, we focus mainly on the additive model of DEA, which benefit lies in the ability to account for all sources of the inefficiency.

3.1. Basic and additive DEA models

The basic radial models of DEA include CCR and BCC models, the difference of which lies in the nature of the returns to scale. Basic input oriented CCR model for the constant returns to scale is expressed by following linear programming task:

$$\begin{gathered} \max v^T y_0 \\ u^T x_0 = 1 \\ v^T y_i \leq u^T x_i \\ u, v \geq 0 \end{gathered} \tag{2}$$

where x_i, y_i are the vectors of inputs/outputs of DMU_i

$\boldsymbol{u}, \boldsymbol{v}$ are the vectors of weights (Wu and Lin, 2022).

The frontier set is subsequently created by the best DMUs from the comparison group. The dual task of CCR model can be expressed as follow:

$$\begin{gathered} \min \theta \\ \sum_{i=1}^{n} \lambda_i y_i \geq y_0 \end{gathered} \tag{3}$$

$$\sum_{i=1}^{n} \lambda_i x_i \geq \theta x_0$$

$$\lambda \geq 0$$

where λ is n-dimensional vector

θ is a real number (Wu and Lin, 2022).

In the BCC model for variable returns to scale, the condition of $\sum_{i=1}^{n} \lambda_i = 1$ need to be added to the limiting conditions of the model represented by formula (3). In this paper, we will focus in detail on another type of DEA, which are the additive models. Additive model is in general a combination of input-oriented and output-oriented models. We divide between two basic additive DEA models, which are the weighted model and Slacks-based Measure model (SBM). The objective function in the additive model maximizes the difference of weighted inputs and weighted outputs. The linear programming task for the weighted additive model can be formulated as follow:

$$\begin{aligned} &\max v^T y_0 - u^T x_0 \\ &v^T y_i \leq u^T x_i \\ &u \geq w^x \\ &v \geq w^y \end{aligned} \tag{4}$$

where w^x, w^y are given vectors representing the minimal positive weights of inputs/outputs (Wu and Lin, 2022).

The unoriented SBM model is using the additional variables, so-called slacks. We assume that all input and output values for each DMU are positive. To determine the efficiency of DMU_O for $o = \{1, \dots, n\}$ using the SBM model, we need to solve the following mathematical programming task:

$$\begin{aligned} &\min \rho = \frac{1 - \frac{1}{m} x_0^{-T} s^x}{1 + \frac{1}{s} y_0^{-T} s^y} \\ &x_0 = \sum_{i=1}^{n} \lambda_i x_i + s^x \\ &y_0 = \sum_{i=1}^{n} \lambda_i y_i - s^y \\ &\lambda \geq 0, s^x \geq 0, s^y \geq 0 \end{aligned} \tag{5}$$

The DMU_O is SBM efficient if the above task has an optimal solution $\rho = 1$, i.e. if the values $s^x = 0$ and $s^y = 0$. If the value $\rho < 1$, then the DMU is inefficient, and this value expresses the degree of efficiency. When using the SBM model, we distinguish between constant and variable returns to scale. The above task represents the constant returns to scale. When using variable returns to scale, it is necessary to add the condition $\sum_{i=1}^{n} \lambda_i = 1$ (Zhou et al., 2021).

The calculation of SBM DEA models for our conditions will be performed in the R language environment, using the *additiveDEA* library. The particular function for calculation of the efficiency rate is as follows:

$$dea.sbm(base, noutput, fixed = NULL, rts = 2, bound = NULL, whichDMUs = NULL, print.status = FALSE) \quad (6)$$

where $base$ is the data frame of DMU´s with inputs and outputs

$noutput$ represents the number of outputs

rts is the returns to scale specification (constant or variable)

other variables are defaults to NULL (RDocumentation, n.d.).

3.2. Data collection and adjustment

Our dataset consists of the performance and financial indicators of groups of public suburban bus transport companies operating within the territory of one regional authority, which are currently operating their services based on the Public Service Obligation (PSO) contract concluded with the state (or regional) authority. Data has been collected for years 2021 and 2022. For the purpose of this paper, we consider following business indicators:

- operational performance resulting from the PSO contract, expressed in the appropriate units (vehicle-kilometres),
- total operational costs spent on the provision of PSO services,
- total revenues from passenger fare,
- compensation of provable loss received from the public authority.

These indicators have been set so that they also consider the size of vehicle fleet and human resources, which is included in the total operational costs. At the same time, these are the main indicators determined and monitored in the PSO contracts, and therefore are compulsorily published and accessible to the general public. In this case, we created groups of bus transport companies (in general private-owned) operating within the territory of each authority responsible for PSO contracting. It is based on the assumption that the production of transport services in the given territory is formed by the sum of services from individual PSO contracts, with a common ordering authority on the regional level.

Table 1 presents an example of how the raw data for our model have been collected. In Czech Republic we divide between 14 regional groups of bus transport companies operating under different currently valid PSO contracts, for Slovakia there are 8 regional groups corresponding to the administrative division of the country. For each group, one performance and three financial indicators are considered. All the financial data are expressed in thousands of the national currency (NC). Considering the character of DEA approach, it is not necessary to convert them to common units.

3.3. Research questions and hypotheses

Based on the aim of this study, the resulting research questions are how the average rate of productive efficiency within the sector of public transport services operated under public interest is, and how significant is the difference in the efficiency rate between individual countries. We can also consider other factors by comparing the results, as size of the companies or their ownership (public or private). Based on the resulting efficiency rates, there is also

Table 1: Raw data for Czech Republic (year 2021)

Regional group of carriers	2021			
	Operational performance (thous. km)	**Operational costs** (thous. NC)	**Revenues from fares** (thous. NC)	**Compensation** (thous. NC)
Karlovarsky	6,745	317,748	101,968	214,055
Stredocesky	77,431	3,144,384	947,309	2,197,074
Ustecky	23,518	1,077,969	398,036	679,933
Plzensky	17,374	836,409	208,573	634,400
Jihocesky	22,070	1,011,599	284,700	726,899
Olomoucky	22,100	931,879	205,475	726,404
Moravskoslezsky	36,212	1,573,500	627,605	921,671
Zlinsky	24,270	1,044,483	437,944	606,539
Jihomoravsky	43,906	1,782,972	672,372	1,110,600
Vysocina	21,733	928,969	242,098	686,871
Pardubicky	16,550	660,652	234,086	426,566
Liberecky	16,889	751,537	296,926	454,608
Kralovehradecky	19,604	838,675	314,358	512,892
Praha	12,547	756,682	154,887	601,795

Source: author by Ministry of Transport of Czech Republic (2023)

possibility to examine the influence of individual inputs and outputs, and how to change them to achieve better efficiency of the individual DMU. According to the research questions, following hypotheses have been set:

Hypothesis 1:

- null hypothesis H_0: There is no significant difference in the efficiency rate within the sample.
- alternative hypothesis H_1: There is significant difference in the efficiency rate within the sample.

Hypothesis 2:

- null hypothesis H_0: There is no significant difference in the average efficiency rate of bus public transport companies between Slovakia and Czech Republic.
- alternative hypothesis H_1: The average efficiency rate of bus public transport companies significantly differs between individual states.

Based on the non-parametric character of chosen method (DEA), all the hypotheses will be tested using non-parametric tests for independent samples. For testing the location of a population based on a sample (hypothesis 1), a Wilcoxon signed rank test for one sample will be performed. For testing hypothesis 2 we use the Mann-Whitney test for independent samples. Both non-parametric tests are performed in the R language environment.

4. Results

Individual indicators related to PSO services are usually subject to correlation – e.g., the operational costs and revenues are both affecting the amount of compensation paid by the state or regional authority. Therefore, an adjustment of inputs and outputs to DEA SBM model was necessary. For this purpose, we chose a proportional indicator of revenues per compensation unit. DMU´s with a greater ratio of revenues to compensation are generating bigger production efficiency, as they require lower amount of funds from the public budget. Table 2 presents the final determination of inputs and outputs to DEA SBM models, which have been used for calculating the productive efficiency for each group of DMU´s.

Table 3 presents the results of SBM DEA model for Czech groups of suburban bus transport operators sorted by individual regional authorities for years 2021 and 2022, including the value of productive efficiency and slacks of individual inputs and output, which mean how

Table 2: DEA SBM model inputs and outputs determination

Inputs	Outputs
Operational performance in mil. kilometres Operational costs in thous. NC	Revenues per compensation unit

Source: author

they would have to be adjusted to achieve the efficiency of DMU. Looking at the results for year 2021, there are three effective DMU´s with productive efficiency rate equal to 1.0 (Karlovarsky, Zlinsky and Liberecky regional groups of public bus transport operators), other DMU´s can be considered as ineffective. In 2022 only two DMU´s are considered as effective. The effectiveness rate of ineffective DMU´s is in average 0.38 in 2021 with standard deviation 0.222, and in average 0.31 in 2022 with standard deviation 0.115. Looking at the slacks of individual inputs, in most cases of inefficient DMU´s there is a space for reducing and optimizing the operating costs, especially for the group of public bus transport companies operating in Stredocesky region, which is the biggest regional unit in the Czech. Republic. Table 4 analogically presents the results of SBM DEA models for Slovak groups of public bus transport companies operating under specific contract with regional authority.

Table 3: SBM model results for Czech suburban bus transport

	2021				2022			
Regional group of bus transport operators	**Efficiency rate (SBM)**	**Slack y_1**	**Slack x_1**	**Slack x_2**	**Efficiency rate (SBM)**	**Slack y_1**	**Slack x_1**	**Slack x_2**
Karlovarsky	1.0	0	0	0	1	0	0	0
Stredocesky	0.09	0.045	70,686	2,826,635	0.11	0.020	52,263	2,119,574
Ustecky	0.55	0	10,516	492,657	0.36	0	15,092	611,890
Plzensky	0.27	0.148	10,629	518,661	0.22	0.170	9,943	450,223
Jihocesky	0.25	0.085	15,325	693,851	0.25	0.093	14,358	580,494
Olomoucky	0.19	0.193	15,355	614,130	0.27	0.061	15,220	574,222
Moravskoslezsky	0.55	0	16,345	703,769	0.58	0	24,517	85,298
Zlinsky	1.0	0	0	0	0.32	0	15,247	690,111
Jihomoravsky	0.34	0	29,756	1,148,565	0.34	0	28,984	994,046
Vysocina	0.24	0.124	14,988	611,221	0.23	0.129	13,468	533,386
Pardubicky	0.70	0	5,650	165,238	0.37	0.055	9,308	369,757
Liberecky	1.0	0	0	0	1.0	0	0	0
Kralovehradecky	0.76	0	5,024	185,866	0.36	0.008	12,277	459,535
Praha	0.26	0.219	5,802	438,934	0.35	0.169	2,263	271,419

Source: author

We can see from the results that in case of SBM model for Slovak public bus transport there are two effective DMU´s (groups of bus transport operators in Bratislavsky and Trnavsky region), while their effectiveness has not changed between the years. The effectiveness rate of ineffective DMU´s is in average 0.23 in 2021 with standard deviation 0.047, and in average 0.42 in 2022 with standard deviation 0.112. In general, year 2022 has brought higher results in the effectiveness rate, in average even double the values from year 2021. This may be caused by the influence of the COVID-19 crisis the effects of which were still felt at the time. Slacks of individual inputs and output are showing us that there is space for reducing the operating costs, excluding the groups of bus public transport operators in Nitriansky region, where in 2022 the productive effectiveness could be achieved only by increasing the operational performance, which will on the other hand cause an increase in the compensation of provable loss, and therefore this effect may not be manifested.

The graphical representation of the variability of resulted efficiency rates within individual groups of DMU´s reflects Figure 1, using the box-plot figure including basic descriptive statistics. On this figure, a significant difference in the variability between years is visible in case of Czech bus transport operators, when the effective DMU´s are even considered

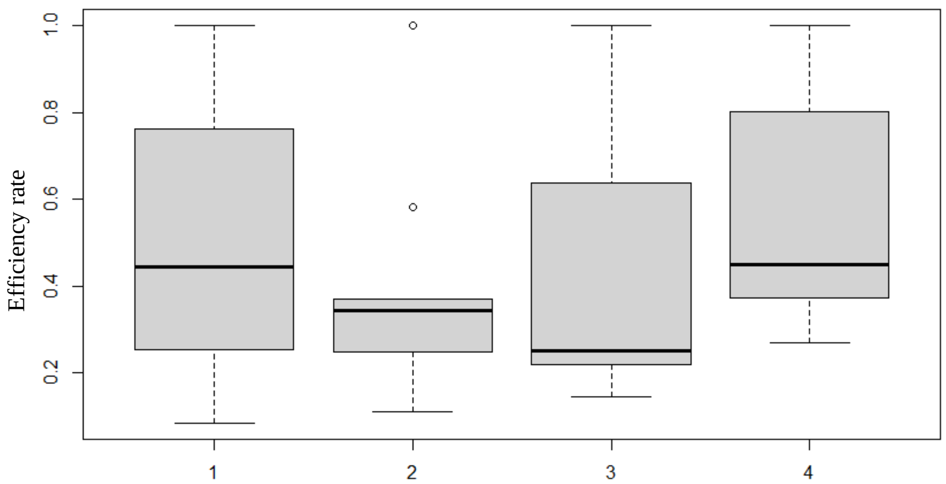
Table 4: SBM model results for Slovak suburban bus transport

	2021				2022			
Regional group of bus transport operators	**Efficiency rate (SBM)**	**Slack y_1**	**Slack x_1**	**Slack x_2**	**Efficiency rate (SBM)**	**Slack y_1**	**Slack x_1**	**Slack x_2**
Bratislavsky	1.0	0	0	0	1.0	0	0	0
Trnavsky	1.0	0	0	0	1.0	0	0	0
Nitriansky	0.25	0	17,947	31,999	0.60	0.19	5,364	0
Trenciansky	0.25	0	17,194	36,006	0.46	0.29	4,249	13,927
Banskobystricky	0.14	0	24,911	48,605	0.27	0.40	10,184	26,400
Zilinsky	0.20	0	21,073	39,112	0.38	0.35	7,335	9,898
Presovsky	0.23	0	23,363	31,737	0.36	0.36	10,188	7,487
Kosicky	0.27	0	21,164	26,970	0.44	0.32	8,443	2,826

Source: author

as outliers. Most of the results for year 2022 lies in the first two quartiles and do not reach the median of efficiency rate within the group of DMU´s. This is not the case of Slovakia, where the difference between individual years is much less expressive and without presence of the outliers. The median value of effectiveness in all four groups of DMU´s can be considered as not too different and ranges in the interval from 0.3 to 0.42, which is in general an insufficient value in terms of economic performance of the sector.

Figure 1: Box-plot of resulting effectiveness of DMU´s



Notes: 1 – Czech Rep. 2021, 2 – Czech Rep. 2022, 3 – Slovakia 2021, 4 – Slovakia 2022
Source: author

Based on the resulting effectiveness rates from the SBM model, our two specific hypotheses have been tested using non-parametric tests. Hypothesis 1 about the significance of results within the sample is performed individually for both groups of DMU´s (Slovakia and Czech Republic). In the hypothesis 2, individual countries are considered as two independent samples and the significance of the difference in average value of efficiency rate is tested. Table 5 shows the results of Wilcoxon test for individual countries and year, with the value of test statistics and p-value.

Looking at the results of non-parametric testing, in all cases we can reject the null hypothesis about non-significance of the difference of median value within the sample, as the p-value is lower than 0.05. Table 6 presents results of Mann-Whitney test, which were used for testing the hypothesis 2.

Table 5: Testing the hypothesis 1 using Wilcoxon test for one sample

Sample	W	p-value	Result
Czech Republic – 2021	105	0.001	reject H_0
Czech Republic - 2022	105	0.001	reject H_0
Slovakia – 2021	36	0.008	reject H_0
Slovakia - 2022	36	0.008	reject H_0

Source: author

Table 6: Testing the hypothesis 2 using Mann-Whitney test for independent samples

Sample 1 vs. Sample 2	U	p-value	Result
Czech Republic 2021 vs. Slovakia 2021	72	0.2896	cannot reject H_0
Czech Republic 2022 vs. Slovakia 2022	29	0.0704	cannot reject H_0

Source: author

Based on the test statistics and p-value for both time periods, we cannot reject the null hypothesis about non-significance of the difference in the efficiency rate of DMU´s between individual countries. Looking at the data from 2022, the p-value is much closer to the critical limit and therefore there is a probability that with a larger sample size, the null hypothesis may be a subject for rejection. From our results it looks like Slovak and Czech groups of bus transport companies are not characterized by a significant difference in the productive effectiveness, when using the SBM DEA approach.

5. Discussion

The topic of economic or productive efficiency was usually a subject for the research in the field of “standard” sectors of the economy. This paper brings a new view on the specific sector which, however, is important for the national economy and affects the living standards of each country. It requires a different approach in determining the inputs and outputs to the model, where the condition of creating a minimum subsidy from the public budget must be considered, as opposed to creating a maximum profit. The majority of published studies have evaluated the transport sector as a whole, or paid more attention to the freight transport, the nature of which is slightly different in terms of costs and revenues. We have focused our paper on the passenger public transport services provided under public interest, and thus helped to fill the research gap in this area.

This study has been limited by the public availability of the data related to the performance and financial indicators of public transport companies, and by the COVID-19 crisis which caused that data before year 2021 were not used as they could distort the results. According to the used methodology, there are limitation in the number of outputs and inputs in the model, which had to adjust to the sample size. DEA approach is also specific, because by adding another DMU to the model we can achieve radically different results of their relative effectiveness. For the future research, it would be appropriate to extend the sample of public transport companies to other countries and other modes of transport, especially rail passenger and urban transport, and then compare the efficiency rate between individual transport modes. Suggested model can be improved by using another approach in addition to non-parametric DEA model, and by including the qualitative research in the process of the determination of appropriate inputs and outputs to the model.

6. Conclusions

The main aim of this paper was to evaluate the productive efficiency in public transport sector using additive approach, which have been performed on the example of Czech and

Slovak suburban bus transport companies represented by the groups of regional operators in time period of 2021-2022. For this evaluation, a DEA SBM weighted model was used, with determination of specific inputs and outputs applicable for this sector of public economy. The results of SBM model show us that the productive efficiency in this sector is relatively low within the selected countries, and there is no significant difference in the average efficiency rate of bus public transport companies between individual countries. Looking at the slacks of individual inputs and output, the higher level of effectiveness can be mainly reached by reducing or optimizing of operating costs, and in some cases also by increasing the operational performance, which, however, will cause higher demands on the public budget and the desired effect may not be achieved. The suggested model could be useful for the monitoring of the efficiency of public transport by individual state or regional authorities responsible for ordering these services, and with slight adjustments of inputs and outputs it can be also implemented for another modes of passenger public transport, mainly regional railway and urban transport.

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