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Does China's stock market react to COVID-19 differently at industry level? Evidence from China

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ABSTRACT

Since the outbreak of the COVID-19 pandemic in 2020, global economic growth has been negatively affected. The reaction of financial markets was particularly dramatic, especially in countries severely affected by the outbreak. Based on Shanghai Stock Exchange (SSE) data from August 13, 2019 to December 31, 2020, this study investigates the short-term and the long-term market reactions of industry indices. The event study method and the Fama-French five-factor model are used to analyse the effect of the COVID-19 pandemic. Findings reveal that cumulative abnormal returns (CARs) in most industries followed a similar short-term trajectory. However, the excess returns of the SSE Information Technology, SSE Telecommunication Services and SSE Materials show different performance in the long term. This study facilitates the analysis of the impact of large public emergencies, such as global pandemics, on investors' expectations and decision-making. It also helps investors to make rational decisions and the government to formulate targeted policies.

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1. Introduction

As economic integration and financial globalization increases, so does uncertainty when it comes to the impact of unexpected public emergencies on the world economy (Ozili & Arun, 2020). The World Health Organization (WHO) identified the spread of a novel coronavirus (COVID-19), which was deemed a global pandemic on March 11, 2020. The global pandemic and its resulting series of chain reactions can have a negative impact on the global economy (Adda, 2016; Baig et al., 2021; Hanspal et al., n.d.; Zhang et al., 2009). Many countries took measures to control the spread of COVID-19 by closing non-essential businesses and restricting the movement of people. As a result, their economies came to a standstill (Narayan et al., 2021). Moreover, international trade has been greatly affected and the potential growth of

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the global economy has been limited. Additionally, the impact of COVID-19 on financial markets was dramatic (Coibion et al., 2020a), leading to a high incidence of 'black swan' events. China has shown some special characteristic during the COVID-19 outbreak. China was the first country to experience the COVID-19 outbreak and also one of the few countries to achieve positive GDP growth in 2020. Therefore, studying the response of the Chinese stock market can not only reveal the characteristics of the Chinese stock market throughout the COVID-19 period, but also help understand the impact of the continuous public crises on investors' expectations.

It is critical to explore the characteristics of the Chinese stock market during the first outbreak of COVID-19, its gradual control period, and its potential short-term and long-term performance.[1] Moreover, the impact on Chinese stock markets from the continuous increase in confirmed cases of COVID-19 outside China also needs to be investigated. This study proposes the following three research hypotheses. Hypothesis 1: the Chinese stock market has experienced a negative shock from COVID-19 in the short term, with responses varying across industries; Hypothesis 2: the short- and long-term responses to COVID-19 in different industries of the Chinese stock market are the same; Hypothesis 3: the rising number of confirmed cases of covid-19 outside of China changed the investors' expectations for the Chinese stock market and partially affected the growth of the Chinese stock market in the second half of 2020. To verify the research hypotheses, this study first uses the event study method to measure the short-term excess returns of different industries in the Shanghai securities composite index (SSE) and to analyse the short-term impact of COVID-19. Then, the Fama-French five-factor model is used to measure and compare the long-term excess returns of different industries in the SSE and to analyse the long-term impact of COVID-19. Finally, this study tests this effect by studying Hong Kong funds and international funds that flow into the A-share market (hereinafter collectively referred to as Northbound capital) as a mediating variable. Its conclusions help explain why China's stock market continues to grow in the second half of 2020.

The main contributions of this study are as follows. Previous studies (Liu et al., 2020b; Wu et al., 2021) have focused on the short-term response of the Chinese stock market to Covid-19. However, the comparison of the long-term and short-term response of the Chinese stock market to COVID-19 has been ignored. This study fills this research gap by using event study and the Fama-French five-factor model to comprehensively analyse the short-term and long-term effects of COVID-19 on different industries of the Chinese stock market. This study also visually illustrates the response of China's stock market under the impact of COVID-19. Furthermore, this study complements research on investor behaviours by analysing the impact of unexpected public events on investor behaviours and by looking at the response of Chinese market investors to COVID-19. Moreover, the expected influence path of world investors on the Chinese stock market in the second half of 2020 is tested using the mediation effect model.

The remainder of this study is organized as follows. Section 2 provides a brief review of the relevant literature. Section 3 introduces the research methodology. Section 4 presents the empirical studies. Section 5 discusses the results and Section 6 concludes.

2. Literature review

COVID-19 is widespread across the world and the pandemic is likely to continue for a long time. As a result, recent studies have begun to investigate the impact of COVID-19 on all aspects of the global economy. In terms of employment, the real number of unemployed people in the U.S. labour market was larger than during the 2007 recession, with unemployment being the worst in May of 2020 (Bick & Blandin, 2021; Coibion et al., 2020a). In Russia, young people, low-educated workers, and residents of regional centers suffered even greater income shocks (Kartseva & Kuznetsova, 2020). Compared with the United States and the United Kingdom, the pandemic has had a lower impact on the German labour market because Germany has implemented a good short-term work plan (Adams-Prassl et al., 2020).

In terms of financial markets, several studies concluded that gold and major sovereign bond indices are value preserving in times of COVID-19. These studies examined the returns and volatility of major sovereign bond indices and gold-backed cryptocurrencies during COVID-19 (Kinateder et al., 2021; Wasiuzzaman & Haji Abdul Rahman, 2021). Regarding international crude oil futures, the quantities of COVID-19 daily confirmed cases had a slight impact on crude oil prices, while volatility in crude oil prices exacerbated uncertainty in the United States economic policies (Albulescu, 2020a, 2020b). In addition, it became more difficult for oil-exporting countries to control the spread of the COVID-19 and maintain normal social order (Bildirici et al., 2020). The pandemic also greatly exacerbated the volatility of the U.S. stock market (Mazur et al., 2021). Heyden and Heyden (2021) found that US and European stock markets reacted differently to the announcement of the first confirmed case and the first death caused by the virus, where stocks reacting significantly negatively only to the first death. When it comes to the impact of unexpected events on investors' expectations, the widespread outbreak of Covid-19 significantly increased anxiety among investors (Baker et al., 2020) and decreased their expectations of a positive economic development (Gormsen & Koijen, 2020; Hanspal et al., 2020). Fluctuations between investor sentiment and crude oil futures prices have become greater (Huang & Zheng, 2020). Recent asset price changes suggest that not only will the impact of COVID-19 persist over time, but that investors will also add COVID-19 to their estimates of asset prices based on expectations (Hanspal et al., 2020; Pagano et al., 2020).

The impact of COVID-19 on the Chinese market is somewhat specific. To begin with, the Chinese market was also negatively impacted by COVID-19. For example, the risk resistance of CSI 300 hedged futures decreased during the crisis (Corbet et al., 2022), the credit mismatch of banks increased (Zhang et al., 2021), and market fears were present in the early stages of the outbreak (Liu et al., 2021). However, the Chinese market did not move in the same direction as most of the global markets, showing some deviations (Chakrabarti et al., 2021; Yuan et al., 2021). Moreover, the Chinese bailout policy promoted the recovery of wholesale firms (Zhang et al., 2021). Liu et al. (2020a) conducted an index analysis and found that the SSE and Shenzhen indices were affected by COVID-19, experiencing significantly lower returns. Nevertheless, this study does not discuss the differential impact of the pandemic on each different industry. Although lockdown policies posed restrictions on business,

Table 1. Indices of ten industries in SSE.

Definition	Abbreviation	Index code
SSE Energy Sector index	SSE-E	000032.SH
SSE Materials Sector index	SSE-M	000033.SH
SSE Industrials Sector index	SSE-I	000034.SH
SSE Consumer Discretionary Sector index	SSE-CD	000035.SH
SSE Consumer Staples Sector index	SSE-CS	000036.SH
SSE Health Care Sector index	SSE-HC	000037.SH
SSE Financials Sector index	SSE-F	000038.SH
SSE Information Technology Sector index	SSE-It	000039.SH
SSE Telecommunication Services Sector index	SSE-TS	000040.SH
SSE Utilities Sector index	SSE-U	000041.SH
SSE Composite Index	SSE-C	000001.SH

Source: calculated from the data from Wind database.

production and personal movement, in turn, these have increased uncertainty in the global economy and reduced the expected future cash flow for most people, which has directly contributed to a decline in consumption (Baig et al., 2021; Coibion et al., 2020b). However, the influence of COVID-19 varies across industries. While most industries have been harmed by the pandemic and saw decreased profitability, there are other industries that benefitted from COVID-19 and the resulting lockdown. Therefore, it is necessary to examine the industry differences in the stock market.

Thus far, the majority of existing studies have focused on the early stages of COVID-19 (about a month into the outbreak). Fewer studies have analysed the response of different industries to the shocks produced by COVID-19 in the medium and long terms. In addition, although some studies have made note of deviations in the Chinese and world markets, they have not explored the reasons for these deviations, nor have they addressed their specific transmission channels. To address these limitations, this study adopts the event study method and the Fama-French five-factor model to examine the potential responses of different industries in the Chinese stock market to COVID-19 in both the short and long terms. It also studies the different conditions of the Chinese stock market at various times throughout the COVID-19 pandemic. Finally, this study uses the mediation effect model to investigate the expected path of world investors on the Chinese stock market in the second half of 2020.

3. Data and methods

3.1. Summary of data used

This study investigated the excess returns of ten different industries. The definitions and abbreviations of the ten SSE industry indices are shown in Table 1. The SSE Composite Index is used as the market return. The daily returns are calculated based on the daily closing prices.[2]

The SSE industry indices and SSE Composite index data required for the event study method were obtained from the Wind database.[3] They ranged from August 13, 2019 to March 16, 2020 for a total of 142 days. The company data required for the Fama-French five-factor model was also obtained from the wind database. For each index, this study selected the 10 companies with the largest share of the SSE index in

that industry.[4] The daily closing price, daily gain/loss, P/N ratio, total market capitalization and book value for a total of 100 companies in 10 industries were extracted.

3.2. Methodology

3.2.1. Event study method

For the short-term analysis (within 5 weeks), this study adopted the event study method for conducting the abnormal return, in order to reduce the estimation error (Easton et al., 2013; Han & Hong, 2014; Fernades et al. 2018). The event study is an empirical research method that analyses the impact of a particular event on the value of a company, using financial market data (Dolley, 1933). This approach is based on the assumption that the shock from an event is immediately reflected in asset prices. Thus, the economic impact of an event can be measured by observing the asset prices over a short period of time. According to Drake (1989), the event study methodology needs to calculate the short-term abnormal returns (ARs) and cumulative abnormal returns (CARs) of the SSE stock indices in different industries experiencing COVID-19 shocks. The applicability of the market model to the emerging markets have been demonstrated in the literature (Dai et al., 2014; Han & Hong, 2014; Suraj and Antony, 2020; Markowski et al., 2020). In this paper, the intercept and slope of the estimation window are fitted using the market model with expected returns based on the following regression model:

$$R_{i,t} = \alpha_i + \beta_i R_{mt} + \varepsilon_{i,t}, \tag{1}$$

where $R_{i,t}$, R_{mt} and $\varepsilon_{i,t}$ are the return of index i, the market return and the random disturbance term at day t, respectively.[5] Since this study focuses on the response of the Chinese stock market to the COVID-19 shock, January 20, 2020 was chosen as the starting point of the event study instead of March 11, 2020.[6] First, the excess returns (ARs) and cumulative excess returns (CARs) were calculated for event windows (-7, …, −1), (0, …, 6), (7, …, 13), (14, …, 20), (21, …, 27), and (28, …, 34). Then, ARs and CARs were used to quantify the short-term impact of COVID-19 on the returns of different industries. After obtaining the estimated coefficients $\hat{\alpha}_i$ and $\hat{\beta}_i$ in Eq. (1), the expected return (ER), abnormal return (AR) and cumulative abnormal return (CAR) of individual indices were calculated with the following equations:

$$E(R_{i,t}) = \hat{\alpha}_i + \hat{\beta}_i R_{mt}, \tag{2}$$

$$AR_{i,t} = R_{i,t} - E(R_{i,t}), \tag{3}$$

$$CAR_i(t_0, t_1) = \sum_{t=t_0}^{t_1} AR_{i,t}, \tag{4}$$

where $E(R_{i,t})$, $R_{i,t}$ and $AR_{i,t}$ are the expected return, the actual return and the abnormal return of index i on day t within the event window, respectively. And

$CAR_i(t_0, t_1)$ denotes the cumulative abnormal return (CAR) of a single index from t_0 to t_1, where t = (-7, −6, −5, −4, …, 34). The average abnormal return (AAR) and cumulative average abnormal return (CAAR) of all indices are given by the following formulas:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t}, \tag{5}$$

$$CAAR(t_0, t_1) = \sum_{t=t_0}^{t_1} AAR_t, \tag{6}$$

where N is the total number of all indices.

3.2.2. The Fama-French five-factor model

To calculate the long-term abnormal returns, the Fama-French five-factor model (Fama and French, 1996, 1993) was adopted to estimate the excess returns of different industries, as the factor models are more involved in monthly and annual long-term analysis (Han & Hong, 2014; Qadan, 2019; Calice & Lin, 2021). Moreover, the effects of the financial information of the firm and the market returns have been also taken into account. The basic formula of the Fama-French five-factor model is as follows:

$$R - r_f = \alpha_i + \beta_1(R_M - r_f) + \beta_2(R_{SMB}) + \beta_3(R_{HML}) + \beta_4(R_{RMW}) + \beta_5(R_{CMA}) + \varepsilon_{it}, \tag{7}$$

where R, R_M and r_f are the expected daily return of the selected assets and the expected daily market return and the risk-free rate,[7] respectively. R_{SMB}, R_{HML}, R_{RMW} and R_{CMA} denote the difference in returns between large-scale and small-scale companies, the difference in returns between value and growth companies, the difference in returns between high and low operating profit companies, and the difference in returns between conservative and aggressive investment styles, respectively. This study uses μ to denote the long-term excess return. After estimating the expected return using the basic formula of the Fama-French five-factor model, the following formula was used to calculate the excess return of the industry in the long-term:

$$\mu = R - r_f - \beta_1(R_M - r_f) - \beta_2(R_{SMB}) - \beta_3(R_{HML}) - \beta_4(R_{RMW}) - \beta_5(R_{CMA}). \tag{8}$$

4. Empirical analysis

4.1. Short-term AR and CAR analysis in the event study

To conduct the event study analysis, the return series of industry indices were divided into two periods, i.e., before and after the event date. In the event analysis method, choosing an estimation window that is too short leads to a loss of accuracy in the

Table 2. Mean and variance in different periods.

Index	Mean return	Std.
Panel A: From 8-13-2019 to 1-8-2020		
SSE-E	0.1454	0.8696
SSE-M	0.0586	0.8439
SSE-I	0.0590	0.8231
SSE-CD	0.1191	0.8432
SSE-CS	0.0686	0.8971
SSE-HC	0.1002	1.0378
SSE-F	0.0658	0.8785
SSE-It	0.2714	1.8473
SSE-TS	0.1895	1.5387
SSE-U	−0.0171	0.6304
SSE-C	0.0883	0.7170
Panel B: From 1-9-2020 to 3-16-2020		
SSE-E	−0.3575	2.2609
SSE-M	−0.4267	1.7555
SSE-I	−0.2206	2.1552
SSE-CD	−0.2854	2.2573
SSE-CS	−0.1291	2.0651
SSE-HC	0.0457	1.9283
SSE-F	−0.3248	1.7971
SSE-It	0.2561	3.4615
SSE-TS	0.2225	3.1795
SSE-U	−0.2516	1.5718
SSE-C	−0.2078	1.8696

Notes: 100 trading days in Panel A,42 trading days Panel B.
Source: calculated from the data from Wind database.

estimation, while one that is too long makes the model parameters unstable (Drake, 1989). Therefore, this study selected 100 days from August 13, 2019 to January 8, 2020 as the estimation window. For the choice of event window, referring to MacKinlay (1997), a 42-day event window is chosen to calculate ARs and CARs. Table 2 shows the descriptive statistics of the return series of all indices in two different panels. Panel A presents the data summary prior to January 9, 2020 (from August 13, 2019 to January 8, 2020, comprising 100 days), which was used as the estimation window for the event.[8] Panel B contains the data after January 8, 2020, comprising 42 days from January 9, 2020 to March 16, 2020 as the event window.

The descriptive statistics show a significant decrease in mean return of the SSE industry indices after January 20, 2020, along with a substantial increase in the standard deviation. This indicates that the shock created by COVID-19 not only decreased the overall returns of different industries of the Chinese SSE, but also caused the investment uncertainty to be much higher (Binder, 2020; Fetzer et al., 2020).

The data from Panel A were used as an estimation window to fit the market model (Table 3). The corresponding results in Table 3 show that the market model predicts industry indices relatively well. All the values for coefficient β for each index are significant at the 1% level.

The data from Panel B were used as an event window to explore the impact of COVID-19 on different industry indices of the SSE (Table 4). The (-7, …, −1) event window in Table 4 shows that COVID-19 was officially recognized by the Chinese government on January 20. However, before January 20, the SSE-HC, SSE-It, and SSE-Ts industries had already experienced significant positive CARs, while SSE-E

Table 3. Estimation results of market model.

Index	α_i	β_i	Adjusted R-squared
SSE-E	−0.0131	0.8117***	0.4702
	(0.0622)	(0.0861)	
SSE-M	0.0630	0.9330***	0.5876
	(0.0566)	(0.0783)	
SSE-I	−0.0340	1.0522***	0.8384
	(0.0335)	(0.0464)	
SSE-CD	0.0328	0.9768***	0.6868
	(0.0478)	(0.0662)	
SSE-CS	0.0041	0.7304***	0.3340
	(0.0741)	(0.1026)	
SSE-HC	0.0231	0.8740***	0.3581
	(0.0842)	(0.1166)	
SSE-F	−0.0234	1.0106***	0.6769
	(0.0506)	(0.0700)	
SSE-It	0.1182	1.7351***	0.4479
	(0.1390)	(0.1924)	
SSE-TS	0.0513	1.5649***	0.5269
	(0.1072)	(0.1484)	
SSE-U	−0.0815	0.7296***	0.6854
	(0.0358)	(0.0496)	

Notes: *, ** and *** denote the significance at the 10%, 5% and 1% level, respectively. The standard deviation is in brackets.
Source: calculated from the data from Wind database.

Table 4. Cumulative abnormal return (CAR) in the event windows.

Index	(−7: −1)	(0:6)	(7:13)	(14:20)	(21:27)	(28:34)
SSE-E	−3.8647**	−5.2215**	0.2798	−3.5492**	2.1362	−0.0692
	(−2.1463)	(−3.0124)	(0.2378)	(−2.6472)	(1.1723)	(−0.0290)
SSE-M	−1.8624	−3.5699*	3.4610	−3.5230***	0.9386	−4.9606***
	(−1.0951)	(−1.8207)	(1.2047)	(−3.5749)	(0.3326)	(−4.6589)
SSE-I	−1.6223*	−0.8571	1.5971**	−2.9801**	4.4263	0.7815
	(−1.8128)	(−0.8567)	(2.5504)	(−2.1269)	(1.2467)	(0.5541)
SSE-CD	1.0691	−2.5703	−0.3166	2.3555**	−2.7639***	−2.6111
	(1.0304)	(−1.0077)	(−0.3079)	(1.9973)	(−3.6917)	(−1.1568)
SSE-CS	2.1474	−3.3316	2.0988	−1.1130	4.0033*	−3.0271
	(1.0733)	(−1.2034)	(1.2560)	(−0.5752)	(1.6835)	(−0.9866)
SSE-HC	5.0164**	11.2591*	−2.2218	−0.9336	−1.3570	−3.1823
	(2.7042)	(2.1832)	(−0.5928)	(−0.2912)	(−0.3891)	(−1.2390)
SSE-F	−0.3690	−0.0006	−1.4550	−2.4560*	1.2390	−0.7958
	(−0.6438)	(−0.0004)	(−0.9585)	(−1.6078)	(0.7361)	(−0.7358)
SSE-It	7.3680**	10.5703**	5.0371	9.6738*	−15.2543**	3.5391
	(2.3476)	(2.5988)	(1.1333)	(1.8366)	(−2.5423)	(0.6525)
SSE-TS	3.5629*	3.9039	0.4778	12.1056*	−9.5558**	10.3531**
	(1.6514)	(0.9722)	(0.2197)	(1.7862)	(−3.0385)	(2.3456)
SSE-U	−1.7216*	−1.3521	−0.2676	−1.43322	2.5712**	1.4274
	(−1.6666)	(−0.5959)	(−0.3194)	(−1.3012)	(2.8140)	(0.9095)

Notes: *, ** and *** denote the significance at the 10%, 5% and 1% level, respectively. The *t*-statistics are reported in parentheses. The *t*-test is used to verify the significance of the CARs. The t-statistic is calculated by $t = \bar{X} - u/(\sigma_x/\sqrt{n-1})$, where $\bar{X}$, σ_x and n are the mean, the variance and the number of observations, respectively. The results of 1000 bootstrapped samples verify the significance of the CARs. Due to the space limitations, the results for the robustness tests are not included in this paper, but available upon request.
Source: calculated from the data from Wind database.

produced significant negative CARs. This phenomenon is quite understandable, as asset prices to some extent reflect rational expectations of the future price of that asset. Before COVID-19 was officially recognized in China, the market and media had been spreading unofficial news and investors made their own decisions based on that. In turn, their decisions were reflected in the current stock prices.

The event window (0, …, 6) shows significant negative CARs for SSE-E and SSE-M, and significant positive CARs for SSE-HC and SSE-It after COVID-19 was recognized by China. The CARs for the event window (-7, …, −1) and the event window (0, …, 6) show that some of the returns of different industries in SSE show approximately the same characteristics in the week after COVID-19 was recognized compared to the week before it was recognized. That is, there was no structural change in investors' expectations during the two different windows, and in both cases they believed that the SSE-HC and SSE-It industries would benefit from COVID-19, while the SSE-E and SSE-M industries would be negatively impacted by COVID-19.

The event window (7, …, 13) shows no significant CARs for the remaining industries except for the significant positive CARs seen for SSE-I. Here, the overall SSE industry indices-wide returns basically returned to normal. The plausible explanation is that at the early onset of COVID-19, investors relied on their limited experience[9] with the pandemic at that time to make judgments about the spread of the virus. Most of them did not expect the pandemic to last for such a long time. Therefore, investors did not believe that COVID-19 would have a long-term far-reaching impact on the Chinese equity market. They believed that different industries of the SSE had been subject to excess positive returns or excess negative returns matching this event during the (-7, …, −1) and (0, …, 6) event windows.

The event window (14, …, 20) shows significant negative CARs for SSE-E, SSE-M, SSE-I, and SSE-F, while SSE-CD, SSE-It, and SSE-TS have significant positive CARs. Of note is that during the event window (21, …, 27), SSE-It, and SSE-TS show dramatic negative CARs, reaching −15.25% and −9.56%, respectively. At this stage, SSE-It and SSE-TS were not only affected by COVID-19, but also by the 5 G national industrial policy. China's 5 G industrial policy was implemented mid-February of 2022. However, there was a time difference between when institutional investors and retail investors received the news and the speed at which they reacted to it. Usually, institutional investors got ahead of the news (Bennett et al., 2003; Boehmer & Kelley, 2009; Boehmer & Wu, 2013; Han & Hong, 2014). They used their advanced knowledge to enter the telecom and information industry early, earning excess returns before the 5 G policy was formally implemented, while choosing to pull out money when retail investors entered. Ultimately, institutional investors reaped industry dividends from new technology and policies, while retail investors suffered losses. As a result, the CARs of SSE-It and SSE-TS experienced inverted returns during the event windows (14, …, 20) and (21, …, 27).

The event window (28, …, 34) shows the stabilization of the impact of COVID-19 on most industries of SSE in the short term, with only SSE-M and SSE-TS showing significant negative or positive CARs. This is because at this time, COVID-19 started to break out widely in Europe and the U.S., and foreign financial assets fell rapidly (Ali et al., 2020). Foreign countries took different precautions against COVID-19 compared to China. The Chinese government took emergency measures to boost investor confidence, such as controlling the scope and speed of COVID-19 transmission as much as possible through measures such as mass city closures. It also coordinated and deployed national medical resources, disseminated information and

Table 5. Event window (14, 20)'s Daily average abnormal return and daily cumulative average abnormal return across all indices.

Event window	AAR	CAAR
14	−0.0684	−0.0684
15	−0.2314	−0.2999
16	−0.0932	−0.3931
17	0.0497	−0.3434
18	−0.1536	−0.4970
19	−0.2658	−0.7628
20	0.0344	−0.7284

Source: calculated from the data from Wind database.

Table 6. Event window (28, 34)'s daily average abnormal return and daily cumulative average abnormal return across all indices.

Event window	AAR	CAAR
28	−0.1965	−0.1965
29	−0.3150	−0.5115
30	0.2170	−0.2946
31	−0.0413	−0.3358
32	−0.1044	−0.4402
33	0.0463	−0.3939
34	−0.3522	−0.7461

Source: calculated from the data from Wind database.

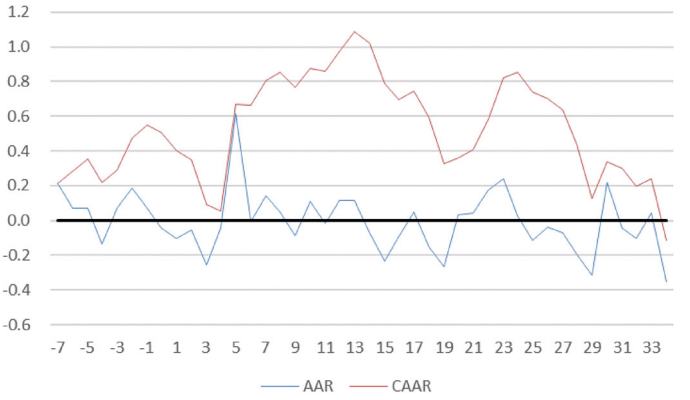

Figure 1. Every event window's daily average abnormal return and daily cumulative average abnormal return across all indices.
Source: calculated from the data from Wind database.

fostered international cooperation. These measures have to some extent eliminated the extraordinary gains in different industries of the SSE.

Tables 5, 6 and Figure 1 show that COVID-19 exhibits different phases of cumulative average abnormal returns (CAARs) for the SSE all-industry. The CAARs are most pronounced in the (14, …, 20) and (28, …, 34) event windows, where negative CAARs are observed almost every day. However, from the perspective of the entire event window (-7, …, 34), there is no significant decline in the SSE industry CAARs. As shown in Figure 1, the CAARs of all industries of the SSE were negative until the last event window, and the CAARs were positive for all time windows before that.

The possible explanation for the difference in AAR and CAAR during the event window is the difference in the share of different industries in the SSE. While the

SSE-It has a cumulative outlier return of over 9.7% during the (14, …, 20) window, the SSE-TS has a cumulative outlier return of over 12.1% and 10.4% during the (14, …, 20) and (28, …, 34) event windows, respectively. However, since the market capitalization of the SSE-It and SSE-TS represents less than 10% of the total SSE indices, the CAARs are negative in the (14, …, 20) and (28, …, 34) event windows. Therefore, when looking at the market effects generated by pandemics such as COVID-19, it makes sense to distinguish between the different characteristics presented by the overall market and the individual industries.

4.2. Long-term excess return analysis

When conducting the long-term excess return analysis, this study used Eq. (7) and Eq. (8) to analyse the extracted daily closing price, daily gain/loss, P/N ratio, total market capitalization and book value. The corresponding results are reported in Table 7.

The long-term factor excess returns in Table 7 show that all significant excess returns for SSE-E, SSE-I and SSE-F from April to December 2020 were negative. SSE-HC had a significant negative excess return in November 2020. Their characteristics are consistent with the conclusions of the short-term event study. SSE-It and SSE-TS, however, exhibit totally different characteristics from the short-term event study, with all significant excess returns being negative in the second half of 2020. In addition, SSE-M and SSE-CS showed extremely high positive excess returns in November and December, reaching over 8% and over 14%, respectively.

A plausible reason for the significant negative excess returns in the second half of 2020 for SSE-It and SSE-TS and the significant negative excess returns in November of 2020 for SSE-HC is investors' excessive expectations. In the early stages of COVID-19, investors generally believed that SSE-It, SSE-TS and SSE-HC would achieve higher returns than other industries. These expectations were reflected in the market, causing a sharp short-term raise in SSE-It, SSE-TS and SSE-HC. However, when everyone held the same expectation, the long-term return of SSE-It, SSE-TS and SSE-HC was already over-consumed by the expectation. Therefore, after the adjustment of investors' expectations, the return of SSE-It, SSE-TS and SSE-HC was appropriately retraced and therefore shows some significant negative return in the second half of 2020. The reason for the SSE-M positive excess return in November 2020 may be related to the gradual return to normalcy in China's economy. In the second half of 2020, China's economic activity gradually returned to normal and most companies in China began to resume production, pulling the SSE-M back up to some extent. In addition, SSE-CS had an excess return of more than 14% in December due in part to the sharp rise in the Chinese liquor sector and the Chinese Lunar New Year. The SSE-CS is composed of a majority of liquor stocks, and the rise in the liquor sector was directly reflected in the rise in the SSE-CS, while the Chinese Lunar New Year caused the expectations of short-term consumer demand.

4.3. Mediation effect analysis

Early in 2020, stock markets around the world fell sharply, including in the U.S. However, as the Federal Reserve continued to introduce new economic stimulus

Table 7. Fama-French's factors excess return.

	SSE-E	SSE-M	SSE-I	SSE-CD	SSE-CS	SSE-HC	SSE-F	SSE-It	SSE-TS	SSE-U
Apr.	−3.3743	0.4665	−1.6199	−2.4052*	−0.7492	−1.0311	−1.2570	3.5361	0.1796	−2.3576*
	(−0.8884)	(−0.1440)	(−1.0403)	(−1.6409)	(−0.1190)	(−0.2561)	(−0.5812)	(0.6978)	(0.0266)	(−1.3870)
May.	−6.5786***	−0.2081	−4.9448***	2.5022	3.8331	4.8227	−2.7288	−3.2129	−6.0915	−2.3630**
	(−3.6928)	(−0.0932)	(−3.6402)	(1.0921)	(0.8348)	(1.0972)	(−1.0965)	(−0.6547)	(−1.0134)	(−1.9279)
Jun.	−7.5000***	−4.4322**	−4.2064***	−0.9869	4.1072	8.9445**	−2.7449**	8.3745**	1.3946	0.5728
	(−2.6160)	(−1.8787)	(−2.7510)	(−0.6141)	(1.2376)	(1.9987)	(−1.7994)	(1.8799)	(0.3386)	(0.2900)
Jul.	−1.0525	6.3078	2.0183	−1.0114	5.9142	−1.1522	−6.7416	−6.5305	−6.4517	0.1646
	(−0.2177)	(1.1264)	(0.5998)	(−0.3977)	(0.7876)	(−0.1225)	(−1.2401)	(−1.0610)	(−1.3202)	(0.0496)
Aug.	−1.0426	−1.7078	0.3542	1.8517	2.8111	−0.8586	−1.7758	−6.3634*	−4.7130	−0.5341
	(−0.3922)	(−0.4744)	(0.1560)	(0.7840)	(0.5850)	(−0.1945)	(−0.8137)	(−1.5305)	(−1.1302)	(−0.1454)
Sep.	−1.2902	−4.1002**	2.7599	1.0992	−2.8020	−1.5919	−0.4782	−1.8191	−4.8911*	−0.7261
	(−0.5061)	(−1.7552)	(1.2749)	(0.6428)	(−0.6739)	(−0.3000)	(−0.2314)	(−0.5361)	(−1.5750)	(−0.323)
Oct.	0.0518	−0.5849	−0.4324	3.4870*	0.5141	−2.9307	0.2945	−0.6425	−1.5482	−0.5816
	(0.0221)	(−0.3131)	(−0.2340)	(1.7330)	(0.1037)	(−0.9156)	(0.1028)	(−0.1591)	(−0.6141)	(−0.3178)
Nov.	4.3705	8.1917**	2.2796	−1.0248	−4.0444*	−5.2187*	−3.3497	−3.8484	−3.1313	1.9237
	(1.1202)	(1.7916)	(1.0425)	(−0.3660)	(−1.3985)	(−1.6367)	(−1.1496)	(−0.7061)	(−0.7115)	(0.7107)
Dec.	−2.6983	−0.7280	1.9936	−1.1220	14.7649***	7.7388*	−5.3135**	−0.9327	−8.5333**	−5.2948*
	(−0.5104)	(−0.1814)	(0.8467)	(−0.6041)	(4.2877)	(1.5549)	(−1.9364)	(−0.1722)	(−1.8720)	(−1.5298)

Notes: *, ** and *** denote the significance at the 10%, 5% and 1% level, respectively. The t-statistics are reported in parentheses. The t-test is used to verify the significance of the CARs. The t-statistic is calculated by $t = \bar{X} - u/\left(\sigma_x/\sqrt{n-1}\right)$, where $\bar{X}$, σ_x and n are the mean, the variance and the number of observations, respectively. The results of 1000 bootstrapped samples verify the significance of the CARs. Due to the space limitations, the results for the robustness tests are not included in this paper, but available upon request.
Source: calculated from the data from Wind database.

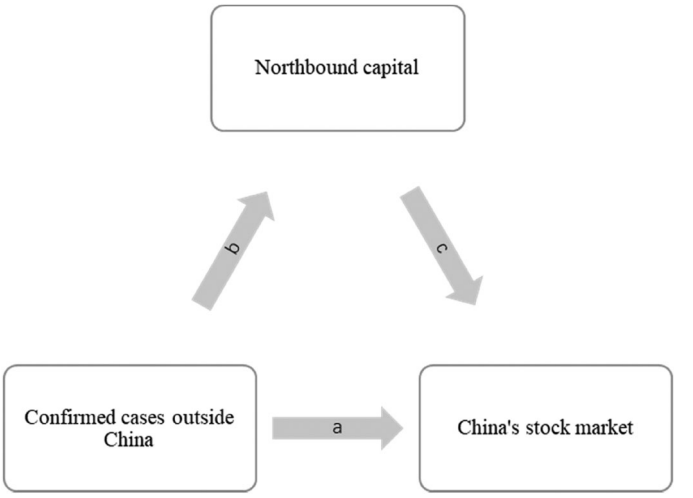

Figure 2. Schematic diagram of mediating effect.
Source: ourselves.

programs and adopt unrestricted quantitative easing, the U.S. stock market not only made up for the decline at the beginning of the year but also reached another record high by the end of 2020. Chen and Yeh (2021) tested the different effects of quantitative easing on the 2008 financial crisis and COVID-19. They found find that quantitative easing is beneficial in improving investor confidence and helping industry development to get back on track. However, the Chinese government did not adopt the same loose monetary policy as the U.S. during the duration of the coronavirus. It adhered to a prudent and neutral monetary policy, but the SSE Index rose over 30% in 6 months, setting a new index price high in 5 years. Why did the Chinese stock market see a sustained rise in the absence of an easy monetary policy? This study proposes the following possible scenarios. (Figure 2)

The continuous increase in the number of confirmed cases of COVID-19 outside of China and the proper prevention and control of COVID-19 in China have changed the expectations of investors around the world for the Chinese market. They are more optimistic that China's economy will recover quickly than that of other countries. As a result, they invest in the Chinese stock market through channels such as the Shanghai-Hong Kong Stock Exchange. The mediating effects model was introduced to test this influence path.

The daily number of confirmed COVID-19 cases outside of China has a significant effect on the daily closing price of the China SSE through regression analysis. However, an increase in confirmed COVID-19 cases outside of China did not have a direct effect on the Chinese stock market. It generally acted indirectly on the Chinese stock market through its impact on the foreign exchange market, the bond market and the Shanghai-Hong Kong Stock Connect Channel. This study focuses on the mediating effect of northbound funds outside of China on COVID-19 confirmed cases affecting the Chinese stock market.

$$M1: \quad \mathrm{L}SSEI_{\mathrm{i,\,t}} = \beta_1 + \mathrm{a}\mathrm{L}confirm_{\mathrm{i,\,t}} + \mathrm{e}_{\mathrm{i,\,t}}, \tag{9}$$

Table 8. Mediating effect of NB.

Formula Variable	M1 LSSEI	M2 LNb	M3 LSSEI
Lconfirm	0.0857***	0.1532***	0.0721***
	(−0.0039)	(−0.0279)	(−0.0033)
LNb	\	\	0.0893***
	\	\	(−0.0084)

Note: *, ** and *** denote the significance at the 10%, 5% and 1% level, respectively.
Source: calculated from the data from Wind database.

$$M2: \quad \mathrm{LNb}_{\mathrm{i,\,t}} = \beta_2 + \mathrm{bL}confirm_{\mathrm{i,\,t}} + \mathrm{e}_{\mathrm{i,\,t}}, \tag{10}$$

$$M3: \quad \mathrm{L}SSEI_{\mathrm{i,\,t}} = \beta_3 + \mathrm{a}'\mathrm{L}confirm_{\mathrm{i,\,t}} + \mathrm{cLNb}_{\mathrm{i,\,t}} + \mathrm{e}_{\mathrm{i,\,t}}, \tag{11}$$

where $LSSEI_{i,t}$ is the daily logarithmic closing price of the SSE index, $Lconfirm_{i,t}$ is the daily logarithm of confirmed cases in all countries in the world except for China, and $LNb_{i,t}$ is the logarithm of the daily inflow of funds from Shanghai Hong Kong stock connect to the SSE. Analysis in this paper was conducted based on the existing studies on the mediating effects model (Baron and Kenny, n.d.; Judd & Kenny, 1981; MacKinnon et al., 2002). The regression results are reported in Table 8.

The regression coefficient a was tested first and, if it was significant, the coefficients b and c continued to be tested in turn. If both were significant, this implies that at least part of the effect of $Lconfirm_{i,t}$ on $LSSEI_{i,t}$ is achieved through the mediating variable $LNb_{i,t}$. Finally, the test coefficient a', if insignificant, indicates that the selected mediating variable is a complete mediating variable. That is, the impact of $Lconfirm_{i,t}$ on $LSSEI_{i,t}$ is completely realized through the mediating variable. If the coefficient a' is significant, it indicates that the mediating variable is only a partially mediating process. That is, only part of the impact of $Lconfirm_{i,t}$ on $LSSEI_{i,t}$ is realized by the mediation variable.

5. Discussion

According to the results of the short-term event method, it is obvious that the characteristics of public events have significant differential impacts on different industries. One of the best performing industries following the short-term impact of COVID-19 is SSE-HC. This is because hospitals are running efficiently in almost every part of China due to the rapid spread of COVID-19, while generating a large demand for medical equipment usage. The other well-performing industries are SSE-It and SSE-TS, which are also currently benefiting from increased demand as malls and tourist attractions have been closed to the public. Information and communications have become a common need as most employees have shifted to online work due to segregation policies. The difference in reaction speed between institutional and retail investors to China's 5 G industry policy led to huge volatility in telecom and information industry returns during the (14, …, 20) and (21, …, 27) event windows and ended with institutional investors earning most of the new policy dividends. Finally, all real and offline industries such as energy and materials suffered significant losses due to the factors outlined above. In addition, the CAAR for all indices shows that

the Chinese stock market was not strongly hit by Covid-19 in the short term. Therefore, Hypothesis 1 has been verified.

With the long-term Fama-French five-factor model analysis, the performance of most industries shows the same characteristics as in the short-term event study. This is because although the two periods have different time spans and time durations, they were both influenced by COVID-19 and other identical factors. However, the excess returns of SSE-IT, SSE-TS and SSE-M have different outcomes than in the short term, and here it is particularly important to note the SSE-It and SSE-TS. Due to the nature of Covid-19, the SSE-It and SSE-TS should be the industries with the largest excess positive returns during the duration of COVID-19. However, this study finds that the SSE-It and SSE-TS in China did not have excess long-term returns during the COVID-19 pandemic. This serves as a warning to investors that understanding the characteristics of the public event will give them excess returns. At the same time, they should be aware of the excessive expectations of society as a whole. In sum, Hypothesis 2 is not supported because the long-term responses of SSE-IT, SSE-TS, and SSE-M to COVID-19 differ from short-term responses.

Based on the results shown in Table 8, this study confirms that Log_$Nb_{i,t}$ is a partial mediating variable between Log_$SSEI_{i,t}$ and Log_$confirm_{i,t}$. That is, the increase in confirmed COVID-19 cases outside of China did change the expectations of investors worldwide. They believed that financial assets in China were potentially more valuable for investment during the COVID-19 pandemic. A plausible reason is that Chinese companies can be the first to resume production and resume work. Their positive expectations for the Chinese market are partially transmitted to the Chinese equity market through the intermediary channel of northbound capital. Therefore, Hypothesis 3 has been verified.

China's stock market received a short-term negative impact from COVID-19, and this finding is similar to the studies conducted by Corbet et al. (2022) and Liu et al. (2021). However, it is notable that although China's stock market suffered a short-term impact from COVID-19, this impact was relatively small. The CAARs for all indices (Figure 1) were not negative until the last event window. In addition, the excess positive returns of SSE-HC, SSE-IT and SSE-TS and the excess negative returns of SSE E indicate that the short-term performance of China's stock market during the pandemic is similar to that of the US stock market (Mazur et al., 2021). However, the excess positive returns of SSE IT and SSE TS have not been sustained in the long-term. The mediating effect of northbound capital is a corroboration and explanation of the fact that the changes in the Chinese market are not in the same direction as most other global markets (Chakrabarti et al., 2021; Yuan et al., 2021).

6. Conclusion

This study aimed to investigate the potential impact of COVID-19 on the Chinese stock market in various time horizons. Based on the data from SSE from August 13, 2019 to December 31, 2020, the event study method and the Fama-French five factor model were used to examine the short-term and long-term effects. The results show that the impact of COVID-19 on the Chinese stock market varies across sectors, and

the impact on the same sector varies across time. Furthermore, the indirect effect of rising confirmed COVID-19 cases abroad on the recovery of the Chinese stock market and the path of this effect are verified in this study.

The findings from this study contribute in several ways to our understanding of how the COVID-19 pandemic influenced stock markets and provides a basis for further research. They provide a deeper insight into the impact of COVID-19 on the Chinese market and new evidence of the temporal and industrial heterogeneity in the impact of COVID-19 on the stock markets. The results are also relevant to both practitioners and policy-makers. The early anticipation of public event characteristics can help generate positive returns. However, investors should be wary of over-expectations. Additionally, capturing country-specific differences in public events can help generate positive returns. For policy-makers, the response to public crises such as COVID-19 should focus on bailing out brick-and-mortar and offline businesses.

As with most studies, there are some limitations in this analysis. Since the SSE and SZSE have different definitions of sector indices, this study does not use the SZSE data. The excess returns from the five-factor model may be somewhat biased by the inclusion of other unexcluded factors due to the absence of assets unaffected by COVID-19 as a reference for the resulting excess returns. Further research could use global investor expectations as a starting point to analyse the impact of unexpected events on investors' expectations and how those expectations make them reacts to different global markets through specific channels.

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Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this study.

Notes

1. In this study, the short-term refers to the period of event study (within 5 weeks), and the long-term refers to the period of Fama-French five-factor model (more than five weeks).
2. The daily return data is the logarithmic return. The return is calculated by.
3. https://www.wind.com.cn/.
4. The stock codes of the selected companies are shown in the Appendix.
5. This study also uses market adjusted model and mean-adjusted model to do robustness checks and the results are similar with the market model. Due to the space limitations, the results for the robustness tests are not included in this paper, but available upon request.
6. Zhong Nanshan officially recognized the transmission of COVID-19 on behalf of the Chinese government on January 20, 2020; the World Health Organization officially recognized the transmission of New Crown pneumonia on March 11, 2020.
7. The risk-free rate of return in this paper selected the three-month treasury bond yield.

8. Because the $(-7, \ldots, -1)$ is considered as time window, Panel B has a substantial event start date of January 20, 2020, even though it begins on January 9, 2020.
9. e.g., the Ebola virus and SARS virus that have appeared in the past.

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Appendix

Table A1. Stock codes of selected companies in each industry.

SSE-E	SSE-M	SSE-I	SSE-CD	SSE–CS	SSE-HC	SSE-F	SSE-It	SSE-TS	SSE-U
600028.SH	600309.SH	601012.SH	601888.SH	600887.SH	600276.SH	600036.SH	603501.SH	600050.SH	600900.SH
601088.SH	601899.SH	600031.SH	600690.SH	600519.SH	603259.SH	601318.SH	600570.SH	600745.SH	601985.SH
601857.SH	600585.SH	601668.SH	600104.SH	603288.SH	600436.SH	601166.SH	600588.SH	601138.SH	600795.SH
601225.SH	600346.SH	600009.SH	600660.SH	600809.SH	600196.SH	600030.SH	603986.SH	600522.SH	600886.SH
600256.SH	603799.SH	601766.SH	601633.SH	600438.SH	600763.SH	601398.SH	600703.SH	688036.SH	600011.SH
600583.SH	600019.SH	600893.SH	600741.SH	600872.SH	600079.SH	601601.SH	600584.SH	600487.SH	600023.SH
600188.SH	603993.SH	600406.SH	601799.SH	603369.SH	603882.SH	601328.SH	688008.SH	600498.SH	600674.SH
600777.SH	600547.SH	601919.SH	601966.SH	600600.SH	600521.SH	600000.SH	603160.SH	603236.SH	600642.SH
601898.SH	600426.SH	601390.SH	603833.SH	600132.SH	600161.SH	600048.SH	603019.SH	600260.SH	600008.SH
601699.SH	600176.SH	601100.SH	600066.SH	601933.SH	600201.SH	600016.SH	688012.SH	603712.SH	600027.SH