Abnormal returns on tourism shares in the Chinese stock exchanges amid COVID-19 pandemic

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ABSTRACT

This study finds significant immediate adverse impact of the novel coronavirus (COVID-19) pandemic on tourism shares listed in the Shanghai and Shenzhen stock exchanges, in terms of breadth and depth. Overall, prices of these shares plunged by 20% in three consecutive days in response to pandemic fears, before technical rebound set in. Significant negative cumulative abnormal returns after the Wuhan lockdown are identified in 18 out of 21 tourism shares traded in the Chinese stock exchanges. These findings could serve as references for the China Security Regulatory Commission to monitor the market in future pandemic management. Investors are advised to avoid tourism shares the moment there is any suspicious development of virus outbreak in the future. Instead, they could look for opportunity to buy dip after massive market decline at the appropriate timing.

JEL classification: G10, G14, G15

Keywords: Tourism; coronavirus pandemic; COVID-19; Chinese stock exchanges; event study; abnormal returns.

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INTRODUCTION

Stock market studies are voluminous but studies on tourism shares and disease outbreak nexus are considerably limited, especially before the recent outbreak of the novel coronavirus pandemic. In this conjunction, three remarkable past studies worth noting are Chen *et al*. (2007), Chen *et al*. (2009) and Chong *et al*. (2010). All of them studied the impacts of the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) epidemic on tourism related shares using event study approach[2]. Specifically, Chen *et al*. (2007) provide evidence of negative SARS-CoV impacts on seven hotel shares listed in Taiwan stock exchange, with sample period covering May 2, 2002 to April 22, 2003. In a separate attempt, Chen *et al*. (2009) analyze a total of 32 stocks of few sectors in Taiwan, over the sample period of September 25, 2002 to May 21, 2003. The authors reported negative impacts of SARS-CoV on the tourism, wholesales and retails sectors. In contrast, biotechnology shares had received positive impacts from the epidemic outbreak.

Similar impacts of SARS-CoV had been reported in Chong *et al*. (2010) from the Chinese stock market perspective. Chong *et al*. (2010) sample five stocks each from the pharmaceutical and tourism industries in the Chinese stock market for the April 19, 2002 to June 23, 2003 period. They revealed significant positive abnormal returns for pharmaceutical shares in China attributed to the same epidemic, while the opposite was found in the tourism shares. With a gap of nearly 17 years, the world today is shocked by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV2), or more commonly known as COVID-19, for the novel coronavirus disease discovered in 2019. The first cluster of this novel coronavirus affected cases was discovered at Wuhan at the end of December 2019. In less than four months, it had transmitted to 213 countries, areas or territories, with 2,787,196 confirmed cases and 198,668 deaths (World Health Organization, 2020)[3]. Although at the time of this writing, this global pandemic is not over yet, it is clearly far more contagious and deadly as compared to SARS coronavirus (SARS-CoV). According to World Health Organization (2003) SARS-CoV had affected 30 countries with 8,456 cases and 744 deaths in about four months (February to June 2003).

Remarkably, while this outbreak of SARS-CoV2 is unsolicited, it has no doubt made available the opportunity for researchers to study the impacts of virus on various aspects of our life. In particular, since the outbreak of the COVID-19 pandemic, there is a surge in the research pertaining to its impact on the stock market. Among others, these studies include Ashraf (2020), Baker et al. (2020), Chia et al. (2020), Gormsen and Koijen (2020), Kotishwar (2020), Liu et al. (2020), Ngwakwe (2020), Topcu and Gulal (2020, Yan et al. (2020), Zhang et al. (2020). Notably, all these studies analyze the stock market composite indices as a whole. In contrast, Al-Awadhi et al. (2020) and Huo and Qiu (2020) include industry level analysis for the China stock exchanges. Al-Awadhi et al. (2020) report that the hotel industry performed significantly worse during the COVID-19 outbreak than before the outbreak, based on panel data analysis. Huo and Qiu (2020) find that leisure service industry performed the worst out of 28 industries considered in

[2] SARS-CoV was identified in February 2003.
[3] As of April 27, 2020, 0800 GMT+8.

the study, with a cumulative abnormal return of –1.60% for the event window [–1, 3]. On the other hand, Liew (2020) shows by regression analysis that individual tourism related share prices were significantly depressed by the Wuhan lockdown to contain the pandemic transmission[4].

As the COVID-19 pandemic spreads rapidly from human to human, many governments have implemented strict control order on its citizens' movements. The Wuhan lockdown was an unprecedented movement control first imposed in the Wuhan city, the densely-populated epicenter of this pandemic, on January 23, 2020. Soon, other cities of China and other countries followed suit. In this respect, tourism industry was instantaneously jeopardized with bans on domestic and international travels over and above the stay-safe-at-home and work-from-home principles, to break the chain of pandemic outbreak. Recently, Ali and Cobangoglu (2020) conduct a quick survey on over 2000 travelers around 28 countries on their behavior during the pandemic. From the feedbacks given by the respondents, they predicted that tourism will loss 50% revenues compared to the year before. This is due to immediate cancel of traveling and fear of traveling in the next 12 months. In addition, the World Travel and Tourism Council (WTTC) predicted that up 50 million jobs in the global travel and tourism industry will be lost due to the pandemic and it may take up to 10 months for the industry to recover after the outbreak is over (Faus, 2020).

While the impact on tourism industry may be long lasting, the current study is set to empirically measure the immediate impact of the coronavirus pandemic on tourism stocks. Specifically, this study attempts to reveal the deepness and extensiveness of the negative immediate impact of pandemic on tourism shares of China, where Wuhan, the epicenter of the COVID-19 pandemic lies. China is also one of the largest consumers and suppliers in the world tourism industry (Thomala, 2020a, b). Investors, fund managers and regulatory commission are among the share market participants who will benefit from this study. The findings serve them reference for advance preparation in handling investment risk and opportunity amid any suspicious and possible virus outbreak in the future. The remainder of this paper is organized as follows. Section 2 specifies the model, while Section 3 describes the data and offers preliminary analysis. The results of event study are reported and discussed in Section 4. The final section contains conclusion and policy recommendation.

MODEL SPECIFICATION

This study attempts to quantify the immediate COVID-19 impact on tourism shares in the Chinese stock exchanges using event study methodology. In particular, this method compares the behavior of tourism shares after the outbreak of the COVID-19 pandemic to

[4] Trip.com Group which was incorporated in China, and two American companies (Booking Holdings Inc. and Expedia Group), in which their global business is generally reflective of various key components of tourism industry as a whole were considered in the study.

the expected behavior if the event had not happened. In this case, the difference between the observed and expected returns, known as abnormal returns is of great interest. If it could be shown that the shares produce significant negative abnormal returns after the event, then one could conclude that the COVID-19 pandemic has significant negative impact on the shares. One way to predict the expected return of a share is to compute the mean of share prices before the occurrence of the event and assume that the share or the investors behave in the same way under the same circumstances (apart from the event) into the future. A more realistic way is to estimate the expected returns using the market model. It assumes that in share investment, a rational investor would demand a normal return of risk-free rate plus a risk premium for her to encounter all market risks. Typically, daily expected return can then be defined as:

$$R_{id}^{e} = \alpha + \beta R_{md} + \varepsilon_{d}, \tag{1}$$

where R_{id}^{e} denotes the expected return, or normal return of individual share i at trading day d, while R_{md} is the benchmark market return on the same day.

Meanwhile, parameters α and β represent the risk-free rate and market risk premium respectively, and ε_{d} is a zero-mean disturbance term.

Equation (1) can be estimated based on the ordinary least squares (OLS) principle such that:

$$\hat{R}_{id}^{e} = \hat{\alpha} + \hat{\beta} R_{md}, \tag{2}$$

where $\hat{R}_{id}^{e}$ represents the estimated abnormal return, which is also known as market-adjusted return or excess return, of individual share i at trading day d.

Before that, the return of share prices needs to be calculated as:

$$R_{jd} = \frac{100(P_{jd} - P_{jd-1})}{P_{jd}}, \text{ for } j = \{i, m\}, \tag{3}$$

where P_{jd} is the closing share price of individual share i, or the closing price of market index m at trading day d, whereas $d - 1$ refers to the previous trading day.

The $\hat{\alpha}$ and $\hat{\beta}$ statistics are obtained from regressing the returns of share i on a constant and returns of the composite index that represents the general market conditions, over the estimation window prior to the event. Abnormal return for any trading day d can then be calculated as:

$$AR_{id} = R_{id} - \hat{R}_{id}^{e}, \tag{4}$$

where AR_{id} and R_{id} stand for abnormal return and actual return of individual share i at trading day d.

The significance of the abnormal return at any trading day d in the event period could be determined by computing the following Student-t statistic (see Brown and Warner, 1985)[5]:

$$t_{AR} = \frac{AR_{id}}{\sqrt{\sigma^2_{AR_i}}}, \tag{5}$$

where $\sigma^2_{AR_i}$ is the variance of AR_{id}, to be estimated by:

$$\sigma^2_{AR_i} = \frac{1}{d_2 - d_1} \sum_{d=d1}^{d2} (AR_{id} - \overline{AR}_i)^2 , \tag{6}$$

where $\overline{AR}_i$ is the mean abnormal return over the estimation window starting from day d_1 and ending on day d_2.

The alternative hypothesis of negative abnormal return, $H_a: AR_i < 0$, could be tested against the null hypothesis, $H_0: AR_i \geq 0$ using one-tailed test. The computed t statistic must be negative and smaller than the conventional critical values at conventional accepted levels[6].

Note that it is far from conclusive to refer to abnormal return from any single trading day. Hence, cumulative abnormal returns are usually computed over a considerable period of trading days, as:

$$CAR_i = \sum_{d=d_3}^{d_4} AR_{id}, \tag{7}$$

where d_3 and d_4 are the starting and ending dates of the period after the event, known as the event window, denoted $[d_3 , d_4]$. The corresponding Student- t statistic is given by:

$$t_{CAR} = \frac{CAR_i}{\sqrt{\sigma^2_{CAR_i}}}, \tag{8}$$

where $\sigma^2_{CAR_i}$ is the variance of CAR_i to be estimated by:

$$\sigma^2_{CAR_i} = (d_4 - d_3 + 1)\sigma^2_{AR_i}. \tag{9}$$

[5] See also Repousis (2016), Wong and Hooy (2016) and Chen and Liew (2019).

[6] For instance, the critical value is –1.645 or –2.236 respectively for 5% or 1% significance level. In contrast, for $H_a: AR_i > 0$. The computed t must be positive and greater than 1.645 or 2.236 for 5% or 1% level of significance.

Analyzing the impact of the COVID-19 pandemic on tourism industry may be inadequate based on a single share and the result may be biased to the selection of the share. Therefore, to reflect the whole industry, a considerable number of shares in the industry must be included. Dealing with various share i across the industry, the average abnormal returns (AAR_d) and cumulative average abnormal returns ($CAAR_d$), in that sequence, can be obtained by:

$$AAR_d = \frac{1}{n}\sum_{i=1}^{n} AR_{id}, \tag{10}$$

and

$$CAAR_d = \sum_{d=d_3}^{d_4} AAR_d. \tag{11}$$

The corresponding cross-sectional Student-t statistics to test for $H_a: AAR_d < 0$ against the null hypothesis, $H_0: AAR_d \geq 0$ can be computed as:

$$t_{AAR} = \sqrt{n}\cdot\frac{AAR_d}{\sqrt{\sigma^2_{AAR_d}}}, \tag{12}$$

where n is the number of shares included in the study and $\sigma^2_{AAR_d}$ is the variance of AAR_d is derived from:

$$\sigma^2_{AAR_d} = \frac{1}{d_2-d_1}\sum_{d=d_1}^{d_2}(AAR_d - \overline{AAR})^2, \tag{13}$$

where $\overline{AAR}$ is the average of AAR_d over the estimation window starting from day d_1 and ending on day d_2.

The corresponding cross-sectional Student- t statistics to test for $H_a: CAAR_d < 0$ against the null hypothesis, $H_0: CAAR_d \geq 0$ is specified as:

$$t_{CAAR} = \frac{CAAR_d}{\sqrt{(d_4-d_3+1)\sigma^2_{AAR_d}}}. \tag{14}$$

DATA AND PRELIMINARY FINDINGS

Tourism shares traded in the Shenzhen and Shanghai stock exchanges are included in this study. The shares are identified and downloaded by searching for 'tourism' and 'travel' keywords in Investing.com website[7]. Table 1 shows a full list with a total of 10 and 11 tourism shares listed in the Shenzhen and Shanghai stock exchanges respectively. All shares obtained are denominated in Chinese Yuan (CNY)[8]. For the market benchmark, the Shenzhen stock exchange (SZSE) and Shanghai stock exchange (SSE) composite

[7] By refining 'equities' to confine to individual shares, and by specifying China as the country where the shares are listed.

[8] Two other individual shares, Hainan Dadonghai Tourism Centre Holdings Co Ltd Class B and Huangshan Tourism Development Co Ltd B, which are traded in US dollar are excluded in this study as they are correspondingly represented by Class A of the same companies.

indices (SZSC and SSEC) are also downloaded from the same source. The sample period of study ranges from March 11, 2019 to April 14, 2020. To establish the impact of the COVID-19 pandemic, this study adopts two separate event days related to the pandemic announcements. The first event fell on December 31, 2019 when Chinese officials first formally announced to World Health Organization (WHO) on the first COVID-19 cluster. The second event happened on January 23, 2020 concurring with the announcement and implementation of Wuhan lockdown on the same day.

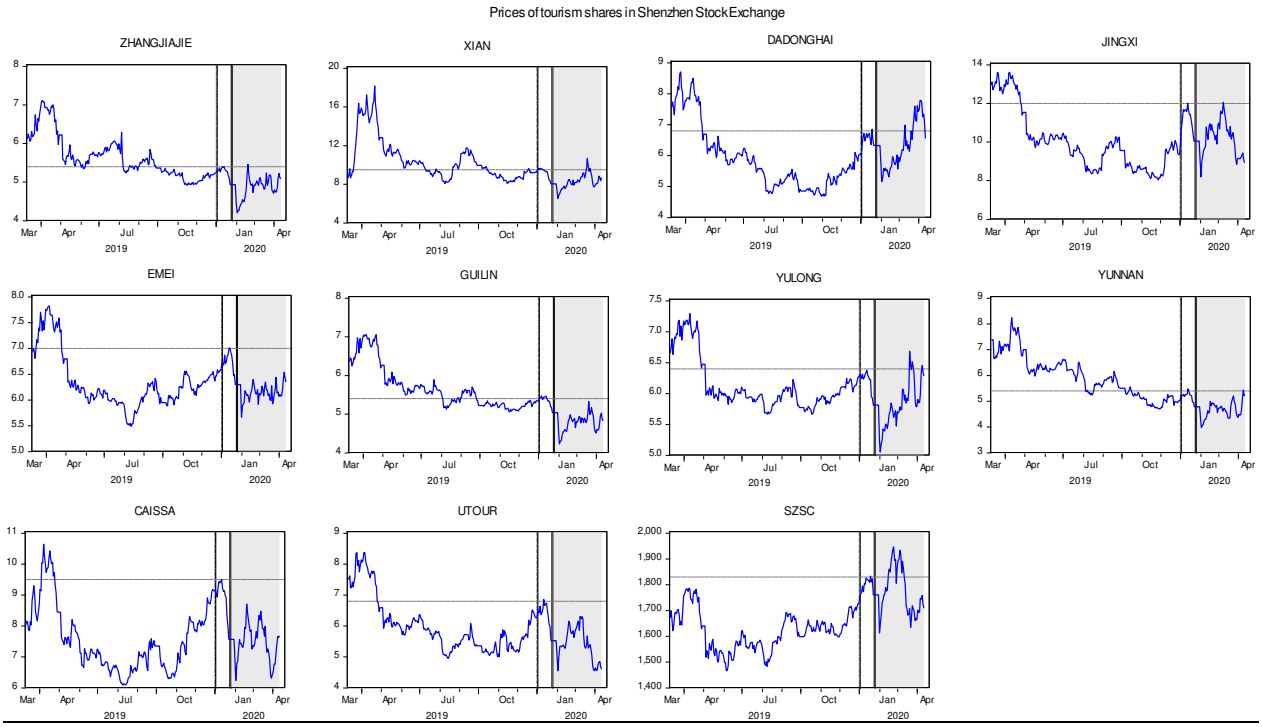
Table 1 A full list of tourism shares listed in Chinese stock exchanges

No	Code	Company
	Shenzhen Stock Exchange	
1	000430	Zhang Jia Jie Tourism Group Co Ltd
2	000610	XiAn Tourism Co Ltd stock
3	000613	Hainan Dadonghai Tourism Centre Holdings Co Ltd Class A
4	000802	Beijing Jingxi Culture & Tourism Co Ltd stock
5	000888	Emei Shan Tourism Co Ltd stock
6	000978	Guilin Tourism Corp Ltd stock
7	002033	LiJiang YuLong Tourism Co Ltd
8	002059	Yunnan Tourism Co Ltd
9	000796	Caissa Travel Group Co Ltd Stock
10	002707	Beijing Utour International Travel Service Co Ltd
	Shanghai Stock Exchange	
1	600054	Huangshan Tourism Development Co Ltd A
2	600593	Dalian Sunasia Tourism Holding Co Ltd
3	600706	XiAn Qujiang Cultural Tourism Co Ltd stock
4	600749	Tibet Tourism Co Ltd
5	603099	Changbai Mountain Tourism Co Ltd
6	603136	Jiangsu Tianmu Lake Tourism Co Ltd
7	603199	Anhui Jiuhuashan Tourism Development Co Ltd
8	603869	Beibu Gulf Tourism Corp Ltd
9	601888	China International Travel Service Corp Ltd
10	600358	China United Travel Co Ltd
11	900929	Shanghai Jinjiang International Travel Co Ltd

Price behavior of tourism shares

The price behavior of these shares and the composite indices are given in Figure 1. In Figure 1, the vertical dotted line and solid line are drawn on December 31, 2019 and January 23, 2020 respectively for references, while horizontal dotted line shows the highest price before the announcement of the Wuhan lockdown. It quickly become evident from Figure 1 that prices of all shares in both stock exchanges including the composite indices were surging in the beginning of the year 2020, even though WHO was first officially informed about the first cluster of pneumonia cases of unknown cause found in the Wuhan city on December 31, 2019. Apparently, the market sentiments were

not affected by the news at all. Perhaps investors were still enjoying the price ride due to seasonal effect as the Chinese New Year was ahead of them then, without realizing the deadly consequence of the virus yet.



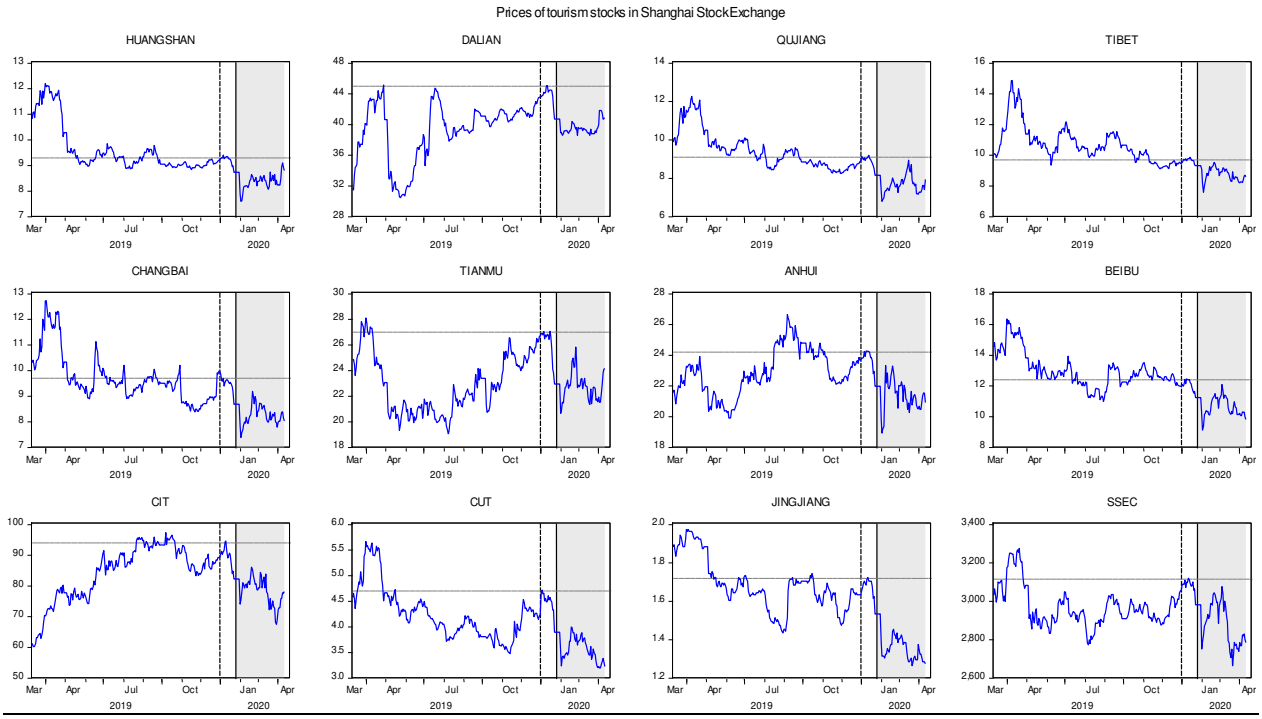
Notes: ZHANGJIAJIE: Zhang Jia Jie Tourism Group Co Ltd, XIAN: XiAn Tourism Co Ltd stock, DADONGHAI: Hainan Dadonghai Tourism Centre Holdings Co Ltd Class A, JINGXI: Beijing Jingxi Culture & Tourism Co Ltd stock, EMEI: Emei Shan Tourism Co Ltd stock, GUILIN: Guilin Tourism Corp Ltd stock, YULONG: LiJiang YuLong Tourism Co Ltd, YUNAN:Yunnan Tourism Co Ltd, CAISSA: Caissa Travel Group Co Ltd Stock, UTOUR: Beijing Utour International Travel Service Co Ltd, and SZSC: Shenzhen stock exchange composite index. The vertical dotted line and solid line are drawn on the dates December 31, 2019 (WHO first received reports of COVID-19 cluster) and January 23, 2020 (announcement of Wuhan lockdown) respectively, while horizontal dotted line shows the highest price before the announcement of Wuhan lockdown.

In fact, the upward trend of the shares was only first reversed with extensive dipped on the January 23, 2020, after the announcement of the Wuhan lockdown was made on 9.44 a.m. and to be commenced from 10 a.m. on the same day[9]. January 23, 2020 also marked the last trading day for both the Chinese stock exchanges and the markets resumed trading on February 3, 2020, after a prolonged holiday amid the pandemic[10]. After the drastic dropped in the prices, Figure 1 reveals an interesting feature that, overall, SZSE exhibited stronger technical rebound compared to SSE. Composite index of the former managed to climb to a higher high compared to the previous pre-market crash high as indicated by horizontal dotted line.

In sharp contrast, the latter did not manage to register for a higher high. Individually, few tourism shares in SZSE also managed to register higher highs or at least on par with the previous high. On the other hand, all of the tourism shares in SSE did not even manage to be on par with the previous high during the technical rebound. As a matter of fact, as

[9] Wuhan Center for Novel Coronavirus Disease Control and Prevention (2020).
[10] The State Council Republic of China (2020).

of April 14, 2020, few of them even went lower than the previous lows attained during the market crash, while all the tourism shares in SZSE were higher than their respective lowest points.



Notes: HUANGSHAN: Huangshan Tourism Development Co Ltd A, DALIAN: Dalian Sunasia Tourism Holding Co Ltd, QUJIANG: XiAn Qujiang Cultural Tourism Co Ltd stock, TIBET: Tibet Tourism Co Ltd, CHANGBAI: Changbai Mountain Tourism Co Ltd, TIANMU: Jiangsu Tianmu Lake Tourism Co Ltd, ANHUI; Anhui Jiuhuashan Tourism Development Co Ltd, BEIBU: Beibu Gulf Tourism Corp Ltd, CIT: China International Travel Service Corp Ltd, CUT: China United Travel Co Ltd, JINGJIANG: Shanghai Jinjiang International Travel Co Ltd, and SSEC: Shanghai stock exchange composite index.

Figure 1 Prices of tourism shares

Returns of tourism shares after Wuhan lockdown

Table 2 provides a snapshot on the percentage returns of tourism shares for the first few days after the Wuhan lockdown[11]. It is seen from Table 2 that prices of individual tourism shares fell drastically for another two consecutive trading days, before technical rebound occurred on February 5, 2020 and after. The magnitude of negative returns peak (about 10% in all cases) on February 3, 2020. Note that all the tourism shares fell with substantially larger intensity (double in magnitude) compared to their composite indices. Meanwhile, the composite indices of both stock exchanges only continued to fall drastically for another consecutive day before it started to rebound technically on February 4, 2020, which is one day earlier than the individual tourism shares.

[11] All returns mentioned in this study are measured in percentage.

Table 2 Daily percentage returns of tourism shares (January 23, 2020 to February 6, 2020)

Shenzhen Stock Exchange

Day	ZJJ	XA	DDH	JX	EM	GL	YL	YN	CS	UT	Average	SZSC
January 23, 2020	-3.73	-3.87	0.00	-4.12	-3.09	-2.91	-1.86	-3.46	-5.51	-7.56	-3.61	-3.45
February 3, 2020	-9.98	-9.94	-10.00	-10.00	-10.03	-9.98	-10.00	-9.89	-9.95	-10.00	-9.98	-8.41
February 4, 2020	-5.43	-10.06	-9.52	-9.56	3.89	-6.65	-3.45	-7.94	-8.54	-8.69	-6.60	1.80
Total	-19.14	-23.87	-19.52	-23.68	-9.23	-19.54	-15.31	-21.29	-24.00	-26.25	-20.18	-10.06
February 5, 2020	1.44	5.28	2.53	9.95	0.51	1.43	2.58	2.03	8.70	9.96	4.44	2.48
February 6, 2020	0.00	2.95	5.51	3.46	0.51	0.70	1.35	1.24	1.33	6.84	2.39	2.90
Total	1.44	8.23	8.04	13.41	1.02	2.13	3.93	3.27	10.03	16.80	6.83	5.38

Shanghai Stock Exchange

Day	HS	DL	QJ	TB	CB	TM	AH	BB	CIT	CUT	JJ	Average	SSEC
January 23, 2020	-2.79	-3.45	-4.14	-2.70	-5.46	-3.66	-4.15	-3.54	-3.05	-9.98	-5.37	-4.39	-2.75
February 3, 2020	-10.00	-4.46	-9.99	-9.98	-9.94	-10.01	-9.99	-10.02	-10.00	-10.05	-9.99	-9.49	-7.72
February 4, 2020	-3.45	0.23	-7.53	-7.14	-5.65	0.92	-4.41	-9.94	1.73	-7.74	-5.00	-4.36	1.34
Total	-16.24	-7.68	-21.66	-19.82	-21.05	-12.75	-18.55	-23.50	-11.32	-27.77	-20.36	-18.25	-9.13
February 5, 2020	0.40	-1.05	1.48	5.44	2.72	3.22	1.64	2.76	3.60	5.59	-0.38	2.31	1.25
February 6, 2020	3.56	0.55	1.31	3.27	1.32	-0.23	0.63	8.27	3.88	0.29	0.00	2.08	1.72
Average	3.96	-0.50	2.79	8.71	4.04	2.99	2.27	11.03	7.48	5.88	-0.38	4.39	2.97

Notes: For the Shenzhen stock exchange, ZJJ: Zhang Jia Jie Tourism Group Co Ltd, XIAN: XA Tourism Co Ltd stock, DDH: Hainan Dadonghai Tourism Centre Holdings Co Ltd Class A, JX: Beijing Jingxi Culture & Tourism Co Ltd stock, EM: Emei Shan Tourism Co Ltd stock, GL: Guilin Tourism Corp Ltd stock, YL: LiJiang YuLong Tourism Co Ltd, YN:Yunnan Tourism Co Ltd, CS: Caissa Travel Group Co Ltd Stock, UT: Beijing Utour International Travel Service Co Ltd, and SZSC: Shenzhen stock exchange composite index. For the Shanghai stock exchange, HS: Huangshan Tourism Development Co Ltd A, DL: Dalian Sunasia Tourism Holding Co Ltd, QJ: XiAn Qujiang Cultural Tourism Co Ltd stock, TB: Tibet Tourism Co Ltd, CB: Changbai Mountain Tourism Co Ltd, TM: Jiangsu Tianmu Lake Tourism Co Ltd, AH; Anhui Jiuhuashan Tourism Development Co Ltd, BB: Beibu Gulf Tourism Corp Ltd, CIT: China International Travel Service Corp Ltd, CUT: China United Travel Co Ltd, JJ: Shanghai Jinjiang International Travel Co Ltd, and SSEC: Shanghai stock exchange composite index.

EVENT STUDY FINDINGS

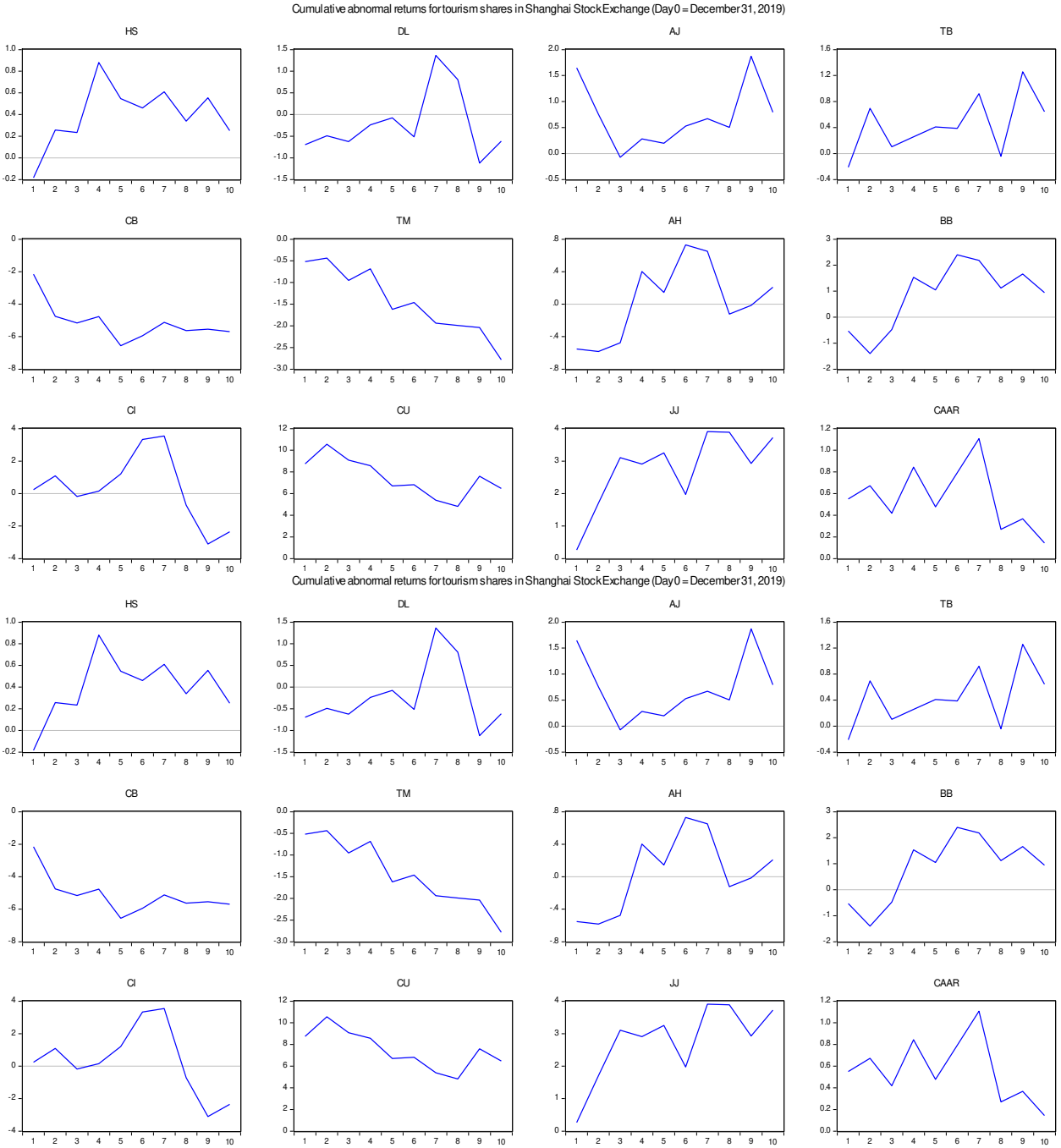
For the event day on December 31, 2019, the estimation window is from March 11, 2019 to December 30, 2019, with a total of 200 trading days. Meanwhile, the event window ranges from December 31, 2019 (Day 0) to January 15, 2020 (Day 10), with a total of 11 trading days. Note that for event study approach here, analysis up to at most Day 10 is considered long enough. Otherwise, it will run into and overlap with the next incoming event, which is the Wuhan lockdown[12]. As such, results longer than Day 10 is not advisable as it may show unreliable results that are contaminated with other events. On the other hand, for the event day on January 23, 2020, the estimation window is from April 2, 2019 to January 22, 2013, also with a total of 200 trading days. The event window also contains a total of 11 trading days, starting from January 23, 2020 (Day 0) to February 14, 2020 (Day 10).

Behaviour of cumulative abnormal returns

Figure 2 and Figure 3 display the cumulative abnormal returns (CAR_i) of all tourism shares examined in this study, for the Day 0 on December 31, 2019 and January 23, 2020 respectively. Horizontal solid line in these figures refers to the zero cumulative abnormal return level. These plots reveal that cumulative abnormal returns of individual tourism

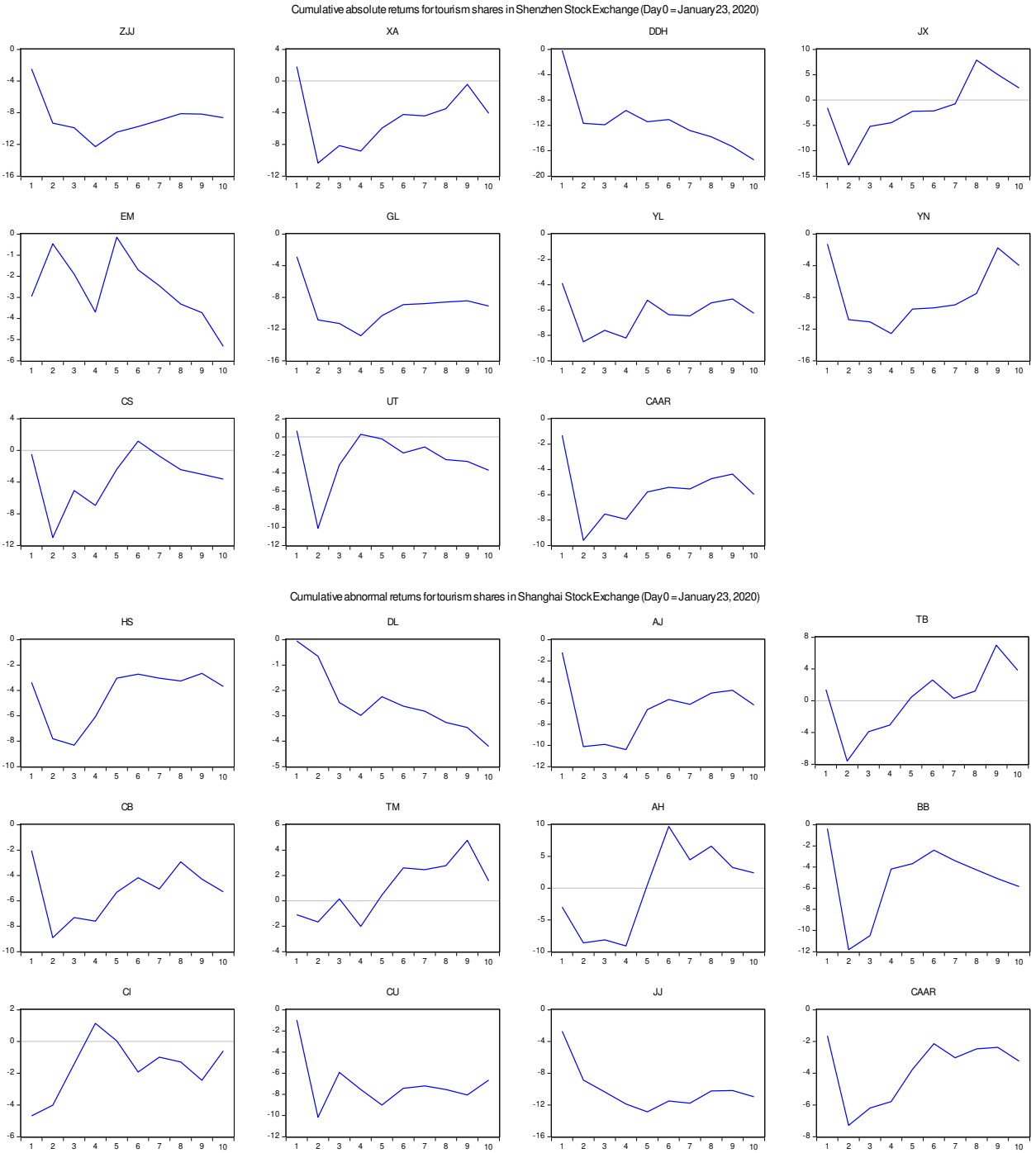
[12] The Wuhan lockdown occurred on Day 16, counting from December 31, 2019 as Day 0.

shares fluctuated in somewhat different ways, with some trending downwards, while others fluctuated horizontally or exhibited upwards movement. More importantly, with Day 0 on December 31, 2019, shares with negative CAR_i most of the time are ZJJ, XA, GL and YL in SZSE, in addition to CB and TM in SSE. Note that there were also shares with positive CAR_i majority of the time like DDH, JX and YN in SZSE, along with HS, AJ, TB, BB, CU and JJ in SSE.



Notes: For symbols of shares, kindly refer to the footnote for Table 2. Horizontal solid line refers to the zero cumulative abnormal return level.

Figure 2 Cumulative abnormal returns (Day 0 = December 31, 2019)



Notes: For symbols of shares, kindly refer to the footnote for Table 2. Horizontal solid line refers to the zero cumulative abnormal return level.

Figure 3 Cumulative abnormal returns (Day 0 = January 23, 2020)

Therefore, in term of cumulative abnormal returns, it can be said that individual tourism shares in SSE performed much better. Nevertheless, once we aggregate the CAR_i of all shares across stock exchange, the resulting cumulative average abnormal returns ($CAAR_d's$) ended up positive for both stock exchanges. However, SZSE exhibited better performance as a whole, as its $CAAR_d's$ were in the range of 1.2% to 2.4%, whereas $CAAR_d's$ of SSE ranges from 0% to 1.2%. As for Day 0 on January 23, 2020, the cumulative abnormal returns of all tourism shares in both stock exchanges were well below zero most of the time, with exception of TM, AH and TB. It is consistent for these three shares that their cumulative abnormal returns were negative for the first half of the time, and then they turned positive for the second half of the time. These three shares enable SSE to perform better than its counterpart in terms of individual tourism shares. Both stock exchanges were badly performed in aggregate their cumulative average abnormal returns were all negative.

Results on abnormal returns

Table 3 and Table 4 summarize the abnormal returns, AR_{id} for individual tourism shares, and the average abnormal returns, AAR_d across this specific industry as a whole, for Day 0 on December 31, 2019 and January 23, 2020 correspondingly. Note that the results of the Binomial test, which is useful albeit its simplicity, are reported in these tables[13]. It tests whether there are significantly more occurrence of negative (positive) abnormal returns in the event period or not, compared to non-negative (non-positive) abnormal returns. This Binomial test determines the quantity aspect on the extensiveness of the impact, while Student-t test determines the quality aspect by allowing one to test for the significance of the impact of an event in terms of magnitude.

This study argues that the Binomial test should be treated as complementary test for Student-t test in event study. This is because, the magnitude of impact due to an event may not be profound enough to be considered as significantly negative (or positive), but the event may have resulted in significantly more occurrence of negative (positive) abnormal returns compared to non-negative (non-positive) abnormal returns. For instance, Table 4 reveals that investor who bought DL shares on the December 30, 2019 and kept it over the event period would suffer negative daily abnormal returns on 10 out of 11 trading days[14]. The number of occurrence of negative abnormal returns is significantly more than the number of occurrence of non-negative abnormal returns, based on the Binomial test. In other words, it can be said that the COVID-19 pandemic had affected the share extensively. Hence, it would be fair to the investor by saying that the COVID-19 pandemic has resulted in negative impact to her. However, by the Student-t test, the magnitude or size of each of the negative abnormal returns [ranging from –

[13] The probability of observing k successes in n trials with probability of success for a single trial, q, is given by $p(k) = \frac{n!}{k!(n-k)!} \cdot q^k(1-q)^k$. As the abnormal return could be negative, zero or positive, q = 1/3.

[14] Unlike cumulative abnormal returns which are accumulated over a period of trading days (event window), abnormal returns are on daily calculation basis.

0.05% to −1.91%%, $t \in \{-0.02, -0.72\} > -1.645$] are by far too small be significantly negative ($H_a: AR_i < 0$) as oppose to non-negative, $H_0: AR_i \geq 0$) for each day[15].

From the cross-sectional aspect, investor who had invested in all the tourism counters in the SZSE would be upset by experiencing negative abnormal returns in 10 counters out of 11 on Day 8 (Table 3, No doubt, the number of occurrence of negative abnormal returns is significantly more than the number of occurrence of non-negative abnormal returns, based on the Binomial test [k = 10, n =11, p (k) < 0.01]. Nevertheless, by the Student-t test, the size of each of the negative abnormal returns [ranging from −0.47% to −3.34%, $t \in \{-034, -1.49\} > -1.645$] are determined to be insignificantly negative on that particular day. It would be unfair to say that the COVID-19 pandemic had had no impact against her on Day 8, merely based on Student-t test, when the investor was miserably holding 10 out of 11 shares with negative abnormal returns. Hence, by solely judging from the Student-t test, one would conclude that there was no significant negative impact of the event, while in fact there was, in terms of coverage measured by the number of occurrence. These time series and cross-sectional cases clearly demonstrate that for impact study using event study approach, one must look into the quantity aspect, to complement the usual Student-t test for the quality aspect[16].

Table 3 reveals that, based on the Binomial test, there is significantly more occurrence of negative abnormal returns for GL, YL and CS in SZSE, in addition to TM, BB and CIT in SSE. On the other hand, more number of positive abnormal returns is significantly observed for DDH and JX in SZSE only. In the same principle of interpretation, investor who had invested in a portfolio that consists of all tourism shares on December 30, 2019 in SZSE would end up with significantly more experiences of negative daily abnormal returns [k= 67, n=121, p (k) of the Binomial test < 0.01] for keeping them until the last event day. However, the results of the Student-t test suggest that none of the above-mentioned negative abnormal returns are significant in terms of magnitude of the impact. As a matter of fact, there are 9 cases of significant positive abnormal returns [$t \in (1.71, 3.51) > 1.645$] out of a total of 121 observations in SZSE, plus 2 out of 132 observations in SSE[17]. As of the average abnormal returns for a portfolio of all tourism shares, AAR_d for the Shenzhen and Shanghai stock exchanges, none of them is significant by the t test.

[15] This abnormal returns are also insignificantly negative even when the investor accumulated them until the last event day, with $CAR_i = -0.62\%$ at Day 10 and $t = -0.09 > -1.645$ (See Table 6).

[16] One may also regard the Binomial test as testing the broadness of the impact, whereas Student-t test for testing the depth of the impact of an event.

[17] In the time of the COVID-19 pandemic outbreak, JX was the only counter that outshined others in the early January 2020. This tourism business company which is also involved in film, television and entertainment and artist management seems to have ridden on the Chinese New Year celebration's advantage to go against the negative trend. Nevertheless, its share price plunged as outrageously as others in the same industry after the Chinese New Year (Table 2).

Table 3 Abnormal returns (Day 0 = December 31, 2019)

Abnormal returns for tourism shares in Shenzhen Stock Exchange (Day 0 = December 31, 2019)

Day	ZJJ	*t*	Sig	XA	*t*	Sig	DDH	*t*	Sig	JX	*t*	Sig	EM	*t*	Sig	GL	*t*	Sig	YL	*t*	Sig	YN	*t*	Sig	CS	*t*	Sig	UT	*t*	Sig	AAR	*t*	Sig	-	+
0	0.15	0.08		0.01	0.00		0.17	0.08		-1.08	-0.55		0.03	0.03		-0.37	-0.31		0.45	0.47		0.18	0.09		-1.13	-0.46		-1.22	-0.57		-0.28	-0.26		0.77	0.06
1	-0.93	-0.51		0.01	0.00		-1.69	-0.75		5.55	2.84	**	0.54	0.52		-0.79	-0.66		-0.55	-0.58		2.32	1.10		-1.81	-0.73		-0.80	-0.38		0.19	0.17		0.06	0.77
2	0.40	0.22		1.08	0.32		4.79	2.14	*	6.86	3.51	**	-0.34	-0.33		0.61	0.51		-0.47	-0.49		-0.70	-0.33		-1.80	-0.72		2.13	1.00		1.26	1.15		0.77	0.06
3	-0.53	-0.29		-1.89	-0.57		3.57	1.59		3.62	1.85	*	-0.79	-0.76		-0.10	-0.08		-1.08	-1.13		-0.12	-0.05		-1.91	-0.77		-1.69	-0.79		-0.09	-0.08		0.00	0.80
4	0.20	0.11		-0.34	-0.10		0.18	0.08		4.25	2.17	*	1.78	1.71	*	-0.28	-0.23		0.22	0.23		-0.07	-0.03		1.82	0.73		1.78	0.84		0.95	0.87		0.74	0.02
5	-0.66	-0.37		0.35	0.10		-2.10	-0.94		0.49	0.25		-1.25	-1.21		-0.69	-0.57		-0.33	-0.35		-0.24	-0.11		3.61	1.45		-2.51	-1.18		-0.33	-0.30		0.02	0.74
6	-0.20	-0.11		-1.65	-0.49		0.03	0.01		-0.79	-0.40		-0.85	-0.82		-0.46	-0.38		-0.75	-0.78		-0.15	-0.07		-2.48	-1.00		-0.93	-0.44		-0.82	-0.75		0.00	0.91
7	1.15	0.64		-0.72	-0.22		1.96	0.87		0.38	0.20		1.65	1.58		0.59	0.49		0.95	1.00		0.13	0.06		0.42	0.17		1.82	0.86		0.83	0.76		0.91	0.00
8	-1.18	-0.65		-2.42	-0.73		-3.34	-1.49		-1.82	-0.93		-0.68	-0.65		-0.88	-0.73		-0.47	-0.49		-0.71	-0.34		-0.87	-0.35		3.20	1.51		-0.92	-0.84		0.00	0.91
9	0.66	0.36		0.22	0.07		1.75	0.78		4.10	2.09	*	1.98	1.90	*	0.47	0.39		0.68	0.71		4.22	2.00	*	-2.67	-1.07		-2.43	-1.14		0.90	0.82		0.80	0.00
10	-0.66	-0.37		-1.40	-0.42		1.11	0.49		-2.57	-1.32		0.36	0.34		-1.01	-0.84		-1.06	-1.11		-1.63	-0.77		-1.03	-0.41		0.94	0.44		2.13	1.95		0.02	0.74
-	0.08			0.08			0.76			0.76			0.83			0.01			0.03			0.03			0.01			0.08			0.83			**0.00**	
+	0.83			0.83			0.01			0.03			0.08			0.76			0.76			0.76			0.76			0.83			0.08				**1.00**

Abnormal returns for tourism shares in Shanghai Stock Exchange (Day 0 = December 31, 2019)

Day	HS	*t*	Sig	DL	*t*	Sig	QJ	*t*	Sig	TB	*t*	Sig	CB	*t*	Sig	TM	*t*	Sig	AH	*t*	Sig	BB	*t*	Sig	CIT	*t*	Sig	CUT	*t*	Sig	JJ	*t*	Sig	AAR	*t*	Sig	-	+
0	0.11	0.09		-0.13	-0.06		0.80	0.52		0.33	0.15		0.65	0.28		1.24	0.58		-1.14	-0.77		-0.56	-0.29		-0.49	-0.46		1.35	0.64		-0.41	-0.35		0.16	0.20		0.83	0.08
1	-0.18	-0.16		-0.70	-0.31		1.65	1.06		-0.21	-0.09		-2.15	-0.94		-0.52	-0.24		-0.55	-0.37		-0.53	-0.27		-1.81	-0.73		8.75	4.15	**	0.26	0.23		0.55	0.69		0.01	0.76
2	0.44	0.38		0.21	0.09		-0.89	-0.57		0.90	0.41		-2.60	-1.13		0.08	0.04		-0.03	-0.02		-0.87	-0.44		-1.80	-0.72		1.80	0.85		1.45	1.24		0.12	0.15		0.83	0.08
3	-0.02	-0.02		-0.13	-0.06		-0.83	-0.53		-0.59	-0.27		-0.41	-0.18		-0.52	-0.24		0.11	0.07		0.92	0.47		-1.91	-0.77		-1.46	-0.69		1.40	1.20		-0.25	-0.32		0.01	0.76
4	0.65	0.55		0.39	0.17		0.36	0.23		0.15	0.07		0.40	0.17		0.27	0.12		0.88	0.59		2.01	1.02		1.82	0.73		-0.53	-0.25		-0.20	-0.17		0.43	0.53		0.84	0.00
5	-0.33	-0.29		0.16	0.07		-0.08	-0.05		0.15	0.07		-1.79	-0.78		-0.93	-0.43		-0.26	-0.17		-0.49	-0.25		3.61	1.45		-1.87	-0.88		0.34	0.29		-0.37	-0.46		0.03	0.76
6	-0.09	-0.07		-0.44	-0.20		0.33	0.21		-0.02	-0.01		0.61	0.27		0.16	0.07		0.59	0.39		1.36	0.69		-2.48	-1.00		0.13	0.06		-1.28	-1.10		0.31	0.39		0.83	0.08
7	0.15	0.13		1.88	0.84		0.14	0.09		0.53	0.24		0.82	0.36		-0.48	-0.22		-0.08	-0.05		-0.22	-0.11		0.42	0.17		-1.43	-0.68		1.94	1.66	*	0.32	0.39		0.76	0.03
8	-0.27	-0.23		-0.56	-0.25		-0.17	-0.11		-0.96	-0.44		-0.51	-0.22		-0.05	-0.03		-0.77	-0.52		-1.07	-0.54		-0.87	-0.35		-0.59	-0.28		-0.02	-0.02		-0.84	-1.05		0.00	0.99
9	0.22	0.19		-1.93	-0.87		1.37	0.88		1.30	0.59		0.09	0.04		-0.05	-0.02		0.11	0.07		0.54	0.27		-2.67	-1.07		2.79	1.32		-0.96	-0.82		0.10	0.12		0.76	0.03
10	-0.30	-0.26		0.51	0.23		-1.07	-0.69		-0.61	-0.28		-0.15	-0.07		-0.74	-0.34		0.22	0.15		-0.72	-0.36		-1.03	-0.41		-1.13	-0.53		0.79	0.68		0.69	0.86		0.01	0.76
-	0.08			0.08			0.83			0.83			0.08			0.03			0.08			0.03			0.01			0.08			0.83			0.76			**0.00**	
+	0.83			0.83			0.08			0.08			0.83			0.76			0.83			0.76			0.76			0.83			0.08			0.01				**1.00**

Notes: For symbols of shares, kindly refer to the footnote for Table 2. Statistical symbol t denotes t_{AR} and t_{AAR} specified in Eq. (5) and Eq. (8) correspondingly for individual shares AR_{id} and the AAR_d as a whole for the specific stock exchange. Sig refers to the significance of the abnormal returns with * and ** indicating significant at 5% and 1% respectively. The – symbol at the second last column shows the probability value of the Binomial test for the alternative hypothesis of significantly more occurrence of negative abnormal returns compared to the null hypothesis of insignificance number of such occurrence across all individual shares in the specific stock exchange for each trading day d. Similarly, + symbol at the last column shows the probability value of the same test for alternative hypothesis of significantly more occurrence of positive abnormal returns across all individual shares in the specific stock exchange for each trading day d. Meanwhile, symbols – and + at the second last and the bottom rows denote the respective tests across all trading days for each i. On the other hand, the figure in bold for – (or +) symbol at the bottom right hand side of the table refers to the probability value of the Binomial test for the null hypothesis of significantly more occurrence of negative (or +) abnormal returns for the specific stock exchange as a whole. In all situations, H_0 can be rejected in favor of H_a if the probability value is less than or equal to 0.05 or 0.01 for 5% or 1% significance level respectively.

Table 4 Abnormal returns (Day 0 = January 23, 2020)

Abnormal returns for tourism shares in Shenzhen Stock Exchange (Day 0 = January 23, 2020)

Day	ZJJ	*t*	Sig	XA	*t*	Sig	DDH	*t*	Sig	JX	*t*	Sig	EM	*t*	Sig	GL	*t*	Sig	YL	*t*	Sig	YN	*t*	Sig	CS	*t*	Sig	UT	*t*	Sig	AAR	*t*	Sig	-	+
0	-0.55	-0.27		1.14	0.36		4.09	1.52		-0.59	-0.24		-0.13	-0.09		0.11	0.07		0.71	0.56		0.20	0.09		-1.61	-0.57		-3.09	-1.19		0.03	0.03		0.14	0.14
1	-2.46	-1.22		1.83	0.57		-0.16	-0.06		-1.55	-0.63		-2.96	-2.03	*	-2.86	-1.90	*	-3.88	-3.02	**	-1.24	-0.53		-0.48	-0.17		0.69	0.26		-1.31	-1.35		0.00	0.80
2	-6.86	-3.39	**	-12.20	-3.83	**	-11.51	-4.28	**	-11.24	-4.59	**	2.50	1.71	*	-7.98	-5.31	**	-4.63	-3.61	**	-9.57	-4.08	**	-10.53	-3.70	**	-10.79	-4.15	**	-8.28	-8.55	**	0.00	0.91
3	-0.58	-0.29		2.21	0.69		-0.24	-0.09		7.59	3.10	**	-1.44	-0.99		-0.47	-0.31		0.91	0.71		-0.28	-0.12		5.95	2.09	*	7.01	2.69	**	2.07	2.13	*	0.14	0.14
4	-2.38	-1.18		-0.68	-0.21		2.26	0.84		0.69	0.28		-1.79	-1.23		-1.53	-1.02		-0.61	-0.48		-1.48	-0.63		-1.88	-0.66		3.37	1.30		-0.40	-0.42		0.02	0.74
5	1.82	0.90		2.90	0.91		-1.76	-0.65		2.29	0.93		3.55	2.44	**	2.52	1.68	*	2.98	2.32	*	3.11	1.32		4.57	1.61		-0.49	-0.19		2.15	2.22	*	0.80	0.00
6	0.71	0.35		1.71	0.54		0.33	0.12		0.06	0.02		-1.56	-1.07		1.42	0.94		-1.13	-0.88		0.15	0.07		3.54	1.24		-1.55	-0.60		0.37	0.38		0.74	0.02
7	0.80	0.39		-0.15	-0.05		-1.75	-0.65		1.41	0.58		-0.75	-0.52		0.12	0.08		-0.11	-0.09		0.38	0.16		-1.87	-0.66		0.67	0.26		-0.13	-0.13		0.14	0.14
8	0.82	0.41		0.90	0.28		-0.97	-0.36		8.61	3.52	**	-0.86	-0.59		0.20	0.13		1.04	0.81		1.44	0.61		-1.71	-0.60		-1.42	-0.54		0.81	0.83		0.77	0.06
9	-0.06	-0.03		3.07	0.96		-1.55	-0.58		-2.86	-1.17		-0.41	-0.28		0.14	0.09		0.29	0.23		5.74	2.45	**	-0.59	-0.21		-0.19	-0.07		0.36	0.37		0.06	0.77
10	-0.46	-0.23		-3.66	-1.15		-2.09	-0.78		-2.66	-1.08		-1.59	-1.09		-0.64	-0.43		-1.12	-0.88		-2.21	-0.94		-0.60	-0.21		-0.97	-0.37		2.25	2.32	*	0.00	0.98
-	0.03			0.76			0.01			0.83			0.00			0.83			0.08			0.83			0.01			0.03			0.76			**0.00**	
+	0.76			0.03			0.76			0.08			0.84			0.08			0.83			0.08			0.76			0.76			0.03				**0.99**

Abnormal returns for tourism shares in Shanghai Stock Exchange (Day 0 = January 23, 2020)

Day	HS	*t*	Sig	DL	*t*	Sig	QJ	*t*	Sig	TB	*t*	Sig	CB	*t*	Sig	TM	*t*	Sig	AH	*t*	Sig	BB	*t*	Sig	CIT	*t*	Sig	CUT	*t*	Sig	JJ	*t*	Sig	AAR	*t*	Sig	-	+
0	-0.34	-0.26		-1.91	-0.89		-0.93	-0.54		1.41	0.56		-2.57	-1.12		-0.46	-0.19		-1.67	-0.98		-0.02	-0.01		-1.23	-0.67		-6.68	-2.89	**	-2.73	-1.83		-1.56	-2.05	*	0.00	0.94
1	-3.36	-2.56	**	-0.05	-0.02		-1.20	-0.71		1.40	0.56		-2.03	-0.89		-1.09	-0.45		-2.98	-1.75	*	-0.37	-0.16		-4.69	-2.55	**	-0.96	-0.42		-2.70	-1.81	*	-1.64	-2.16	*	0.00	0.94
2	-4.44	-3.38	**	-0.60	-0.28		-8.91	-5.24	**	-9.01	-3.58	**	-6.87	-3.00	**	-0.57	-0.24		-5.64	-3.32	**	-11.46	-5.12	**	0.67	0.37		-9.20	-3.99	**	-6.18	-4.13	**	-5.65	-7.46	**	0.00	0.94
3	-0.52	-0.40		-1.83	-0.85		0.20	0.12		3.70	1.47		1.59	0.69		1.83	0.76		0.49	0.29		1.35	0.60		2.60	1.41		4.23	1.83	*	-1.47	-0.99		1.10	1.46		0.76	0.01
4	2.24	1.71	*	-0.50	-0.23		-0.49	-0.29		0.85	0.34		-0.28	-0.12		-2.17	-0.90		-0.96	-0.56		6.28	2.81	**	2.55	1.39		-1.61	-0.70		-1.53	-1.02		0.40	0.53		0.03	0.76
5	3.04	2.31	*	0.74	0.34		3.79	2.23	*	3.50	1.39		2.28	0.99		2.46	1.02		9.63	5.66	**	0.52	0.23		-1.10	-0.60		-1.46	-0.63		-1.00	-0.67		2.04	2.68	**	0.76	0.01
6	0.33	0.25		-0.37	-0.17		0.94	0.55		2.16	0.86		1.15	0.50		2.14	0.89		9.18	5.40	**	1.28	0.57		-1.97	-1.07		1.58	0.69		1.38	0.92		1.62	2.13	*	0.84	0.00
7	-0.31	-0.24		-0.20	-0.09		-0.45	-0.26		-2.30	-0.92		-0.89	-0.39		-0.14	-0.06		-5.27	-3.10	**	-1.02	-0.46		0.94	0.51		0.23	0.10		-0.29	-0.19		-0.88	-1.16		0.00	0.84
8	-0.23	-0.18		-0.43	-0.20		1.06	0.63		0.91	0.36		2.16	0.94		0.32	0.13		2.17	1.28		-0.84	-0.38		-0.30	-0.16		-0.34	-0.15		1.54	1.03		0.55	0.72		0.83	0.08
9	0.61	0.47		-0.21	-0.10		0.25	0.15		5.79	2.30	*	-1.37	-0.60		1.99	0.82		-3.36	-1.98	*	-0.84	-0.38		-1.16	-0.63		-0.51	-0.22		0.07	0.05		0.11	0.15		0.08	0.83
10	-1.04	-0.79		-0.74	-0.34		-1.38	-0.81		-3.18	-1.27		-1.01	-0.44		-3.20	-1.32		-0.86	-0.51		-0.73	-0.33		1.86	1.01		1.41	0.61		-0.80	-0.53		1.32	1.74		0.00	0.84
-	0.03			0.00			0.08			0.76			0.03			0.08			0.03			0.03			0.08			0.03			0.01			0.76			**0.00**	
+	0.76			0.94			0.83			0.01			0.76			0.83			0.76			0.76			0.83			0.76			0.76			0.03				**0.97**

Notes: For symbols of shares, kindly refer to the footnote for Table 2. Statistical symbol t denotes t_{AR} and t_{AAR} specified in Eq. (5) and Eq. (8) correspondingly for individual shares AR_{id} and the AAR_d as a whole for the specific stock exchange. Sig refers to the significance of the abnormal returns with * and ** indicating significant at 5% and 1% respectively. The – symbol at the second last column shows the probability value of the Binomial test for the alternative hypothesis of significantly more occurrence of negative abnormal returns compared to the null hypothesis of insignificance number of such occurrence across all individual shares in the specific stock exchange for each trading day d. Similarly, + symbol at the last column shows the probability value of the same test for alternative hypothesis of significantly more occurrence of positive abnormal returns across all individual shares in the specific stock exchange for each trading day d. Meanwhile, symbols – and + at the second last and the bottom rows denote the respective tests across all trading days for each i. On the other hand, the figure in bold for – (or +) symbol at the bottom right hand side of the table refers to the probability value of the Binomial test for the null hypothesis of significantly more occurrence of negative (or +) abnormal returns for the specific stock exchange as a whole. In all situations, H_0 can be rejected in favor of H_a if the probability value is less than or equal to 0.05 or 0.01 for 5% or 1% significance level respectively.

Turning to Table 4 for event day on January 23, 2020, the same conclusion can be made for the individual shares by the Binomial test regardless of stock exchanges. Remarkably, there are 33 cases of significant negative abnormal returns [$t \in (-1.68, -8.55) < -1.645$], compared to none at all for the event day on December 31, 2019. Moreover, there is one case of significant negative AAR_d in SZSE in addition to 3 cases of significant negative AAR_d in SSE. In contrast, there are 2 cases of significant positive AAR_d in SSE in addition to 3 cases of significant negative AAR_d in SZSE. Overall, Table 3 and Table 4 disclose that shares in the tourism sector as a whole has been generating significant more occurrence of negative (compared to non-negative) abnormal returns due to the news related to the COVID-19 pandemic outbreak. This finding drawn from the Binomial test is true regardless of whether the tourism shares are listed in Shenzhen or Shanghai stock exchanges. Based on the Student-t test, the negative impact of the COVID-19 pandemic is detected only after the Wuhan lockdown. This reflects that tourism industry has been negatively impacted amid the COVID-19 pandemic outbreak and the negative impact is more severe for the industry after the Wuhan lockdown.

Results on cumulative abnormal returns

Table 5 and Table 6 summarize the cumulative abnormal returns, CAR_{id} for individual tourism shares, and the cumulative average abnormal returns, $CAAR_d$ across the specific industry as a whole, for Day 0 on December 31, 2019 and January 23, 2020 correspondingly. Table 5 shows that, by the Binomial test, the COVID-19 pandemic has prompted significantly more negative (than non-negative, $p < 0.01$) impact in the tourism shares in SZSE, in contrast to significantly more positive (than non-positive, $p < 0.01$) impact in SSE. By the Student-t test, CAR_{id} is significantly positive ($t > 1.645$) for DDH, JX and CUT, with no significant negative CAR_{id} at all for December 31, 2019 as event day in the two Chinese stock exchanges. For the $CAAR_d$, they are all positive in direction, but none of them has significant size by the t test for both stock exchanges.

In sharp contrast, Table 6 reveals that, by the Binomial test, 18 out of 21 tourism counters in the Chinese stock exchanges experience significantly more occurrence of negative CAR_{id} ($p < 0.01$) when January 23, 2020 is taken as event day. This shows the extensiveness of the COVID-19 negative impact on the tourism shares. Moreover, in terms of fatality of the impact, all the 18 counters have registered for at least one significant negative CAR_{id} ($t < -1.645$) over the event period. Furthermore, $CAAR_d$ is consistently negative from event window [0, 1] to [0, 10] in both stock exchanges. In addition, they are significantly negative up to event window [0, 7] in SZSE and up to [0, 5] in SSE. Overall, it can be concluded while the negative impact on the spread of the COVID-19 pandemic against tourism shares in the Chinese stock markets are more obvious and intensified after the Wuhan lockdown.

Similar to the findings in for the abnormal returns, and cumulative abnormal returns, this study demonstrates the importance of Binomial test in quantifying the extensiveness of the impact of an event on average abnormal stock returns, as to complement the Student-

t test which quantifies the magnitude of the impact. Specifically, COVID-19 has been shown to have extensively impacted the of tourism shares in China negatively in terms of average abnormal returns by the Binomial test. However, based on Student-*t* (for magnitude of impact), it is shown that the null hypothesis of no negative average abnormal returns cannot be rejected, in many cases in negative impact is established by the Binomial test (for extensiveness of impact)[18].

[18] One the other hand, while Student-*t* is more on identifying the magnitude of impact, it may tend to over-reject the null hypothesis of no average abnormal returns when it is in fact true under certain circumstances (see Ng et al. 2000).

Table 5 Cumulative abnormal returns (Day 0 = December 31, 2019)

Cumulative abnormal returns for tourism shares in Shenzhen Stock Exchange (Day 0 = December 31, 2019)

Window	ZJJ	*t*	Sig	XA	*t*	Sig	DDH	*t*	Sig	JX	*t*	Sig	EM	*t*	Sig	GL	*t*	Sig	YL	*t*	Sig	YN	*t*	Sig	CS	*t*	Sig	UT	*t*	Sig	CAAR	*t*	Sig	-	+
[0, 1]	-0.93	-0.51		0.01	0.00		-1.69	-0.75		5.55	2.84	**	0.54	0.52		-0.79	-0.66		-0.55	-0.58		2.32	1.10		-1.81	-0.73		-0.80	-0.38		0.19	0.17		0.06	0.77
[0, 2]	-0.53	-0.21		1.09	0.23		3.10	0.98		12.41	4.49	**	0.20	0.13		-0.18	-0.10		-1.02	-0.76		1.63	0.55		-3.61	-1.03		1.33	0.44		1.44	0.93		0.77	0.06
[0, 3]	-1.06	-0.34		-0.80	-0.14		6.66	1.72	*	16.03	4.73	**	-0.60	-0.33		-0.27	-0.13		-2.10	-1.27		1.51	0.41		-5.52	-1.28		-0.36	-0.10		1.35	0.71		0.02	0.74
[0, 4]	-0.86	-0.24		-1.14	-0.17		6.84	1.53		20.28	5.18	**	1.18	0.57		-0.55	-0.23		-1.88	-0.99		1.44	0.34		-3.70	-0.74		1.42	0.33		2.30	1.05		0.14	0.14
[0, 5]	-1.52	-0.38		-0.79	-0.11		4.75	0.95		20.77	4.75	**	-0.07	-0.03		-1.24	-0.46		-2.21	-1.04		1.21	0.26		-0.10	-0.02		-1.09	-0.23		1.97	0.81		0.02	0.74
[0, 6]	-1.72	-0.39		-2.44	-0.30		4.78	0.87		19.98	4.17	**	-0.92	-0.36		-1.70	-0.58		-2.96	-1.27		1.06	0.21		-2.58	-0.42		-2.02	-0.39		1.15	0.43		0.02	0.74
[0, 7]	-0.57	-0.12		-3.15	-0.36		6.74	1.14		20.36	3.93	**	0.72	0.26		-1.10	-0.35		-2.01	-0.79		1.19	0.21		-2.16	-0.33		-0.19	-0.03		1.98	0.68		0.06	0.77
[0, 8]	-1.75	-0.34		-5.58	-0.59		3.40	0.54		18.54	3.35	**	0.04	0.02		-1.98	-0.58		-2.47	-0.92		0.49	0.08		-3.03	-0.43		3.01	0.50		1.07	0.34		0.14	0.14
[0, 9]	-1.09	-0.20		-5.35	-0.53		5.14	0.77		22.64	3.86	**	2.02	0.65		-1.51	-0.42		-1.79	-0.63		4.70	0.74		-5.70	-0.76		0.58	0.09		1.97	0.60		0.14	0.14
[0, 10]	-1.75	-0.31		-6.75	-0.64		6.25	0.88		20.06	3.24	**	2.38	0.72		-2.52	-0.66		-2.85	-0.95		3.08	0.46		-6.73	-0.86		1.53	0.23		1.27	0.37		0.14	0.14
-	0.00			0.01			0.94			0.99			0.76			0.00			0.00			0.99			0.00			0.83			0.99			**0.00**	
+	0.99			0.84			0.00			0.00			0.03			0.99			0.99			0.00			0.99			0.83			0.00				**0.99**

Cumulative abnormal returns for tourism shares in Shanghai Stock Exchange (Day 0 = December 31, 2019)

Window	HS	*t*	Sig	DL	*t*	Sig	QJ	*t*	Sig	TB	*t*	Sig	CB	*t*	Sig	TM	*t*	Sig	AH	*t*	Sig	BB	*t*	Sig	CIT	*t*	Sig	CUT	*t*	Sig	JJ	*t*	Sig	CAAR	*t*	Sig	-	+
[0, 1]	-0.18	-0.16		-0.70	-0.31		1.65	1.06		-0.21	-0.09		-2.15	-0.94		-0.52	-0.24		-0.55	-0.37		-0.53	-0.27		0.24	0.14		8.75	4.15	**	0.26	0.23		0.55	0.69		0.03	0.76
[0, 2]	0.26	0.16		-0.49	-0.16		0.76	0.34		0.69	0.22		-4.75	-1.46		-0.44	-0.14		-0.58	-0.28		-1.40	-0.50		1.10	0.46		10.55	3.54	**	1.71	1.04		0.67	0.59		0.83	0.08
[0, 3]	0.23	0.12		-0.62	-0.16		-0.07	-0.03		0.10	0.03		-5.16	-1.30		-0.95	-0.25		-0.48	-0.18		-0.47	-0.14		-0.18	-0.06		9.10	2.49	**	3.11	1.54		0.42	0.30		0.03	0.76
[0, 4]	0.88	0.38		-0.24	-0.05		0.28	0.09		0.26	0.06		-4.76	-1.04		-0.69	-0.16		0.40	0.14		1.54	0.39		0.15	0.04		8.57	2.03	*	2.91	1.25		0.84	0.53		0.76	0.01
[0, 5]	0.55	0.21		-0.08	-0.02		0.20	0.06		0.41	0.08		-6.56	-1.28		-1.62	-0.34		0.14	0.04		1.05	0.24		1.21	0.32		6.70	1.42		3.25	1.25		0.48	0.27		0.76	0.01
[0, 6]	0.46	0.16		-0.51	-0.09		0.53	0.14		0.39	0.07		-5.95	-1.06		-1.46	-0.28		0.73	0.20		2.40	0.50		3.33	0.81		6.83	1.32		1.97	0.69		0.79	0.40		0.76	0.01
[0, 7]	0.61	0.20		1.36	0.23		0.67	0.16		0.92	0.16		-5.12	-0.84		-1.94	-0.34		0.65	0.17		2.18	0.42		3.55	0.80		5.40	0.97		3.91	1.26		1.11	0.52		0.84	0.00
[0, 8]	0.34	0.10		0.81	0.13		0.50	0.11		-0.04	-0.01		-5.63	-0.87		-1.99	-0.33		-0.12	-0.03		1.12	0.20		-0.72	-0.15		4.81	0.81		3.89	1.18		0.27	0.12		0.83	0.08
[0, 9]	0.56	0.16		-1.12	-0.17		1.87	0.40		1.26	0.19		-5.54	-0.80		-2.04	-0.31		-0.02	0.00		1.66	0.28		-3.10	-0.61		7.60	1.20		2.93	0.84		0.37	0.15		0.83	0.08
[0, 10]	0.25	0.07		-0.62	-0.09		0.80	0.16		0.65	0.09		-5.69	-0.78		-2.78	-0.41		0.21	0.04		0.94	0.15		-2.35	-0.44		6.47	0.97		3.72	1.01		0.14	0.06		0.76	0.03
-	0.91			0.00			0.91			0.80			0.00			0.00			0.86			0.74			0.77			0.98			0.98			0.98			**0.97**	
+	0.00			0.80			0.00			0.00			0.98			0.98			0.86			0.02			0.06			0.00			0.00			0.00				**0.00**

Notes: For symbols of shares, kindly refer to the footnote for Table 2. Statistical symbol t denotes t_{CAR} and t_{CAAR} specified in Eq. (12) and Eq. (14) correspondingly for individual shares CAR_{id} and the $CAAR_d$ for the specific stock exchange as a whole. Sig refers to the significance of the cumulative abnormal returns with * and ** indicating significant at 5% and 1% respectively. The – symbol at the second last column shows the probability value of the Binomial test for the alternative hypothesis of significantly more occurrence of negative abnormal returns compared to the null hypothesis of insignificance number of such occurrence across all individual shares in the specific stock exchange for each trading day d. Similarly, + symbol at the last column shows the probability value of the same test for alternative hypothesis of significantly more occurrence of positive abnormal returns across all individual shares in the specific stock exchange for each trading day d. Meanwhile, symbols – and + at the second last and the bottom rows denote the respective tests across all trading days for each i. On the other hand, the figure in bold for – (or +) symbol at the bottom right hand side of the table refers to the probability value of the Binomial test for the null hypothesis of significantly more occurrence of negative (or +) abnormal returns for the specific stock exchange as a whole. In all situations, H_0 can be rejected in favor of H_a if the probability value is less than or equal to 0.05 or 0.01 for 5% or 1% significance level respectively.

Table 6 Cumulative abnormal returns (Day 0 = January 23, 2020)

Cumulative abnormal returns for tourism shares in Shenzhen Stock Exchange (Day 0 = January 23, 2020)

Window	ZJJ	*t*	Sig	XA	*t*	Sig	DDH	*t*	Sig	JX	*t*	Sig	EM	*t*	Sig	GL	*t*	Sig	YL	*t*	Sig	YN	*t*	Sig	CS	*t*	Sig	UT	*t*	Sig	CAAR	*t*	Sig	-	+
[0, 1]	-2.46	-1.48		1.83	0.69		-0.16	-0.07		-1.55	-0.75		-2.96	-3.05	**	-2.86	-2.74	**	-3.88	-4.43	**	-1.24	-0.64		-0.48	-0.20		0.69	0.34		-1.31	-0.95		0.00	0.80
[0, 2]	-9.32	-3.95	**	-10.38	-2.78	**	-11.68	-3.72	**	-12.79	-4.36	**	-0.46	-0.33		-10.84	-7.37	**	-8.51	-6.88	**	-10.81	-3.94	**	-11.01	-3.20	**	-10.10	-3.54	**	-9.59	-5.71	**	0.00	0.98
[0, 3]	-9.90	-3.43	**	-8.16	-1.79	*	-11.91	-3.10	**	-5.19	-1.44		-1.90	-1.13		-11.31	-6.28	**	-7.60	-5.01	**	-11.09	-3.30	**	-5.06	-1.20		-3.10	-0.89		-7.52	-3.88	**	0.00	0.98
[0, 4]	-12.28	-3.68	**	-8.85	-1.68	*	-9.66	-2.17	*	-4.50	-1.08		-3.69	-1.91	*	-12.84	-6.17	**	-8.21	-4.69	**	-12.57	-3.24	**	-6.94	-1.43		0.27	0.07		-7.93	-3.66	**	0.00	0.91
[0, 5]	-10.46	-2.81	**	-5.95	-1.01		-11.42	-2.30	*	-2.21	-0.48		-0.14	-0.07		-10.32	-4.44	**	-5.22	-2.67	**	-9.46	-2.18	*	-2.37	-0.44		-0.22	-0.05		-5.78	-2.43	*	0.00	0.98
[0, 6]	-9.75	-2.39	**	-4.24	-0.66		-11.08	-2.04	*	-2.15	-0.42		-1.70	-0.72		-8.90	-3.49	**	-6.36	-2.97	**	-9.31	-1.96	*	1.16	0.20		-1.77	-0.36		-5.41	-2.11	*	0.00	0.91
[0, 7]	-8.96	-2.03	*	-4.39	-0.63		-12.83	-2.18	*	-0.74	-0.14		-2.45	-0.96		-8.78	-3.19	**	-6.47	-2.79	**	-8.93	-1.74	*	-0.71	-0.11		-1.11	-0.21		-5.54	-2.02	*	0.00	0.98
[0, 8]	-8.13	-1.72	*	-3.50	-0.47		-13.80	-2.20	*	7.87	1.34		-3.31	-1.21		-8.58	-2.91	**	-5.43	-2.19	*	-7.49	-1.36		-2.42	-0.35		-2.52	-0.44		-4.73	-1.63		0.00	0.91
[0, 9]	-8.19	-1.64		-0.43	-0.05		-15.35	-2.31	*	5.01	0.80		-3.72	-1.28		-8.43	-2.70	**	-5.13	-1.96	*	-1.75	-0.30		-3.01	-0.41		-2.72	-0.45		-4.37	-1.43		0.00	0.91
[0, 10]	-8.65	-1.64		-4.09	-0.49		-17.44	-2.48	**	2.35	0.36		-5.32	-1.74	*	-9.08	-2.76	**	-6.26	-2.26	*	-3.96	-0.64		-3.61	-0.47		-3.68	-0.58		-5.97	-1.86		0.00	0.91
-	0.00			0.00			0.00			0.03			0.00			0.00			0.00			0.00			0.00			0.01			0.00			**0.00**	
+	0.99			0.94			0.99			0.76			0.99			0.99			0.99			0.99			0.94			0.84			0.99				**1.00**

Cumulative abnormal returns for tourism shares in Shanghai Stock Exchange (Day 0 = January 23, 2020)

Window	HS	*t*	Sig	DL	*t*	Sig	QJ	*t*	Sig	TB	*t*	Sig	CB	*t*	Sig	TM	*t*	Sig	AH	*t*	Sig	BB	*t*	Sig	CIT	*t*	Sig	CUT	*t*	Sig	JJ	*t*	Sig	CAAR	*t*	Sig	-	+
[0, 1]	-3.36	-3.30	**	-0.05	-0.02		-1.20	-0.93		1.40	0.68		-2.03	-0.98		-1.09	-0.51		-2.98	-2.06	*	-0.37	-0.20		-4.69	-2.75	**	-0.96	-0.48		-2.70	-2.29	*	-1.64	-2.16	*	0.00	0.94
[0, 2]	-7.80	-5.41	**	-0.65	-0.22		-10.11	-5.51	**	-7.61	-2.61	**	-8.90	-3.05	**	-1.66	-0.55		-8.62	-4.21	**	-11.82	-4.44	**	-4.01	-1.66	*	-10.16	-3.59	**	-8.87	-5.32	**	-7.29	-6.80	**	0.00	0.99
[0, 3]	-8.32	-4.71	**	-2.48	-0.69		-9.90	-4.41	**	-3.91	-1.09		-7.32	-2.04	*	0.16	0.04		-8.13	-3.24	**	-10.48	-3.21	**	-1.42	-0.48		-5.93	-1.71	*	-10.35	-5.06	**	-6.19	-4.71	**	0.00	0.94
[0, 4]	-6.08	-2.98	**	-2.98	-0.72		-10.39	-4.01	**	-3.07	-0.74		-7.60	-1.84	*	-2.01	-0.47		-9.09	-3.14	**	-4.19	-1.11		1.14	0.33		-7.54	-1.88	*	-11.88	-5.03	**	-5.79	-3.82	**	0.00	0.94
[0, 5]	-3.04	-1.33		-2.25	-0.49		-6.60	-2.28	*	0.44	0.09		-5.32	-1.15		0.46	0.10		0.54	0.17		-3.68	-0.87		0.04	0.01		-9.00	-2.01	*	-12.88	-4.88	**	-3.75	-2.21	*	0.03	0.76
[0, 6]	-2.72	-1.09		-2.62	-0.52		-5.66	-1.78	*	2.60	0.51		-4.18	-0.83		2.60	0.50		9.72	2.74	**	-2.40	-0.52		-1.93	-0.46		-7.42	-1.51		-11.50	-3.98	**	-2.14	-1.15		0.01	0.76
[0, 7]	-3.03	-1.12		-2.82	-0.52		-6.11	-1.78	*	0.30	0.05		-5.07	-0.93		2.46	0.43		4.46	1.16		-3.42	-0.69		-0.99	-0.22		-7.20	-1.36		-11.78	-3.77	**	-3.02	-1.50		0.01	0.76
[0, 8]	-3.26	-1.13		-3.26	-0.56		-5.04	-1.38		1.21	0.21		-2.92	-0.50		2.78	0.46		6.63	1.62		-4.27	-0.80		-1.29	-0.27		-7.54	-1.33		-10.24	-3.07	**	-2.47	-1.15		0.01	0.76
[0, 9]	-2.65	-0.87		-3.46	-0.56		-4.79	-1.23		7.00	1.13		-4.29	-0.69		4.77	0.74		3.26	0.75		-5.11	-0.90		-2.45	-0.48		-8.05	-1.34		-10.17	-2.87	**	-2.36	-1.04		0.01	0.76
[0, 10]	-3.69	-1.14		-4.20	-0.64		-6.17	-1.51		3.82	0.58		-5.29	-0.81		1.57	0.23		2.40	0.52		-5.84	-0.98		-0.59	-0.11		-6.65	-1.05		-10.97	-2.94	**	-3.24	-1.35		0.01	0.76
-	0.00			0.00			0.00			0.74			0.00			0.74			0.77			0.00			0.00			0.00			0.00			0.00			**0.00**	
+	0.98			0.98			0.98			0.02			0.98			0.02			0.06			0.98			0.80			0.98			0.98			0.98				**1.00**

Notes: For symbols of shares, kindly refer to the footnote for Table 2. Statistical symbol t denotes t_{CAR} and t_{CAAR} specified in Eq. (12) and Eq. (14) correspondingly for individual shares CAR_{id} and the $CAAR_d$ for the specific stock exchange as a whole. Sig refers to the significance of the cumulative abnormal returns with * and ** indicating significant at 5% and 1% respectively. The – symbol at the second last column shows the probability value of the Binomial test for the alternative hypothesis of significantly more occurrence of negative abnormal returns compared to the null hypothesis of insignificance number of such occurrence across all individual shares in the specific stock exchange for each trading day d. Similarly, + symbol at the last column shows the probability value of the same test for alternative hypothesis of significantly more occurrence of positive abnormal returns across all individual shares in the specific stock exchange for each trading day d. Meanwhile, symbols – and + at the second last and the bottom rows denote the respective tests across all trading days for each i. On the other hand, the figure in bold for – (or +) symbol at the bottom right hand side of the table refers to the probability value of the Binomial test for the null hypothesis of significantly more occurrence of negative (or +) abnormal returns for the specific stock exchange as a whole. In all situations, H_0 can be rejected in favor of H_a if the probability value is less than or equal to 0.05 or 0.01 for 5% or 1% significance level respectively.

CONCLUSION

This study is set to examine the performance of the tourism shares in the pandemic catastrophe by scrutinizing the returns of the shares listed in the Shenzhen and Shanghai stock exchanges. A close examination on the daily percentage returns of tourism shares for the first few days after Wuhan lockdown reveals that, on average each share price had cumulatively shredded some 18% (in Shanghai stock exchange) to 20% (in Shenzhen stock exchange) per share within three consecutive trading days amid Wuhan lockdown to contain the pandemic. This intensity is double the magnitude of their respective market's composite index (8 to 9%) The market composite indices, however, began to rebound technically after two consecutive days of deep market corrections, followed by shares in the tourism industry on the next day.

To establish the immediate impact of the COVID-19 pandemic outbreak, this study adopts event study approach with two separate event days related to the pandemic announcements. The results obtained suggest the pandemic has extensive adverse impact on the tourism industry as a whole. To sum up, this paper contributes to the stock market literature on tourism shares study in the occurrence of the novel coronavirus pandemic, which is miserably limited. Besides, it demonstrates that while Student-*t* test is commonly adopted to quantify the depth (intensity) of impact, Binomial test is useful in event study to measure the breath (extensiveness) of impact. It is not only applicable to stock market study, but also on economic studies like tourist arrivals.

On policy implications, this study furnishes all investors, fund managers and the China Securities Regulatory Commission with the most recent lesson for future planning and actions. First, the Chinese stock market crashed with an accumulated plunge of 10% in the composite indices within two consecutive trading days in response to fears that developed due to pandemic. Second, the impact was double in intensity after another day of drastic fall for the tourism shares. Third, Chinese stock market as a whole was exhibiting a quick technical rebound which occurred on the third day after two days of deep market corrections, with tourism shares followed suit on the next day. The revealed extensiveness, intensity and duration of the adverse pandemic impact on tourism shares may serve the regulatory commission to better monitor the market movement in the midst of the pandemic outbreak. Investors are advised to avoid tourism shares whenever there is any suspicious development of virus outbreak in the future. Instead, they could look for opportunity to buy dip after massive market decline at the appropriate timing.

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