Chinese Industries under the Impact of Pandemic Lock-down Policies: A Comparison Event Study on Wuhan and Shanghai

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ABSTRACT

Significant impacts of the COVID-19 pandemic were detected in multiple sectors of the Chinese market during its 2020 outbreak in Wuhan, where most non-medical sectors were reported to be adversely affected. Although later, the "dynamic clearance strategy" adopted by the Chinese government produced an overall satisfactory outcome for the country's economic recovery, another large-scale outbreak of the Omicron variant took place in Shanghai, causing the local economy to suffer again from the pandemic. In this paper, we aim to examine and compare the impact of the two significant lockdowns (Wuhan & Shanghai) in China on the major sectors of the Chinese industry. Our study demonstrates an overall diminishing effect of the pandemic and the lockdown policies, which is considered to be in line with a rise in the market anticipation. The background investigation and literature review part (Section 1) was completed by Zhou; the suggestions (Section 4) were provided by Pan; the data, methodology and analysis parts (Section 2 &3) were carried out by Dong.

Keywords: *COVID-19; Pandemic; Event Study; Shanghai; Wuhan*

1. INTRODUCTION

The 2020 outbreak of the 2019 coronavirus (COVID-19) in Wuhan, as well as the lockdown policy accompanied on Jan 23, 2020, has been widely regarded to have a significant impact on various sectors of the Chinese industries and the market [1-3]. Literature has been abundant on studying the market behaviour in China during the period of the first outbreak and lockdown in Wuhan. Most of them have detected consistent evidence for the resilient or positive behaviour in pharmaceutical (or medical) sectors, as well as IT sectors, while a significant negative impact on other non-medical sectors, such as transportation and energy supply industries, has also been recorded [1,3].

The Chinese government has been following a ``dynamic clearance strategy" to restrict the dissemination of the covid virus ever since the reopening of Wuhan in early April 2020 [4]. Despite the minor inconvenience that the strategy has brought to everyday life, the result seems to be beneficial - based on data provided by the WHO [5], the overall number of confirmed cases of COVID-19 in China has only increased by 70% over the period between April 1, 2020, and Jan 31, 2022, which is significantly lower than the tremendous increase of 417% globally. Moreover, the Chinese economy was also reported to be recovering quickly from the disruption of the Wuhan pandemic [6].

Yet as many of the former lockdown countries began to relax their pandemic policies, another severe outbreak of Coronavirus occurred in Shanghai, leading to an increase of 7-fold in confirmed cases within a period of less than a month [5], which forced the local authorities to implement their second large-scale citywide lockdown following Wuhan. This paper aims to compare the performance of several primary industries in China under two key lockdown policies (Wuhan and Shanghai) based on the event study method. In general, the results of the study demonstrate a decreasing impact of the pandemic lockdown policies relative to the Chinese industries selected, which we interpret as a reflection of the increased market anticipation of the sectors in China we focused on.

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The remainder of this paper is organized as follows. The next section will describe the data and the principal methodology applied in the study. Section 3 explains the empirical results, while the Suggestions and the conclusion will be discussed in the final section.

2. DATA & METHODOLOGY

2.1. Data

We used the SSE 180 Index [7] to measure the return of each selected Chinese industry. The index consists of 180 most market representative A-share stocks from various sectors within China. The sample companies are classified into 13 main categories, which have been summarized in table 1. Our data collection covered all listed indexes between January 1, 2019 and April 15, 2022.

Table 1. Industry Categories

Index Code	Industry Group
H50001.SH	Energy
H50002.SH	Material
H50003.SH	Manufacturing
H50004.SH	Optional
H50005.SH	Necessary
H50006.SH	Medical
H50007.SH	Financial
H50008.SH	IT
H50009.SH	Telecommunication
H50010.SH	Public Utilities
000025.SH	Infrastructure
000026.SH	Resource
000027.SH	Transportation

(* Manufacturing, Optional, Necessary & Medical in this article is referred to as Industrial, Consumer Discretionary, Consumer Staples & Health Care respectively in the original document of SSE, 2017 [7])

2.2. Event Study

The event study suggested by Fama, et al. [8] is the primary methodology used throughout this research. This is a common method used in the literature of economics and finance for examining the impact of new information resulting from a particular event on stock prices. The test was once applied to determine the semi-strong efficiency of the market [9], which suggests that stock prices have already incorporated all publicly available information, for which reason they should respond to public information promptly following their announcements. For the purpose of this study, "public information" is defined as the announcements of the lockdown policies.

Typically, an event study starts by regressing stock returns on market returns within a preselected estimation window I_{est} , which provides parameters needed to estimate fair stock returns around the target event (the event window I_{evt}). In our research, the simplest CAPM is used to estimate the fair stock prices around the announcement of the lock down policies:

$$\hat{R}_{it} = \hat{\alpha}_{it} + \hat{\beta}_{it} R_{Mt} \ , \ t \in I_{est} \qquad (1)$$

Where $\hat{\mathrm{R}}_{\mathrm{it}}$ represents the fair return of the industry i according to the given market return R_{Mt} at time t, $\hat{\alpha}_{it}$ & $\hat{\beta}_{it}$ are estimated regression parameters for the industry i. The estimation windows selected for the Wuhan and Shanghai lockdowns are 2019/01/01 ~ 2019/11/29 and 2020/4/1 ~ 2022/1/28, respectively. For Wuhan, the estimation window covers a period when the onset of a pandemic is not expected; and for Shanghai, it covers a period after the former major outbreak in Wuhan so the extra effect of the former pandemic can be incorporated when estimating fair stock returns around the lockdown and thus could be eliminated while calculating the abnormal returns. The abnormal returns AR_{it} within the corresponding event window $t \in I_{evt} = [\ -T\ ,\ T\ ]$ are given as follows:

$$AR_{it} = R_{it} - \hat{R}_{it} \sim N(\ 0\ ,\ \delta_{it}^2\ ) \qquad (2)$$

In order to improve the statistical power and to eliminate the heteroskedasticity among different industries [10][11], we further standardized abnormal returns instead of using them directly:

$$SAR_{it} = \frac{AR_{it}}{\hat{\delta}_{it}} \sim N(0,1)^* \qquad (3)$$

$$\hat{\delta}_{it} = \sqrt{MSE_i \left\{1 + \frac{1}{n} + \frac{(R_{Mt} - \bar{R}_M)^2}{R_{M.}^2 - n\bar{R}_M^2}\right\}} \qquad (4)$$

Where n is the sample size of the estimation window, MSE_i denotes the Regression Error Mean Square:

$$MSE_i = \frac{\sum_{t \in I_{est}} (R_{it} - \hat{R}_{it})^2}{n - 2} \qquad (5)$$

$$R_{M.}^2 = \sum_{t \in I_{est}} R_{Mt}^2 \quad \bar{R}_M = \frac{\sum_{t \in I_{est}} R_{Mt}}{n} \qquad (6)$$

Note that $SAR_{it} \sim N(0,1)^*$ holds for sufficiently large n. Next, to measure the total abnormal returns within a certain interval $[\ t_1\ ,\ t_2\ ]$, cumulative standardized abnormal return is defined as:

$$CSAR_i(\ t_1\ ,\ t_2\ ) = \sum_{t_1}^{t_2} SAR_{it} \qquad (7)$$

for which we have:

$$CSAR_i(\ t_1\ ,\ t_2\ ) \sim N(\ 0\ ,\ t_2 - t_1 + 1\ ) \qquad (8)$$

According to the null hypothesis which claims that there should be no abnormal returns, as well as cumulative abnormal returns (EMH), SAR_{it} and $CSAR_i(\ t_1\ ,\ t_2\ )$ are considered to be statistically

significant ($i.e., \alpha = 5\%$) if one of the following conditions are satisfied:

$$SAR_{it} \notin [-1.96, 1.96] \quad (9)$$

$$CSAR_i(t_1, t_2) \notin \sqrt{t_2 - t_1 + 1}[-1.96, 1.96] \quad (10)$$

In this paper, the event day for Wuhan and Shanghai lockdowns are defined as Jan 23, 2020, and Mar 28, 2022, respectively, when the city-wide lockdown policy was first announced to the public. For the rest part of this paper, we will also apply the following notation:

$$\text{Pre-event window} = I_{pre-evt} = [-T, -1] \quad (11)$$

$$\text{Post-event window} = I_{pst-evt} = [-T, 0] \quad (12)$$

2.3. Run-up Index

After finishing the event study part, run-up indexes [12] will be calculated to provide a superficial perception of the market anticipation of each event. The run-up index of a specific industry stock i under the corresponding event

$$j \in \{\text{Wuhan lockdown}, \text{Shanghai lockdown}\} \quad (13)$$

is defined as:

$$RI_{ij}(t) = \frac{CSAR_i(t,-1)}{CSAR_i(t,1)} = \frac{CSAR_i(t,-1)}{CSAR_i(t,-1)+CSAR_i(0,1)} \in [0,1]^*, \quad t \in I_{pre-evt} \quad (14)$$

If the signal of the event has been detected by the market for some reason (due to information leakage $etc.$) at some time \$t\$ before the announcement day $t = 0$, then $CSAR_i(t,-1)$ should already contain all information of the event before day 0, thus the expected value of $CSAR_i(0,1)$ should be minor and $RI_{ij}(t)$ will be close to 1. On the other hand, If the market fails to anticipate the effect of the event, the $CSAR_i(t,-1)$ before the event day should be close to 0, leading $RI_{ij}(t)$ to be close to 0 as well. In general, the closer the run up index is to 1, the higher the market anticipation could be interpreted, and thus may also indicate a less significant (cumulative) abnormal return around the event day.

Note that to restrict $RI_{ij}(t)$ within the interval of $[0, 1]$, we admit the basic assumption of the market anticipation that the behavior of the market after detecting the event signal before it happens should share the same pattern with that after the information is open to the public, in short,

$$CSAR_i(t,-1) \times (0,1) \geq 0 \quad (15)$$

Otherwise, we consider the market fails to detect the event in advance and thus we set $RI_{ij}(t) = 0$ for convenience.

3. EMPIRICAL RESULTS & ANALYSIS

3.1. Basic result presentation

Before carrying out any formal analysis, we give some basic description of the result we get from the calculation. We first calculate and plot the SARs & CSARs separately for both industries in Figure 1 & 2. For the SARs (Figure 1), we discover that despite that the magnitude of the abnormal return varies over two different periods of time, the results show that, for the majority of the industries we studied, the changes and trends associated with the SARs around the event dates are highly identical, even if there are some lag effects. For example, the energy industry (Figure 1) had experienced significant negative abnormal returns within two days following the announcement of the lockdown policies in both Wuhan and Shanghai, despite the differences in the overall magnitude of the abnormal returns between the two periods of time (Figure 2). Analogous phenomena could be observed in the behaviour of the manufacturing industry, the resource industry, and the transportation industry for identical negative impacts, as well as in the medical and necessary consumption industries for positive impacts (Figure 1).

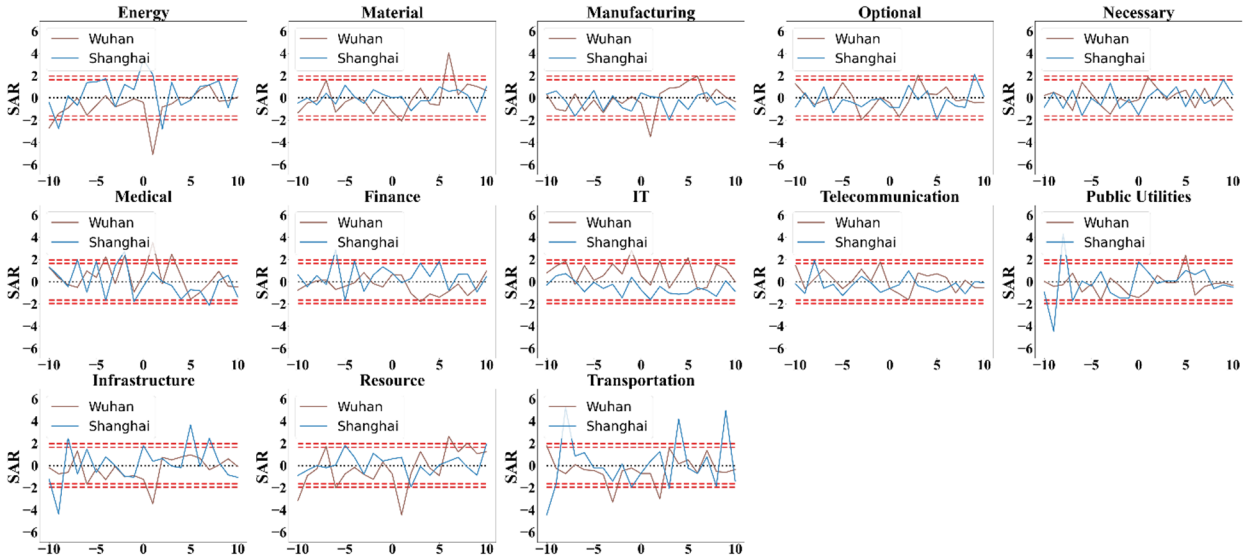

Figure 1: $SAR_i(t)$: [−10 , 10]

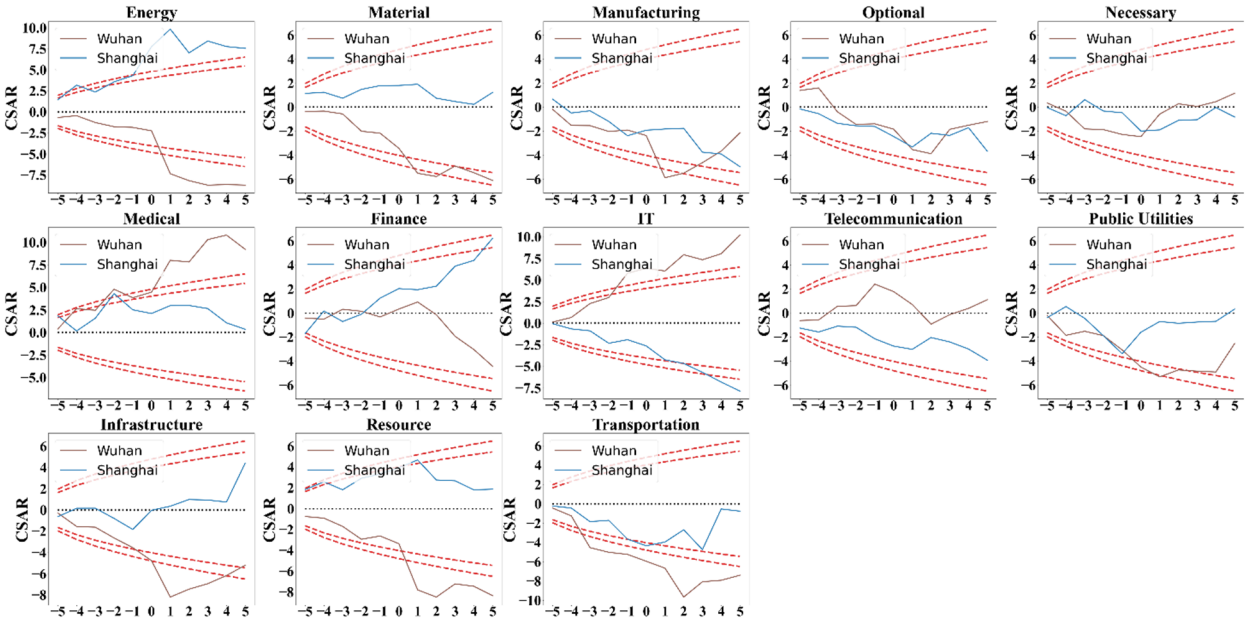

Figure 2. $CSAR_i(-10,t)$: [−10 , 10]

3.2 Impact on major Chinese industries

In this subsection, we compare and discuss the impact of two lockdown policies on the major Chinese industries. We divided each event window into three parts: **pre-event [-5 , -1], on-event [-2 , 2], post-event [0 , 5]**, and calculate the CSARs within these subintervals separately to see whether the effect of the two events are significant before, during or even after their occurrence as discussed in section 2.2.. We also test whether the announcement of the lockdown policies had in fact led to an apparent fluctuation of the stock prices using the differences of the On-event and Pre-event CSARs. The differences are considered to be significant if $\mathrm{CSAR}_i(-2,2) - \mathrm{CSAR}_i(-5,-1) \notin \sqrt{6} \cdot [\,-1.96\,,\,1.96\,]$ as $\mathrm{CSAR}_i(-2,2) - \mathrm{CSAR}_i(-5,-1) = \sum_{t=-2}^{2} SAR_{it} - \sum_{t=-5}^{-1} SAR_{it} = \sum_{t=0}^{2} SAR_{it} - \sum_{t=-5}^{-3} SAR_{it} \sim N(0,6)$. The results are presented in Table 2 and are further summarized in Figures 3 ~ 6.

Table 2. CSAR for individual industries during different event window periods

Industry	Pre-event CSAR(-5,-1)	On-event CSAR(-2,2)	Post-event CSAR(0,5)	Pre – On Change CSAR(-2,2) - CSAR(-5,-1)

	WH	SH	WH	SH	WH	SH	WH	SH
Energy	-1.85	**4.31**	**-6.9**	**4.65**	**-6.85**	3.24	**-5.06**	0.35
Material	-2.17	1.79	**-5.22**	0.00	-3.93	-0.57	-3.04	-1.79
Manufacturing	-1.91	-2.38	-3.96	-1.46	-0.23	-2.58	-2.05	0.92
Optional	-1.39	-1.61	-3.5	-0.83	0.19	-2.06	-2.11	0.78
Necessary	-2.78	-0.46	2.09	-1.72	3.43	-0.36	**4.37**	-1.26
Medical	3.85	2.51	**5.36**	1.42	**5.37**	-2.16	1.5	-1.1
Finance	-0.32	1.25	-0.46	2.95	**-4.11**	**4.98**	-0.14	1.7
IT	**5.8**	-1.91	**5.66**	-3.78	**4.42**	**-5.96**	-0.14	-1.87
Telecommunication	2.41	-2.14	-1.49	-0.95	-1.3	-1.78	-3.9	1.2
Public Utilities	-3.07	-3.38	-3.22	-0.41	0.53	3.71	-0.15	2.97
Infrastructure	-3.54	-1.83	**-5.84**	0.83	-1.66	**6.29**	-2.29	2.66
Resource	-2.62	3.33	**-6.79**	0.94	**-5.73**	-1.46	**-4.17**	-2.39
Transportation	**-5.24**	-3.36	**-5.12**	-0.85	-2.16	2.9	0.12	2.81

RED Statistical significance at the 1% level; BROWN Statistical significance at the 5% level; BLUR Statistical significance at the 10% level.

As we can see from Table 2 (or Figure 4), most industries suffered negative impacts during the Wuhan lockdown, except those related to Medical, Information Technology (IT), and necessities. Among the ten industries with a general negative CSAR, five were accompanied by a significance level that of than 5% (Transportation, Material, Infrastructure, Resource, Energy). Moreover, the level for the Resource and Energy industries even fell below 1%, confirming strong evidence for a significant negative return brought by the lockdown; the evidence remains strong for the Energy industry even five days after the announcement of the policy in the post-event window. The (Energy) industry was also discovered to have experienced the most significant negative growth in the CSAR (-5.06%) between the pre-event and the on–event periods.

Nevertheless, while some industries were subject to an inevitable loss during the lockdown in Wuhan, there were also several candidates who had actually benefitted from the pandemic as expected. For example, the IT and medical sectors both achieved a positive CSAR of over 5% (IT 5.66%, medical 5.36%) during the lockdown period, which also persisted five days after the lockdown announcement. Furthermore, the announcement also boosted the stock price of the necessary Consumption industry, resulting in a most significant increase in all CSARs reaching 4.37% (Figure 5).

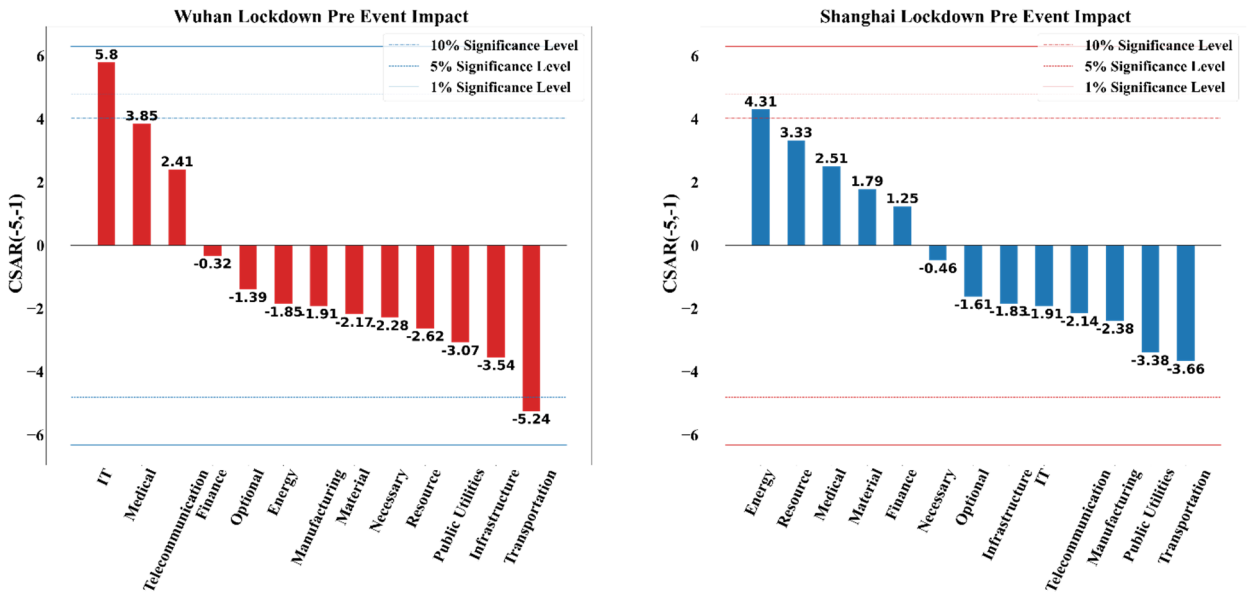

Figure 3: *Pre − event CSAR*

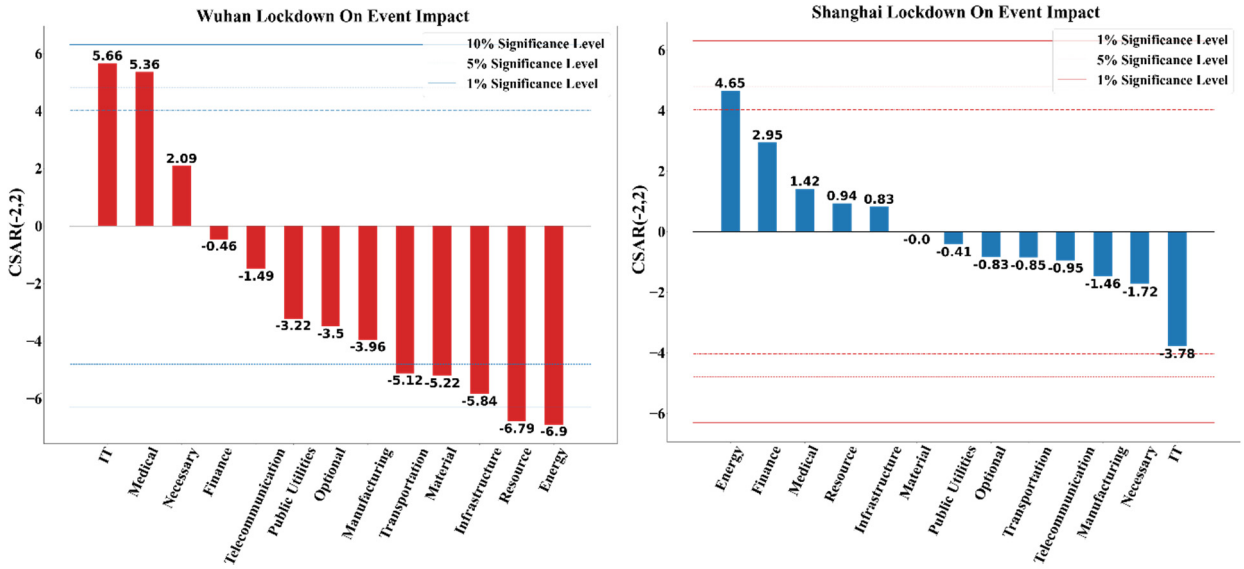

Figure 4: *On − event CSAR*

For the data related to the recent lockdown in Shanghai, most of the significant impacts that were previously apparent during the Wuhan lockdown vanished - not only for the positive impacts but also for the negative impacts. Within the on-event window, most CSARs failed to reach even a weak significance level of 10%. Furthermore, differences in return between the pre-event and the on-event windows did not provide evidence that could be considered strong enough to indicate a substantial effect. Interestingly, some of the industries which used to be demonstrated to benefit or suffer from the lockdown or the pandemic, displayed a completely different behavior this time (IT, Infrastructure & Energy in particular). The phenomenon of such discrepancies could be explained by the effects of other factors other than the lockdown itself, as it has already been established that the lockdown in Shanghai did not lead to a significant fluctuation of the stock market at least within a short period of time following its announcement; thus, the effects of other factors in the study may be exaggerated. The details of the decline in the significance level around the lockdown event will be discussed in the next subsection, where we try to interpret the phenomenon as the result of the increase in market anticipation.

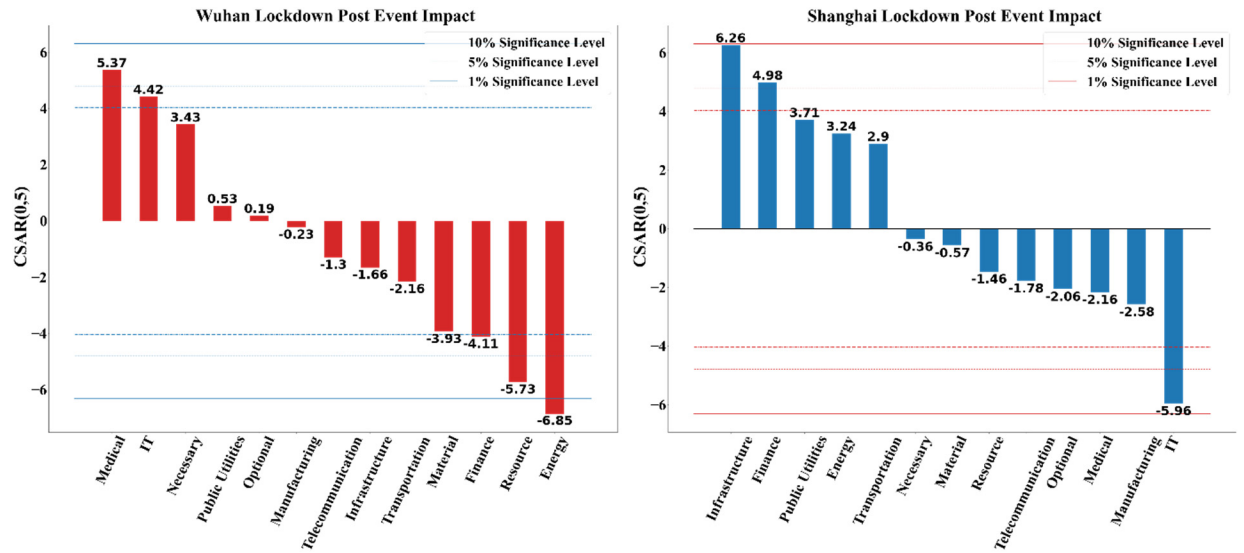

Figure 5: *Post − event CSAR*

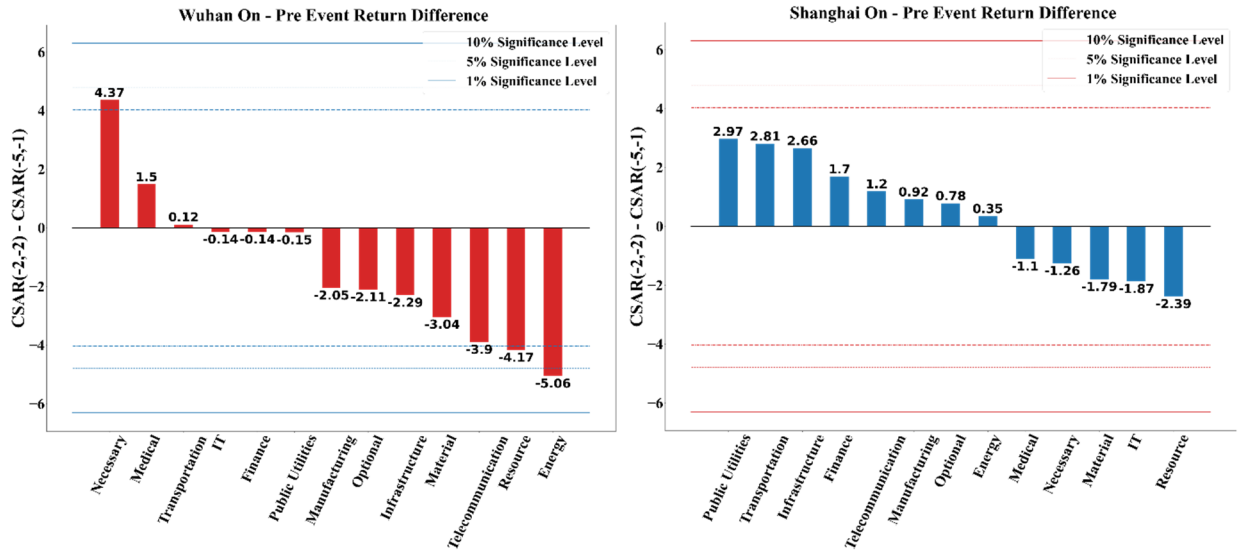

Figure 6: *CSAR Changes*

3.3. Declining impact & Market anticipation

According to the discussion in the earlier section, the impact of the lockdown policy appeared to be less significant during the Shanghai pandemic than it was in Wuhan. CSARs were restricted within the 90% confidence interval during the Shanghai pandemic revealing a different pattern from their former values during the Wuhan epidemic that had mostly exceeded the same restriction (figure 7).

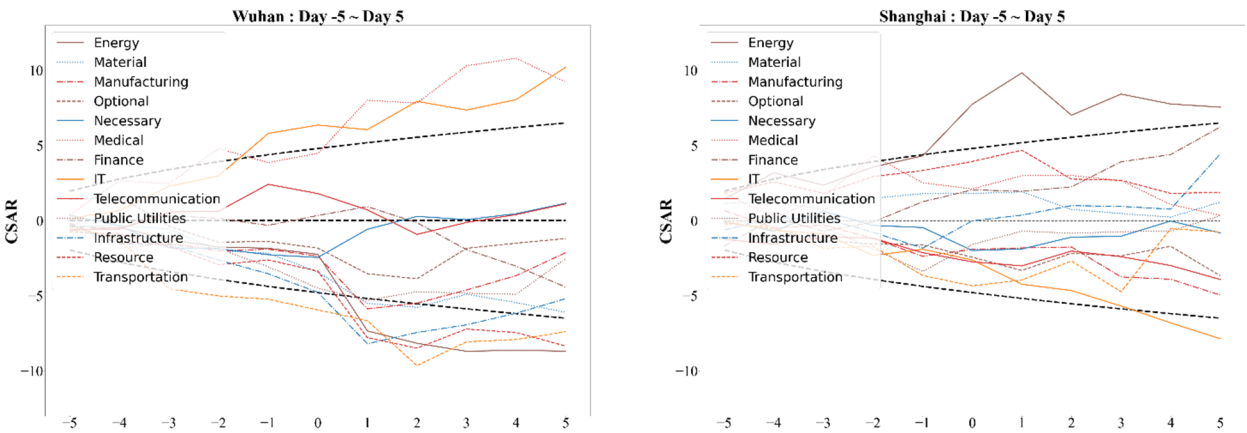

Figure 7: Industries Horizontal Comparison: Wuhan VS Shanghai

Based on the finding that the actual impact of the lockdown policies has been decreasing, this paper attempts to provide evidence for a possible interpretation that the Chinese market has been trying to adjust to the policy changes during the epidemic since the strike of the first massive lockdown policy in Wuhan, which increased market anticipation, and thus, produced a lesser amount of volatility after the Shanghai lockdown.

As such, when the second major outbreak occurred in Shanghai, preventative measures could be taken in advance against the potential negative impacts, or the market could overact earlier within some other timeframe that exceeds the window we have chosen, both of which scenarios could give rise to a less profound impact on the announcement day (of the lockdown policy). To verify our hypothesis, we calculated the run up indexes RI for each of the industries during the two lockdowns respectively. The results are consistent with what we had previously expected.

The following Figure 8 suggests that, according to the Shanghai lockdown, industries displayed a higher level of market anticipation than previously in Wuhan. Furthermore, we calculated the average RIs of each industry under the two major lockdowns and then ranked them in Figure 9, showing that the transportation, IT, material, medical, and resource industries have the highest average market anticipation, which denotes that these industries are more sensitive to policy changes during the pandemic than other sectors.

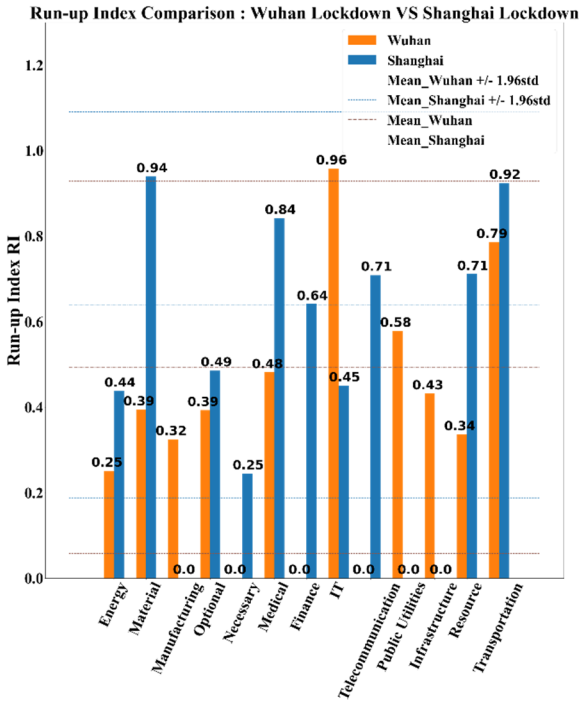

Figure 8: *Run − up Indexes*

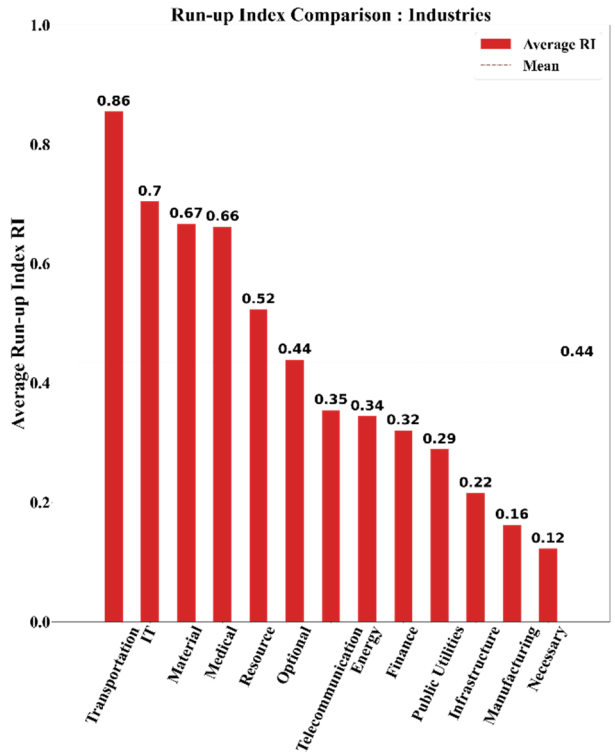

Figure 9: *Average Run − up Indexes*

4. CONCLUSIONS

4.1. Suggestions

Although our study concludes that the negative impact of the pandemic and the lockdown policies is being mitigated, it does not mean that the influence of the virus is close to deracinate. Based on this, this paper proposes the following policy recommendations.

From the perspective of the country and the government, the authorities concerned should continue to implement normalized epidemic prevention and control measures to maintain the stable operation of each sector, as well as the financial market. On the one hand, the government should pay close attention to industries with high market anticipation (transportation, information technology, medicine, etc.), which are likely to promptly reflect the overall industry dynamics. On the other hand, sectors with low anticipation (necessary consumption, optional consumption, etc.) should be protected since they are less able to predict and resist the effects of the pandemic. Finally, aside from introducing relevant medical and health policies, macroprudential measures should also be taken in reaction to international capital flows to guard against the spillover effects of external risks and prevent the superposition of domestic and foreign economic downward pressure [13]

For companies and securities market regulators, it is paramount to choose the appropriate disclosure approach if they want to convey specific information to investors in order to maintain the market stability [14]. Information regarding the pandemic should be disclosed prudently to guide investor sentiment appropriately. Meanwhile, due to the significant impact of external information on stock price volatility [15], market regulations concerning the corporate disclosure system, the emergency management system, and the security warning system should also be improved in order to prevent unexpected events from causing drastic fluctuations in the capital market [16], so as to avoid vicious events that are detrimental to the development of the country's market.

Finally, in terms of individual investors, regardless of the fact that the IT and pharmaceutical sectors had a robust trend during the outbreak, the overall market trend under the pandemic was still weak. Also, despite a short-term surge in the pharmaceutical sector, considering the laws of the market, there might be a significant degree of retracement in the period afterward. Therefore, investors should maintain a rational and calm investment mentality rather than blindly chasing the rise and fall in order to prevent severer economic losses in the future.

4.2. Conclusions

This paper applied an event study approach to empirically study the impact of lockdown policies on the stock prices of 13 major Chinese industries during the Wuhan COVID-19 outbreak and the recent Shanghai outbreak. In line with the previous literature, the pandemic in Wuhan significantly affected some traditional industries in China, such as transport, infrastructure, and energy industries. However, it also

stimulated some high-tech industries, such as the information technology and the medical sectors.

Nevertheless, the impact turned out to be less significant than one might expect when it comes to the Shanghai outbreak. Several significant market responses that were apparent in the former massive outbreak in Wuhan disappeared in Shanghai, and some even presented an inverse pattern, even though most of them can hardly be regarded as significant. The inverse pattern may likely be caused by other events outside of the disease outbreak and the lockdown policy, which our study did not focus on. Apart from that, we provide two possible interpretations for the decreasing impact detected in our research. 1) The increased market anticipation may suggest an improvement in market predictive skills; companies belonging to those industries which might be negatively affected by the policy could have implemented stop-loss strategies before the lockdown was formally announced; 2) the overreaction of the market could happen even earlier within the period which our event window failed to cover, for which reason, our data might not capture the actual fluctuation of the market caused by the lockdown policy.

In conclusion, although the COVID-19 pandemic, as well as the lockdown took place in Wuhan, brought evident adverse impacts on some of the major Chinese industries, the impact has been shown to reduce two years later in Shanghai, which might indicate strong adaptability of the Chinese market under the pandemic, or an overall diminishing effect of the virus on the Chinese economy.

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