Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company’s public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Coronavirus (Covid-19) outbreak, investor sentiment, and medical portfolio: Evidence from China, Hong Kong, Korea, Japan, and U.S

Yunpeng Sun\textsuperscript{a}, Qun Bao\textsuperscript{b}, Zhou Lu\textsuperscript{a,}\textsuperscript{*}

\textsuperscript{a} School of Economics, Tianjin University of Commerce, Tianjin, China
\textsuperscript{b} School of Economics, Nankai University, Tianjin, China

\textbf{ARTICLE INFO}

\textbf{Keywords:}
Coronavirus
CRNs
ERAs
Investor sentiment
Medical companies

\textbf{ABSTRACT}

This study explores whether investor sentiment, driven by Coronavirus-related news (CRNs) and economic-related announcements (ERAs) associated with the Coronavirus outbreak, is priced in medical stock portfolios in China, Hong Kong, Korea, Japan, and U.S. We find that the CRNs and ERAs do not trigger irrational investment behaviours towards medical stocks. CRNs exert significant and positive effects on the five markets’ medical portfolios. ERAs also pose positive and significant effects on five markets’ medical portfolios. Furthermore, ERAs have stronger effects on the institutional investor sentiment than the individual investor sentiment. Total effects of CRNs and ERAs on five markets’ medical stock portfolios are positive and significant, meaning the optimistic investor sentiment on the medical industry, which plays the critical role in preventing this unprecedented infectious disease.

\section{1. Introduction}

Investor sentiment refers to personal beliefs of investors about future cash flows and risk of their investment, which may not be justified by the existing facts (Baker and Wurgler, 2007). Instead, such sentiment is largely determined by the investors’ own perceptions of news released and/or events occurred. Investors may be over or under confident when receiving a news published and/or witnessing an event regarding the behavioral finance theory (Raissi and Missaoui, 2015). Thus, their sentiment varies, leading to their either rational or irrational behaviours (Hudson et al., 2020).

The study of investor sentiment is critically concerned since this sentiment drives economic agent’s investment decisions (Kaplanski et al., 2015). Empirically, the behavioral finance literature provides a significant number of empirical evidences, which confirms the relationship between stock returns and investor sentiment (Kaplanski and Levy, 2010a, 2010b, Donadelli et al., 2016, etc.). Hence, an in-depth understanding of determinants of investor’s sentiment and its effects on stock market performance is helpful for practitioners, policy makers in making their relevant decisions.

Among determinants of investor sentiment, the announcement of disease-related news has been documented as one of critical factors that shape investor’s sentiment. Donadelli, et al. (2017) indicated that the fear of dangerously infectious diseases such as H1N1, SARS, etc. from 2003 to 2014 reduced the US investor’s sentiment, leading to the negative performance of the US stock markets. However, such news also increased investor’s sentiment for the US pharmaceutical industry, leading to the improvement of pharmaceutical stock portfolio’ performance as investors anticipated higher demand for pharmaceutical products in the context of the
spread of such diseases. Nonetheless, this study just focused on the period of 2003–2014 to investigate effects of investor’s mood on pharmaceutical stocks in the US. Thus, it did not cover well such effects in other countries. Furthermore, the study on such effects of the recent infectious disease-related news – Coronavirus outbreak (Covid-19) has been underexplored. Therefore, a literature gap has been determined as the shortage of research studies documenting effects of this most recent outbreak on investor’s sentiment and stock market performance. This study, thus, is motivated from this literature gap.

Covid-19 outbreak emerged from Wuhan – a Chinese city in the late December 2019 (Fernandes, 2020). As a response to this public health emergency, China’s President Xi Jinping has claimed several disease preventions and controls, including the lockdown of this city and the implementation of social distance and travel restrictions. Such responses led the whole Chinese economy into the stagnation due to the disruption of supply chains as well as the significant decline of demands (Qiu et al., 2020).

Being the world factory, China is the manufacturing site of several countries (Zhang, 2006). Furthermore, with a huge population of more than 1.3 billion people, China is also an important market of international companies. The stagnation of Chinese economy caused by Covid-19 outbreak, hence, negatively influenced other economies through different transmissional channels (Fernandes, 2020). In the other words, the spillover effects of China’s economic problems on the global economy were expected to be much greater nowadays than the outbreak of SARS in 2003. IMF (2020) estimates the expected growth rate of developed countries to be approximately –6.1% and severe slowdown in other regions will experience a severe economic decline. OECD (2020) indicates that the cut-off measures in China has led to the reduction of global output levels and consumption level. Obviously, sentiments of global investors would be affected by the Coronavirus outbreak in China.

In the context of Covid-19 outbreak, the medical industry has received significant attention of global investors. This industry plays the critical role in preventing the spread of Covid-19 outbreak, relieving the health disaster, protecting, and improving public health, improving quality of life, and promoting economic development and social progress (Lazonick and Tulum, 2011). Hinman et al. (2006) state that under public health events, such as SARS, the medical companies do not only provide medical devices, but they also conduct research and development, drug tests, and vaccine manufacturing. When the dangerous infectious diseases occur, governments and companies tend to allocate more resources for this industry with an aim to figure out the effective treatment for such diseases. Consequently, compared to other industries, the medical industry has several business opportunities in the context of the spread of Covid-19 outbreak.

Nonetheless, according to Donadelli, et al. (2017), the spread of infectious diseases also creates a fear to the market. This fear induces investors to invest in safe assets to deal with uncertainties. Consequently, the fear of infectious diseases may also reduce performance of stock markets in general and medical stocks, in particular. Considering to the shortage of the literature on investigating effects of Covid-19 related news on stock performance in general and medical companies, which play the critical role in preventing and controlling this outbreak, this study is proposed to address such a research gap. It focuses on China and several countries, which have the close business relationships with China to examine impacts of Covid-19 related news and economic related news associated with this outbreak on investor sentiment and medical portfolios’ performance since this outbreak emerged in China and spread to other countries. This study is also expected to clarify whether Covid-19-related news pose both side effects on stock performance of the medical industry in several countries as found for infectious disease-related news from 2003 to 2014 by Donadelli, et al. (2017) in the US stock market.

Because of its research goals, this study is mainly concentrated with two kinds of information, which are Covid-19 news and economic announcements. Donadelli, et al. (2017) state that the infectious diseases are perceived by the public as largely negative. Since Covid-19 outbreak firstly broke out in China, this study examines how the Covid-19-related news (CRNs) released by China’s Health Commission and the economic-related announcements (ERAs) by China’s Development and Reform Commission influence investor sentiment, which is reflected in the performance of medical portfolios in Mainland China, Hong Kong, Korea, Japan and U.S. The first hypothesis of this study is that the fear of Covid-19 outbreak is negatively associated with investor sentiment, whereas CRNs positively affect medical stocks. This hypothesis is developed based on findings on the negative effects of the fear of infectious diseases on stock performance of the pharmaceutical industry of Donadelli, et al. (2017). The second hypothesis is that economic policy announcements (ERAs) have negative effects on investor sentiment presented at the negative performance of medical stocks. Because of Covid-19 spread, Chinese government announced several economic policies to alleviate the adverse effects of disease on economy with ten ERAs have been issued in first two months of 2020. However, these disease-targeting economic policies, including regional economic lockdowns and travel restrictions, seem to increase the degree of economic policy uncertainty (EPU). Such uncertainty would pose depressing effects on investor sentiment, thereby reducing the investment in medical companies. The essential insights provided by this study is that investor sentiment can be driven by the fear of the CRNs and ERAs. Furthermore, this study also develops two other hypotheses to examine the variation of impacts of CRNs and ERAs across investor’s groups and countries.

By the application of the event study approach and regression analysis, this study has academic contributions to the existing literature regarding economic impacts of Covid-19 outbreak on stock markets. It expands the study of Donadelli, et al. (2017) on two side effects of infectious disease related news on stock performance of the medical industry with the focus on the most recent infectious diseases and stock performance of medical industry in different countries – China, Hong Kong, Korea, Japan, and USA. Thus, it offers the up-to-date findings on this topic and helpful implications for practitioners and policy makers. On the other hand, it applies the Principle Component Analysis (Abdi and Williams, 2010) to construct the investor sentiment indexes for different types of investors – the general investor sentiment index, the individual investor sentiment index, and the institutional investor sentiment index. This approach is objective as it extracts components from the raw data using the statistical methods. With different investor sentiment indexes, the study can examine impacts of Covid-19 related news on sentiment of different investors in five studied countries. This study focuses on top 10 market capitalization medical companies listed on stock markets of five studied countries to construct medical portfolios as suggested by Donadelli, et al. (2017) since large pharmaceutical firms pay significant attention to develop and
manufacture vaccines, which provide significant business opportunities for them in the future.

The study results indicate that CRNs and ERAs do not trigger irrational behaviours towards medical stock investment. Additionally, CRNs produce negative investor sentiment on medical portfolios in China mainland and Hongkong, whereas the positive investor sentiment has been found in Korea, Japan, and U.S. The CRNs exert significant and positive effects on the five markets’ medical portfolios, in general. Moreover, the ERAs generate significantly positive investor sentiment on medical portfolios in China mainland and Hongkong, whereas the negative investor sentiment in Korea, Japan, and U.S. The effects of ERAs have positive and significant effects on five markets’ medical portfolios, in overall. Furthermore, we observe the ERAs have stronger effects on the institutional investor sentiment in five markets’ medical portfolio returns than the individual investor sentiment. Total effects of CRNs and ERAs on five markets’ medical stock portfolios are positive and significant through the optimistic investor sentiment.

This paper is organized as follows. Section 2 outlines the theories that underlie the investor sentiment and sets hypothesis. Section 3 provides the methodology and data. Section 4 summarizes empirical findings. Section 5 discusses the related results. And, Section 6 concludes.

2. Literature review and hypothesis

In the existing literature, the relationship between investor sentiment and stock market performance has been discussed extensively. Barberis et al. (1998) consider the investor sentiment as investors’ reaction to the news, announcements or stock price movements. Baker and Stein (2004) argue that the investor sentiment can be treated as the propensity of investors to speculate. Brown and Cliff (2005) believe that investor sentiment is the attitude of investors towards stocks. Moreover, some studies observe the weather, sports and some disasters can drive the investor sentiment and affect stock market. Saunders (1993) states that the cloud coverage as a weather index can affect the stock market through investors sentiment. Edmans et al. (2007) argue that the results of sport games heavily affect investor sentiments, and in turn, stock market return. Kaplanski and Levy (2010b) analyze the aviation events have strongly negative effects on the investor sentiment.

However, the relationship between medical portfolio returns and news-driven investor sentiment has not been fully investigated. Some researchers examined how some diseases drive the medical portfolio returns and investor sentiment. Huberman and Regev (2001) use stock price of EntreMed to analyze the effects of investor sentiment on cancer research. Donadelli et al. (2016) examine the effects of investor mood, driven by the alerts of WHO (World Health Organization) on the stocks of US pharmaceutical companies. Nevertheless, these studies neither (i) generalize their results to the worldwide, nor (ii) consider the effects of economic announcements on the investor sentiment under the dangerous infectious disease, nor (iii) distinguish the different effects of individual investors and institutional investors; nor (iv) explore the total effects of disease news and economic announcements on investor sentiment in different stock markets.

In this section, we review the existing literature on news and investor sentiment. Then based on the existing literature, four testable hypotheses are developed for exploring the research gaps.

2.1. Investor sentiment, internet, and emergency news: the case of CRNs

There are a large number of existing studies that confirms the effect of emergency events on investor sentiment through the media. For instance, Kaplanski and Levy (2010a) argue that with the development of Internet media, reports of air crashes, including pictures and live video, have a strong impact on investor sentiment, which in turn has a significant impact on abnormal returns. Berkman et al. (2011) establish the crisis index through 447 reported international political emergencies from 1918 to 2006 and find the index has a significant impact on the volatility of global stock markets. Nowadays, investors tend to obtain news or announcements through the Internet, which implies that the reaction of Internet users to emergency events can affect the investor sentiment. The studies using Internet data to measure the public reaction firstly appeared in the health field. Ginsberg et al. (2009) firstly use Google data to establish the influenza surveillance model and state that people tend to search the keywords about the influenza through search engine to make related decisions. The results of Ginsberg et al. (2009) have been confirmed by Vasterman et al. (2005), Mairal (2011), Young et al. (2013). Unpredictable emergency events, such as the dangerous disease outbreak, can generate intensive media and public concerns. These fears exert significant effects on the investor sentiment. Under efficient capital market, new information is the main factor driving the movements of stock market. Overall, the emergency events as a temporary exogenous shock can affect the public and investors’ concerns. Then, the concerns further change the investor sentiment and behaviours. This study provides a theoretical

![Diagram](source: Author's own elaboration)

Fig. 1. Framework of investor sentiment, internet, and emergency events. (Source: Author’s own elaboration)
framework on the relationship of investor sentiment, Internet, and emergency events in Fig. 1, as following:

As a public health emergency event, the outbreak of Coronavirus in China has been widely reported by media across different countries and regions. Based on the theoretic framework, the public attention to Coronavirus has been increased through the Internet. In this scenario, CRNs may affect the concerns of the public and investors. Households tend to purchase medical products. Meanwhile, investors might consider the Coronavirus outbreak as a profitable investment opportunity for medical portfolio. Under this condition, the positive sentiment could increase the valuation of medical portfolio. Therefore, this study proposes a positive relation between CRNs and returns on medical portfolio across the five markets.

**Hypothesis 1.** CRNs have a positive effect on the medical portfolio returns in the five markets.

### 2.2. Investor sentiment and economic policy uncertainty (EPU): the case of ERAs

The global financial crisis of 2008/2009 exerts a negative effect on the mood of the investors. Many countries have intensively issued economic stabilization measures (Baker et al., 2016). However, changes in economic policies often cause uncertainties, hinder the rational judgment of investors, and have unpredictable effects on market stability (Li et al., 2013).

Changes in economic policy may largely change individual investors’ expected returns and risk expectations since individuals are not as competent as institutional investors in acquiring information. Consequently, their behaviours may be irrational due to impacts of emotional and herding factors. Under economic policy uncertainty (EPU), investors are more likely to have negative emotions, such as anxiety and fear. Baker and Wurgler (2006, 2007) find that investors show an ambiguity aversion in face of economic policy uncertainty. In this condition, Brogaard and Detzel (2015) argue that the EPU leads investors to make decisions more cautiously. From the perspective of institutional investors, Gilchrist et al. (2010) find that the EPU increases financial market friction, reduces credit supply, and lead to investor sentiment pessimistic. Moreover, Lee et al. (1991) point out that the buoyant investor sentiment significantly increased the volatility of the stock market. This study builds a theoretical framework of investor sentiment, and EPU in Fig. 2, as following:

In the context of the spread of Covid-19 outbreak, China’s government has issued a series of economic announcements to alleviate the adverse effects on economy. For example, in the first-two months in 2020, there were ten ERAs issued regarding economic adjustments, monetary policy, and fiscal policy. Among these, there were several policies that raised the concerns of economic uncertainty such as the regional lockdowns and travel restrictions, which led to the disruption of supply chains and the reduction of consumer’s demands; the requirements on standard salary for employees during the Covid-19 outbreak, leading to the significant labor cost burdens while revenues of firms are expected to reduce; etc. To a certain extent, these ERAs would increase the EPU in China. Since China has in a severe struggle against Covid-19 outbreak with the number of infected people increased dramatically in the first quarter of 2020, the fear increased, and economic uncertainty caused by the ERAs also accelerated. Considered the spillover effects from Chinese economy, the EPU of China can exert a significant negative effect on the global economy. With an increase in EPU, individual and institutional investors increase their anxiety on the medical stocks. The expectation for the effective treatment as well as the development of vaccines in the short time is considered to be not as high as in the period of 2003–2014 in the US when SARS occurred (Donadelli, et al., 2017). The main reason is that Covid-19 outbreak is the unprecedented virus disease. Consequently, although medical companies have a huge business opportunity when they can develop vaccines to treat this disease, it will take time for them. Consequently, investors are expected to not be willing to invest in medical stocks as significant as in the stable healthcare and economic conditions. Thus, the valuation of medical portfolio is expected to decrease. Hence, this study proposes a negative relation between ERAs and returns on medical portfolio of the five markets in **Hypothesis 2**.

**Hypothesis 2.** ERAs have a negative effect on the medical portfolio returns in the five markets.

Compared with the institutional investors, individual investors are more constrained. First, individual investors are limited in financial knowledge and have limited resources for the investment in stock market. Second, the ability of individual investors in

---

**Fig. 2.** Framework of investor sentiment and EPU.
(Source: Author’s own elaboration)
acquiring information and analyzing it is also limited compared to institutional investors. Thus, it is difficult for individual investors to effectively analyze the effects of new information on the financial market in a timely manner. Third, most of individual investors have poor risk controls. When the Coronavirus outbreak has been spread, the risk of individual investors is apparently greater than the institutional investors. Based on former analysis, this study proposes the effects of ERAs on individual investors’ sentiment are stronger than on the institutional investors.

**Hypothesis 3.** Compared with institutional investors, ERAs have stronger significant effects on the individual investor sentiment and their medical portfolio returns in the five stock markets.

2.3. Investor sentiment, resource allocation and total effects: the case of CRNs and ERAs

Reviewed the existing literature, the investor sentiment has two effects on stock return. On the one hand, investor sentiment may distort corporate investment decisions, thereby resulting in inefficient resource allocation. On the other hand, investor sentiment may ease corporate financing constraints, making some effective investment projects implemented (Farhi and Panageas, 2004). There may be significant differences in the returns of investor sentiment on corporate investment behavior due to different financing constraints (Ross, 1973; Holmstrom and Weiss, 1985).

Specifically, there exist two opposite investor sentiments, optimistic one and pessimistic one. When the investor sentiment is optimistic m, the managers tend to increase investment to cater to the investor sentiment. When pessimistic investor sentiment, external pressure on managers is relatively small, and the catering motivation is weakened. In this condition, firms tend to reduce investment. When the effect of optimistic one is stronger than that of the pessimistic one, the total effects of investor sentiment will increase the valuation of stock. By contrast, the effect of optimistic one is smaller than that of the pessimistic one, the total effects of investor sentiment will decrease the valuation of stock. This study establishes a theoretical framework of investor sentiment, resource allocation and total effects in Fig. 3, as following:

Based on the above hypothesis, the effect of CRNs and the effect of ERAs on the medical portfolio returns in the five markets are opposite to each other. Hence, this study needs to explore the total impact of the CRNs and ERAs on the five markets’ medical portfolios. CRNs have aroused more concerns from the public and investors under the Coronavirus outbreak, making investment sentiment for listed medical companies soaring. The optimistic investment sentiment brought by CRN has affected the resource allocation of medical enterprises and make them increase investment in vaccines or other anti-epidemic items. Moreover, the purpose of ERAs is to maintain economic stability under the Coronavirus. However, a series of ERAs have stimulated economic policy uncertainty and produced a pessimistic investment sentiment. To some extent, the medical enterprises worry that the adverse effects of uncertainty will tend to decrease the investment scale. With dangerous infectious disease outbreak, the disease prevention and control as the top priority of worldwide. Under this condition, the total effects of optimistic sentiment from CRNs may be stronger than that of pessimistic one from ERAs. Hence, this study proposes there exists a positive relation between total effects of CRNs and ERAs with returns on medical portfolio of five markets.

**Hypothesis 4.** The total effects of CRNs and ERAs on the medical portfolio returns in the five markets are positive.

3. Data and methodology

In this part, we briefly describe the data selection and model construction for exploring the four hypotheses.

3.1. Data selection

(1) Coronavirus Related News (CRNs)

The CRNs include announcements on Coronavirus during the outbreak period in China from December 2019 to February 2020 as shown in Table 1. There four different CRNs categories, namely Internet news, China’s Health Commission Statement, WHO Statement, and Government Order.

Internet news can be treated as an unofficial channel to communicate Coronavirus news to the public. For example, the Fellow of China Science Academy, Dr. Zhong believed the peak of Coronavirus in China would be in mid-to-late February 2020. The Internet news in this study are obtained by the rigorous online search. For the statements from China’s Health Commission, WHO, and Chinese Government, they are obtained through the official website. Considering that the Coronavirus first broke out in China, the statement of

---

*Fig. 3. Framework of investor sentiment resource allocation and total effects. (Source: Author’s own elaboration)*
the Chinese Health Commission can be regarded as the formal statement to the public about the current situation of Coronavirus. Orders by China’s Government are the official announcements to the public about the control and prevention of Coronavirus. Table 1 shows that most of news about Coronavirus are originated from Internet since December 1st, 2019 to January 20th, 2020. By dispatching to Wuhan on January 1st, 2020, Chinese Health Commission and China’s government have attracted more information about the Coronavirus, which later led to the decision of Wuhan lockdown on January 23rd, 2020.

In Coronavirus outbreak, China’s Health Commission Statement cannot immediately confirm Internet news. For example, Internet reported the no human-to-human transmission on December 31st, 2019. While Chinese Health Commission did not confirm this information until January 1st, 2020. Donadelli et al. (2016) argue that all regularly spaced updates may be anticipated by stock market investors and may be priced in prior to the actual update. Based on this reason, the sample of events will identify the first-time reported news or events. Totally, there are 13 CRNs. To some extent, this method can maintain the continuity of news or announcements about CRNs, as the spread of Coronavirus is unpredictable.

(2) Economic Related Announcements (ERAs)

With Coronavirus outbreak, China’s economic authorities have issued a series of announcements from January 1st, 2020 to February 23rd, 2020. Table 2 summarizes the 10 ERAs respectively from China’s Central Bank, Ministry of Finance, Government Order, and China’s Development and Reform Commission, respectively. These announcements are obtained through the official websites.

The ERAs can be divided into three categories, which are the temporary economic adjustment, monetary policy, and fiscal policy. We can investigate the Government Order and China’s Development and Reform Commission Statement are based on the status of Coronavirus to adjust the economic policies. For example, when the Coronavirus broke out and the knowledge about the epidemic disease was quite limited, the Chinese government decided to make temporary concessions to economic development in January 20th, 2020. According to the Government Order, the national development and Reform Commission, the people’s Bank of China and the Ministry of finance have issued an announcement for maintaining macroeconomic stability, releasing liquidity and helping enterprises operate.

(3) Medical Stocks in China, Hongkong, Korea, Japan and U.S.

This study uses the medical stocks from China, Hongkong, Korea, Japan, and U.S. stock market. There are some main reasons for selecting: (1) these countries and regions have closed economic and trade relationship with China; (2) there exist significant co-movement effects across these five markets. When Coronavirus outbreak in China, the other four stock markets can effectively respond to this emergency public health event. To the medical stocks, this study considers two criteria for selecting medical companies: (1) company is mainly engaged in medical device production, chemical pharmaceuticals, vaccine research and development; (2) company has a large market capitalization. With the Coronavirus outbreak, medical companies engaged in relevant areas can attract the investors’ attention. Additionally, Donadelli et al. (2016) state that large medical companies are more likely to engage in new vaccines. Based on this condition, this study respectively selects ten medical companies’ stock from China, Hongkong, Korea, Japan
and U.S. stock market. All medical companies are classified and summarized in Table A1 in the Appendix. For observing the effects of CRNs and ERAs on the medical stock returns, this study uses an equally weighted method to construct the medical portfolio. We use daily data for the period 12/01/2019 – 2/21/2014 (a total of 60 observations). The descriptive statistics are presented in Table 3. In the sample period, the mean return of medical stock portfolio in China stock market, 0.003698%, is greater than the mean of other stock markets’ portfolios. The medical stock portfolio in Japan stock market has the largest difference between the mean and median. The range of variation between the maximum and the minimum returns is greatest for Japan medical stock portfolio (0.123414% and 0.019592%, respectively) and lowest for U.S. medical stock portfolio (0.0308% and 0.02745%, respectively). The Japan medical stock portfolio has the highest idiosyncratic risk, as measured by the standard deviation (0.019691%), whereas the U.S. medical stock portfolio is the least risky to invest (0.009884%). Medical portfolio returns are positively skewed, with the exception of the Hongkong medical stock portfolio. The coefficients of kurtosis of five medical portfolios are greater than zero.

3.2. Methodology

This study uses the event-study and regression-based methodologies to test Hypotheses 1–4.

(1) Event study methodology

Following the event study methodology, this study investigates the CRNs and ERAs through computing the cumulative abnormal returns \(1\) (CARs). To explore medical stock portfolios in five markets, this study uses the Fama–French three-factor model \(^2\) to estimate the expected return rates. From Tables 1 and 2, we observe temporal clustering of CRNs and ERAs during the peak period of Coronavirus infections. Based on this condition, this study chooses event window length to cover 5 days before and 5 days after CRNs or ERAs. The selected CRNs and ERAs are listed in chronological order. This study starts with the first CRNs or ERAs, ignoring all the other news or events within 10 days, then select the next CRNs or ERAs in succession, ignoring the following 10 days, and so on. This iteration proceeds until the whole sample is exhausted. Panels A and B in Fig. 4 illustrate one example for CRNs and ERAs, respectively.

(2) Regression-based Methodology

Following the relevant literature, this study uses regression models to explore the hypothesis 1-4 (Kaplanski and Levy, 2010a, 2010b; Curatola et al., 2016; Donadelli et al., 2016). For testing the effects of CRNs, we construct the regression model, as following:

\[
R_t = \beta_0 + \sum_{i=1}^{3} \beta_{1,i} R_{t-i} + \sum_{i=0}^{j} \beta_{2,i} D_{t-i} + \beta_3 FIS_t + \beta_4 DC + \beta_5 DE + u_t
\]

where \(R_t\) is return rate of medical stock portfolio at time \(t\) in one market, measured by the logarithmic value of the ratio between the

---

1 The abnormal returns are defined as the difference between the observed return rate of a medical portfolio and its expected return rate over the whole length of the event window.

2 This study uses the the Fama–French three-factor model to estimate. Our research focuses on the CRNs and ERAs to analyze the effects of investor sentiment on the medical stock portfolios in five markets. The SMB factor in the three-factor Fama–French model may capture some of the effects of investment sentiment on the CARs.
return of the portfolio in the time t and the time t-1. This value, thus, can address the significant skewness of data and enables the interpretation of $R_t$ in the relative measure (Kaplanski and Levy, 2010a, 2010b). $\alpha_0$ is the regression intercept, and $R_{t-1}$ are lagged values of dependent variable. This study uses three lagged returns to account for the possible serial correlations as used by Donadelli, et al. (2017). $D_t$ represents the dummy variable that captures the effect of Chinese New Year (or the Spring Festival effect). This variable is used since this study’s time horizon is the first quarter of 2020, when China was celebrating the New Year Festival, which is the biggest National Festival in China. During this festival, stock markets closed. However, after its open, the effects of the New Year Festival might still last and they might influence investors’ investment decisions. $C_t$ represents the CRNs. Based on Donadelli et al. (2016), we should consider the effects of the three previous news announcements on stock market returns. Moreover, the news coverage intensifies and peaks on the third day (Kaplanski and Levy, 2010b; Donadelli et al., 2016). This study uses $\sum_{i=0}^{3} C_{t-i}$ to capture all the three previous CRNs. The coefficient $\beta_3$ reflects the contemporaneous effect of CRNs on the portfolio rate of return. $FIS_t$ denotes the investor sentiment. This study uses Principal Component Analysis (PCA) to identify the factors driving investor sentiment since this is an effective statistical method to construct the investor sentiment index with the least biasness generated (Abdi and Williams, 2010). In the PCA method, upon the raw variables measuring the investor sentiment, the extraction of components with Eigenvalues higher than 1 from the large number of raw variables is implemented. Sequently, the investor sentiment index is constructed based on the estimation of weights of different extracted components of each observation scaled by the difference between the max and min weight values of all observations (Abdi and Williams, 2010). Table A2 in Appendix shows the related variables of investor sentiment factors in the five markets. $\epsilon_t$ is an error term.

Moreover, with Coronavirus outbreak, ERAs may cause an increase in China’s EPU as new economic policies created uncertainties as mentioned by Li et al. (2013). Taking this into consideration, we explore the effects of ERAs on the medical stock portfolios in the five markets through the investor sentiment. For testing the Hypothesis 2, this study uses the multiple stepwise regression models, as following:

$$R_t = \alpha_0 + \sum_{i=0}^{3} \alpha_i E_{t-i} + \alpha_2 GDP_{t-1} + \alpha_3 CREDIT_{t-1} + \alpha_4 DC + \alpha_5 DE + \epsilon_t$$

(2)

$$R_t = \alpha_0 + \alpha_1 EP\text{U}_{t-1} + \alpha_2 GDP_{t-1} + \alpha_3 CREDIT_{t-1} + \alpha_4 DC + \alpha_5 DE + \epsilon_t$$

(3)

$$FIS_t = \alpha_0 + \sum_{i=0}^{3} \alpha_i E_{t-i} + \alpha_2 EP\text{U}_{t-1} + \alpha_3 GDP_{t-1} + \alpha_4 CREDIT_{t-1} + \alpha_5 DC + \alpha_6 DE + \epsilon_t$$

(4)

$$R_t = \alpha_0 + \alpha_1 FIS_{t-1} + \alpha_2 GDP_{t-1} + \alpha_3 CREDIT_{t-1} + \alpha_4 DC + \alpha_5 DE + \epsilon_t$$

(5)

$$R_t = \alpha_0 + \sum_{i=0}^{3} \alpha_i E_{t-i} + \alpha_2 EP\text{U}_{t-1} + \alpha_3 FIS_{t-1} + \alpha_4 GDP_{t-1} + \alpha_5 CREDIT_{t-1} + \alpha_6 DC + \alpha_7 DE + \epsilon_t$$

(6)

Where $R_t$ is return rate of medical stock portfolio at time $t$ in one market as mentioned in the model (1). $EP\text{U}_{t-1}$ represents China’s Economic Policy Uncertainty Index. As there is a lag in the effect of EPU growth on investor sentiment and stock market volatility, we set to lag first order. The involvement of the lag variable is motivated from the possibility of the correlation between the lag value and current value of a variable in the regression model (Verbeek, 2008). $FIS_t$ denotes the investor sentiment, estimated by the PCA method as mentioned above. $\sum_{i=0}^{3} E_{t-i}$ is the ERAs effect variable. The coefficient of $E_{t}$ reflects the contemporaneous effect of ERAs on the rate of portfolio return. $GDP_{t-1}$ is growth rate of GDP. This variable is added into the regression model since economic growth may
Panel A. CRNs (January 23rd 2020)

China

HongKong

Korea

Japan

USA

Panel B. ERAs (January 20th 2020)

China

HongKong

Korea

Japan

USA

(caption on next page)
Fig. 4. Cumulative abnormal returns of medical portfolios in five markets.

Notes: This figure describes the cumulative abnormal returns around the event date of CRNs and ERs (t = 0) for medical stock portfolios in China, Hongkong, Korea, Japan, and U.S. The vertical axis represents the rate of cumulative abnormal returns. The horizontal axis represents event window. Panel A is CRNs. The event date (t = 0) is January 23rd, 2020. Panel B is ERs. The event date (t = 0) is January 20th, 2020. The abnormal returns are defined as the difference between the observed return rate of a medical portfolio and its expected return rate over the whole length of the event window. The estimation window is 120 days. The three-factor model is $r_t = \alpha + \beta_1 r_{mt} + \beta_2 smb_t + \beta_3 hml_t + \epsilon_t$. $r_t$ is the medical stock portfolio return and $r_{mt}$, $smb_t$, and $hml_t$ are Fama-French factors. This study starts with the first CRNs or ERs, ignore all news or events in the proximate 10 days, select the next CRNs or ERs in succession, ignore the following 10 days, and so on. This ensures that event windows are non-overlapping. CRNs occurred from December 1st, 2019 to February 18th, 2020, which includes 6 event days with non-overlapping event windows. ERs occurred from January 1st, 2020 to February 21st, 2020, which includes 5 event days with non-overlapping event windows. The significance of the cumulative abnormal returns is tested through the application of the t-test (Kothari and Warner, 2007).

Influence stock markets in general as well as the medical stocks, in particular through its effects on investor sentiment (Donadelli et al., 2017). $CREDIT - t$ is the growth rate of credit scale. This variable is selected because the growth of credit scale is an indicator of economic certainty (Liu et al., 2016). With the decline of credit scale, firms will be difficult to access funding that assist them to grow in the future. Consequently, investor sentiment towards the future growth of firms will decline (Gilchrist et al., 2010). $\epsilon_t$ is economic certainty. With the decline of credit scale, firms will be difficult to access funding that assist them to grow in the future. Consequently, investor sentiment towards the future growth of firms will decline (Gilchrist et al., 2010). $EPU_t$ is the factor of investor sentiment. The log-likelihood value of the estimated model is shown in the last column. The p-values are in parentheses. * is $p < 0.1$ (10% significant), ** is $p < 0.05$ (5% significant), *** is $p < 0.01$ (1% significant).

Notes: Table 4 shows the results of effects of CRNs and investor sentiment on day-to-day percentage returns of medical portfolios in China (CHN), Hongkong (HK), Korea (KOR), Japan (JPN), and U.S.(US). $\sum_{i=0}^{t} C_{t-i}$ in Panel A is the accumulated effects of all CRNs. $\sum_{i=0}^{t} FIS_{t-i}$ in Panel B measures the accumulated effects of China’s Health Commission Statement and Internet News. $FIS_t$ is the factor of investor sentiment. The log-likelihood value of the estimated model is shown in the last column. The p-values are in parentheses. * is $p < 0.1$ (10% significant), ** is $p < 0.05$ (5% significant), *** is $p < 0.01$ (1% significant).

Table 4

Regression results of CRNs and FIS$_t$.

Panel A. All CRNs (China’s Health Commission Statement + Internet News + Government Order) with FIS$_t$

| Markets | Const. | $R_{-1}$ | $R_{-2}$ | $R_{-3}$ | $D_t^j$ | $\sum_{i=0}^{t} C_{t-i}$ | FIS | DC | DE | LogL |
|---------|--------|---------|---------|---------|--------|-------------------------|------|-----|-----|------|
| CHN     | 0.2093*** | 0.0424* | 0.0239  | 0.0074* | 0.1445** | 0.0133*** | $-0.0119^{***}$ | -0.0069 | -4781.83 |
|         | (0.0407) | (0.0422) | (0.3342) | (0.0618) | (0.0281) | (0.0001) | (0.0001) | (0.6532) |
| HK      | -0.1291** | -0.0586 | -0.0102* | 0.0074  | 0.0843** | 0.0215*** | $-0.0107^{***}$ | $-0.0032$ | -4764.96 |
|         | (0.0235) | (0.4855) | (0.0407) | (0.6119) | (0.0305) | (0.0001) | (0.0000) | (0.4811) |
| KOR     | 0.0529   | $-0.0229$ | 0.0029  | $-0.0269*$ | 0.0697* | 0.0209**  | 0.0752** | $-0.0083$ | -4755.41 |
|         | (0.2388) | (0.3491) | (0.1983) | (0.0869) | (0.0860) | (0.0001) | (0.0000) | (0.5326) |
| JPN     | 0.0492   | $-0.0319$ | 0.0058* | $-0.0325$ | 0.0834** | 0.0094*** | 0.0883*** | $-0.0104$ | -4759.46 |
|         | (0.6721) | (0.4782) | (0.0711) | (0.3627) | (0.0358) | (0.0001) | (0.0000) | (0.7469) |
| US      | 0.0073*  | 0.0155** | $-0.0459$ | 0.0143* | 0.0193** | 0.0211*** | 0.0919*** | $-0.0051$ | -4776.83 |
|         | (0.0877) | (0.0207) | (0.5190) | (0.0792) | (0.0201) | (0.0001) | (0.0000) | (0.4019) |

Panel B. China’s Health Commission Statement + Internet News with FIS$_t$

| Markets | Const. | $R_{-1}$ | $R_{-2}$ | $R_{-3}$ | $D_t^j$ | $\sum_{i=0}^{t} C_{t-i}$ | FIS | DC | DE | LogL |
|---------|--------|---------|---------|---------|--------|-------------------------|------|-----|-----|------|
| CHN     | 0.3219*** | 0.0330  | 0.0193  | 0.0091  | 0.0991** | 0.0117*** | $-0.0210^{***}$ | -0.0045 | -4777.58 |
|         | (0.0000) | (0.2982) | (0.3871) | (0.4731) | (0.0329) | (0.0001) | (0.0001) | (0.3411) |
| HK      | $-0.1028*$ | $-0.0419$ | $-0.0115$ | 0.0137  | 0.0232** | 0.0219*** | $-0.0179^{***}$ | $-0.0137$ | -4754.58 |
|         | (0.0665) | (0.4815) | (0.5194) | (0.5794) | (0.0429) | (0.0000) | (0.0000) | (0.3491) |
| KOR     | 0.0130   | $-0.0622$ | 0.0699  | $-0.0667$ | 0.0109* | 0.0103**  | 0.0126** | $-0.0120$ | -4782.65 |
|         | (0.2345) | (0.5637) | (0.2476) | (0.3404) | (0.0604) | (0.0001) | (0.0000) | (0.2334) |
| JPN     | 0.0174   | $-0.0422$ | 0.0350  | $-0.0117$ | 0.0281** | 0.0087**  | 0.0139** | $-0.0087$ | -4729.58 |
|         | (0.4939) | (0.2429) | (0.3681) | (0.1384) | (0.0291) | (0.0001) | (0.0001) | (0.6481) |
| US      | 0.0642*  | 0.0312*  | $-0.0519$ | 0.0787  | 0.1734** | 0.0269*** | 0.0291*** | $-0.0199$ | -4795.68 |
|         | (0.0578) | (0.0739) | (0.3688) | (0.4463) | (0.0339) | (0.0001) | (0.0001) | (0.2910) |
where \( R_t \) is return rate of medical stock portfolio at time \( t \) in one market measured as in the model (1), \( \gamma_0 \) is the regression intercept, and \( R_{t-1} \) are lagged dependent variables. \( EPU_{t-1} \) represents the China’s Economic Policy Uncertainty Index. Moreover, \( \sum_{t=0}^{T} I_{C_t} \) is the CRNs effect variable. The coefficient \( \gamma_3 \) reflects the contemporaneous effect of CRNs on the portfolio return rate. \( \sum_{t=0}^{T} I_{E_t} \) is the ERAs effect variable. The coefficient \( \gamma_4 \) reflects the contemporaneous effect of ERAs on the portfolio return rate. \( FIS_t \) denotes the investor sentiment. \( \mu_t \) is an error term. Based on the Hypothesis 4, the total effects are measured by the coefficient of CRNs and ERAs. Based on the Eq. (7), we can compare \( \gamma_3 \) and \( \gamma_4 \) to explore the relationship between total effects of CRNs and ERAs with the medical portfolio returns in the five markets. Notably, we also add two dummy variables, which are \( DC \) and \( DE \), to respectively control for Coronavirus news mainly from Hong Kong, Korea, Japan and U.S. and other macroeconomic announcements from China, that may affect return of the medical stocks. Table A5 and A6 in Appendix shows the details of these announcements and news. In which, this variable is measured at 1 for the occurrence of other macroeconomic news in studied windows and 0 for otherwise.

4. Results

4.1. Event study approach

This study starts from the first event of CRNs or ERAs and ignores other events within 10 days to avoid the overlapping. Fig. 4 respectively describes the CRAs around event dates of CRNs (January 23rd, 2020) and ERAs (January 20th, 2020). Based on this method, we can observe: 1) an increase in returns of the medical stock portfolios on the event day of CRNs in the five markets; 2) a decrease in returns of the medical stock portfolios on the event day of ERAs. Moreover, the CRAs of the five stock markets after the case events of CRNs (ERAs) are persistent increasing (decreasing) following the event. However, medical stock portfolio in the U.S. does not support the results. Compared with regression model, the event study results may be weaker, as 9 out of 13 CRNs and 6 out of 10 ERAs were employed (Donadelli et al., 2016). This study also computes the other selected CRNs and ERAs, as shown Fig. 1 in Appendix. These results of other events of CRAs and ERAs are similar with Fig. 4. Hence, the results of event study reveal the persistent effects of CRNs and ERAs on the return of medical stock portfolios in the five markets.

4.2. Regression analysis

To examine Hypothesis 1, we observe the effects of CRNs and investor sentiment on the returns of medical stock portfolios in the five markets. Based on Eq. (1), Panel A in Table 4 shows that the effects of all CRNs and investor sentiment on medical stock portfolios. For robustness test, we use the China’s Health Commission statements and Internet news to replace the CRNs, as shown in Panel B. From Panel A and B in Table 4, CRNs have a significant and positive effect on the medical portfolio returns in the five markets, which confirmed Hypothesis 1. The coefficient \( \beta_2 \) estimate ranges from 0.0107 (Korea) to 0.0501 (Hong Kong). The investor sentiment factor in the five stock markets on the medical portfolio returns are significant at the 1% level.

We can find some interesting results for the coefficient of CRNs and investor sentiment factor in Chinese-related stock markets and non-Chinese stock markets in Table 4 (Panel A and B). To the Chinese-related markets, we find that the effects of CRNs on the Hong Kong medical portfolios return (0.0501) are stronger than the China mainland (0.0324). Specifically, as the result of weak prevention of SARS, the Hang Seng Index experienced a significant decline from February to April 2003. Since January 2020, the dangerous spread of Coronavirus has generated intensive public concerns in Hong Kong by the coverage of CRNs. To a certain extent, the CRNs have released a positive signal to Hong Kong stock market; that is, there will be no further decline in stock prices caused by the control and prevention of the Coronavirus.

Additionally, the investor sentiment factors in China mainland (−0.1591) and Hong Kong (−0.1022) play negative effects on the medical portfolios return. In the epicenter of the outbreak, the public and investors in China mainland and Hong Kong are sensitive to the CRNs. Based on this, the pessimistic investment sentiment in China mainland and Hong Kong stock market are stronger than non-Chinese stock markets. This result confirms Kaplan and Levy (2012), who state investor sentiment has a negative effect on the stock market return of the Tel Aviv Stock Exchange under the 1973 Arab–Israel War. Furthermore, this the negative effects of CRNs on sentiment of investors in China aligned with findings on the negative effects of the fear of infectious diseases on investor sentiment of Donadelli, et al. (2017).

To the non-Chinese stock markets, we find that the effects of CRNs and investor sentiment on medical stock portfolios are positive, wherein the effects on U.S. market are strongest. We could interpret this result in two perspectives. First, from the cases of infection, the smaller the number of cases, the greater the effects of CRNs and investor sentiment on the return of medical stocks portfolio. In the period of Coronavirus outbreak in China, there is no or small number of Coronavirus cases in United States. Therefore, the fear of Covid-19 outbreak in other countries outside China, including the United States was not as high as in China, which was experiencing the boom of infected cases and deaths. This explanation can be supported by Donadelli et al. (2016), wherein when disease does not actually spread in the United States, the related disease information can trigger a positive sentiment among U.S. investors. Second, from the perspective of technological level of medical industry, the more advanced the technology of medical industry, the greater the effects of CRNs and investor sentiment on the return of medical stocks portfolio. As we known, the U.S. medical industry is at the

---

3 Based on the Table 1, the news from the China’s Health Commission and Internet have occupied the majority of CRNs. China’s Health Commission Statement and Internet news can represent the official and unofficial channel of CRNs.
world’s leading level. When Coronavirus outbreak is announced in China, these medical list companies on the NYSE or NASDAQ tend to invest in production and R&D for raising the positive expectations on their future cash flows and valuation. The coefficient of \( DC \) and \( DE \) are respectively insignificant on the five markets’ medical portfolio returns.

Moreover, we observe the effects of ERAs and investor sentiment on the returns of the five markets’ medical stock portfolios for exploring Hypothesis 2. Firstly, this study examines that all \( \alpha_1 \) of Eq. (2) to (5) are significant at the 5% level, which indicates that there exists significant relationship between ERAs, EPU, investor sentiment with the return of the five markets’ medical stock portfolios. Based on Eq. (6), Panel A in Table 5 shows the effects of all ERAs and investor sentiment on the return of medical stock portfolios. This study uses the China’s Development and Reform Commission Statement to represent the ERAs for the robustness checking, as shown in Panel B. From Panel A and B in Table 5, CRNs have a significant and positive effect on the medical portfolio returns in the five markets, which rejected Hypothesis 2. The coefficient \( \alpha_1 \) estimate ranges from 0.0057 (U.S.) to 0.0146 (Hongkong). Additionally, the investor sentiment factor in the five stock markets on the medical portfolio returns are significant at the 1% level. The coefficient of \( DC \) and \( DE \) are respectively insignificant on the five markets’ medical portfolio returns.

To Chinese-related stock market, we find that the effects of ERAs and investor sentiment on the medical stock portfolios in China mainland and Hongkong are positive and significant. With Coronavirus outbreak, ERAs have been frequently issued in first two months of 2020. From Table 2, we investigate the ERAs through the monetary and fiscal instruments for controlling the adverse effects of epidemic, which the ERAs stabilize China mainland and Hongkong investors’ panic on macroeconomic recession caused by the Coronavirus. In this scenario, the ERAs for stabilizing the Coronavirus can be treated as a positive signal to investors in China mainland and Hongkong. Moreover, the demand of medical products in China mainland and Hongkong can increase the expected valuation of medical stocks in epidemic outbreak. This result agrees with Donadelli et al. (2016), who state investors should buy medical stocks when an infectious disease outbreak is announced. Under this condition, ERAs have positive and significant effects on the return of medical stock portfolios in Chinese-related stock market. Although the effects of ERAs on five stock markets are relatively consistent in Table 5, there are significant differences in investor sentiment between Chinese-related stock markets and non-Chinese stock markets. The ultimate differences emerge from the effects of Chinese economic policy uncertainty (EPU). With the frequently issued ERAs, the \( EPU_{-1} \) has significant and negative effects on the non-Chinese stock markets, whereas the effects on Chinese-related stock markets are insignificant. China as a major producer of intermediate products in the world has stronger spillover effects on the global economic stable, which means that the Chinese EPU increased can induce the pessimistic investor sentiment (Baker and Wurgler, 2006; Li et al., 2013; Zhang, 2018). Hence, investors in Korea, Japan and U.S. adjust their existing investment portfolio and invest in the medical industry which will benefit from the Coronavirus for avoiding the risk of economic policy uncertainty.

Furthermore, we investigate the effects of ERAs and different kinds of investors on the returns of five markets’ medical stock portfolios for testing the Hypothesis 3. This study uses the PCA method to construct the factor of individual investor sentiment (IIS) and institutional investor sentiment (IIS). Panel A and B in Table 6 respectively shows the effects of ERNs and individual/institutional investor sentiment on the five markets’ medical stock portfolios. From Table 6, the effects of ERAs and individual (institutional) investor sentiment on the five markets’ medical stock portfolios are similar with the FIS, ERAs have significant effects at the 5% level on the institutional investor sentiment and medical portfolio returns are stronger than the individual investor (significant at the 10% level), which rejected the Hypothesis 3. This result agrees with Schmeling (2008), who argues that the institutional investor sentiment is the representative of “smart money” and the individual investor sentiment is the representative of noise trader risk. In Table 6, we can observe the effects of EPU in Panel B are significant, whereas the insignificant effects in Panel A. Kumar and Lee (2006) state that the individual investors’ portfolios are relatively simplistic. This statement supports the institutional investors need to collect more information than the individual investors. Through the depth interpretation of ERAs and related Coronavirus information, the institutional investor sentiment can determine the investors’ overall mood. Within Coronavirus outbreak, any wrong investment decisions would cost much more than the normal period. In this scenario, individual investors prefer to hold the limited assets and wait for the institutional investors’ decisions. Based on this condition, the ERAs have stronger effects on the institutional investor sentiment and five markets’ medical portfolio returns than the individual investor sentiment.

Lastly, for examining Hypothesis 4, we explore the total effects of the CRNs and ERAs on the five markets’ medical stock portfolios. Based on Eq. (7), Panel A in Table 7 shows that the total effects of the two kinds of news and investor sentiment on medical stock portfolios. For robustness checking, we respectively use the China’s Health Commission Statement and Internet news and China’s Development and Reform Commission Statement to replace the CRNs and ERAs, as shown in Panel B. From Panel A and B in Table 7, CRNs have positive and significant effects at the 1% level on the five markets’ medical stock portfolio returns. While the effects of ERAs on the five markets’ medical stock portfolios returns are negative and significant at the 10% level. The investor sentiment with CRNs and ERAs are positive and significant on the medical stock portfolios. Hence, the total effects of CRNs and ERAs on the medical portfolio returns in five markets are positive, which confirmed Hypothesis 4. This result agrees with Donadelli et al. (2016), who underscore that investors should buy stocks when an infectious disease outbreak is announced. It means that the CRNs with Coronavirus outbreak can attract a large scale of asset to invest the medical companies, which CRNs can trigger an optimistic view and a positive sentiment effect on the five markets’ investors. Based on this condition, the total effects of CRNs and ERAs on the five markets’ medical stock portfolios are positive and significant through the optimistic investor sentiment. The coefficient of \( DC \) and \( DE \) are respectively insignificant on the five markets’ medical portfolio returns.

---

4 Based on the Table 2, the announcements from the China’s Development and Reform Commission Statement have occupied the majority of ERAs.
returns in five stock markets. Hence, investors perceived that the investment in pharmaceutical stocks would be a good choice in the context of the spread of this unprecedented infectious disease.

This finding, hence, is in the alignment with findings of Donadelli et al. (2016) as these scholars have found that news associated with dangerously infectious disease positively influenced the stock returns of pharmaceutical industry.

It is the factor of investor sentiment. The log-likelihood value of the estimated model is shown in the last column. The p-values are in parentheses. “<” p < 0.1 (10% significant), “<” p < 0.05 (5% significant), “<” p < 0.01(1% significant).

5. Discussions

This study has found that although CRNs posed significant negative effects on investor sentiment in Chinese stock markets, their effects on investor sentiment in other stock markets were positive. The negative effects of CRNs on investor sentiment in Chinese stock markets can be justified by the spread of Covid-19 outbreak in this country in the first quarter of 2020 with significant chaos, the emergence of fear due to the increasing number of infected cases and deaths, and the economic uncertainties with regional lockdowns, travel restrictions, and demand drops (Fernandes, 2020). However, at that time, the spread of this outbreak outside China was limited, so investor sentiment in other stock markets was positive as investors believed that the medical industry could deal well with this outbreak and huge business opportunities could be gained for this industry. Such findings, thus, supported findings of Donadelli et al. (2017) since the author found that infectious diseases related news created a fear, which reduced investor sentiment in the pharmaceutical industry (on Main street) but increased investor sentiment on Wall street. The divergent effects of CRNs on investor sentiment reflected the different perceptions of investors regarding news published as mentioned by the behavioral finance (Kaplanski and Levy, 2010a, 2010b).

In overall, this study confirmed the first hypothesis as CRNs positively influence pharmaceutical stock returns in five stock markets. Hence, investors perceived that the investment in pharmaceutical stocks would be a good choice in the context of the spread of this unprecedented infectious disease.

On the other hand, this study has found that ERNs significantly and positively influenced medical stock performance of five countries’ stock markets. Thus, the second hypothesis has been rejected as it hypothesized that ERNs have a negative effect on stock returns of medical portfolios in five countries as suggested by the linkage between changes in economic policies and economic uncertainties (Liu et al., 2016). This finding, hence, is in the alignment with findings of Donadelli et al. (2016) as these scholars have found that news associated with dangerously infectious disease positively influenced the stock returns of pharmaceutical industry. Despite the reduction of investor sentiment found in Chinese stock markets, the investment in the medical industry was still a better choice than other industries in the context of Covid-19 outbreak due to the investor’s consideration to their future gains through the development of vaccines.

Unlike hypothesized, this study has found that the ERNs have stronger significant positive effects on institutional investors’ sentiment and their medical portfolio’s performance. Thus, the third hypothesis has been rejected. This finding, thus, agreed with Schmeling (2008), who argued that the institutional investor sentiment is the representative of “smart money” and the individual investor sentiment is the representative of noise trader risk. With the ability to acquire information and analyze it, institutional investors would be more confident to the future of medical stocks than individual investors, who might be significantly driven by the fear...
effects on the five markets produce negative investor sentiment on medical portfolios in Chinese-related stock markets, aligned with findings of Donadelli, et al. (2017) on the negative impacts of the fear of infectious diseases on pharmaceutical stock performance. Differently, the investor sentiment has been found to be positive in other countries, meaning that when China was in struggle with the Covid-19 outbreak in the first quarter of 2020 and this outbreak was not spread outside China at that time, the fear of this disease did not emerge in other stock markets. However, in general, the CRNs exert significant and positive effects on the five markets’ medical portfolios. Secondly, the ERAs generate significantly positive investor sentiment on medical portfolios in Chinese-related stock markets, whereas the negative investor sentiment in non-Chinese stock markets. For all market in general, the effects of ERAs medical portfolios are significant and of Covid-19 outbreak.

Lastly, this study confirmed the fourth hypothesis, which hypothesized that total effects of CRNs and ERNs on investor sentiment and medical stock returns were positive. This finding, thus, confirmed the claim of Donadelli, et al. (2017) as these scholars indicated that in the context of the spread of dangerous infectious diseases, while the overall market might experience the significant fear due to travel restrictions, supply chain disruptions, and demand decline, investors tended to allocate their resources to the medical industry. Therefore, the stock returns of medical portfolios increased. In the other words, the decline in investor sentiment (i.e. negative effects of CRNs and ERNs on investor sentiment in Chinese stock markets) would be offset by potential benefits that investors could gain when investing in this industry.

In a summary, this study, with its empirical evidence, suggested that investors did not behave irrationally in general during the Covid-19 outbreak emerged and spread over the first quarter of 2020 in China. Thus, the argument of Donadelli, et al. (2017) on the non-existence of irrational behaviours of investors when getting dangerously infectious diseases-related news is still confirmed by this study with several additional contributions added – the difference in investor sentiment between institutional and individual investors as well as their medical portfolios, the heterogeneity in effects of CRNs on investor sentiment in different countries due to different institutional factors, and the overall positive effects of both CRNs and ERNs on investor sentiment and medical stock returns.

### 6. Conclusions

The large number of relevant studies show that new information about emergency events plays a significant effect on the investor sentiment. With Coronavirus outbreak in January 2020, this study investigates whether CRNs and ERAs have significant sentiment effects on the five markets’ medical companies.

These results show that the different kinds of investors in different markets have different investment sentiments, while they have the same investment decisions; that is, to invest in the medical stocks. Four main conclusions are drawn in this paper. First, CRNs produce negative investor sentiment on medical portfolios in Chinese-related stock markets, aligned with findings of Donadelli, et al. (2017) on the negative impacts of the fear of infectious diseases on pharmaceutical stock performance. Differently, the investor sentiment has been found to be positive in other countries, meaning that when China was in struggle with the Covid-19 outbreak in the first quarter of 2020 and this outbreak was not spread outside China at that time, the fear of this disease did not emerge in other stock markets. However, in general, the CRNs exert significant and positive effects on the five markets’ medical portfolios. Secondly, the ERAs generate significantly positive investor sentiment on medical portfolios in Chinese-related stock markets, whereas the negative investor sentiment in non-Chinese stock markets. For all market in general, the effects of ERAs medical portfolios are significant and
Table 7
Regression results of total effects

Panel A. All CRNs and ERAs with FIS

| Markets | Const.  | \( R_{-1} \) | \( R_{-2} \) | \( R_{-3} \) | \( EPU_{-1} \) | \( \sum_{i=0}^{3} C_{-i} \) | \( \sum_{i=0}^{3} E_{-i} \) | FIS \( t \) | DC | DE | LogL |
|---------|---------|-------------|-------------|-------------|-------------|----------------|----------------|----------|----|----|------|
| CHN     | 0.0198**, 0.0116* | 0.0047 | 0.0128* | -0.0419 | 0.0186*** | -0.00115* | 0.0049*** | -0.0218 | -4794.62 |
| HK      | -0.0208*, -0.0636* | -0.0219* | 0.0276 | -0.0418 | 0.0198*** | -0.0109* | 0.0079*** | -0.0245 | -4776.86 |
| KOR     | 0.0397 | -0.0329 | -0.0291 | -0.0376* | -0.0390* | 0.0119*** | -0.00129* | 0.0059*** | -0.0198 | -4790.58 |
| JPN     | 0.0096 | -0.0397 | -0.0516* | -0.0526 | -0.0419* | 0.0167*** | -0.0135* | 0.0073*** | -0.0151 | -4791.43 |
| US      | 0.0292* | 0.0119* | -0.0391 | 0.0137* | -0.0291* | 0.0188*** | -0.0179* | 0.0089*** | -0.0289 | -4798.86 |

Panel B. Partly CRNs and ERAs with FIS

| Markets | Const.  | \( R_{-1} \) | \( R_{-2} \) | \( R_{-3} \) | \( EPU_{-1} \) | \( \sum_{i=0}^{3} C_{-i} \) | \( \sum_{i=0}^{3} E_{-i} \) | FIS \( t \) | DC | DE | LogL |
|---------|---------|-------------|-------------|-------------|-------------|----------------|----------------|----------|----|----|------|
| CHN     | 0.0159**, 0.0048* | 0.0074 | 0.0096* | -0.0481 | 0.0083*** | -0.0114* | 0.0049*** | -0.0371 | -4688.78 |
| HK      | -0.0219* | -0.0205 | -0.0252* | 0.0198 | -0.0431 | 0.0134*** | -0.0105* | 0.0064*** | -0.0299 | -4647.91 |
| KOR     | 0.0139 | -0.0598 | -0.0155 | -0.0295* | -0.0426* | 0.0068*** | -0.0115* | 0.0057*** | -0.0317 | -4677.46 |
| JPN     | 0.0085 | -0.0291 | -0.0496* | -0.0536 | -0.0512* | 0.0079*** | -0.0109* | 0.0086*** | -0.0298 | -4694.52 |
| US      | 0.0179* | 0.0059* | -0.0286 | 0.0138* | -0.0493* | 0.0094*** | -0.0079* | 0.0104*** | -0.0382 | -4773.93 |

Notes: Table 7 shows the results of effects of ERAs and investor sentiment on day-to-day percentage returns of medical portfolios in China (CHN), Hongkong (HK), Korea (KOR), Japan (JPN), and U.S. (US). \( \sum_{i=0}^{3} C_{-i} \) in Panel A is the accumulated effects of all CRNs. \( \sum_{i=0}^{3} E_{-i} \) in Panel B measures the accumulated effects of China’s Health Commission Statement and Internet News. \( \sum_{i=0}^{3} C_{-i} \) in Panel A is the accumulated effects of all ERAs. \( \sum_{i=0}^{3} E_{-i} \) in Panel B measures the accumulated effects of China’s Development and Reform Commission Statement. FIS \( t \) is the factor of investor sentiment. The log-likelihood value of the estimated model is shown in the last column. The p-values are in parentheses. *" is \( p < 0.1 \) (10% significant), **" is \( p < 0.05 \) (5% significant), ***" is \( p < 0.01 \) (1% significant).
positive. Third, the effects of ERAs on the institutional investor sentiment in the five markets’ medical portfolio returns are stronger than the individual investor sentiment. Last, the total effects of CRNs and ERAs on five markets’ medical stock portfolios are positive and significant through the optimistic investor sentiment.

Overall, with the Coronavirus, we argue that CRNs and ERAs do not trigger irrational investment decisions. When there is no obvious way to control the Coronavirus, investors with different sentiments should allocate asset to the medical companies. With Coronavirus outbreak, the expected cash flows of these medical companies should be raised by the demand for medical device, chemical pharmaceuticals, vaccine research and development. Moreover, the unpredicted Coronavirus directly lead to a reduction in capital allocation, which means that the costs of wrong investment decision are higher than the normal period. When an infectious disease outbreak announced, invested in medical companies could effectively avoid risks (Donadelli et al., 2016).

Acknowledgement

The authors acknowledge the financial supports from the Philosophy & Social Science Fund of Tianjin City, China (TJYYQN19-004).

Appendix A. Appendix

Table A1

| Market | Code   | Name                                      | Market Capital |
|--------|--------|-------------------------------------------|----------------|
| CHN    | 300,122.SZ | Chongqing Zhifei Biological Products Co., Ltd. | 100.8810       |
| CHN    | 601,607.SH | Shanghai Pharmaceuticals Holding Co., Ltd | 65.1831        |
| CHN    | 002252.SZ | Shanghai RAAS Blood Products Co., Ltd      | 50.7650        |
| CHN    | 000028.SZ | China National Accord Medicines Corporation Ltd. | 25.1588 |
| CHN    | 300,685.SZ | Amoy Diagnostics Co., Ltd                  | 14.7811        |
| CHN    | 002880.SZ | Shenzhen Weiguang Biological Products Co., Ltd | 7.36744        |
| CHN    | 300,078.SZ | Hangzhou Century Co., Ltd                 | 15.5318        |
| CHN    | 300,253.SZ | Winning Health Technology Group Co., Ltd.  | 35.5721        |
| CHN    | 300,451.SZ | B-Soft Co., Ltd.                          | 17.1611        |
| CHN    | 300,550.SZ | Heren Health Co., Ltd.                    | 4.4778         |
| HK     | 2269.HK | Wuxi Biologics (Cayman) Inc.              | 163.1231       |
| HK     | 0241.HK | Alibaba Health Information Technology Limited | 138.2753      |
| HK     | 1099.HK | Sinopharm Group Co., Ltd.                 | 107.9912       |
| HK     | 2196.HK | Shanghai Fosun Pharmaceutical (Group) Co., Ltd. | 92.8444        |
| HK     | 0874.HK | Guangzhou Baiyunshan Pharmaceutical Holdings Company Limited | 78.8603 |
| HK     | 1833.HK | Ping An Healthcare And Technology Company Limited | 77.5036      |
| HK     | 1066.HK | Shandong Weigao Group Medical Polymer Co. Limited | 53.95315983  |
| HK     | 1255.HK | S.Culture International Holdings Limited | 19.3742        |
| HK     | 0512.HK | China Grand Pharmaceutical and Healthcare Holding Limited | 18.2927      |
| HK     | 0460.HK | Siluan Pharmaceutical Holdings Group Ltd. | 11.2445        |
| US     | EBS-N | Emergent Biosolutions Inc.                | 1165.9845      |
| US     | GNCA.O | Genocea Biosciences Inc.                  | 540.9828       |
| US     | HTBX.O | Heat Biologics Inc.                       | 416.4352       |
| US     | BIOA.O | iBio, Inc.                                | 416.4352       |
| US     | INO-O | Inovio Pharmaceuticals, Inc.              | 120.5587       |
| US     | MRKR-O | Marker Therapeutics, Inc.                 | 62.3617        |
| US     | SVA.O | Sinovac Biotech Ltd.                      | 33.8078        |
| US     | BAX.N | Baxter Intl                               | 28.8103        |
| US     | CEMI.O | Chembio Diagnostics Inc.                  | 28.3207        |
| US     | CMD.N | Cantel Medical Corp                       | 26.9658        |
| JPN    | 4502.T | Takeda Pharmaceutical Company Limited     | 641.4568       |
| JPN    | 4519.T | Chugai Pharmaceutical Co., Ltd.           | 488.6260       |
| JPN    | 4568.T | Daiichi Sankyo Co., Ltd                  | 444.3934       |
| JPN    | 4543.T | Terumo Corporation                        | 266.4706       |
| JPN    | 4523.T | Eisai Co., Ltd.                           | 219.6892       |
| JPN    | 7733.T | Olympus Corporation                       | 203.3582       |
| JPN    | 2413.T | M3Inc.                                    | 186.5418       |
| JPN    | 4556.T | Rainos Laboratories                       | 0.4010         |
| JPN    | 4582.T | Symbio Pharmaceuticals Limited            | 1.4264         |
| JPN    | 4503.T | Astellas Pharma Inc.                      | 322.1937       |
| KOR    | 207,940.KS | Samsung Biologies Co., Ltd            | 220.1322       |
| KOR    | 068270.KS | Celltrion Inc.                          | 188.8055       |
| KOR    | 128,940.KS | Hanmi Pharm. Co., Ltd.              | 31.3686        |
| KOR    | 000100.KS | Yuhan Corporation                        | 23.3344        |
| KOR    | 145,020.KS | Hugel Inc.                         | 16.8190        |
| KOR    | 084990.KS | Helixmith                             | 16.3858        |
| KOR    | 009420.KS | Hanall Biopharma Co., Ltd.              | 14.9512        |

(continued on next page)
Table A1 (continued)

| Market | Code     | Name                  | Market Capital |
|--------|----------|-----------------------|----------------|
| KOR    | 095700.KS| Genexine Inc.         | 10.2941        |
| KOR    | 215,600.KS| Sillajen Inc.         | 8.7107         |
| KOR    | 303,360.KS| Proteometech Inc.     | 0.5524         |

Notes: List of medical companies in five market are sorted by two criteria: (1) Medical company is mainly engaged in medical device production, chemical pharmaceuticals, vaccine research and development; (2) Medical company has a large market capitalization. Market capitalization is the sample average during the analyzed period in millions of USD.

Table A2
Variable list of investor sentiment in five markets.

| Market | Name Variables | Transformation Code | Factor Loadings | Weight of Main Variables |
|--------|----------------|---------------------|-----------------|--------------------------|
| China  | IS1 Growth rate of New investor account opening | 2 | 0.0231 | 24.78% |
|        | IS2 Discount rate Closed-end fund | 1 | 0.1460 | 18.96% |
|        | IS3 Turnover rate | 2 | 0.0143 | 9.05% |
|        | IS4 Growth rate of Consumer Confidence Index (CCI) | 1 | 0.1364 | 13.19% |
|        | IS5 VIX | 2 | 0.2647 | 34.02% |

Notes: Data are extracted from Wind database and Bloomberg. The transformation codes (T) are: 1 – no transformation; 2 – first difference. This table summarizes results factor loadings and weight of main variables in five markets’ investor sentiment group. VIX indicates the investor fear (Whaley, 2009).

Table A3
Variable list of individual investor sentiment in five markets.

| Market | Name Variables | Transformation Code | Factor Loadings | Weight of Main Variables |
|--------|----------------|---------------------|-----------------|--------------------------|
| China  | DIS1 Growth rate of new people opening accounts | 2 | 0.0132 | 56.78% |
|        | DIS2 Discount rate Closed-end fund | 1 | 0.0417 | 24.96% |
|        | DIS3 Turnover rate | 2 | 0.0292 | 11.47% |
### Table A3 (continued)

#### China

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| DIS4  | Deposit Reserve Ratio                  | 2                   | 0.0233          | 6.79%                    |

#### Hongkong

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| DIS1  | Growth rate of new people opening accounts | 2                 | 0.0119          | 51.23%                   |
| DIS2  | Discount rate Closed-end fund          | 1                   | 0.0346          | 19.96%                   |
| DIS3  | Turnover rate                          | 1                   | 0.0294          | 12.15%                   |
| DIS4  | Deposit Reserve Ratio                  | 2                   | 0.0167          | 16.66%                   |

#### Korea

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| DIS1  | Growth rate of new people opening accounts | 1                 | 0.0202          | 57.31%                   |
| DIS2  | Discount rate Closed-end fund          | 1                   | 0.0173          | 16.53%                   |
| DIS3  | Turnover rate                          | 2                   | 0.0239          | 13.67%                   |
| DIS4  | Deposit Reserve Ratio                  | 2                   | 0.0083          | 12.49%                   |

#### Japan

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| DIS1  | Growth rate of new people opening accounts | 2                 | 0.0188          | 55.68%                   |
| DIS2  | Discount rate Closed-end fund          | 1                   | 0.0169          | 19.29%                   |
| DIS3  | Turnover rate                          | 2                   | 0.0352          | 14.51%                   |
| DIS4  | Deposit Reserve Ratio                  | 2                   | 0.0117          | 10.52%                   |

#### U.S.

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| DIS1  | Growth rate of new people opening accounts | 1                 | 0.0216          | 56.12%                   |
| DIS2  | Discount rate Closed-end fund          | 1                   | 0.0193          | 17.65%                   |
| DIS3  | Turnover rate                          | 2                   | 0.0373          | 15.98%                   |
| DIS4  | Deposit Reserve Ratio                  | 2                   | 0.0217          | 10.25%                   |

Notes: Data are extracted from Wind database and Bloomberg. The transformation codes (T) are: 1 – no transformation; 2 – first difference. This table summarizes results factor loadings and weight of main variables in five markets' individual investor sentiment group.

### Table A4

Variable list of institutional investor sentiment in five markets.

#### China

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| IIS1  | Growth rate of institutions' new opening accounts | 2                 | 0.0322          | 27.38%                   |
| IIS2  | Turnover rate                          | 2                   | 0.0107          | 14.63%                   |
| IIS3  | P/E ratio                              | 1                   | 0.0286          | 23.76%                   |
| IIS4  | VIX                                    | 2                   | 0.0442          | 34.29%                   |

#### Hongkong

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| IIS1  | Growth rate of institutions' new opening accounts | 2                 | 0.0143          | 25.53%                   |
| IIS2  | Turnover rate                          | 2                   | 0.0249          | 16.59%                   |
| IIS3  | P/E ratio                              | 1                   | 0.0167          | 22.49%                   |
| IIS4  | VIX                                    | 1                   | 0.0442          | 35.39%                   |

#### Korea

| Name  | Variables                              | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|----------------------------------------|---------------------|-----------------|--------------------------|
| IIS1  | Growth rate of institutions' new opening accounts | 1                 | 0.0224          | 23.48%                   |
| IIS2  | Turnover rate                          | 2                   | 0.0135          | 13.88%                   |
| IIS3  | P/E ratio                              | 1                   | 0.0264          | 26.37%                   |
| IIS4  | VIX                                    | 2                   | 0.0398          |                          |

(continued on next page)
### Table A4 (continued)

| Korea | Variables | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|-----------|---------------------|-----------------|--------------------------|
| Name  | IIS1      | Growth rate of institutions' new opening accounts | 2 | 0.0126 | 24.33% |
|       | IIS2      | Turnover rate       | 2 | 0.0189 | 16.74% |
|       | IIS3      | P/E ratio           | 1 | 0.0218 | 26.59% |
|       | IIS4      | VIX                 | 1 | 0.0325 | 32.34% |

| Japan | Variables | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|-----------|---------------------|-----------------|--------------------------|
| Name  | IIS1      | Growth rate of institutions' new opening accounts | 2 | 0.0126 | 24.33% |
|       | IIS2      | Turnover rate       | 2 | 0.0189 | 16.74% |
|       | IIS3      | P/E ratio           | 1 | 0.0218 | 26.59% |
|       | IIS4      | VIX                 | 1 | 0.0325 | 32.34% |

| U.S.  | Variables | Transformation Code | Factor Loadings | Weight of Main Variables |
|-------|-----------|---------------------|-----------------|--------------------------|
| Name  | IIS1      | Growth rate of institutions' new opening accounts | 1 | 0.0217 | 25.68% |
|       | IIS2      | Turnover rate       | 2 | 0.0156 | 12.69% |
|       | IIS3      | P/E ratio           | 1 | 0.0254 | 25.39% |
|       | IIS4      | VIX                 | 1 | 0.0391 | 36.24% |

Notes: Data are extracted from Wind database and Bloomberg. The transformation codes (T) are: 1 – no transformation; 2 – first difference. This table summarizes results factor loadings and weight of main variables in five markets’ institutional investor sentiment group.

### Table A5
Coronavirus news from Hongkong, Korea, Japan and U.S.

#### Panel A. Hongkong

| Date   | News/Announcement                             |
|--------|-----------------------------------------------|
| 2020/1/3 | Five Coronavirus cases in Hongkong            |
| 2020/1/20 | Passenger Health Declaration System for Flights from Wuhan |
| 2020/2/4 | Reported 1 death case of Coronavirus in Hongkong |

#### Panel B. Korea

| Date   | News/Announcement                             |
|--------|-----------------------------------------------|
| 2020/1/8 | Unexplained pneumonia patient in Korea        |
| 2020/1/20 | Five Coronavirus cases in Korea               |
| 2020/2/4 | Restrictions on Hubei residents and who have visited Hubei within 14 days |
| 2020/2/5 | Suspension of visa free policy for Chinese citizens in Korea |
| 2020/2/18 | Korea brings Coronavirus infection into “severe acute respiratory infectious disease supervision system” |
| 2020/2/20 | Reported 1 death; the possibility of human-to-human transmission in Korea |
| 2020/2/21 | Confirmed that medical staff are infected by Coronavirus in Korea |

#### Panel C. Japan

| Date   | News/Announcement                             |
|--------|-----------------------------------------------|
| 2020/1/16 | First Coronavirus cases in Japan             |
| 2020/1/23 | All entry personnel from Wuhan to report immediately if they have fever and other symptoms |
| 2020/2/5 | 33 confirmed Coronavirus cases in Japan      |
| 2020/2/11 | Restrictions on Hubei residents and who have visited Hubei within 14 days |
| 2020/2/13 | Reported 1 death; the possibility of human-to-human transmission in Japan |
| 2020/2/18 | 500 confirmed Coronavirus cases in Japan     |

#### Panel D. U.S.

| Date   | News/Announcement                             |
|--------|-----------------------------------------------|
|        | First Coronavirus case in U.S.                |

(continued on next page)
Table A5 (continued)

Panel D. U.S.

| Date   | News/Announcement                                                                 |
|--------|-----------------------------------------------------------------------------------|
| 2020/1/21 | First case of human-to-human transmission in U.S.                                  |
| 2020/1/30 | Restrictions on Hubei residents and who have visited Hubei within 14 days          |
| 2020/2/1  | If the Coronavirus risk escalates, measures such as closing schools and enterprises may be taken |

Table A6

Macroeconomic news/announcement from China.

| China    | Announcements                                                                 |
|----------|-----------------------------------------------------------------------------|
| 2020/1/26 | Facilitation of procurement for epidemic prevention and control              |
| 2020/2/6  | Support novel coronavirus infection in preventing and controlling the epidemic situation of pneumonia |
| 2020/2/7  | Guarantee enterprise financial support in Coronavirus                        |
| 2020/2/22 | Reduce the power cost of enterprises in Coronavirus                          |
Panel A. CRNs

December 1st 2019

December 31st 2019

January 12th 2020

February 7th 2020

February 18th 2020

Panel B. ERAs

January 1st 2020

February 1st 2020

February 12th 2020

February 23rd 2020

Fig. A1. Cumulative abnormal returns of medical stock portfolios in five markets.

References

Abdi, H., Williams, L., 2010. Principal component analysis. Wiley Interdiscip. Rev. Comput. Stat. 2 (4), 433–459.
Baker, M., Stein, J., 2004. Market liquidity as a sentiment indicator. J. Financ. Mark. 7, 271–299.
Baker, M., Wurgler, J., 2006. Investor sentiment and the cross-section of stock return. J. Financ. 61 (4), 1645–1680.
Baker, M., Wurgler, J., 2007. Investor sentiment in the stock market. J. Econ. Perspect. 21 (2), 129–152.
