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Transportation industries during the COVID-19 pandemic: stock market performance of the largest listed companies

Branże transportowe w okresie pandemii COVID-19: notowania największych spółek giełdowych

Abstract. The paper aims to identify the differences in stock prices' rate of return of companies from transportation industries in 2020, i.e., the first year of the COVID-19 pandemic. We focus on the largest companies by market capitalization from airlines, logistics and air freight, marine, rail, and road industries, using Global Industry Classification Standard (GICS). We use Standard Industrial Classification (SIC) to identify the company profile. We conduct the analysis on average weekly rates of return based on daily market prices and use data from Refinitiv Datastream and Yahoo Finance. Based on ANOVA, we confirm that the stock market performance of the largest companies during the COVID-19 pandemic is industry-specific and varies among transportation industries. Moreover, based on descriptive statistics and Tukey Multiple Comparison test (Tukey's HSD), we reveal that the airlines is the transportation industry that is the most affected by the COVID-19 pandemic.

Key words: transportation, transportation industry, COVID-19 pandemic, listed company, stock market rate of return

JEL codes: G01, G10, L90, R40

Synopsis. Badanie miało na celu identyfikację różnic w stopach zwrotu cen akcji spółek transportowych w 2020 roku, tj. pierwszym roku pandemii COVID-19. Skupiono się na największych spółkach pod względem kapitalizacji rynkowej z branż: lotniczej, logistycznej i frachtu lotniczego, morskiej, kolejowej oraz drogowej, wykorzystując globalny standard klasyfikacji branżowej – GICS (ang. *Global Industry Classification Standard*). Do identyfikacji profilu spółki zastosowano klasyfikację działalności gospodarczej – SIC (*Standard Industrial Classification*). Przeprowadzono analizę średnich tygodniowych stóp zwrotu na podstawie dziennych cen rynkowych. Dane pochodziły z Refinitiv Datastream i Yahoo Finance. Na podstawie jednoczynnikowej analizy wariancji ANOVA wykazano, że wyniki giełdowe największych spółek transportowych w okresie pandemii COVID-19 różniły się w zależności od branży transportowej. Ponadto, wykorzystując statystyki opisowe oraz test HSD Tukeya, potwierdzono, że linie lotnicze były najbardziej dotkniętą pandemią COVID-19 branżą transportową.

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Introduction

COVID-19, an infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is the seventh coronavirus known to infect people [Andersen et al. 2020]. The COVID-19 pandemic is the most defining socio-economic event in decades [Czech et al. 2020]. It has not only caused millions of infections and deaths, but it has also wreaked havoc with the global economy on an enormous scale, not seen since the Great Depression in 1929–1933 [Laing 2020]. Nicola et al. [2020] show the substantial, negative consequences of COVID-19 in all sectors of the economy, including primary, secondary, and service sectors.

The spread of the COVID-19 pandemic has caused the common implementation of measures restricting travel, movement, and activity participation worldwide [De Vos 2020, Koh 2020]. Restrictions and fear of contagion have influenced mobility patterns worldwide [Bonaccorsi et al. 2020, Czech et al. 2021]. The majority of the countries have imposed restrictions on traveling, including long-distance, which has affected people's mobility behavior [Fatmi 2020]. Wielechowski et al. [2020] confirm that COVID-19-induced restrictions significantly decreased human mobility in transport.

He et al. [2020] claim that transportation was the first industry group to be hit by the COVID-19 pandemic. Shen et al. [2020] reveal that the transportation industry was among the more negatively affected industries, especially in the first quarter of 2020. According to Liu et al. [2020], the COVID-19 pandemic has an unprecedented and inevitable impact on the logistics, i.e., industry that connects various economic activities. Due to common lockdown implementation in the early stage of the COVID-19 pandemic, logistics activities have been suspended, and it has affected the demand and supply of various products [Singh et al. 2021].

The stock market response to the novel coronavirus pandemic also seems to be industry-specific [Al-Awadhi et al. 2020, Stephany et al. 2021, Wielechowski and Czech 2022]. Moreover, the stock market stance might also vary within a specific industry. We aim to identify the differences in stock price changes of companies from transportation industries at the time of the COVID-19 pandemic. Haroon and Rizvi [2020], analysing the changes in volatility in various industrial sectors of US equity markets induced by COVID-19-driven panic in the initial phase of the novel coronavirus pandemic, find that transportation belongs to the most affected industries of the economy. Loske [2020] claims that given transportation modes, i.e., air, marine, rail, and road, might play different roles at different stages of epidemic outbreaks. Ho et al. [2021] find that COVID-19 positively impacts the road freight transport turnover. However, Świtała and Łukasiewicz [2021] observe a destructive impact of the novel coronavirus pandemic on road transport activities. Kamal et al. [2021], using daily data of the listed companies from the maritime shipping industry, observe the stock market's quick reaction to the COVID-19 existence. However, the response varies with the level of outbreak and hope of recovery.

According to Sun et al. [2020], aviation belongs to the industries suffering the most due to the consequences of the novel coronavirus pandemic outbreak, despite probably being one

of COVID-19 largest initial drivers. As a consequence of COVID-19, this industry experiences many flight cancellations and airport closures [Bao et al. 2021]. ICAO [2021] indicates a decline of about 50% of offered seats, resulting in a 2.9 billion passengers' decrease and an approximate financial loss of 390 billion USD for 2020 in the airlines industry. By the end of March 2020, global road transport activity was almost 50% below the 2019 average and air transport 60% below [IEA 2020].

To our knowledge, we are the first to assess the stock market performance of transportation industries by analysing the stock market prices of the largest listed companies from developed countries.

The paper is organized as follows: the next section presents the methodology, i.e., the aim of the study, research hypotheses, and description of material and methods. The subsequent section presents the empirical findings and discussion, while the final section offers our conclusions.

Materials and methods

Our study aims to identify the differences in stock prices' rate of return of companies from transportation industries. We conduct the analysis for 2020, i.e., the first year of the COVID-19 pandemic.

We analyze transportation industries, i.e., airlines, logistics and air freight, rail, and road, using Global Industry Classification Standard (GICS). The classification is developed by MSCI and Standard & Poor's Dow Jones Indices and provides an investment tool to capture the economic sectors' liquidity and evolution. The GICS is a hierarchical classification system, and consists of 11 sectors, 24 industry groups, and 68 industries. In comparison to GICS, we present the rail and road industry as two separate subindustries, i.e., road and rail. We consider the five largest companies by market cap from each transportation industry listed in stock exchanges from developed countries. We use Standard Industrial Classification (SIC) to identify the company profile. Table 1 presents the list of all analyzed companies from each transportation industry.

Table 1. The largest listed companies from transportation industries in 2020: based on the market capitalization
Tabela 1. Największe spółki giełdowe z branży transportowej w 2020 r. na podstawie kapitalizacji rynkowej

Transportation industry	Company 1	Company 2	Company 3	Company 4	Company 5
Airlines	Southwest Airlines	Delta Air Lines	Ryanair	United Airlines	American Airlines
Logistics and air freight	United Parcel Service	Deutsche Post	FedEx	DSV	Kuehne + Nagel
Marine	A.P. Moller – Maersk	Hapag Lloyd	Orient Overseas	Nippon Yusen	Mitsui O.S.K. Lines
Rail	Union Pacific	Canadian Pacific Railway	Canadian National Railway	CSX Transportation	Norfolk Southern
Road	Uber	Old Dominion Freight Line	XPO Logistics	Knight-Swift	J.B. Hunt

Source: own study based on Global Industry Classification Standard (GICS), Standard Industrial Classification (SIC), Refinitive datastream and Yahoo Finance.

We conduct the analysis on average weekly rates of return based on daily market prices of the five largest companies from five transportation industries. The research covers 2020, i.e., the first year of the COVID-19 pandemic.

To achieve the aim of the study, we formulate two research hypotheses:

H_1: The stock market performance of the largest companies during the COVID-19 pandemic varies among transportation industries.

H_2: Airlines is the transportation industry most affected by the COVID-19 pandemic.

To identify the significant differences in average weekly rates of return for analyzed companies from five transportation industries, we apply one-factor variance analysis (ANOVA). ANOVA is applied in the literature to study macroeconomics, behavioral economics, corporate finance, banking, and public finance issues. Schultz and Snedecor [1933] were among the first to show the application of ANOVA in economics. Tan et al. [1997], using the analysis of variance, showed that the average values of financial indicators of enterprises from various industries differ significantly. ANOVA is a parametric statistical technique introduced by Fisher and Mackenzie [1923] and Fisher [1925]. ANOVA aims to determine statistically significant differences between the means of multiple groups of observations. ANOVA concerns a situation in which we examine the influence of one factor, i.e., a qualitative variable, on the qualitative dependent variable.

In our study, the qualitative variable refers to five analyzed transportation industries, i.e., airlines, logistics and air freight, marine, rail, and road, while the quantitative variable refers to the average weekly rates of return of each out of 25 analyzed listed companies from developed countries.

Referring to H_1 research hypothesis, we formulate the following null and alternative hypotheses, i.e.:

$$H_0 = \mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$$
$$H_1 = \text{not all the } \mu_i \text{ are equal}$$

The total variation of the dependent variable (total sum of squares – SST) is the sum of the intergroup variation that is caused by the factor (sum of squares for treatment – $SSTR$) and the intra-group variation that is caused by the random effects (sum of squares for errors – SSE).

$$SST = SSTR + SSE$$

The test statistic follows F distribution with the numbers of degrees of freedom $p - 1$ in the numerator and $n - p$ in the denominator, where $n = n_1 + \cdots + n_\mathrm{p}$ is the sample size, and p is the number of groups of the random variable Y.

$$F_{(p-1,n-p)} = \frac{SSTR/p - 1}{SSE/n - p}$$

The F statistic takes higher values when the intergroup differentiation caused by the selected factor is greater compared to the intragroup differentiation caused by random effects. The critical area of the F-test is the right-sided. The rejection of the null hypothesis means that at least two means in the groups differ from each other, i.e., factor A significantly affects the dependent variable y_{ji}.

In our study, p equals 5 and refers to the number of transportation industries, while n equals 5 and corresponds to the number of the largest stock market companies in each transportation industry.

Moreover, we use Tukey Multiple Comparison test (Tukey's HSD) to verify whether the significant differences refer to all five analyzed categories (transportation industries) or only selected ones [Tukey 1953]. In Tukey's test statistic is as follows:

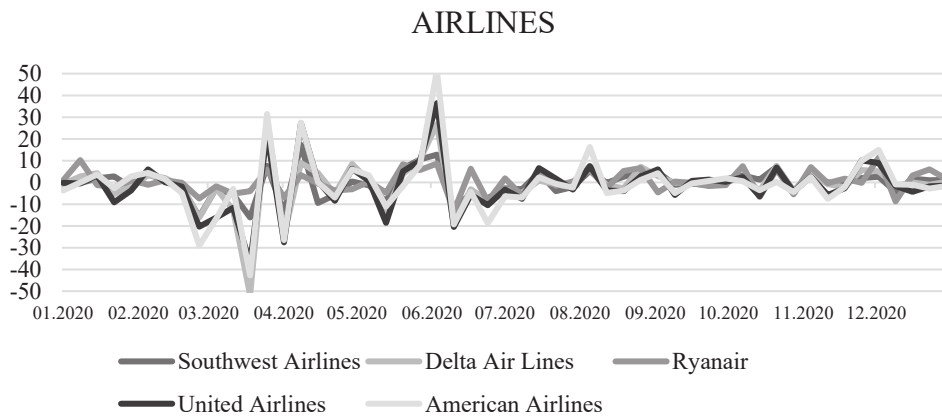$$T = q_{\mathrm{p,n-p},\alpha} \sqrt{\frac{SSE}{n-p}\left(\frac{1}{n_{\mathrm{j}}}\right)}$$

where $q_{\mathrm{p,n-p},\alpha}$ is the appropriate quantile of the studentized range at p and $n-p$ degrees of freedom and significance level α.

The second research hypothesis is verified using descriptive statistics and Tukey's HSD test.

We verify the joint distribution of analyzed variables' normality with the Shapiro-Wilk test. Moreover, to check the heteroscedasticity, we apply the Breusch-Pagan test. We use data form Refinitiv Datastream and Yahoo Finance. The entire analysis is conducted in R.

Results and Discussion

The outbreak of the COVID-19 has made a significant impact on the global financial markets, including the stock market [Czech et al. 2020]. Companies from the transportation sector belong to the most affected during the first year of the novel coronavirus pandemic [Haroon and Rizvi 2020]. Figure 1 depicts the average weekly rates of return of all analyzed listed companies in the division to transportation industries.

AIRLINES

LOGISTICS & AIR FREIGHT

United Parcel Service — Deutsche Post — FedEx — DSV — Kuehne + Nagel

MARINE

A.P. Moller - Maersk — Hapag Lloyd — Orient Overseas — Nippon Yusen — Mitsui O.S.K. Lines — Average

RAIL

Union Pacific — Canadian Pacific Railway — Canadian National Railway — CSX Transportation — Norfolk Southern

ROAD

Figure 1. Average weekly rates of return of the largest listed companies from transportation industries in 2020: based on daily market prices
Rysunek 1. Średnie tygodniowe stopy zwrotu największych spółek giełdowych z branży transportowej w 2020 r.: na podstawie dziennych cen rynkowych
Source: Own calculation and elaboration based on Refinitiv Datastream and Yahoo Finance.

In the initial phase of the COVID-19 pandemic, the analyzed companies experienced the largest negative rates of return (Figure 1). Definitely, airlines suffered the most. In the second half of 2020, we observe lower stock price volatility in all analyzed transportation industries. Table 2 presents descriptive statistics, i.e., the mean values (Avg.), minimum and maximum values (Min and Max), and coefficient of variation (CV) among five analyzed transportation industries, using average weekly rates of return based on daily market prices.

Table 2. Descriptive statistics for average weekly rates of return of transportation industries: based on daily market prices of the largest listed companies in 2020
Tabela 2. Statystyki opisowe dla średnich tygodniowych stóp zwrotu branż transportowych: na podstawie dziennych cen rynkowych największych spółek giełdowych w 2020 roku

Industry	Avg.	CV	Min	Max
Airlines	−0.66	13.62	−30.31	27.19
Logistics and air freight	0.68	4.71	−7.98	9.81
Marine	0.39	11.13	−11.56	9.93
Rail	0.70	5.04	−8.95	15.75
Road	0.74	6.43	−14.11	14.03

Source: Own calculation based on Refinitiv Datastream and Yahoo Finance.

Table 2 results show that the airlines industry is the only which achieved the substantial negative mean value of the rate of return in 2020 (based on average weekly rates of return). Moreover, this industry is characterized by the highest volatility measured by CV and the largest range. However, at the same time, we observe the similar and positive stock market performance of logistics and air freight, rail, and road industries.
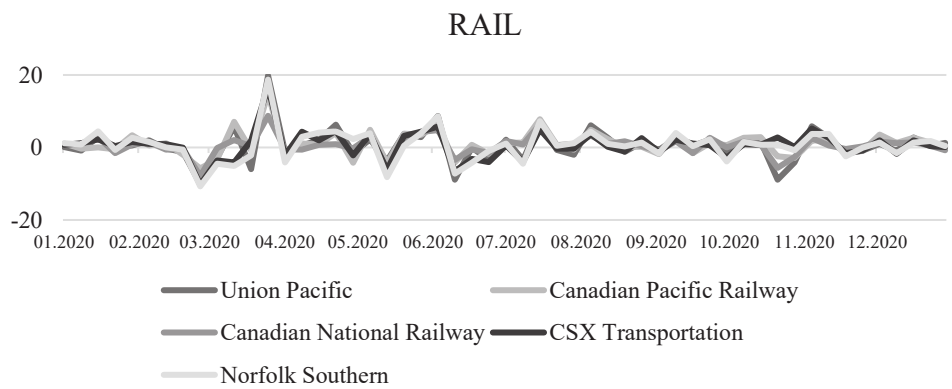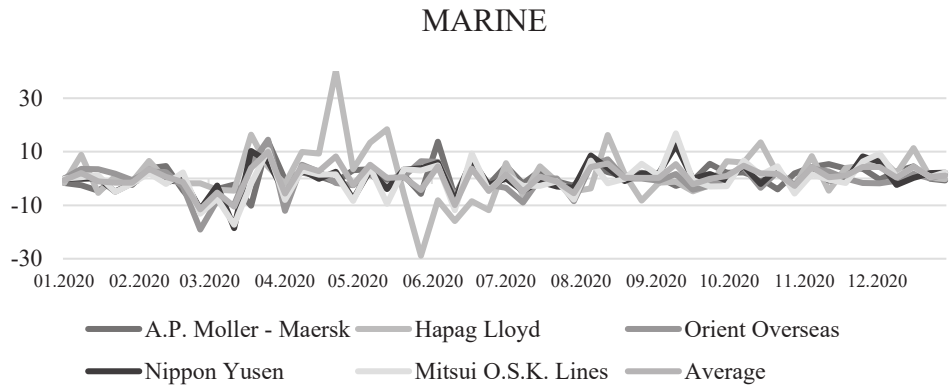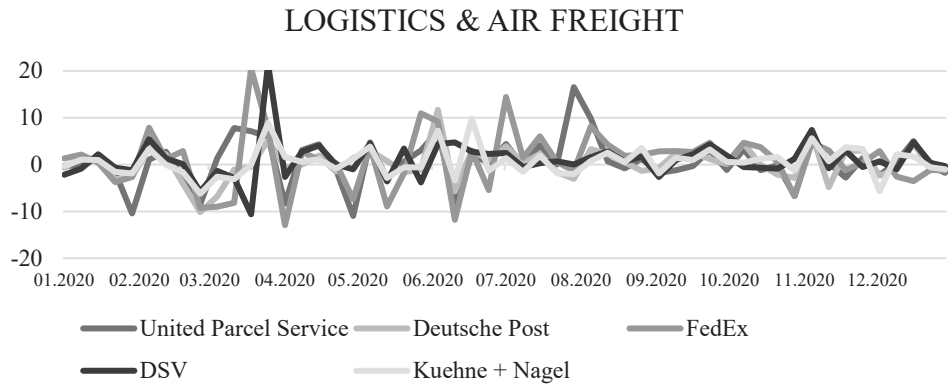
Table 3 illustrates the transportation industries' situation in detail, i.e., focusing on each out of 25 analyzed listed companies. It presents the descriptive statistics both for weekly rates of return and daily prices.

Table 3. Descriptive statistics for average weekly rates of return and market daily prices of the largest listed companies from transportation industries in 2020
Tabela 3. Statystyki opisowe średnich tygodniowych stóp zwrotu i dziennych cen rynkowych największych spółek giełdowych z branży transportowej w 2020 roku

Industry	Company	Weekly rates of return				Daily prices				
		Avg.	CV	Min	Max	Avg.	CV	Min	Max	RoR*
Airlines	company 1	−0.38	16.74	−16.10	17.22	40.16	0.21	23.87	58.54	−13.65
	company 2	−0.90	12.46	−51.72	28.51	35.18	0.33	19.19	62.03	−31.24
	company 3	0.32	16.66	−13.34	11.38	12.42	0.19	8.14	17.06	14.63
	company 4	−1.37	8.67	−37.00	36.42	43.00	0.43	19.92	89.74	−50.90
	company 5	−0.98	14.19	−42.77	51.48	15.39	0.38	9.04	30.47	−45.01
Logistics and air freight	company 1	0.60	8.24	−10.96	16.53	129.7	0.24	86.17	176.5	43.86
	company 2	0.28	12.47	−10.15	11.70	33.67	0.17	19.00	41.71	19.73
	company 3	0.90	6.87	−12.94	20.48	186.4	0.34	90.49	301.5	71.70
	company 4	0.98	4.25	−10.63	21.44	841.4	0.19	458.8	1119	32.85
	company 5	0.64	4.77	−6.24	9.85	163.2	0.13	120.5	205.7	23.04
Marine	company 1	0.58	8.12	−12.27	13.85	8828	0.24	5034	14115	41.50
	company 2	1.53	6.54	−28.88	40.38	70.92	0.38	42.45	186.4	19.10
	company 3	−0.34	15.68	−19.11	14.49	125.2	0.16	101	182.0	−29.70
	company 4	0.29	18.32	−18.56	12.43	1716	0.18	1138	2445	21.25
	company 5	−0.09	70.28	−17.30	16.87	2227	0.20	1550	3185	4.13
Rail	company 1	0.64	7.22	−10.10	19.83	178.1	0.12	114	209.8	15.17
	company 2	1.04	3.33	−5.77	14.81	54.78	0.15	36.27	69.80	35.98
	company 3	0.57	4.73	−7.89	8.73	94.82	0.12	67.75	112.1	21.45
	company 4	0.58	6.65	−10.26	16.64	24.76	0.13	15.89	31.00	25.41
	company 5	0.67	6.61	−10.73	18.72	195.9	0.15	118.9	246.8	22.40
Road	company 1	0.97	8.65	−22.03	25.39	35.58	0.22	14.82	54.86	78.72
	company 2	0.97	4.51	−11.03	11.34	168.1	0.17	107.3	211.1	54.27
	company 3	0.57	15.33	−29.90	20.89	48.80	0.21	23.67	70.32	49.56
	company 4	0.40	10.61	−16.77	8.45	39.59	0.10	28.59	46.80	16.69
	company 5	0.77	5.88	−8.84	13.05	119.5	0.13	75.38	142.8	17.01

* annual rate of return achieved in 2020 based on daily prices

Source: own calculation based on Refinitiv Datastream and Yahoo Finance.

Table 3 reveals that the stock market performance is not only industry-specific but also company-specific within each transportation industry. Nevertheless, the world's largest airlines companies achieved the worst stock market results. Analysing the annual rates of return (based on daily market prices), apart from the airlines industry, we observe only one company, i.e., Orient Oversees, that achieved a negative rate of return in 2020. Moreover, in the case of as many as eight analyzed companies, annual daily price changes exceeded 30%.

The results of descriptive statistics from Table 2 and Table 3 indicate differences in analyzed companies' stock market performance and imply that the performance is industry-specific. To show the differences between average weekly rates of return among analyzed companies from five transportation industries in 2020, we present box plots in Figure 2.
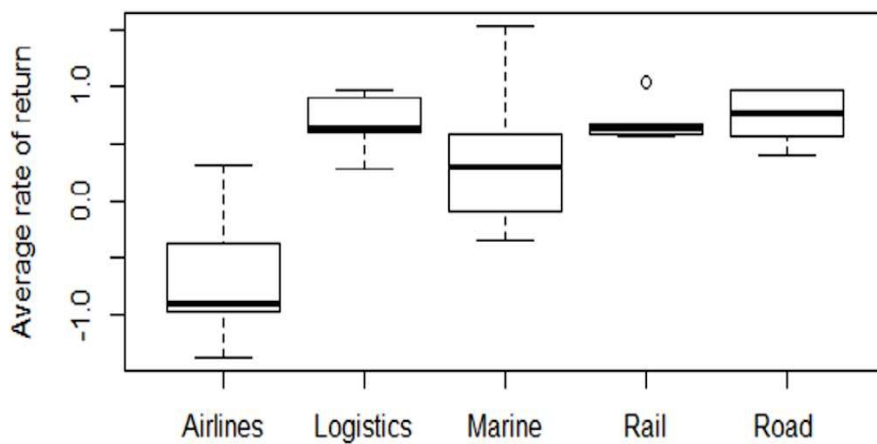
Figure 2. Box plots presenting average weekly rates of return of transportation industries: based on daily market prices of the largest listed companies in 2020
Rysunek 2. Diagramy pudełkowe przedstawiające średnie tygodniowe stopy zwrotu z branż transportowych: na podstawie dziennych cen rynkowych największych spółek giełdowych w 2020 roku
Source: own calculation and elaboration based on Refinitiv Datastream and Yahoo Finance.

Figure 2 implies the substantial differences in average rates of return between airlines companies and companies from the four remaining transportation industries. Based on the graphical analysis we might assume that logistics, marine, road, and rail companies perform similarly during the first year of the pandemic, while airlines suffer most. These results correspond to the above-presented descriptive statistics.

To verify whether the differences between the five analyzed transportation industries, i.e., airlines, logistics and air freight, rail, and road, are statistically significant, we apply one-factor variance analysis – ANOVA. The results are presented in Table 4.

Table 4. Descriptive statistics for average weekly rates of return of transportation industries: based on daily market prices of the largest listed companies in 2020
Tabela 4. Statystyki opisowe dla średnich tygodniowych stóp zwrotu branż transportowych: na podstawie dziennych cen rynkowych największych spółek giełdowych w 2020 roku

Degrees of freedom	Sum Sq	Mean Sq	*F* Statistics	*p*-value
4	7.034	1.757	7.778	<0.001

Source: Own calculation and elaboration based on Refinitiv Datastream and Yahoo Finance.

ANOVA reveals statistically significant differences in average weekly rates of return between at least two out of five analyzed transportation industries. To verify which transportation industries vary, we apply Tukey Multiple Comparison test (Table 5).

Table 5. Results of Tukey Multiple Comparison test (Tukey's HSD)
Tabela 5. Wyniki testu wielokrotnych porównań Tukeya (HSD Tukeya)

Industries	Difference	*p*-value
Airlines-Logistics	−1.344	0.002
Airlines-Marine	−1.056	0.017
Airlines-Rail	−1.362	0.002
Airlines-Road	−1.400	0.001
Logistics-Marine	0.288	0.871
Logistics-Rail	−0.018	0.999
Logistics-Road	−0.056	0.999
Marine-Rail	−0.306	0.844
Marine-Road	−0.344	0.782
Rail-Road	−0.038	0.999

Source: Own calculation and elaboration based on Refinitiv Datastream and Yahoo Finance.

Tukey's HSD test confirms the result of the initial analysis based on descriptive statistics and boxplots. It shows that the airlines transportation industry's performance during the first year of the COVID-19 pandemic significantly differs from four other industries, i.e., logistics and air freight, marine, road, and rail. The airlines industry's stock market results are substantially worse in 2020 than in the case of other analyzed industries.

Based on ANOVA, we confirm that the stock market performance of the largest companies during the COVID-19 pandemic is industry-specific and varies among transportation industries. Our results correspond to [Al-Awadhi et al. 2020, Stephany et al. 2021] and are consistent with the first research hypothesis. Moreover, based on descriptive statistics and Tukey's HSD test, we reveal that the airlines is the transportation industry that is the most affected by the COVID-19 pandemic. It confirms the second research hypothesis.

Our results are in line with Sun et al. [Sun et al. 2020] who reveal that aviation belongs to the industries that have been suffering most due to the COVID-19 pandemic outbreak. Bao et al. [2021] indicate that common flight cancellations and airport closures mainly drove it.

Conclusion

Due to anti-COVID-19 restrictions, including lockdown implementation, transportation activities have been suspended, and transportation supply chains have been negatively affected. The paper aims to identify the differences in stock prices' rate of return of companies from transportation industries. The analysis is focused on 2020, i.e., the first year of the pandemic.

The study reveals that the stock market performance of the largest companies during the COVID-19 pandemic is industry-specific and varies among analysed transportation industries. Moreover, we observe that the airlines is the transportation industry most affected by the COVID-19 pandemic. The results show that the airlines industry is the only which achieved the substantial negative mean value of the rate of return and is characterized by the highest price volatility in 2020. Surprisingly, four other transportation industries, i.e., logistics and air freight, rail, and road, performed positively. Tukey's HSD test reveals that only the airlines industry differs from other industries, and its stock market results are significantly worse than in the case of other analyzed industries in 2020.

The analysis of reasons for the differences in the stock market performance of companies from different transportation industries at the time of the COVID-19 pandemic is a challenge for future research.

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