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Chinese stock market sector indices performance in the time of novel coronavirus pandemic

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Abstract

This paper aims to quantify the effect of the deadly novel coronavirus (COVID-19) pandemic outbreak on Chinese stock market performance. Shanghai Stock Exchange Composite Index and its component sector indices are examined in this study. The pandemic is represented by a lockdown dummy, new COVID-19 cases and a dummy for 3 February 2020. First, descriptive analysis is performed on these indices to compare their performances before and during the lockdown period. Next, regression analysis with Exponential Generalized Autoregressive Conditional Heteroscedasticity specification is estimated to quantify the pandemic effect on the Chinese stock market. This paper finds that health care, information technology and telecommunication services sectors were relatively more pandemic-resistant, while other sectors were more severely hurt by the pandemic outbreak. The extent to which each sector was affected by pandemic and sentiments in other financial and commodity markets were reported in details in this paper. The findings of this paper are resourceful for investors to avoid huge loss amid pandemic outburst and the China Securities Regulatory Commission in handling future pandemic occurrence to cool down excessive market sentiments.

Keywords: Novel coronavirus, COVID-19, SARS-CoV-2, pandemic, Chinese stock market, Exponential Generalized Autoregressive Conditional Heteroscedasticity

JEL Classification: G14, G15

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Introduction

The novel coronavirus (COVID-19) pandemic was first detected in Wuhan, Central China in December 2019 (Wuhan Municipal Health Commission, 2019)[1]. This human transmitted disease spread at a rapid rate to other parts of China, and then to other parts of the world[2][3]. As of 28 April 2020, there were total of 2,883,603 confirmed cases, while the death toll had reached 198,842 cases (6.9%) (World Health Organization, 2020). To halt the outbreak, China swiftly imposed the unprecedented lockdown in Wuhan city, the epicenter of COVID-19, and nearby cities (so-called Wuhan lockdown), starting from 23 January 2020. By mid-February, some 200 other cities around the nation had implemented similar social distancing measures, control of movement, closed management and ban on travels[4]. Disregarding the sudden spike on 12 February 2020 (due to diagnostic changes), it took 2 weeks after the lockdown imposition for the daily new COVID-19 confirmed cases and deaths to exhibit declining trends, see Figure 1.

While China was able to curtail the outbreak of COVID-19 by containment, its production and economy were badly affected. Businesses and factories in China were essentially scaled down if not totally shutdown in the lockdown period. Subsequently, the country's industrial profit plunged by 38.3% in the first two months of the year 2020. Meanwhile, some 5 million employees lost their jobs in the same period, with urban unemployment surged to 6.2% in February 2020, up from 5.2% in December 2019. Moreover, barometers of economic growth such as retail sales of consumer goods and investment spending (on infrastructure, property, machinery and equipment) fell 29.5 and 24.5% respectively (Bermingham. and Wang, 2020; Chen, 2020; National Bureau of Statistics of China, 2020; Roper, 2020). As China's economy sank to all-time low in the first two months of the year, International Monetary Fund remarked on 20 March 2020 that "China's slowdown in the first quarter of 2020 will be significant and will leave a deep mark for the year" (Berger *et al*., 2020). In fact, China economy shrank 6.8% in the first quarter compared with the year before (Vaswani, 2020).

[1] On 31 December 2019, World Health Organization (WHO) China Country Office was officially informed of the new virus with a total of 27 cases detected.

[2] On 30 January 2020, WHO declared the outbreak an International Emergency. On 11 February 2020, WHO assigned it the name of SARS-CoV2 for Severe Acute Respiratory Syndrome Coronavirus 2, and COVID-19 for Coronavirus Disease discovered in 2019.

[3] The total number of confirmed cases in China were 27; 11,791; 79,824 and 81,584 for 31 December 2019, 31 January 2020, 29 February 2020 and 31 March 2020 respectively. On 11 January 2020, China reported the first and only death case (in China, and also the world) due to COVID-19 for that day. By the end of January, February and March 2020, total confirmed deaths were 259; 2,890 and 3,312 correspondingly.

[4] The lockdown was finally lifted on 25 March 2020, after 8 weeks of imposition for areas except Wuhan, while lockdown in Wuhan was lifted in 8 April (The State Council Republic of China, 2020a; Hubei Novel Coronavirus Prevention and Control Center, 2020; Wikipedia, 2020).

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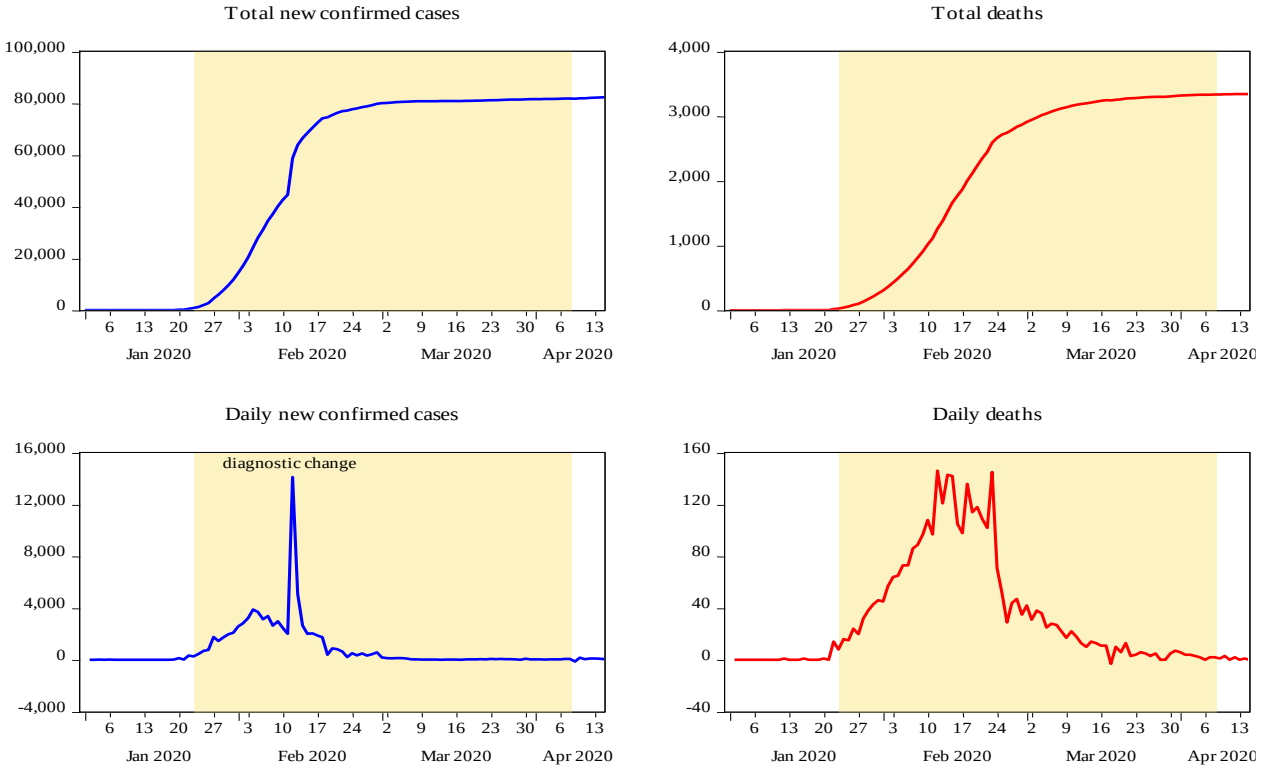
Figure 1: COVID-19 confirmed cases and deaths (31 December 2019 to 15 April 2020)



Source: Worldometer (2020).
Note: Shaded region denotes Wuhan lockdown period (23 January 2020 to 8 April 2020).

From the perspective of stock exchange, another barometer of economic growth[5], Chinese stock markets had tumbled following the news of COVID-19 outbreak (Avalos and Zakraišek, 2020; Oxford Analytica, 2020). In this respect, the Shanghai and Shenzhen composite indices recorded the biggest single-day loss (2.75% and 3.25% respectively) in almost 9 months on 23 January 2020 (Chinanews.com, 2020a)[6]. On the next trading day (3 February, 2020), these two indices further suffered a gap down of 8% in the opening session. They eventually closed with a loss of 7.72% for Shanghai and 8.45% for Shenzhen composite indices, with the single day biggest loss in 12 months (Chinanews.com, 2020b). The current empirical study attempts to provide a

[5] For the role of exchange market in fostering economic growth, see for instance World Federation of Exchanges (2017).
[6] The last trading day before Chinese New Year holidays (24 to 31 January 2020). The holidays were prolonged to 2 February 2020 to contain COVID-19 outbreak (Moon et al., 2020; The State Council Republic of China, 2020b). Hence, the stock markets in China was closed from 24 January to 2 February 2020.

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comprehensive measure on the effect of the deadly COVID-19 outbreak on Chinese stock market performance, with reference to Shanghai Composite index and its component sectors indices.

The rest of this paper is structured as followed. The Brief Literature Overview section points out the urgency of conducting the current research. The Empirical data and descriptive analysis section describes the data sources and variables involved in this study. Besides, descriptive analysis is performed for data exploration. The Regression model section explains the ordinary least squares regression model with the EGARCH (1,1) specification employed in this study. The Regression results section presents the estimated results and interpretation of results. The last section on Conclusion and policy recommendation summarizes the key findings, suggests policy implications and concludes this paper.

Brief Literature Overview

In the recent decade, there has been a considerable surge in Chinese stock market research in conjunction to the intensifying China's influential roles on various aspects of the world including the stock exchanges. Majority of these studies focused on the efficiency (see among others, Chong *et al*., 2012; Han *et al*., 2019, Liu *et al*., 2020 and references therein) or relationship analysis between Chinese stock market with international stock markets (Zhang and Li, 2014; He *et al*., 2015; Hung, 2019), commodity markets or/and macroeconomic aspects (Ahmed and Huo, 2020; Zhuang *et al*., 2015, Jebran, 2019, Wei *et al*., 2019; Wen *et al*. 2019; Yousaf and Hassan, 2019; Zhao *et al*., 2020 and references therein).

Remarkably, effect of financial crises on Chinese stock market was also commonly examined in the past (Jebran, 2019; Han *et al*., 2019; Hung, 2019; Lin and Tsai, 2019; Yousaf and Hassan 2019, and Wei *et al*., 2019), while studies on natural disasters were rare. Two contributions in this aspect are worth-mentioning. Specifically, Li *et al*. (2015) examine 60 natural disaster announcements over the period 2003-2013 and find that they produced significant negative stock returns in China. Earlier on, Chong *et al*. (2010) report significant positive abnormal returns for pharmaceutical stocks in China, while tourism stocks were significantly affected by the severe acute respiratory syndrome (SARS) caused by coronavirus[7]. These two studies adopted the event study approach. The current study attempts to estimate the nature, magnitude and significance of effect of COVID-19 pandemic on Chinese stock market with regression analysis that controls for the plausible financial and commodity markets spillover effects[8].

Empirical data and descriptive analysis

The data set spanning from 2 September 2019 to 27 March 2020 are considered in this study. To estimate the effect of COVID-19 pandemic on the Chinese stock market, Shanghai Stock Exchange Composite Index (*SSE*) and its component sector indices are employed. They are from

[7] SARS first emerged in the human population near Guangdong, China in November 2002. SARS is alternatively known as SARS-CoV.
[8] See Abdelhedi and Boujelbène-Abbes (2020).

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the sectors of energy (*EN*), materials (*MT*), industrials (*IND*), consumer discretionary (*CD*), consumer staples (*CS*), health care (*HC*), financials (*FN*), information technology (*INT*), telecommunication services (*TS*), and utilities (*UL*)[9]. COVID-19 pandemic is represented by a lockdown dummy (*LD*), the daily new confirmed cases in China (*CNCC*) and the first trading day after the Chinese New Year holidays (*D*1). *LD* assumes a value of 1 for observations ranging from 23 January 2020 to 27 March 2020, and zero otherwise. Other financial market variables specifically the New York Stock Exchange Composite Index (*NYSE*), the remninbi per US dollar exchange rate (*ER*), and commodity markets represented by spot gold price (*GP*) and crude oil WTI spot US dollar price (*OP*) are included for control purpose. Daily financial and commodity variables are obtained from *Investing.com*. Daily new confirmed cases in China is obtained from *Worldometer*. These time series are plotted in Figure 2.

Financial and commodities variables

Figure 2 depicts that, for the first weeks upon the first official COVID-19 outbreak report to the World Health Organization (WHO), the markets in China (*SSE*) and US (*NYSE*) did not respond negatively. In the meantime, the China exchange rate and the spot gold price were continuing their value appreciation trend, while the crude oil was extending its declining trend. After the Wuhan lockdown imposition, the Chinese and US stock markets did not only behave differently in the process but they eventually ended up with significant different performances. *SSE* and *NYSE* stood at 14,102.04 and 2,976.53 respectively on the Wuhan lockdown day. As of 27 March 2020, they remained 8,777.38 and 2,660.17. This is equivalent to a considerable loss of 60.66% for *NYSE* in the US and 11.89% for *SSE* in China within 41 trading days.

Figure 3 shows that there was an increasing trend starting from November 2019 in majority of the sectors in Shanghai Stock Exchange, and so the composite index, probably due seasonal effects [10]. This trend was extended into the middle of January 2020 or later, although WHO was officially informed of the of the new virus on 31 December 2019. For the composite index, it reached its peak at 3,115.57 (H1) on 13 January 2020, and from there on it slipped to 2,746.61(L1) on 3 February 2020.

Sector indices performance

Sector-wise, both consumer discretionary and staples sector indices reached their peaks (H1) at 2,548.69 and 11,128.32 respectively on 13 January 2020. Besides, information technology as well as telecommunication services and health care sector indices further climbed to H1 at 4, 611.15 (22 January); 3,442.73 (22 January) and 6,967.30 (21 January) correspondingly, before the trend reversed. In this conjunction, it is evident from Figure 2 that, the reversal trend ended with a big dip for all sectors on 3 February 2020[11]. In fact, on this first trading day after the extended Chinese New Year celebrations, the composite index plunged by 7.72% amid the fear of the COVID-19 pandemic rapid outbreak when millions of workforces were commuting to work. Meanwhile, all

[9] See, China Securities Index Co., Ltd. (n.d.) for a list of *SSE* component sectors.
[10] See, among others, Yuan and Gupta (2014), Casalin (2018), Chia and Teng (2018) and Wagner *et al*. (2019) for significant positive holidays, new year and Chinese new year effects in China market. Meanwhile, better trade outlook as the US-China tariffs tension diminished may had also contributed (Li, 2020).
[11] All these indices found their first lows (L1) on the same day.

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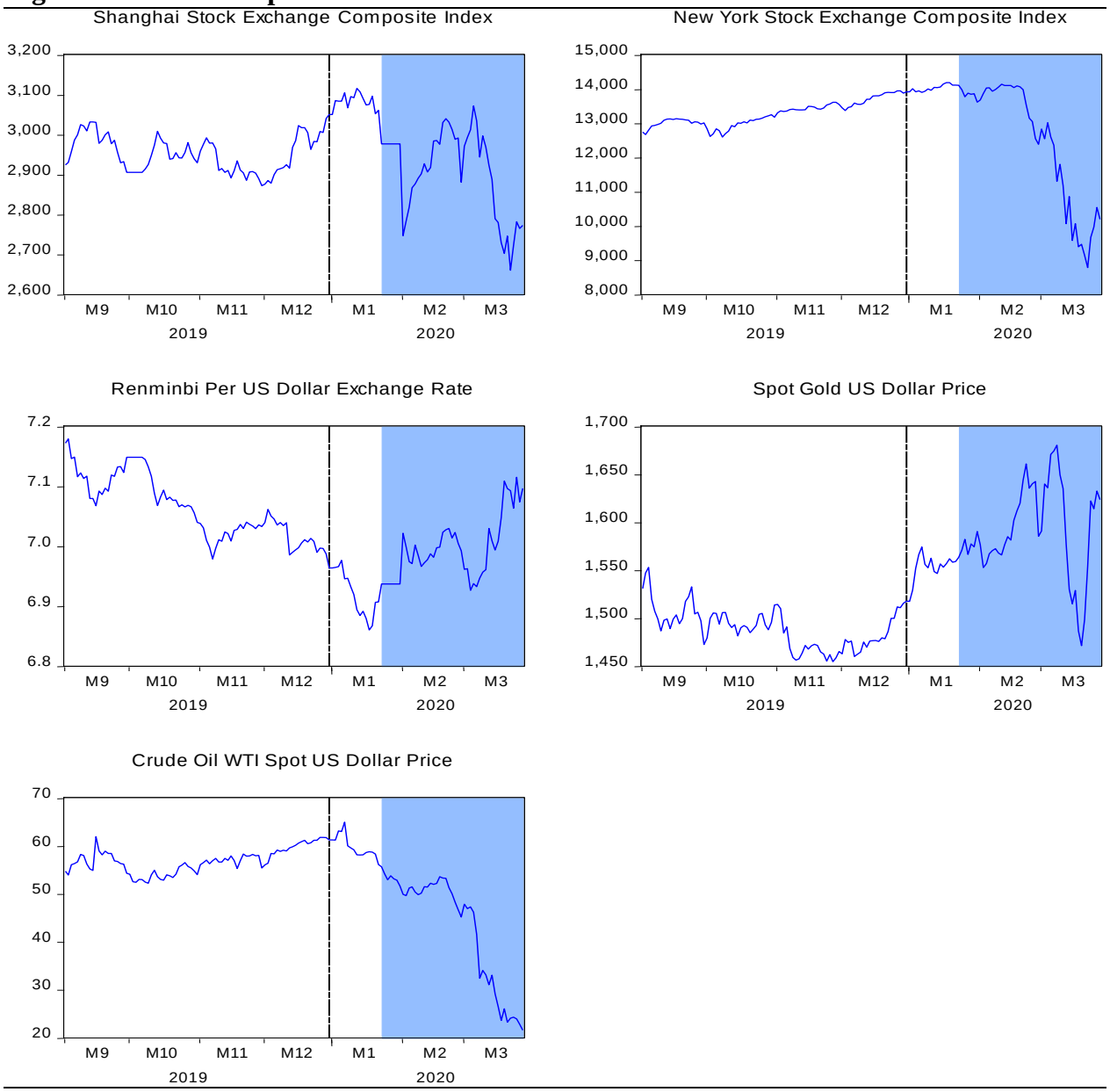
sectors were extensively down without exception, see Table 1 which highlights of percentage returns of SSE stock indices in the first three months of the year 2020.

Figure 2: Time series plots of financial and commodities variables



Notes: Dotted vertical line denotes 31 December 2019 when WHO first received COVID-19 official report. Shaded region denotes Wuhan lockdown period.

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After the deep market correction on 3 February 2020, sending the indices to their new lows (at L1) in 12 months, all these indices exhibited technical rebound with different strengths (Figure 2). In general, this round of rebound ended on 5 March (H2), and then they started to decline again until 23 March (L2), with the exception of information technology and telecommunication sectors. As we can observe in Column 4 of Table 1, the energy and financials sectors set for the comparatively weakest rebound[12] before their indices continued with another fall to find their lower lows (L2 < L1) at 1,019.20 and 4,614.08 respectively on 23 March 2020[13].

As for information technology, telecommunication sectors and consumer staples, they exhibited the strongest strength in rebound to succeed their higher highs (H2 > H1) (see Figure 2) of 5,578, 3,803 and 11,229.08 on 24 February, 25 February and 5 March respectively[14]. Remarkably, they managed to pose higher lows (L2 > L1), in the following round of price falling action, indicating a better future prospect than other sectors. The index of health care (H2 at 6 February) sector also managed to find their higher highs (compared H1) but like the majority of other sectors, it ended up with lower lows (L2 < L1). Indices which rebounded for only lower highs (H2 < H1) and ended up eventually with lower lows (L2 < L1) were materials, industrials, energy, consumer discretionary and financials.

[12] These indices registered a rise of 6.47% and 8.13% corresponding, from 3 February until the end of this rebound on 5 March (H2), see Column 4, Table 1.

[13] Equivalent to a drop of -12.53% (energy) and -14.85% (financials) from 5 March to 23 March. Utilities sector ranked the third in terms of weakness in strength of renouncing (8.68%) but it only dropped to a low (L2) of 1,678 on 19 March, which was 2 points higher than its previous low (L1) of 1,676.

[14] A rise of 38.4% (information technology) and 28.9% (telecommunication), counting from L1 on 3 February 2020.

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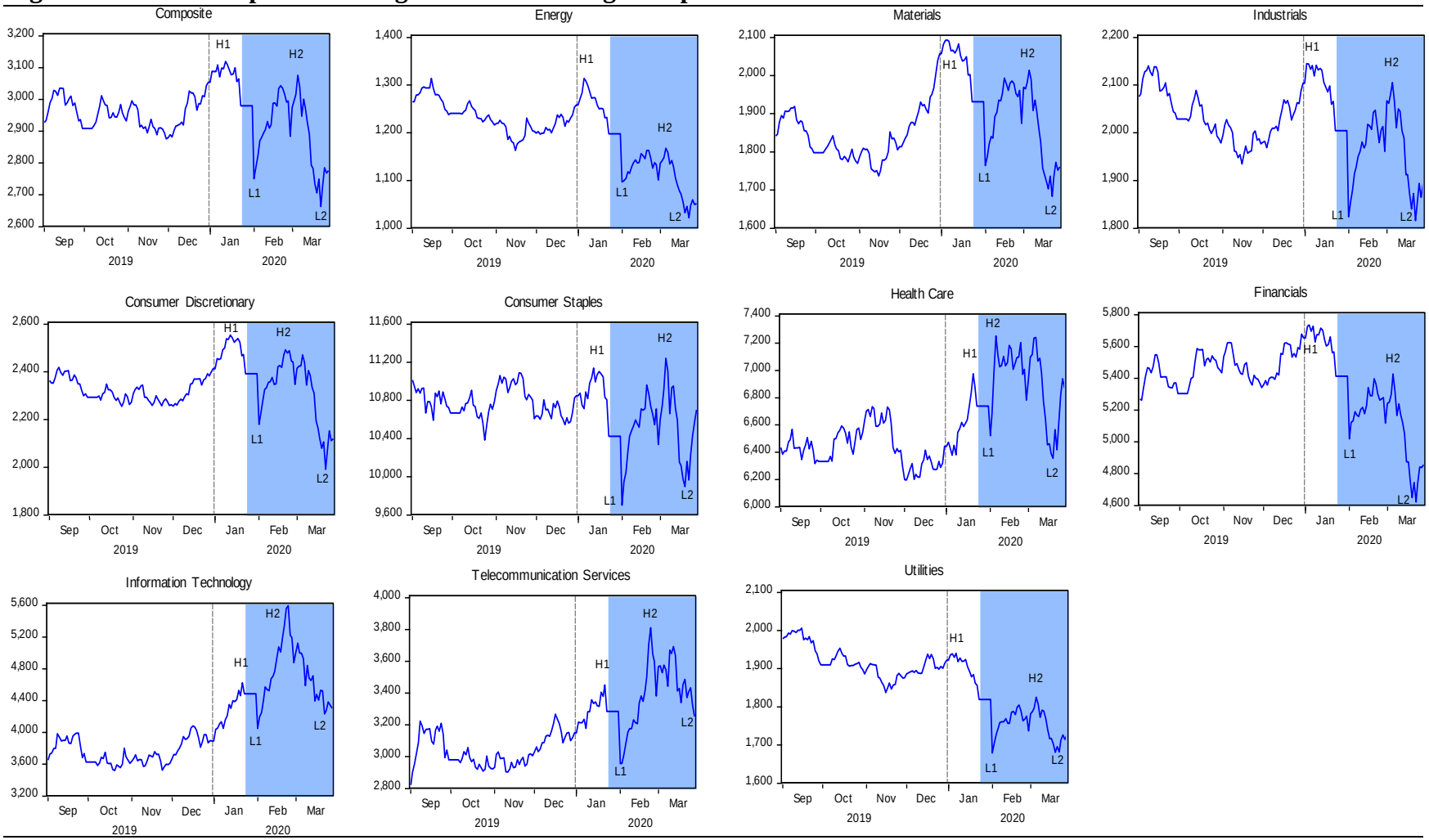
Figure 3: Time series plots of Shanghai Stock Exchange composite and sector indices



Note: Shaded region indicates Wuhan lockdown period (23 January 2020 to 27 March 2020). Dotted vertical line denotes 31 December 2019 when WHO first received COVID-19 official report. H1 denotes the index's peak (high) pre-Wuhan lockdown, while H2 refers to the next peak occurred on 5 March 2020 for majority of the indices. Conversely, L1 refers to the index's first bottom (low) (occurred on 3 February 2020), whereas L2 denotes the second bottom occurred on 23 March 2020 in most cases. Technically, if an index exhibits H2 > H1, one can say that it has a higher high. Similarly, H2 < H1 means lower high, L2<L1 means lower low, and L2 > L1 means higher low.

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Table 1 (Column 3) shows that the daily performances of these sectors on the 3 February, from the most wounded to the least hurt were: telecommunication services (-9.99%), information technology (-9.72%), industrials (-9.03%), consumer discretionary (-8.91%), materials (-8.64%), energy (-8.44%), utilities (-7.68%), financials (-7.28%), consumer staples (-6.85%) and health care (-3.22%). Indeed, this scenario was the extension of the market fears which drove all the indices far to the south on 23 January 2020, when Wuhan city was locked down[15]. The daily performances of these sectors on Wuhan lockdown day, in the same manner were: telecommunication services (-4.79%), materials (-3.57%), consumer staples (-3.53%), consumer discretionary (-3.28%), information technology (-3.07%), industrials (-2.96%), energy (-2.78%), financials (-2.73%), utilities (-7.68%) and health care (-2.08%) (see Column 2, Table 1).

Table 1 also reveals that the indices of consumer discretionary (-19.45%), materials (-16.44%) and information technology (-15.32%) performed the worst in terms of periodic returns from 5 March to 23 March 2020. On the other hand, telecommunication services (-5.69%) and utilities (-7.86%) sectors experienced the smallest loss over the same period.

Table 1: Highlights of percentage returns of SSE stock indices in the early 2020

	Daily		Periodic	
Index	**23 Jan**	**3 Feb**	**3 Feb to 5 Mar**	**5 Mar to 23 Mar**
Shanghai Stock Exchange Composite	-2.75	-7.72	11.84	-13.40
Energy sector	-2.78	-8.44	6.47	-12.53
Materials sector	-3.57	-8.64	14.14	-16.44
Industrials sector	-2.96	-9.03	15.45	-13.74
Consumer discretionary sector	-3.28	-8.91	13.44	-19.45
Consumer staples sector	-3.53	-6.95	15.88	-11.36
Health care sector	-2.08	-3.22	10.97	-11.33
Financials sector	-2.73	-7.28	8.13	-14.85
Information Technology sector	-3.07	-9.72	23.42	-15.32
Telecommunication services sector	-4.79	-9.99	20.92	-5.69
Utilities sector	-2.04	-7.68	8.68	-7.86

Note: China stock market was closed from 24 January to 2 February 2020 for Chinese New Year holidays.

[15] It was coincidently the last trading day before the Chinese New Year holidays. See Footnote 6.

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Table 2 summarizes the descriptive statistics of SSE composite and sector indices before and during lockdown, after controlling for equal window length for the sub-samples. Indices that consistently have lower maximum, average, minimum prices during the lockdown period compared to pre-lockdown period are Shanghai Stock Exchange Composite Index (*SSE*), energy (*EN*) materials (*MT*), industrials (*IND*), consumer discretionary (*CD*), financials (*FN*), and utilities (*UL*). Moreover, all their returns were turning from positive pre-lockdown to negative during lockdown, with the exception of utilities sector index which was already in the negative pre-lockdown. This means the price performance of these sectors was very much affected by the lockdown as a result of COVID-19 outbreak. In sharp contrast, health care (*HC*), information technology (*INT*), telecommunication services (*TS*) sectors were able to record higher maximum, average and minimum prices during the lockdown period. In fact, health care is the only sector that was able to maintain its positive return amid the lockdown, while information technology (-4.06%) and telecommunication services (-0.98%) sectors suffered relatively milder losses in indices returns in the lockdown period.

Having analyze the indices price behavior and return performance before and during the lockdown to prevent COVID-19 outbreak, another key finding can be derived from Table 2. Specifically, the standard deviation of all indices were larger during lockdown in relation to pre-lock period, with the exception of industrial sector. This is probably because investors' reaction was more sensitive to COVID-19 news such that the overall Chinese stock market was relative more volatile during lockdown.

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Table 2: Descriptive statistics of SSE indices before and during lockdown

Sector	*SSE*	*EN*	*MT*	*IND*	*CD*	*CS*	*HC*	*FN*	*INT*	*TS*	*UL*
	Before lockdown: 19 November 2019 to 22 January 2020 (47 Observations)										
Maximum	3115.57	1311.43	2089.99	2142.36	2548.69	11128.32	6967.30	5728.18	4611.15	3442.73	1937.13
Mean	2991.69	1230.73	1937.31	2047.56	2374.87	10793.78	6425.86	5533.44	3955.53	3149.82	1896.75
Median	3004.94	1228.53	1920.68	2051.27	2364.70	10793.64	6384.99	5553.48	3917.71	3142.43	1895.06
Minimum	2871.98	1178.09	1775.37	1954.34	2250.94	10534.66	6187.27	5333.64	3510.85	2933.69	1843.28
S.D.	80.79	33.92	105.64	59.48	99.33	169.07	191.36	126.39	271.43	130.80	24.93
Skewness	-0.02	0.60	0.04	0.10	0.38	0.41	1.03	-0.14	0.55	0.28	-0.17
Kurtosis	-1.55	-0.34	-1.51	-1.28	-1.25	-0.89	0.52	-1.45	-0.26	-0.66	-0.78
Return %	4.32	4.35	12.60	4.72	7.56	-2.55	2.23	1.21	23.14	15.8	-0.31
	Lockdown period: 23 January 2020 to 27 March 2020 (47 Observations)										
Maximum	3071.68	1195.24	2010.43	2102.50	2487.30	11229.08	7245.17	5419.06	5578.16	3803.48	1821.89
Mean	2907.10	1122.87	1880.34	1967.21	2321.78	10491.87	6876.68	5152.72	4675.81	3377.55	1760.33
Median	2943.29	1133.34	1928.03	2001.80	2371.40	10521.21	6963.39	5210.14	4556.56	3374.02	1766.31
Minimum	2660.17	1019.2	1679.94	1813.57	1986.88	9690.30	6347.41	4614.08	4035.15	2950.24	1676.42
S.D.	107.86	48.67	94.45	74.35	131.05	328.39	250.99	226.96	360.69	198.33	42.59
Skewness	-0.65	-0.35	-0.66	-0.46	-0.95	-0.25	-0.51	-0.89	0.69	-0.09	-0.38
Kurtosis	-0.78	-0.58	-0.96	-0.75	-0.21	0.03	-0.78	-0.2	-0.08	-0.27	-0.88
Return %	-6.86	-12.24	-8.85	-5.53	-11.41	2.65	1.93	-10.33	-4.06	-0.98	-5.14

Notes: Shanghai Stock Exchange Composite Index (*SSE*), energy (*EN*) materials (*MT*), industrials (*IND*), consumer discretionary (*CD*), consumer staples (*CS*), health care (*HC*), financials (*FN*), information technology (*INT*), telecommunication services (*TS*), and utilities (*UL*). S.D. stands for standard deviation.

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Regression model

This study adopts regression model to quantify the effect on COVID-19 pandemic on the Chinese stock market. The following regression model is estimated:

$$INDEX_t = \theta_0 + \theta_1 LD_t + \theta_2 CNCC_t + \theta_3 D1_t + \theta_4 ER + \theta_5 NYSE_t + \theta_6 GOLD_t + \theta_7 OIL_t + \varepsilon_t, \qquad \varepsilon_t \sim \mathrm{N}(0, \sigma_t^2), \tag{1}$$

$$log\hat{\sigma}_t^2 = \phi_0 + \phi_1 \left(|\hat{\varepsilon}_{t-1}/\hat{\sigma}_{t-1}| - \sqrt{2/\pi} \right) + \phi_2 (\hat{\varepsilon}_{t-1}/\hat{\sigma}_{t-1}) + \phi_3 log\hat{\sigma}_{t-1}^2 , \tag{2}$$

where *INDEX* denotes the composite or sector index to be tested, including Shanghai Stock Exchange Composite Index (*SSE*), energy (*EN*) materials (*MT*), industrials (*IND*), consumer discretionary (*CD*), consumer staples (*CS*), health care (*HC*), financials (*FN*), information technology (*INT*), telecommunication services (*TS*), and utilities (*UL*) sector indices. In addition, *ER*, *NYSE*, *GOLD* and *OIL* represent the exchange rate of China in terms of renminbi per US dollar, New York Stock Exchange Composite Index of US, spot gold US dollar price and crude oil WTI US dollar price, accordingly. Subscript t for refers to daily observation, and θ_i for $i = 0, 1, \dots, 7$ are the parameters to be estimated. The model residuals series is denoted by ε_t and σ_t^2 is the heteroscedastic variance of ε_t. In the meantime, ϕ_i for $i = 0, 1, \dots, 3$ are the parameters to be estimated in the variance equation.

Notably, as this study estimates the effect of the COVID-19 outbreak, three proxies are included. *LD* is the dummy variable for lockdown as a result of COVID-19 outbreak. *LD* assumes a value of one for dates (inclusively) ranging from 23 January 2020 to 27 March 2020, and zero otherwise. *CNCC* stands for daily new confirmed COVID-19 cases in China. A dummy variable (*D1*) is included to estimate the effect of the incident of drastic plunged in the Chinese stock market on the first trading day after the prolonged Chinese New Year holidays, amid the fears of rapid spread COVID-19[16]. *D1* takes a value of one for the day 3 February 2020 and zero for all other dates.

It is expected that the Chinese stock market is adversely affected by the lockdown, and so the coefficient of *LD* (θ_1) should be negative, for lower index price during the lockdown period. On the other hand, *CNCC* signals the condition of the coronavirus outbreak with higher (lower) value means more (less) confirmed COVID-19 cases in China. A rational investor would take less cases as favorable news of improving condition and more cases as deteriorating condition. Thus, $\theta_2 < 0$ is expected. On the other hand, θ_3 should be negative to confirm with the observations of market plunged. Importantly, the magnitude of θ_1, θ_2 and θ_3 will reveal the extent of the COVID-19 effect on the Chinese stock market.

[16] Another purpose for the inclusion of *D*1 is to normalized the model's residuals.

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Equation (1) is estimated with Exponential General Autoregressive Conditional Heteroscedasticity EGARCH (1, 1) specification as shown in Equation (2) to model the residuals. In this respect, EGARCH (1, 1) is commonly used to model and predict the financial time series that exhibit time-varying volatility[17, 18]. Remarkably, ϕ_2 and ϕ_3 are of particular interest. ϕ_2 is the asymmetry parameter. If $\phi_2 \neq 1$, then positive and negative shocks/news, ε_t , will have asymmetric effect on the price volatility on the next day. If $\phi_2 = 0$, there is no asymmetrical behavior detected. ϕ_3 is the persistence parameter. The larger (smaller) the ϕ_3, the longer (shorter) it takes for the shocks/news to decay. In this respect, following Olbrys and Majewska (2017), this study measures the persistence by calculating the half-life, which is the time taken for ε_t to be reduced to one–half of their original size. Specifically,

$$\text{Half-life} = \ln(0.5)/\ln(|\phi_3|). \quad (3)$$

In addition, for the conditional volatility process as represented in Equation (2) to be stationary, the condition for $|\phi_3| < 1$ must be met. Otherwise the process is explosive and the index is unpredictable.

Regression results

The estimated regression models over the sample period spanning from 2 September 2019 to 27 March 2020 are reported in Table 3[19]. First and foremost, it is evident from Table 3 that the lockdown imposition to circumvent COVID-19 outbreak had exerted a significant impact on the Shanghai stock exchange, as the estimated θ_1 coefficient is significant at 5% statistical level for the over market composite index and all its component sectors. Second, different sectors received different COVID-19 effect in terms of lockdown, depending on their nature of business. Specifically, negative effect is observed in the Shanghai Stock Exchange overall market as well as the energy, materials, industrials, consumer discretionary, consumer staples, financials and utilities sectors. In contrast, positive effect is revealed in the health care, information technology and telecommunication services sectors in specific. These sectors had benefited from their important contributions to the fight against COVID-19. Third, estimated coefficient for the lockdown to was -67.99 points for Shanghai Stock Exchange Composite Index as dependent variable. It reveals, overall, that the composite index had slumped by an average of 67.99 points significantly (as noted in the first point) in response to the lockdown, compared to the its average value before lockdown, holding other variables constant. Similarly, on average, the indices of the energy, materials, industrials, consumer discretionary, consumer staples, financials and utilities sectors were down by 129.80, 52.88, 60.35, 64.02, 693.23, 272.62, 148.83 points respectively during the lockdown. Conversely, the indices for the health care, information technology and telecommunication services sectors were up by 237.46, 654.92 and 159.81 corresponding.

[17] See Nelson (1991) for more information on EGARCH model. See Lin (2018), for instance, for the application of GARCH family models in SSE Composite Index. Lin (2018) reports that EGARCH (1,1) model outperforms the other GARCH models in both in-sample fitting and out-of-sample forecast performances for this index.

[18] In fact, the residuals of Equation (1) estimated by the ordinary least squares (OLS) regression principle exhibit ARCH effect. Moreover, they do not pass the serial correlation test (results are omitted here to conserve space).

[19] Except for the dummy variables, all variables included in Equation (1) are stationary in their level by the augmented Dickey-Fuller unit root test. These variables are found to be cointegrated various indices based on the Phillips-Ouliaris residual-based tests for cointegration. Both sets of results are omitted here to conserve space.

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Fourth, the estimated coefficient θ_2 for daily new confirmed COVID-19 cases in China (*CNCC*) is essentially negligible in size and it was insignificant at all for all sectors, except for financials sector ($\theta_2 = -0.01, msv < 0.05$). It reveals, in general, that the market was insignificantly affected by the new developments of COVID-19 cases.

Fifth, the estimated sign of coefficient θ_2 is negative in all sectors. Moreover, the effect is significant for all sectors, excluding the energy and financials sectors. This indicates that the fears of COVID-19 outbreak did not only persisted but it had mounted over this long holidays with no share trading activities. Subsequently, the whole Chinese stock market reacted negatively when the market resumed trading on 3 February 2020.

Sixth, exchange rate had significant and negative effect on Shanghai Stock Exchange Composite Index (-301.66 points), materials (-612.02), industrials (-53.43), consumer discretionary (-345.26), consumer staples (-391.20), financials (-945.88), information technology (-1196.89) and telecommunication services (-1046.23). It suggests that lower (higher) indices are associated to appreciation (depreciation) of renminbi with respect to the US dollar[20]. In other words, depreciation of renminbi is favorable for the growth of these sectors in China. Conversely, the results indicate that appreciation of renminbi is favorable for the energy and utilities sectors.

Seventh, the US stock market as the world's leading stock market on the Chinese stock market is minute if not totally negligible as the magnitude is less than one point in all sectors. Eighth, the Chinese stock market is significant and positively related to the spot gold market. The coefficient is significant and positive for all indices with no exception. Ninth, the Chinese stock market is significant and positively affected by the crude oil market, with the exception of consumer staples (negative effect) and health care (insignificant effect).

Tenth, the estimated ϕ_2 is insignificantly different from zero in all sectors, implying the absence of asymmetrical reactions on favorable or unfavorable news in the Chinese stock market. Last but not least, the estimated ϕ_3 are all less than one in magnitude, implying the conditional volatility process is stationary and the index is predictable. Moreover, the half-life values calculated from estimated ϕ_3 suggest fast market digestion of shocks as it took the Chinese stock market less than 3 trading days for shocks to be reduced to one-half its original size.

[20] For instance, a one renminbi appreciation in the Chinese currency with respect to US dollar can be associated to and a drop of 301.66 point in the composite index.

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Table 3: Estimated regression results

Sector	*SSE*	*EN*	*MT*	*IND*	*CD*	*CS*	*HC*	*FN*	*INT*	*TS*	*UL*
C	3236.51	-242.99	4257.70	904.59	2339.65	8130.54	2135.08	9615.44	8027.69	8914.31	-98.55
	*0.00**	*0.24*	*0.00**	*0.00**	*0.00**	*0.00**	*0.01**	*0.00**	*0.00**	*0.00**	*0.66*
LD	-67.99	-129.80	-52.88	-60.35	-64.02	-693.23	237.46	-272.62	654.95	159.81	-148.83
	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**
CNCC	0.00	0.00	0.00	0.00	0.00	0.01	0.02	-0.01	0.00	0.00	0.00
	0.33	*0.34*	*0.90*	*0.99*	*0.77*	*0.49*	*0.21*	*0.02***	*0.90*	*0.72*	*0.68*
D1	-149.61	-42.37	-77.58	-135.34	-219.62	-956.30	-569.74	-159.82	-706.38	-373.63	-127.82
	*0.00**	*0.89*	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.39*	*0.00**	*0.00**	*0.01**
ER	-301.66	76.06	-612.02	-53.43	-345.26	-391.20	-96.88	-945.88	-1198.89	-1046.23	165.50
	*0.00**	*0.00**	*0.00**	*0.01**	*0.00**	*0.00**	*0.32*	*0.00**	*0.00**	*0.00**	*0.00**
NYSE	-0.02	0.00	-0.04	-0.04	0.00	0.08	0.06	0.03	-0.03	-0.13	-0.01
	0.06	*0.65*	*0.00**	*0.00**	*0.24*	*0.00**	*0.02**	*0.00**	*0.31*	*0.00**	*0.22*
GOLD	1.12	0.55	1.30	1.02	1.44	3.22	2.87	1.01	2.56	1.64	0.49
	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**
OIL	7.04	2.52	7.80	8.27	5.63	-9.03	-1.71	9.45	13.76	14.13	3.30
	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.02**	*0.55*	*0.00**	*0.00**	*0.00**	*0.00**
ϕ_0	2.01	1.79	0.42	1.82	6.70	5.88	2.70	2.84	1.22	1.56	0.69
	0.07	*0.07*	*0.60*	*0.02**	*0.00**	*0.00**	*0.12*	*0.06*	*0.36*	*0.27*	*0.42*
ϕ_1	1.38	1.23	1.45	1.59	1.61	1.35	1.78	1.11	1.67	1.23	1.41
	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**
ϕ_2	0.00	0.03	-0.18	0.07	0.18	0.14	0.15	0.10	0.21	0.17	0.16
	0.99	*0.88*	*0.39*	*0.73*	*0.27*	*0.53*	*0.61*	*0.61*	*0.37*	*0.41*	*0.48*
ϕ_3	0.54	0.54	0.77	0.55	-0.13	0.29	0.56	0.55	0.72	0.71	0.68
	*0.00**	*0.00**	*0.00**	*0.00**	*0.26*	*0.06*	*0.00**	*0.00**	*0.00**	*0.00**	*0.00**

Notes: Independent variables are Shanghai Stock Exchange Composite Index (*SSE*), energy (*EN*) materials (*MT*), industrials (*IND*), consumer discretionary (*CD*), consumer staples (*CS*), consumer commodity (*CC*), health care (*HC*), financials (*FN*), information technology (*INT*), telecommunication services (*TS*), and utilities (*UL*). Dependent variables include renminbi per US dollar (ER), New York Stock Exchange Composite Index (NYSE), spot gold US dollar price (GOLD), crude oil WTI US dollar price (OIL), a lockdown dummy variable (LD), daily new confirmed COVID-19 cases in China (CNCC) and a dummy variable specifically for 3 February 2020 (D1). The marginal significance value (*msv*) is in italic * denotes statistical significant at 5% level (*msv*<0.05).

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Table 3: Estimated regression results (continued)

Sector	*SSE*	*EN*	*MT*	*IND*	*CD*	*CS*	*HC*	*FN*	*INT*	*TS*	*UL*
Half-life	1.12	1.12	2.65	1.16	0.34	0.56	1.20	1.16	2.11	2.02	1.80
Adj. R^2	0.78	0.82	0.75	0.64	0.75	0.53	0.65	0.88	0.79	0.66	0.85
AIC	9.89	9.06	10.15	9.89	10.08	12.91	12.59	11.38	12.88	12.00	9.15
Q(10)	6.82	7.47	9.79	6.86	21.54	14.64	4.91	4.77	5.16	2.64	10.17
	0.74	*0.68*	*0.46*	*0.79*	*0.02**	*0.15*	*0.91*	*0.05**	*0.88*	*0.99*	*0.43*
ARCH	0.01	0.01	0.06	0.14	3.56	0.00	0.62	0.87	0.14	0.08	0.01
	0.91	*0.95*	*0.81*	*0.71*	*0.06*	*0.98*	*0.35*	*0.60*	*0.71*	*0.78*	*0.93*
JB	0.60	1.34	2.66	0.99	1.43	1.08	3.74	4.23	5.69	3.22	7.51
	0.74	*0.51*	*0.26*	*0.61*	*0.47*	*0.58*	*0.12*	*0.08*	*0.06*	*0.20*	*0.02**

Notes: Shanghai Stock Exchange Composite Index (*SSE*), energy (*EN*) materials (*MT*), industrials (*IND*), consumer discretionary (*CD*), consumer staples (*CS*), health care (*HC*), financials (*FN*), information technology (*INT*), telecommunication services (*TS*), and utilities (*UL*). ARCH denotes heteroscedasticity test for Autoregressive Conditional Heteroscedasticity effect. AIC stands for Akaike Information Criterion, Q (10) denotes the Q-statistics of correlogram standardized squared residuals at lag 10. *JB* stands for Jarque-Bera normality test. The marginal significance value (*msv*) is in italic * denotes statistical significant at 5% level (*msv*<0.05).

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Conclusion and policy implications

The current empirical study attempts to provide a comprehensive measure on the effect of the deadly COVID-19 outbreak on Chinese stock market performance, with reference to Shanghai Composite index and its component sectors indices. The data set spanning from 2 September 2019 to 27 March 2020 are considered in this study. Shanghai Stock Exchange Composite Index and its component sector indices (energy, materials, industrials, consumer discretionary, consumer staples, health care, financials, information technology, telecommunication services, and utilities are examined. COVID-19 is represented by a lockdown dummy (*LD*), the daily new confirmed cases in China (*CNCC*) and a proxy for the first trading day after the Chinese New Year holidays. Financial market variables specifically the New York Stock Exchange Composite Index (*NYSE*) and exchange rate (*ER*), and commodity markets represented by spot gold price (*GP*) and crude oil WTI spot US dollar price (*OP*) are included for control purpose.

Few key findings could be drawn from the numerical analysis over the Chinese stock markets data. First, when the market resume trading after a prolonged Chinese New Year celebrations, the composite index unreservedly plunged by 7.72% amid the extended fear of the COVID-19 rapid outbreak. With no exception, all sectors were extensively down and the daily performances of these sectors on the 3 February 2020, from the most wounded to the least were: telecommunication services (-9.99%), information technology (-9.72%), industrials (-9.03%), consumer discretionary (-8.91%), materials (-8.64%), energy (-8.44%), utilities (-7.68%), financials (-7.28%), consumer staples (-6.85%) and health care (-3.22%). In fact, on 23 January 2020, when Wuhan city was locked down, there was already one round of market considerable drop. The daily performances of these sectors in the same manner were: telecommunication services (-4.79%), materials (-3.57%), consumer staples (-3.53%), consumer discretionary (-3.28%), information technology (-3.07%), industrials (-2.96%), energy (-2.78%), financials (-2.73%), utilities (-7.68%) and health care (-2.08%). Second, after the deep market correction on 3 February 2020, sending the indices to their new lows in 12 months, all these indices exhibited technical rebound with different strengths. In general, the energy and financials sectors set for the comparatively weakest rebound, while information technology, telecommunication sectors and consumer staples exhibited the strongest strength in rebound (Table 1). These findings suggest investors who hold shares should close their trades to avoid huge loss, as soon as quality information on negative shocks are received. Besides, short-term investors could buy low whenever there is a substantially dip in the market and close the trade within 5 to 10 trading days upon technical rebound for sizable profits. On the other perspective, the China Securities Regulatory Commission should immediately prohibit short-selling for considerate period in handling future events of pandemic outbreak and other crisis. This could avoid market over-reaction and to reduce market volatility.

Third, sub-sample analysis for the composite and sector indices before and during lockdown, with equal window length reveals that all the indices returns of materials, industrials, consumer discretionary and financials sectors dropped from positive to negative after the lockdown as a result of COVID-19 outbreak. Contradictory, health care is the only sector that was able to maintain its positive return amid the lockdown, while information technology and telecommunication services sectors suffered mild losses in indices returns in the lockdown period.

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Fourth, the standard deviation of all indices were larger during lockdown in relation to pre-lockdown period, with the exception of industrial sector, implying the Chinese stock market as a whole turned relatively more volatile during lockdown (Table 2). In this respect, risk adverse investors are advised to stay away from the market amid pandemic outbreak or crisis in the future.

First, different sectors received significant but different COVID-19 effect in terms of lockdown, depending on their nature of business. Specifically, overall, Shanghai Stock Exchange Composite Index slumped by an average of 67.99 points significantly in response to the lockdown. In the meantime, the indices of the energy, materials, industrials, consumer discretionary, consumer staples, financials and utilities sectors were down by 129.80, 52.88, 60.35, 64.02, 693.23, 272.62, 148.83 points respectively during the lockdown. Conversely, the indices for the health care, information technology and telecommunication services sectors were up by 237.46, 654.92 and 159.81 corresponding. This reveals that health care, information technology telecommunication services sectors are potential avenues for profit-seeking in the time of pandemic outbreak.

Second, the fears of COVID-19 outbreak had mounted over the prolonged Chinese New Year holidays with no share trading activities. Subsequently, the all indices in the Chinese stock market was negative and significant when the market resumed trading on 3 February 2020, confirming the significance of the findings from descriptive analysis. On the other hand, the estimated results suggest that the Chinese stock market was insignificantly affected by the new developments of COVID-19 cases, probably the effect was overshadowed by the other two COVID-19 proxies.

Third, it is found that depreciation of renminbi is favorable for the growth of materials, industrials, consumer discretionary, consumer staples, financials, information technology and telecommunication services sectors in China. Conversely, appreciation of renminbi is favorable for the energy and utilities sector, probably due to the oil importing nature of China. As such, the Chinese government should maintain a fair renminbi in order to promote its economic growth by expanding its exports on consumer and industrial products as well as information technology and telecommunication services.

Fourth, the Chinese stock market is significant and positively related to the spot gold market and crude oil market in general. Thus, these two commodity markets are not suitable avenue for investment diversification. However, investors could detect the sentiments in these commodity markets for plausible trading signals for the Chinese stock market.

Fifth, this study finds no asymmetrical reactions on favorable and unfavorable shocks in the Chinese stock market. Nevertheless, these shocks were digested quickly as it took the Chinese stock market less than 3 trading days for shocks to be reduced to one-half its original size. This suggests that the COVID-19 effect on the Chinese stock market in general and the various sectors in the country specifically is not persistent and hence these sectors will recover very soon upon removal of lockdown and when the pandemic is over.

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