Impact of COVID-19 on investor sentiment in China's stock markets

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A R T I C L E I N F O

A B S T R A C T

Large-scale public health emergencies may exert significant adverse effects on market sentiment. This study utilizes interrupted time series analysis (ITSA) to explore the shift in Chinese investors' sentiment in response to the uncertainties due to the outbreak of the COVID-19 pandemic. The empirical findings demonstrate that COVID-19 had a notable impact on investor sentiment within China's stock markets. Before the outbreak of COVID-19, investor sentiment had been on an upward trend. However, since the onset of the pandemic, there has been a sustained decline in investor sentiment, aligning with the downward trend observed in China's stock markets. Interestingly, the immediate effect of the COVID-19 intervention was positive, briefly boosting investor sentiment. As of 2023, with the conclusion of the pandemic and the Chinese government's decision to end the zero COVID-19 policy, we anticipate resurgence in investor sentiment within China's stock markets.

1. Introduction

On May 5, 2023, the WHO declared that the COVID-19 pandemic no longer constituted a Public Health Emergency of International Concern. Over the course of approximately three years, this pandemic has exerted profound repercussions on various facets of human society, including the realms of economy, politics, and social psychology. Throughout the pandemic, nearly all nations worldwide implemented measures of varying stringency (e.g., lockdowns, mask mandates, social distancing, etc.) to reduce infection rates and impede the transmission of COVID-19. While these anti-pandemic measures have proven effective in disease control, they have inevitably incurred economic and social costs. Notably, the economic growth of nearly every country has decelerated in the aftermath of COVID-19, concomitant with declines in their respective stock markets. For instance Ref. [1], estimated a 20.3 % annual decline in U.S. GDP, equivalent to $4.3 trillion, over a three-month period. In addition, research indicates that the financial toll of the initial two months dedicated to combating the pandemic in the United States amounted to an estimated USD 2.14 trillion [2].

In China, broadly speaking, the COVID-19 outbreak commenced in January 2020 and concluded in December 2022 with the discontinuation of the zero COVID-19 policy by the Chinese government. China's zero COVID-19 policy seemingly introduced additional uncertainties into its stock markets, as this unique policy prompted an unprecedented stop-and-start economy. Drawing upon behavioral theory, stock prices are influenced by two primary factors: investors' rational behavior and their irrational behavior [3,4]; Berk and Stanton, 2004). The latter can be encapsulated by the term "investor sentiment," denoting the general mood of investors

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toward the stock markets [5,6]. Theoretically, systematic shifts in investor sentiment can impact the financing efficiency of the capital market, thereby influencing economic growth. The principal objective of this paper is to assess the ramifications of COVID-19 on investor sentiment, with a specific focus on China's stock markets, and evaluate the changes that occurred before and after the outbreak of COVID-19.

In this paper, the interrupted time series analysis (ITSA) serves as the primary analytical tool. The authors commence by employing principal components analysis (PCA) to generate time series data, specifically the China Investor Sentiment Composite Index ($CISCI_t$). Subsequently, the z-score formula is applied to standardize $CISCI_t$, resulting in the derivation of $StdCISCI_t$. To address autocorrelation, the authors incorporate $StdCISCI_t$ into the ITSA model, utilizing Newey-West standard errors. Finally, the authors proceed to analyze the regression results and provide a comprehensive discussion. The empirical findings demonstrate a significant shift in investor sentiment within China's stock markets as a consequence of the COVID-19 pandemic. Since the onset of the pandemic, investor sentiment has exhibited a persistent downward trend, aligning with the declining trend observed in China's stock markets. The subsequent sections of this paper are structured as follows: Section 2 comprises a literature review, Section 3 delves into the empirical model and data selection, Section 4 presents the model results and ensuing discussion, and Section 5 concludes the paper.

2. Literature review

Major public emergencies can elicit adverse psychological reactions, which ultimately impact social order and economic productivity [7]. conducted a study on the 1918 influenza pandemic, revealing that public health emergencies exert a significant impact on economic and social order. Specifically, major infectious diseases disrupt a nation's normal production and living conditions in the short term. Such public health emergencies can induce fear, anxiety, and psychological imbalances, thereby significantly affecting investors' trading behavior and decision-making processes [8]. When the majority of market participants experience negative psychological reactions, an excessive market response ensues [9]. [10] discovered that investors amplify emotional impacts during the trading process, leading to excessive deviations of prices from their intrinsic values and thus enhancing asset price volatility [11]. employed the Ebola virus outbreak as an instance, demonstrating that it resulted in negative excess returns within the stock market. Numerous researchers have also examined the pronounced negative correlation between COVID-19 and stock prices [12,13]. The aforementioned empirical studies collectively support the conclusion that major public emergencies exert an influence on investor sentiment and amplify stock market volatility.

The existing literature on investor sentiment and COVID-19 predominantly focuses on the relationship between investor sentiment and stock prices or stock market returns. Most researchers have observed precipitous declines in stock prices or stock market returns concomitant with the deterioration of investor sentiment during the pandemic [14,15]. Baozhen et al. (2021) employed the Baidu Index as an indicator to appraise China's stock markets from an investor perspective. The researchers discovered that investor sentiment was influenced by the information provided by the Baidu search engine, potentially leading to stock price fluctuations. Yaogeng et al. (2022) assessed the impact of COVID-19 on investor behavior and stock prices from an event-driven standpoint. The empirical results indicated that the pandemic's impact on investor sentiment gradually dissipated after a span of 10 months, while its impact on stock prices endured for a longer duration [16]. utilized the weekly Google search volume index spanning from March 2020 to May 2021 to document the significant relationship between investor sentiment and stock market returns. They discovered that the impact of investor sentiment on volatility remained consistent across the distribution: negative emotions led to volatility, whereas positive emotions mitigated it [17]. determined that the COVID-19 outbreak had prompted shocks to the global economy, and the resultant uncertainty in the capital market had contributed to fluctuations in investor sentiment, thereby impacting enterprise development, particularly manifesting as intensified financing constraints.

The contribution of this paper to the literature lies in its analysis of the impact of the COVID-19 pandemic on investor sentiment in China's stock market. Currently, there is a dearth of detailed studies concerning the changes in investor sentiment before and after the outbreak of COVID-19. Despite the WHO's declaration of the end of the pandemic, the emotional repercussions of COVID-19 on individuals persist. Therefore, it is of great significance to carefully analyze the shifts in investor sentiment that occurred in the pre- and post-COVID-19 periods. To this end, this paper employs the ITSA model, utilizing China's stock markets as a case study, to appraise the shifts in investor sentiment before and after the COVID-19 pandemic.

3. Methodology and data

When evaluating the impact of large-scale interventions (e.g., population-based health interventions) or public policy changes (e.g., new laws), the ITSA method proves to be a suitable approach. In this method, the treated group may comprise the local community, a state, or an even larger unit. ITSA, sometimes termed "quasi-experimental" time series analysis, is a statistical analysis technique that involves tracking the long-term time period before and after the intervention point to evaluate the effect of the intervention. ITSA enables an understanding of whether and how the outcome has changed subsequent to the implementation of an intervention, policy, or program for the entire population at a specific point in time. The effect of the intervention is assessed by examining the changes in the level and slope of the time series, as well as the statistical significance of the intervention parameters. The ITSA method has been employed in research examining the effects of policies and interventions, such as community interventions [18], public policies [19], regulatory actions [20], and health technologies [21]. Considering that COVID-19 has affected the entire population and there is no control group, with the treated group being limited to a state or an economy, ITSA is an appropriate tool for studying changes in investor sentiment within an economy before and after the COVID-19 pandemic.

Firstly, a Principal Components Analysis (PCA) is conducted on the original data to measure investor sentiment. The original data

consists of a monthly time series obtained from the China Stock Market & Accounting Research (CSMAR) database. The time period selected for analysis spans from 2013m1–2022m12. The total number of observations is 120, with 84 observations falling within the pre-COVID-19 period and the remaining 36 observations falling within the post-COVID-19 period. This indicates that 2020m1 functions as the month of the COVID-19 outbreak, which also acts as the intervention point in the ITSA model. The prevailing model for measuring investor sentiment in China's stock markets was developed by Ref. [22]. These researchers first selected six proxies to measure the sentiment of Chinese stock investors. Subsequently, they constructed a comprehensive index that provides a more accurate measurement of investor sentiment using the PCA model. Moreover, during the index construction process, they strictly adhered to the criterion that the cumulative interpretation variance should not be less than 85 %. In this study, we adopt their methodology to measure the investor sentiment index of China's stock markets. Table 1 presents the descriptions of the proxies utilized in our PCA model in eq. (1), and the corresponding results are as follows:

$$CISCI_t = 0.231DCEF_t + 0.224TRUN_{t-1} + 0.257IPON_t + 0.322IPOR_t + 0.268CCI_t + 0.405NIA_{t-1} \tag{1}$$

The sentiment proxies, namely $DCEF_t$, $TRUN_{t-1}$, $IPON_t$, $IPOR_t$, CCI_t, and NIA_{t-1}, are of critical importance in this study. For a more comprehensive understanding of these proxies, please refer to the work of [22]. Specifically, $DCEF_t$ represents the weighted average of the discount observed in closed-end funds during period t. Numerous scholars [6,23,24] have posited that if closed-end funds are predominantly held by retail investors, the average discount on closed-end equity funds may serve as a sentiment index, with the discount increasing during bearish periods when retail investors exhibit pessimism. Moving on, $TRUN_{t-1}$ denotes the share turnover divided by the total stock market value during the preceding period t-1. Share turnover, to a certain extent, reflects market liquidity. Additionally, it can also indicate the level of investor participation, as high investor sentiment is often accompanied by increased enthusiasm for stock investment. Moreover, $IPON_t$ represents the volume of IPOs during period t, while $IPOR_t$ signifies the weighted average of IPO first-day returns observed during the same period. In the stock market, phenomena such as "hot issue market" and "cold issue market" are frequently observed, with low returns often attributed to market timing [25,26]. Therefore, both $IPON_t$ and $IPOR_t$ can reasonably reflect investor enthusiasm and serve as positive indicators of investor sentiment. Additionally, CCI_t represents the consumer confidence index during period t. Theoretically, the Investor Confidence Index (ICI) should be more adept at capturing changes in investor sentiment compared to the Consumer Confidence Index (CCI). However, due to data availability, many scholars have found that the CCI is better suited for measuring changes in investor sentiment. Finally, NIA_{t-1} corresponds to the natural logarithm of new investor accounts during the preceding period t-1 [27]. argues that a bull market aligns with a significant increase in the number of individuals directly participating in the stock market (excluding institutional participation). To enhance data processing, the natural logarithm form of New Investor Accounts is adopted.

To enhance the study, the z-score formula is employed to standardize $CISCI_t$ and generate a standardized investor sentiment index, denoted as $StdCISCI_t$ in eq. (2):

$$\mathrm{Std}CISCI_t = \frac{CISCI_t - \overline{CISCI}}{s} \tag{2}$$

where $\overline{CISCI} = \frac{1}{N}\sum_{t=1}^{N} CISCI_t$, and $s = \frac{1}{N-1}\sum_{t=1}^{N}(\mathrm{CISCI}_t - \overline{\mathrm{CISCI}})^2$.

Thereafter, the ITSA model is utilized to test the impact of the COVID-19 outbreak on investor sentiment and determine the nature of this impact. This paper focuses on a single group, and the standard ITSA regression model assumes the following form in eq. (3):

$$StdCISCI_t = \beta_0 + \beta_1 Time_t + \beta_2 COVID19_t + \beta_3 TimeSinceCOVID19_t + \varepsilon_t \tag{3}$$

At each monthly time point t, the outcome variable, StdCISCI_t, is measured. Time_t represents the duration since the commencement of this study. A dummy variable, COVID − 19_t, distinguishes observations collected before (=0) and after (=1) the onset of COVID-19. The intervention time point is denoted as 2020m1. The interaction term, TimeSinceCOVID19_t, indicates the elapsed time since the outbreak of COVID-19. Prior to the COVID-19 pandemic, TimeSinceCovid19_t is equal to 0. The intercept or starting level of the outcome variable is denoted as β_0, while β_1 represents the slope of the outcome variable until the introduction of COVID-19. The change in the level of the outcome that occurs immediately following the introduction of COVID-19 is represented by β_2. The disparity between the pre-COVID-19 and post-COVID-19 slopes of the outcome is captured by β_3. Finally, ε_t denotes the random error terms.

Table 1
Descriptions of the $CISCI_t$ and its proxies that appear in the PCA model.

Proxy	Description
$CISCI_t$	China Investor Sentiment Composite Index in the t period
$DCEF_t$	weighted average of closed-end fund discount in the t period
$TRUN_{t-1}$	share turnover divided by total stock market value in the t-1 period
$IPON_t$	IPO volume in the t period
$IPOR_t$	weighted average of IPO first-day returns in the t period
CCI_t	consumer confidence index in the t period
NIA_{t-1}	natural log of new investor accounts in the t-1 period

4. Empirical results and discussion

In this study, the utilization of the Stata 16.0 software package is employed for the purpose of conducting statistical analysis on ITSA. It is necessary to first consider the presence of autocorrelation in such analysis. When employing the ordinary least squares (OLS) method, it is assumed that the error terms associated with each observation are devoid of correlation. However, in the case of autocorrelation, this assumption is rendered invalid. Failure to rectify the issue of autocorrelation would result in an underestimation of standard errors, thus leading to an overestimation of statistical significance. To address this concern, the Cumby-Huizinga test for autocorrelation is utilized in conjunction with ITSA [28]. The findings indicate the presence of serial correlation at lag-1 ($p < 0.001$), while no correlation is observed at lag-2 ($p = 0.149$) and lag-3 ($p = 0.984$). Therefore, it can be inferred that a first-order positive autocorrelation exists within this time-series model. As a means of mitigating the adverse impact of autocorrelation on the standard errors of coefficients, the Newey-West standard errors are employed in this model, with a lag order of 1. The results of the ITSA model are presented in Table 2.

The empirical findings of this study reveal a significant shift in investor sentiment within China's stock markets, both prior to and subsequent to the outbreak of COVID-19. Moreover, it is evident that the intervention measures implemented in response to the pandemic have exerted both immediate and sustained effects. Notably, the trends observed are diametrically opposed. Prior to the emergence of COVID-19, the regression line exhibits a positive slope, indicative of an upward trend in investor sentiment, which aligns with the rapid growth of China's GDP. Conversely, following the onset of COVID-19, the regression line displays a negative slope, signifying a sustained downward trend in investor sentiment, consistent with the adverse shock experienced by China's stock markets. Interestingly, the immediate effect of the COVID-19 intervention is found to be positive, implying that the outbreak of COVID-19 momentarily enhanced investor sentiment. The existing body of literature fails to provide an explanation for this phenomenon. Plausible reasons for this improvement may be attributed to the overwhelming majority of individual investors within China's stock markets and the temporary success achieved in combating COVID-19 in the country. According to the 2021 China Securities and Futures Statistical Yearbook, the total number of investors in China's stock markets had reached 177,774,900 by the end of 2020. Of this figure, 176,761,300 were individual investors, accounting for 99.42 % of the total. Generally, individual investors tend to exhibit more irrational decision-making tendencies compared to institutional investors. Thus, the initial positive effect can be reasonably understood. Fig. 1 presents these findings.

Throughout the course of the pandemic, the persistent decline in investor sentiment serves as an indication that COVID-19 has inflicted a sustained and profound structural impact on the Chinese economy. The significant decline in China's industrial added value and fixed assets has inflicted harm upon the economy, inevitably affecting listed companies, which play a pivotal role within the capital market. As a result of declining stock prices and the interconnection between the stock market and the bond market, the credit ratings of enterprises are downgraded by the stock market, thereby impacting the financing constraints faced by these enterprises. During the pandemic, the informational value embedded within the stock prices of listed companies has diminished, thus leading to a decrease in the efficiency of information disclosure by these companies. This, in turn, heightens the risk of stock price collapse and further exacerbates the constraints faced by these companies in terms of equity financing, ultimately resulting in a weakening of the operational efficiency of the capital market.

5. Conclusion

The impact of the COVID-19 pandemic on investor sentiment in China's stock markets has been profound. Investor sentiment, a crucial determinant of stock prices, can exacerbate market volatility when it undergoes changes. In this study, the authors employed ITSA to appraise the transformation of Chinese investor sentiment resulting from the uncertainties arising from the COVID-19 pandemic. Empirical findings reveal a significant shift in investor sentiment subsequent to the outbreak of COVID-19. Prior to the pandemic, investor sentiment exhibited an upward trend. However, following the onset of the pandemic, investor sentiment experienced a sustained downward trend. Notably, an intriguing discovery emerged, indicating that the immediate impact of the COVID-19 pandemic was a temporary improvement in investor sentiment. Nevertheless, this response was ephemeral, as the persistently declining trend in investor sentiment signifies that COVID-19 has inflicted a lasting and severe structural impact on the Chinese economy.

In light of the World Health Organization's declaration of the conclusion of the global health emergency posed by COVID-19, it is necessary for the Chinese government to implement further measures aimed at relaxing pandemic control, reducing market transaction costs, and fostering investor sentiment. Firstly, the Chinese government ought to eliminate all pandemic control measures to stimulate

Table 2
Model results of ITSA.

StdCISCI	Coef.	Newey-West Std. Err.	t	p	[95 % Conf. Interval]
Time	0.0156071	0.0033714	4.63	0.000	[0.0089295,0.0222846]
COVID19	0.9917951	0.3973325	2.50	0.014	[-0.2048281,1.778762]
TimeSinceCOVID19	−0.0594719	0.0157287	−3.78	0.000	[-0.0906245,-0.0283193]
β_0	−0.327098	0.1968115	−1.66	0.099	[-0.7169081,-0.062712]

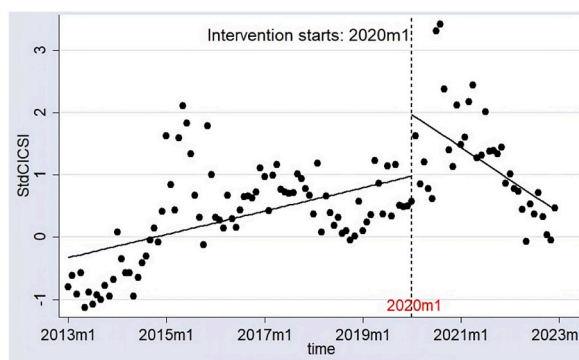(Number of obs = 120; $F_{(3,116)} = 13.33$; Prob $>$ F = 0.0000).

Fig. 1. Regression with Newey-West standard errors – lag (1).

production factors and commodity circulation, thereby bolstering investor confidence. Secondly, regulatory bodies should actively disseminate pertinent investment knowledge, guide institutional investors' entry into the market, and narrow the asymmetrical gap in investment structure. Thirdly, regulators should expeditiously release authoritative investor sentiment indices, curbing irrational investment behavior among investors, while concurrently fortifying and enhancing relevant market systems. Finally, investors themselves should adopt a rational perspective when assessing the impact of major public health emergencies on the market.

Data availability statement

Data will be made available on request (https://www.gtarsc.com/).

CRediT authorship contribution statement

Jianwei Gao: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Haiwei Li:** Conceptualization, Data curation, Funding acquisition, Project administration, Writing – review & editing. **Zhou Lu:** Conceptualization, Methodology, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that there is no conflict of interest.

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