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## APPLICABILITY OF THE DEA METHOD ON THE TRANSPORT UNDERTAKINGS IN SELECTED REGIONS

*With respect to achieving the economic goals within ordering of the suitable public transport system it is currently necessary that the economic indicators which contribute to the amount of a provable loss be evaluated rationally. The authors, therefore, will use the DEA method to efficiently assess the economic situation of the specific transport company to find out whether its business is economically attractive. At the same time, the involved companies will be compared with respect to their economically attractive behaviour. The article is based on the public domain information – economic indicators which the undertakings are obliged to publish by law. Despite this fact, it can be concluded that the source data are suitable for the analysis of economic health of a particular transport company.*

**Keywords:** Input-oriented BCC model, transport companies, the DEA method, the constant revenue of scale, the variable revenue of scale.

### 1. Introduction

This paper is aimed to ascertain whether the selected transport companies are effective in using their inputs and outputs.

For the evaluation of effectiveness of these entities, the DEA (Data envelopment analysis) will be used; or more precisely, the input-oriented BCC model will be used under the conditions of variable revenue of scale (BCC).

The DEA method is a specialized model tool used especially to assess the effectiveness, performance and productivity of the homogeneous production entities. The selection of these entities was made upon the identical production, i.e. with the same inputs and outputs. This method is aimed to break the entities down into the effective and ineffective ones as well as to recommend reduction or increase in the inputs or outputs.

The DEA-method based models consider the set of admissible options formed by possible combinations of inputs and outputs. For graphic representation, the so-called effective boundary is used, i.e. the entities lying on this effective boundary are considered effective. Otherwise, they are considered ineffective and the changes thereof need to be proposed.

The CCR model maximizes the rate of effectiveness of the evaluated entity as a quotient of weighted outputs and weighted inputs on condition that the rates of effectiveness of other entities are less than or equal to one. The input-oriented CCR model focuses on such an amount of inputs which are consequently

evaluated by this model. The model recommends such changes so that the ineffective entity becomes the effective one. At the same time, the model foresees the constant revenue of scale; i.e. the change in the amount of inputs will be directly proportional to the change in the output amount. For each entity this model will set individual weights of inputs and outputs to maximize the technical efficiency coefficient.

Certain conditions, however, must be met, namely:

- Weights cannot be negative;
- When using this set of weights for all entities, no coefficient of the technical efficiency must be greater than one.

The input-oriented BCC model is the modification of the previous model CCR. This model already takes into consideration the variable revenue of scale, i.e. increasing, decreasing or constant revenue. It foresees the variable, in certain parts linear revenue of scale and can evaluate the efficiency of entities for the generally non-constant output of scale [1 and 2].

Table 1 contains the basic input data to evaluate the economic health of the specific transport company. For the evaluation purposes, the regional towns without a specific traffic (except for Prague and Brno) were selected [3 - 5].

Table 2 contains the values recommended by the DEA method so that the management of the specific transport company is effective, i.e. the company effectively uses its income to perform traffic services. To take the saving measures, it is appropriate to consider the modification of those inputs which do not have a direct effect on the traffic services, i.e. they will concern only

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the modification of the scope of travelled kilometres. Here, the effective tool can be the modification of employment in the context of modification of the number of vehicles (better distribution of vehicles throughout the day - optimization of circulations and the

related optimization of the number of employees - optimization of shifts). The appropriate tool is also the modification of sales from the transportation activity. However, with respect to the current issue, i.e. the massive growth of private motor vehicle transport,

Basic input data of selected transport companies

Table 1

	Number of employees	Personnel costs	Cost of sales	Travelled kilometres in relation to the specific route	Vehicle - kilometres	Number of vehicles	Sales	Transported passengers
Ceske Budejovice	398	178 399 000	117 146 000	564776000	5651000	139	123 462 000	38541000
Hradec Kralove	385	155 784 000	112 194 000	475524000	5950000	126	118 345 000	34106000
Chomutov - Jirkov	239	98 824 000	103 313 000	172550000	1825000	47	47 432 000	5102000
Jihlava	175	70 657 000	31 579 000	212255000	3032000	63	47 867 000	13777000
Karlovy Vary	258	109 810 000	78 809 000	225242000	2584000	61	58 868 000	9587000
Liberec	390	152 472 000	130 418 000	680462000	7755000	212	195 909 000	42045000
Most - Litvinov	446	175 507 000	145 362 000	419405000	4512000	138	103 496 000	27420000
Olomouc	438	175 092 000	138 433 000	651153000	6196000	150	146 783 000	52193000
Pardubice	404	162 308 000	85 734 000	557912000	5730000	129	117 220 000	25919000
Teplice	263	107 571 000	109 808 000	299597000	5658000	130	95 164 000	14843000
Usti nad Labem	484	205 627 000	145 958 000	733999000	7266000	150	186 476 000	43162000
Zlin - Otrokovice	331	129 335 000	77 076 000	451512000	4824000	95	117 620 000	31866000

Source: Authors

Recommended values as per the input-oriented BCC model

Table 2

	Number of employees	Personnel costs	Cost of sales	Travelled kilometres in relation to the specific route	Vehicle - kilometres	Number of vehicles	Sales	Transported passengers
Ceske Budejovice	365	144 884 774	102 826 113	513193026	5188460	115	123 462 000	38541000
Hradec Kralove	339	133 356 942	84 354 747	470012254	4942745	102	118 345 000	34106000
Chomutov - Jirkov	239	98 824 000	103 313 000	172550000	1825000	47	47 432 000	5102000
Jihlava	175	70 657 000	31 579 000	212255000	3032000	63	47 867 000	13777000
Karlovy Vary	258	109 810 000	78 809 000	225242000	2584000	61	58 868 000	9587000
Liberec	390	152 472 000	130 418 000	680462000	7755000	212	195 909 000	42045000
Most - Litvinov	310	122 156 819	79 365 839	400970253	4313677	88	103 496 000	27420000
Olomouc	438	175 092 000	138 433 000	651153000	6196000	150	146 783 000	52193000
Pardubice	330	128 998 510	76 815 097	450139976	4813724	95	117 220 000	31762268
Teplice	263	107 571 000	109 808 000	299597000	5658000	130	95 164 000	14843000
Usti nad Labem	484	205 627 000	145 958 000	733999000	7266000	150	186 476 000	43162000
Zlin - Otrokovice	331	129 335 000	77 076 000	451512000	4824000	95	117 620 000	31866000

Source: Authors

Total evaluation as per the input-oriented BCC model

Table 3

Input - oriented BCC model BCC		
Transport undertaking	Percentage	Effectiveness evaluation
Chomutov - Jirkov	100%	effective
Hradec Kralove	98,80%	ineffective
Jihlava	100%	effective
Karlovy Vary	100%	effective
Liberec	100%	effective
Most - Litvinov	95,60%	ineffective
Olomouc	100%	effective
Pardubice	89,60%	ineffective
Teplice	100%	effective
Zlin - Otrokovice	100%	effective
Ceské Budejovice	91,80%	ineffective
Usti nad Labem	100%	effective

Source: Authors

Recommended percentage changes as per the input-oriented BCC model

Table 4

	Number of employees	Personnel costs	Cost of sales	Travelled kilometres in relation to the specific route	Vehicle - kilometres	Number of vehicles	Sales	Transported passengers
Ceske Budejovice	-8,19%	-18,79%	-12,22%	-9,13%	-8,19%	-17,20%	0,00%	0,00%
Hradec Kralove	-11,86%	-14,40%	-24,81%	-1,16%	-16,93%	-19,03%	0,00%	0,00%
Chomutov - Jirkov	0%	0%	0%	0%	0%	0%	0%	0%
Jihlava	0%	0%	0%	0%	0%	0%	0%	0%
Karlovy Vary	0%	0%	0%	0%	0%	0%	0%	0%
Liberec	0%	0%	0%	0%	0%	0%	0%	0%
Most - Litvinov	-30,51%	-30,40%	-45,40%	-4,40%	-4,40%	-36,47%	0,00%	0,00%
Olomouc	0%	0%	0%	0%	0%	0%	0%	0%
Pardubice	-18,29%	-20,52%	-10,40%	-19,32%	-15,99%	-26,50%	0,00%	22,54%
Teplice	0%	0%	0%	0%	0%	0%	0%	0%
Usti nad Labem	0%	0%	0%	0%	0%	0%	0%	0%
Zlin - Otrokovice	0%	0%	0%	0%	0%	0%	0%	0%

Source: Authors

this point depends on the promoter's decision on how the urban traffic will be promoted. This aspect is not directly depending on the transport company. With respect to this fact all values of the modification of sales are zero!!! The results of recommended modifications are listed in Table 4 [6, 7, 8 and 9].

## 2. Results

Table 3 shows that the transport companies in the towns of Chomutov - Jirkov, Jihlava, Karlovy Vary, Liberec, Olomouc, Teplice, Zlin - Otrokovice and Usti nad Labem are the effective entities, i.e. the model entities for the ineffective transport undertakings. Based on the model entities, the % change is recommended for the ineffective entities to make them effective. For the needs of the specific percentage changes, the input-oriented BCC model has been proposed (i.e. minimization of the costs under the conditions of maintaining the same volume of outputs (sales, number of transported passengers). The transport companies marked in blue (Table 4) are ineffective.

The transport company in Pardubice is the least effective and, therefore, the result is not only the input change but also the output change. To achieve higher effectiveness, it is recommended to increase the number of transported passengers by 22.54%, i.e. by 5,843,268 transported passengers and, at the same time, to reduce the number of employed vehicles by 26.5%. It follows that the time interval should be increased by a few minutes and the number of links should be reduced or cancelled.

In case of the Most - Litvínov transport company, nearly 40% changes are recommended for some inputs, however, this recommended change is practically unreal. The prerequisite would be reduction of some inputs if the situation allowed so. The highest and the most recommended change is the cost of sales which includes, but is not limited to, the consumption of material and services. It is, therefore, appropriate to find a more effective method for the management of material and other items. Personnel costs represent the next group of recommended changes. Here, it is necessary to distinguish the wages of the drivers, clerical employees, managers and other staff. It is advised to decrease the salaries of senior managers, however, the wages of drivers should be maintained on the same level.

The transport company in Ceske Budejovice is the second most ineffective entity. The biggest change is foreseen in the personnel cost item. This case is identical with the transport company in Most - Litvinov. The next important item to be changed is the number of employees which is closely related to the change in the number of employed vehicles. The cost of sales concern all ineffective entities and it is generally recommended to find more appropriate methods of use of materials and other items.

The transport company in Hradec Králové should also shift its focus on the cost of sales. Reduction of the number of employees and the number of vehicles concern all transport undertakings. Of all ineffective transport companies, the required change of the personnel costs is, however, the lowest. The same also applies to the travelled kilometres in relation to the specific route [10 - 14].

## 3. Conclusion

Based on the above table it can be concluded that the cost of sales of selected transport companies require the necessary changes. The task is to find an appropriate way how to manage the cost of sales items.

The input-oriented BCC model where only the minimization of inputs was applied while maintaining the same outputs (this rule was exceptionally breached in case of the Pardubice transportation company) is just an indicative model. For more detail recommended changes it would be desirable to break down some cost items. Another factor for evaluating the transport undertakings is the verification of the accounting data quality, i.e. quantitative and qualitative data.

The DEA method focuses on a few models: the CCR and BCC models, which evaluate effectiveness of the entities using the set parameters in terms of constant revenue of scale and variable revenue of scale. The goal is to determine the preference of transport companies, i.e. if they want to expect the increase (maximization) in outputs or decrease (minimization) in inputs. Each of the applied models will evaluate the effectiveness of entities with the recommended different changes [15 - 19].

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