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Evaluation of the efficiency and corporate social responsibility of the transport industry using the Data Envelopment Analysis method[1]

Ocena efektywności i społecznej odpowiedzialności biznesu w branży transportowej metodą Data Envelopment Analysis

Abstract

Involvement in corporate social responsibility (CSR) is of increasing importance across different economic sectors, including transport industry. This study examines the relationship between CSR and efficiency of companies in the transport industry. It belongs to the type of quantitative research and extends the scope of research related to the subject of CSR and efficiency of companies in the transport industry. Whereas previous literature lacks empirical research analyzing the relation between CSR and efficiency in the transport industry, the present study aims to fill in this research gap. The study focuses on data for 2013–2015 period and on major transport companies in the USA, in particular those representing the air and road transport sectors. The paper is based on Data Envelopment Analysis method which is used to measure efficiency, while the Pearson correlation coefficient is used to detect the relationship between CSR and efficiency. The results confirm positive relationship between CSR and efficiency of transport companies. The paper contains further evidence on the relationship between individual CSR areas (social, environmental and governance CSR) and efficiency. This study can contribute not only as a recommendation for transport companies, but also as an introduction to further and more detailed research of the relation between CSR and efficiency.

Keywords:
Corporate Social Responsibility, Data Envelopment Analysis, Pearson correlation, efficiency measurement, air transport, road transport

Streszczenie

Zaangażowanie w społeczną odpowiedzialność biznesu (CSR) nabiera coraz większego znaczenia w różnych sektorach gospodarki, w tym w branży transportowej. W niniejszym artykule zbadano związek pomiędzy CSR a efektywnością przedsiębiorstw branży transportowej. Opracowanie należy do typu badań ilościowych i poszerza zakres badań związanych z tematyką CSR i efektywnością przedsiębiorstw branży transportowej. W dotychczasowej literaturze brakowało badań empirycznych analizujących związek między CSR i efektywnością branży transportowej i właśnie niniejszy artykuł ma na celu wypełnienie tej luki badawczej. Badanie opiera się na danych z lat 2013–2015 i dotyczy czołowych firm transportowych w Stanach Zjednoczonych, reprezentujących sektor transportu lotniczego i drogowego. W artykule wykorzystano metodę Data Envelopment Analysis, która służy do pomiaru efektywności, natomiast współczynnik korelacji Pearsona został wykorzystany do analizy związku pomiędzy CSR a efektywnością. Wyniki badań potwierdzają pozytywny związek pomiędzy CSR a efektywnością firm transportowych. Artykuł zawiera również analizy dotyczące związku pomiędzy poszczególnymi obszarami CSR (społecznym, środowiskowym i ładem korporacyjnym) i efektywnością. Niniejsze opracowanie może stanowić nie tylko rekomendację dla firm transportowych, ale także wstęp do dalszych i bardziej szczegółowych badań nad związkiem między CSR i efektywnością.

Słowa kluczowe:
społeczna odpowiedzialność biznesu, Data Envelopment Analysis, korelacja Pearsona, pomiar efektywności, transport lotniczy, transport drogowy

Introduction

In modern conditions of rapid development of the world community, market saturation, global crises and environmental disasters, issues related with ensuring acceptable living conditions, safety and environmental protection have particular importance. Therefore, more companies are strengthening social orientation of their activities and start looking for solutions that can ensure long-term loyalty of customers, employees and other stakeholders, as well as sustainable development. An answer to these challenges is found in the concept of Corporate Social Responsibility (CSR). CSR refers to the broad role of business in the society and can be defined as voluntary activities: a company undertakes "activities that seem to support a certain social good, that go beyond the interests of the company and that required by law" (McWilliams & Siegel, 2001). Benefits of CSR include improved reputation, insurance-like protection, improved shareholder wealth, better risk management, improved market demand from customers, increased transparency in disclosure and reporting, and general ability to access financial markets on better conditions (Guillamon-Saorin et al.; 2018, Askari et al., 2021).

The freight transport industry is an essential component of economic development of any nation, while also imposing many negative externalities for environmental and social welfare (Kumar & Anbanandam, 2020; Konieczny et al., 2013). Based on a survey by Forrester Research among Fortune 500 companies, P. S. Meral (2013) summarizes that 78% of the companies surveyed outsource transport, 54% distribution services, and 46% manufacturing; the author also emphasizes that the third-party logistics industry has achieved the value of USD 50 billion, globally. The freight transport industry heavily depends on natural resources, including those causing carbon dioxide emission and aggravating the global warming, therefore it is imperative to address environmental challenges of the industry (Lee, 2010). It is also essential to include the social sustainability dimension in the freight transport planning, which reduces its negative impacts (McKinnon et al., 2010). Due to the fact that the essence of the CSR concept is also associated with the companies' involvement in mitigating negative environmental externalities, the application of CSR in the transport industry is also increasing, which motivates the current study analysis of the CSR in this sector.

Despite a lot of research on the performance implications of CSR, this concept is still under discussion among stakeholders. A majority of CSR studies focus on the businesses' financial performance (e.g., Flammer, 2015; Khan et al., 2019, for recent review see: Busch & Friede, 2018). Some CSR-dedicated literature also addresses the efficiency dimension of corporate performance (e.g., Sun & Stuebs, 2013). It should be emphasized, however, that the scientific literature lacks research combining the concepts of efficiency and CSR in the context of the transport industry. This is the literature gap we aim to fill in with this study.

The aim of the study is to analyze the relationship between CSR and efficiency of companies in the transport industry. The study covers major air and road transport companies operating in the USA in the period 2013–2015. Regarding research methods used herein, Data Envelopment Analysis (DEA) is applied to measure the businesses' efficiency (Charnes et al., 1978; Banker et al., 1984), while the Pearson correlation coefficient is used to detect the relationship between CSR and efficiency.

The rest of this paper is organized as follows: next section reviews relevant literature that analyses the link between CSR and efficiency, highlighting the research gap. Subsequent sections describe the dataset and the variables used in the empirical application, together with their descriptive statistics. Next, methods used in the study are introduced. Section that follows presents the results. The final section offers concluding comments and suggests the lines for future research.

Corporate social responsibility and efficiency – review of prior research

Table 1 represents empirical studies relating to the analysis of the relationship between CSR and efficient (or productive) performance, emphasizing the sector in question. In order to create the list of papers, the following procedure was applied: we searched Google Scholar with the following keywords: "efficiency", "productivity" and "corporate social responsibility", which yielded the papers included in the table.

The literature that analyzes the link between CSR and efficiency appeared as recently as in 2011, with the study by L. Becchetti and G. Trovato (2011). Literature and previous researches generally report some positive relation between CSR and efficiency (e.g., Zhu et al., 2017; Guillamon-Saorin et al., 2018; Sun & Stuebs, 2013). The literature focuses on several sectors, including telecommunications industry (Wang et al., 2014), food and beverage manufacturing industry (Kapelko et al., 2021) and creative industry (Hou et al., 2019). Nevertheless, the majority of the studies focus on banking sector in different contexts (e.g., Fukuyama & Tan, 2021). To sum up, scientific literature lacks research focusing on linking CSR with the efficiency in the transport sector.

Table 1

Empirical studies that analyze the link between CSR and efficiency (or productivity change)

Author(s) and year of publication	Research period	Sector	Research methods and main conclusions
Wei-Kang et al. (2014)	2004–2008	Telecommunications industry in the USA	Dynamic DEA, ordinary least squares and clusters regression models. Significant relationships between CSR and corporate performance was confirmed
Becchetti & Trovato (2011)	1990–2004	Energy, financial, healthcare, industrial, technology, telecommunications and utilities in the USA	Latent class stochastic frontier model. Companies with CSR do not appear to be more distant from the production frontier than companies in the control sample
Jacobs et al. (2016)	1999–2009	Manufacturing industry in the USA	DEA approach, Tobin's q indicator, Altman Z-score – relationship between operational productivity, CSR, financial performance and risk. Operational productivity moderates the CSR–financial performance and CSR–risk relationships
Zhu et al. (2017)	2008–2013	Chinese banking sector	Conditional efficiency approach. CSR has positive impact on banking performance
Shahwan and Habib (2020)	2012–2018	Egyptian banks	DEA method, Tobit regression model. Positive association between CSR practices and banks' technical efficiency
Sun & Stuebs (2012)	1998–2009	Chemical industry in the USA	DEA method, regression analysis. Positive relationship between CSR and future productivity
Chen & Tebourbi (2021)	2016	Taiwan's manufacturing sector	DEA model, Pearson correlation. The relationship between innovation capital, CSR, and business performance fails to reach any significant level
Cho & Lee (2017) managers	2003–2011	Major US companies (with no sectors distinguished)	DEA, regression model. Efficient are more likely to involve in the product-related CSR, but are less likely to involve in the environment-related CSR
Hou et al. (2019)	2010–2013	Creative industry in the USA	DEA method, regression analysis. Positive influence of CSR on the performance
Yang (2015)	2001–2008	Major US companies (with no sectors distinguished)	DEA, Tobit and threshold regressions. The companies' long-term CSR involvement will improve their efficiency
Fukuyama & Tan (2021)	2007–2017	Chinese banking industry	DEA methodology, bootstrapped truncated regression method. Potential gains from improvement in technical efficiency can enhance its CSR activity
Forgione et al. (2020)	2013–2017	Commercial banking worldwide	Stochastic frontier analysis. Positive impact of CSR on bank efficiency
Ngo & Tian (2020)	2013–2017	Chinese airports	DEA method, truncated bootstrap regression. CSR awareness positively contributes to the improvement of the performance
Kapelko et al. (2021)	2004–2015	Food and beverage manufacturing industry in the USA	Input-specific dynamic Luenberger indicator, regression analysis. Association between CSR and productivity changes is positive or negative, depending on specific inputs and investments
Lu et al. (2013)	2004–2008	US semiconductor industry	DEA method, panel data regression. Social responsibility investment by businesses has positive effect on their performance

Author(s) and year of publication	Research period	Sector	Research methods and main conclusions
Belasri et al. (2020)	2007–2017	Banking sector worldwide	DEA dynamic network model, regression analysis. Positive impact of CSR on bank efficiency
Xie et al. (2019)	2015	Global companies in energy, materials, industrials, consumer discretionary, consumer staples, healthcare, financials, information technology, telecommunications services, utilities and real estate	DEA model, Tobin's q. Positive relationships confirmed
Guillamon-Saorin et al. (2018)	2004–2015	Major US companies (with no sectors distinguished)	Dynamic DEA, regression analysis. Lower inefficiency occurs in companies with a higher commitment to CSR
Fijałkowska et al. (2018)	2012–2016	Banks in Central and Eastern Europe	DEA, regression analysis. Banks with better financial efficiency have higher efficiency of CSR activities
Kapelko (2020)	2004–2015	Major US companies (with no sectors distinguished)	Dynamic Luenberger indicator, regression analysis. Positive association between CSR and dynamic productivity change

Source: own work.

Dataset and variables

In this study, enterprises operating in the USA were analyzed. The main type of their activity is providing logistics services in the field of cargo organization and passenger transport by air and road, as well as the provision of value-added services and other logistics services. As for the sources of data used, business information on the CSR results of the companies analyzed in this study was taken from the Kinder, Lydenberg & Domini (KLD) database and supplemented with financial data from Compustat Global Vantage for 2013–2015.

Financial data consisted of the following variables to estimate DEA model: fixed assets, costs of goods sold and number of employees as measures of inputs, and revenues as a measure of output. Following the previous studies (e.g., Kapelko et al., 2021), the data were constructed in a manner making them comparable over time. These variables (except for the number of employees) have been adjusted by the relevant price indices provided by the Bureau of Labor Statistics (USA) (2020). In particular, fixed assets have been adjusted using the private capital equipment price indices for the non-processing industry. Costs of goods sold are adjusted by indicators reflecting supply prices to non-processing industries, while revenues have been adjusted by price indicators reflecting the performance of transport companies.

The KLD database is a popular source of CSR data in scientific research. It contains data grouped into seven CSR-related areas, namely: community, diversity, employee relations, human rights, products, environment and corporate governance for a large proportion of US listed companies (Kapelko, 2020). Further, these areas were grouped into three dimensions of CSR: social responsibility (comprising of community, diversity, employee relations, human rights and products), environmental impact, and corporate governance. KLD database lists all positive and negative factors of the three categories resulting into total strength and total concern aspects of CSR. In particular, KLD assigns values 1 or 0 to each factor, depending on whether a given factor is present in the company or not (1 where it is; otherwise 0). The advantage of the KLD ranking is its comprehensiveness, ensured by the analysis of various dimensions of CSR. Based on the information contained in KLD, and following previous research (e.g., Kang, 2013), we constructed a netscore variable that indicates the difference between positive and negative aspects of CSR (that is the difference between total strengths and total concerns). We further split the netscore into its social, environmental and governance dimensions. Finally, we looked specifically into CSR strengths and concerns.

When searching for companies according to established criteria, a large amount of data was found in the databases that met the search criteria. Outliers and data with atypical characteristics were eliminated. As a result, and to assure a balanced panel for 2013–2015, 26 companies were selected, 14 of which belong to the air transport sector and 12 operate in the road transport sector.

Descriptive statistics of the variables to compute efficiency and of the CSR indicators

Table 2 shows the descriptive statistics for each input and output variable for the years 2013–2015.

Analyzing the variable fixed assets, it can be observed that over the three-year period the average remained practically unchanged and in 2015 it finally reached the level of USD 4,234.58 million. At the same time, the standard deviation of the analyzed variable reaches high values in relation to the mean, which proves a high variability of this data in the analyzed sample. When analyzing the next variable of costs of

Table 2
Descriptive statistics of efficiency variables 2013–2015

Year	Statistics	Fixed assets	Costs of goods sold	Number of employees	Revenues
2013	Mean	3672.31	3797.75	0.04	5629.39
	St. dev.	6008.26	6949.97	0.09	9617.06
	Median	721.83	653.46	0.00	1187.52
	Minimum	121.69	101.22	0.00	214.43
	Maximum	18,642.60	25,494.21	0.40	29,270.33
2014	Mean	3912.15	3998.86	0.04	5788.99
	St. dev.	6123.47	7333.84	0.10	9709.20
	Median	795.65	722.08	0.01	1289.00
	Minimum	149.80	113.20	0.00	233.44
	Maximum	18,447.65	27,254.29	0.44	29,365.61
2015	Mean	4234.58	4977.17	0.05	5949.52
	St. dev.	6557.43	9182.50	0.11	9883.22
	Median	949.11	936.25	0.01	1356.84
	Minimum	147.16	122.69	0.00	206.07
	Maximum	20,168.89	34,768.74	0.44	29,761.47

Note: monetary variables are in million dollars, constant prices from 2013. Number of employees are in million.

Source: own work.

Table 3
Descriptive statistics of CSR variables, 2013–2015

Year	Statistics	Netscore	Total strength	Total concern	Social	Environmental	Governance
2013	Mean	0.65	2.08	1.42	0.15	0.54	–0.04
	St. dev.	2.86	2.84	1.10	1.95	1.21	0.34
	Median	0	1	1	0	0	0
	Minimum	–2	0	0	–2	0	–1
	Maximum	9	10	4	6	5	1
2014	Mean	0.27	1.12	0.85	–0.19	0.50	–0.04
	St. dev.	1.91	1.82	0.97	1.17	1.17	0.34
	Median	0	0	1	0	0	0
	Minimum	–3	0	0	–3	0	–1
	Maximum	5	7	4	2	5	1
2015	Mean	0.31	1.15	0.85	–0.19	0.58	–0.08
	St. dev.	1.67	1.85	0.88	0.90	1.27	0.39
	Median	0	0	1	0	0	0
	Minimum	–2	0	0	–2	0	–1
	Maximum	5	6	3	2	5	1

Source: own work.

goods sold, it can be seen that the average gradually increased and finally reached the highest result in 2015, amounting to USD 4,977.17 million. Moreover, the standard deviation is getting bigger and bigger every year (the highest jump can be observed in 2015, up to the value of over USD 9,000 million). The variable number of employees was growing over the following years as well, as more and more employees were employed in the companies observed. The average number of them had been steadily increasing from 2013 to 2015. The average revenues of enterprises also increased from year to year, which may prove the success of the companies' operations and general growth in industries in question.

Table 3 presents the calculated descriptive statistics of CSR variables used in the study by each year of the analyzed period. When it comes to data variability, the variables in Table 3 are more diverse than the input and output parameters analyzed previously. This is evidenced by high values of the standard deviation in individual years in relation to the average. The maximum value of netscore achieved 9 points in 2013, and reached the minimum of –3 points in 2014. Discussing the individual dimensions of CSR, the maximum result was observed for social area, which was equal to 6 points in 2013, and stood for the highest result among all enterprises analyzed over the entire period in study. The worst result, however, which regarded the social dimension among all enterprises and periods, was –3 in 2014. It should be observed that for environmental area the highest point was 5 and it remained at this level for all the considered years. Analyzing the governance dimension of CSR in corporations, it is visible that, on average, companies are little involved in this dimension of CSR.
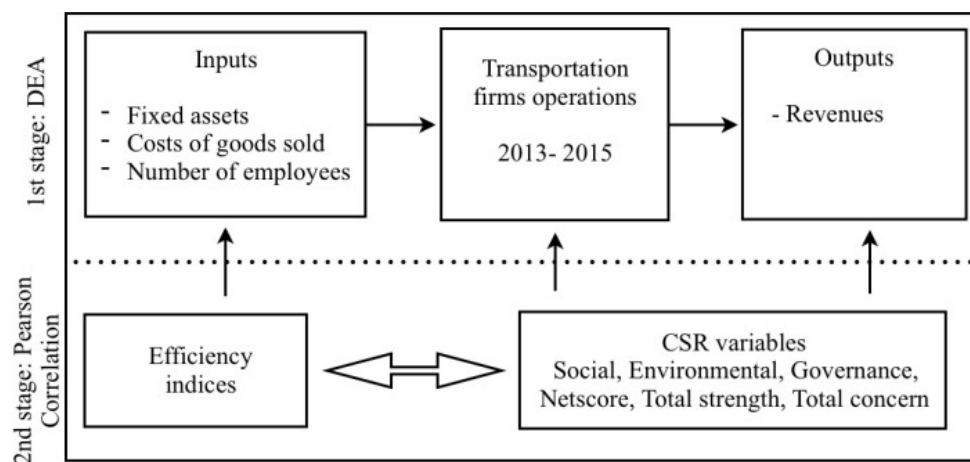
Methods

Research methodology of the paper consists in two stages. In the first step, efficiency indices of the firms in the sample are computed using DEA, based on the information about the companies' inputs and outputs. In the second stage, efficiency indices measured in the first stage are related to CSR variables using Pearson correlation. The research methodology is summarized in Figure 1.

The measurement of efficiency

In this study we applied the DEA method to measure efficiency. The idea of the DEA method focuses on using empirical amounts of inputs and outputs and derive weights that maximize efficiency for a given decision-making unit (DMU). In this way, DEA is a mathematical programming problem, which is about determining the efficiency of specific DMUs in relation to the group of best practices (Thanassoulis, 2003).

This technique is possible to use when the values of the variables are expressed in different units (e.g., passengers in number of persons and goods in tons). The convenience of the method also stems from the fact that it allows to determine benchmarks for inefficient units from the group of units with a relative efficiency equal to 100% (Stolp, 1990). From the efficiency measure point of view, input- and output-oriented models can be distinguished. The choice of orientation is often influenced by external conditions related to the entities examined. In input-oriented models, inefficient units can increase their efficiency by reducing inputs, whereas

Figure 1

Illustration of research methodology

Source: own work.

in output-oriented models increasing efficiency occurs by increasing results. Moreover, the assumption of returns to scale makes it possible to distinguish DEA models assuming Constant Returns to Scale (CRS) (Charnes et al., 1978) and Variable Returns to Scale (VRS) (Banker et al., 1984). Due to the high variability of data, the VRS assumption was used in the calculations. Furthermore, we applied input-oriented model and assumed that companies in the sample have more control over their inputs than outputs. The following linear model is used to compute efficiency:

$$\theta^* = \text{Min} \quad \theta$$
$$s.t.$$

$$\sum_{j=1}^{n} x_{ij} \cdot \lambda_j \leq \theta \cdot x_{ij0},$$

$$\sum_{j=1}^{n} y_{rj} \cdot \lambda_j \geq y_{rj0},$$

$$\sum_{j=1}^{n} \lambda_j = 1,$$

$$\lambda_j \geq 1,$$

where:
θ – the efficiency coefficient,
x_{ij} – quantity of input $i = \{1, 2, ..., m\}$ consumed by DMU$_j$ ($j = 1, ..., n$),
y_{rj} – quantity of output $r = \{1, 2, ..., s\}$ produced by DMU$_j$,
x_{ij0} – quantity of input i consumed by the unit observed under analysis DMU$_{j0}$,
y_{rj0} – quantity of output r produced by the unit observed under analysis DMU$_{j0}$,
λ_j – the activity levels associated with inputs and outputs of DMU$_j$.

Pearson correlation

In the second step of the analysis, the relation between efficiency and CSR was analyzed using the Pearson correlation. The formula for this correlation is as follows:

$$r_{xy} = \frac{\text{cov}(X, Y)}{\sigma_X \sigma_Y},$$

where:
$\text{cov}(X, Y)$ – covariance between X and Y
σ_X, σ_Y – standard deviation of X and Y.

Pearson's correlation coefficient always takes values in the range of (–1, 1). The sign of the correlation coefficient informs us about the direction of the correlation, while its absolute value lets us know about the strength of the relationship. The coefficient 0 means there is no correlation between the variables X and Y examined. The closer the absolute value of the correlation coefficient is to 1, the stronger the correlation between the variables.

Results and discussion

Efficiency results

Table 4 shows the results of the efficiency and benchmarks for enterprises in 2013–2015. Please consider that the numbers included in the columns "Benchmarks" for efficient businesses (that is with efficiency = 100%) indicate how many times a company in question is a benchmark for inefficient companies. Otherwise, the columns "Benchmarks" show the efficient companies (DMUs) that should serve as benchmarks for inefficient ones. The table also summarizes the results of the L. Simar and V. Zelenyuk (2006) test to assess the statistical significance of the differences in the efficiencies between road transport and air transport companies.

While analyzing the descriptive statistics of the efficiency scores, it can be seen that the average for all enterprises is quite high, exceeding the level of 90%, and the highest result was 92.31% in 2013 for the road sector enterprises. It is also worth mentioning that the differences between the efficiency of individual modes of transport (air, road) are small. The results of the statistical test show further that the differences in efficiencies between sectors are not statistically significant. Efficiency at the level of 92.31% means that in order to achieve 100% efficiency, on average, companies could reduce their inputs by approx. 8%, maintaining a constant level of outputs, due to the fact that the calculated efficiency is input-oriented. On the other hand, comparing year to year over the 2013–2015 period, an average decrease by a certain percent can be observed: of 3.2% for road transport and of 1.6% for air transport. Generally speaking, it can be concluded that there is a downward trend in terms of the average efficiency of the enterprises in question. Taking into account the standard deviation, which is lower than the average efficiency and remains within the range of 8–12%, it can be concluded that there is no much differentiation in the sample of companies in terms of the efficiency they achieve. All enterprises operate quite efficiently with regard to their inputs. In addition, when analyzing the results from the table, it is

Table 4

A summary of the results of the efficiency and benchmarks for enterprises in 2013–2015

DMU	Efficiency 2013 [%]	Benchmarks 2013	Efficiency 2014 [%]	Benchmarks 2014	Efficiency 2015 [%]	Benchmarks 2015
Road Transport						
DMU 6	94.43	DMU 10, DMU 15, DMU 25, DMU 8	91.44	DMU 15, DMU 11, DMU 1	74.25	DMU 10, DMU 25, DMU 1
DMU 10	100.00	2	97.06	DMU 15, DMU 25, DMU 1	100.00	3
DMU 11	94.01	DMU 13, DMU 1, DMU 23	93.16	DMU 13, DMU 1, DMU 23	89.18	DMU 13, DMU 1, DMU 7
DMU 12	82.26	DMU 10, DMU 25, DMU 1, DMU 8	78.13	DMU 15, DMU 25, DMU 1, DMU 8	79.52	DMU 10, DMU 25, DMU 1
DMU 13	100.00	12	100.00	11	100.00	11
DMU 15	100.00	2	100.00	4	97.55	DMU 10, DMU 25, DMU 8
DMU 16	84.68	DMU 13, DMU 1, DMU 23	87.97	DMU 13, DMU 1, DMU 23	83.26	DMU 13, DMU 1, DMU 7
DMU 18	80.15	DMU 13, DMU 25, DMU 1	80.34	DMU 13, DMU 25, DMU 1	80.45	DMU 13, DMU 25, DMU 1
DMU 22	90.66	DMU 13, DMU 1, DMU 23	89.22	DMU 13, DMU 1, DMU 23	85.24	DMU 13, DMU 1, DMU 7
DMU 24	100.00	1	100.00	1	100.00	1
DMU 25	100.00	5	100.00	7	100.00	6
DMU 26	81.53	DMU 13, DMU 1, DMU 23	81.49	DMU 13, DMU 1, DMU 23	79.91	DMU 13, DMU 1, DMU 7
Mean	**92.31**	x	**91.57**	x	**89.11**	x
St. dev.	**8.14**	x	**8.22**	x	**9.85**	x
Air transport						
DMU 1	100.00	11	100.00	13	100.00	12
DMU 2	83.94	DMU 13, DMU 15, DMU 8	85.37	DMU 15, DMU 25, DMU 8	81.87	DMU 13, DMU 25, DMU 8
DMU 3	96.57	DMU 13, DMU 1, DMU 8, DMU 14	96.85	DMU 13, DMU 1, DMU 8, DMU 14	100.00	1
DMU 4	90.47	DMU 13, DMU 8, DMU 14	90.22	DMU 13, DMU 8, DMU 14	87.99	DMU 13, DMU 8, DMU 14
DMU 5	82.10	DMU 13, DMU 1, DMU 14, DMU 20	81.86	DMU 13, DMU 1, DMU 14, DMU 20	72.47	DMU 13, DMU 1, DMU 3, DMU 14
DMU 7	100.00	0	100.00	0	100.00	6
DMU 8	100.00	6	100.00	5	100.00	4
DMU 9	78.26	DMU 13, DMU 24, DMU 23	78.43	DMU 13, DMU 24, DMU 23	74.23	DMU 13, DMU 24, DMU 7
DMU 14	100.00	3	100.00	3	100.00	4
DMU 17	81.74	DMU 13, DMU 25, DMU 1, DMU 8	82.27	DMU 13, DMU 25, DMU 1, DMU 8	82.39	DMU 13, DMU 25, DMU 1, DMU 8
DMU 19	72.65	DMU 1, DMU20, DMU 23	72.65	DMU 1, DMU 20, DMU 23	68.88%	DMU 1, DMU 14, DMU 20
DMU 20	100.00	2	100.00	2	100.00	3
DMU 21	94.85	DMU 13, DMU 25, DMU 1	95.67	DMU 13, DMU 25, DMU 1	98.60	DMU 13, DMU 1, DMU 14, DMU 20
DMU 23	100.00	6	100.00	6	99.77	DMU 1, DMU 7, DMU 20
Mean	**91.47**	x	**91.62**	x	**89.83**	x
St. dev.	**10.06**	x	**10.06**	x	**12.55**	x
Significance of the differences between sectors (*p*-values)	**0.90**	x	**0.72**	x	**0.29**	x

Source: own work.

possible to highlight 3 companies from the road transport group and 6 companies from the air transport group, which maintained their efficiency at the highest level compared to others over the entire period 2013–2015.

Analysis of the relation between CSR and efficiency

Table 5 shows the relationship between CSR variables, and the performance results for each year of the period 2013–2015, as measured by the Pearson correlation.

Interpreting the results from the table, one can observe that there is a relationship between the above-mentioned variables. It is evident that this relationship is not large and is positive in case of the total strength and overall netscore. In the case of the dependence of the efficiency variables and total concern, negative relationship and a growing trend of this relationship are seen. Furthermore, it is noticed that the relationship for netscore was decreasing year after year and in 2015 it reached the level of 0.26. This can be explained by the fact that in 2015 most companies were less involved in CSR, as the netscore average for this year is 0.31 which is 47% lower than in 2013.

As in the case of netscore, the correlation coefficient for individual CSR areas shows a downward trend from year to year. However, for the environmental dimension, this relationship has increased in 2014 and then decreased in 2015.

Furthermore, it can be concluded that the social area has a large impact on the average enterprises' efficiency score in the periods under analysis. When calculating the correlation between the variables, this result is at the level of 0.46 in 2013 and is considerably different from the results for other areas in the same year. This means that by acting in accordance with the CSR principles within the social dimension, by correctly integrating them with business goals, transport companies increase their opportunities for obtaining better efficiency results through, for example, improving their reputation among stakeholders.

In case of the environmental dimension, according to the correlation results, the relationship with efficiency is also positive. This proves that the greater involvement of companies in pro-environmental activities focused on reduction of exhaust emissions, e.g. through modernization of motor vehicles, the better the efficiency results. This seems related with the specificity of the transport industry which produces many negative externalities for the environment.

The interesting finding is the relationship between the efficiency and governance dimension of CSR as the results show the growing negative values, which in 2015 reach the level of –0.20. This indicates the reverse relationship, i.e. the lower (or higher) values for the corporate governance dimension of CSR, the higher (or lower) the performance scores for a given DMU. In other words, little involvement in corporate governance is related with better performance scores. This finding can be explained by the fact that, perhaps, companies incur less expenditure related to this area of CSR, or less investment in governance dimension of CSR provides benefits that can be observed not immediately but only in a longer perspective. Nevertheless, the values of these correlations are really insignificant, thus making it difficult to come up with certain conclusions regarding the relationship between the variables analyzed.

Classification of enterprises according to CSR and efficiency

In order to provide further insights into the relationship between CSR and efficiency, we now look into the findings for each DMU. In order to define which companies are more and which are less involved in CSR, categories of businesses were created based on the average netscore for all the years under consideration. As a result, two groups of enterprises were distinguished: one with high

Table 5

Relationship between CSR and efficiency results for 2013–2015

Efficiency / CSR	2013	2014	2015
Netscore	**0.42**	0.38	0.26
Total strength	0.24	0.31	0.19
Total concern	**–0.46**	–0.16	–0.09
Social	**0.46**	0.31	0.27
Environmental	**0.24**	0.32	0.21
Governance	**–0.01**	–0.02	–0.20

Source: own work.

CSR – high performance CSR (average CSR score ≥ 0) and another with low CSR – low performance CSR (average CSR score < 0). Table 6 shows the average values for CSR variables and the average efficiency over the entire period under study, together with the results of L. Simar and V. Zelenyuk (2006) test to assess the differences in efficiencies between the two groups.

Looking at the performance of companies with netscore above 0, 91.6% of them have an average efficiency score above 90%. High performance CSR group is characterized by the higher average efficiency than the low performance CSR group (96.44% versus 85.77%), and these differences prove to be statistically significant. Therefore, based on the calculations regarding the correlation between these variables presented in Table 5, and on the outcomes from Table 6, one can conclude that high CSR results are related with high values of the efficiency of enterprises. This finding goes in line with the results of previous research (e.g., Hou et al., 2019; Fukuyama & Tan, 2021; Belasri et al.,

Table 6

CSR and average efficiency results for 2013–2015

DMU	Average Netscore	Average for social	Average for environmental	Average for governance	Average efficiency[%]	Sector
High performance CSR group						
DMU 1	0.33	0.33	0.00	0.00	100.00	AT
DMU3	0.67	1.33	0.00	−0.66	97.81	AT
DMU 4	1.00	1.00	0.00	0.00	89.56	AT
DMU 5	1.67	0.66	0.00	1.00	78.81	AT
DMU 7	3.67	1.66	2.00	0.00	100.00	AT
DMU 8	0.00	0.00	0.00	0.00	100.00	AT
DMU 10	0.00	0.00	0.00	0.00	99.02	RT
DMU 11	0.00	0.00	0.00	0.00	92.12	RT
DMU 13	0.33	0.33	0.00	0.00	100.00	RT
DMU 20	6.33	3.33	3.00	0.00	100.00	AT
DMU 21	0.67	−0.33	1.00	0.00	96.37	AT
DMU 23	1.33	0.66	1.00	−0.33	100.00	AT
DMU 24	5.67	1.00	5.00	−0.33	100.00	RT
Average	1.67	0.77	0.92	−0.02	96.44	x
Low performance CSR group						
DMU 2	−1.33	−1.33	0.00	0.00	83.73	AT
DMU 6	−1.00	−1.00	0.00	0.00	86.71	RT
DMU 9	−0.33	−1.33	2.00	−1.00	76.97	AT
DMU 12	−0.33	−0.33	0.00	0.00	80.31	RT
DMU 14	−0.33	−0.33	0.00	0.00	100.00	AT
DMU 15	−1.33	−1.33	0.00	0.00	99.18	RT
DMU 16	−0.67	−0.66	0.00	0.00	85.30	RT
DMU 17	−1.00	−1.00	0.00	0.00	82.13	AT
DMU 18	−0.33	−0.33	0.00	0.00	79.97	RT
DMU 19	−0.67	−0.66	0.00	0.00	71.39	RT
DMU 22	−2.00	−2.00	0.00	0.00	88.37	RT
DMU 25	−0.67	−0.66	0.00	0.00	100.00	RT
DMU 26	−1.00	−1.00	0.00	0.00	80.98	RT
Average	−0.85	−0.92	0.15	−0.08	85.77	x

Note: significance of the differences between groups (p-values) = 0.01 (significant differences at 1% level). RT = road transport; AT = air transport

Source: own work.

2020), even if undertaken in a different sector than transport. When analyzing enterprises in terms of the sector in which they operate, it can be observed that the majority of companies in the high performance CSR group (69.2%) belong to companies specialized in air transport. On the other hand, the low performance CSR category includes mainly road transport companies which account for 61.5% in it. This might indicate that road transport companies are doing worse in terms of the corporate social responsibility. In this situation, relevant efforts should be made by road transport businesses to improve their results in that area.

Conclusions

The aim of this study was to investigate the relationship between CSR and the efficiency of companies in the transport industry. The study covered air and road transport companies operating in the USA in the period from 2013 to 2015. Using the DEA method, the analysis of the dynamics of the changes in the efficiency of companies was carried out and the downward trend was noticed in terms of the average efficiency of the surveyed companies. Based on the standard deviation, which is lower than the average efficiency and remained at the level of 8–12%, it can be concluded that the efficiency achieved by enterprises does not differ significantly from one enterprise to another. However, companies from the air transport sector should be highlighted because, compared to road transport, a greater number of them achieved the level of 100% efficiency. When analyzing the relationship between CSR and efficiency in more

details, it was noticed that the majority of analyzed companies with fairly high CSR results also have efficiency above 90%. Therefore, it can be concluded that proper involvement in the concepts of corporate social responsibility increases a company's efficiency by, for example, improving the brand, thus gaining new stakeholders and increasing revenues. On the other hand, the remaining part of enterprises, that are less CSR-oriented, achieve much lower efficiency.

Referring to the research questions, it can be stated that positive correlation was detected between the variables describing the involvement of transport industry companies in CSR and the efficiency of their activities. The analysis shows that the areas focused on activities related to social responsibility and environmental protection have the greatest impact upon efficiency. This can be explained by the specificity of the industry under study, which over the years has been facing more and more pressures from various stakeholders and governing bodies (Kumar & Anbanandam, 2021). Nevertheless, in-depth analyses should be carried out in the future not only on the example of the USA, but also, for example, in the European Union context, also using other methods for efficiency measurement, such as parametric approach. Also, it should be observed that, due to the relatively small number of the enterprises used in the study, future analyses are needed to assess the credibility of the results obtained on the larger sample. Finally, econometric approaches such as regression analysis should be applied in the future to detect the relationship between CSR and efficiency in the transport sector more precisely. That would require an application of a different dataset that should contain the information on a set of control variables.

Notes/Przypisy

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