PIONEER
ACADEMIC PUBLISHING LIMITED

Journal of World Economy
ISSN 2709-3999
www.pioneerpublisher.com/jwe
Volume 3 Number 1 March 2024

Did Adjustment of Price Limits Enhance Stock Price Volatility? — Evidence from the Reform of Price Limits on China's Growth Enterprise Market

Tengfei Yang[1], Xingzhi Lyu[1#] & Congcong Jia[1#]

[1] China University of Mining and Technology, China
Correspondence: Tengfei Yang, China University of Mining and Technology, China.
[#] These authors shared last authorships.

doi:10.56397/JWE.2024.03.04

Abstract

The adjustment of price limits represents a crucial attempt in the gradual opening of China's capital market, and the effectiveness of the price limit system has long been a contentious focus among scholars worldwide. Leveraging the quasi-natural experiment of the 2020 price limits reform in China's Growth Enterprise Market (GEM), this paper employs the differences in difference method to assess the impact of adjusted price limits on stock price volatility and conducts mechanism tests to explore influencing factors. The research findings indicate that the adjustment of price limits significantly increases stock price volatility, with its effectiveness being influenced by stock liquidity, investor speculative desires, and stock trading volume.

Keywords: price limits, quasi-natural experiment, stock volatility, differences in difference method

1. Introduction

As an integral component of securities market trading mechanisms, the price limit system was initially designed to prevent drastic fluctuations in stock prices from deviating significantly from their intrinsic values, thereby reducing financial risks and enhancing the stability of capital market operations. China implemented a 10% price limit system in 1996. In 2019, the Science and Technology Innovation Board (STAR Market) implemented a 20% price limit for the first time, followed by the relaxation of the price limit system for the Growth Enterprise Market (GEM) to 20% starting from August 24, 2020.

While price limit systems are widely employed in stock exchanges around the world, there exists a divergence of opinions among domestic and international scholars regarding their effectiveness. Supporters argue from the perspective of herding behavior and overreaction, contending that when new information enters the market, there is a potential for significant volatility as investors may exhibit irrational overreactions. Additionally, the presence of herding behavior, due to investors blindly following the market, can lead to short-term large fluctuations in stock prices, followed by price reversals. The existence of price limits provides investors with a cooling-off period, calming the market, reducing noise trading, suppressing overreactions, and to some extent, preventing deviations from normal volatility

(Bondt & Thaler, 1985; French & Roll, 1986; Chowhdry & Nanda, 1998; Wu, 2003; Zeng, 2004).

Opponents argue that price limit systems may lead to volatility spillover, liquidity disruption, and delayed price discovery, potentially influencing investors' trading decisions and stock liquidity, thereby reducing market efficiency (Lehmann, 1989; Ma, Rao & Sears, 1989; Sun & Shi, 2001). Therefore, the effectiveness of price limit systems requires further exploration from various perspectives.

As a crucial market trading mechanism in the Chinese stock market, the price limit system constrains stock prices within a certain range, halting trading when stocks hit their upward or downward limits. The relaxation of price limits may increase the magnitude of stock price fluctuations and the probability of abnormal fluctuations. Therefore, considering the disruptive nature of abnormal stock price fluctuations on market order and the urgent need for further development in the Chinese stock market, this paper aims to utilize the differences in difference method to investigate the impact of relaxed price limits on stock price volatility. Through mechanism analysis, this study seeks to identify the channels through which such impact occurs, with the goal of proposing a price limit system that effectively curbs abnormal stock price fluctuations, thereby enhancing the quality and efficiency of the stock market.

2. Theoretical Analysis and Research Hypotheses

The design purpose of the price limits system is to prevent extreme fluctuations in stock prices, curbing excessive volatility in the securities market. The adjustment of the Growth Enterprise Market's (GEM) price limits from 10% to 20% expands the potential profit space for investors. The relaxation of price limits may create more arbitrage opportunities, allowing investors to exploit price differentials more flexibly and intensifying market fluctuations. Based on the analysis above, the following hypothesis is proposed.

Hypothesis 1 (H1): Holding other conditions constant, the reform of the GEM price limits increases the stock price volatility.

Firstly, price limits directly impede investors' normal trading activities (Chan et al., 2005). These limits may force interruptions in regular trading. When the intraday trading price of a stock reaches the price limits, liquidity traders are unable to submit trading instructions exceeding the price limits to the trading system, restricting liquidity supply within a certain price range. The relaxation of price limits increases the flexibility of traders to act within a broader price range, reducing market interruptions caused by restrictions on price fluctuations. This can be interpreted as enhancing stock liquidity, and higher liquidity usually enables the market to more swiftly reflect new information. Information can be incorporated into stock prices more rapidly, leading to an intensification of stock price volatility. Based on the analysis above, the following hypothesis is proposed.

Hypothesis 2 (H2): In the context of the GEM price limit adjustment, the impact of stock liquidity on stock price volatility is positive.

Typically, when investors observe significant price fluctuations, it often triggers speculative desires, potentially leading to irrational decision-making driven by excessive emotional reactions. The key to circuit breaker limits lies in setting the range of price fluctuations, providing investors with a cooling-off period to stabilize market sentiment and avoid excessive volatility (Li Chao, 2005). Once investors notice significant price fluctuations, speculative desires may lead to overreactions due to heightened emotions. Therefore, the relaxation of price limits increases speculative desires, thereby enhancing stock price volatility. Based on the analysis above, the following hypothesis is proposed.

Hypothesis 3 (H3): In the context of the GEM price limits adjustment, the impact of investors' speculative desires on stock price volatility is positive.

After the relaxation of price limits, institutional investors are more likely to participate in trading. Since institutional investors are typically more prudent and rational, they tend to choose high-quality blue-chip stocks. Their large transactions can have a stabilizing effect on the market, reducing the severity of price fluctuations. Based on the analysis above, the following hypothesis is proposed.

Hypothesis 4 (H4): In the context of the GEM price limits adjustment, stocks with higher total trading amounts exhibit relatively lower volatility.

3. Research Design and Data

(1) Measurement of Overall Stock Price Volatility

To measure the overall volatility of stock prices, we adopt a methodology inspired by Li et al. (2015), utilizing the absolute values of daily price fluctuations for each individual stock.

$$Wave_{i,t} = abs(high_{i,t} - low_{i,t})/open_{i,t} \quad (1)$$

In this formula, $Wave_{i,t}$ represents the volatility of stock i on day t, where $high_{i,t}$ denotes the highest price of stock i on day t, $low_{i,t}$ indicates the lowest price of stock i on day t, and $open_{i,t}$ represents the opening price of stock i on day t.

(2) Explanation of Variable Settings

1) Grouping Variables, Time Variables

The empirical data selected for this study consist of daily trading data for stocks listed on the Growth Enterprise Market (GEM) and the Small and Medium Enterprise (SME) Board in Shenzhen for the year before and after the relaxation of the daily price limit. Therefore, there are two dummy variables. For the grouping variable, if the stock is traded on the GEM, Treated is assigned the value of 1; conversely, if the stock is traded on the SME Board in Shenzhen, Treated is assigned the value of 0. For the time variable, if the trading day falls after the relaxation of the daily price limit reform on August 24, 2020, Reform is assigned the value of 1; otherwise, if the trading day falls before the reform, Reform is assigned the value of 0.

2) Control Variables

Following the practices of Zhang et al. (2022) and Shi et al. (2023) and considering relevant factors influencing volatility, the following control variables are selected: Daily Opening Price (Open), Daily Highest Price (High), Daily Lowest Price (Low), Daily Closing Price (Close), Price Change Percentage (Change), Daily Trading Volume of Individual Stocks (Volume), Market Capitalization (Market Cap), Price-to-Book Ratio (PB), Price-to-Cash Ratio (PC), Price-to-Sales Ratio (PS), Turnover Ratio (Turnover).

3) Mechanism Analysis Variables

In accordance with the three hypotheses, three mechanism analysis variables are set as follows: Illiquidity Indicator (ILLIQ), Speculative Desire (Speculation), and Trading Amount (Amount).

The Illiquidity Indicator (ILLIQ) is proposed by Amihud (2002):

$$ILLIQ_{i,t} = \frac{1}{n}\sum_{d=1}^{n}\frac{|R_{id}|}{Volume_{id}} \quad (2)$$

Where $|R_{id}|$ represents the absolute value of the return rate of stock i during high-frequency time period d on trading day t; $Volume_{id}$ is the trading amount corresponding to the stock at the given time; n represents the number of high-frequency trading periods into which a single trading day is divided. A higher value of the Illiquidity Indicator indicates poorer stock liquidity, while a lower value suggests better liquidity.

Following the approach of Zhang and Li (2022), the Speculation dummy variable is set, taking the value of 1 when the daily stock price return rate is above 5%, and 0 otherwise.

(3) Differences in Difference Model (DID)

To examine the impact of the GEM daily price limit reform on stock price volatility, this study utilizes daily trading data for stocks listed on the SME Board and GEM in Shenzhen for the year before and after the reform. The core explanatory variable is the interaction term ($Treated * Reform$). The model compares and tests the difference in stock volatility between the experimental group and the control group. The specific model is as follows:

$$\begin{aligned} Wave_{i,t} &= \beta_0 + \beta_1 Treated_i * Reform_t \\ &+\beta_2 Treated_i + \beta_3 Reform_t \\ &+Controls_{i,t} + DateFE + EntityFE + \varepsilon_{i,t} \end{aligned} \quad (3)$$

Where i represents the firm, t represents the date, $Wave$ represents stock volatility; $Treated * Reform$ is the interaction term, serving as the core explanatory variable; $treated$ is a dummy variable, taking the value of 1 for GEM-listed companies and 0 for SME Board-listed companies; $Reform$ is a dummy variable, taking the value of 1 after the reform and 0 otherwise; $Controls$ include various control variables, encompassing financial and technical indicators; $DateFE$, $EntityFE$ are time fixed effects and entity fixed effects, respectively; β_0 is the intercept, and ε is the residual term in the model.

(4) Sample Selection and Descriptive Statistics

This study utilizes the stock trading data of companies listed on the Shenzhen Stock Exchange from August 26, 2019, to August 20, 2021, covering a one-year period around the adjustment of the daily price limit from 10% to 20% on the GEM. To ensure the reliability of stock price volatility measures, ST companies and those that underwent trading suspension or

delisting were excluded, along with companies with a listing duration of less than 24 months. Finally, 356 stocks of GEM-listed companies were selected as the experimental group, and 190 stocks of SME Board-listed companies were chosen as the control group, resulting in balanced panel data at a daily frequency. The daily stock data were sourced from the CSMAR database. Descriptive statistics of the data are presented in Table 1. To address stationarity concerns, logarithmic transformations were applied to some variables.

Table 1. Descriptive Statistics Table

Var.	Group	Mean	Std.Dev.	Min	Max
Wave	Treated	0.046	0.029	0.000	0.365
	Control	0.037	0.024	0.000	0.215
Open	Treated	13.152	14.271	1.310	227.000
	Control	11.714	17.311	1.020	423.240
High	Treated	13.494	14.684	1.340	231.190
	Control	11.980	17.879	1.060	432.000
Low	Treated	12.856	13.886	1.290	223.010
	Control	11.476	16.836	1.020	389.650
Close	Treated	13.171	14.292	1.320	225.450
	Control	11.734	17.399	1.030	432.000
Change	Treated	0.001	0.035	-0.202	0.202
	Control	0.001	0.028	-0.102	0.102
lnVolume	Treated	16.147	1.100	11.738	20.807
	Control	16.173	1.108	11.330	20.970
lnAmount	Treated	18.431	1.211	14.273	23.709
	Control	18.254	1.370	12.765	23.382
Turnover	Treated	0.036	0.038	0.001	0.603
	Control	0.024	0.031	0.000	0.521
lnMarketCap	Treated	15.259	0.855	13.437	19.517
	Control	15.550	0.959	13.459	20.172
PE	Treated	100.881	209.167	3.664	6797.987
	Control	76.953	122.901	1.864	3169.326
PB	Treated	3.972	3.934	0.697	76.498
	Control	2.923	2.832	0.343	30.161
lnPC	Treated	4.117	1.302	1.137	10.644
	Control	3.699	1.190	1.039	9.742
PS	Treated	6.539	8.452	0.088	168.973
	Control	4.455	10.443	0.115	238.633
ILLIQ	Treated	0.031	0.072	0.000	5.080
	Control	0.034	0.130	0.000	14.227
Speculation	Treated	0.063	0.244	0.000	1.000
	Control	0.048	0.213	0.000	1.000

4. Experimental Findings

(1) Baseline Regression Results

Using stock volatility as the dependent variable, the differences in difference empirical test is conducted on the sample. Table 2 presents the regression results for research hypothesis H1. In Table 2, column (1) includes only interaction terms and fixed effects in the preliminary regression equation, excluding financial and technical analysis indicator variables. Columns (2) and (3) subsequently add financial analysis indicator variables and technical analysis indicator variables for regression analysis. Regardless of the inclusion of various control variables, the coefficient of the interaction term (treated*reform) is consistently significant at the 1% level, indicating that the reform of the Growth Enterprise Market (GEM) price limits effectively increases stock volatility. Thus, hypothesis H1 is confirmed. It is noteworthy that, with the introduction of different levels of control variables, the R-squared of the regression equation gradually increases, suggesting that the explanatory power of the regression equation for the dependent variable improves with the addition of control variables.

Table 2. Regression Results Table

Var.	(1)	(2)	(3)
	Wave	Wave	Wave
Treated*Reform	0.009***	0.007***	0.002***
	(0.000)	(0.000)	(0.000)
Treated	0.019***	-0.011***	-0.004***
	(0.000)	(0.000)	(0.000)
Reform	0.005***	0.000	-0.003***
	(0.001)	(0.892)	(0.001)
Cons	0.042***	0.016***	1.766***
	(0.000)	(0.000)	(0.000)
Financial Indicators	NO	YES	YES
Technical Indicators	NO	NO	YES
Date-fixed Effect	YES	YES	YES
Entity-fixed Effect	YES	YES	YES
Observations	263281	263281	263281
R-squared	0.2401	0.2879	0.6619

Note: *** significance at p<0.01, ** significance at p<0.05, *significance at p<0.1

(2) Testing Mechanisms

Drawing inspiration from the approach of Shi and Li (2020), we embed the moderating variables into the baseline model (3) and construct the following moderation effect model:

$$\begin{aligned} Wave_{i,t} &= \beta_0 \\ &+\beta_1\left(Treated_i * Reform_t * Moderator_{i,t}\right) \\ &+\beta_2(Treated_i * Reform_t) \\ &+\beta_3 Moderator_{i,t} + Controls_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (4)$$

Where i represents the firm, t represents the date, $Wave$ represents stock price volatility; $Treated_i * Reform_t$ is the interaction term, and $Moderator_{i,t}$ represents the moderating variables, specifically stock liquidity, speculative desire, and trading amount. The focus is primarily on the coefficient significance of the interaction term $Treated_i * Reform_t * Moderator_{i,t}$.

1) Stock Liquidity:

The results of the mechanism analysis for the impact of stock liquidity on stock price volatility are presented in the second column of Table 3. It is noteworthy that the interaction term is significant, indicating that the effect of the adjustment of daily price limits on stock price volatility is moderated by stock liquidity. The

positive coefficient of the interaction term suggests that an increase in stock liquidity will lead to an increase in stock price volatility. Thus, Hypothesis 2 is validated.

2) Investor Speculative Desire:

The mechanism analysis results for the impact of investor speculative desire on stock price volatility are shown in the third column of Table 3. The significant interaction term indicates that the effect of daily price limit adjustments on stock price volatility is moderated by investor speculative desire. The positive coefficient of the interaction term implies that an increase in investor speculative desire will increase the stock price volatility. Hence, Hypothesis 3 is validated.

3) Stock Trading Amount:

The mechanism analysis results for the impact of stock trading amount on stock price volatility are presented in the fourth column of Table 3. The significant interaction term suggests that the effect of daily price limit adjustments on stock price volatility is moderated by the stock trading amount. The negative coefficient of the interaction term implies that an increase in trading volume will decrease the stock price volatility. In other words, for stocks with smaller trading amount, the stock price volatility may be higher. Therefore, Hypothesis 4 is validated.

Combining the results from the three mechanism analyses, the positive effects of stock liquidity and investor desire outweigh the negative effect of stock trading amount. Therefore, the adjustment of daily price limits on the GEM has a positive impact on the stock price volatility. This is consistent with the results of the baseline regression, validating Hypothesis 1.

Table 3. Mechanism Test Table

Var.	Wave		
	（1）Liquidity	（2）Speculation	（3）Amount
Treated*Reform*Moderator	0.003***	0.009***	-0.003***
	(0.000)	(0.000)	(0.000)
Treated*Reform	0.018***	-0.006***	-0.061***
	(0.000)	(0.000)	(0.000)
Moderator	-0.001***	0.045***	0.020***
	(0.000)	(0.000)	(0.000)
Cons	0.007***	0.208***	0.002***
	(0.000)	(0.000)	(0.000)
Control	YES	YES	YES
Date-fixed Effect	YES	YES	YES
Entity-fixed Effect	YES	YES	YES
Observations	256035	263281	263281
R-squared	0.2618	0.1409	0.5972

Note: *** significance at p<0.01, ** significance at p<0.05, *significance at p<0.1

(3) Parallel Trends Test

To ensure that the treatment and control groups have consistent trends before the implementation of the policy, a parallel trends test is conducted. Graphs are plotted to observe how the stock price volatility in the treatment and control groups changes over time one month before and after the implementation of the daily price limit reform policy. Figure 1 illustrates this, with the orange vertical line representing the implementation point of the GEM daily price limit reform policy on August 24, 2020. From the graph, it can be observed that the trends in the stock price volatility for the treatment and control groups are generally consistent before the policy implementation, indicating that the parallel trends assumption is satisfied. After the implementation of the daily price limit reform policy, there is a deviation in the stock price volatility between the treatment and control

groups, which can be attributed to the impact of the policy implementation.

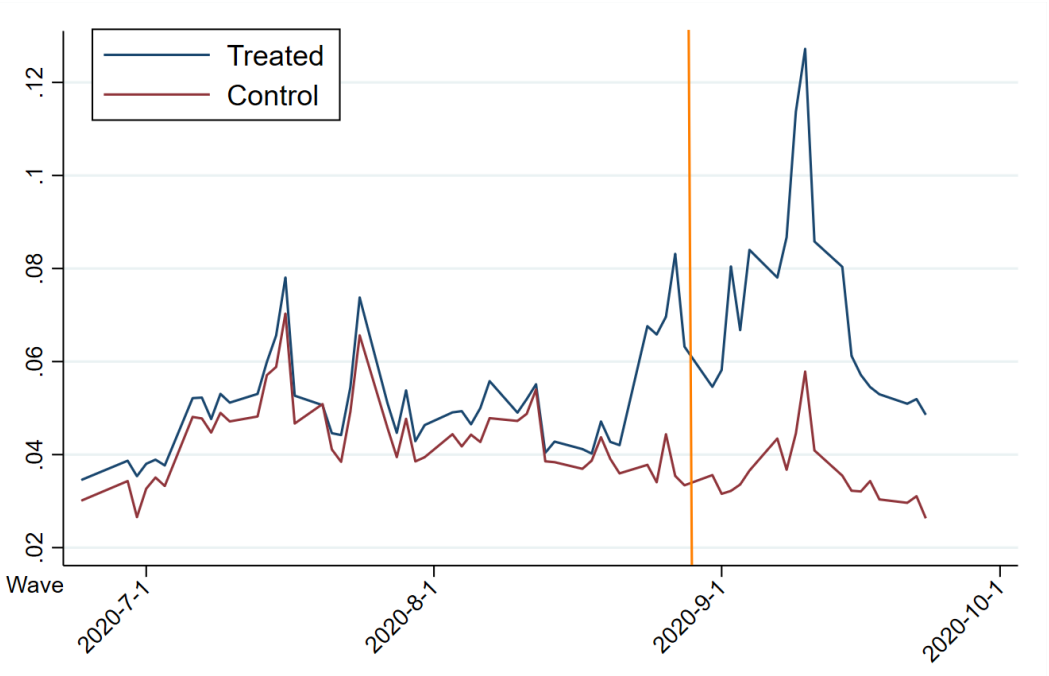

Figure 1. Parallel Trends Graph One Month Before and After Policy Implementation

(4) Placebo Test

To mitigate the influence of other unknown factors on the experimental results and ensure that the conclusions are attributed to the adjustment of price limits policy, a placebo test is conducted. In this study, a time-based placebo test is employed, where the procedure involves conducting baseline regressions at various time points ranging from 10 to 100 days before the policy implementation, with intervals of ten days. According to Table 4, the results indicate that the p-values for all placebo effects are greater than 0.1, supporting the acceptance of the null hypothesis that "placebo effects are zero." In Figure2, the 95% confidence intervals for the placebo effects in each time period are examined. Importantly, all confidence intervals encompass the value of zero, indicating that the placebo effects are not statistically significant. Therefore, the placebo test suggests that the observed effects are likely attributed to the adjustment of the price limits policy.

Table 4. Results of in-time placebo test

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
F10.	-0.00013	0.001574	-0.08	0.935	-0.00321	0.002958
F20.	-2.5E-05	0.00131	-0.02	0.985	-0.00259	0.002542
F30.	0.000461	0.001222	0.38	0.706	-0.00193	0.002856
F40.	0.000759	0.00109	0.7	0.486	-0.00138	0.002895
F50.	0.00057	0.00101	0.56	0.573	-0.00141	0.002549
F60.	0.00069	0.000969	0.71	0.476	-0.00121	0.002588
F70.	0.000915	0.00093	0.98	0.325	-0.00091	0.002737
F80.	0.000849	0.000912	0.93	0.352	-0.00094	0.002636
F90.	0.000539	0.000904	0.6	0.551	-0.00123	0.00231
F100.	0.000283	0.000891	0.32	0.751	-0.00146	0.00203

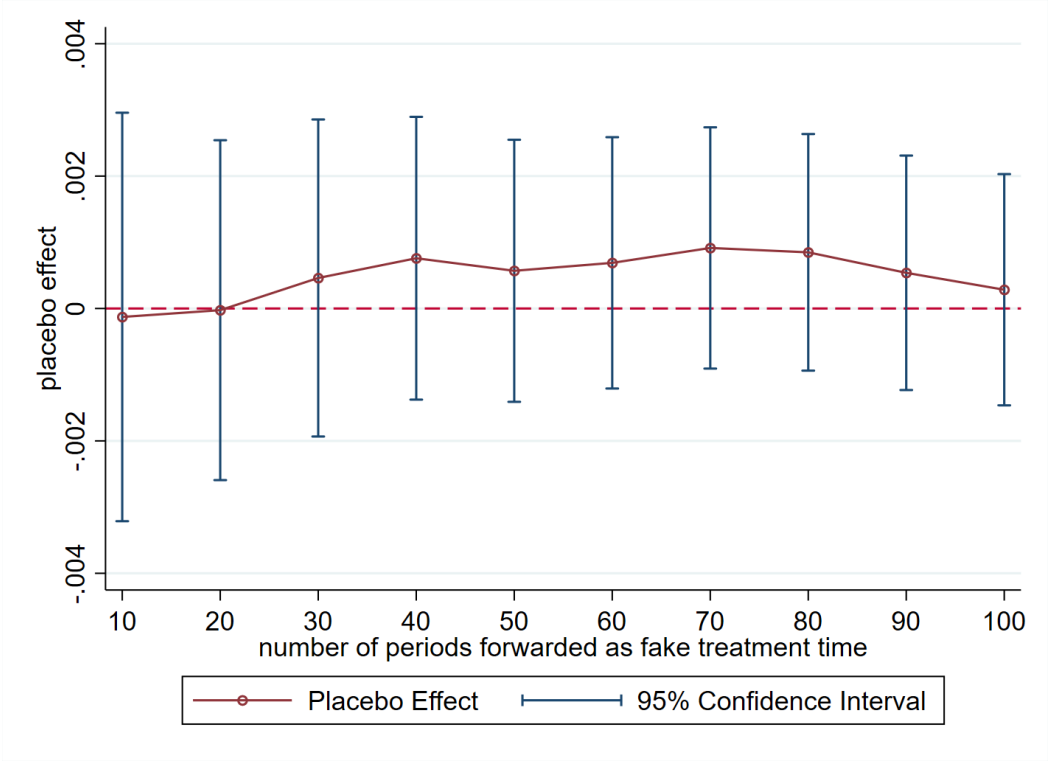

Figure 2. In-time Placebo Test

5. Conclusion and Policy Recommendations

The adjustment of price limits is an inevitable trend in the development of China's capital market and is part of the strategic considerations in gradually opening up the capital market. However, the adjustment of daily price limits in the GEM market also poses certain market risks that may impact stock volatility. Therefore, based on the quasi-natural experiment of the GEM daily price limit relaxation to 20% in 2020, this study first theoretically analyzes its impact on stock price volatility. Subsequently, employing the differences in difference fixed-effects model, it investigates the influence of the GEM daily price limit adjustment on the stock price volatility and conducts mechanism analysis.

The research findings indicate the following: On one hand, regarding the overall impact of the price limits adjustment on the stock price volatility, the policy significantly increases stock price volatility. On the other hand, concerning the influencing mechanisms, the increase in stock price volatility is significantly affected by stock liquidity, investor speculative desire, and stock trading amount. Specifically, an increase in stock liquidity and investor speculative desire significantly increases stock price volatility, while an increase in stock trading amount significantly reduces stock price volatility.

The comprehensive conclusions of the study lead to the following recommendations: 1) Considering the observed increase in stock price volatility due to the relaxation of price limits, policymakers may need to contemplate regulatory measures to balance the market and enhance overall stability. 2) The study indicates that smaller stock trading amount tend to exhibit relatively higher stock price volatility. Therefore, stock exchanges could strengthen regulations and information disclosure systems for small enterprises, enhancing transparency. This would enable investors to better understand the financial and operational conditions of small enterprises, reducing information asymmetry-induced investor uncertainty, and subsequently lowering stock price volatility. 3) Drawing insights from the experiences of foreign stock exchanges, it is advisable to actively explore new reform measures. This could include initiatives to promote greater openness and transparency of market information, reduce information asymmetry, and effectively protect the interests of small and medium-sized investors. These recommendations aim to strike a balance between the market's need for flexibility and stability, enhance investor confidence, and

contribute to the healthy development of the market, particularly focusing on the GEM.

Fund Project

This research was supported by the "Undergraduate Training Program for Innovation and Entrepreneurship, China University of Mining and Technology", Xuzhou, China, 221100.

Reference

Amihud Y. (2002). Illiquidity and Stock Returns: Cross- Section and Time- Series Effects. *Journal of Financial Markets, 5*(1), 31-56.

Chowdhry B, Nanda V. (1998). Leverage and market stability: The role of margin rules and price limits. *The Journal of Business, 71*(2), 179-210.

De Bondt W F M, Thaler R. (1985). Does the stock market overreact? *The Journal of finance, 40*(3), 793-805.

Duffie D, Gârleanu N, Pedersen L H. (2005). Over-the-Counter Markets. *Econometrica, 73*(6), 1815-1847.

French K R, Roll R. (1986). Stock return variances: The arrival of information and the reaction of traders. *Journal of financial economics, 17*(1), 5-26.

Lehmann B N. (1989). Commentary: Volatility, price resolution, and the effectiveness of price limits. *Regulatory Reform of Stock and Futures Markets: A Special Issue of the Journal of Financial Services Research*, 107-111.

Li Chao. (2005). The Impact of Price Limits on Investors' Trading Behavior in the Chinese Stock Market. *Journal of Central University of Finance and Economics*, (9), 30-34.

Li Zhisheng, Chen Chen, Lin Bingxuan. (2015). Did Short Selling Mechanism Improve the Pricing Efficiency of the Chinese Stock Market? — Evidence from a Natural Experiment. *Economic Research (in Chinese)*, (4), 165-177.

Ma C K, Rao R P, Sears R S. (1989). Volatility, price resolution, and the effectiveness of price limits. *Regulatory Reform of Stock and Futures Markets: A Special Issue of the Journal of Financial Services Research*, 67-101.

Shi Dan, Li Shaolin. (2020). Emission Trading System and Energy Utilization Efficiency — Measurement and Empirical Evidence from Prefecture-Level and Above Cities. *China Industrial Economy*, (09), 523.

Sun Peiyuan, Shi Donghui. (2001). Reforming Trading Mechanisms from the Perspectives of Liquidity and Bid-Ask Spread — An Empirical Study Based on the Shanghai Stock Market. *Listed Companies (in Chinese)*, 12, 54-57.

Wu Linxiang, Xu Longbing, Wang Xinping. (2003). Did Price Limits Play a Role in Facilitating Price Increases and Decreases? *Economic Research (in Chinese)*, (10), 59-65+93.

Zeng Changhong. (2004). Factor Analysis of the Impact of Price Limits on Liquidity and Volatility. *Financial Research (in Chinese)*, (04), 37-44.

Zhou Qianglong, Zhu Yanjian, Jia Luxi. (2015). Probability of Informed Trading, Liquidity, and Volatility — Empirical Evidence from the Chinese Stock Index Futures Market. *Financial Research (in Chinese)*, (05), 132-147.