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Short-Term Stock Performance of Health Care Companies in Times of Viral Epidemics and Pandemics

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Abstract The spread of Coronavirus Disease 2019 significantly influenced the global economy. Companies from the health care industry could emerge as potential winners in health crises, and their listed stocks could potentially outperform. For the first time in the English and German language literatures, this study investigates whether this occurred and which factors influenced the short-term stock price performance of companies from the health care industry during epidemics and pandemics. An event study of virus-related epidemics and pandemics from 2000 to 2020 was conducted. The results show that the stocks of companies from the health care industry tend to outperform the market during pandemics. The selection of the subindustry in the health care industry and the region of the stock markets significantly influenced abnormal returns. The results are especially relevant for investors seeking short-term trading opportunities but also provide implications for diversifying their portfolios during epidemics and pandemics.

Keywords Portfolio choice · Pandemics · Epidemics · Event study · Health care industry

JEL Classification G11 · G12 · G15

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Introduction

There needs to be more extensive analysis in the literature regarding the influence of epidemics and pandemics on stock price performance in the health care industry. That may seem surprising since the impact should be noticeable intuitively, as widespread infectious diseases likely strongly affect the health care industry. However, this study is the first in the English and German literatures to empirically examine how companies' stock prices in the health care industry react in the short run during times of epidemics and pandemics from 2000 to 2020.

The results show that, in the short run, health care companies' stocks tend to outperform the market during pandemics, but not during epidemics. The paper discusses implications for diversifying investors' portfolios during epidemics and pandemics as well as for companies in the health care industry that would like to conduct an initial public offering (IPO) or raise capital shortly after the outbreak of viral epidemics and pandemics, but experience a shortage of information about share price performance in such periods and, therefore, lack insight into whether such actions are likely to be successful.

Related Literature

The few existing event studies that deal with epidemics and pandemics focus on specific industries and individual outbreak events. Nippani and Washer (2004) examined the impact of the Severe Acute Respiratory Syndrome (SARS) on stock markets in Canada, China, Hong Kong, Indonesia, the Philippines, Singapore, Thailand, and Vietnam. They analyzed the performance of the leading stock indices in these countries shortly before and during the SARS outbreak using the Standard & Poor Global Index 1200 (S&P Global Index 1200) as the benchmark. In most cases, they found no statistically significant negative influence from SARS on the considered stock markets with the exception of Vietnam and China, which showed a statistically significant negative impact. This was not surprising as SARS had a powerful effect on life in those two countries.

Chen et al. (2007) also looked at the SARS outbreak and its impact on the performance of hotel company stocks in Taiwan. The outbreak of SARS in 2003 weakened the Taiwanese economy, with its tourism industry suffering the most. This was reflected in a stock price decline in the tourism industry sector of almost 29% within one month of the outbreak. Using an event study, the authors examined the SARS epidemic's impact on Taiwanese hotel companies' stock prices. They found significant negative cumulative abnormal returns on the day the outbreak was reported and one day after, which they interpreted as evidence that the SARS outbreak negatively affected the performance of hotel stocks.

Ichev and Marinč (2018) investigated whether the geographical proximity of information disseminated about the 2014–2016 Ebola outbreak, combined with intense news coverage about the virus, affected stock prices in the United States (U.S.). They found that the Ebola outbreak most strongly influenced the securities of companies doing business in West African countries and the U.S. They also

found a relationship between stock price performance and geographical proximity to the Ebola outbreak. The study also showed that the effect depended on the media's reporting intensity, particularly for smaller, more volatile stocks and stocks in specific industries. Finally, they observed a notable increase in implied volatility after the Ebola outbreak.

In addition to these three studies on SARS and Ebola, several event studies were conducted regarding stock prices and the COVID-19 pandemic. Pandey and Kumari (2021) considered the impact of the COVID-19 outbreak on global stock markets by examining the performance of 49 stock market indices. They concluded that the COVID-19 outbreak significantly affected global equity markets, with Asian markets most affected. They also analyzed the impact of lockdowns some countries imposed to contain the outbreak. They found that early closures and restrictions helped to prevent the spread of the novel coronavirus, which helped to restore investor confidence and significantly reverse stock market losses. Their results show that cumulative abnormal returns (CARs) were highly negatively correlated with cumulative country-specific cases and deaths and moderately negatively correlated with global cases and deaths. This suggested that cross-country variations in the distribution of patients and death rates partially explain stock market reactions (Pandey & Kumari, 2021).

Chowdhury and Abedin (2020) conducted a similar event study using three event window elements (pre-event, event day, and post-event) to assess the effect of COVID-19 on the U.S. stock market, where the pre-event window was the period before the event and post-event window was the period after the event. They showed that the U.S. stock market reacted negatively to confirmed cases and deaths and that growth in fatalities had a significant impact on stock market volatility.

In another event study on COVID-19 and stock price performance, Kulal et al. (2020) analyzed the impact of COVID-19 on the Indian stock market, examining the behavior of the National Stock Exchange Fifty Index (NIFTY 50). Their event period was defined as January 2, 2020, to January 22, 2020, with January 13, 2020, chosen as the event day and event windows of $(-7, 0)$ and $(0, +7)$. The pandemic was found to have a significant, negative influence on the Indian stock market.

He et al. (2020) examined the effects of the pandemic on share prices in various Chinese industries using an event study approach. They found that stock price performance in the transportation, mining, power, energy generation, and environmental industries was negative, while the manufacturing, information technology, and education industries were less affected though still negative.

In a study on the impact of COVID-19 on the Thai stock market, Panyagometh (2020) used a sample of 46 stocks to investigate the response of stock prices and market volatility in Thailand's stock market. The results suggested that the pandemic had a negative impact on stock prices based on negative abnormal returns. However, the reaction was not uniform across industries, as some companies in the commerce sector, particularly distributors of pharmaceutical products and services, benefited. Panyagometh (2020) also found increased volatility in the Stock Exchange of Thailand during COVID-19.

This study extends the existing literature by simultaneously examining stock prices from Asia, America, and Europe. In contrast to previous studies, it does not

consider only individual regions or countries. This makes the results of this study more relevant to the broader target group of globally active investors. Furthermore, this is essential when studying pandemics, as they have a global impact. Additionally, this study focuses on the health care industry. In a global analysis, this aspect represents the direct link between health, threats to global health, and the global health care industry. This study also contributes data and analysis regarding all epidemics and pandemics in the last 20 years, providing complete insight into the health care sector, though it does not investigate other economic sectors. Overall, this study extends the existing literature in regional and temporal dimensions with a relevant industry focus.

Outbreaks were generally found to have negative effects on the market in the vast majority of regions and industries examined in this study. Prior to this study, there had not been an in-depth analysis carried out specifically on the health care sector in various regions of the world. However, there is preliminary evidence that different sectors of industry are generally not equally negatively affected by outbreaks. In particular, the findings of Panyagometh (2020) suggest that companies in the health care sector may be beneficiaries of such outbreaks. This study helps fill that gap in literature.

Data, Methodology, and Hypotheses Development

An epidemic is characterized by the heightened occurrence of an illness or specific health-related event within a particular community or region, surpassing the normal expected levels. The affected community or region must be precisely identified. The threshold for determining an epidemic varies depending on certain factors, such as the causative agent, the size and type of the exposed population, how novel the disease is, and the timing and location of the outbreak. Consequently, epidemicity is relative to the typical frequency of the disease in the same area, among the specified population, and during the corresponding season of the year (Porta, 2014). It is important to note an epidemic is not limited to only infectious diseases (Kiehl, 2015).

A pandemic refers to an outbreak of an infectious disease that spreads extensively across a vast geographic area, transcending international borders and, typically, affecting a large population. While some pandemics may lead to severe illness in specific individuals or affect entire communities significantly, not all pandemics have such severe consequences. Several key characteristics of an infectious illness contribute to the likelihood of causing a pandemic. First, the illness must possess the ability to infect humans. Second, it should be capable of inducing disease in humans. Last, the infection must be able to spread quickly from one human to another, facilitating rapid transmission and widespread dissemination of the disease (Porta, 2014).

Thus, experts regard a pandemic as an epidemic where a disease outbreak is not confined locally and spreads across national borders and continents. Such transnational, even global, disease outbreaks have occurred throughout human history. Sometimes, pandemic outbreaks of infectious diseases have been so devastating that millions of people have fallen victim to them. The Plague, also known as the

Black Death, was a bacterial infection reaching pandemic proportions that wiped out roughly one-third of Europe's population between 1347 and 1351 (Radtke, 2020). Recently, illnesses at the root of so-called classic epidemics, such as smallpox, cholera, or The Plague, have lost their intensity due to medical advances and are unlikely to break out globally. Viral infectious diseases, such as influenza and COVID-19, pose a continuing threat to the global population (Radtke, 2020).

The analysis in this study focuses on outbreaks of viral strains with very high mortality rates because only in these cases could significant, measurable reactions in the global financial markets be expected. Annual viral influenzas were not included in this study because of their (yearly) regularity. When determining what epidemics to include in this study, one thing that was considered was whether or not effective drug therapies were already available during the outbreak. As such, some diseases, such as measles, dengue fever, and chikungunya fever, were not included since the pathogens of those diseases are well known to researchers worldwide, and they have recognized (and at least partly effective) forms of treatment. Also, mortality and casualty rates argue against including such diseases in an empirical study as illnesses with few cases or low mortality rates tend to garner little interest from the public and media, which in turn means low impact on the market. The availability of recognized treatment in the form of effective antibiotics is why bacterial epidemics and pandemics were not included in this study. However, it should be noted that although treatment is available, these antibiotics may not be used sufficiently in all affected countries due to an unfortunate lack of economic resources in some areas.

Following previous studies that examined the impact of epidemics and pandemics on stock price performance, this study also used the event study methodology based on Bowman's work (1983). In the case of epidemic and pandemic outbreaks, many options exist for determining the event date: (a) the date when information about the occurrence of a new pathogen reaches the public; (b) the date of the first fatality; (c) the date when infections cross country borders; (d) the date when fatalities have occurred in several countries; or (e) the date when the outbreak is classified as an epidemic or pandemic by the World Health Organization (WHO).

All of these options are reasonable, but the first option was applied in the analysis of this study, as justified by the efficient market hypothesis (Fama et al., 1969). By assuming medium-strict information efficiency, which is also the basis of an event study, one can expect a stock market to react when information on the occurrence of the new pathogen becomes available to the public. Therefore, for this study, the day of the first mail notification from the Program for Monitoring Emerging Diseases (ProMED) regarding the outbreak of a new (not always synonymous with unknown) pathogen was selected as the event day. If the message was sent after 6:00 p.m. (i.e., after the market close), the following day was designated as the event day. If the first notification was issued on a Saturday or Sunday, the following Monday was the event day, as it was (usually) the first trading day of the week. Once an outbreak has ended, ProMed mail subscribers are also informed. However, this had no relevance for this investigation, as the end of the outbreak was often outside the relevant period.

Although the WHO is a widely respected medical organization, it has a political dimension, unlike ProMED, which only addresses the medical and research-based dimension. This contributed to the decision to use the status messages from

ProMED as a signaling device for this study. ProMED mail is one of the largest publicly accessible reporting systems for emerging pathogens/diseases and outbreaks worldwide, with over 80,000 subscribers (Bahnsen et al., 2021). An independent organization, the International Society for Infectious Diseases, operates the reporting system. It has had a good reputation and strong credibility since at least 2003 when it was the first non-Chinese source to report on the SARS outbreak (Bahnsen et al., 2021). The categorization into pandemic and epidemic was done ex post by the ProMED system.

In this study's analysis, the market model to estimate expected returns was applied, and it was defined as follows:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}$$

$R_{i,t}$ is the return of stock i at time t; α_i represents the security-specific return of security i β_i measures the sensitivity to the market return on $R_{i,t}$; $R_{m,t}$ represents the market return for market proxy, m, at time t; and $\varepsilon_{i,t}$ stands for the error term i at time t.

In estimating α_i and β_i, the parameters from MacKinlay (1997) were applied. The CAR approach by Fama et al. (1969) for return aggregation was applied. Setting the abnormal return ($AR_{i,t}$) as the starting point, the average abnormal return over N observations was calculated using:

$$\overline{AR_t} = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \text{ (for a long estimation period } L_1),$$

$$var(\overline{AR_t}) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma^2_{\epsilon_i}$$

This is equivalent to a continuous equal weighting of the N securities. In other words, a rebalancing occurs at the end of each period in which holdings of stocks with high returns were partly reduced in the following period to buy more of the stocks with lower returns. Applying these equations allowed the researchers in this study to calculate the average abnormal returns during the event window. For any time interval within the event window, the following was applied:

$$\overline{CAR}(T_1, T_2) = \sum_{t=T_1}^{T_2} \overline{AR_t}$$

$$\text{and } var(\overline{CAR}(T_1, T_2)) = \sum_{t=T_1}^{T_2} var(\overline{AR_t})$$

In determining $\text{var}(\overline{CAR}(T_1, T_2))$, any overlap of events was prevented which, consequently, allowed for the assumption of independence between the abnormal returns of the individual observations. Assuming a large number of observations and a sufficiently long estimation period L_1, the following distribution could be assumed (MacKinlay, 1997):

$$CAR_i(T_1, T_2) \sim N(0, \sigma_i^2(T_1, T_2)).$$

If autocorrelation was detected in the observations of abnormal returns, the Brown and Warner (1985) adjustment was applied. To maximize the power of the analysis, the study was restricted to events with no overlaps in the event window or the

estimation window. When overlaps in the estimation window used in this study did occur, they were excluded. While the authors were aware that excluding events could lead to a selection bias, they considered selection bias to be less impactful than the estimation bias of expected returns that would result from shrinking the event window. According to Dyckman et al. (1984) and Nageswara Rao and Sreejith (2014), researchers in scenarios like this study should eliminate concurrent events to obtain unbiased results.

"Possibly the most crucial research design issue is the length of the event window used in an event study" (McWilliams & Siegel, 1997, p. 636). One reason is that the probability of overlapping events increases with the length of the event window, and the easiest way to avoid bias is to exclude such events. Most event studies used event windows of three to 61 days, including the event day. This study used a maximum event window of 61 days. The estimated period of alpha and beta in this study was 180 days. Campbell et al. (1997) recommended a minimum estimation period of 120 days, while most event studies used an estimation window between 150 and 210 days.

During the observation window of this study, ProMED identified eight epidemic or pandemic outbreaks, four of which were excluded from the analysis of this study because the event windows were overlapping: Ebola Fever 1, Zika Fever, The Avian Flu (A/N5H1), and SARS. This left two epidemics (Middle East Respiratory Syndrome (MERS), 09.20.2012; Ebola Fever 2, 05.09.2018) and two pandemics (Swine Flu, 11.26.2008; COVID-19, 01.06.2020) to be considered and analyzed in this study.

To determine the securities to include in this study, data from Wallmine.com (2022) were used, which divided the health care industry into the following subindustries: pharmaceuticals, managed health care, health care equipment, health care distributors, health care supplies, health care services, health care information, life sciences tools and services, biotechnology, drug manufacturers - general, drug manufacturers - specialty, drugs - generic, medical care facilities, and pharmaceutical retailers. With the help of this fine-tooth segmentation of the health care industry, it was possible to identify positive or negative relationships with viral epidemics or pandemics in the individual subindustries as a robustness check of the hypotheses. Because some of the subindustries defined by Wallmine.com (2022) were so narrow, they did not include enough companies to create meaningful measurements. Thus, in this study, some subindustries were combined to create aggregates (biotech, health care, and pharmaceutical) to ensure all subindustries included a sufficient number of companies in the performance measurement as well as sufficient diversification within a portfolio. Therefore, unsystematic risks had a negligible influence on performance evaluation.

Possible dependencies among the listings on a particular stock exchange or continent were also included in the analysis as a robustness check. Data differed among Asia, North America, and Europe as regions in the analysis. Table 1 provides an overview of the applied dataset by stock exchange and aggregation to regions.

The data for duplicate listings were adjusted, retaining only data for the listings on the home stock exchange, which was usually the exchange with the highest trading volume for the stock. Historical stock prices (opening and closing prices,

Table 1 Distribution of Securities by Stock Exchange and Region

Stock Exchanges	Region	Number of Listed and Considered Health Care Companies from 2000 till 2020
NASDAQ, New York Stock Exchange, OTC	North America	1267
Toronto, TSX Venture	North America	143
Frankfurt (XETRA)	Europe	42
Amsterdam, Brussels, Ireland, Paris (EURONEXT)	Europe	113
London Stock Exchange	Europe	105
Shanghai Stock Exchange, Shenzhen Stock Exchange, Hong Kong Stock Exchange	Asia	144
Mumbai Stock Exchange, NSE	Asia	145
Australia Stock Exchange	Asia	177
Total: 2,136		

Table 1 presents the distribution of considered health care companies from 2000 to 2020 by stock exchange and region. Data Sources: Unicorn Data Services (2022) and Wallmine.com (2022)

volume) from 2000 to 2020 were obtained from Unicorn Data Services (2022). Discrete returns were calculated using the adjusted closing prices (dividends and stock splits excluded). The MSCI World Index, according to MSCI (2022), functioned as the benchmark portfolio within the market model's framework to measure abnormal returns. Based on Wallmine.com's (2022) original data, 2,460 companies could be identified as part of the health care sector. The final number of companies used for the study was 2,136, after adjusting for multiple listings on different stock exchanges and missing data.

Based on the literature review and the methodology described herein for conducting an event study of stock price performance in the pharmaceutical/medical/biotechnology industry during epidemics and pandemics, the following describes the hypotheses which were tested.

Hypothesis 1

The research question at the core of this study is whether it is possible to achieve abnormal returns by investing in health care stocks during outbreaks of epidemics and pandemics. If information about an infectious disease outbreak positively affects stock prices in one or more of these industries, it should produce positive abnormal returns. Timeliness is considered by measuring the event over a maximum of 30 days (shorter event windows are also tested). The robustness of the results was tested for subindustries (pharmaceutical, medical, and biotechnology) of the health care industry as well as specific regions to examine the potential of geographical dependence (the location of the stock exchange on which a security is listed aggregated to regions).

Hypothesis 2

The second hypothesis examines whether there are different responses regarding stock price returns during virus-related epidemics versus during pandemics. Supposing information about an outbreak of an infectious disease has a positive effect on stock prices in one or more of these industries, it should produce positive abnormal returns in both virus-related epidemics and pandemics in the same way. Timeliness is considered by measuring the event over a maximum of 30 days (shorter event windows were also tested).

Results and Discussions

The results show that in a joined analysis, epidemics and pandemics positively influence excess stock price returns for health care companies (Table 2). All event windows tested generated statistically and economically significant CAR values with the exception of $(-30, -21)$. In almost all cases, when pre-event windows were a part of the whole event window, smaller CAR values resulted as compared to when whole event windows included post-event windows.

Table 2 Results for Hypothesis 1: All Considered Epidemic and Pandemic Outbreaks during 2000 and 2020

Event window (days)	**Results from all events (without overlaps)**	
	CAR	**t-Test**
$(-30, +30)$	8.95%	9.797***
$(-20, +20)$	6.59%	9.500***
$(-10, +10)$	4.39%	9.985***
$(-5, +5)$	2.35%	6.863***
$(-2, +2)$	0.59%	3.123***
$(-1, +1)$	0.52%	3.255***
$(-2, 0)$	0.80%	4.362***
$(-5, 0)$	0.96%	4.207***
$(-10, -1)$	1.34%	4.745***
$(-20, -11)$	1.20%	4.06***
$(-30, -21)$	0.07%	0.215
$(0, +2)$	0.70%	4.210***
$(0, +5)$	1.92%	6.653***
$(+1, +10)$	2.53%	8.228***
$(+1, +20)$	3.53%	7.197***
$(+1, +30)$	5.82%	9.464***
$(+11, +20)$	1.01%	2.661***
$(+21, +30)$	2.29%	6.935***

Table 2 presents the event study results for all events without overlapping (two pandemics and two epidemics). In the event window (-30, +30), the t-test value is 9.797, and CAR is 8.95%. The symbols ***, **, and * denote the statistical significance of t-tests at the one, five, and ten percent levels, respectively. Data Sources: MSCI (2022), Unicorn Data Services (2022), and Wallmine.com (2022)

This study analyzed stock price performance across biotechnology, health care, and pharmaceutical industries to investigate if performance within those subindustries followed similar patterns in times of pandemics or epidemics. This would provide important information as to whether differences in performance within the health care industry should be considered (e.g., in the context of portfolio decisions by investors). Table 3 shows that CAR values ranged from 1.09% to 13.10% over the periods under consideration in the biotech subindustry and are statistically significant in many cases. The health care subindustry also shows many statistically significant excess returns. There are fewer positive excess returns in the pharmaceutical subindustry, the possibility of negative excess returns is more pronounced, and fewer returns are statistically significant. These results provide evidence that there are differences in performance across the subindustries.

Specifically in relation to Hypothesis 1, the results of this study were examined to determine whether stock price performance in the health care industry during the outbreak of epidemics and pandemics is related to the region in which the primary stock exchange is located. The results (Table 3) show that the CAR values for stocks listed on exchanges in North America range from 0.37% to 10%. Most observed periods are significant at the one-percent level. For all regions, CAR values are statistically highly significant only for the periods $(-30,+30)$, $(-20,+20)$, and $(-10,+10)$ and show the highest CAR values. Excess returns for Asia are the lowest, with a maximum of 5.69%, but these values are also statistically significant at the one-percent level. These results provide evidence of varying performance in different regions in which the primary stock exchange is located.

To test Hypothesis 2, the data were analyzed to determine if there were differences in stock performances during epidemics versus pandemics. Table 4 presents the results for the MERS and Ebola 2 epidemics. In the case of MERS (left side of Table 4), the CAR values for the event windows $(+1,+10)$, $(+11,+20)$, $(+21,+30)$, $(+1,+20)$ and $(+1,+30)$ are negative; otherwise, the CAR values are positive, reaching a maximum value during the event window $(-2,+2)$. It is evident that, especially during the shorter time windows around the official announcement of the MERS virus, the highest CAR values are statistically significant. This suggests that investors could have realized positive excess returns immediately before and after the official announcement. The right side of Table 4 shows results for the Ebola 2 outbreak. The CAR values ranged from -2.65% to 2.45%, with significant results only for the time windows $(-1,+1)$, $(-30,-21)$, $(+21,+30)$, $(0,+2)$, and $(+1,+30)$. Overall, this is a very mixed picture when comparing MERS and Ebola 2, which does not allow for a fundamentally valid recommendation for action based on these two case studies.

On the other hand, Table 5 presents the results of the H1N1 (left side) and COVID-19 (right side) pandemics. CAR values associated with the H1N1 pandemic range from -6.11% to 16.40%, depending upon the event window. Many excess returns are statistically significant, but some are positive, and others are negative. In the case of COVID-19, all event windows except (-20, -11) and $(+11,+20)$ generate significantly positive excess returns. The CAR values range from -0.25% to 17.88% across the various event windows, and most of them are highly significant at the one-percent level.

Table 3 Robustness Checks of CARs Related to Subindustries and Regions

Event window (days)	Results by subindustries						Results by regions					
	Biotech		Health Care		Pharma		North America		EU		Asia	
	CAR	t-Test	CAR	t-Test	CAR	t-Test	CAR	t-Test	CAR	t-Test	CAR	t-Test
(−30, +30)	13.10%	8.84***	7.35%	5.65***	4.59%	2.09**	10.00%	7.76***	8.70%	5.39***	5.69%	4.12***
(−20, +20)	9.45%	8.09***	4.66%	4.92***	4.97%	3.01***	7.22%	7.30***	6.32%	5.15***	5.14%	4.48***
(−10, +10)	6.91%	9.24***	2.75%	4.24***	2.87%	3.03***	5.22%	8.55***	2.94%	3.88***	3.11%	3.77***
(−5, +5)	3.72%	6.83***	1.88%	3.08***	0.83%	1.41	2.66%	6.04***	2.13%	3.67***	1.68%	2.12**
(−2, +2)	1.15%	3.28***	0.27%	1.08	0.15%	0.40	0.37%	1.40	0.88%	2.36**	0.98%	3.12***
(−1, +1)	1.09%	3.62***	0.54%	2.50**	−0.49%	−1.61	0.57%	2.45**	0.35%	1.20	0.50%	2.06**
(−2, 0)	1.45%	4.34***	0.59%	2.30**	0.03%	0.07	1.21%	4.47***	−0.01%	−0.04	0.19%	0.81
(−5, 0)	2.01%	4.66***	0.43%	1.39	0.07%	0.16	1.24%	3.69***	0.58%	1.35	0.47%	1.55
(−10, −1)	3.07%	5.89***	0.21%	0.57	0.28%	0.47	1.36%	3.32***	1.46%	2.79***	1.21%	2.96***
(−20, −11)	1.03%	2.37**	1.27%	3.39***	1.36%	1.60	0.78%	1.82*	2.54%	4.42***	1.49%	3.64***
(−30, −21)	1.59%	2.78***	−0.24%	−0.48	−2.01%	−3.76***	0.42%	0.95	0.60%	1.01	−1.15%	−1.99**
(0, +2)	1.67%	4.89***	0.44%	2.11**	−0.51%	−1.96**	1.20%	4.93***	0.56%	1.91	−0.53%	−2.45**
(0, +5)	2.71%	6.38***	1.83%	3.20***	0.72%	1.86*	2.32%	6.50***	1.35%	3.53***	1.21%	1.64
(+1, +10)	2.84%	6.18***	2.16%	3.92***	2.63%	4.44***	2.96%	7.22***	1.69%	3.55***	1.90%	2.86***
(+1, +20)	4.34%	5.08***	2.80%	3.79***	3.37%	3.43***	4.18%	6.11***	2.53%	3.19***	2.44%	2.66***
(+1, +30)	6.40%	6.31***	5.73%	6.15***	5.00%	3.69***	6.81%	7.80***	4.31%	4.03***	4.15%	3.98***
(+11, +20)	1.51%	2.13**	0.65%	1.26	0.74%	1.02	1.22%	2.27**	0.83%	1.37	0.54%	0.83
(+21, +30)	2.05%	4.12***	2.93%	5.70***	1.62%	2.05**	2.63%	5.38***	1.78%	3.29***	1.71%	3.84***

Table 3 shows the robustness check results related to different health care industry subindustries on the left side. In the biotech industry, the excess returns (ranging from 1.03% to 13.10%) are significant for all event windows. In the Health Care industry, excess returns range from −0.24% (−30, −21) to 7.35% (−30, +30), and many are significant. CAR values for the Pharma Industry range from −2.01% (−30, −21) to 5.00% (+1, +30), but far from all are significant. The negative, significant return (−2.01%) for the event window (−30, −21) is striking. Table 3 also presents the robustness check related to different regions on the right side. The stock exchanges in North America (USA & Canada) generate the highest excess returns (0.37% −10%). Not all results are significant. The excess returns of the EU stock exchanges are in the interval of −0.01% (−2, 0) and 8.70% (−30, +30). The stock markets in Asia had the weakest excess return (−1.15% – 5.69%). The symbols ***, **, and * denote the statistical significance of t-tests at the one, five, and ten percent levels, respectively. Data Sources: MSCI (2022), Unicorn Data Services (2022) and Wallmine.com (2022)

Table 4 CARs during Epidemic Outbreaks

Event window (days)	Results of the MERS outbreak		Results of the Ebola 2 outbreak	
	CAR	t-Test	CAR	t-Test
(−30, +30)	1.82%	0.725	−0.40%	−0.294
(−20, +20)	2.41%	1.349	0.86%	0.800
(−10, +10)	1.81%	1.705*	0.32%	0.553
(−5, +5)	1.83%	2.402**	0.15%	0.379
(−2, +2)	2.04%	3.470***	−0.27%	−1.031
(−1, +1)	1.24%	2.457**	−0.72%	−3.538***
(−2, 0)	1.85%	3.454***	0.34%	1.593
(−5, 0)	1.79%	2.791***	0.04%	0.146
(−10, −1)	1.44%	2.133**	−0.01%	−0.030
(−20, −11)	1.84%	1.904*	−0.36%	−0.994
(−30, −21)	0.23%	0.306	−2.65%	−7.230***
(0, +2)	0.73%	1.253	−0.44%	−2.245**
(0, +5)	0.58%	0.924	0.28%	0.993
(+1, +10)	−0.17%	−0.276	0.16%	0.446
(+1, +20)	−1.40%	−1.541	1.07%	1.286
(+1, +30)	−2.22%	−1.558	2.45%	2.569**
(+11, +20)	−1.24%	−2.023**	0.90%	1.285
(+21, +30)	−0.81%	−0.943	1.39%	3.138***

Table 4 presents the results of testing hypothesis 2 using the MERS (left side) and the Ebola 2 (right side) outbreaks as representatives of an epidemic outbreak based on data from 996 and 1,664 securities, respectively. In the case of the MERS outbreak, half of the event windows tested produced statistically significant results. Most of the negative CARs after the event day are not statistically significant. The CAR values were positive but insignificant over the long event windows (−30, +30) & (−20, +20). The Ebola 2 CAR values are obtained at −2.65% and +2.45% intervals. Significant results were found for the event windows of (−1, +1), (−30, −21), (+21, +30), (0, +2), and (+1, +30). The symbols ***, **, and * denote the statistical significance of t-tests at the one, five, and ten percent levels, respectively. Data Sources: Data Sources: MSCI (2022), Unicorn Data Services (2022) and Wallmine.com (2022)

In terms of Hypothesis 1, a positive impact on the stock price performance of companies in the health care industry was expected during the viral epidemic and pandemic outbreaks, and the results provide strong evidence that this hypothesis is correct. The results for events without overlap support a semi-strong form of the efficient market hypothesis. CAR values are economically and statistically significantly positive after the selected event day. High CAR values were obtained for event windows of (−10, +10), (−20, +20), (−30, 30), (+1, +20), and (+1, +30).

Furthermore, the data were analyzed to examine the impact of pandemics and epidemics on the stock price performance of different subindustries in the health care industry. The results provide evidence that the strength of the impact on stock prices may depend on the subindustry. The results show the biotech industry has the highest CAR values in each event window when compared to the pharmaceutical and health care subindustries, which are statistically significant, as well. Most likely, this is related to the fact that the biotech industry includes many

Table 5 CARs during Pandemic Outbreaks

Event window (days)	Results of the H1N1 outbreak		Results of the COVID-19 outbreak	
	CAR	**t-Test**	**CAR**	**t-Test**
(−30, +30)	15.40%	6.031***	17.88%	11.932***
(−20, +20)	8.69%	4.530***	12.78%	10.913***
(−10, +10)	−2.15%	−1.650*	12.05%	15.383***
(−5, +5)	−0.44%	−0.445	5.72%	8.393***
(−2, +2)	0.48%	0.668	1.69%	5.226***
(−1, +1)	0.47%	0.963	1.24%	5.178***
(−2, 0)	0.23%	0.365	0.89%	3.196***
(−5, 0)	−2.21%	−3.132***	2.69%	7.242***
(−10, −1)	−6.11%	−6.557***	5.66%	12.147***
(−20, −11)	6.88%	7.329***	−0.25%	−0.599
(−30, −21)	−3.64%	−3.704***	3.92%	6.571***
(0, +2)	2.12%	4.294***	1.05%	4.633***
(0, +5)	3.64%	4.004***	3.28%	5.642***
(+1, +10)	2.08%	1.940*	6.14%	10.767***
(+1, +20)	6.05%	4.336***	7.11%	7.995***
(+1, +30)	16.40%	8.721***	8.29%	8.050***
(+11, +20)	3.97%	3.647***	0.97%	1.468
(+21, +30)	10.34%	8.245***	1.18%	2.606***

Table 5 presents the test results of hypothesis 2 using the H1N1 (left side) and the COVID-19 (right side) outbreaks as representatives of an epidemic outbreak based on data 835 and 1.934 stocks securities, respectively, In the case of the H1N1 outbreak, the CAR values obtained ranged from −6.11% (−10, −1) to +16.40% (+1, +30), The excess returns during the COVID-19 outbreak ranged from −0.25% (−20, −11) to +17.88% (−30, +30), The symbols ***, **, and * denote the statistical significance of t-tests at the one, five, and ten percent levels, respectively, Data Sources: Data Sources: MSCI (2022), Unicorn Data Services (2022), Wallmine.com (2022)

young and dynamic companies that are generally more susceptible to fluctuations (size effect). Those same companies may also be seen as more innovative and promising in their ability to develop treatments to combat epidemics and pandemics and to convert them into economic successes, which could also contribute to the higher CAR values. Another potential reason for this result could be that the vaccines with the most significant positive effect in the context of the COVID-19 pandemic, messenger ribonucleic acid (mRNA) vaccines, are exclusively attributed to manufacturers (BioNTech as well as Moderna) from the biotech subindustry. This could potentially result in spillover effects on other companies from the biotech subindustry that also experiment with this technology in other fields of application (e.g., cancer research). The abnormal returns found for the other two subindustries cannot be interpreted because it is unclear which of the two performs better. What is striking, however, is the negative cumulative abnormal return for the pharmaceutical industry shortly after the event day (0, +2), which was not observed in the other subindustries. Overall, as it relates to Hypothesis

2 and the effect of pandemics and epidemics on stock performances of health care subindustries, it can be concluded that the results depend on the health care subindustry in question.

The second robustness check for Hypothesis 1 leads to the conclusion that abnormal stock performance during epidemics and pandemics depends on the regions where the stocks' primary exchanges are located. Differences in CAR values exist among stock markets examined in North America, Europe, and Asia, with the highest returns observed on North American exchanges (U.S. and Canada), followed by stock exchanges in Europe (XETRA, EURONEXT, London Stock Exchange). The lowest abnormal returns were recorded in the Asian region. This is surprising given that several pathogens that caused epidemics and pandemics are suspected to have originated in Asia. One explanation could be that investors believe that companies in the health care industry that are listed on a North American stock exchange are more likely to achieve commercial success by developing treatments for viral pathogens, though that is only conjecture.

The negative CARs observed on the Asian stock exchanges shortly after the outbreak of an event $(0, +2)$ can most likely also be explained by the fact that many of the outbreaks examined here presumably occurred in the Asian region. It could be interpreted as a negative bias from an investors' perspective on Asian markets in general, which leads to a discount on companies from the Asian region. It is also possible that during the outbreaks prior to the COVID-19 pandemic, there was an insufficient number of health care companies listed in the Asian stock markets to provide accurate information, which could have skewed the dataset as a whole. Indeed, a limitation of this study is that the applied dataset does not include the Japanese stock market. However, the Japanese stock market is not the home country to many health care companies (especially global players) related to the main-listing stock exchange that could presumably significantly influence the results. This is different for the Chinese and Indian stock markets, where many companies from the health care industry are listed.

The results related to Hypothesis 2 are more heterogeneous. Looking at the CARs and *t-tests* for MERS and Ebola 2 as sample epidemics, it can be seen that epidemics do not necessarily have a positive effect on the stock price performance of companies in the health care industry. While the CAR values for MERS are still positive after the event day in the event window $(0, +2)$, they are significantly negative for Ebola 2. Regarding the analysis of H1N1 as a sample of a pandemic outbreak, the cumulative returns vary widely over various event windows. While there are negative cumulative returns before the event, these largely resolve before the event day, and the following CAR values increase and are statistically significant. The results for the COVID-19 pandemic show that after the event day $(0, +5)$, positive CARs are observed with an average of just under 3%. For the event window of $(+1, +10)$, it is noticeable that the cumulative return increases to just under 6% and is statistically significant. However, the abnormal return before the event day $(-10, -1)$ is also strongly positive and significant. The CARs over the entire period $(-30, +30)$, as well as for event windows $(-20, +20)$ and $(-10, +10)$, are between 12 and 20% and are significant. Therefore, Hypothesis 2 can be confirmed only for pandemic

outbreaks. We believe that a pandemic has a more global impact than epidemics with a more local focus. Our conclusion is that the larger the problem (mortality and number of cases), the higher the positive abnormal return, at least in the binary comparison between epidemic and pandemic.

In a period of up to 30 days after the event, there are certainly opportunities for establishing trading strategies that could lead to purchasing stocks from the biotechnology sector to achieve an excess return, at least for a short investment period. Considering this aspect in the context of investment and financing as two sides of the same coin, it can also be rewarding for equity attraction from an issuing company. Of course, this presupposes that such an issue can be realized quickly, and according to the results, the listing place plays a significant role, and, as such, should be a consideration in all decision making.

Additionally, the results have interesting implications for portfolio diversification. Of course, as in the COVID-19 outbreak, some companies can be assumed to be winners (e.g., Biontech) and, at first glance, provide an argument for stock picking as an investment strategy. The results indicate that an investment strategy based on investments in the biotechnology sector might make more sense from a risk-return perspective, at least in a short investment horizon. Furthermore, because the globalization of the financial markets has increased considerably over the past ten years, it is reasonable to assume that the COVID-19 pandemic carried more weight in influencing the dataset than the other outbreaks studied here. In addition, the Chinese and Indian stock markets have become significantly more critical in a global comparison of trading in recent years, which may mean that these markets only had much of an impact on the data from COVID-19 while playing hardly any role in earlier outbreaks. Consequently, the results are presumably biased toward the COVID-19 outbreak's outsized influence on the results. However, it can be argued that the COVID-19 outbreak is the deadliest epidemic (in terms of casualty figures) to hit the world in the past 50 years. Therefore, it received more attention in the stock markets than other epidemics and pandemics and led to a potential size effect in our empirical analysis. This also means that a pandemic disease needs to reach a critical size (as measured by mortality rates and individuals infected) to have a measurable impact on stocks from the health care industry.

Including other pandemics and epidemics from the past in this study would have been desirable, but events that are further in the past create other challenges for the study design. First, it would be difficult to define a uniform event or event window like the reporting system used here, ProMED mail, was only created roughly 25 years ago. However, more significant are problems related to data availability regarding earlier outbreaks. Still, it is possible that adding events occurring before 2000 could underscore or challenge these findings. Furthermore, we recommend that future work in this area include additional stock exchanges, such as Tokyo or Seoul, in the design to provide better coverage of the Asia–Pacific region. In addition, stock exchanges from South American countries, such as Brazil (which was strongly affected by the COVID-19 pandemic), could also be included in the analysis. Conducting a country-level analysis would also be helpful, as relationships could not

be determined in the rather rough regional clustering study. Further studies could define event days and windows differently and adjust the estimation period.

The focus on an event study as the applied methodology also offers grounds for criticism. Of course, it is essential to define the event date. In the applied methodology, great care was taken to use a nonpolitical signaler (ProMED) that has widespread public attention and acceptance. Therefore, an empirical analysis focusing on different event dates, excess returns, and corresponding trading strategies could be another important aspect for further research.

Finally, the one-factor market model proposed by MacKinlay (1997) was used to model the expected stock performance. MacKinlay (1997) stated that most advantages of employing multifactor models in event studies are modest. The reason for limited benefits lies in the empirical evidence showing that the added factors, beyond the market factor, have a minimal impact on explaining abnormal returns. Consequently, there is little reduction in the variance of the abnormal returns (MacKinlay, 1997). As such, this study used the market model exclusively. While this does result in a limitation of the empirical work, as multifactor models were not used to estimate the expected returns, the limitation can be considered minor.

Conclusion

The existence of abnormal returns of stocks from the health care industry around the time of an outbreak of a viral epidemic or pandemic can be confirmed based on the event study approach. For the first time in the English and German language literatures, a detailed analysis was applied to companies from the health care industry in this study. The results show that abnormal returns were mainly observed for pandemics but could not be confirmed for virus-related epidemics. Furthermore, individual influencing factors were identified, such as the subindustry within health care. Institutional investors could use these factors for future investment decisions and portfolio management, such as short-term investments in the North American biotechnology industry during the beginning of an outbreak of a viral disease with pandemic potential. In addition, an initial public offering or a secondary offering for a company already listed on the stock exchange, especially from the health care industry in North America and Europe, could be a possibility at the beginning of virus-related pandemics for both issuers and investors. That could be an interesting concept to explore in further research.

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