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The Response of Selected Domestic Capital Markets on the Development of COVID-19 Pandemic – a Broader View

Reakcja wybranych krajowych rynków kapitałowych a rozwój pandemii COVID-19 – szersze spojrzenie

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ABSTRACT

Objective: The study examines how the record of the first, hundredth, thousandth, ten-thousandth, one-hundred-thousandth, and millionth cases of COVID-19 affected investor behaviour in capital markets. It also looks at whether the month in which the first case was recorded in a given market affected the direction and strength of investor reactions. Lastly, it verifies whether the two announcements made by the WHO related to COVID-19 differently affected the behaviour of investors in markets where the first case of the epidemic had already been recorded and in markets where there were not yet officially confirmed cases.
Research Design & Methods: Event analysis is used in looking at 77 financial markets.
Findings: Investor reactions to emerging information are extreme. The largest sell-off of shares was observed when the first and hundredth cases of the disease were recorded. No statistically significant and negative abnormal rates of return were found for other points studied. The later the first case was recorded in a given market, the greater the scale of discounting in that market.

In markets where the first case of infection had already been recorded, the negative reaction of investors was greater than in markets where the first case had not yet been found.
Implications/Recommendations: A small number of cases and high uncertainty about COVID-19 have a more substantial negative impact on investors than a high number of cases coupled with a better understanding of the pandemic. WHO announcements further contributed to the occurrence of stronger declines in countries in which people had already become infected by COVID-19.
Contribution: The current study is the first of its kind, focusing not only on the first case of COVID-19, but also on other focal points of the evolving pandemic. The other aspects (month, WHO announcements) covered are also analysed from a different, broader view than in other studies.

Article type: original article.

Keywords: event study, overreaction, COVID-19, stock markets, abnormal returns.

JEL Classification: G14, G15, E44.

STRESZCZENIE

Cel: W artykule zbadano, w jaki sposób ogłoszenie pierwszego, setnego, tysięcznego, dziesięciotysięcznego, stutysięcznego i milionowego przypadku COVID-19 wpłynęło na zachowanie inwestorów na rynkach kapitałowych. Przeanalizowano, czy miesiąc, w którym zanotowano pierwszy przypadek zachorowania na danym rynku, wywołał odmienne reakcje inwestorów pod względem ich kierunku i siły. Zweryfikowano również, czy dwa komunikaty WHO dotyczące COVID-19 w różny sposób wpłynęły na zachowanie inwestorów na rynkach, na których odnotowano już pierwszy przypadek pandemii, oraz na rynkach, na których nie było jeszcze oficjalnie potwierdzonych przypadków.
Metodyka badań: Wykorzystano analizę zdarzeń do analizy próby składającej się z 77 rynków finansowych.
Wyniki badań: Wykazano, że inwestorzy gwałtownie reagują na pojawiające się informacje. Największą wyprzedaż akcji odnotowano w momencie potwierdzenia pierwszego i setnego zachorowania. Dla pozostałych badanych punktów nie stwierdzono statystycznie istotnych i ujemnych ponadprzeciętnych stóp zwrotu. Im później na danym rynku odnotowano pierwszy przypadek, tym skala wyprzedaży na rynku była większa. Na rynkach, na których odnotowano już pierwszy przypadek zachorowania, negatywna reakcja inwestorów była większa niż na rynkach, na których pierwszego przypadku jeszcze nie stwierdzono.
Wnioski: Na inwestorów większy negatywny wpływ wywiera mała liczba pojawiających się przypadków i wysoki poziom niepewności związany z COVID-19 niż duża liczba przypadków i jednocześnie lepsze rozumienie mechanizmu badanej pandemii. Zapowiedzi WHO dodatkowo przyczyniły się do wystąpienia silniejszych spadków w krajach już dotkniętych pandemią.
Wkład w rozwój dyscypliny: Jest to pierwsze tego rodzaju badanie skupiające się nie tylko na pierwszym przypadku COVID-19, ale także na innych centralnych punktach rozwoju pandemii. Pozostałe aspekty (miesiąc, komunikaty WHO) również zostały przeanalizowane z innego, szerszego niż w dotychczasowych badaniach, punktu widzenia.

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Typ artykułu: oryginalny artykuł naukowy.

Słowa kluczowe: analiza zdarzeń, nadreakcja, COVID-19, rynek giełdowy, ponadprzeciętna stopa zwrotu.

1. Introduction

As the COVID-19 pandemic spread, stock prices declined significantly in countries throughout the world (Al-Awadhi *et al*. 2020, Baker *et al*. 2020). This article compares whether the appearance of the first case of infection has the same effect on capital markets as crossing other psychological barriers in the number of infections. In this study, in addition to the first case of infection, the hundredth, thousandth, ten-thousandth, one-hundred-thousandth, and millionth case of infection were analysed. These are points of special importance, and are referred to as focal points. Other researchers have mainly concentrated on the reaction of markets when the first COVID-19 case occurred (Bash 2020, Behera & Rath 2021, Khatatbeh, Bani Hani & Abu-Alfoul 2020, Trpkova-Nestorovska, Trpeski & Peovski 2021). Assessing the reaction of financial markets at different stages of the pandemic's evolution can clarify which has the higher impact on investors: a small number of cases and high uncertainty level about COVID-19 or a high number of cases but a better understanding of the epidemic. The study also assesses whether the month in which the first infected person was recorded affected the strength with which capital markets reacted. This question has yet to be answered by scientific research.

The first research hypothesis adopted for this study was that crossing successive important barriers of the number of infected persons in a given country does not cause such significant discounts as the appearance of the first case of infection. This, like the other hypotheses examined here, is tied to market efficiency theory and the issue of overreaction (de Bondt & Thaler 1985). While numerous studies have been done on the impact of the COVID-19 pandemic on capital markets, no attempt has been made to compare the reactions of investors when the subsequent threshold of the number of infected persons was crossed or to determine whether the moment of the appearance of the first case of infection (at the beginning of the outbreak of the pandemic or during subsequent months) can affect investor behaviour. This article is intended to fill this research gap.

The second hypothesis is that investors reacted less nervously in countries where the threat of the pandemic appeared at the early stage of its detection than in those where the first cases were recorded and information had been provided about the threat. In turn, in countries where the first case was reported at the latest stage (after the WHO announced the outbreak of the pandemic), no extraordinary discounting of securities should have occurred, as investors should by then have

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been anticipating the threat and considered the prospect of COVID-19 appearing on their market much earlier. Were this true, it would have been possible to indicate when, from the point of view of capital markets, the first case of the pandemic should appear in a given country, and minimise the fall in the markets.

The study also analyses how the announcement by WHO that COVID-19 was a serious threat to human health (30 January 2020) and then that the world was indeed dealing with a pandemic (11 March 2021) affected the rates of return quoted in the capital markets. This study also assesses whether the first case of the COVID-19 pandemic recorded in a given country prior to the above two events contributed to the way some investors reacted, and if so, then to what extent. Research hypothesis 3 is that both events announced by the WHO would have triggered statistically significant discounts in stock markets. However, in a country where the first case of the disease had already been recorded, the discounts (if they occurred) should have been lower than in markets where the first case of infection had yet to be recorded.

2. Literature Review

In the studies conducted to date, more than a dozen authors have assessed the impact of information related to the outbreak of COVID-19 on capital markets using event analysis. Significant findings from these studies are presented below. The first section presents studies that looked at single national markets or selected sectors of the economy, while the second cites studies covering at least a few national capital markets.

In their study, Trpkova-Nestorovska, Trpeski and Peovski (2021) did not confirm that the first recorded case of COVID-19 had a statistically significant negative impact on the North Macedonia capital market. They showed that the publication of information about the first identified case of COVID-19 virus infection on 26 February 2020 did not contribute to statistically significant abnormal rates of return in that market. However, the introduction of a national lockdown and a curfew (16 March 2020 and 23 March 2020, respectively) did have a statistically significant impact on rates of return in the capital market. There was no statistically significant rate when the curfew was lifted, either. However, only four large publically traded companies were used in the analysis.

Behera and Rath (2021) have also come away with interesting findings in their study, which analysed the share prices of nine Indian pharmaceutical companies during the COVID-19 pandemic. In India, the date of the first confirmed case of the virus, and of lockdown, was 30 January 2020. The authors showed that, on average, the prices of the companies studied reacted positively and in a statistically significant way to both the first case and the lockdown. However, at the level of individual company analysis, the results are not so clearcut.

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Another study (Schaub 2021) also examined the effect of emerging information on prices, this one on two disinfectant manufacturers. The author examined how two Environmental Protection Agency (EPA) announcements affected the prices of two companies, Clorox and Reckitt Benckiser, as well as 13 of their direct competitors. The main finding concerns the occurrence of an abnormal, positive and statistically significant rate of return when a government agency recommends a particular company's products. Harabida and Radi (2020), meanwhile, investigated how the declaration of a health emergency on 16 March 2020 affected the capital market in Morocco. They calculated four rates – AR, AAR, CAR and CAAR – for 72 companies listed on the Casablanca Stock Exchange. They concluded that there were abnormal negative rates of return on the day of the event, and a strong and immediate impact on the share prices of the market in question.

In their study, Karaömer and Kakilli Acaravcı (2022) examined four sectors (banking, transportation, telecommunication and food-beverage) of stocks traded on the Turkish stock exchange. The authors ultimately prove that the event studied contributed to abnormal negative rates of return in the transportation and banking sectors, which experienced a slowdown during the pandemic. Meanwhile, the other two sectors saw an increase in value in light of the event studied, as the emergence of the pandemic contributed to a significant recovery in these industries

Yiğit and Canöz (2020) examined a specific market segment (companies in the aviation industry) while also looking at companies listed in 14 European markets. The authors examined the change in share prices for 38 companies on 11 March 2020, the day the WHO declared COVID-19 a pandemic. They found that airline stocks on the Austrian, Finnish, Icelandic, Norwegian, Russian, and Turkish stock exchanges reacted quickly to the pandemic announcement. During the longest window studied, the stocks of all aviation industry companies recorded abnormal, negative, and statistically significant rates of return.

In their study Harjoto and Rossi (2023) examined investor reaction to the WHO's declaration of COVID-19 as a pandemic in countries with developed and developing capital markets. The authors demonstrated that losses from the COVID-19 pandemic were greater and statistically significant in emerging than in developed markets. They also noted that the telecommunications and health care sectors responded positively to the crisis while the financial and energy sectors did not.

In terms of event analysis methodologies used in domestic financial markets, Bash examined the impact of publishing the first case of infection in 30 countries and the reaction of capital markets to the event (Bash 2020). It was proved that the publication of information about the first case had a significant effect on obtaining abnormal negative and statistically significant rates of return. Surveying G-20 countries, Singh *et al*. (2020) also deployed event methodology to assess the impact of the COVID-19 pandemic on capital markets. They used 20 January 2020

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as the event date when it was reported, in an interview with Zhong Nanshan, that COVID-19 is being transmitted. The authors showed significant discounts due to "panic selling" in equity markets directly following the report. At the same time, they note that these markets recoup losses in the long run through new capital inflows.

3. Methodology and Data

The research method adopted for this study is event analysis. For all calculations, logarithmic and daily rates of return were used, calculated according to the formula below (Prusak & Potrykus 2021):

$$R_{i,t} = \ln\left(\frac{CP_{i,t}}{CP_{i,t-1}}\right),$$

where:

$R_{i,t}$ – the rate of return for market (country) i on day t,

$CP_{i,t}$ – the closing price for the market (country) i on day t,

$CP_{i,t-1}$ – the closing price for the market (country) i on day $t-1$.

The day of the event was assumed to be one of three: the appearance of the first case of COVID-19 infection in a country or the day when the next barrier in the number of infected persons was crossed (research hypotheses 1 and 2), or the date of announcements issued by the WHO (research hypothesis 3). A market model was used to determine the abnormal return (AR) (Castro-Iragorri 2019), while MSCI's data ACWI Standard (Large + Mid Cap) index (MSCI 2021) was used as a benchmark. Eventually, AR rates were calculated using this formula (Prusak & Potrykus 2020):

$$AR_{i,t} = R_{i,t} - (\alpha_i + \beta_i \cdot R_{m,t}),$$

where:

$R_{m,t}$ – the rate of return for the MSCI ACWI index on day t,

α_i, β_i – the estimated market-based model parameters.

The MSCI ACWI index was selected as the benchmark because, as stated on the index's website, its quotations are influenced by the total price change for more than three thousand companies listed in 50 countries around the world. It is the flagship index that reflects price changes for the global capital market (MSCI 2021).

Abnormal rates of return for each market were the basis for determining AAR and CAAR rates, which were used to verify the three research hypotheses. AAR and CAAR rates were calculated as follows (Schimmer, Levchenko & Müller 2015):

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$$AAR = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t}$$

$$CAAR = \frac{1}{N}\sum_{i=1}^{N} CAR(t_1, t_2)$$

$$CAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{i,t},$$

where:

AAR – average abnormal return,
N – number of markets in the group under analysis,
CAAR – cumulative average abnormal return,
t_1 – start of the event window (two days before the event),
t_2 – end of the event window (three days after the event),
CAR – cumulative abnormal return.

The event window adopted in the study covered the period (–2, 3) for each defined event. The event window was defined in this way because the shortest period between crossing successive points was three days. Thus, determining the beginning of the event window to be two days before and three days after the event minimised the chance that a disruptive event could occur as a result of the overlap of two examined points in one analysed event window.

The shortest period observed occurred in the Turkish stock exchange and, in that country, the hundredth case of COVID-19 was recorded on 19 March 2020, while already a thousand cases were registered in Turkey on 22 March 2020. Additionally, to avoid the influence of disruptive events, it was assumed that the estimation window ended 11 days before the event, and the length of the estimation window was 120 days. When the day of the event fell on a non-trading day, the event was assumed to be the next business day on that market.

To evaluate the statistical significance of the AAR and CAAR rates obtained, two statistical tests (parametric and non-parametric) were used. The Kolari and Pynnönen adjusted Patell or Standardised Residual Test was the parametric test used (hereinafter called "Adjusted Patell Z" or APZ). How it should be done is described in (Kolari & Pynnönen 2010). The non-parametric test was Generalised Rank Z (GRZ), and is described in (Kolari & Pynnonen 2011).

As Ashraf (2020) did, the study was conducted for 77 national securities markets, while the dates when the successive thresholds in the number of infected persons were crossed were taken from Mathieu *et al*. (2020), as shown in Table 1. Index values for individual national financial markets were taken from Investing.com (https://pl.investing.com/indices/world-indices?, accessed: 8.04.2021).

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Table 1. Markets and Dates of Occurrence of the Events under Study

Sr. no.	Country	Confirmation date of specific number of COVID-19 cases					
		1	100	1,000	10,000	100,000	1,000,000
1	Argentina	3.03.2020	20.03.2020	31.03.2020	22.05.2020	12.07.2020	19.10.2020
2	Australia	26.01.2020	10.03.2020	21.03.2020	13.07.2020		
3	Austria	25.02.2020	8.03.2020	16.03.2020	31.03.2020	31.10.2020	
4	Bahrain	24.02.2020	10.03.2020	11.04.2020	28.05.2020	25.01.2021	
5	Bangladesh	8.03.2020	6.04.2020	14.04.2020	4.05.2020	18.06.2020	
6	Belgium	4.02.2020	6.03.2020	16.03.2020	29.03.2020	19.09.2020	
7	Brazil	26.02.2020	13.03.2020	21.03.2020	4.04.2020	3.05.2020	19.06.2020
8	Bulgaria	8.03.2020	20.03.2020	22.04.2020	24.07.2020	16.11.2020	
9	Canada	26.01.2020	11.03.2020	21.03.2020	2.04.2020	13.06.2020	3.04.2021
10	Chile	3.03.2020	15.03.2020	25.03.2020	18.04.2020	28.05.2020	1.04.2021
11	China	8.12.2019	20.01.2020	25.01.2020	1.02.2020	31.01.2021	
12	Colombia	6.03.2020	18.03.2020	1.04.2020	8.05.2020	1.07.2020	24.10.2020
13	Cote d'Ivoire	11.03.2020	27.03.2020	23.04.2020	3.07.2020		
14	Croatia	25.02.2020	19.03.2020	2.04.2020	30.08.2020	21.11.2020	
15	Cyprus	9.03.2020	23.03.2020	4.07.2020	28.11.2020		
16	Denmark	27.02.2020	10.03.2020	17.03.2020	5.05.2020	10.12.2020	
17	Ecuador	1.03.2020	18.03.2020	24.03.2020	20.04.2020	15.08.2020	
18	Egypt	14.02.2020	14.03.2020	4.04.2020	12.05.2020	7.09.2020	
19	France	24.01.2020	29.02.2020	8.03.2020	19.03.2020	12.04.2020	21.10.2020
20	Germany	27.01.2020	1.03.2020	8.03.2020	18.03.2020	5.04.2020	26.11.2020
21	Greece	26.02.2020	13.03.2020	28.03.2020	30.08.2020	27.11.2020	
22	Hungary	4.03.2020	21.03.2020	10.04.2020	10.09.2020	7.11.2020	
23	Iceland	28.02.2020	12.03.2020	29.03.2020			
24	India	30.01.2020	14.03.2020	29.03.2020	13.04.2020	18.05.2020	16.07.2020
25	Indonesia	2.03.2020	15.03.2020	27.03.2020	30.04.2020	27.07.2020	26.01.2021
26	Iraq	24.02.2020	13.03.2020	6.04.2020	6.06.2020	23.07.2020	
27	Ireland	29.02.2020	14.03.2020	23.03.2020	13.04.2020	3.01.2021	
28	Israel	21.02.2020	13.03.2020	22.03.2020	9.04.2020	21.08.2020	
29	Italy	31.01.2020	23.02.2020	29.02.2020	10.03.2020	30.03.2020	11.11.2020
30	Jamaica	11.03.2020	15.04.2020	8.08.2020	18.11.2020		
31	Japan	16.01.2020	21.02.2020	20.03.2020	18.04.2020	30.10.2020	
32	Kazakhstan	13.03.2020	26.03.2020	13.04.2020	30.05.2020	4.08.2020	
33	Kenya	13.03.2020	2.04.2020	20.05.2020	12.07.2020	25.01.2021	
34	Lebanon	21.02.2020	15.03.2020	21.05.2020	19.08.2020	12.11.2020	
35	Malaysia	25.01.2020	9.03.2020	20.03.2020	16.09.2020	24.12.2020	

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Table 1 cnt'd

Sr. no.	Country	Confirmation date of specific number of COVID-19 cases					
		1	100	1,000	10,000	100,000	1,000,000
36	Mauritius	18.03.2020	28.03.2020	31.03.2021			
37	Mexico	28.02.2020	18.03.2020	30.03.2020	22.04.2020	3.06.2020	14.11.2020
38	Mongolia	10.03.2020	16.05.2020	21.12.2020	4.04.2021		
39	Morocco	2.03.2020	22.03.2020	5.04.2020	22.06.2020	20.09.2020	
40	Namibia	14.03.2020	25.06.2020	16.07.2020	17.09.2020		
41	Netherlands	27.02.2020	6.03.2020	15.03.2020	29.03.2020	21.09.2020	3.02.2021
42	New Zealand	28.02.2020	22.03.2020	5.04.2020			
43	Nigeria	28.02.2020	29.03.2020	24.04.2020	31.05.2020	10.01.2021	
44	Norway	26.02.2020	6.03.2020	14.03.2020	16.08.2020		
45	Oman	24.02.2020	26.03.2020	16.04.2020	30.05.2020	4.10.2020	
46	Pakistan	26.02.2020	15.03.2020	24.03.2020	21.04.2020	7.06.2020	
47	Peru	6.03.2020	17.03.2020	31.03.2020	14.04.2020	20.05.2020	23.12.2020
48	Philippines	30.01.2020	14.03.2020	28.03.2020	6.05.2020	2.08.2020	
49	Poland	4.03.2020	14.03.2020	25.03.2020	22.04.2020	4.10.2020	2.12.2020
50	Portugal	2.03.2020	13.03.2020	20.03.2020	4.04.2020	19.10.2020	
51	Qatar	29.02.2020	11.03.2020	3.04.2020	26.04.2020	6.07.2020	
52	Romania	26.02.2020	14.03.2020	26.03.2020	23.04.2020	11.09.2020	
53	Russia	31.01.2020	17.03.2020	27.03.2020	9.04.2020	30.04.2020	2.09.2020
54	Saudi Arabia	2.03.2020	14.03.2020	26.03.2020	20.04.2020	7.06.2020	
55	Serbia	6.03.2020	19.03.2020	1.04.2020	9.05.2020	19.11.2020	
56	Singapore	23.01.2020	29.02.2020	1.04.2020	22.04.2020		
57	Slovakia	6.03.2020	18.03.2020	17.04.2020	30.09.2020	26.11.2020	
58	Slovenia	5.03.2020	13.03.2020	6.04.2020	15.10.2020	16.12.2020	
59	South Africa	5.03.2020	18.03.2020	27.03.2020	10.05.2020	22.06.2020	27.12.2020
60	South Korea	20.01.2020	20.02.2020	26.02.2020	3.04.2020	24.03.2021	
61	Spain	1.02.2020	2.03.2020	9.03.2020	17.03.2020	1.04.2020	21.10.2020
62	Sri Lanka	27.01.2020	24.03.2020	19.05.2020	30.10.2020		
63	Sweden	31.01.2020	6.03.2020	15.03.2020	10.04.2020	13.10.2020	
64	Switzerland	25.02.2020	5.03.2020	13.03.2020	25.03.2020	23.10.2020	
65	Taiwan	21.01.2020	18.03.2020	19.03.2021			
66	Tanzania	16.03.2020	17.04.2020				
67	Thailand	13.01.2020	15.03.2020	26.03.2020	8.01.2021		
68	Tunisia	4.03.2020	24.03.2020	2.05.2020	20.09.2020	4.12.2020	
69	Turkey	11.03.2020	19.03.2020	22.03.2020	30.03.2020	23.04.2020	10.12.2020
70	Uganda	21.03.2020	6.05.2020	9.07.2020	14.10.2020		

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Table 1 cnt'd

Sr. no.	Country	Confirmation date of specific number of COVID-19 cases					
		1	100	1,000	10,000	100,000	1,000,000
71	Ukraine	3.03.2020	25.03.2020	3.04.2020	30.04.2020	20.08.2020	22.12.2020
72	United Arab Emirates	29.01.2020	18.03.2020	2.04.2020	26.04.2020	6.10.2020	
73	United Kingdom	31.01.2020	2.03.2020	11.03.2020	22.03.2020	14.04.2020	31.10.2020
74	United States	21.01.2020	4.03.2020	11.03.2020	19.03.2020	27.03.2020	27.04.2020
75	Venezuela	14.03.2020	26.03.2020	23.05.2020	14.07.2020	23.11.2020	
76	Vietnam	23.01.2020	22.03.2020	20.08.2020			
77	Zambia	18.03.2020	30.04.2020	27.05.2020	19.08.2020		
Number of countries that have reached a given threshold of confirmed cases		77	77	76	71	59	21

Source: the author.

If there is no date provided in a cell, the country did not exceed the given threshold of confirmed infections on the date of the test. In the research sample, for the first two items (the first and the hundredth confirmed case of COVID-19), 77 national securities markets were examined. The thousand-case threshold was crossed by 76 countries while the million-case threshold was recorded in only 21 countries. Believed to be the country where the world's first case of COVID-19 was diagnosed, China reported its first case as early as 8 December 2019, but official information about the disease was released only at the end of 2019 and the beginning of 2020.

Further study of the table reveals that the first cases of the pandemic were reported in as many as 21 countries (including China) in January 2020, and the first cases of infection were recorded in 24 countries in 2020, while cases were reported in as many as 32 countries in March. Thus, all of the markets reported the first case of infection on their territory between January 2020 to March 2020. On 27 April, 2020, 97 days after the first case was detected, the United States was the first country to report a million cases. Interestingly, Canada reached the million--case mark a full 433 days after the first infection was detected. The average number of days it took the 21 countries that reached the one-million case mark was 269 days after the first infected person was recorded.

4. Research Results and Discussion

The first part of this study evaluated whether abnormal negative returns were recorded for markets when the first cases of COVID-19 were reported and a subse-

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quent threshold related to the number of infected persons was crossed. Table 2 presents the value of the AAR rate with an assessment of statistical significance for each examined case threshold.

Table 2. Results of AAR Value and Statistical Tests for the AAR Rate, Number of Recorded Cases

No. of confirmed cases	Data	AAR(–2)	AAR(–1)	AAR(0)	AAR(1)	AAR(2)	AAR(3)
1 case	AAR value (%)	–0.3	–0.5	–0.5	–0.9	–0.5	–0.5
	APZ	–3.66 (***)	–3.85 (***)	–5.56 (***)	–10.41 (***)	–3.82 (***)	–2.73 (***)
	GRZ	–1.55	–0.98	–2.8 (***)	–2.2 (**)	–1.11	–1.59
100 cases	AAR value (%)	–1.3	–0.9	–0.7	–0.4	0.3	–0.1
	APZ	–12.25 (***)	–7.87 (***)	–7.48 (***)	–2.9 (***)	2.77 (***)	0.27
	GRZ	–3.06 (***)	–2.13 (**)	–2.44 (**)	–0.54	0.09	–0.58
1,000 cases	AAR value (%)	–1.1	0.2	0.2	0.2	0.6	0.3
	APZ	–10.07 (***)	3.93 (***)	1.64	0.31	8.28 (***)	0.38
	GRZ	–4.05 (***)	0.24	–0.11	–0.01	0.54	0.78
10,000 cases	AAR value (%)	–0.1	–0.1	0.2	0.2	–0.1	–0.1
	APZ	–0.66	–0.52	1.56	2.71 (***)	0.46	–0.06
	GRZ	–0.37	–0.6	1.25	0.72	–0.57	–0.26
100,000 cases	AAR value (%)	–0.3	0.3	0.0	0.3	0.2	0.3
	APZ	–2.06 (**)	1.76 (*)	–0.61	1.5	0.63	0.58
	GRZ	–0.85	1.56	–0.78	1.13	1.08	–0.29
1,000,000 cases	AAR value (%)	0.4	0.1	–0.1	–0.1	0.2	0.5
	APZ	1.16	0.57	–0.54	–0.28	0.46	1.57
	GRZ	0.89	0.81	–0.45	–0.03	0.37	0.95

Notes: *, **, *** denote statistical significance of 10%, 5% and 1%, respectively.

Source: the author.

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The data in Table 2 show that the greatest impact on every national stock exchange was the discovery of the first case of COVID-19. The day after the first confirmed case was announced an abnormal, nearly one-percent decline was observed in a given market. Abnormal negative rates of return were also recorded both on the day of the event and on the remaining days of the examined event window. Investors started selling their shares prior to the event, and the information of the first reported case only deepened the decline. In total, a loss of approximately 3.2% was recorded within the event window, an average decline of 0.5% per day. While these are the abnormal declines recorded in stock exchanges, significant discounts had also been observed in the first quarter of 2020. The announcement of the first confirmed case of the pandemic only sharpened the decline.

For the hundredth, thousandth, ten-thousandth, one-hundred-thousandth, and one-millionth cases, no clear abnormal rates of return were observed. Surprisingly, only when the million-infection threshold was reached was there, on the day after the event, an abnormal negative rate of return (0.1%), while in the other three cases the rates of return were positive. The appearance of the first or hundredth case of infection clearly caused investors to react nervously and sell shares, resulting in significant discounts. Though far more burdensome for health care systems and a country's populace, reaching subsequent thresholds did not lead to such significant discounts. Investors appear to become inured to the bad news, and in a way bear out the overreaction hypothesis that emerged with reports of initial cases.

The results of the statistical tests confirm that the rates of return on the stock exchange, in the countries where the first case of COVID-19 infection was announced, were above average and statistically significant both on the day of the event and the day after the event. The same strong and statistically significant pattern was confirmed when the one hundred-case threshold was reached. Furthermore, abnormal and statistically significant negative rates of return were also observed both two days and one day before before the event. This suggests investors were bracing for the negative news, selling shares before the one-hundred case threshold was reached. A similar reaction occurred when the thousand-case threshold was reached: both tests indicate statistically significant abnormal negative rates of return as early as two days before the event, while no such reaction was observed on the day of or the day after the event. Table 3 presents the characteristics of the CAAR rate.

As with AAR, a statistically significant value was observed for CAAR only for the first and one-hundredth case thresholds (a cumulative abnormal rate of return of nearly 3%). For the other thresholds, no statistically significant cumulative rates of return were observed.

The next stage of the study verified whether the month when the first case recorded in a given country was associated with cumulative abnormal rates of return of different values. The first case of the pandemic was reported in China.

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Table 3. Results of Statistical Tests for the CAAR Rate, Number of Recorded Cases

Grouping variable	CAAR value (%)	pos:neg CAR	Number of CARs considered	APZ	GRZ
1 case	–3.2	23:54	77	–11.51 (***)	–4.45 (***)
100 cases	–3.0	26:51	77	–9.18 (***)	–3.32 (***)
1,000 cases	0.4	43:33	76	1.60	0.70
10,000 cases	0.1	39:32	71	1.46	0.26
100,000 cases	0.7	30:29	59	0.76	0.19
1,000,000 cases	1.1	13:8	21	1.08	1.73 (*)

Notes: *, **, *** denote statistical significance of 10%, 5% and 1%, respectively.

Source: the author.

However, due to a delay of nearly three weeks in disclosing this information, the reaction of investors in the Chinese market was analysed separately and excluded from the month of January. The results are shown in Table 4.

Table 4. Results of the AAR Value and Statistical Tests for the AAR Rate, by Month First Case of Infection Was Reported

Month of first confirmed case	Data	AAR(–2)	AAR(–1)	AAR(0)	AAR(1)	AAR(2)	AAR(3)
January	AAR value (%)	–0.1	0.0	–0.1	–0.6	–0.1	–0.1
	APZ	–0.36	–0.09	–0.51	–3.96 (***)	–0.03	–1.87 (*)
	GRZ	–0.31	–0.17	–0.79	–1.41	0.36	–1.17
February	AAR value (%)	–0.8	0.1	0.0	–1.1	–0.3	0.4
	APZ	–4.27 (***)	0.46	–0.77	–5.2 (***)	–1.73 (*)	2.03 (**)
	GRZ	–1.54	0.8	–0.98	–1.4	0	0.41
March	AAR value (%)	–0.2	–1.3	–1.1	–1.1	–0.8	–1.4
	APZ	–1.75 (*)	–6.33 (***)	–7.59 (***)	–8.56 (***)	–4.3 (***)	–4.83 (***)
	GRZ	–0.92	–1.96 (**)	–2.95 (***)	–1.3	–1.8 (*)	–2.16 (**)

Notes: *, **, *** denote statistical significance of 10%, 5% and 1%, respectively.

Source: the author.

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For each month, there was a significant sell-off on the capital market on the day after the event. Crucially, the later the first case was reported, the greater was the value of the average loss recorded on a given capital market. In January, the day after the event there was a loss of 0.6% while in February and March the loss was 1.1%. The low values in the analysed event window for the month of March are also interesting. For that period, for practically the entire event window (with the exception of the rate two days before the event), abnormally low rates of return were observed, though they were not lower than –0.7%. Therefore, based on the presented data, it is possible to draw a preliminary conclusion that the later the first case of infection was reported on a given market, the greater the scale of discounts on the capital market.

APZ test confirms the presence of statistically significant and negative rates of return on the day after the event, while the results of the other performed test do not confirm that conclusion. Furthermore, when the first case of COVID-19 was recorded in March, the abnormal and statistically significant rates of return – at least at the level of $\alpha = 0.05$ – were recorded on five out of six tested days in the event window (APZ) or on three days examined (GRZ). Both tests also indicate the presence of abnormal negative rates on the event date, when the first case of the outbreak of the pandemic was observed in March.

The strong scale of discounts in March is also evidenced by the value of the CAAR rate in individual months. These data are presented in Table 5.

Table 5. Results of Statistical Tests for CAAR Rate, by Month First Case of Infection Was Reported

Grouping variable	CAAR value (%)	pos:neg CAR	Number of CARs considered	APZ	GRZ
January	–1.1	6:14	20	–2.87 (***)	–1.96 (*)
February	–1.7	7:17	24	–3.73 (***)	–1.94 (*)
March	–5.8	9:23	32	–12.70 (***)	–3.99 (***)

Notes: *, **, *** denote statistical significance of 10%, 5% and 1%, respectively.

Source: the author.

The results of statistical significance for the CAAR rate, presented in Table 5, confirm the previously observed correlations for AAR rates. When the first case of the pandemic was recorded in a given market in March, the scale of discounts was more than three times higher than in the other two months. Both statistical tests used in the study also indicate statistical significance of the result obtained for the

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$\alpha = 0.01$ level. For the two remaining months, the test value of the abnormal rate of return was much lower, while the second test indicated statistical significance at $\alpha = 0.1$. These results therefore do not suggest that the later the first case of infection was reported in a given market, the smaller the scale of the discount. Quite the opposite, in fact. Nevertheless, such a strong market reaction to the announcement of the first case of the COVID-19 epidemic in March may be associated with the WHO's 11 March 2020 declaration a global pandemic was indeed afoot. In fact, a third of the countries examined here experienced their first case in the same month that the WHO's declaration came, perhaps explaining the panic selling that occurred in their markets. Cote d'Ivoire, Jamaica and Turkey announced their first cases on the same day that the WHO statement, so a single source can not be isolated for the decline in their markets.

The WHO put out two early messages about the pandemic: that is was threat to human health and that it had grown to the magnitude of a pandemic. Whether these messages were associated with the strong response of the capital markets was also examined. Table 6 shows the value of abnormal rates of return for the markets, with statistical test value, when the two messages were announced. It was examined whether, in the light of those two messages, differences could be observed between the markets if they were in a state before or after its first case was announced.

Table 6. Results of AAR Value and Statistical Tests for AAR Rate, the WHO Announcements

WHO communicate	Data	AAR(–2)	AAR(–1)	AAR(0)	AAR(1)	AAR(2)	AAR(3)
Emergency	AAR value (%)	–0.3	0.2	–0.2	0.0	–0.4	–0.1
	APZ	–1.88 (*)	2.15 (**)	–4.06 (***)	–0.79	–4.22 (***)	–0.11
	GRZ	–1.60	2.71 (***)	–2.62 (***)	0.54	–2.80 (***)	0.69
Pandemic	AAR value (%)	–2.2	–1.0	0.7	–1.4	–2.4	–0.2
	APZ	–21.23 (***)	–11.78 (***)	8.22 (***)	–14.15 (***)	–22.36 (***)	–2.51 (**)
	GRZ	–4.40 (***)	–3.49 (***)	2.38 (**)	–3.95 (***)	–5.91 (***)	–0.60
Emergency (before the first case)	AAR value (%)	–0.2	0.2	0.0	0.1	–0.3	–0.2
	APZ	–0.57	1.50	–1.69 (*)	0.99	–3.50 (***)	–1.02
	GRZ	–1.05	1.75 (*)	–2.19 (**)	1.44	–2.33 (**)	0.15

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Table 6 cnt'd

WHO communicate	Data	AAR(–2)	AAR(–1)	AAR(0)	AAR(1)	AAR(2)	AAR(3)
Emergency (after the first case)	AAR value (%)	–0.6	0.3	–1.1	–0.7	–0.5	0.3
	APZ	–3.10 (***)	1.82 (*)	–5.77 (***)	–3.80 (***)	–2.46 (**)	1.83 (*)
	GRZ	–1.84 (*)	3.10 (***)	–2.20 (**)	–1.15	–1.72 (*)	1.65 (*)
Pandemic (before the first case)	AAR value (%)	–1.0	–1.7	0.9	–0.2	–2.2	–1.7
	APZ	–5.24 (***)	–4.34 (***)	4.28 (***)	–4.56 (***)	–7.85 (***)	–4.94 (***)
	GRZ	–0.98	–2.35 (**)	1.42	–0.67	–3.00 (***)	–1.37
Pandemic (after the first case)	AAR value (%)	–2.4	–0.9	0.7	–1.6	–2.4	0.1
	APZ	–20.80 (***)	–10.94 (***)	7.14 (***)	–13.43 (***)	–20.95 (***)	–0.70
	GRZ	–4.35 (***)	–2.90 (***)	2.00 (**)	–4.03 (***)	–5.23 (***)	–0.22

Notes: *, **, *** denote statistical significance of 10%, 5% and 1%, respectively.

Source: the author.

Based on the data in Table 6, it can be concluded that the two messages issued by the WHO significantly influenced the rates of return, which fell significantly after both announcements two days after the event. In the event of a pandemic declaration, and also a day after the event, a significant sell-off (reaching nearly 1.5%) on the capital markets occurred on the day of and the day after the pandemic was declared. A significant decline also occurred before the declaration of the pandemic, and a positive rate of return was observed on the day of the event – a correction following the steep decline of the previous days. The warning the WHO declared also caused a decline of rates of up to 0.2% on the day of the event.

AAR rate charts are also interesting for those countries which had already recorded their first cases prior to the announcement of both the threat and the pandemic, respectively, and for those countries that had not yet identified the first cases of the infection. In those markets where the first case had already been identified, significantly greater discounts were observed than in markets where the first case had not been recorded prior to the announcement. Investors in the markets where cases had already been recorded were more likely to withdraw from the market due to the WHO's announcements than investors operating in markets where first cases had not yet been reported.

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No part of the study found statistically insignificant abnormal rates of return two days after the event. The declines recorded two days after the event were a continuation of the declines from the day before. The day after the event, no subgroups demonstrated statistical significance in the rates of return. Detailed data on the values obtained in the event window are shown in Table 7.

Table 7. Results of Statistical Tests for CAAR Rate, WHO Announcements

Grouping variable	CAAR value (%)	pos:neg CAR	Number of CARs considered	APZ	GRZ
Emergency	–0.7	29:48	77	–2.84 (***)	–2.22 (**)
Pandemic	–6.4	15:62	77	–17.49 (***)	–5.77 (***)
Emergency (before the first case)	–0.4	26:36	62	–1.50	–1.10
Emergency (after the first case)	–2.1	3:12	15	–3.86 (***)	–2.71 (***)
Pandemic (before the first case)	–5.9	1:10	11	–8.73 (***)	–2.62 (***)
Pandemic (after the first case)	–6.5	14:52	66	–16.16 (***)	–5.15 (***)

Notes: *, **, *** denote statistical significance of 10%, 5% and 1%, respectively.

Source: the author.

As the data in Table 7 show, a statistically significant (at least $\alpha = 0.05$) abnormal cumulative negative rate was observed in all cases, except in countries with no first case of infection after the WHO issued a warning about COVID-19. Equity market discounts were several times higher following the WHO's declaration of a pandemic than after it declared an emergency.

5. Conclusion

This study has examined three questions: first, whether the appearance of the first case of COVID-19 infection had the same effect on capital markets as the crossing other subsequent psychological barriers in case numbers. Second, whether the month in which the first case was recorded in a range of countries also had an impact on the strength with which their capital markets reacted. And third, how investors responded to two announcements from the WHO: first, that COVID-19 was a danger, and second, that COVID-19 had become a global pandemic.

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The research confirms that investors reacted very rapidly to the emerging information on the pandemic, illustrating that the phenomenon of overreaction occurred in the context of the COVID-19 pandemic as indicated in (de Bondt & Thaler 1985).

First, it was shown investors had the strongest negative reaction when the first case was reported in their country. This finding accords with the work of a number of other researchers (Bash 2020, Behera & Rath 2021, Khatatbeh, Bani Hani & Abu-Alfoul 2020, Trpkova-Nestorovska, Trpeski & Peovski 2021). As further case thresholds were crossed, significant discounts were not observed. When the one-hundred-thousandth or even one-millionth cases were crossed, investors did not react as strongly as when the first case was announced. This too supports the overreaction hypothesis.

Secondly, it was not confirmed that the response of investors in countries where the first case of infection appeared the earliest (December 2019, January 2020) and the latest (March 2020) was less intense than in countries where the first case was recorded between those two extremes (i.e. February 2020). However, the later the first case was reported in a given capital market, the stronger the negative reaction of investors. It can therefore be assumed that the earlier the first case occurred, the better it was for a given capital market. This would appear to contravene the overreaction hypothesis.

Third, the two WHO announcements also negatively affected the capital markets. However, the warning that COVID-19 was a threat to human health globally triggered much smaller discounts than did declaring COVID-19 a pandemic. Importantly, it was observed that in countries where the first case of infection had already been recorded, the negative response of investors was stronger than in countries in which the first case of infection had not yet been recorded. This shows that the WHO announcements further added to the scale of the sell-off in markets that had already been "infected". In contrast, there was no statistically significant negative investor reaction in markets where the first case of infection had not yet been recorded when the WHO issued its warning announcement.

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