

CHAPTER 25

Covid-19 as an ultimate stock market Black Swan

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Abstract

The economic consequences of COVID-19 are detrimental not only to public health systems but to trade and travel, food and agriculture industries, financial markets and others. The financial markets exhibited quick fall after the outbreak of the COVID-19 infection, which was an unprecedented stock market reaction to the biggest global pandemics in the last 100 years. Its devastating impact on economy and financial markets makes it an ultimate Black Swan event. Goal of this paper is to investigate the impact of COVID-19 disease on values of eight major stock market indices: Nikkei 225, DAX performance-index (DAX), Dow Jones Industrial Average (Dow Jones), NASDAQ Composite (NASDAQ), S&P 500, France CAC 40 Index (FCHI), FTSE 100 and FTSE MIB Index. The results of the analysis have shown that COVID-19 variables had negative impact on the values of all observed market indices. The same conclusion was brought when the COVID-19 variables were observed on the world level and on the level of individual countries, in which the certain market index is used. According to the regression results it was shown that the value of market indices has dropped roughly a month or month and a half before it should, depending on the confirmed cases of infection. This can be explained with the destructive effect of COVID-19 outbreak started in Wuhan, China in December 2019 and negative expectations on the stock markets. The results obtained from this paper can be important and relevant for market experts and investors as a guide in making investment decisions.

Key words: COVID-19, stock market indices, Black Swan.

JEL classification: G15, I19

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1. Introduction

The economic consequences of COVID-19 are detrimental not only to public health systems but to trade and travel, food and agriculture industries and financial markets, (Evans, 2020). A global spillovers of COVID-19 are also evident in hospitality and sport industry, oil industry and import-dependent countries, event and entertainment industries, (Peterson and Thankom, 2020). COVID-19 pandemics had also negative impact on financial markets and stock market indices. Its devastating impact on economy and financial markets makes it an ultimate black swan event. The characteristics of a black swan event are rarity, extreme impact and retrospective predictability. Black swans come out of nowhere to derail financial markets. They are so-called due to an old saying stating that „black swans did not exist, until one appeared to prove otherwise“, (Smith, 2020). The financial markets exhibited quick fall after the outbreak of the COVID-19 infection, (Liu et al., 2020). There was an unprecedented stock market impact of Covid-19, Baker et al. (2020), that has not been seen in 20th century, not even after Spanish flu influenza. Investors reacted with fear which had a negative impact on stock markets. Although there was an evident sharp loss in stock markets returns, the financial markets are showing signs of recovery in the long run.

Goal of this paper is to investigate whether COVID-19 is a major stock market black swan event. The data for eight major stock market indices, Nikkei 225, DAX performance-index (DAX), Dow Jones Industrial Average (Dow Jones), NASDAQ Composite (NASDAQ), S&P 500, France CAC 40 Index (FCHI), FTSE 100 and FTSE MIB Index, are brought into connection with the selected COVID-19 variables: new cases and total cases of COVID-19 infection, new death and total death due to COVID-19 infection. A simple linear regression models will be used to estimate market indices based on actual values of COVID-19 variables at the world level and on the level of individual countries in which the observed market index is used. It is expected that there exists a negative impact of COVID-19 infection on the values of stock market indices.

The paper consists of five chapters. After the introduction, in short literature review the state-of-the-art on the impact of COVID-19 on financial stock markets is presented and elaborated. In the methodology and data section the data sources and methodology of the paper are explained. In the results and discussion section the main results of the analysis for eight stock market indices are displayed. Final chapter presents concluding remarks.

2. Short literature review

Global financial markets entered a state of collective hysteria triggered by the Covid-19 virus suggesting that Covid-19 is a financial markets “black swan” event, (Morales and Andreosso-O’Callaghan, 2020). Markets did not react well to volatility levels exhibited by the Shanghai stock market but awoke when Italy registered its first cases of infection with financial markets free fall at the end of the February 2020. Onali (2020) investigated the impact of Covid-19 cases and related deaths on the United States’ stock market indices (Dow Jones and S&P500). The main findings suggested that changes in the number

of cases and deaths in the United States and six other observed countries did not have an impact on the United States' stock market returns. The only significant were reported cases from China. Liu et al. (2020) evaluated the impact of COVID-19 outbreak on 21 leading stock market indices in major affected countries. Stock markets in major affected countries fell quickly after the virus outbreak with Asia experiencing more negative returns as compared to other countries. Investors' fear sentiment was proved to be a transmission channel for the COVID-19 infection negative effect on the stock markets. No previous infectious disease outbreak has impacted the stock market as powerfully as the COVID-19 pandemic, (Baker et al., 2020). Yan et al. (2020) analysed the potential effects of the COVID-19 on the stock markets and investment strategies. Past outbreaks propose a possible ways that an individual can profit off because markets react adversely to such incidents in the short run but eventually correct themselves in the long run. Adenomon et al. (2020) examined the effect of COVID-19 outbreak on the performance of the Nigeria stock exchange. There was an evident loss in stock returns and high volatility in stock returns under the COVID-19 period compared to the normal period before the outbreak. Financial markets reacted dramatically to the global COVID-19 pandemic, creating an unprecedented level of risk and causing investors to suffer significant losses in short period of time, (Dayong et al., 2020). Pavlyshenko (2020) studied different regression approaches for modeling COVID-19 spread and its impact on the stock markets. The results have shown that different crises with different reasons have different impact on the same stocks so it is important to analyze their impact separately. Sansa (2020) revealed the positive and significant relationship between the COVID-19 confirmed cases of infection and trends in financial markets in China and USA. The analysis was conducted in the period from March 1st 2020 to March 25th 2020 by applying a simple regression model in order to investigate the impact of COVID-19 on the Shanghai Stock Exchange and New York Dow Jones Index. Zeren and Hizarci (2020) using cointegration test investigated the effect of reported COVID-19 cases on stock markets. The existence of cointegration between daily cases of death and volatility in stock markets was detected in all observed countries.

3. Data and methods

In the analysis the data for eight stock market indices are compared with the COVID-19 variables on the global (World) data and on the country data where the observed stock market index is used. Following eight market indices are chosen: Nikkei 225, DAX performance-index (DAX), Dow Jones Industrial Average (Dow Jones), NASDAQ Composite (NASDAQ), S&P 500, France CAC 40 Index (FCHI), FTSE 100 and FTSE MIB Index. The four COVID-19 variables are observed: new cases, total cases, new deaths and total deaths. The values of the chosen market indices and the COVID-19 variables are compared for Japan (where Nikkei 225 is used), Germany (where DAX is used), the United States of America (Dow Jones, NASDAQ and S&P 500), France (FCHI), the United Kingdom (FTSE 100) and Italy (FTSE MIB Index). The data for the selected market indices are taken from the Fusion Media (2020) and the Yahoo! Finance web pages (Yahoo! Finance, 2020,

a-g). The daily close values of market indices are used in the analysis. The values of market indices are expressed in national currencies (yens, euros, British pounds or US dollars). The data for COVID-19 variables are collected from the EU Open Data Portal (2020) webpage. The data for all variables are observed for the period from December 31, 2019 to April 20, 2020. The limitation of the analysis is the lack of data for some days in the observed period due to weekends, holidays and other restrictions related to the indices.

The number of daily data between the observed market indices is different. In the analysis the main emphasize will be given to correlation and regression analyses. In the simple linear regression models the role of dependent variable will have the actual value of the observed market indices whereas the independent variable will be the one of COVID-19 variables. The estimated linear regression models will be then employed to estimate market indices' values based on an actual values of the COVID-19 variable. Therefore, the actual values of COVID-19 variables will be put in the regression equation. In that way the estimates of the observed market indices will be calculated by taking into account COVID-19 variables at the World level and on the country level where the observed market index is used.

4. Results and discussion

In Table 1 the regression results for the Nikkei 225 market index are presented. According to the results from Table 1 all regression models are highly statistically significant. Furthermore, all correlations between the Nikkei 225 values and the observed COVID-19 variables are of medium strength and, what is more important, of negative direction. In other words, with increase of COVID-19 variables the value of Nikkei 225 decreases. If regression coefficients between the World and Japan are compared, it can be concluded that situation in Japan regarding the COVID-19 variables has much higher impact on the value of Nikkei 225 than the situation in the World related to the COVID-19. On average, the highest impact on the value of the Nikkei 225 seems to have new deaths variable due to the COVID-19 infection.

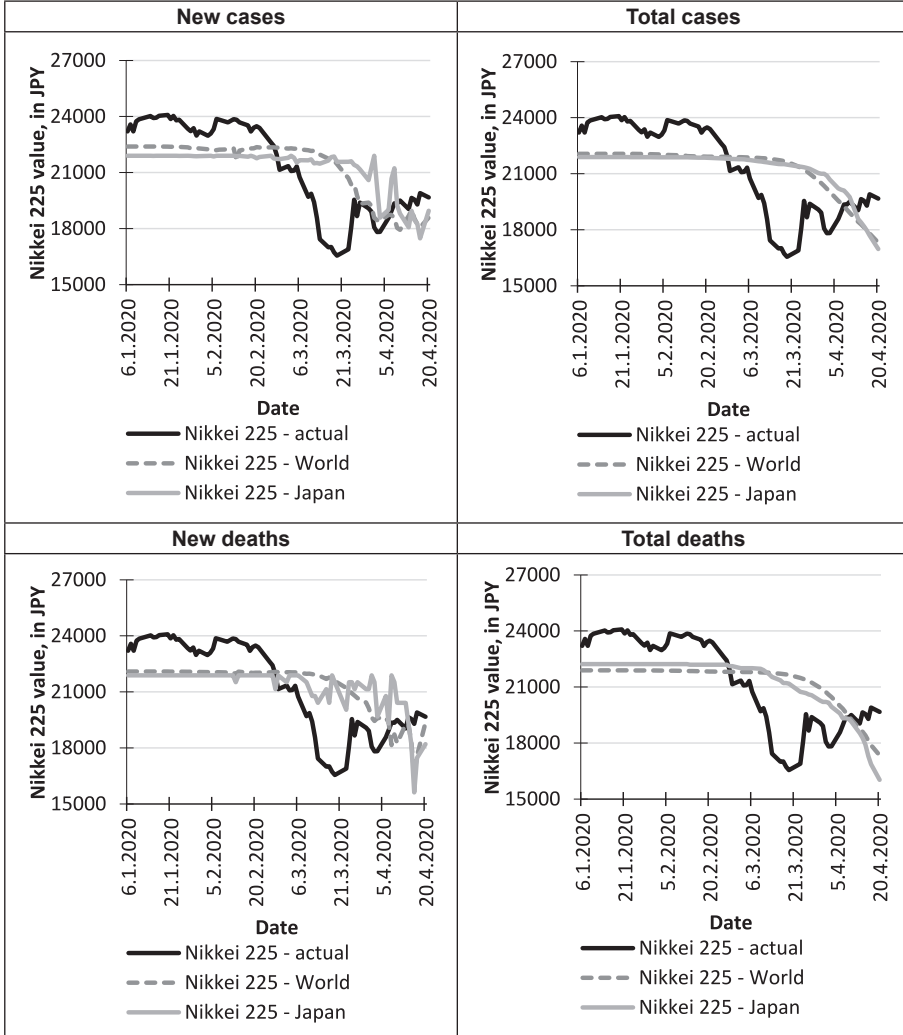
Table 1: Linear regression results, dependent variable Nikkei 225, n = 72 daily data

Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.6458	0.4171	22389.98	2.05E-71	-0.051	9.03E-10
	Total cases	-0.5224	0.2729	22066.85	7.46E-69	-0.002	2.51E-06
	New deaths	-0.5515	0.3041	22089.07	9.16E-70	-0.531	5.16E-07
	Total deaths	-0.4621	0.2135	21889.06	1.94E-68	-0.028	4.39E-05
Japan	New cases	-0.4706	0.2214	21900.09	1.31E-68	-7.561	3.03E-05
	Total cases	-0.4651	0.2163	21889.16	1.56E-68	-0.458	3.86E-05
	New deaths	-0.4795	0.2299	21884.05	4.71E-69	-368.485	2.03E-05
	Total deaths	-0.6043	0.3652	22227.74	8.90E-71	-36.240	1.90E-08

Source: EU Open Data Portal (2020), Yahoo! Finance (2020f), authors.

In Figure 1 the actual values of the Nikkei 225 and estimated values based on the regression models are shown.

Figure 1: Actual and estimated values of the Nikkei 225 based on estimated regression models for World and Japan



Source: EU Open Data Portal (2020), Yahoo! Finance (2020f), authors.

All figures are suggesting that the estimated linear regression models have weaker reaction than the actual values. The length of the lag seems to be about a month. For example, the actual Nikkei 225 values started to decrease at the end of February 2020 whereas the estimated regression lines for new cases, both for the World and Japan, started do decrease at the end of March 2020.

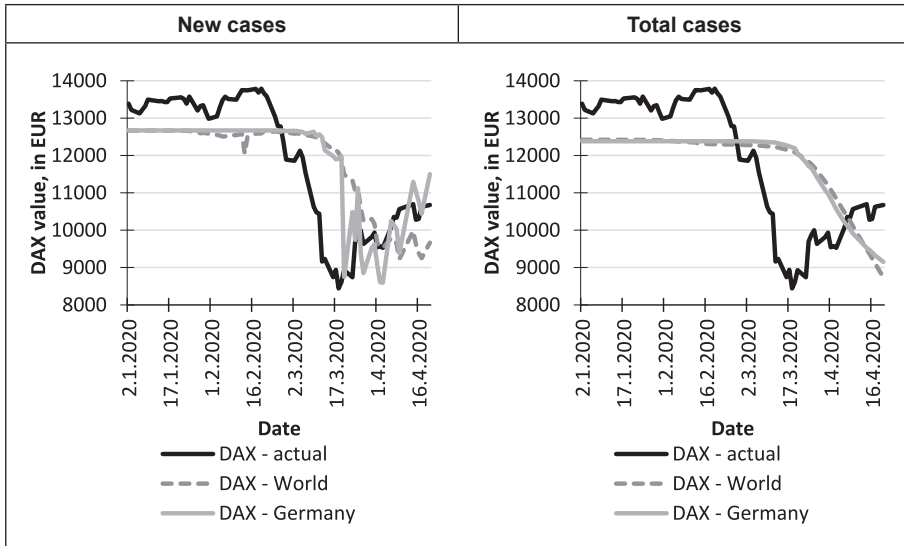
Table 2: Linear regression results, dependent variable DAX, n = 76 daily data

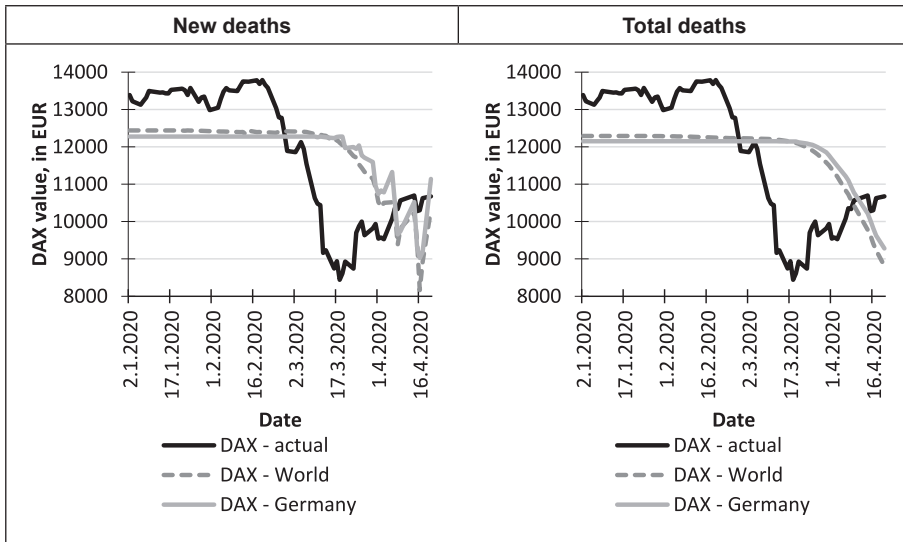
Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.6545	0.4284	12666.12	2.15E-68	-0.040	1.43E-10
	Total cases	-0.5114	0.2615	12418.49	5.79E-65	-0.002	2.35E-06
	New deaths	-0.5473	0.2995	12438.08	4.36E-66	-0.413	3.13E-07
	Total deaths	-0.4470	0.1998	12290.11	2.06E-64	-0.021	5.18E-05
Germany	New cases	-0.7201	0.5185	12671.22	6.15E-72	-0.660	2.29E-13
	Total cases	-0.5196	0.2700	12381.18	1.03E-65	-0.023	1.51E-06
	New deaths	-0.4558	0.2077	12275.36	7.05E-65	-10.315	3.52E-05
	Total deaths	-0.3554	0.1263	12150.11	8.81E-64	-0.652	0.0016

Source: EU Open Data Portal (2020), Yahoo! Finance (2020b), authors.

Table 2 contains the regression results for the market index DAX. All conclusions based on the regression models are identical to the conclusions for the Nikkei 225.

Figure 2: Actual and estimated values of the DAX based on estimated regression models for World and Germany





Source: EU Open Data Portal (2020), Yahoo! Finance (2020b), authors.

In Figure 2 the actual and estimated regression values for DAX are given. Again, regression models have shown that the DAX value should decrease but with a certain lag.

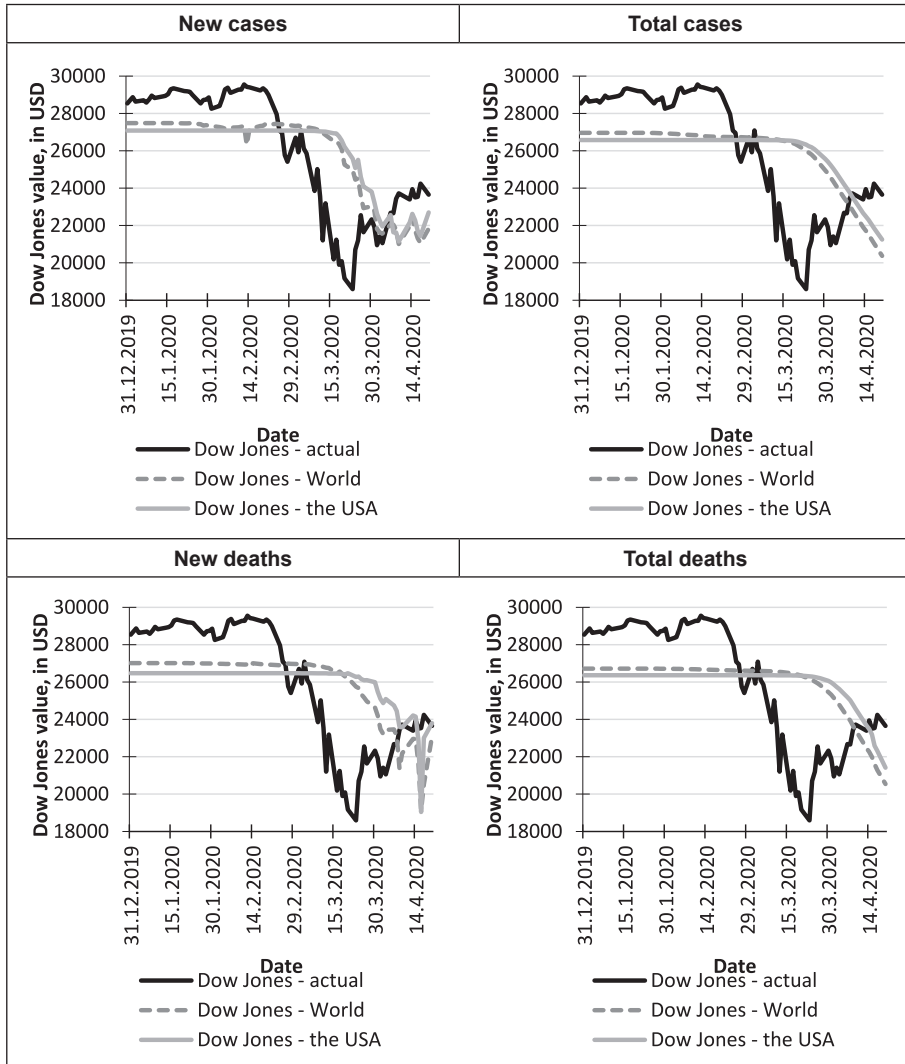
Table 3: Linear regression results, dependent variable Dow Jones, n = 76 daily data

Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.6619	0.4382	27482.70	1.27E-72	-0.076	7.48E-11
	Total cases	-0.5007	0.2507	26960.27	9.45E-69	-0.003	4.11E-06
	New deaths	-0.5411	0.2928	27015.31	6.31E-70	-0.762	4.50E-07
	Total deaths	-0.4343	0.1887	26717.03	3.14E-68	-0.037	8.85E-05
the United States of America	New cases	-0.5792	0.3355	27085.14	5.01E-71	-0.178	4.22E-08
	Total cases	-0.3929	0.1543	26576.13	4.63E-68	-0.007	0.0004
	New deaths	-0.3586	0.1286	26471.77	5.87E-68	-1.508	0.0015
	Total deaths	-0.3034	0.0921	26363.59	1.68E-67	-0.122	0.0077

Source: EU Open Data Portal (2020), Yahoo! Finance (2020c), authors.

The linear regression results in Table 3, related to Dow Jones market index, are in the line with previous linear regression results displayed in Table 1 and Table 2. So, the correlations between the Dow Jones market index and the observed COVID-19 variables are negative. Again, the highest impact on the Dow Jones market index seems to have new deaths variable due to the COVID-19.

Figure 3: Actual and estimated values of the Dow Jones based on estimated regression models for World and the United States of America



Source: EU Open Data Portal (2020), Yahoo! Finance (2020c), authors.

Figure 3 shows actual and estimated values of Dow Jones index by taking into account the observed COVID-19 variables at the World level and for the United States of America. According to the results, regression models have pretty high lag. The regression models pointed out that the Dow Jones market index should decrease about three months after the start of epidemic of the COVID-19.

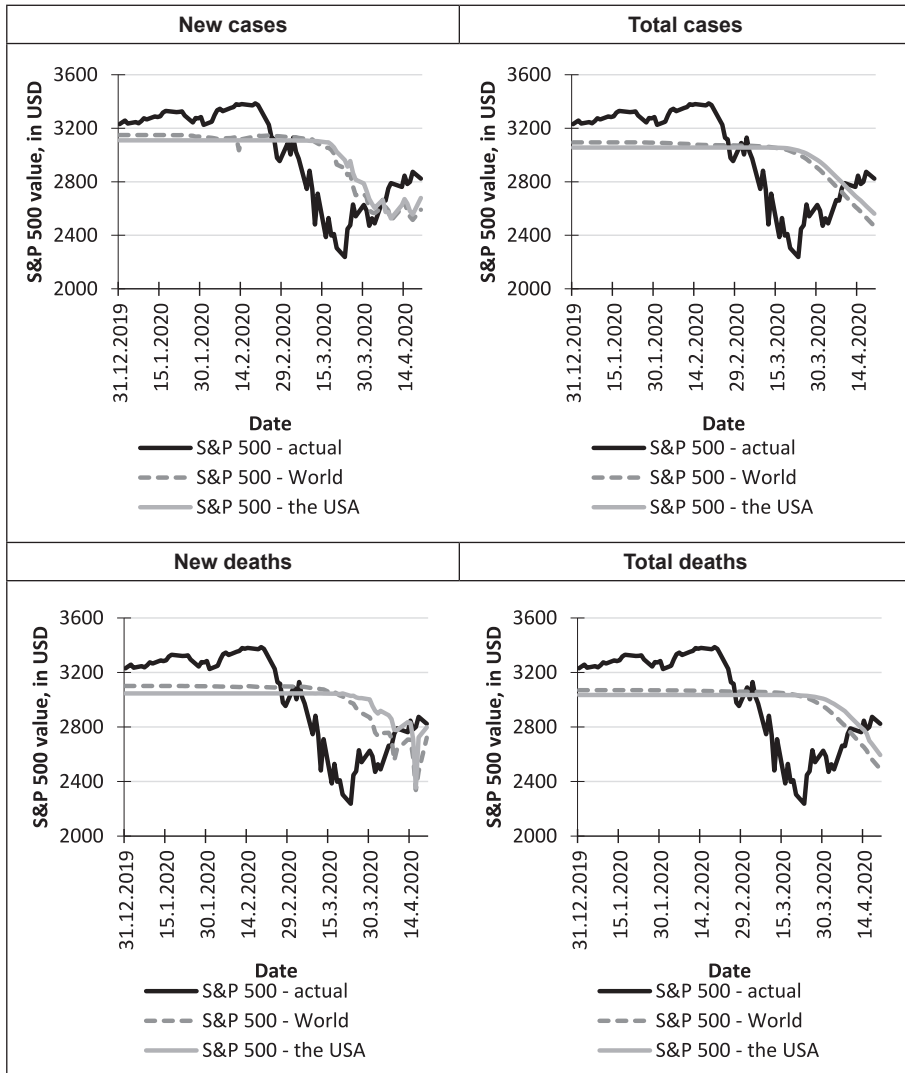
Table 4: Linear regression results, dependent variable S&P 500, n = 76 daily data

Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.6396	0.4091	3149.39	1.91E-75	-0.0075	4.98E-10
	Total cases	-0.4656	0.2168	3094.07	1.04E-71	-0.0003	2.25E-05
	New deaths	-0.5127	0.2628	3101.18	6.14E-73	-0.0739	2.19E-06
	Total deaths	-0.3977	0.1582	3069.83	2.44E-71	-0.0035	0.0004
the United States of America	New cases	-0.5562	0.3094	3109.42	4.33E-74	-0.0175	1.82E-07
	Total cases	-0.3567	0.1272	3056.15	2.79E-71	-0.0007	0.0016
	New deaths	-0.3263	0.1065	3046.56	2.64E-71	-0.1403	0.0040
	Total deaths	-0.2642	0.0698	3034.89	7.18E-71	-0.0108	0.0211

Source: EU Open Data Portal (2020), Yahoo! Finance (2020g), authors.

The results given in Table 4 have confirmed that the correlations between the market indices and the COVID-19 variables are negative. However, the impact of COVID-19 variables seems to be lower for S&P 500 than at Dow Jones market index.

Figure 4: Actual and estimated values of the S&P 500 based on the estimated regression models for World and the United States of America



Source: EU Open Data Portal (2020), Yahoo! Finance (2020g), authors.

According to Figure 4, the lag between actual decrease of the S&P 500 market index value and the decrease suggested by the regression models seems to be between one and one and half months.

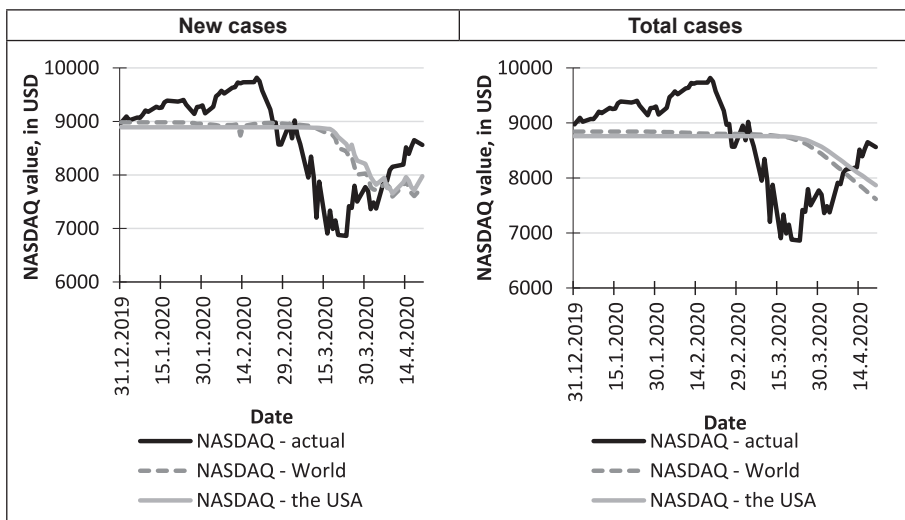
Table 5: Linear regression results, dependent variable NASDAQ, n = 76 daily data

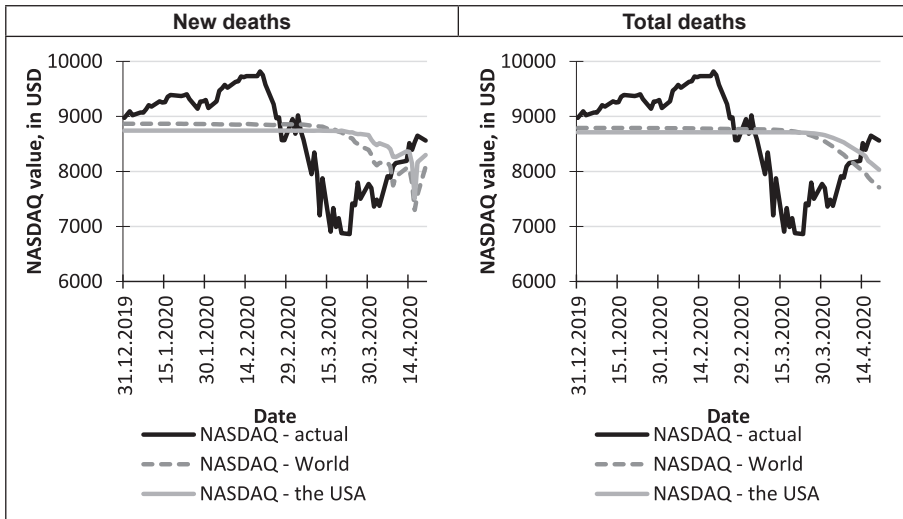
Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.5587	0.3122	8982.69	1.82E-77	-0.016	1.56E-07
	Total cases	-0.3679	0.1353	8843.12	1.25E-74	-0.001	0.0011
	New deaths	-0.4235	0.1793	8866.19	9.69E-76	-0.151	0.0001
	Total deaths	-0.2990	0.0894	8788.88	1.22E-74	-0.007	0.0087
the United States of America	New cases	-0.4761	0.2267	8891.27	8.30E-77	-0.037	1.38E-05
	Total cases	-0.2594	0.0673	8759.92	8.23E-75	-0.001	0.0236
	New deaths	-0.2343	0.0549	8741.51	4.95E-75	-0.250	0.0417
	Total deaths	-0.1648	0.0272	8712.36	8.62E-75	-0.017	0.1548

Source: EU Open Data Portal (2020), Yahoo! Finance (2020e), authors.

In Table 5 the main estimates for the regression models for the NASDAQ market index are given. All correlations between the NASDAQ market index and the COVID-19 variables are negative. However, it seems that variables new deaths and total deaths do not have statistically significant impact, at significance level of 1%, on the value of the NASDAQ market index.

Figure 5: Actual and estimated values of the NASDAQ based on estimated regression models for World and the United States of America





Source: EU Open Data Portal (2020), Yahoo! Finance (2020e), authors.

In Figure 5 the actual and estimated values of the NASDAQ market index, based on estimated regression models for World and the United States of America, are given. Again, the response of regression models is about a month behind the actual decrease.

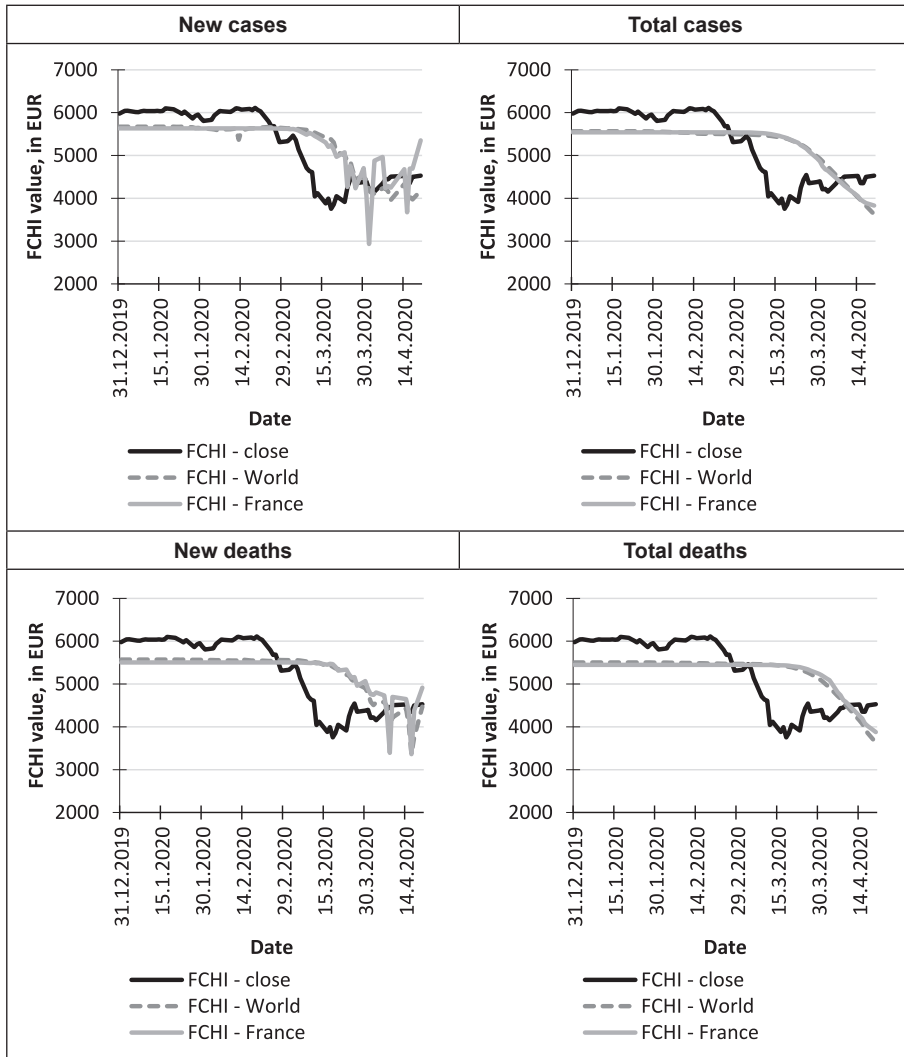
Table 6: Linear regression results, dependent variable FCHI, n = 77 daily data

Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.7028	0.4940	5673.04	2.55E-70	-0.020	1.04E-12
	Total cases	-0.5801	0.3365	5565.96	1.32E-66	-0.001	3.21E-08
	New deaths	-0.6085	0.3703	5570.57	1.05E-67	-0.213	4.35E-09
	Total deaths	-0.5182	0.2685	5503.81	1.00E-65	-0.011	1.39E-06
France	New cases	-0.7017	0.4924	5631.36	4.57E-71	-0.356	1.17E-12
	Total cases	-0.5806	0.3371	5540.64	3.38E-67	-0.015	3.11E-08
	New deaths	-0.5388	0.2903	5504.75	2.00E-66	-1.490	4.31E-07
	Total deaths	-0.4484	0.2011	5447.37	6.47E-65	-0.080	4.32E-05

Source: EU Open Data Portal (2020), Yahoo! Finance (2020a), authors.

In Table 6 the linear regression results for French market index FCHI are presented. Again, all correlations between the FCHI market index and the COVID-19 variables are negative and highly statistically significant.

Figure 6: Actual and estimated values of the FCHI based on estimated regression models for World and France



Source: EU Open Data Portal (2020), Yahoo! Finance (2020a), authors.

Actual and estimated values of the FCHI based on estimated regression models for World and France are given in Table 6. The response lag of the regression models again seems to be between one and one and half months.

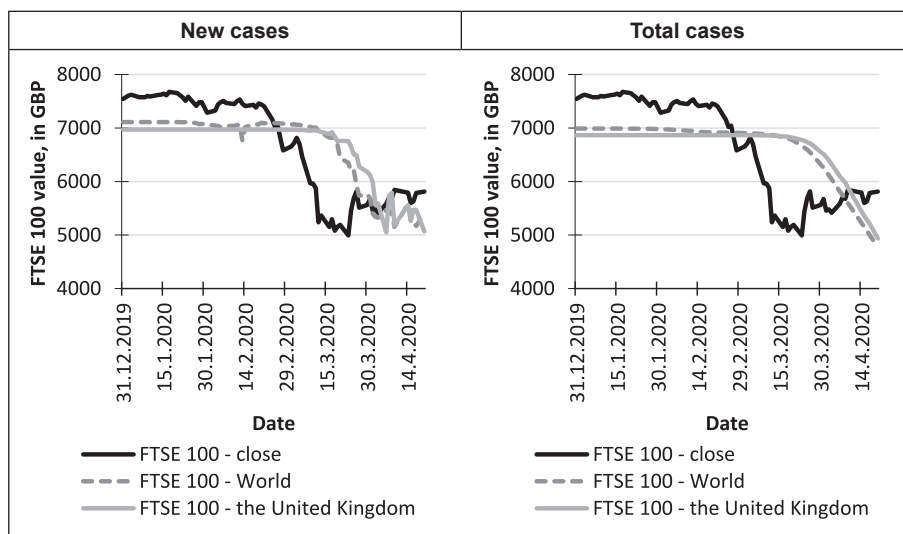
Table 7: Linear regression results, dependent variable FTSE 100, n = 77 daily data

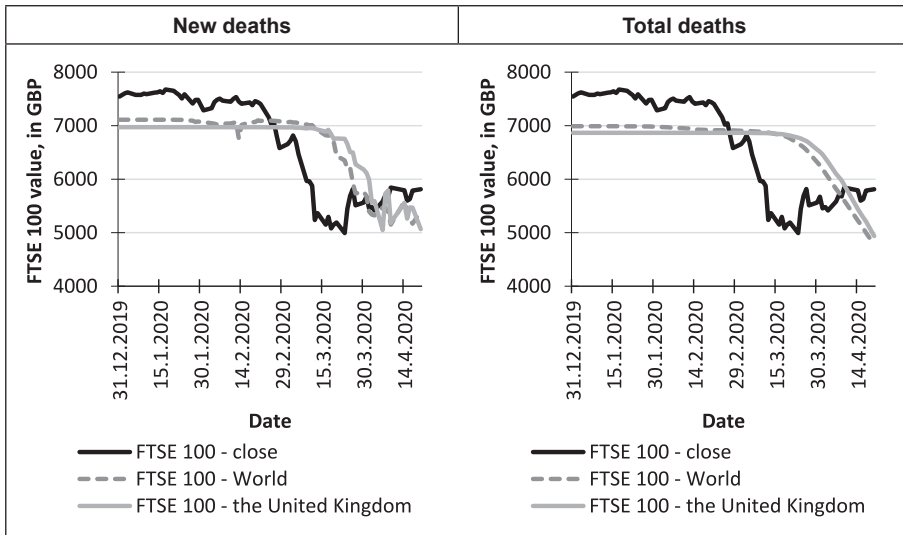
Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.7041	0.4957	7110.66	2.04E-73	-0.023	9.10E-13
	Total cases	-0.5807	0.3372	6988.07	1.06E-69	-0.001	3.10E-08
	New deaths	-0.6067	0.3681	6992.12	9.94E-71	-0.243	4.95E-09
	Total deaths	-0.5167	0.2670	6916.24	8.44E-69	-0.013	1.50E-06
the United Kingdom	New cases	-0.5943	0.3532	6970.98	1.29E-70	-0.325	1.21E-08
	Total cases	-0.4666	0.2177	6866.47	2.82E-68	-0.016	1.89E-05
	New deaths	-0.5071	0.2571	6895.79	6.51E-69	-1.892	2.52E-06
	Total deaths	-0.4047	0.1638	6822.64	1.46E-67	-0.109	0.0003

Source: EU Open Data Portal (2020), Yahoo! Finance (2020d), authors.

The linear regression models from the Table 7 are suggesting that the correlations between the FTSE 100 market index value and the observed COVID-19 variables are negative. Also, the highest impact on the FTSE 100 market index value has new deaths variable.

Figure 7: Actual and estimated values of the FTSE 100 based on estimated regression models for World and the United Kingdom





Source: EU Open Data Portal (2020), Yahoo! Finance (2020d), authors.

In Figure 7 the actual and estimated values of the FTSE 100 based on estimated regression models for World and the United Kingdom are shown. The response of the regression models seems to be about one month behind the actual changes of FTSE 100 market index.

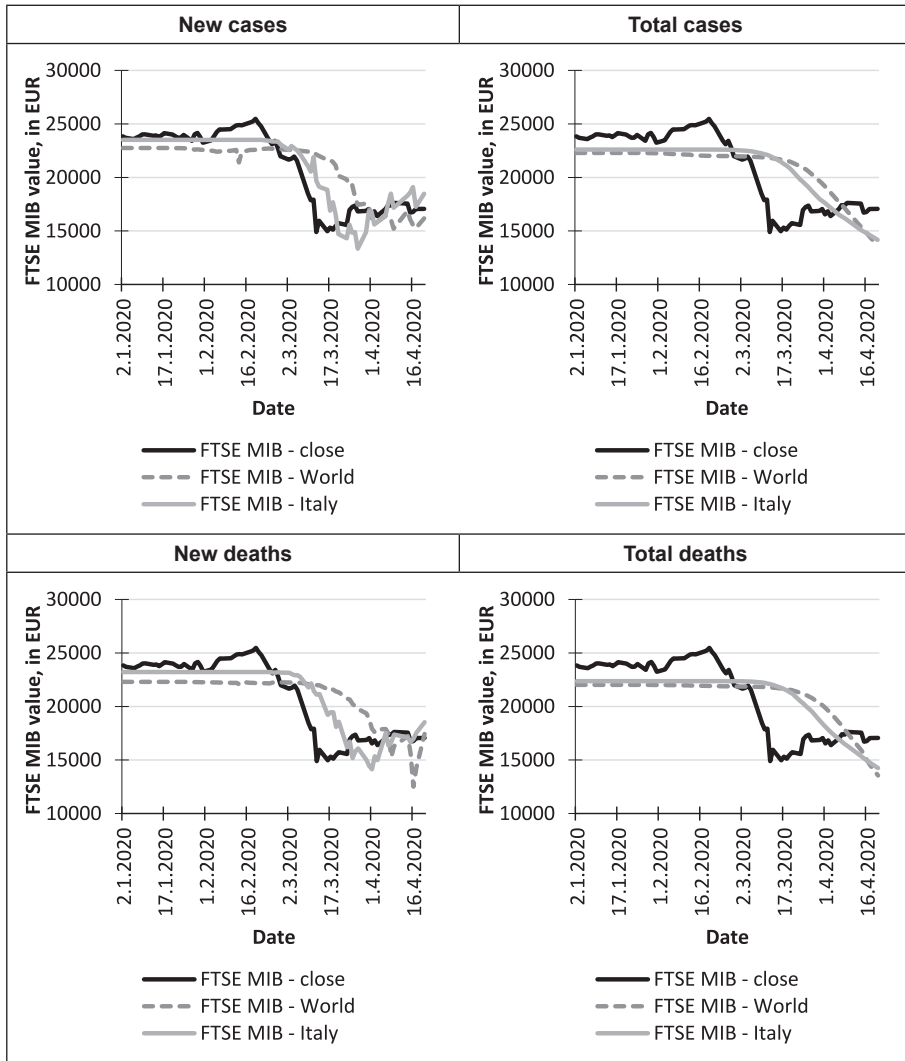
Table 8: Linear regression results, dependent variable FTSE MIB, n=76 daily data

Area / country	COVID-19 variable	Statistics					
		Coef. of correl.	Coef. of determ.	Intercept		Regression coefficient	
				Estimate	P-value	Estimate	P-value
World	New cases	-0.7102	0.5044	22,750.33	6.21E-67	-0.089	6.73E-13
	Total cases	-0.5959	0.3550	22,292.18	2.24E-63	-0.004	1.36E-08
	New deaths	-0.6209	0.3856	22,304.74	2.14E-64	-0.947	2.18E-09
	Total deaths	-0.5387	0.2902	22,021.78	1.59E-62	-0.051	5.18E-07
Italy	New cases	-0.9079	0.8242	23,509.13	4.09E-83	-1.653	1.18E-29
	Total cases	-0.7059	0.4983	22,597.20	2.45E-67	-0.047	1.07E-12
	New deaths	-0.8521	0.7260	23,215.11	2.35E-76	-10.822	1.69E-22
	Total deaths	-0.6481	0.4201	22,364.12	2.31E-65	-0.343	2.46E-10

Source: EU Open Data Portal (2020), Fusion Media (2020), authors.

Lastly, in Table 8 the linear regression results for regression models in which the FTSE MIB market index variable was the dependent variable and the COVID-19 variable being an independent variable in the models, are shown. All regression models turned out to be highly statistically significant. Also, all individual correlations between the FTSE MIB variable and the COVID-19 variables seems to be negative.

Figure 8: Actual and estimated values of the FTSE MIB based on estimated regression models for World and Italy



Source: EU Open Data Portal (2020), Fusion Media (2020), authors.

According to Figure 8, it seems that the response lag of the regression models is lower than one month for the FTSE MIB market index. It can be concluded that the value of all eight world major stock market indices have fallen dramatically due to the confirmed cases of COVID-19 infection and the number of fatalities. The main findings of this paper are in the line with previous research in this field. There was a sharp fall in major stock market indices in the middle of the February which coincides with the first reported

cases of COVID-19 infection outside the China. The results obtained from this analysis can be relevant for market experts and investors as a guide when making investment decisions. One could ask what should investors do? According to Smith (2020) they should avoid fear of missing out, forget trying to time the market, try to be prudent and invest in safe forms of investments such as gold, sovereign and corporate bonds.

6. Conclusions

Goal of this paper was to investigate the impact of COVID-19 infection on the values of major stock market indices. The case of eight stock market indices was investigated. The research results have shown that the observed COVID-19 variables have negative impact on the values of all observed market indices. The same conclusion was brought when the COVID-19 variables were observed on the World level and on the level of an individual country in which the certain market index is used. It has been shown that the highest impact on stock market index value has the COVID-19 new deaths variable. The value of market indices has dropped roughly a month or month and a half before it should according to regression results and the number of confirmed cases of infection respectively. That can be explained with negative expectations of destructive effect of COVID-19 outbreak started in Wuhan, China in December 2019.

Limitations of the paper are related to the uneven number of days for different stock market indices due to the data unavailability for each observed day due to weekends, holidays and other restrictions related to the indices. There is also a methodology problem related to confirmed number of infected persons and the number of fatalities because official data does not take into account unconfirmed or unreported cases of infection. Recommendation for future research is to inspect in more details the lags between the actual and regression values due to market negative expectations. If the lag is precisely estimated, the regression models could be used for predicting the actual values of market indices.

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