Monthly Effects and Volatility Asymmetry in Chinese Stock Market

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Abstract: In order to study the monthly effects and volatility asymmetry of Chinese stock market, this paper tests the Shanghai Securities Composite Index data from 2001 to 2020 with rolling sample test method based on the EGARCH model. The results show that there are significant positive January effect and negative April effect in Chinese stock market since 2001, and the effects in these two months extend to the following one or two months. There is also volatility asymmetry in Chinese stock market, which generally reflects the phenomenon of leverage effect, but in the period of stock market reform that in 2005 and 2013, it shows as the counter-leverage effect. The results also capture the impact of major events such as the financial crisis in 2008, the stock market crash in 2015 and the stock market reforms.

1. Introduction

With the empirical studies of the effectiveness of the securities market, many scholars have found that there are many phenomena in stock market and investor behaviors contrary to the efficient market hypothesis. Behavioral finance theory challenges the rational man hypothesis, revealing small firm effect, scale effects, calendar effects, momentum effects and so on.

Calendar effects include day-of-the-week effects, monthly effects and holiday effects, seasonal effects, etc., there are a lot of studies about monthly effects in Chinese stock market, most of existing research cover the period began from 1994 or 1996 to 2010 years. This article is based on the Shanghai Securities Composite Index yields data from 2001 to 2020. EGARCH model and rolling sample test method are used to conduct empirical analysis on the monthly effects of Chinese stock market. In addition, EGARCH model can also investigate the reflection of volatility asymmetry in Chinese stock market. The test of monthly effects and volatility asymmetry is helpful to explore the operation characteristics of Chinese stock market.

The remainder of the paper is organized as follows, the second part reviews the studies about calendar effects and volatility asymmetry, the third part explains how the data is chosen and processed, the fourth part contains the empirical model and test results of monthly effects and volatility asymmetry, and the last part is conclusion.

2. Literature Review

2.1 Calendar Effects

Cross (1973) analyzes the S&P 500 index data from 1953 to 1970, and finds that the average return on Friday is 0.12%, which is -0.18% on Monday, and the probability of the index rising on Friday is nearly 20% higher than that on Monday. Gultekin (1983) analyzes the stock index data of 17 major industrialized countries from 1959 to 1979, and finds that most countries have strong seasonal effect which mostly come from the exceptionally high returns in January.

Studies shows that calendar effects also exist in Chinese stock market. Zhu and He (2001) argue that the Spring Festival in China is corresponding to Christmas in U.S., so the January effect in the U.S. shows as the February or March effect in China. Xu and Zhang (2005) find that returns in Chinese stock market are significantly positive in March and April and negative in September and October. Lu

and Liu (2008) find that Monday effect is significantly positive in bull market, but negative in bear market in China. Zhang and Zhu (2019) analyze the data from SZSE and find there exist positive Tuesday effect and negative Thursday effect. They also test the holiday effects of New Year's Day, Chinese New Year, Tomb-sweeping Day, Labors' Day and National Day. The results show that post-holiday excess returns are significantly positive.

However, studies also find that the calendar effects are fading. Xu and Zhang (2005) find that December effect shows in early days but fades away and this change is closely related to the institutional characteristics of Chinese stock market. Zhang (2005) argues that once a calendar effect is suggested, it will be weaker. Akbalik and Ozkan (2017) conduct an empirical test on the stock markets of Brazil, India, Indonesia and Turkey after the global financial crisis in 2008 and find that the day-of-the-week calendar effects have been significantly reduced except Indonesia.

In summary, research on the calendar effect of the securities market has been carried out at home and abroad for a long time, and inconsistent conclusions have been drawn in different periods and different markets. In terms of methods, the GARCH model has been widely used.

2.2 Volatility Asymmetry

Volatility asymmetry is reflected by leverage effect and counter-leverage effect. Specifically, if the current moment price rises, for a period of time in the future price volatility falls, the market tends to smooth, on the other hand, the price volatility rises, market is volatile, then the stock market exists leverage effect. Counter-leverage effect is the opposite of leverage effect.

Chen and Huang (2002) find that there was leverage effect in Chinese stock market at a significant level of 10% from 1993 to 2001, and at a significant level of 5% from 1997 to 2000. However, from 1993 to 1997, positive news had a greater impact on market volatility than negative news, in other words, there is an counter-leverage effect. There are studies show that positive news has a greater impact on the stock market than negative news in the bull market, while the opposite is true in the bear market (Lu and Xu,2004, Li,2017). Besides, Zhu and Xie (2011) find that the volatility of the stock market is more sensitive to the positive shock in the high volatility state, but on the contrary in the low volatility state.

In a word, the studies have found that the volatility asymmetry of Chinese stock market is inconsistent in different periods and market conditions.

3. Data and Sample Definition

Daily return rate of Shanghai Securities Composite Index (SSE Composite Index) from January 2, 2001 to December 23, 2020 is selected as the data sample, which includes 20 years and 4844 trading days. The daily return rate is calculated from the closing price data from RESSET database with the formula below, in which $close_t$ means the closing price of SSE Composite Index on day t.

$$r_t = 100 \times [\ln(close_t) - \ln(close_{t-1})] \tag{1}$$

This paper uses the method of rolling sample test method (Zhang,2005). The rolling window is set to 500 days and there are 4,345 rolling windows in total. Specifically, the first window includes the data from the first to the 500th trading day, the second window includes the second to the 501st trading days, …, the 4345th window includes the data from the 4345th to the 4844th trading day. By setting the rolling window to test the samples, whether and how the monthly effects exist in different periods can be observed. The rolling window moves forward at an interval of one trading day, so that subtle changes can be observed.

Before empirical test, basic tests and statistics are performed on the data. Firstly, through the Jarque-Bera test, the sample does not obey the standard normal distribution. Secondly, Table 1 reports summary statistics for the sample. The sample has the feature of slight left skewness, which means that the probability of loss is higher than the probability of gain. The kurtosis of the data sample is greater than 3, showing the distribution characteristics of sharp peak and thick tail.

Table 1. Summary statistics for data sample

Mean	0.0101
Maximum	9.4008
Minimum	-9.2562
Standard deviation	1.5575
Skewness	-0.3981
Kurtosis	7.9176
Sample size	4844

Thirdly, through ADF test and ARCH effect test, the results show that ARCH/GARCH models can be applied. Fourthly, a simple test of volatility asymmetry is conduct by the method of Xie and Zhu (2019). The samples of each group are divided into two sub-samples which are larger than average $\bar{r}$ and smaller than average $\bar{r}$ respectively, and the absolute value of relative return rate r_t^+ and relative loss rate r_t^- are calculated respectively as follow.

$$\begin{cases} \text{Relative return rate: } r_t^+ = r_t - \bar{r}, \ r_t > \bar{r} & (2) \\ \text{Relative loss rate: } \quad r_t^- = \bar{r} - r_t, \ \bar{r} < r_t & (3) \end{cases}$$

Table 2 shows the calculation results of volatility asymmetry test. The mean and standard deviation of relative return rate are greater than relative loss rate so that there exists asymmetry in the mean and volatility of return rate. In this case, EGARCH and TGARCH model are suitable for empirical test.

Table 2. Volatility asymmetry test

	Relative return rate	Relative loss rate
Mean	1.0158	1.1106
Maximum	9.3907	9.2663
Standard deviation	1.0518	1.2276
Skewness	2.4014	2.5114
Kurtosis	12.7496	11.4987
Sample size	2530	2314

4. Empirical Analysis

4.1 Model

Since the sample sequence does not obey normal distribution, this paper chooses the EGARCH (1,1) model based on t distribution, and adds dummy variables of months into the mean equation for analysis. The model is as follows.

$$\text{Mean equation}: \quad y_t = c + \phi y_{t-1} + \varepsilon_t + \theta \varepsilon_{t-1} + \delta_i X_i \tag{4}$$

$$\text{Variance equation}: \quad \ln(\sigma_t^2) = \omega + \beta \ln(\sigma_{t-1}^2) + \alpha \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} - E\left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right) \right| + \gamma \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \tag{5}$$

In mean equation, y_t denotes the rate of return on day t, y_{t-1} is the first-order autoregressive term, ε_t obeys $N(0,\sigma_t^2)$ distribution, ε_{t-1} is the first-order moving average term, X_i are the dummy variables of months in which i=1,2,3, … ,11,12. The dummy variables will be substituted into mean equation for model simulation. Monthly effects can be observed with the characteristics (positive or negative, significance) of coefficients δ_i. In variance equation, σ_t^2 is the variance term, $\frac{\varepsilon_{t-1}}{\sigma_{t-1}}$ is leverage term. Leverage effect can be observed with the characteristics of coefficients γ. Specifically, if γ is not 0, then volatility asymmetry exists; if γ is negative, then there is leverage effect; if γ is negative, then there is counter-leverage effect.

4.2 Descriptive Statistics

Table 3 shows the basic descriptive statistics of sample which is calculated by month. On the whole, compared with other months, the return rate of February has the characteristics of larger mean, more severe volatility and greater negative skewness, while the return rate of December has the characteristics of larger mean, less volatility and slightly positive skewness.

Table 3. Descriptive statistics of sample calculated by month

	Mean	Std.	Skewness	Kurtosis
January	-0.0551	1.8828	-0.8189	3.8803
February	0.1271	1.7351	-0.8643	5.5472
March	0.0367	1.3875	-0.2202	1.9116
April	0.1021	1.4399	0.2552	4.9435
May	-0.0247	1.4768	-0.7640	3.1305
June	-0.1253	1.7607	-0.4320	6.2435
July	0.0344	1.5948	-0.6475	4.2532
August	-0.0861	1.6222	-0.8775	6.0498
September	-0.0083	1.4252	1.0045	6.1308
October	-0.0206	1.6010	0.1131	4.5738
November	0.0396	1.4553	-0.1984	3.9434
December	0.1103	1.2952	0.0769	1.8618

4.3 Model Fitting and Analysis

EGARCH (1,1) model fitting is carried out according to equations (4) and (5) for the samples in each rolling window by month. The results are represented by the *t*-statistics of coefficients δ_i and γ. The signs of the *t*-statistic are the same as the signs of the corresponding coefficient and if the absolute value of the *t*-statistic is greater than 1.96 then the coefficient is significant at the 5% confidence level.

4.3.1 Monthly Effects

The subfigures in Figure 3 display the *t*-statistics of δ_i ,which is the coefficients of dummy variables of each month. Two lines meaning *t*-statistics=-1.96 and *t*-statistics =1.96 are added in the figures, a point beyond the interval where the absolute value of *t*-statistics is larger than 1.96 means that significant month effect exists in the 500 trading days (about 2 years) starting from this corresponding trading day at the level of 5%, which is called significant point below. Besides, the same trading day will be included in 500 rolling windows at most. Table 4 shows the calculations of significant points in each month. Further, Figure.1 and Figure.2 show the sequence diagram of the closing prices and return rate of SSE Composite Index within the sample time interval respectively. Next, we will analyze each month with a combination of the above-mentioned figures and tables.

Table 4. Calculations of significant points of δ_i

	January	February	March	April	May	June
t-statistics >1.96	621	126	147	123	18	42
t-statistics <-1.96	14	18	12	732	144	54
Total	635	144	159	855	162	96
	July	August	September	October	November	December
t-statistics >1.96	77	16	93	160	209	173
t-statistics <-1.96	27	67	57	123	19	44
Total	104	83	150	283	228	217

Figure 1. Closing prices of SSE Composite Index

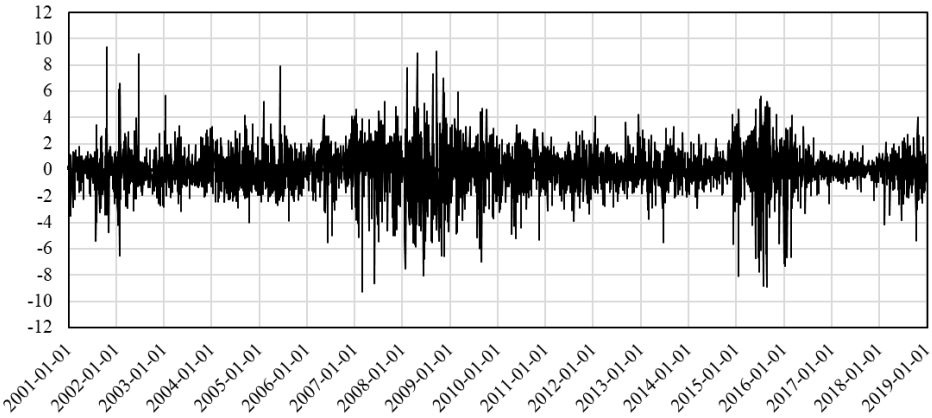
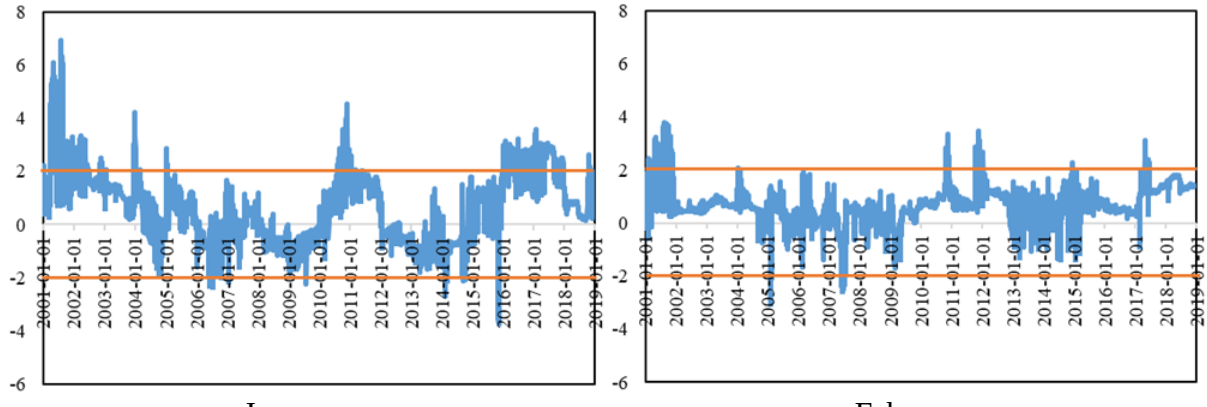
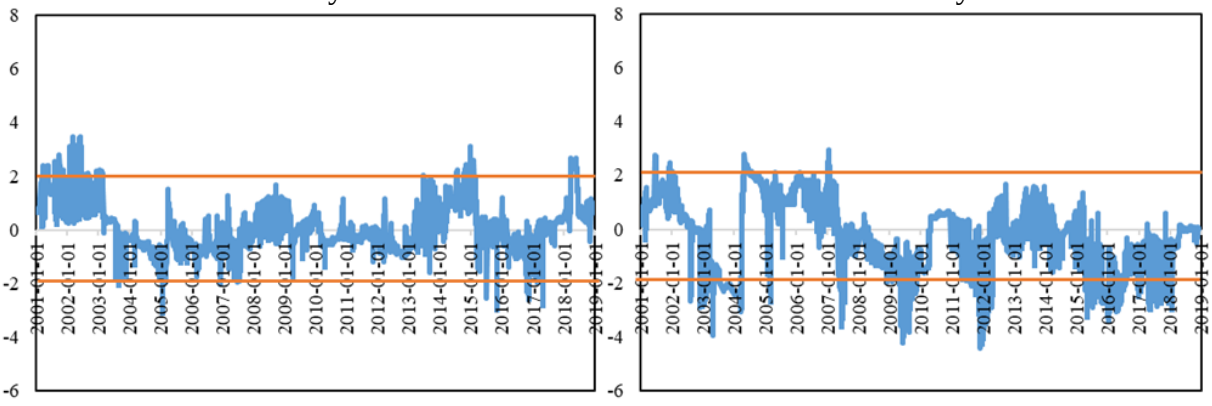


Figure 2. Return rates of SSE Composite Index



January February



March April

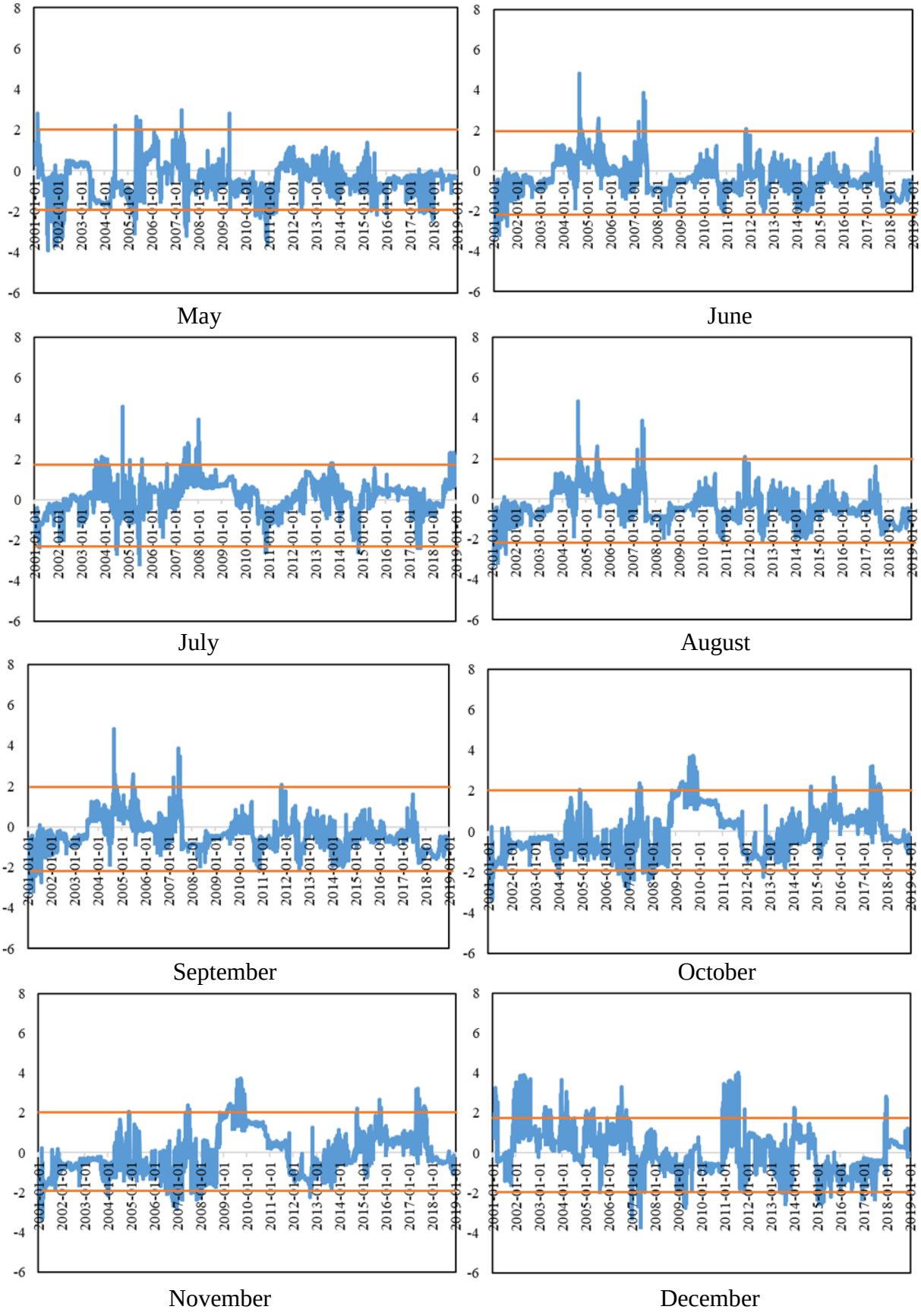


Figure 3. *t*-statistics of δ_i

1) January

There exists positive monthly effect in January. There are 621 positive significant points which are distributed in the periods from 2001 to 2006, 2010 to 2012, and 2015 to 2020. 14 negative significant

points are distributed in the periods from 2006 to 2010 and 2014 to 2016, which cover the sharp stock price falls and high volatility showed in Figure 1 and 2, corresponding to financial crisis in 2008 and stock market crash in 2015.

2) February and March

In Figure 3, the curve trend of February is similar to that of January, but with a smaller amplitude. The period of occurrence of significant points are similar to that of January, but the number is much smaller, with 126 positive and 18 negative significant points. March had a similar pattern to February, with 147 positive and 12 negative significant points.

3) April

April mainly shows negative month effect, with 123 positive significant points scattered before 2007 and 732 negative significant points widely distributed after 2002. It can be considered that there has been a negative April effect since 2002, and the robustness has not been affected by the stock market crashes in 2008 and 2015.

4) May

There are 18 positive and 144 negative significant points in May. As observed from the Figure 3, the period of occurrence of significant points is similar to that of April, which mainly has a relatively significant negative monthly effect.

5) June, July and August

The three months are similar, with few significant points. In Figure 3, the curve trend of theirs is similar, and positive month effect can be observed in all the three months before 2008. However, at the beginning of the sample range, June has a positive month effect, while July and August have a negative month effect. In the window that includes 2008, June and July have significant positive effects, while August's original positive effects disappear.

6) September and October

In Figure 4, put curves of September (the darker one) and October (the lighter one) which in Figure 3, it can be found that 2008 is a notable watershed. Before 2008, the curve of the two movements are similar and sample windows that contain 2008 reflect positive monthly effects. But after 2008, both begin to reflect opposite effect and this state continues until 2018.

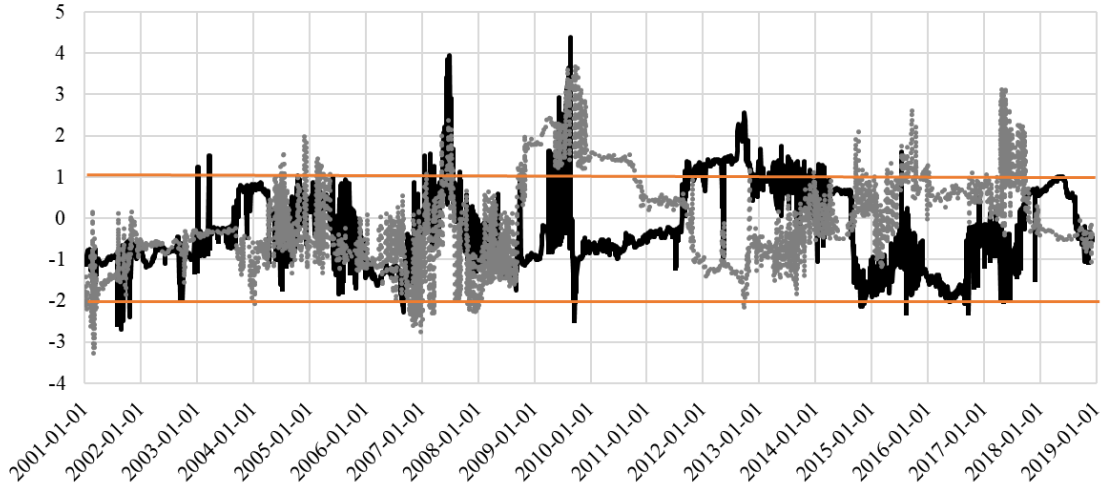


Figure 4. *t*-statistics of δ_i in September and October

7) November

November mainly reflects the positive monthly effect, with 209 positive and 19 negative significant points. The positive significant points are widely distributed, while the negative significant points are concentrated around 2007, which may be affected by the 2008 financial crisis

8) December

December is similar to November, with 173 positive and 44 negative significant points, and the positive significant points are widely distributed. The difference is that in addition to 2007, the negative December effect has also been significant after 2009 and 2015.

4.3.2 Leverage Effect

Since dummy variables of months are not added into the variance equation, the *t*-statistics values of coefficients γ obtained by the model fitting are highly similar in the twelve months. In Figure 5, the curve of January is shown as representative. Similar to Table 4, Table 5 shows the calculations of significant points of γ in each month. We can find that the number of negative significant points is far more than that of positive significant points, which mainly reflects the negative significance, that is, leverage effect exists. In particular, under the impact of the 2008 financial crisis, general and particularly significant leverage effect is observed in the windows starting from 2007 to 2008.

Positive significant points mainly appear in 2005 and 2013. As shown in Figure 5, both of these two time points were immediately followed by periods of stock market surge. The year 2005 corresponds to the time when China implemented the reform of non-tradable shares, and the year 2013 corresponds to the suspension of IPO throughout the year. And China Securities Regulatory Commission issued "Opinions on Further Promoting the Reform of IPO System" at the end of 2013. The absolute value of the positive significance point is much larger than the negative significance point, that is to say, the significance of the counter-leverage effect is stronger than that of the leverage effect.

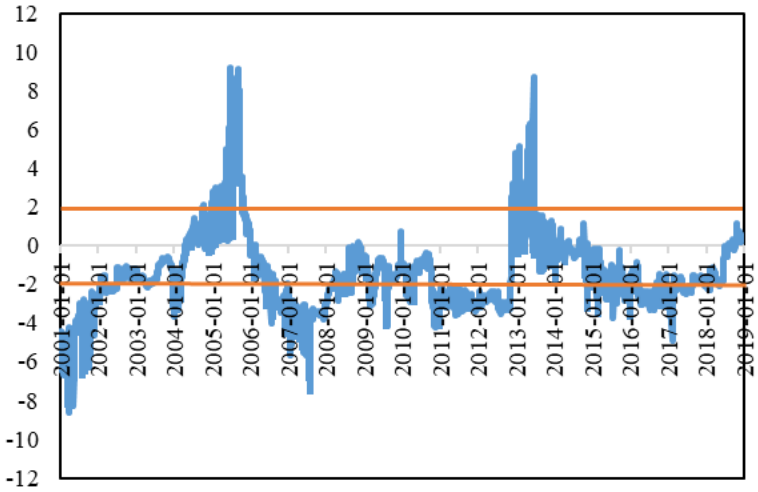


Figure 5. *t*-statistics of γ (January)

Table 5. Calculations of significant points of γ

	January	February	March	April	May	June
t-statistics >1.96	198	163	244	178	216	213
t-statistics <-1.96	1885	1655	1666	1734	1688	1633
Total	2083	1818	1910	1912	1904	1846
	July	August	September	October	November	December
t-statistics >1.96	206	193	199	229	175	179
t-statistics <-1.96	1777	1675	1639	1926	1746	1708
Total	1983	1868	1838	2155	1921	1887

4.4 Results

1) January effect and April effect

In general, the Chinese stock market has a significant positive January effect and negative April effect. January effect in the study of Chinese and foreign have been confirmed that many times before, while the negative April effect is contrary to the result of Xu and Zhang (2005). This difference may be caused that data is adopted in different periods, which means April effect at different times has different performance.

2) Correlation between adjacent months

In February and March follow closely with January and the two months have similar but not so significant monthly effects with January. Similarly, may also has a similar but not so significant

monthly effect with April. Besides, among June, July and August as well as between December and October, there are certain correlations, which reflect significant continuity of monthly effects and nonnegligible correlation between adjacent month.

3) Volatility asymmetry

There is a significant leverage effect in Chinese stock market as a whole, which indicates that investors react more smoothly when facing good news, and thus the stock market also maintains a relatively stable state. On the contrary, in the face of bad news, their reaction will be more intense. However, in special periods (the reform of non-tradable shares in 2005, IPO suspension and IPO system reform in 2013), Chinese stock market has a counter-leverage effect, which may be because people are optimistic about the prospect of reforms, and the reaction degree to this positive news is more than the reaction degree to the negative news.

4) The impact of major events

In the test of this study, the influence of major events on Chinese stock market is well captured. The 2008 financial crisis strengthened the leverage effect of the stock market, and most months have negative monthly effects. The January effect, which is originally significantly positive, is significantly negative under this influence. The stock market crash in 2015 also has similar effect on most monthly effects, but it is not as strong as the impact of the financial crisis in 2008. In addition, two major stock market reforms in 2005 and 2013 lead to a significant counter-leverage effect in the stock market.

5. Conclusion

In order to study the monthly effects and volatility asymmetry of Chinese stock market since 2001, this paper uses the EGARCH model to test the data of SSE Composite Index from 2001 to 2020. The test of the month effect shows that since 2001, there are significant positive January effect and negative April effect in Chinese stock market, and these two significant monthly effects can affect the following one or two months, making them have similar but less strong monthly effects. The test of volatility symmetry shows that Chinese stock market has a relatively common leverage effect, but in the period of important financial system reform in 2005 and 2013, it reflects the counter-leverage effect. The empirical results also show that this study has better captured the impact of major events such as the financial crisis in 2008, the stock market crash in 2015 and financial system reforms on Chinese stock market. The conclusion of this paper can be a supplement to the research on the operation characteristics of Chinese stock market.

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