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By Xiaolin Huo and Zhigang Qiu*

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ABSTRACT

In this paper, we study how China’s stock market reacts to the sudden outbreak of COVID-19 in 2020, particularly to the announcement of the pandemic lockdown. In general, we observe reversals both at the industry level and at the firm level due to investors’ overreactions to the pandemic lockdown. For industry- and firm-level stocks with positive cumulative abnormal returns (CARs) in the event window when Wuhan was locked down, the reversals are stronger. Thus, the reversal effects are mostly driven by industries and stocks that positively overreact to COVID-19 than do others. Further investigation shows that overreactions are stronger for stocks with lower institutional ownership, which means that retail investors react more strongly to COVID-19. Among stocks with positive CARsin the event window, those with higher idiosyncratic volatilities and lower book-to-market ratios tend to have worse performance after one month.

KEYWORDS: COVID-19; pandemic lockdown; China’sstock market; overreaction

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Introduction

The sudden outbreak of the coronavirus 2019 disease (COVID-19) has significantly increased economic uncertainty (Baker, Bloom, Davis, and Terry 2020), leading to a turbulent global economy in 2020.To avoid the spread of COVID-19, theChinese government proposed a series of effectivehealth policies,such as a pandemic lockdown, which may have had some negative consequences for China's economy.On23 January 2020, one day before the Lunar New Year, the most celebrated Chinese holiday, thecity of Wuhan was locked down, and all public transportation was suspended.[*]In addition, the central government suspended schooling for all students and prohibited travel and public gatherings.[†]For common people in China, the 2020 Chinese New Year was extremely quiet. Thus, economic activities were substantially affected, and the current economic slowdown was well anticipated. The stock market, as an important part of the economy, has also been strongly influenced. For example, Baker, Bloom, Davis, Kost et al.(2020) show that the stock market volatility in the United States has reached its highest point in history. Although several papers investigate the economic consequences (e.g. Chen, Qian, and Wen 2020) and economic policies (e.g. Huang et al. 2020) related to COVID-19 in China, their impact on the Chinese stock market has been relatively unexplored. In this paper, we investigate the impact of COVID-19, particularly the announcement of the pandemic lockdown, on the Chinese stock market for both industry- and firm-level stocks.

The stock market in China experienced unprecedented uncertainty during the 2020 Chinese New Year. On 23 January 2020, the last trading day of the year2019on thelunar calendar, the central government completely locked down Wuhan to control the spread of COVID-19. Moreover, the 2020 Lunar New Year holiday was also extended to2 February2020. Although the opening of the stock market on3 February 2020 was expected to be a positive signal ofeconomic conditions (Huang et al. 2020), the reopening seemed to be risky, and thus, the market jumped downwards significantly on the first trading day after the New Year holiday.Thus, the Chinese New Year in 2020 is thekey event window for the stock market when facing thepandemic lockdown caused by COVID-19, andit is important for researchers and policy makers to understand the consequences of these market reactions. For this reason, we choose the Chinese

[*]The Lunar New Year was actually on 25 January 2020, but the holiday started from 24 January 2020.
[†] Only long-distance studying is allowed for students in all grades.

Lunar New Year holiday as the event window to examine stock market reactions to the pandemic lockdown in China. In general, we observe overreactions of stocks atboth the industry and the firm level.

We obtain the data for stocks and firm fundamentals from the China Stock Market and Accounting Research Database (CSMAR) and divide all stocks into 28 industry categories following the Shenwanfirst class industry classification.[‡] To fully examine the impact of the pandemic lockdown caused by COVID-19, we choose the time period from 22 January to 5 February 2020 as the event window in which both the 2020 Chinese New Year and the lockdown of Wuhanare included. Then, following the standard procedure in the literature, we calculate the cumulative abnormal returns (CARs) in the event window for both industry- and firm-level stocks. To examine the consequences of market reactions after thepandemic lockdown in the event window, we choose the time period from 6 February to 3 March 2020 as the post-event window and compute the CARs in the post-event window for both industry- and firm-level stocks.

We start our empirical analysis with industry-level stocks.A casual look reveals that the pandemic lockdown affected various industries differently. Among the 28 industries, 22 have negative CARs in the event window, and the Leisure Service industry has the lowest CAR of -1.6%. Since most policies encourage people to stay at home, the Leisure Service industry has been seriouslyhurt. There are six industries with positive CARs in the event window, and the Pharmaceutical & Biotechnology industry has the highest positive CAR of 2.46%. Investors may expect a high demand for epidemic prevention tools and medical services when facing the‘infectious diseases’, and thus positively react to the Pharmaceutical & Biotechnology industry.[§]

In general, we observe stock market reversalsfor industries. Among the 22 industries with negative CARs in the event window, 19 recovered with positive CARswithin a month. For thesix industries with positive CARs in the event window, the reversals are even stronger. Although the Pharmaceutical & Biotechnology industry has the best performance in the event window, its CAR in the post-event window became the lowest after a month. A formal regression analysis confirms

[‡] The Shenwan first class industry classification is one of the most widely accepted industry standards. We will explain the industry classification in more details below.

[§] In fact, the demand fordisinfect mask(what is “disinfect mask”?)(it means “消毒口罩”, we may simply use mask?) and alcohol is extremely high.

these observations. However, for the Computer industry, we observe positive CARs in both the event window and post-event window.In fact, COVID-19 changes people's consumption behaviours (Baker, Farrokhnia et al. 2020). Long distance working and studying, for instance, may become routine in our daily life, which may generate high demand for certain equipment such as a computer stylus. Thus, investors continuously react positively to the computer industry.

We next conduct an empirical analysis for each stock at the firm level. We double-sort the stocks intoseven groups based on the performances in both the event window and the post-event window. Then, we construct a transition matrix that shows the probability of stocks in groups based on their performance in the event window transitioning to groups based on their performance in the post-event window. At a glance, we can observe very strong reversals for stocks in the group with the best performance in the event window. Fifty-one percent of stocks in this group transit to the group with the worst performance in the post event window. Formally, we run the regression to test thereversal effects between the CARs in both the event window and post-event window, and the results are statistically significant. To further confirm that the stocks with positive CARs in the event window have stronger reversal effects, we construct a dummy variable, *Positive*, that takes a value of one for stocks with positive CARs in the event window and zero otherwise. We then examine the differential sensitivity of the reversal effects for stocks with positive CARs in the event window and find that the reversals are indeedstronger.

We then explore the characteristics of the stocks with reversal effects. We consider four types of characteristicsof stocks: size, book-to-market ratio(e.g. Fama and French 1992,1993; Liu, Stambaugh, and Yuan 2019), institutional ownership (e.g. Nagel 2005) and idiosyncratic volatility (e.g. Ang et al. 2006). From the regression analysis, we observe that stocks with smaller size, lower institutional ownership or lower idiosyncratic volatility tend to have higher CARs in the post-event window. Moreover, we observe that reversals are stronger for stocks with lower institutional ownership, which means that the effectsare mainly driven by retail investors. For size, book-to-market ratio and idiosyncratic volatility, the differential sensitivity tests are not statistically significant. Reversals can also be explained by a rational liquidity-based story.[**]Given this explanation, Avramov, Chordia, and Goyal (2006) find that reversal effects are mainly evident for small stocks. In our paper, size is not related to reversals, so we focus onoverreaction

[**] We will review the literature for reversals in the next section.

explanations.

Finally, we investigate the characteristics of stocks with positive CARs in the event window because these stocks have stronger reversals. First, stocks with positive CARs in the event window tend to have lower institutional ownership, which means that retail investors are dominant. Reversals are stronger for stocks with positive CARs in the event window because retail investors are more likely to overreact than are institutional investors. Second, stocks with smaller idiosyncratic volatility prior to the COVID-19 outbreak tend to have higher and positive CARs in the event window. Ang et al. (2006) show that stocks with smaller idiosyncratic volatility are more likely to have larger future expected returns. Thus, our result is consistent with the literature. Third, size is not statistically significant but stocks with high book-to-market ratios tend to have higher and positive CARs.Lastly,among stocks with positive CARs in the event window, those with higher idiosyncratic volatilitiesand lower book-to-market ratiostend to have stronger reversals.This finding of idiosyncratic volatility is consistent with the limits to arbitrage literature: high idiosyncratic volatility may prevent arbitrageurs from correcting the temporary mispricing (e.g. De Long et al. 1990; Shleifer and Vishney 1997; Gromb and Vayanos 2010). Thus, stronger reversals exist.

The rest of the paper is organised as follows. We first provide a literature review, and then describe the background of the COVID-19 outbreak. In the next section, we present the data and summary statistics. The main empirical analysis and results are provided in the following section. The final section concludes the paper. In the Appendix, we present the Chinese names and industry codes for the Shenwan first class industry classification.

Related literature

The outbreak of COVID-19 was sudden and unprecedented, and it has induced significant uncertainty in the global economy (Baker, Bloom, Davis, and Terry 2020). Many papers have emerged in a short period to investigate the economic consequences of COVID-19. For example, Hassan et al. (2020) study the immediate shock of COVID-19 on individual firms, andJordà, Singh, and Taylor (2020) investigate its economic impact in the long run. Moreover, Baker, Farrokhnia et al. (2020) show that household consumption behaviours have changed due to the

COVID-19 outbreak, and Ludvigson, Ma, and Ng (2020) find that COVID-19 has seriously affected labor market activities and employment. In addition, different countries have variouspolicies for COVID-19, which also leads to hot debates. Krueger, Uhlig and Xie (2020) discuss government intervention and its effectiveness, Caballero and Simsek (2020) study the monetary policy, and Moser and Yared (2020) explore economic consequence of the lockdown policies. In particular, focussing on the Chinese economy, Huang et al. (2020) document several economic and financial policies to decrease economic meltdown. Regarding the impact of the outbreak on the stock market, Baker, Bloom, Davis, Kost et al. (2020) show that stock market volatility in the United States reached its highest point in history. Ru, Yang, and Zou (2020)provide international evidence that stock markets in countries without SARS experience have underreacted to COVID-19. Our paper, complementary to the literature, analyses the reactions of the Chinese stock market to COVID-19, particularly to the announcement of the pandemic lockdown.

Our paper identifies market overreactions to the announcement of the pandemic lockdown, leading to return reversals. The phenomenon of reversals dates back to Jegadeesh (1990) and continues to receive much attention. One strand of the literature is behavioural andexplains reversalsas investors overacting to information (e.g.Shiller 1984;Black 1986; Stiglitz 1989; Summers and Summers 1989;and Subrahmanyam 2005). The other strand of the literature is based on liquidity provision. Since some traders need liquidity and initiate trading in the market, the price is temporally lower than the fundamental price to compensate for some uninformed traders who provide liquidity (e.g. Grossman and Miller 1988; Jegadeesh and Titman 1995). Our paper is about the market reactions to the announcement of the pandemic lockdown, and hence belongs to the literature on overreaction. Moreover, based on the liquidity explanation, Avramov, Chordia and Goyal (2006) show that reversal effects are mainly evident for small stocks. In our paper, however, size is not related to reversals, which confirms the overreaction story.

When exploring the characteristics of stocks with reversals, we consider six types of characteristicsof stocks: size, book-to-market ratio (e.g. Fama and French 1992,1993; Liu, Stambaugh, and Yuan 2019), momentum (Jegadeesh and Titman 1993; Carhart 1997),trading volume (Lee and Swaminathan 2000; Conrad, Hameed, and Niden 1994), institutional ownership (e.g. Nagel 2005) and idiosyncratic volatility (e.g. Ang et al. 2006).[††]We find that among stocks with positive CARs in the event window, those with higher idiosyncratic volatility tend to have stronger reversals. This result is related to the limits to arbitrage literature. Because of the existence of high idiosyncratic volatility, arbitrageurs are reluctant to correct temporary mispricing (e.g. De Long et al. 1990; Shleifer and Vishney 1997; Gromb and Vayanos 2010).

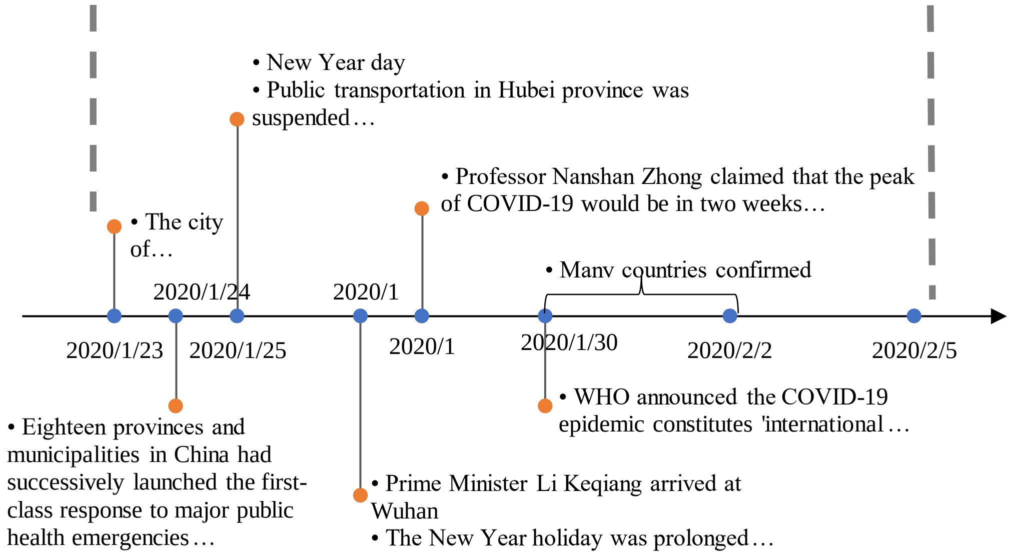
Background of COVID-19

The outbreak of COVID-19 in China started as early as December 2019. However, people started to pay attention to COVID-19 after mid-January, especially when Professor Nanshan Zhong confirmed the human-to-human transmission of COVID-19.[‡‡]In a very short period, the number of infected patients increased dramatically, and the central government initiated several very aggressive but effective policies to control the spread of COVID-19. On 23January 2020, Wuhan was locked down completely. Since Wuhan is one of the largest cities in China and the population in the city is approximately 11 million, its lockdown is truly a significant shock to the public. Consequently, we choose the time period from 23 Januaryto 3 February 2020 as the event window and explore how COVID-19 has affected the Chinese stock market. In Figure 1, we summarise the important events in the event window.

[††]We use trading volume as the control variable because it has explanatory power for overreactions and underreactions; see e.g. Lee and Swaminathan (2000).

[‡‡] Professor Nanshan Zhong is one of the most respected scientists in China and is well-known for his discovery of SARS coronavirus in 2003. He is a fellow of Chinese Academy of Engineering, the highest honor in the field of science and engineering in China.

Figure 1. Event window for COVID-19.



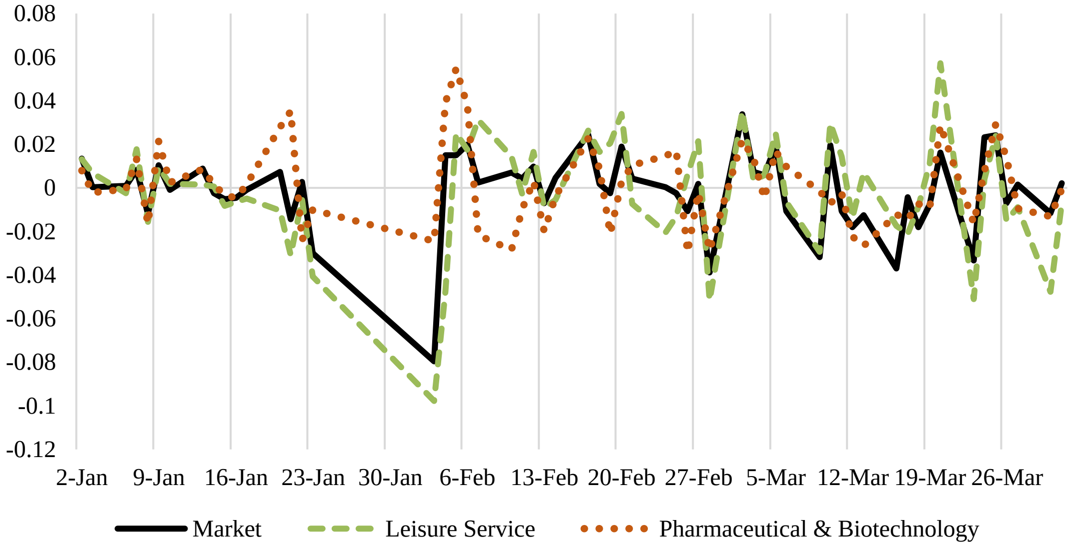
In the event window, COVID-19 induced much uncertainty, and people became panicked. By 24 January 2020, 18 provinces and municipalities in China had successively launched first-class responses to major public health emergencies,[§§] and seven major cities in Hubei Province were also locked down. Moreover, the Chinese New Year holiday started, and the stock market was closed. The New Year day was on 25January 2020, but all public transportation in Hubei Province was suspended. The public gatherings wereprohibited and almost all New Year dinner reservations were cancelled. Even during the New Year holiday, the Prime Minister, Li Keqiang, arrived at Wuhan on 27 January 2020. On 28 January 2020, the total number of people infected by COVID-19 surpassed that of people infected by SARS in 2003. On 30 January 2020, the WHO announced that the COVID-19 epidemic constituted an‘international public health emergency’, and all air travels to Hubei were suspended. Eventually, COVID-19 became a pandemic and spreadthroughout the world.[***]

To deal with the spread of COVID-19, the central government enactsvarious policies that may have had negative effectson the economy (e.g. Huang et al. 2020). For example, the government suspended schooling for all students and prohibited travel and public gatherings. Thus, certain

[§§]These include Guangdong, Hunan, Zhejiang, Hubei, Tianjin, Anhui, Beijing, Shanghai, Chongqing, Sichuan, Jiangxi, Yunnan, Shandong, Guizhou, Guangxi, Hebei, Fujian, and Jiangsu.
[***] According to the Wind database, approximately three million people had been infected by COVID-19 by the end of April 2020.

economic activities were substantially affected, and people's consumption behaviours also changed accordingly. The New Year holiday was extended to 2 February 2020 and the stock market reopened on 3 February 2020. We plot the market returns during the event window to illustrate the market reaction to COVID-19 in Figure 2.

Figure 2. Raw returns in the event window.



Note: This figure plots the raw returns of the whole A-share stock market, Leisure Service industry and Pharmaceutical & Biotechnology industry.

Figure 2 plots the raw returns of the market during the event window, and we can observe that market jumped downwards significantly with a return of approximately -8% on 3 February 2020. For the purpose of comparison, we also plot two industries: the Leisure Service industry and the Pharmaceutical &Biotechnology industry. Given that all the policies encouraged people to 'stay at home', the Leisure Service industry was seriously hurt. The return on 2 February 2020 wasapproximately -10% (the lowest possible returnto anindividual stock for one day in China).[†††] For the Pharmaceutical &Biotechnology industry, the performance was much better than the market, reflecting positive reactions from investors. We will investigate the market reactions to COVID-19 in more details in the following sections.

[†††]In the Chinese stock market, there is a price limit system: up to 10% daily price change is allowed.

Data and summary statistics

In this section, we describe the data used in this paper. Since we analyse the stock market reactions to COVID-19 at both the industry and the firm level,we collect the firm level stock data from the China Stock Market and Accounting Research Database (CSMAR) and apply the Shenwan first class industry classification.

Industry classification and data for the Chinese stock market

The Shenwan first class industry classification is provided by SWS Research, a subsidiary of the leading securities company, SWS Securities. The Shenwan industry classification has three classes, and we choose the first-class industry classification, which was updated in 2014. In particular, SWS Research divides all stocks into 28 categories for itsfirst-class industry classification. We present the industry names (both in English and Chinese) and codes in the Appendix (Table A1). Moreover, we collect firm-level stock trading data, market returns, firm fundamentals and institutional ownership from the CSMAR. We focus on the Chinese A-share market, including both the Shanghai and Shenzhen exchanges.

Variable construction

Because our objective is to investigate the stock market reactions to the announcement of the pandemic lockdown, the key variable we need to construct is the CARs. Following the standard literature, we first compute the abnormal returns based on the market model:

$$Abnormal\ Return_{i,t} = Ret_{i,t} - \widehat{\alpha_i} - \widehat{\beta_i} Ret_{M,t} \quad (1)$$

where$Ret_{i,t}$is the daily returnthat takes into account the reinvestment of the cash dividend of stock *i* at date *t*, and $Ret_{M,t}$ is the Chinese A-share market return that takes into account the reinvestment of the cash dividend. Moreover, we choose the pre-event window period from 1 July to 31 December 2019and estimate$\widehat{\alpha_i}$ and $\widehat{\beta_i}$in this period.Then, we calculate the CARs for both industry- and firm-level stocks.

To fully examine the impact of the COVID-19 outbreak, we choose the Chinese New Year as the event and calculate the CARs based on the event.[‡‡‡] Because Wuhan was locked down on23 January2020, and the stock market was closed between 24 Januaryand2 February 2020, we set the time period from22 January to 5 February 2020 as our event window and calculate CAR [-1,3] accordingly.[§§§]Similarly, we set the time period from 6 February to 3 March 2020 as the post-event window and compute CAR [4,30] accordingly.

Following similar proceduresas those ofLiu, Stambaugh and Yuan (2019), we keep the stocks listed before 2019 and conduct certain filters. In particular, we eliminate stocks: (1) having fewer than 60 trading records in the estimation window, from 1 July to 31 December 2019, (2) having less than 15 days of trading records during the most recent month, December 2019, (3) having missing values of daily returns, and (4) with ST, *ST, SST, and *SST signs.[****]

Summary statistics

We present the summary statistics of the variables at both the industry level (Panel A) and the individual firm level (Panel B) in Table 1.[††††]

Table 1. Summary statistics.

Variable	N	Min	Mean	Median	Max	Std
			Panel A. Industry level			
CAR [-1,3] (%)	28	-1.60	-0.39	-0.55	2.46	0.73
CAR [4,30] (%)	28	-0.56	0.20	0.20	0.64	0.25
CAR [4,10] (%)	28	-1.38	0.26	0.33	1.12	0.43
CAR [11,20] (%)	28	-0.75	0.15	0.08	1.15	0.38
CAR [21,30] (%)	28	-0.33	0.22	0.15	1.21	0.40
Positive_Reaction	2,664	0.00	0.21	0.00	1.00	0.41

[‡‡‡] As we discussed, most of the important events occurred in this time period, and the stock market was closed due to the Chinese New Year holiday.
[§§§] The New Year holiday as a whole is the actual event, so there are only four trading days from 22 January to 5 February 2020.
[****] ST-related stocks are problematic, and ST stands for special treatment.
[††††]If the data are quarterly reported and most are in the third quarter of 2019, then we choose those data for our regressions.

Negative_Reaction	2,664	0.00	0.25	0.00	1.00	0.43
			Panel B. Individual level			
AR(-3) (%)	2,661	-11.48	0.01	-0.21	9.69	2.41
AR(-2) (%)	2,661	-9.10	0.58	0.20	12.62	2.71
AR(-1) (%)	2,663	-11.02	-0.42	-0.39	9.97	2.47
AR(0) (%)	2,663	-7.99	0.26	0.12	15.46	2.77
AR(1) (%)	2,664	-13.65	0.71	0.00	28.02	4.65
AR(2) (%)	2,664	-13.76	-2.51	-3.25	9.55	4.73
AR(3) (%)	2,664	-8.93	0.81	0.19	9.42	2.68
AR(4) (%)	2,664	-10.51	0.13	-0.67	9.97	2.75
AR(5) (%)	2,664	-11.57	0.63	0.12	10.14	3.09
AR(8) (%)	2,664	-11.50	0.84	0.78	10.01	3.30
AR(9) (%)	2,664	-11.32	-0.94	-0.86	9.81	2.70
AR(10) (%)	2,663	-10.13	0.26	-0.20	9.40	2.12
CAR [-1,3] (%)	2,664	-5.07	-0.23	-0.56	12.11	1.90
CAR [4,30] (%)	2,664	-2.67	0.18	0.10	5.16	0.67
Rank_CAR[-1,3]	2,664	0.01	13.33	13.33	26.64	7.69
CAR[4,10] (%)	2,664	-5.59	0.18	0.09	8.21	1.18
CAR[11,20] (%)	2,664	-5.09	0.14	0.02	8.24	1.00
CAR[21,30] (%)	2,664	-5.80	0.21	0.03	8.95	1.17
Positive	2,664	0.00	0.29	0.00	1.00	0.45
EPS	2,664	13.83	15.78	15.53	21.18	1.10
ROA	2,663	-3.86	0.45	0.25	25.80	0.94
Size (10^{12}CNY)	2,664	0.00	0.02	0.00	1.59	0.07
B/M	2,663	0.04	0.73	0.75	1.41	0.26
INI (%)	2,644	0.00	2.48	0.68	71.38	4.38
IVOL	2,664	0.00	0.01	0.01	0.06	0.01
Momentum	2,664	-0.63	0.17	0.08	4.05	0.38
Trading Volume	2,664	0.01	0.40	0.22	6.34	0.52

Notes: This table presents the descriptive statistics of the main variables. Panel A is for the stocks at the industry level classified by the Shenwanfirst class industry classification. Panel B is for stocks at the firm level. In Panel A, *CAR [-1,3]* is the CARs for 28 industries calculated in the event window (from 22 January 2020 to 5 February 2020) and *CAR [4,30]* is the CARs for 28 industries calculated in the post event window (from 6 February 2020 to 3 March 2020).*CAR [4,10], CAR [11,20]* and*CAR [21,30]* are the CARs for 28 industries calculated in the sub-periods of post event window, respectively.*Positive_Reaction* is the dummy that takes the value of one for stocks in the four industries with the most positive CAR [-1,3] in the event window, and zero otherwise. *Negative_Reaction* is the dummy that take the value of one for stocks in the eight industries with most negative CAR [-1,3], and zero otherwise. In Panel B, *AR* (from *AR(-3)* to *AR(10)*)are the abnormal returns from various date in the event and post event window. *CAR [-1,3]* and *CAR [4,30]* are calculated in the same way but for individual stocks. *Rank_CAR [-1,3]* is the ranking of corresponding CAR [-1,3] in an ascending order, divided by 100 for convenience. *CAR [4,10], CAR [11,20]* and*CAR [21,30]* are calculated in the same way but for individual stocks.*Positive* is the dummy that takes the value of one if the CAR [-1,3] is positive and zero otherwise. *EPS* is the earnings per share, *ROA* is the returns on asset. *Size* is calculated based on market capitalisation, *B/M* is book-to-market ratio, *INI* denotes the institutional ownership of each stock, and *IVOL* is the idiosyncratic volatility identified by Ang et al. (2006). *EPS, ROA, Momentum,Trading Volume, Size, B/M, INI* and *IVOL* are all computed in December 2019. *Momentum* is the cumulative returns from month *t*-1 to *t*-11 identified by Jegadeesh and Titman (1993), *Trading Volume* is defined as the ratio between monthly stock's dollar trading volume and market value of tradable shares (Lee and Swaminathan 2000).

EPS and *ROA* are downloaded directly from the China Stock Market Financial Database. *Size* is market capitalisation, and*B/M* is the book-to-market ratio. *INI* denotes the institutional ownership of each stock, and *IVOL* is the idiosyncratic volatility identified by Ang et al. (2006). Moreover, we also include momentum and trading volume as control variables for our regression analysis.

On average, the industry cumulative abnormal returns in the event window are negative, with a mean of -0.39%, and positive in the post-event window in which the mean of CAR [4,30]is0.2%. We also calculate CARs for the post-event window (CAR [4,10], CAR [11,20] and CAR [21,30]) and find they all have positive means.Thus, we observe a pattern of reversals at the industry level. For firm-level stocks, similar reversals are also observed, with a negative mean of -0.23% in the event window and positive means in the post-event window. Moreover, we also calculate the abnormal returns (AR) from various dates in the event and post-event windows[from AR(-3) to AR(10) , respectively). It turns out that the most negative abnormal return occurred on 4 February2020,AR(2),with a mean of -2.51%.[‡‡‡‡]From AR(4) to AR(10), although AR(9) has a negative mean, we overall observe positive abnormal returns in the post event window, which further confirms our observations of return reversals. The variable *Positive* is the dummy that takes a value of one if the CAR [-1,3] for an individual stock is positive and zero otherwise. Note that *Positive* has a mean of 0.29, which means thatonly approximately 29% stocks have a positive CAR in the event window. Thus, on average, COVID-19 has negatively affected the Chinese stock market.

Empirical results

In this section, we conduct a formal empirical analysis to explore the impact of the announcement of the pandemic lockdown on China’s stock market. We first conduct our analysis at the industry level and then at the firm level.

Industry-level analysis

We begin our empirical analysis with industry-level stocks. In Table 2,we sort 28 industries based onboth CAR [-1,3] and CAR [4,30], and the two columns with the label *RANK* show the rankings of each industry for CAR [-1,3] and CAR [4,30].[§§§§]Our first observation is that 22 out of 28 industries have negative CARs in the event window, which reflects the nature of the negative shock from the COVID-19 outbreak. Since most of the policies encourage people to stay at home, the Leisure Service industry has been seriously affected,withthe lowest CAR [-1,3] of -1.6%. Among thesix industries with positive CARs, the Pharmaceutical & Biotechnology industry has the best performance, with its CAR [-1,3] being 2.46%. This observation supports the hypothesis

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[‡‡‡‡]Note that the market index increased approximately 1% on 4 February 2020, which means that the prices of individual stocks decreased significantly. Moreover, the market return was very negative on 3 February 2020 (refer to Figure 2), so AR(1) is positive.

[§§§§]For convenience, the ranking for CAR[-1,3] is in an ascending order.

that the demand for medical service will be high with the shock from‘infectious diseases’.

Table 2. Cumulative abnormal returns for industry.

Industry name	Industry code	NUM	[-1,3]		[4,30]	
			CAR	RANK	CAR	RANK
Leisure Service	460000	29	-1.60%	1	0.31%	17
Commerce	450000	86	-1.17%	2	0.10%	8
Agriculture	110000	62	-0.93%	3	0.53%	27
Mining	210000	56	-0.88%	4	-0.02%	4
Light-industry Manufacturing	360000	112	-0.88%	4	0.08%	7
Architectural Ornament	620000	97	-0.87%	6	0.51%	26
Real Estate	430000	121	-0.77%	7	0.16%	11
Nonferrous Metal	240000	97	-0.75%	8	0.32%	19
Transportation	420000	105	-0.73%	9	-0.02%	4
Defence & Military	650000	44	-0.73%	9	0.49%	25
Utilities	410000	126	-0.72%	11	0.16%	11
Food & Beverage	340000	81	-0.65%	12	0.17%	13
Machinery Equipment	640000	206	-0.64%	13	0.35%	21
Textile & Apparel	350000	74	-0.55%	14	0.32%	19
Ferrous Metal	230000	31	-0.54%	15	0.14%	10
Electrical Equipment	630000	127	-0.53%	16	0.39%	23
Automobile	280000	141	-0.36%	17	0.31%	17
Building Material	610000	55	-0.34%	18	0.46%	24
Banking	480000	28	-0.30%	19	-0.22%	2
Non-bank finance	490000	71	-0.30%	19	0.13%	9
Telecommunication	730000	51	-0.26%	21	0.64%	28
Chemicals	220000	239	-0.07%	22	0.21%	15
Conglomerate	510000	25	0.06%	23	0.01%	6
Media	720000	109	0.08%	24	-0.06%	3
Household Appliances	330000	46	0.10%	25	0.21%	15

Electronics	270000	146	0.33%	26	0.20%	14
Computer	710000	93	0.62%	27	0.36%	22
Pharmaceutical & Biotechnology	370000	206	2.46%	28	-0.56%	1

Notes: This table presents the CARs and industry rankings based on CAR [-1,3] and CAR [4,30] in the event window, respectively. We also report the Industry name, Industry code and the number of stocks in each industry.

The COVID-19 outbreak is unprecedented, and thus, uncertainty in the stock market is extremely high, especially after the prolonged New Year holiday in China. In general, we observe market reversals. For the 22 industries with negative CAR [-1,3], 19 of them recover after a month with positive CAR [4,30]. For the industries with positive CAR [-1,3], although the reversals are not very obvious at first glance, we do observe that the Pharmaceutical & Biotechnology industry has the lowest CAR [4,30], -0.56%, among all 28 industries. Clearly, investors positively overreact to the Pharmaceutical & Biotechnology industry in the event window.For the Computer industry, however, we observe continuously good performance, with both CAR [-1,3] and CAR [4,30] being positive. Although COVID-19 has damaged the economic activities dramatically, long-distance working and studying will probably become routine in our daily life, so investors react positively to the computer industryeven after a month.Moreover, some industries, such as mining and transportation, continuously perform poorly, with both CAR [-1,3] and CAR [4,30] being negative, which proves that labor mobility has been seriously affected by COVID-19 (e.g. Ludvigson, Ma, and Ng 2020).

We next perform the regression analysis at the industry level. In particular, we estimate the following regression:

$$CAR\ [A,B]_i = a + bDummy\_Industry_i + c\boldsymbol{X}_i + \varepsilon_i. \quad (2)$$

The dependent variablesare *CAR [-1,3]* and *CAR [4,30]* for each individual stock, and the independent variable, *Dummy_Industry*, is a dummy that takes a value of one if the stock belongs to industry*i* and zero otherwise. The control variables, ***X***, include the*Size*,*B/M*, *EPS*, *ROA*, *Momentum* and *Trading Volume* of each stock.[*****]

Table 3. Regression for each industry.

	Dependent variable: *CAR [−1,3]*				Dependent variable: *CAR [4,30]*			
	Panel A. No control		Panel B. Control		Panel C. No control		Panel D. Control	
Industry	*b*	*t*−value	*b*	*t*−value	*b*	*t*−value	*b*	*t*−value
Leisure Service	−0.0139***	(−3.92)	−0.0147***	(−4.15)	0.0013	(1.05)	0.0012	(0.96)
Commerce	−0.0097***	(−4.66)	−0.0094***	(−4.52)	−0.0008	(−1.05)	−0.0010	(−1.41)
Agriculture	−0.0072***	(−2.95)	−0.0081***	(−3.30)	0.0036***	(4.24)	0.0040***	(4.63)
Mining	−0.0066***	(−2.58)	−0.0058**	(−2.24)	−0.0020**	(−2.18)	−0.0021**	(−2.28)
Light-industry Manufacturing	−0.0067***	(−3.68)	−0.0068***	(−3.71)	−0.0010	(−1.49)	−0.0009	(−1.44)
Architectural Ornament	−0.0067***	(−3.39)	−0.0060***	(−3.06)	0.0035***	(5.05)	0.0033***	(4.73)
Real Estate	−0.0057***	(−3.22)	−0.0050***	(−2.78)	−0.0002	(−0.27)	−0.0005	(−0.72)
Nonferrous Metal	−0.0054***	(−2.75)	−0.0056***	(−2.87)	0.0015**	(2.20)	0.0015**	(2.10)
Transportation	−0.0052***	(−2.73)	−0.0048**	(−2.54)	−0.0020***	(−2.98)	−0.0021***	(−3.19)
Defence & Military	−0.0051*	(−1.75)	−0.0058**	(−1.99)	0.0031***	(3.09)	0.0029***	(2.90)
Utilities	−0.0052***	(−2.97)	−0.0047***	(−2.67)	−0.0001	(−0.24)	−0.0004	(−0.64)
Food & Beverage	−0.0044**	(−2.04)	−0.0066***	(−3.02)	−0.0000	(−0.06)	0.0006	(0.81)
Machinery Equipment	−0.0044***	(−3.21)	−0.0045***	(−3.29)	0.0019***	(4.00)	0.0018***	(3.77)
Textile & Apparel	−0.0033	(−1.47)	−0.0031	(−1.37)	0.0015*	(1.86)	0.0013*	(1.66)
Ferrous Metal	−0.0032	(−0.92)	−0.0022	(−0.64)	−0.0003	(−0.26)	−0.0004	(−0.30)
Electrical Equipment	−0.0032*	(−1.84)	−0.0032*	(−1.86)	0.0023***	(3.73)	0.0021***	(3.42)
Automobile	−0.0014	(−0.86)	−0.0009	(−0.54)	0.0014**	(2.44)	0.0013**	(2.17)
Building Material	−0.0011	(−0.43)	−0.0013	(−0.51)	0.0029***	(3.14)	0.0031***	(3.47)
Banking	−0.0007	(−0.19)	−0.0004	(−0.09)	−0.0040***	(−3.18)	−0.0034**	(−2.47)
Non-bank finance	−0.0007	(−0.30)	0.0001	(0.04)	−0.0004	(−0.54)	−0.0003	(−0.32)
Telecommunication	−0.0003	(−0.12)	−0.0005	(−0.20)	0.0048***	(5.05)	0.0048***	(5.10)
Chemicals	0.0018	(1.38)	0.0018	(1.42)	0.0003	(0.76)	0.0003	(0.71)
Conglomerate	0.0029	(0.76)	0.0034	(0.88)	−0.0016	(−1.22)	−0.0022	(−1.63)
Media	0.0033*	(1.76)	0.0034*	(1.81)	−0.0025***	(−3.84)	−0.0025***	(−3.80)
Household Appliances	0.0033	(1.18)	0.0028	(1.00)	0.0003	(0.35)	0.0005	(0.54)
Electronics	0.0059***	(3.65)	0.0068***	(4.02)	0.0002	(0.41)	0.0008	(1.37)
Computer	0.0088***	(4.38)	0.0083***	(4.09)	0.0019***	(2.67)	0.0021***	(2.88)
Pharmaceutical & Biotechnology	0.0292***	(23.20)	0.0291***	(22.76)	−0.0080***	(−17.24)	−0.0081***	(−17.46)

Notes: This table presents the OLS regression results for stocks in each industry. The dependent variables are *CAR [−1,3]* (Panels A and B) and *CAR [4,30]* (Panels C and D) for each individual stock, and the independent variable, *Dummy_Industry*, is a dummy that takes the value of one if the stock belongs to the industry *i* and zero otherwise. The control variables include *Size, B/M, EPS, ROA, Momentum* and *Trading Volume* for each stock. Panels A to B report the regression coefficients of the industry dummy, *b*, when *CAR [−1,3]* is the dependent variable with (Panel B) and without (Panel A) the control variables. Panels C to D report the regression coefficients of the industry dummy, *b*, when *CAR [4,30]* is the dependent variable with (Panel D) and without (Panel C) the control variables. Estimated *t*-statistics (White 1980) are in parentheses. *, **, *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panels A and B of Table 3report the regression coefficients of the industry dummy, *b*, when*CAR [-1,3]* is the dependent variable with (Panel B) and without (Panel A) the control variables.For theindustries with negative CAR [-1,3], most have statistically significant coefficients.[†††††] Thus, the event of the Wuhan lockdown caused a serious shock to many industries. However, several industries, including the Pharmaceutical & Biotechnology, Computer

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[*****]We use italics to denote the variables in the regressions. For example, *CAR[-1,3]* is the variable in the regression, and CAR[-1,3] is the cumulative abnormal returns in the event window.

[†††††]The industries include Leisure Service, Commerce, Agriculture, Mining, Light-industry Manufacturing, Architectural Ornament, Real Estate, Nonferrous Metal, Transportation, Defense and Military, Utilities, Food andBeverage,and Machinery Equipment.

and Electronics industries, have been positively affected, and the regression coefficients are statistically significant.

Panels C and D of Table 3 report the regression coefficients of the industry dummy, *b*, when *CAR [4,30]* is the dependent variable with (Panel D) and without (Panel C) the control variables. The reactions of industries after one month vary, but we generally observe reversals. The Pharmaceutical & Biotechnology industry, for example, moves from the best performance of CAR [-1,3] to the worst performance of CAR [4,30], and the results are statistically significant. However, for the Mining and Transportation industries, investors may underestimate the impacts of COVID-19, and thus we observe momentum effects with continuously bad performances for both CAR [-1,3] and CAR [4,30].

To further confirm our results, we conduct the following regression analysis.

$$CAR\ [A,B]_i = \alpha + \beta_1\, Positive\_Reaction_i + \beta_2\, Ngative\_Reaction_i + \gamma \boldsymbol{X}_i + \varepsilon_i. (3)$$

The dependent variables are still *CAR[-1,3]* and *CAR[4,30]*. For independent variables, *Positive_Reaction* is a dummy that takes a value of onefor the four industries that have the most positive CAR [-1,3] and zero otherwise, and *Negative_Reaction* is a dummy that takes a value of one for the eight industries that have the most negative CAR [-1,3], and zero otherwise.[‡‡‡‡‡]The control variables include the*Size,B/M, EPS, ROA, Momentum* and *Trading Volume*for each stock, and we present the results in Table 4.

Table 4. Reversals at the industry level.

	Dependent variable: *CAR [-1,3]*			Dependent variable: *CAR [4,30]*		
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Intercept	-0.0059***	-0.0001	-0.0046***	0.0025***	0.0015***	0.0039***
	(-15.18)	(-0.13)	(-3.51)	(17.60)	(10.35)	(7.95)

[‡‡‡‡‡]To be specific, *Positive_Reaction* is equal to one if a stock belongs to the Pharmaceutical &Biotechnology, Computer, Electronics and Media industries because these four industries not only have the most positive CAR[-1,3] but are also statistically significant (Table 3). Similarly, *Negative_Reaction* is equal to one for the Leisure Service, Commerce, Agriculture, Mining, Light-industry Manufacturing, Architectural Ornament, Real Estate and Nonferrous Metal industries.

Positive_Reaction	0.0171***		0.0169***	-0.0036***		-0.0038***
	(20.19)		(18.54)	(-11.47)		(-11.07)
Negative_Reaction		-0.0091***	-0.0049***		0.0009***	-0.0002
		(-10.87)	(-5.98)		(2.88)	(-0.50)
Size			0.0036			-0.0068***
			(0.65)			(-3.22)
B/M			0.0014			-0.0010*
			(0.93)			(-1.94)
EPS			0.0005			-0.0001
			(1.03)			(-0.78)
ROA			0.0138*			-0.0100***
			(1.80)			(-3.51)
Momentum			-0.0019*			-0.0002
			(-1.89)			(-0.48)
Trading Volume			-0.0035***			-0.0000
			(-5.04)			(-0.11)
Adj.*R*	0.1324	0.0421	0.1561	0.0466	0.0027	0.0591
*R*square	0.1327	0.0425	0.1586	0.0470	0.0031	0.0619
Obs.	2,664	2,664	2,663	2,664	2,664	2,663

Notes: This table presents the regression to examine the industry performance reversals. The dependent variables are still *CAR [-1,3]* and *CAR [4,30]*, respectively. For independent variables, *Positive_Reaction* is the dummy that takes the value of one for the four industries which have the most positive CAR [-1,3], and zero otherwise, and *Negative_Reaction* is the dummy that takes the value of one for the eight industries which have the most negative CAR [-1,3], and zero otherwise. The control variables include *Size, B/M, EPS, ROA, Momentum* and *Trading Volume* for each stock. Estimated *t*-statistics (White 1980) are in parentheses. * and *** denote statistical significance at the 1% and 10% levels, respectively.

Columns (1) and (3) of Table 4 show that the coefficients for *Positive_Reaction*are positive andsignificantlydifferent from zero when the dependent variable is *CAR [-1,3]*. The regression coefficient associated with*Positive_Reaction*in Column (1) implies that the stocks in the industries with the most positive CAR [-1,3] on average have CARs1.71% higher than those of stocks in other industries. Thus,similar to the results in Table 3,the announcement of the pandemic lockdownhas caused investors to react positively to industries such as thePharmaceutical & Biotechnology, Computer, Electronics and Media industries. Moreover, we also observe reversals. Columns (4) and (6) show that the coefficients for *Positive_Reaction* are negative and significantly different from zero when the dependent variable is *CAR [4,30]*. As expected, we observe return reversals.

Similarly, Columns (2) and (3) of Table 4 show that the coefficients for *Negative_Reaction* are negative and significantly different from zero when the dependent variable is *CAR [-1,3]*, and Columns (5) and (6) show the opposite results when the dependent variable is *CAR [4,30]*. Note that the coefficient associated with *Negative_Reaction* in Column (6) is not significantly different from zero. Thus, although similar reversals are observed, the results are not as strong as the stocks in industries with positive CAR [-1,3] values.

Firm-level analysis

Now, we conduct an empirical analysis for each stock at the firm level. First, we sort all the stocks equally into seven groups based on their performance in the event window. Specifically, the group with the highest CAR [-1,3] is labeled 'Group 7', and the group with the lowest CAR [-1,3] is labeled 'Group 1'. Second, we independently sort all the stocks equally into seven groups based on their performance in the post-event window. Similarly, Group 7 has the highest CAR [4,30], and Group 1 has the lowest CAR [4,30]. Third, we calculate the transition matrix, which presents the probabilities of stocks in the groups sorted in the event window transiting to groups sorted in the post-event window. The results are shown in Table 5.

Table 5. Transition probability matrix.

		Post event window						
		1	2	3	4	5	6	7
Event window	1	0.08	0.11	0.13	0.17	0.17	0.17	0.17
	2	0.04	0.12	0.19	0.18	0.18	0.17	0.12
	3	0.04	0.16	0.20	0.17	0.16	0.15	0.12
	4	0.07	0.18	0.16	0.17	0.14	0.15	0.13
	5	0.07	0.19	0.14	0.15	0.16	0.12	0.18
	6	0.19	0.15	0.12	0.12	0.10	0.14	0.17
	7	0.51	0.09	0.07	0.05	0.09	0.09	0.11

Notes: This table presents the transition probability matrix firm level stocks. First, we sort all the stocks equally into seven groups based on the performance in the event window. To be specific, the group with the highest CAR [-1,3] is labeled as Group 7, and the group with the lowest CAR [-1,3] is labeled as Group 1. Second, we independently sort all the stocks equally into seven groups based on performance in the post-event window. Similarly, Group 7 has the highest CAR [4,30], and Group 1 has the lowest CAR [4,30]. Third, we calculate the probabilities for stocks in the groups sorted in the event window transiting to groups sorted in the post-event window.

In Table 5, we can observe very strong reversals for stocks in Group 7 in the event window. The stocks in Group 7have the highest CAR [-1,3] in the event window, but 51% of them are in the group with the lowest CAR [4,30], which is Group 1 in the post event window.For stocks in other groups in the event window, we can still observe some reversal effects, but they are not as strong as those of Group 7 in the event window. Since approximately 29% of all stocks have positive CAR [-1,3], stocks in Group 7 all have positive abnormal returns in the event window. Thus, when facing the outbreak of COVID-19 in the event window, investors strongly overreactedto stocks with positive abnormal returns.

To formally examine the reactions of stocks to COVID-19 at the firm level, we conduct the following regressions:

$$CAR\ [4,30]_i = \alpha + \beta_1 Reversal_i + \beta_2 Positive_i + \beta_3 Positive_i * Reversal_i + \gamma \boldsymbol{X}_i + \varepsilon_i \quad (4)$$

where *Reversal*represents two independent variables, *CAR [-1,3]* and *Rank_CAR [-1,3]*. *Rank_CAR [-1,3]*represents the rankings ofCAR [-1,3] in an ascending order, divided by 100 for convenience. *Positive* is a dummy that takes a value of one if the CAR [-1,3] is positive and zero otherwise. The control variables include *Size,B/M, EPS, ROA, Momentum* and *Trading Volume*. The regression results are shown in Table 6.

Table 6. Reversals at the firm level.

	Dependent variable: *CAR [4,30]*							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0026***	0.0040***	0.0026***	0.0025***	0.0046***	0.0035***	0.0033***	0.0039***
	(16.84)	(15.57)	(16.84)	(5.42)	(8.71)	(7.19)	(6.11)	(7.33)
CAR [−1,3]	−0.0027***			−0.0855***			−0.0296	
	(−9.68)			(−12.94)			(−1.58)	
Rank_CAR [−1,3]		−0.0002***			−0.0002***			−0.0000
		(−10.00)			(−9.41)			(−0.73)
Positive			−0.0027***			−0.0026***	−0.0003	0.0224***
			(−9.68)			(−9.13)	(−0.75)	(9.48)
*CAR [−1,3]*Positive*							−0.0743***	
							(−3.42)	
*Rank_CAR [−1,3]*Positive*								−0.0011***
								(−10.21)
Size				−0.0058***	−0.0053**	−0.0061***	−0.0063***	−0.0064***
				(−2.80)	(−2.49)	(−2.88)	(−3.01)	(−3.09)
B/M				−0.0003	−0.0000	−0.0004	−0.0005	−0.0006
				(−0.55)	(−0.07)	(−0.80)	(−0.95)	(−1.18)
EPS				−0.0001	−0.0001	−0.0001	−0.0002	−0.0002
				(−0.85)	(−0.76)	(−0.77)	(−0.95)	(−0.91)
ROA				−0.0080***	−0.0077***	−0.0081***	−0.0086***	−0.0081***
				(−2.83)	(−2.68)	(−2.83)	(−3.02)	(−2.89)
Momentum				−0.0005	−0.0004	−0.0004	−0.0005	−0.0005
				(−1.37)	(−1.09)	(−1.03)	(−1.37)	(−1.27)
Trading Volume				−0.0006**	−0.0006**	−0.0004	−0.0005*	−0.0004
				(−2.21)	(−2.18)	(−1.64)	(−1.89)	(−1.55)
Adj. *R*	0.0336	0.0358	0.0336	0.0722	0.0456	0.0438	0.0756	0.0836
R square	0.0339	0.0361	0.0339	0.0747	0.0481	0.0463	0.0787	0.0867
Obs.	2,664	2,664	2,664	2,663	2,663	2,663	2,663	2,663

Notes: This table presents the OLS regression results for firm-level stocks. The dependent variable *CAR [4,30]* represents the CARs in the post-event window. The independent variables include *CAR [−1,3]* and *Rank_CAR [−1,3]*, *Positive* and interaction terms. *CAR [−1,3]* refers to the CARs in the event window, and *Rank_CAR [−1,3]* is the order of corresponding CAR [−1,3] in an ascending order, divided by 100 for convenience. *Positive* is a dummy that takes the value of one if the CAR [−1,3] is positive and zero otherwise. Control variables include *Size, B/M, EPS, ROA, Momentum* and *Trading Volume* for each stock. Estimated *t*-statistics (White 1980) are in parentheses. *,** and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Columns (1) and (4) of Table 6 present the regression coefficients when the independent variable is *CAR [-1,3]*, which are negative and significantly different from zero. Thus, reversals areobserved, indicating the overreactions of investors to the outbreak of COVID-19. Similarly, when we use *Rank_CAR [-1,3]*asthe independent variable to test for reversals, Columns (2) and (5) show that the regression coefficients are negative and statistically different from zero. From the results in Table 4, we notice that stocks with positive CAR [-1,3] have stronger reversals, so we use the dummy variable *Positive* for regression.Columns (3) and (6) show that the coefficients associated with*Positive*are negative and significantly different from zero. Thus, stocks with positive CAR [-1,3] in the event window have worse performance than those with negative CAR [-1,3] after one month, and the magnitude is approximately 26 basis points. The coefficient associated with the interaction term, *Positive * Reversal*, is β_3, which measures the differential sensitivity of the reversals for stocks with positive CAR [-1,3] in the event window. Columns (7) and (8) show that the coefficients are negative and significantly different from zero.Thus, the reversal effects are more pronounced for stocks with positive abnormal returns in the event window.

Next, we explore the characteristics of the stocks with reversals. In particular, we conduct the following regression:

$$CAR\ [4,30]_i=\alpha+\beta_1 Reversal_i+\beta_2 Characteristics_i+\beta_3 Reversal_i*Characteristics_i+\gamma \boldsymbol{X}_i+\varepsilon_i \quad (5)$$

The dependent variable is CARs in the post event window and *Reversal* still represents two independent variables, *CAR [-1,3]* and *Rank_CAR [-1,3]*. We consider four types of characteristicsfor stocks: size, book-to-market ratio, institutional ownership and idiosyncratic volatility. Thus, *Characteristics*represents four variables– *Size*, *B/M*, *INI* and *IVOL*– in which *Size* is the market capitalisation, *B/M* is the book-to-market ratio, *INI* is the proportion of institutional ownership for each stock, and *IVOL* is the idiosyncratic volatility (e.g. Ang et al.2006). The control variables include *EPS*,*ROA*, *Momentum* and *Trading Volume*. Before we run regression equation (5), we first run the univariate regressions by *Size*, *B/M*, *INI* and *IVOL*, and the results are shown in Table 7.

Table 7. Regression for size, book-to-market, institutional ownership and idiosyncratic volatility.

	Dependent variable: *CAR [4,30]*							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0019***	0.0011***	0.0021***	0.0025***	0.0025***	0.0023***	0.0027***	0.0031***
	(14.16)	(2.77)	(14.05)	(10.05)	(13.31)	(4.90)	(13.44)	(11.37)
Size	*−0.0076****				−0.0060***			
	(−3.96)				(−2.79)			
B/M		0.0009*				0.0001		
		(1.87)				(0.23)		
INI			−0.0001***				−0.0001***	
			(−4.56)				(−3.28)	
IVOL				−0.0509***				−0.0622***
				(−3.41)				(−3.20)
EPS					−0.0002	−0.0004***	−0.0003**	−0.0004***
					(−1.18)	(−2.66)	(−2.13)	(−2.68)
ROA					−0.0088***	−0.0074**	−0.0072**	−0.0083***
					(−3.06)	(−2.56)	(−2.54)	(−2.91)
Momentum					−0.0005	−0.0005	−0.0003	−0.0003
					(−1.36)	(−1.38)	(−0.94)	(−0.96)
Trading Volume					−0.0004*	−0.0004	−0.0005*	0.0002
					(−1.75)	(−1.47)	(−1.85)	(0.73)
Adj. *R*	0.0054	0.0009	0.0074	0.0039	0.0144	0.0116	0.0159	0.0154
R Square	0.0058	0.0013	0.0078	0.0043	0.0163	0.0134	0.0178	0.0172
Obs.	2,664	2,663	2,644	2,664	2,663	2,663	2,643	2,663

Notes: This table presents the results of the cross-sectional regression. The dependent variable is *CAR [4,30]*. The independent variables include four variables: *Size*, *B/M*, *INI* and *IVOL*, in which *Size* is the market capitalisation, *B/M* is the book to market ratio, *INI* is the proportion of institutional ownerships for each stock and *IVOL* is the idiosyncratic volatility (Ang et al. 2006). Control variables include *EPS, ROA, Momentum* and *Trading Volume*. Estimated *t*-statistics (White 1980) are in parentheses. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

In Table7, we observe that stocks with smaller size, higherbook-to-market ratio, lower institutional ownership and loweridiosyncratic volatility tend to have higher CAR [4,30] and the coefficient related to book to market ratio is not significantly different from zero with the control variables.

We next examine the differential sensitivity for the characteristics on the reversals and focus on the estimated coefficients associated with the interaction terms. Table 8 shows the regression results when the independent variable is *CAR [-1,3]*, and Table 9 shows the results when the independent variable is *Rank_CAR [-1,3]*.

Table 8. Differential sensitivity analysis for reversals (A).

	Dependent variable: *CAR [4,30]*							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0017***	0.0012***	0.0019***	0.0022***	0.0023***	0.0025***	0.0024***	0.0027***
	(12.87)	(3.12)	(12.72)	(9.05)	(12.43)	(5.31)	(12.42)	(10.06)
CAR [−1,3]	−0.0870***	−0.0928***	−0.0780***	−0.0827***	−0.0879***	−0.0922***	−0.0781***	−0.0799***
	(−12.42)	(−4.77)	(−10.03)	(−6.08)	(−12.52)	(−4.74)	(−10.06)	(−5.90)
Size	−0.0070***				−0.0054**			
	(−3.75)				(−2.52)			
B/M		0.0005				−0.0003		
		(1.07)				(−0.58)		
INI			−0.0001***				−0.0001***	
			(−3.98)				(−2.88)	
IVOL				−0.0447***				−0.0453**
				(−3.06)				(−2.39)
*CAR [−1,3]*Size*	0.0637				0.3117			
	(0.24)				(1.08)			
*CAR [−1,3]*B/M*		0.0092				0.0097		
		(0.34)				(0.36)		
*CAR [−1,3]*INI*			−0.0035*				−0.0029	
			(−1.77)				(−1.48)	
*CAR [−1,3]*IVOL*				−0.2322				−0.2706
				(−0.31)				(−0.36)
EPS					−0.0002	−0.0003**	−0.0003*	−0.0004**
					(−1.20)	(−2.28)	(−1.85)	(−2.35)
ROA					−0.0074***	−0.0067**	−0.0064**	−0.0071**
					(−2.64)	(−2.40)	(−2.30)	(−2.56)
Momentum					−0.0005	−0.0006	−0.0003	−0.0004
					(−1.29)	(−1.52)	(−0.82)	(−1.00)
Trading Volume					−0.0005**	−0.0005**	−0.0005**	−0.0000
					(−2.19)	(−2.01)	(−2.11)	(−0.10)
Adj. *R*	0.0649	0.0604	0.0649	0.0632	0.0725	0.0695	0.0716	0.0713
R Square	0.066	0.0614	0.0659	0.0643	0.0750	0.0720	0.0740	0.0738
Obs.	2,664	2,663	2,644	2,664	2,663	2,663	2,643	2,663

Notes: This table presents the results of the cross-sectional regression. The dependent variable is *CAR [4,30]*. For independent variables, *CAR [−1,3]* is the cumulative abnormal return in the event window, *Size* is the market capitalisation, *B/M* is the book-to-market ratio. *INI* is the share of institutional ownerships, and *IVOL* is the idiosyncratic volatility (Ang et al. 2006). Control variables include *EPS, ROA, Momentum* and *Trading Volume*. Estimated *t*-statistics (White 1980) are in parentheses. *, ** and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 9. Differential sensitivity analysis for reversals (b).

	Dependent variable: *CAR [4,30]*							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0041***	0.0044***	0.0038***	0.0045***	0.0046***	0.0055***	0.0043***	0.0048***
	(15.36)	(5.70)	(13.04)	(9.17)	(15.65)	(6.71)	(13.45)	(9.67)
Rank_CAR [−1,3]	−0.0002***	−0.0002***	−0.0001***	−0.0002***	−0.0002***	−0.0002***	−0.0001***	−0.0001***
	(−9.56)	(−4.80)	(−6.97)	(−4.75)	(−9.41)	(−4.64)	(−6.83)	(−4.45)
Size	−0.0109				−0.0149*			
	(−1.36)				(−1.81)			
B/M		−0.0006				−0.0014		
		(−0.62)				(−1.32)		
INI			0.0001				0.0001	
			(0.78)				(0.92)	
IVOL				−0.039				−0.0401
				(−1.39)				(−1.28)
*Rank_CAR [−1,3]*Size*	0.0003				0.0006			
	(0.60)				(1.21)			
*Rank_CAR [−1,3]*B/M*		0.0001				0.0001		
		(1.47)				(1.46)		
*Rank_CAR [−1,3]*INI*			−0.0000**				−0.0000**	
			(−2.35)				(−2.14)	
*Rank_CAR [−1,3]*IVOL*				−0.0007				−0.0007
				(−0.36)				(−0.38)
EPS					−0.0002	−0.0003**	−0.0002	−0.0003**
					(−1.14)	(−2.02)	(−1.59)	(−2.08)
ROA					−0.0072**	−0.0064**	−0.0065**	−0.0071**
					(−2.50)	(−2.26)	(−2.32)	(−2.53)
Momentum					−0.0004	−0.0005	−0.0003	−0.0003
					(−1.09)	(−1.23)	(−0.72)	(−0.80)
Trading Volume					−0.0006**	−0.0005**	−0.0005**	−0.0000
					(−2.28)	(−2.08)	(−2.13)	(−0.04)
Adj. *R*	0.0391	0.0365	0.0409	0.0389	0.0461	0.0441	0.0471	0.0458
R Square	0.0402	0.0376	0.0420	0.0400	0.0486	0.0466	0.0496	0.0483
Obs.	2,664	2,663	2,644	2,664	2,663	2,663	2,643	2,663

Notes: This table presents the results of the cross-sectional regression. The dependent variable is *CAR [4,30]*. The independent variable *Rank_CAR [−1,3]* is the ranking of CAR [−1,3] in an ascending order, divided by 100. *Size* is the market capitalisation, *B/M* is the book-to-market ratio. *INI* is the share of institutional ownerships, and *IVOL* is the idiosyncratic volatility (Ang et al. 2006). Control variables include *EPS, ROA, Momentum* and *Trading Volume*. Estimated *t*-statistics (White 1980) are in parentheses. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 8 examines the differential sensitivity of the four variables,*Size*, *B/M*, *INI* and *IVOL*,to the reversals when *CAR [-1,3]* is the independent variable. Only the coefficient of the interaction term *CAR [-1,3]* INI* is negative and significantly different from zero, with a significance level of 10% without control variables.[§§§§§]Thus, reversals might be stronger for stocks with lower institutional ownership. To conductfurther analysis, we also use *Rank_CAR [-1,3]* as the independent variable for reversals. Here we focus on the regression coefficient associated with the interaction term *Rank_CAR [-1,3]* INI*. Columns (3) and (7) of Table 9 show that the coefficientsare negative and significantly different from zero (*t*-value is -2.14 with control variables). Thus, retail investors are more sensitive than institutional investors, so we observe stronger reversals for stocks that are mainly held by retail investors.Note that the differential sensitivity tests are not statistically significant for size. Because Avramov, Chordia, and Goyal (2006) find that reversal effects are mainly evident for small stocks with liquidity explanations, the results help us focus on overreaction explanations.

From the results in Table 6, we know that stocks with positive CAR [-1,3] have stronger reversal effects than those with negative CAR [-1,3]. Thus,the announcement of the pandemic lockdown caused investors to strongly overreact tostocks with positive abnormal returns in the event window.For this reason, it would be interesting to investigate the characteristics of stocks with stronger reversals. We conduct the following cross-sectional logistic regression:

$$Positive_i=\alpha+\beta_1\, Size_i+\beta_2\, B/M_i+\beta_3\, INI_i\ +\beta_4\, IVOL_i+\gamma \boldsymbol{X}_i+\varepsilon_i. \quad (6)$$

The dependent variable *Positive* is a dummy that takesa value of one if CAR [-1,3] is positive and zero otherwise. The independent variable *Size* measures market capitalisation, *B/M* is the book to market ratio,*INI* is the proportion of institutional ownership for each stock and*IVOL* is idiosyncratic volatility (e.g. Ang et al. 2006). The control variables include the *EPS*, *ROA*, *Momentum* and *Trading Volume* for each stock. The results are shown in Table 10.

[§§§§§]When we add control variables, the coefficient is not significantly different from zero but is still negative with a *t*-value of -1.48.

Table 10. Logistic regression for size, book-to-market, institutional ownership and idiosyncratic volatility.

	Dependent variable: *Positive*							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.8960***	−0.0278	0.9938***	1.2663***	1.1212***	0.2172	1.1868***	1.4905***
	(418.82)	(0.05)	(392.65)	(239.15)	(289.75)	(1.95)	(300.31)	(251.46)
Size	−0.6265				0.2452			
	(1.15)				(0.11)			
B/M		1.2823***				1.1373***		
		(58.74)				(38.78)		
INI			−0.0422***				−0.0301***	
			(19.03)				(9.09)	
IVOL				−26.433***				−35.386***
				(31.17)				(31.31)
EPS					−0.1199*	−0.1580**	−0.0822	−0.1142*
					(3.28)	(5.45)	(2.10)	(3.46)
ROA					−2.2676**	−0.8935	−2.1642**	−2.8234**
					(4.09)	(0.77)	(3.99)	(6.45)
Momentum					−0.3266***	−0.1184	−0.2645**	−0.2189*
					(8.02)	(0.99)	(5.13)	(3.54)
Trading Volume					−0.1106	−0.0418	−0.1484*	0.2432**
					(1.81)	(0.25)	(3.25)	(5.08)
Obs.	2,664	2,663	2,644	2,664	2,663	2,663	2,643	2,663

Notes: This table presents the results of the cross-sectional logistic regression examining characteristics for stocks with positive CAR [−1,3] in the event window. The dependent variable *Positive* is the dummy that takes the value of one if the CAR [−1,3] is positive and zero otherwise. The independent variable *Size* is the market capitalisation, *B/M* is the book-to-market ratio. *INI* is the share of institutional ownerships, and *IVOL* is the idiosyncratic volatility (Ang et al. 2006). Control variables include *EPS, ROA, Momentum* and *Trading Volume*. Wald chi-squares are reported in parentheses. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Columns (3) and (7) of Table 10 show that the regression coefficients associated with *INI*, institutional ownership, are negative and significantly different from zero. Thus, stocks with positive CAR [-1,3] tend to have lower institutional ownership, which means that retail investors are dominant. Because reversals are stronger for stocks with positive CAR [-1,3], retail investors are more likely to overreact than are institutional investors when facing the COVID-19 outbreak. Similarly, Columns (4) and (8) show that the regression coefficient associated with *IVOL* is also negative and significantly different from zero. Thus, the stocks with smaller idiosyncratic volatility before the COVID-19 outbreak tend to have higher and positive CAR [-1,3]. Ang et al. (2006) show that stocks with smaller idiosyncratic volatility are more likely to have larger future expected returns. Thus, this result is consistent with the literature. The regression coefficient associated with *B/M* is positive and significantly different from zero [Columns (2) and (6)], so stocks with positive CAR [-1,3] tend to have high book to market ratio. In addition, Columns (1) and (5) show that the regression coefficient associated with *Size* is statistically insignificant. Avramov, Chordia, and Goyal (2006) show that reversal effects are mainly evident for small stocks, and we find that size is not statistically significant. This result confirms the overreaction story.

With a focus on the stocks with positive CAR [-1,3], we further explore the characteristics of the stocks. In particular, we conduct the following regression:

$$CAR\ [4,30]_i=\alpha+\beta_1\, Characteristics_i\ +\beta_2\, Positive_i+\beta_3\, Positive_i{*}\ Characteristics_i+\gamma \boldsymbol{X}_i+\varepsilon_i.(7)$$

Similar to the previous analysis, we still consider four types of characteristicsof stocks: size,book-to-market ratio, institutional ownership, and idiosyncratic volatility (*Size*, *B/M*, *INI* and *IVOL*, respectively). The control variables include *EPS*, *ROA*, *Momentum* and *Trading Volume*. Here we pay more attention to the interaction term *Positive * Characteristics*. The results are shown in Table 11.

Table 11. Differential sensitivity analysis for stocks with positive CAR [−1,3].

	Dependent variable: *CAR [4,30]*							
Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0027***	0.0029***	0.0028***	0.0028***	0.0032***	0.0039***	0.0032***	0.0032***
	(17.3)	(6.14)	(16.09)	(9.79)	(15.94)	(7.24)	(15.10)	(10.67)
Positive	−0.0028***	−0.0043***	−0.0024***	−0.0017***	−0.0027***	−0.0041***	−0.0023***	−0.0015***
	(−9.59)	(−5.30)	(−7.12)	(−3.05)	(−9.31)	(−4.97)	(−6.94)	(−2.72)
Size	−0.0086***				−0.0080***			
	(−3.77)				(−3.45)			
B/M		−0.0005				−0.0011*		
		(−0.76)				(−1.73)		
INI			−0.0001***				−0.0001*	
			(−2.58)				(−1.96)	
IVOL				−0.0158				−0.0222
				(−0.89)				(−1.02)
*Positive *Size*	0.0044				0.0088*			
	(1.08)				(1.95)			
*Positive *B/M*		0.0024**				0.0021*		
		(2.13)				(1.93)		
*Positive *INI*			−0.0001				−0.0001	
			(−1.11)				(−0.82)	
*Positive *IVOL*				−0.0644**				−0.0661**
				(−2.02)				(−2.08)
EPS					−0.0003	−0.0003**	−0.0003*	−0.0004**
					(−1.60)	(−2.20)	(−1.83)	(−2.33)
ROA					−0.0068**	−0.0066**	−0.0063**	−0.0070**
					(−2.36)	(−2.34)	(−2.23)	(−2.49)
Momentum					−0.0003	−0.0004	−0.0002	−0.0002
					(−0.84)	(−1.11)	(−0.49)	(−0.66)
Trading Volume					−0.0004	−0.0004	−0.0004	0.0001
					(−1.59)	(−1.54)	(−1.55)	(0.28)
Adj. *R*	0.0386	0.0346	0.0379	0.0364	0.0449	0.0421	0.0432	0.0439
R Square	0.0396	0.0357	0.0390	0.0375	0.0474	0.0446	0.0457	0.0464
Obs.	2,664	2,663	2,644	2,664	2,663	2,663	2,643	2,663

Notes: This table presents the results of the cross-sectional regression. The dependent variable is *CAR [4,30]*. For independent variables, *Positive* is the dummy that takes the value of one if the CAR [−1,3] is positive and zero otherwise. *Size* is the market capitalisation, *B/M* is the book-to-market ratio, *INI* is the share of institutional ownerships, and *IVOL* is the idiosyncratic volatility (Ang et al. 2006). Control variables include *EPS, ROA, Momentum* and *Trading Volume*. Estimated *t*-statistics (White 1980) are in parentheses. *, **, and *** denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Columns (4) and (8) of Table 11 present the regression coefficient associated with the interaction term *Positive* * *IVOL*, which is negative and significantlydifferent from zero (*t*-value is -2.08 with control variables). We observe stronger overreactions for stocks with positive CAR [-1,3] than for those with negative CAR [-1,3]. Thus, among stocks with positive CAR [-1,3], those with higher idiosyncratic volatility tend to have lower CAR [4,30], meaning stronger reversals. Consistent with the limits to arbitrage literature, high idiosyncratic volatility may prevent arbitrageurs from correcting temporary mispricing. Moreover, Columns (2) and (6) show that the regression coefficient associated with the interaction term *Positive* * *B/M* is positive and significantly different from zero, with a *t*-value of 1.93 with control variables. Thus, among stocks with positive CAR [-1,3], reversals are stronger for stocks with high book-to-market ratios.

Conclusion

The outbreak of COVID-19 has led to an unprecedented pandemic worldwide. Because of its infectious nature, many aggressive policies have been adoptedby central governments worldwide, which may seriously and negatively affect economic activities. In China, the announcement of the COVID-19 pandemic lockdown, happened during the 2020 Chinese New Year holiday, has beena significant shock in the stock market. Due to the extended New Year holiday, the stock market was closed for a longer period than usual, and reopening was seen as risky. For this reason, we study how the Chinese stock market reacted to the announcement of the pandemic lockdown in this paper by choosing the Chinese New Year holiday in 2020 as the event window.

In general, our paper finds the existence of reversals at both the industry and the firm level; and for industry- and firm-level stocks with positive CARs in the event window, we find stronger reversals. Thus, the overeactions in the Chinese stock market have mostly been driven by industries and stocks that reacted positively to the announcement of the pandemic lockdown. Moreover, overreactions are stronger for stocks with lower institutional ownership, and thus, retail investors have reacted more strongly to the COVID-19 outbreak. Among stocks with positive CARs in the event window, those with higher idiosyncratic volatilities tend to have worse performance after one month.

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