PERFORMANCE OF ROAD FREIGHT TRANSPORT COMPANIES BASED ON DEA ANALYSIS

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Abstract
This study evaluates the performance of road transport companies using Data Envelopment Analysis (DEA) to measure relative technical efficiency. The analysis is based on multiple input variables, including employees, assets, material costs, and labor costs, and output indicators such as EBIT, efficiency ratio, and value added. An input-oriented CCR model under constant returns to scale is applied to assess how efficiently firms utilize their resources. The results indicate substantial variability in efficiency levels across the sample, with only a limited number of companies operating on the efficiency frontier. Most firms exhibit varying degrees of inefficiency, suggesting significant potential for improving resource utilization. The analysis of slack variables reveals that inefficiencies are not purely proportional but also structural, requiring targeted adjustments in specific inputs and outputs. Efficient firms serve as benchmarks for less efficient ones, highlighting best practices within the sector. The findings emphasize the importance of optimizing input use and enhancing output generation to improve overall performance. Overall, the study demonstrates the usefulness of DEA as a tool for performance evaluation and benchmarking in the road transport sector, offering valuable insights for managerial decision-making and policy development aimed at increasing efficiency and competitiveness.

Keywords: *road freight transport, performance, DEA, efficiency*
JEL: C14, D24, R40

INTRODUCTION

Road freight transport is an important factor in a country's economy. It enables the fast and efficient movement of goods between different regions. In doing so, it supports the functioning of industry, trade, and supply chains. It also contributes to infrastructure development and job creation. Its role is crucial in connecting local and international markets.

In the production structure of Slovenia’s GDP, the transport and storage sector generates around 6% of total value added. More than half of this share is represented by land transport, within which road freight transport holds a dominant role with more than 80%. This highlights the significant importance of road transport for the functioning of the entire logistics system and supply chains in the country. Between 2020 and 2024, the total volume of transported tonnes increased by more than 10%, indicating growing demand for transport services. This growth was mainly driven by economic recovery, increased trade activity, and the development of logistics services. In domestic transport, the volume of transported goods increased by as much as 24%, reflecting a strengthening of the internal market. In contrast, international transport recorded a decline in transported goods, which may be a result of changes in global supply chains or broader economic conditions (SORS, 2026).

The efficiency of the transport sector can be evaluated at both national and company levels, as performance varies depending on scale, organization, and market conditions. Key performance criteria include fleet productivity, vehicle load factors, and the share of empty trips, all of which directly influence operating costs and environmental impact. High fleet productivity and optimal load factors indicate better utilization of resources, while a lower share of empty trips reflects more efficient route planning and demand coordination. While Slovenia performs comparably to the EU average in international transport, it shows lower efficiency in domestic transport, primarily due to a higher proportion of empty runs and shorter transport distances that limit consolidation opportunities. This suggests that there is still considerable potential for improvement, particularly through better logistics coordination, digitalization, and collaboration between transport operators. Similar criteria can be applied to assess transport companies, although these indicators are generally more suitable for larger firms with extensive vehicle fleets and advanced tracking systems. Larger companies are typically better equipped to optimize routes, reduce empty mileage, and invest in modern technologies that improve overall efficiency. However, in addition to non-financial indicators, financial performance measures are also essential (Gunasekaran & Kobu, 2007), especially for small and medium-sized enterprises (Töyli et al., 2008), which make up the majority of transport companies in Slovenia. These measures include profitability, cost efficiency, liquidity, and return on investment, all of which provide insight into the financial sustainability of a company. For smaller firms, balancing operational efficiency with financial stability is particularly important, as they often operate with limited resources and face stronger market pressures. The research thesis is based on the assumption that companies that manage their available resources more efficiently achieve better output results in terms of profitability, cost efficiency, and value added per employee. However, it is important to emphasize that high revenue alone does not necessarily imply high efficiency. Companies with the highest revenues often operate with larger capacities, higher costs, and more complex business structures, which may lead to lower technical efficiency compared to smaller, more flexible, and better-optimized firms.

Therefore, the study assumes that there is a difference between company size or revenue level and actual technical efficiency measured by the DEA method, and that companies with lower revenues may achieve the same or even higher levels of efficiency than larger companies in road freight transport.

1. LITERATURE REVIEW

The efficiency of road freight transport has been widely discussed in the literature as a multidimensional concept encompassing operational, economic, and environmental aspects. Increasing demand for freight services, cost pressures, and sustainability requirements have intensified the need for improving resource utilization and optimizing logistics processes. In this context, efficiency is not only reflected in operational performance but also in the financial outcomes of transport companies.

Traditional approaches to evaluating transport efficiency rely on indicators such as fleet productivity, vehicle utilization, and service quality. However, these measures alone are insufficient to capture the complexity of modern freight transport systems. As highlighted by McKinnon (2009), efficiency assessment should incorporate a broader framework that reflects different types of freight operations and service characteristics. Recent studies emphasize additional indicators, including load factors, empty running, transit times, and system flexibility (Sencer & Turan, 2019). These operational indicators are closely linked to financial performance, as better utilization of vehicles and reduced idle time directly contribute to lower costs and higher profitability.

One of the most critical inefficiencies in road freight transport is empty running. According to SORS (2026), empty trips can account for 15% to 35% of total vehicle kilometers, representing significant economic losses and environmental burdens. This issue is closely related to structural imbalances in freight flows, commonly referred to as the backhaul problem. The persistence of empty running not only increases operational costs—such as fuel consumption, labor, and maintenance—but also negatively affects financial performance indicators, including cost efficiency and profit margins. Therefore, reducing empty mileage is a key objective for improving both operational and financial efficiency.

Digitalization has emerged as a key enabler of efficiency improvements in the transport sector. The use of big data analytics and artificial intelligence allows companies to better understand demand patterns, optimize routing, and improve load planning (Iliashenko et al., 2021). In addition, digital freight platforms facilitate real-time matching of supply and demand, thereby reducing empty trips and improving asset utilization (Krajewska et al., 2008). From a financial perspective, these improvements translate into lower operating costs, better asset turnover, and increased revenue potential. Investments in digital technologies are therefore increasingly viewed as strategic decisions that enhance both operational and financial performance.

Efficiency is not determined solely by technology but also by organizational and managerial practices. Effective route planning, fleet management, and inter-firm collaboration play a crucial role in improving performance (Cruijssen et al., 2007). Collaborative logistics models, such as shared transportation networks, can significantly enhance vehicle utilization and reduce costs. Furthermore, strategic decisions regarding fleet composition, outsourcing, and investment planning directly influence financial outcomes, including return on assets (ROA) and return on investment (ROI). Larger firms often benefit from economies of scale, while small and medium-sized enterprises (SMEs) must rely on flexibility and niche specialization to maintain financial viability. Financial efficiency is a critical dimension of overall performance in road freight transport. It is commonly assessed through indicators such as profitability, cost efficiency, liquidity, and solvency.

According to McKinnon (2009), transport companies operate in a highly competitive and cost-sensitive environment, where even small improvements in operational efficiency can significantly impact financial results. Operating costs in road freight transport are dominated by fuel, labor, vehicle maintenance, and capital costs. Therefore, efficient cost management is essential for maintaining competitiveness. Studies show that companies with higher vehicle utilization rates and better route optimization tend to achieve lower cost per kilometer and higher profit margins (Nivetha & Prasanth, 2025).
Moreover, financial efficiency is closely linked to pricing strategies and market conditions. Transport companies must balance competitive pricing with cost recovery, particularly in volatile markets characterized by fluctuating fuel prices and demand uncertainty. For SMEs, which represent the majority of firms in the sector, maintaining liquidity and financial stability is especially challenging, making financial management a key success factor.
The reviewed literature indicates that the efficiency of road freight transport companies is a complex and multifaceted issue, encompassing operational, organizational, and financial dimensions. Major challenges include low capacity utilization, high levels of empty running, and cost pressures. At the same time, digitalization, collaboration, and improved financial management provide significant opportunities for enhancing both operational and financial performance. A comprehensive approach that integrates these aspects is essential for ensuring the long-term competitiveness and sustainability of transport companies.

2. METHODOLOGY

The efficiency of road freight transport can be comprehensively assessed using the DEA (Data Envelopment Analysis) method, which enables a comparison of the relative technical efficiency of companies based on the relationship between inputs and outputs. In this study, the input variables include the number of employees, the level of assets, and material and labour costs, which represent the key production resources in transport activity. The output variables include EBIT as an indicator of operational profitability, economic efficiency as a measure of cost efficiency, and value added per employee as an indicator of labour productivity. In the study, we analyzed the 50 largest carriers based on generated revenue in 2026.
In the study, we used Data Envelopment Analysis (DEA), which is suitable for assessing efficiency in different transport systems (Markovits-Somogyi, 2011). DEA is a linear mathematical programming approach that evaluates the efficiency of decision-making units (DMUs). It calculates a maximal performance measure for each DMU relative to other DMUs (Charnes et al., 1994).
Various DEA models have been developed (Charnes et al., 1994; Adler et al., 2002). Markovits-Somogyi (2011) notes that in the field of transport, the most commonly used models are the CCR (Charnes, Cooper and Rhodes) and BCC (Banker, Charnes and Cooper) models. The most appropriate for the road transport sector is the CCR input-oriented model. The mathematical formulation of the CCR input-oriented model is:

$$max \frac{\sum_r u_r y_{ro}}{\sum_i v_i x_{io}} \tag{1}$$

$$\frac{\sum_r u_r y_{rj}}{\sum_i v_i x_{ij}} \leq 1, for\ j = 0, 1, \dots, n \tag{2}$$

$$\frac{u_r}{\sum_i v_i x_{io}} \geq \varepsilon, for\ r = 1, \ldots, s \tag{3}$$

$$\frac{v_i}{\sum_i v_i x_{io}} \geq \varepsilon, for\ i = 1, \ldots, m \tag{4}$$

where ia:

- *x* and *y* are the input and output vectors,
- *v* and *u* are the input and output weight

Descriptive statistics reveal considerable variability across all observed variables, indicating heterogeneity in firm size, resource endowment, and performance levels. Input variables show particularly high dispersion, especially in total assets and material costs, suggesting significant differences in scale among the analyzed firms. This is consistent with the presence of both small and large logistics providers within the sample.

The distribution of the number of employees is moderately skewed, with a concentration of firms employing a relatively smaller workforce, while a few larger firms contribute to higher maximum values. A similar pattern can be observed in labor and material costs, where the majority of firms operate at lower cost levels, but a small number of firms exhibit substantially higher expenditures. On the output side, EBIT and value added demonstrate substantial variability, including the presence of lower-performing firms with relatively weak financial outcomes and high-performing firms generating significantly higher returns. This dispersion reflects differences in operational efficiency, pricing strategies, and market positioning.

The efficiency ratio appears less dispersed compared to financial variables, suggesting some degree of consistency in operational performance across firms, despite differences in scale.

Overall, the descriptive statistics confirm that the sample is highly heterogeneous, which justifies the application of DEA as a non-parametric method capable of handling such variability without imposing restrictive assumptions on the production function.

Table 1: Descriptive statistics

	Mean	Median	Maximum	Minimum	Standard deviation
Inputs					
X_1 Number of employees	108	92	480	8	89
X_2 Total assets	15.002.320	11.490.795	57.443.701	3.541.698	10.397.359
X_3 Costs of goods, material and services	14.139.109	12.074.648	51.717.092	6.671.850	8.390.096
X_4 Labour costs	3.333.499	2.737.176	13.319.369	354.348	2.639.493
Outputs					

Y_1 EBIT	936.730	478.890	7.948.451	-159.209	1.326.581
Y_2 Efficiency	1,04	1,03	1,27	0,99	0,055
Y_3 Added value per employee	63.038	53.948	219.333	2.289	36.994

Data were analysed by using the Open Source DEA software (Virtos).

3. RESULTS

To assess the relative technical efficiency of the analyzed decision-making units (DMUs), Data Envelopment Analysis (DEA) was applied using the CCR model with an input orientation under the assumption of constant returns to scale (CRS). The model incorporates multiple input variables (employees, assets, material costs, and labor costs) and output indicators (EBIT, efficiency ratio, and value added).

The results reveal substantial heterogeneity in efficiency levels across the observed units. The average technical efficiency is relatively low, indicating that the majority of DMUs operate below the efficient frontier.

Table 2: Efficieny score of transport companies

Company	Objective Value	Company	Objective Value	Company	Objective Value
Milšped	0,1850	Gatis	0,6327	Avtotransporti Zupančič	1
Klemen transport	0,3199	Petrans	0,5230	Ko-trans	0,7477
Avtotransporti Kastelec	1	Prevozništvo Klaut	0,6637	Brus	0,7494
Kobal Transporti	0,3404	Prevozništvo Daniel Fijavž	0,6864	Tramper	0,9407
Frikus	0,8159	Hoedlmayr	0,7791	Auta Marocchi S.P.A.	0,8989
Jurčič&CO	0,4566	FedEx Express Slovenija	0,7219	Habjan Transport	0,7145
Hubat	0,5040	Bizjak Aleksander	0,7424	Avtotransporti Kastelec Lado	1
Šuštar Trans	0,5035	Campagnolo Koper	0,7714	Makše	1
Sigr	0,6356	GLT	0,5751	Bonta	0,9987
Global Sistem	0,4673	Marlot Beton	0,7786	Globus	1
Pfeifer	0,5309	Fijavž Logistics	0,7596	MP-Trans	1
Transport Finec	0,5449	Frigotransport Pišek&Hsf	0,6882	BZ Transport	0,9922
Petek Transport	0,5073	Ažman	1	Nastran	0,9636
Ploj	0,5306	Kaas-Prevozi	0,8351	A-Sprint	0,9872
Eurotrek Trebnje	0,5292	FF Group	1	Škofic Promet	1
Špedicija Goja	0,5586	Forbiz	0,8068	Slo-Car	1
SILO Jeličič	0,5462	Koptrans	1		

Fully efficient units (efficiency score equal to 1) form the efficiency frontier and represent benchmarks of best practice. These include: Avtotransporti Kastelec, Ažman, FF Group, Koptrans, Avtotransporti Zupančič, Avtotransporti Kastelec Lado, Makše, Globus, MP-Trans, Škofic Promet, and Slo-Car. These DMUs define the efficient envelope and serve as reference points for the evaluation of less efficient units.

Most of the analyzed units are inefficient, with efficiency scores distributed over a wide range. The lowest efficiency levels are observed for units such as Milšped (0.185) and Klemen transport (0.3199), indicating significant potential for input reduction while maintaining current output levels. This suggests substantial inefficiencies in resource utilization.

A group of moderately efficient units (efficiency scores approximately between 0.5 and 0.8), including Hoedlmayr, FedEx Express, and Fijavž Logistics, demonstrates partial efficiency, but still with notable room for improvement. Additionally, several units (e.g., Tramper, Auta Marocchi, Nastran, A-Sprint) operate close to the efficient frontier and could achieve full efficiency with relatively minor adjustments.

Beyond radial efficiency measures, the DEA model provides deeper insights into inefficiency through slack variables, which capture non-proportional excesses in inputs and shortfalls in outputs. The results indicate that inefficiency is not purely radial but also structural. Many inefficient DMUs exhibit:

- positive input slacks, indicating excessive use of specific resources (e.g., labor or capital),
- output slacks, reflecting insufficient generation of outputs relative to their input levels.

This combination suggests that improvements require not only proportional input reductions but also targeted adjustments in specific inputs and outputs.

Units with the lowest efficiency scores (e.g., Milšped and Klemen transport) tend to exhibit substantial slack values, pointing to deeper structural inefficiencies. In contrast, units close to the efficiency frontier typically show minimal slacks, indicating that their inefficiencies are relatively minor and primarily operational.

For each inefficient DMU, the DEA model identifies a set of reference units (peer group) composed of efficient DMUs that serve as benchmarks. These reference units define the target performance levels that inefficient units should strive to achieve.

The analysis shows that certain efficient DMUs appear more frequently in the reference sets, indicating their strong role in shaping the efficiency frontier. Notably, Autotransporti Kastelec, Ažman, FF Group, Koptrans, and MP-Trans emerge as dominant benchmarks.

Inefficient units are typically compared to a convex combination of multiple reference units, rather than a single peer. The associated weights determine the relative importance of each benchmark, implying that performance improvement strategies should be based on a combination of best practices rather than direct imitation of a single unit.

The combined interpretation of efficiency scores, slack variables, and reference units provides actionable insights for improving performance:

- DMUs with significant input slacks should focus on reducing excess resource utilization (e.g., optimizing workforce size or capital allocation),
- DMUs with output slacks should aim to enhance value creation (e.g., improving productivity or profitability),

- Reference units serve as practical benchmarks, offering guidance for restructuring operations and adopting more efficient practices.

Overall, the DEA results highlight substantial inefficiencies within the sector and underscore the importance of both operational optimization and strategic benchmarking. Importantly, DEA not only ranks units by efficiency but also provides concrete directions for performance improvement, making it a valuable tool for managerial decision-making and policy analysis.

CONLUSION

The study provides a comprehensive assessment of the performance of road transport companies using Data Envelopment Analysis (DEA). The results reveal substantial differences in technical efficiency across firms, confirming that a significant proportion of companies operate below the efficiency frontier. This indicates considerable potential for improving resource utilization within the sector.

Efficient firms serve as important benchmarks, demonstrating that high levels of performance are achievable under existing market conditions. In contrast, inefficient firms exhibit both radial inefficiencies and structural imbalances, as evidenced by the presence of input and output slacks. These findings suggest that performance improvements require not only reductions in input usage but also better alignment between resources and outputs.

The analysis further highlights the importance of benchmarking against best-performing peers, as inefficient companies can improve by adopting a combination of practices observed in efficient firms. The heterogeneity of the sample underscores the relevance of DEA as a methodological approach, given its ability to accommodate differences in scale and operational structure.

Overall, the study contributes to a better understanding of efficiency dynamics in the road transport sector and provides practical implications for managers and policymakers. By identifying inefficiencies and offering clear improvement targets, the results support more informed decision-making and promote increased competitiveness and sustainability within the industry.

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