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Effects of the COVID-19 pandemic on stock price performance of blockchain-based companies

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ABSTRACT

The price of a stock rises or falls in relation to a number of different factors, including changes to the economy brought about by pandemics. A few studies have already identified the effect of the COVID-19 pandemic on the stock market. However, empirical evidence is lacking on changes in stock price performance of blockchain-based companies as a result of the COVID-19 pandemic. We use the event study approach to estimate stock expected returns by applying an asset pricing model over a thirty-day event window around the announcement on March 11, 2020 by the World Health Organization (WHO) regarding the outbreak of the coronavirus (COVID-19) as a global pandemic, using a sample of S&P Global 1200 companies. Overall, our results indicate more sensitivity in blockchain-based companies' stock prices to the COVID-19 pandemic compared to those of non-blockchain-based companies. Cumulative abnormal returns show that the stock price of blockchain-based companies recover losses slower than non-blockchain companies. Our findings are important for investors and shareholders for future pandemics and events.

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1. Introduction

The COVID-19 pandemic is an extreme event that has brought uncertainty to the financial markets, led to a sudden fall in stock prices, and has given rise to financial volatility (Mahata et al., 2021). The term 'extreme events' in this article refers to rare natural and human-made disasters, including tsunamis, earthquakes, floods, macroeconomic shocks and crises, major political and global financial crises, wars, and disasters such as epidemics and pandemics (Brück et al., 2011; Gries & Naudé, 2020). Several studies provide empirical evidence on stock market responses to past major epidemics and pandemics, including H1N1, Ebola and MERS (Baker et al., 2020; Chen et al., 2007; David et al., 2021; Donadelli et al., 2017). These studies

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demonstrate mixed results in terms of stock market reaction and highlight the importance of various factors, including country, industry, culture, and geographical proximity when studying the impact of pandemics on stock markets. The impact of different epidemics and pandemics on stock market performance can be useful in current conditions, yet in contrast to previous diseases, the COVID-19 pandemic has spread to nearly all countries within a few months, causing lockdowns in China, Europe, and the US, pauses in global economic activity, and widespread social disruption. Moreover, as every disease happens in specific economic conditions, investors require both historical and new knowledge to make well-grounded decisions.

Current studies have already collected some empirical evidence on the effect of the COVID-19 pandemic on stock market performance at several levels, including country (Ashraf, 2020; Liu et al., 2020; Singh et al., 2020), industry (Huo & Qiu, 2020) and company (Ding et al., 2020; Eldar & Wittry, 2020; Fahlenbrach et al., 2020; Landier & Thesmar, 2020). These studies overall, demonstrate that some countries, industries, and companies experienced better stock returns than others, calling for further empirical evidence in different research settings.

One of the twenty-first century's emerging digital technologies is blockchain. In this research, companies that use blockchain technology in their business operations or profit from it are referred to as blockchain-based companies. The focus of this article is on blockchain companies since blockchain technology lowers transaction costs, increases speed, and makes transactions more transparent, and is considered to be a key enabling technology to overcome pandemic challenges and provide operational and economic benefits (Glaser, 2017). However, recent studies demonstrate that an announcement of intention to create a blockchain-based stock increased the stock price along with high volatility and created an investment bubble (Corbet et al., 2020). There is also evidence that an announcement of blockchain-related companies' names brought more persistent cumulative abnormal returns (Akyildirim et al., 2020). The aforementioned evidence demonstrates that investors and shareholders are challenged by the problem of whether stocks of blockchain-based companies are better alternatives to traditional assets, especially in extreme events such as pandemics. Therefore, the objective of the study is to examine changes in stock price performance of blockchain companies as a result of the COVID-19 pandemic with the purpose of providing relevant insights to investors and shareholders when considering future pandemics and extreme events.

In line with previous studies, we apply the theory of market efficiency (Baumol, 1965), which asserts that a market based on the latest available information can correctly set prices in a timely manner. Moreover, we consider the investor overreaction hypothesis, which demonstrates that a market can overreact to extreme events, resulting in stock over- and underpricing (Boubaker et al., 2015; De Bondt & Thaler, 1985, 1987). We aim to add new empirical evidence from blockchain companies.

We apply the event study approach and asset pricing model over a thirty-day event window around the announcement of the global pandemic on March 11, 2020. Our final sample size consisted of 193 companies from S&P Global 1200 companies, of which 87 and 106 are categorized as blockchain and non-blockchain companies, respectively. The main focus of this study is the impact of COVID-19 on the stock price of blockchain-based companies and excludes already-studied factors such as country, industry, culture, and geographical proximity when studying the impact of pandemics on the stock market. Since disruptive technologies provide new markets and sources of revenue compared to traditional companies, it would be of interest to analyse their stock price during the severe pressure of a pandemic. Thus, this article contributes to the literature on the effect of extreme events such as pandemics on stock markets with a specific focus on blockchain companies. We confirm the investor overreaction hypothesis and show that investment in blockchain-based stocks at a company level is risky during extreme events such as a pandemic.

2. Literature review

2.1. Pandemic disease outbreaks and stock market reaction

A number of studies have already collected empirical evidence on how stock markets react to major crisis events in terms of stock prices, including pandemic disease outbreaks. For example, an event study found the negative impact of the SARS outbreak on the price of a hotel stock (Chen et al., 2007). The results indicated that the impact of the outbreak was negative in the tourism and retail sectors, but not the biotechnology sector, meaning that each industry in such crisis situations reacts differently to a disease outbreak and needs special attention from the government. Wang et al. (2013) investigated the impact of different diseases, including SARS, H1N1, dengue fever, and Enterovirus 71, concluding that there is a significant abnormal return on pharmaceutical and biotechnological companies' shares, and that investors rationally estimated conditions of biotechnology companies and adjusted their portfolio accordingly during outbreaks. Donadelli et al. (2017) showed that the impact of a disease outbreak on an investor's sentiment is more noticeable in culturally interdependent countries.

Some recent studies provide comparative evidence on market performance between the COVID-19 and previous disease outbreaks. For example, David et al. (2021) demonstrated that after the Ebola, MERS, and SARS pandemics, stock exchange indices recovered faster in comparison to COVID-19. Ru et al. (2020) compared global stock market reactions to COVID-19 and SARS and found that stock markets in countries that suffered from SARS (specifically SARS-CoV-1) reacted more quickly to the COVID-19 outbreak. Baker et al. (2020) investigated the effect of COVID-19 on stock market behaviour in comparison with SARS, H1N1, Ebola, and MERS, concluding that the COVID-19 effect is different from previous disease outbreaks and is not identical to the effects on market behaviour from previous pandemics.

Overall, previous studies on pandemic disease outbreaks demonstrate mixed results in relation to stock market reactions. These studies highlight the importance of different factors that can affect the stock market reaction, including country, industry, culture, and geographical proximity. The studies also provide evidence that knowledge collected from previous pandemics and their effects on stock market performance can be useful, but further research is required, since if investors perceive the disease outbreak and related news wrongly, they can make wrong investment decisions and affect stock prices.

2.2. COVID-19 and stock market performance

Although a number of studies have investigated the impact of different diseases on stock market performance, emerging literature presents new evidence on the impact of the COVID-19 pandemic and the reaction of financial markets to its spread worldwide. For example, Liu et al. (2020) demonstrated in an event study that the COVID-19 outbreak had a negative impact on stock markets and weakened their performance in many countries, including Korea, Japan, the USA, Germany, the UK, etc. Ashraf (2020) found that confirmed COVID-19 cases had a quick and negative impact on stock markets. This study showed that responses from the stock markets varied over time depending on the stage of outbreak. For example, a negative market reaction was strong during the early days of confirmed cases. Al-Awadhi et al. (2020) showed in an experimental study on COVID-19 that the daily growth in total number of confirmed cases and total number of deaths had a significant negative impact on stock returns of all companies in the Chinese stock market. Albulescu (2020) highlighted that confirmed cases and deaths due to COVID-19 positively influenced the market volatility index within and outside China. Baker et al. (2020) demonstrated that voluntary social distancing and government restrictions on commercial activity were the main reasons the US stock market reacted more heavily to the COVID-19 than to previous pandemics. Khan et al. (2020) investigated the stock markets of sixteen countries and came to the conclusion that once the WHO confirmed the human-to-human transmissibility of COVID-19, all stock markets reacted negatively. While the aforementioned studies demonstrate the negative impact of the COVID-19 pandemic on stock markets in different countries, Singh et al. (2020) found that after some time (app. 1.5 months) stock markets recovered from the negative impact of COVID-19 in G-20 countries.

While researchers focused on the market reaction to the COVID-19 pandemic at a country level, the research community is also currently exploring whether stock markets reacted differently at the industry and company level. For example, Huo and Qiu (2020) demonstrated that among 22 industries with negative cumulative abnormal returns in the event window in China, 19 recovered with positive cumulative abnormal returns within a month. The pharmaceutical and biotechnology industries had the best performance in the event window, and their cumulative abnormal returns became the lowest after a month. Remarkably, the computer industry had positive cumulative abnormal returns in both the event window and post-event window. For company-level stocks with positive cumulative abnormal returns, stronger reversals were found. Landier and Thesmar (2020) observed US companies and noticed downward revisions and negative stock returns over the period between January and March 2020. Ding et al. (2020) demonstrated that among 6,000 companies in 56 countries, weekly returns were less negative for companies with more cash, less debt, larger profits, more CSR activities, and larger non-financial corporate ownership. Companies with less financial flexibility experienced worse stock returns (Fahlenbrach et al., 2020). In addition, companies with low liquidity and high leverage had steeper price declines (Eldar & Wittry, 2020).

Overall, the COVID-19 pandemic has already had a significant impact on stock markets. Most of the studies confirm the impact of the pandemic at the country, industry, and company level. These studies also demonstrate that the impact from the pandemic was different for different industries and companies. One explanation could be that these studies chose different time frames and metrics to measure the pandemic and utilised different stock market indices. Moreover, some issues still remain and require further research. In contrast to previous studies, blockchain companies are relatively new and underexplored, yet important. Moreover, the effect of the COVID-19 pandemic on the stock price performance of such companies has still not received attention.

2.3. COVID-19 and stock price performance of blockchain companies

Digitalisation is a blanket term for breakthrough technologies such as 3D printing, big data, blockchain, machine learning, and robotics that affect the business context (Schmidt & Wagner, 2019; Vendrell-Herrero et al., 2017). Blockchain is a digitised trust system based on distributed ledger technology that eliminates the need for intermediaries to perform authentication (Wang et al., 2020). The most well-known use of blockchain technology is in currency. Some examples include bitcoin and ethereum, which have a volatile value against fiat currencies. Alternative currencies to bitcoin are referred to as Altcoins. In contrast to bitcoin and ethereum, central bank digital currency (CDBC) are centralised digital currencies that are provided and regulated by central banks based on a fiat currency. Blockchain has changed the financial markets with the introduction of digital currency like bitcoin and subsequent developments in smart contracts (Wang et al., 2020). Blockchain-based solutions, due to their automation, can reduce expenses including but not limited to post-contract control, as well as monitor partner performance (Schmidt & Wagner, 2019).

Bounded rationality limits human ability to make rational choices due to an inability to obtain all information (Grover & Malhotra, 2003). This uncertainty can increase during a pandemic, since it becomes more difficult to gain and assess information. Also, partners in a transaction sometimes show a tendency toward opportunistic behaviours by withholding information and breaking contracts (Gulbrandsen et al., 2009). The probability of opportunistic behaviour might also increase during a pandemic because of the sudden changes in market situations. However, blockchain-based transactions can reduce the need for bounded rationality under restrictive conditions and prevent opportunistic behaviour as a result of changelessness (Schmidt & Wagner, 2019). Blockchain not only reduces the need for brokers and human traders, but also makes transactions more transparent, increases speed, and lowers transaction costs (Glaser, 2017; Lee, 2015). Research shows that an announcement of intention to create a blockchain-based stock creates an investment bubble and increases stock price with high volatilities for Kodak (Corbet et al., 2020).

Building on the safe-haven assets or stocks that are uncorrelated with a market crash, Mariana et al. (2020) argued that bitcoin and ethereum are short-term safe-haven alternatives, but with high exhibited volatility. However, other research shows contradictory findings on increased downside risk in terms of value-at-risk and conditional value-at-risk as a result of investing in bitcoin portfolios in a pandemic (Conlon & McGee, 2020). In other research, eight cryptocurrencies were considered across ten sectors, and the results show that some currencies exhibited safe-haven properties while others did not (Bouri et al., 2020).

The market efficiency of digital currencies has been a growing research topic in recent years. Using daily price data of the S&P 500 between 2013 and 2014, bitcoin reflected the efficient market hypothesis (Bartos, 2015). Another study considered using data between 2010 and 2016 and splitting into subsamples found inefficiency of bitcoin in the whole sample, but signals of efficiency in the subsample (Urquhart, 2016). Another study using data between 2011 and 2018 found a connection between traditional financial assets and bitcoin (Kurka, 2019). They showed that shocks transfer from this digital currency to traditional financial markets. Another example of market overreaction to shocks is the Kodak announcement regarding a shift toward using blockchain (Corbet et al., 2020). This study showed that the Kodak announcement created a market overreaction and caused an investment bubble, which resulted in high volatility. However, it is difficult to say that blockchain-based stocks are becoming completely efficient. Gil-Alana et al. (2020), using the six cryptocurrencies of bitcoin, ethereum, ripple, litecoin, stellar, and tether, explained that these currencies are decoupled from financial and economic assets. They used daily price data between 2015 and 2018 and found high return with high volatility as well as large variations in the returns among digital currencies. A more recent study demonstrates that COVID-19 affected the market scenarios of cryptocurrencies differently depending on the pandemic's intensity, while small shocks from COVID-19 led to positive gains, and larger changes in infections and deaths rates were difficult to overcome (Iqbal et al., 2021).

Summarising the literature above, it is still difficult to judge whether stocks of blockchain-based companies are better alternatives to non-blockchain stocks in extreme events that create huge market shocks and overreaction. Previous cryptocurrency-specific studies considered country and economy-based research, but there is still a need for studies that include company-level investment in blockchain technology to explore market efficiency theory further. The importance of studying blockchain-based companies is mainly related to the disruptive nature of this technology in changing business models and transactions. Also, transparency in this technology makes a fundamental difference compared to traditionally less transparent businesses. Also, the effects of market overreaction due to the COVID-19 pandemic are still unclear because it has not yet ended, which calls for more research. Furthermore, blockchain-based stocks are still new to investors (Urquhart, 2016), and thus needs more empirical research to show its connection to financial markets and how it can be affected during financial market crashes. Hence, this research aims to study how the stock price of blockchain-based companies reacted and changed as a result of the COVID-19 pandemic.

3. Methodology

In this article, we use an event study approach to examine the effects of the COVID-19 pandemic on stock price performance of blockchain (BC) companies relative to those of non-blockchain (non-BC) companies. In particular, we are interested in evaluating these effects on the stocks' abnormal returns and volatilities. In doing so, we use a sample of the S&P global 1200 index. The data, including daily adjusted prices, is obtained from Eikon Thomson Reuters. This list, which captures 70% of global market capitalization, can give a clear picture of how investors make decisions during events. We use two criteria to choose the sample of companies. First, they should not have dividend announcements in order to reduce the probability of abnormal returns. Second, the average market value in 2019 was between 10 and 25 million dollars. We categorized companies by reading information on their website and excluding companies where it was unclear whether they are BC or non-BC. These two criteria and exclusion of unclear companies resulted in a total sample of 193 companies, of which 87 and 106 are categorized as BC and non-BC, respectively.[1]

Then, abnormal returns (AR), cumulative abnormal returns (CAR), and cumulative abnormal volatilities (CAV) were estimated over an event window around a specific announcement: March 11, 2020, the day that the World Health Organization (WHO) officially declared the coronavirus (COVID-19) outbreak to be a global pandemic as the event day. This selection is in accordance with Zhang et al. (2020).

Let $R_{jt} = \ln\left(\frac{P_{jt}}{P_{j,t-1}}\right)$ be the logarithmic return for asset $j = 1, 2, \ldots, d$ at time t. Assuming the market model holds, we set the mean equation to be driven by the recursive volatility process. With the existence of volatility clustering and heteroscedasticity, the asset returns are modelled as:

$$\begin{cases} R_{jt} = \mu_j + \beta_j R_{mt} + \varepsilon_{jt}, \quad \varepsilon_{jt} \sim N\left(0, \sigma_{jt}^2\right), \\ \sigma_{jt}^2 = \omega_j + \gamma_{1j}\sigma_{j,t-1}^2 + \gamma_{2j}\varepsilon_{j,t-1}^2, \end{cases} \tag{1}$$

where μ_j and $\omega_j > 0$ are constants, and R_{mt} is the return of the global market (S&P global 1200 index), with parameter restrictions $\gamma_{1j} \geq 0$, $\gamma_{2j} \geq 0$ and $\gamma_{1j} + \gamma_{2j} < 1$. We notice in equation (1) that the conditional variance σ_{jt}^2 is modeled using a standard GARCH (1,1) process.

Using the market model, one can estimate abnormal return as:

$$AR_{jt} = R_{jt} - \hat{\mu}_j - \hat{\beta}_j R_{mt}, \tag{2}$$

where R_{mt} is the return of the global market (S&P global 1200 index), and $\hat{\alpha}_j$ and $\hat{\beta}_j$ are the coefficients estimated from the market model using an estimation window of $[\tilde{t} - 1000, \tilde{t}]$, with $\tilde{t} < t$ the last day of the estimation window.

For an event interval $[t_1, t_2]$, the cumulative abnormal return is given by:

$$CAR_{j;t_1,t_2} = \sum_{t=t_1}^{t_2} AR_{jt}. \tag{3}$$

Let $\overline{AR}_t$ and $\overline{CAR}_{t_1,t_2}$ be the average abnormal and cumulative abnormal returns over the companies, the t-statistics given by:

$$t_{AR_t} = \overline{AR}_t d^{\frac{1}{2}} \left[\frac{\sum_{j=1}^{d} (AR_{jt} - \overline{AR}_t)^2}{d-1} \right]^{-\frac{1}{2}}, \tag{4}$$

$$t_{CAR_{t_1,t_2}} = \overline{CAR}_{t_1,t_2} d^{\frac{1}{2}} \left[\frac{\sum_{j=1}^{d} (CAR_{j;t_1,t_2} - \overline{CAR}_{t_1,t_2})^2}{d-1} \right]^{-\frac{1}{2}}. \tag{5}$$

Following Białkowski et al. (2008), we use GARCH (1,1) as a benchmark model in creating expectations on return volatilities during the event window. Given the information set $\Omega_{\tilde{t}}$ and parameters from the estimation window $[\tilde{t} - 1000, \tilde{t}]$, we obtain step-ahead conditional variance for the k-th day of the event window as:

$$E\left[\sigma^2_{j,\tilde{t}+k} \middle| \Omega_{\tilde{t}}\right] = \hat{\omega}_j \sum_{i=1}^{k-1} (\hat{\gamma}_{1j} + \hat{\gamma}_{2j})^i + (\hat{\gamma}_{1j} + \hat{\gamma}_{2j})^{k-1} \hat{\gamma}_{1j} \hat{\sigma}^2_{j,\tilde{t}} + (\hat{\gamma}_{1j} + \hat{\gamma}_{2j})^{k-1} \hat{\gamma}_{2j} \hat{\varepsilon}^2_{j,\tilde{t}}. \tag{6}$$

Let M_t be the multiplicative effect of the event on volatility, and we impose the *i.i.d.* residuals to follow Gaussian distribution s.t. $\varepsilon_{jt} \sim N\left(AR_{jt}, M_t E\left[\sigma^2_{jt} \middle| \Omega_{\tilde{t}}\right]\right)$. With the null hypothesis that the volatilities are not affected by the event, we have $M_t = 1$. Białkowski et al. (2008) suggests estimating the multiplicative effect M_t as the cross-sectional variance of demeaned residuals:

$$\hat{M}_t = (d-1)^{-1} \sum_{j=1}^{d} \frac{\left(d\hat{\varepsilon}_{jt} - \sum_{n=1}^{d} \hat{\varepsilon}_{nt}\right)^2}{d(d-2)E\left[\sigma^2_{jt} \middle| \Omega_{\tilde{t}}\right] + \sum_{n=1}^{d} E\left[\sigma^2_{nt} \middle| \Omega_{\tilde{t}}\right]}. \tag{7}$$

For an event interval $[t_1, t_2]$, the cumulative abnormal volatility is given by:

$$CAV_{t_1,t_2} = \left[\sum_{t=t_1}^{t_2} \hat{M}_t\right] - (t_2 - t_1 + 1). \tag{8}$$

Under the null hypothesis of no impact, $H_0 : \sum_{t=t_1}^{t_2} M_t(d-1) = (t_2 - t_1 + 1)(d-1)$, we have $\hat{M}_t(d-1) \sim \chi^2_{(d-1)}$, with the test statistic given by:

$$\emptyset(t_1, t_2) = \sum_{t=t_1}^{t_2} \hat{M}_t(d-1) \sim \chi^2_{(d-1)(t_2-t_1+1)}. \tag{9}$$

4. Results

Table 1 reports descriptive statistics for the abnormal return of stocks belonging to BC and non-BC companies. Stock price declined in both cases, and deviation from the mean is bigger in BC companies. Median and average show almost similar values in both samples, indicating that changes in stock prices are almost evenly distributed. The minimum is lower in BC companies, showing a steeper price fall in BC samples as well as a higher maximum. The distribution is approximately symmetrical since skewness is between −0.5 and 0.5. Non-BC companies show a higher kurtosis, which indicates more financial risk due to extreme values. However, they are both in range.

Table 2 shows companies averaged abnormal returns on a 30-day window around the event day. On the event day, BC companies experience a significant abnormal return, but non-BC companies manage an overreaction to the announcement of COVID-19 better, and this effect lasts even one day after. However, the biggest decline in the event window happens for both stock groups on March 13, in which the largest belongs to BC companies followed by non-BC companies. On that day, both stock groups responded to the market and stock prices experienced the worst market crash. The rest of the values show that blockchain companies showed more abnormal returns compared to non-BC companies, but both suffered from the impact of the pandemic on stock price. The numbers are apparent in Table 3, which shows the cumulative abnormal returns. Considering the symmetrical panel, both BC and non-BC stocks showed cumulative abnormal returns led by BC stocks. These negative abnormal returns show that stock groups responded to market information, and prices fell below what is expected from market model. The asymmetrical panel shows that the biggest impact of the pandemic on stocks was five days after the event day, which indicates an overreaction of the market to available information. But non-BC stocks show lower and insignificant CAR at 10, 15, and 20 days after the event day. As a robustness check and to control for non-Gaussian (cumulative) abnormal returns, we also apply the non-parametric approach where the signed-rank test is utilized. Tables A3 and A4 in Appendix A provide the results of the non-parametric tests for abnormal and cumulative abnormal returns. Similar results are obtained based on both parametric and non-parametric tests.

Table 4 shows the result of cumulative abnormal volatility tests. Considering the symmetrical panel, both BC and non-BC stocks show greater volatility as the window size increases with BC stocks leading this increase. This indicates the instability of stock prices and high risks associated with trading. Considering the asymmetrical

Table 1. Descriptive statistics for abnormal returns.

Statistics	Blockchain	Non-blockchain
Average	−0.249	−0.177
St. Deviation	1.217	1.032
Median	−0.095	−0.05
Minimum	−4.196	−3.663
Maximum	2.954	2.661
Skewness	−0.339	−0.485
Kurtosis	1.326	1.922
No. Companies	87	106

Notes: This table provides descriptive statistics for abnormal returns (expressed as percentages) estimated during a 30-day window before and after COVID-19 announcement (11 March 2020).
Source: Authors' calculation.

Table 2. *t*-Test for abnormal returns.

Date	Blockchain	Non-blockchain	Date	Blockchain	Non-blockchain
2020-01-29	0.072 (0.474)	0.249* (1.810)	2020-03-11	1.289*** (4.125)	0.350 (1.029)
2020-01-30	−0.746*** (−3.757)	−1.185*** (−6.485)	2020-03-12	−1.581*** (−2.646)	−0.914 (−1.595)
2020-01-31	0.332* (1.685)	0.388** (2.490)	2020-03-13	−4.196*** (−7.436)	−3.663*** (−8.433)
2020-02-03	−0.143 (−1.107)	−0.079 (−0.569)	2020-03-16	1.785*** (3.902)	1.254** (1.985)
2020-02-04	−0.133 (−0.851)	0.136 (0.891)	2020-03-17	−2.444*** (−4.242)	−2.565*** (−5.273)
2020-02-05	−0.047 (−0.333)	0.062 (0.370)	2020-03-18	0.153 (0.259)	−0.050 (−0.080)
2020-02-06	0.935*** (3.954)	0.365* (1.874)	2020-03-19	0.874 (1.433)	0.821 (1.314)
2020-02-07	−0.205 (−1.161)	−0.380* (−1.970)	2020-03-20	2.954*** (4.970)	2.661*** (4.422)
2020-02-10	−0.529*** (−4.233)	−0.652*** (−4.781)	2020-03-23	0.859 (1.493)	0.419 (0.871)
2020-02-11	0.136 (1.321)	0.390*** (3.629)	2020-03-24	0.094 (0.221)	0.365 (0.676)
2020-02-12	−0.095 (−0.584)	−0.253 (−1.645)	2020-03-25	2.394*** (4.937)	2.244*** (4.636)
2020-02-13	0.105 (0.601)	0.081 (0.570)	2020-03-26	−2.835*** (−5.908)	−2.25*** (−5.973)
2020-02-14	−0.122 (−1.149)	−0.177 (−0.904)	2020-03-27	0.817* (1.697)	0.598 (1.312)
2020-02-17	0.044 (0.332)	−0.024 (−0.264)	2020-03-30	−2.496*** (−5.919)	−1.813*** (−4.549)
2020-02-18	−0.095 (−0.674)	−0.152 (−1.112)	2020-03-31	0.659 (1.434)	0.872** (2.526)
2020-02-19	0.122 (0.995)	0.144 (1.013)	2020-04-01	−1.311*** (−3.380)	−0.146 (−0.431)
2020-02-20	0.076 (0.504)	0.106 (0.559)	2020-04-02	−1.476*** (−4.098)	−1.326*** (−3.698)
2020-02-21	−0.274** (−2.402)	−0.082 (−0.686)	2020-04-03	0.000 (−0.001)	0.277 (1.177)
2020-02-24	−0.206 (−1.093)	−0.333 (−1.538)	2020-04-06	0.049 (0.151)	0.322 (0.871)
2020-02-25	−0.344* (−1.772)	−0.204 (−1.122)	2020-04-07	2.042*** (6.413)	1.442*** (4.507)
2020-02-26	0.226 (1.309)	−0.042 (−0.276)	2020-04-08	−1.023*** (−3.615)	−0.816*** (−3.211)
2020-02-27	−0.141 (−0.504)	0.297 (1.529)	2020-04-09	0.151 (0.502)	−0.150 (−0.551)
2020-02-28	−1.427*** (−6.029)	−1.151*** (−4.638)	2020-04-10	0.417*** (2.820)	0.147* (1.767)
2020-03-02	−2.103*** (−7.576)	−1.998*** (−7.923)	2020-04-13	0.012 (0.061)	−0.399** (−2.004)
2020-03-03	0.847*** (3.774)	0.873*** (3.732)	2020-04-14	−1.032*** (−3.614)	−1.031*** (−3.411)
2020-03-04	−1.448*** (−6.297)	−1.151*** (−4.770)	2020-04-15	−0.758** (−2.333)	−0.496* (−1.802)
2020-03-05	0.147 (0.530)	0.267 (1.147)	2020-04-16	−1.129*** (−4.196)	−0.588** (−2.294)
2020-03-06	−1.314*** (−6.633)	−1.089*** (−5.026)	2020-04-17	0.380* (1.822)	0.507* (1.926)
2020-03-09	−1.288*** (−4.552)	−0.432 (−0.957)	2020-04-20	0.353* (1.892)	0.659*** (3.332)
2020-03-10	−1.374*** (−4.459)	−1.211*** (−4.151)	2020-04-21	−0.243 (−1.119)	0.116 (0.550)
			2020-04-22	−0.929*** (−3.819)	−0.413* (−1.738)

Notes: This table reports the *t*-test results for abnormal returns (expressed as percentages) estimated during a 30-day window before and after the COVID-19 announcement (11 March 2020). The *t*-statistics are given in parentheses. ***, **, * denote significance at the 1%, 5% and 10% level, respectively.
Source: Authors' calculation.

Table 3. *t*-Test for cumulative abnormal returns.

Event window	Blockchain	Non-blockchain
Panel (i): Symmetrical event windows		
[−5,5]	−10.272*** (−6.093)	−9.203*** (−4.031)
[−10,10]	−5.695*** (−4.451)	−4.714*** (−2.670)
[−15,15]	−11.486*** (−6.150)	−7.824*** (−3.190)
[−20,20]	−12.059*** (−6.303)	−8.449*** (−3.777)
[−25,25]	−12.979*** (−6.408)	−10.594*** (−4.381)
[−30,30]	−15.165*** (−6.821)	−10.804*** (−4.278)
Panel (ii): Asymmetrical event windows		
[−30,0]	−7.704*** (−7.142)	−6.889*** (−4.730)
[−25,0]	−7.086*** (−6.697)	−6.398*** (−4.401)
[−20,0]	−7.376*** (−7.006)	−6.182*** (−4.340)
[−15,0]	−7.212*** (−7.639)	−5.656*** (−4.011)
[−10,0]	−6.586*** (−7.644)	−5.286*** (−4.366)
[−5,0]	−3.988*** (−6.706)	−3.265*** (−3.279)
[0,0]	1.289*** (4.125)	0.350 (1.029)
[0,5]	−4.995*** (−3.375)	−5.588*** (−3.118)
[0,10]	2.180* (1.897)	0.923 (0.714)
[0,15]	−2.986** (−2.126)	−1.817 (−1.051)
[0,20]	−3.395** (−2.436)	−1.917 (−1.300)
[0,25]	−4.604*** (−3.245)	−3.845** (−2.312)
[0,30]	−6.172*** (−3.84)	−3.565** (−2.038)

Notes: This table reports the *t*-test results for cumulative abnormal returns (expressed as percentages) estimated during a 30-day window before and after the COVID-19 announcement (11 March 2020). The *t*-statistics are given in parentheses. ***, **, * denote significance at the 1%, 5% and 10% level, respectively.
Source: Authors' calculation.

Table 4. χ^2-test for cumulative abnormal volatility.

	Blockchain		Non-Blockchain	
Event window	CAV	p-value	CAV	p-value
Panel (i): Symmetrical event windows				
[−5,5]	22.621	0.00	21.457	0.00
[−10,10]	37.913	0.00	34.980	0.00
[−15,15]	44.819	0.00	40.177	0.00
[−20,20]	45.517	0.00	40.934	0.00
[−25,25]	45.821	0.00	40.526	0.00
[−30,30]	48.478	0.00	41.967	0.00
Panel (ii): Asymmetrical event windows				
[−30,0]	8.881	0.00	6.186	0.00
[−25,0]	6.729	0.00	6.004	0.00
[−20,0]	7.464	0.00	6.694	0.00
[−15,0]	8.960	0.00	8.169	0.00
[−10,0]	8.827	0.00	7.555	0.00
[−5,0]	5.573	0.00	5.550	0.00
[0,0]	0.708	0.00	0.431	0.00
[0,5]	17.757	0.00	16.339	0.00
[0,10]	29.794	0.00	27.856	0.00
[0,15]	36.568	0.00	32.440	0.00
[0,20]	38.762	0.00	34.672	0.00
[0,25]	39.800	0.00	34.953	0.00
[0,30]	40.304	0.00	36.213	0.00

Notes: This table reports the χ^2-test results for cumulative abnormal volatilities (expressed as percentages) estimated during a 30-day window before and after COVID-19 announcement (11 March 2020).
Source: Authors' calculation.

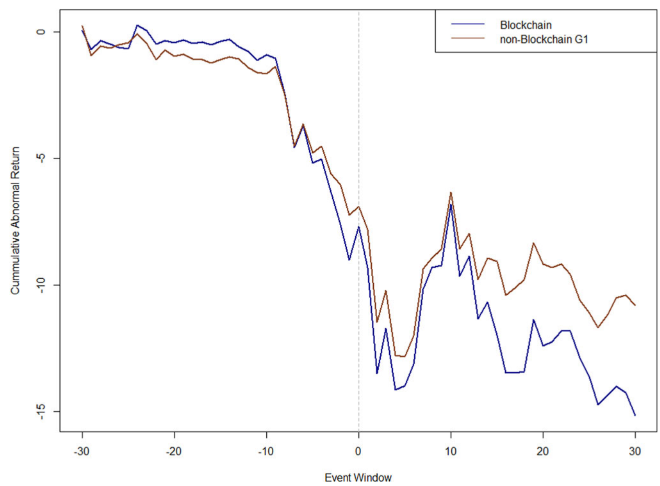

Figure 1. Cumulative abnormal return.
Source: Authors' calculation.

panel gives a better understanding of what happens before and after the announcement. BC stocks show more risk and surpass the volatility of the non-BC companies. This difference grows bigger after event windows [0,10], [0,15], [0,20], [0,25], [0,30]. Figure 1 confirms the results in Tables 2 and 3 that both stock groups show a large CAR in which BC stock groups show a higher CAR. This illustrates that in the beginning, BC companies showed slightly less loss compared to non-BC companies up to 10 days before event. Then both stock groups began to respond to market information and continuously showed losses up to almost five days after the event; then,

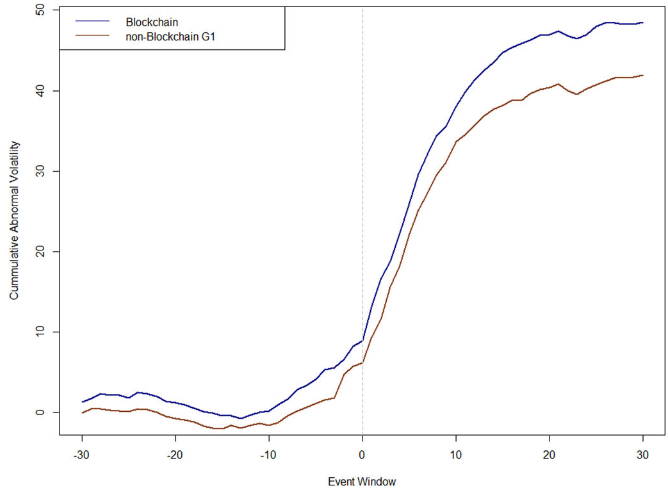

Figure 2. Cumulative abnormal volatility.
Source: Authors' calculation.

both stock groups started to catch up and showed gains up to 10 days after the event. The downward inclination continues for both samples, but it shows a decreasing trend as we approach the end of the event window, and non-BC companies showed slightly less loss. Also, Figure 2 confirms the results in Table 3, showing that both stock groups show high volatility before and after the announcement of the COVID-19 pandemic. Both stock groups show tendencies in reducing volatility, with non-BC companies doing slightly better.

We did two robustness checks in order to check whether the measurement of event effects is accurate. Table A1 in Appendix A shows the results of the robustness test for a 45-day event window. Symmetrical event windows demonstrate that the results are accurate, with stock price performance showing a significant CAR and CAV. The figures for CAR are slightly higher, and they are almost the same for the CAV values. The changes in the results could be because the number of stocks reduces to 79 BC and 95 non-BCs. This drop in the number of stocks is because of the dividend announcements that increased as a result of expanding the event windows from 30 to 45 days. The results of asymmetrical event windows also confirm the robustness of the results of the event windows for CAR and CAV values for BC and non-BC stocks.

Table A2 in Appendix A shows the results of a larger event window, which is 60 days before and after the pandemic event. As expected, the number of stocks reduces to 69 BCs and 88 non-BCs. Several CAR values are insignificant for non-BC stocks, indicating that non-BC stocks show slightly fewer CAR compared to BC stocks. The results of the CAV values are also consistent with the 30-day event windows, which also shows that non-BC stocks show less volatility compared to BC stocks.

5. Discussion and conclusion

In this article, we studied the effects of the COVID-19 pandemic on the stock performance of blockchain-based companies in comparison to non-blockchain companies. Applying an event study approach, we examined the impact of the COVID-19 pandemic announcement (March 11, 2020) on stock returns and volatilities. Using a sample of S&P global 1200 index constituents, we estimated abnormal returns and volatilities in stocks of blockchain and non-blockchain companies around the announcement.

Results show that the performance of both blockchain and non-blockchain stocks worsened after the announcement of the COVID-19 pandemic. In this regard, our study is consistent with results obtained by similar research (Li et al., 2021; Shaikh, 2021; Singh et al., 2020; Umar et al., 2021), confirming the investor overreaction hypothesis (Boubaker et al., 2015; De Bondt & Thaler, 1985, 1987). In the later stages of the event window, our results do not demonstrate that stock markets recovered significantly after the negative impact of the COVID-19 pandemic. However, the reduction of negative CAR shows that both stocks are on the way to recovery from the negative impact of the COVID-19 outbreak, when the window size increases to 55 and 60 days.

In most cases the blockchain companies showed higher and significant cumulative abnormal returns and volatilities based on different event windows in comparison to non-blockchain companies. This shows that BC companies follow an efficient market and have a connection with financial markets. The overreaction of the market because of COVID-19, which resulted in a reduction of stock prices, can be compared to the study done by Corbet et al. (2020) on the investment bubble created by Kodak after their announcement to a shift to use of blockchain. These results were also confirmed with the help of robustness checks on event window length. This result is aligned with a relevant study on cryptocurrencies (Iqbal et al., 2021) that such cryptocurrencies respond efficiently to extreme market events such as COVID-19. To the best of our knowledge, this is one of the first studies to examine the performance of stock markets among blockchain companies under the present conditions of the COVID-19 pandemic. Findings suggest that blockchain-based stocks as alternatives to traditional assets in the case of pandemics can be questioned. Investors should consider this result for future pandemics, as BC companies might not be a less risky asset, with high abnormal returns and volatilities in day trading during the pandemic.

Previous studies showed that it is difficult to determine whether blockchain-based currencies are a safe haven during extreme events (Bouri et al., 2020; Conlon & McGee, 2020; Mariana et al., 2020). The present study provides comparative insights to investors, banks, stock market regulators and government authorities on how both blockchain and non-blockchain companies reacted to the extreme event of the COVID-19 pandemic in terms of stock market performance. More detailed analysis provides insights to investors as to whether to invest in blockchain companies in extreme events and shows that investment in blockchain-based stocks at a company level is risky during a bearish market. However, we acknowledge that a larger sample size and the extension of the event window can provide additional insights into the stock market behaviour of both blockchain and non-blockchain companies in a period of uncertainty. The main contribution of this study is the identification and description of the impact of the COVID-19 pandemic on the stock price performance of blockchain-based companies, which is an unexplored factor. Moreover, it sets a baseline for more inclusive future research regarding this inclusive technology.

6. Limitations and further research

This study has several limitations, including the period for the event window, number of factors studied, and sample size. Increasing window size showed a reduction of negative CAR and an increase in positive CAR. Could this reduction be a result of monetary policies or insensitivity of stakeholders to the impact of COVID-19 on the stock market (Gao et al., 2021)? Since it is expected that this pandemic will end in the near future, it would be possible to study this impact over a larger time horizon. This study provided a baseline to include more influential factors. Moreover, blockchain technology is proliferating in various industries, and it would be therefore possible to study larger sample sizes in the future.

For further research, it would be interesting to expand the factors to explore a blockchain-based company's stock price based on industry, country, culture, and geographical proximity while studying the impact of pandemics on the stock market. In addition, studying companies based on the use of blockchain (e.g., in product or service or use of cryptocurrencies) would be the next step. Moreover, it would be necessary to look at a longer time horizon and possible impacts if a disease becomes pandemic.

Note

1. Although previous studies have shown that significant differences exist between industries in relation to the impacts of diseases on stock performance (see, e.g., Chen et al., 2009), we leave the investigation of the industry-level impacts for future research. In the current study, we follow Naidu and Ranjeeni (2021) and Pandey and Kumari (2021) and investigate the impact on the whole market.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix A

Table A1. Robustness check (event window = 45 days).

Event window	Blockchain CAR	Blockchain CAV	Non-Blockchain CAR	Non-Blockchain CAV
Panel (i): Symmetrical event windows				
[−5,5]	−10.636***	21.814***	−9.056***	21.187***
[−10,10]	−5.704***	36.542***	−4.708**	34.325***
[−15,15]	−11.607***	43.529***	−8.285***	39.04***
[−20,20]	−12.003***	44.152***	−8.891***	39.482***
[−25,25]	−13.246***	44.523***	−11.264***	39.011***
[−30,30]	−15.295***	46.365***	−11.643***	39.854***
[−35,35]	−13.439***	47.050***	−9.067***	40.37***
[−40,40]	−15.702***	46.588***	−9.561***	40.251***
[−45,45]	−16.363***	48.218***	−9.496***	40.18***
Panel (ii): Asymmetrical event windows				
[−45,0]	−7.592***	2.770***	−7.361***	0.601
[−40,0]	−7.901***	4.256***	−7.410***	1.960*
[−35,0]	−7.527***	6.065***	−7.216***	3.891***
[−30,0]	−7.471***	6.995***	−7.166***	5.358***
[−25,0]	−6.919***	5.922***	−6.689***	5.585***
[−20,0]	−7.172***	6.728***	−6.380***	6.344***
[−15,0]	−7.174***	8.240***	−5.778***	7.994***
[−10,0]	−6.705***	8.190***	−5.482***	7.614***
[−5,0]	−4.110***	5.288***	−3.211***	5.652***
[0,0]	1.370***	0.678***	0.220	0.381***
[0,5]	−5.155***	17.204***	−5.629***	15.917***
[0,10]	2.371**	29.030***	0.990	27.092***
[0,15]	−3.063**	35.967***	−2.290	31.427***
[0,20]	−3.461**	38.101***	−2.290	33.520***
[0,25]	−4.957***	39.279***	−4.358**	33.808***
[0,30]	−6.454***	40.047***	−4.260**	34.877***
[0,35]	−4.543***	41.663***	−1.63	36.860***
[0,40]	−6.431***	43.010***	−1.93	38.673***
[0,45]	−7.400***	46.126***	−1.92	39.961***

Notes: This table reports the cumulative abnormal returns and volatilities (expressed as percentages) estimated during a 45-day window before and after the COVID-19 pandemic announcement (11 March 2020). The sample includes 79 BC and 95 non-BC companies. ***, **, * denote significance at the 1%, 5% and 10% level, respectively.
Source: Authors' calculation.

Table A2. Robustness check (event window = 60 days).

Event	Blockchain CAR	CAV	Non-Blockchain CAR	CAV
Panel (i): Symmetrical event windows				
[−5,5]	−10.530***	23.596***	−9.114***	21.603***
[−10,10]	−5.424***	38.690***	−4.641**	35.590***
[−15,15]	−12.359***	45.471***	−8.705***	40.534***
[−20,20]	−12.653***	46.279***	−9.044***	40.706***
[−25,25]	−14.640***	46.664***	−11.620***	40.344***
[−30,30]	−17.230***	47.390***	−12.188***	41.398***
[−35,35]	−15.181***	48.137***	−9.376***	41.886***
[−40,40]	−18.141***	47.655***	−9.971***	41.764***
[−45,45]	−19.217***	48.993***	−9.724***	41.433***
[−50,50]	−19.406***	48.212***	−9.911***	42.592***
[−55,55]	−15.885***	46.964***	−7.665***	39.845***
[−60,60]	−14.493***	45.806***	−7.485***	38.847***
Panel (ii): Asymmetrical event windows				
[−60,0]	−10.071***	−7.823	−8.821***	−8.925
[−55,0]	−9.739***	−5.164	−8.327***	−6.316
[−50,0]	−9.000***	−1.038	−7.438***	−2.234
[−45,0]	−9.402***	1.609*	−7.459***	0.007
[−40,0]	−9.426***	3.413***	−7.714***	1.614**
[−35,0]	−8.733***	5.286***	−7.509***	3.589***
[−30,0]	−8.615***	6.155***	−7.554***	5.059***
[−25,0]	−7.731***	5.925***	−6.876***	5.147***
[−20,0]	−7.658***	6.840***	−6.498***	5.883***
[−15,0]	−7.451***	8.383***	−5.805***	7.624***
[−10,0]	−6.802***	8.587***	−5.38***	7.300***
[−5,0]	−3.956***	5.590***	−3.128***	5.265***
[0,0]	1.483***	0.712***	0.140	0.463***
[0,5]	−5.091***	18.718***	−5.848***	16.801***
[0,10]	2.860**	30.815***	0.880	28.753***
[0,15]	−3.425**	37.800***	−2.760	33.374***
[0,20]	−3.512**	40.150***	−2.410	35.287***
[0,25]	−5.426***	41.450***	−4.607**	35.661***
[0,30]	−7.132***	41.947***	−4.496**	36.802***
[0,35]	−4.965***	43.562***	−1.730	38.760***
[0,40]	−7.232***	44.955***	−2.120	40.614***
[0,45]	−8.332***	48.096***	−2.130	41.889***
[0,50]	−8.923***	49.962***	−2.340	45.290***
[0,55]	−4.663**	52.840***	0.800	46.624***
[0,60]	−2.940	54.341***	1.470	48.236***

Notes: This table reports the cumulative abnormal returns and volatilities (expressed as percentages) estimated during a 60-day window before and after the COVID-19 pandemic announcement (11 March 2020). The sample includes 69 BC and 88 non-BC companies. ***, **, * denote significance at the 1%, 5% and 10% level, respectively.
Source: Authors' calculation.

Table A3. Signed-rank test for abnormal returns.

Date	Blockchain	Non-blockchain	Date	Blockchain	Non-blockchain
2020-01-29	3.101***	3.638***	2020-03-11	4.699***	2.977***
2020-01-30	−7.961***	−8.913***	2020-03-12	−0.781	−0.849
2020-01-31	2.858***	1.562	2020-03-13	−12.021***	−12.51***
2020-02-03	−1.441	−1.143	2020-03-16	3.808***	3.638***
2020-02-04	−1.107	−1.443	2020-03-17	−3.258***	−7.425***
2020-02-05	−0.152	2.286**	2020-03-18	1.299	0.539
2020-02-06	4.260***	0.000	2020-03-19	2.1**	0.272
2020-02-07	−0.463	−1.75*	2020-03-20	6.335***	5.661***
2020-02-10	−7.400***	−8.913***	2020-03-23	0.737	0.272
2020-02-11	−0.152	1.562	2020-03-24	−0.781	1.313
2020-02-12	−1.441	−3.050***	2020-03-25	4.481***	4.478***
2020-02-13	−0.463	0.802	2020-03-26	−8.549***	−10.00***
2020-02-14	−1.441	−4.111***	2020-03-27	1.571	1.313
2020-02-17	−0.152	−2.385**	2020-03-30	−9.168***	−7.425***
2020-02-18	−1.441	−0.560	2020-03-31	2.1**	2.75***
2020-02-19	0.447	2.520**	2020-04-01	−4.93***	0.539
2020-02-20	−0.781	1.060	2020-04-02	−4.49***	−8.398***
2020-02-21	−1.107	0.539	2020-04-03	0.151	2.52**
2020-02-24	−1.107	−0.849	2020-04-06	−2.137**	0.802
2020-02-25	−2.137**	−1.143	2020-04-07	5.539***	3.852***
2020-02-26	1.571	−2.714***	2020-04-08	−6.864***	−4.111***
2020-02-27	−1.107	1.807*	2020-04-09	1.571	−3.395***
2020-02-28	−10.51***	−6.963***	2020-04-10	−6.351***	−11.20***
2020-03-02	−13.75***	−16.499***	2020-04-13	3.808***	2.52**
2020-03-03	3.576***	3.638***	2020-04-14	−3.258***	−4.111***
2020-03-04	−10.51***	−10.59***	2020-04-15	−1.441	0.000
2020-03-05	2.610***	2.750***	2020-04-16	−5.385***	−3.395***
2020-03-06	−10.51***	−7.903***	2020-04-17	0.737	1.313
2020-03-09	−7.400***	−1.443	2020-04-20	0.737	3.852***
2020-03-10	−6.864***	−5.261***	2020-04-21	−0.781	−0.277
			2020-04-22	−4.49***	−3.050***

Notes: This table reports singed-rank test statistics for abnormal returns (expressed as percentages) estimated during a 30-day window before and after COVID-19 announcement (11 March 2020). ***, **, * denote significance at the 1%, 5% and 10% level, respectively.
Source: Authors' calculation.

Table A4. Signed-rank test for cumulative abnormal returns.

Event window	Blockchain	Non-Blockchain
Panel (i): Symmetrical event windows		
[−5,5]	−10.51***	−7.425***
[−10,10]	−7.961***	−3.395***
[−15,15]	−11.24***	−5.667***
[−20,20]	−13.75***	−6.517***
[−25,25]	−12.85***	−6.085***
[−30,30]	−12.02***	−6.963***
Panel (ii): Asymmetrical event windows		
[−30,0]	−12.85***	−8.913***
[−25,0]	−9.168***	−6.085***
[−20,0]	−12.85***	−6.085***
[−15,0]	−12.85***	−6.963***
[−10,0]	−16.91***	−8.398***
[−5,0]	−12.85***	−4.484***
[0,0]	4.699***	2.977***
[0,5]	−6.864***	−3.748***
[0,10]	2.61***	1.313
[0,15]	−2.137**	0.272
[0,20]	−4.066***	−0.849
[0,25]	−4.93***	−2.064**
[0,30]	−5.858***	−0.849

Notes: This table reports singed-rank test statistics for cumulative abnormal returns (expressed as percentages) estimated during a 30-day window before and after the COVID-19 pandemic announcement (11 March 2020). ***, **, * denote significance at a the 1%, 5% and 10% level, respectively.
Source: Authors' calculation.