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Public holidays effects on volatility in Shanghai stock exchange market

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ABSTRACT

In this paper, we investigate the impact of China's seven major public holidays on Shanghai Stock Exchange Composite Index daily returns' volatility from January 4, 2002, to November 17, 2023. Utilizing the GARCH (1, 1) model, we aim to uncover whether there are the seven public holiday effects in addition to the well-known conventional holiday effects in stock returns' volatility. There are a lot of research papers on the seven public holiday effects in the return level but few ones in the return volatility. Especially, we investigate both pre- and post-holiday effects in the seven major public holidays. As a result, we find that the pre-holiday effects are insignificant in most of the seven major public holidays, suggesting that investor behavior does not change significantly before the public holidays. In contrast, the post-holiday effects are significant in most of the seven major public holidays, indicating high volatility after the public holidays. Because the stock market is worldwide and operates continuously, the volatility of stock returns increases significantly when China's stock market opens after the public holidays. Through these findings, inventors can better understand market volatility and the accompanying risks before and after the public holidays.

Contribution/ Originality: This study uniquely analyzes the impact of seven major public holidays on the volatility of Shanghai Stock Exchange Composite Index daily returns, focusing on the pre- and post-holiday effects. Most of the seven major public holidays have insignificant pre-holiday effects and significant post-holiday effects.

1. INTRODUCTION

According to the efficient stock market hypothesis, security prices adequately reflect the available information. It is well known that the prices follow a random walk process and accordingly they are unpredictable (Fama, 1970). Market uncertainty is directly related to volatility, which affects the investment behavior of firms and individuals. Engle and Patton (2001) illustrate the prediction of volatility and its importance from the aspect of market timing, futures market fluctuations, adjustment of investment strategies and so on. Due to the increased share of emerging markets in the global stock market, international investors are interested in analyzing these markets, which have characteristics different from developed markets (Seif, Docherty, & Shamsuddin, 2017). It is essential to analyze the volatility of China's stock market as one of Asia's largest and most developed stock markets. There are some stock markets in China. In this paper, we choose Shanghai Stock Exchange Composite Index (hereafter, SSECI), because the Shanghai Stock Exchange market is characterized by large market value, a wide range of industries, high liquidity, and a great amount of trading volume in China. [1]

It is well known that volatility of stock returns is an increasing function of the length of holidays (for example, see (Andersen, 1996; Tanizaki, 2004; Tsiakas, 2005, 2010; Watanabe, 1999)). Utilizing SSECI, in this paper we analyze whether there are specific holiday effects on seven major public holidays in China, which is different from the conventional holiday effects. In this paper, we consider two holiday effects in volatility of China's stock returns. One is called the conventional holiday effect, which is based on the number of holidays between two trading days t and $t-1$, while another is called the major public holiday effect, which is a specific effect other than the conventional holiday effect.

It should be noted that the seven major public holidays in China consist of New Year's Day, Spring Festival, Qingming Festival, Labour Day, Dragon Boat Festival, Mid-Autumn Festival, and National Day. The seven major public holidays are designed for a specific period and purpose. January 1 is universally recognized as New Year's Day. The Spring Festival (also called the Chinese Lunar New Year) occurs in late January or February. During the Qingming Festival, which takes place between April 4 and 6, Chinese people memorialize their ancestors and sweep up their graves. Labour Day occurs on May 1. Dragon Boat Festival in May or June honors poet Qu Yuan. In the Mid-Autumn Festival in September or October, we celebrate autumn harvest and reunion. The Mid-Autumn Festival is overlapped with the National Day in 2009, 2012, 2017, and 2023. National Day is scheduled on October 1. The Qingming Festival, the Dragon Boat Festival, and the Mid-Autumn Festival became public holidays starting from 2008. The exact dates of the seven public holidays are reported in the China government website (https://english.www.gov.cn/). Furthermore, the stock exchanges market closure dates are announced in the Shanghai Stock Exchange website (http://english.sse.com.cn/). See Table 1 for the public holidays.

Table 1. The length of seven public holidays from January 4, 2002, to November 17, 2023.

Public holidays	Season	Length of public holidays (Including weekends)		
		Min.	Max.	Median
(1) New year's day	January	1	5	3
(2) Spring festival	January or February	7	16	9
(3) Qingming festival	April	1	5	3*
(4) Labour day	May	3	11	5
(5) Dragon boat festival	May or June	3	5	3*
(6) Mid-autumn festival	September or October	2	10	4*
(7) National day	October	7	10	9

Note: (i) For the length of public holidays, note as follows. We take an example of the Qingming festival in 2022, which is April 5, 2022 (Tuesday). The weekends which are adjacent to April 5 are given by April 2 (Saturday) and April 3 (Sunday). Due to the holiday shifting policy in China, the weekday of April 4 is turned into a holiday and April 2 (Saturday) is shifted from a holiday into a weekday. Accordingly, the Qingming Festival holiday is given by April 3-5 (3 days). Although April 2 is shifted to weekday, the stock market is not open on April 2 because of Saturday. Therefore, the length of the Qingming festival holiday in 2022 is counted as $\boldsymbol{L_t = 4}$ when time $\boldsymbol{t}$ is April 6, 2022 (the stock market is closed from April 2 to April 5).
(ii) Median indicates the median for 22 years from 2002 to 2023, and * in the three festivals represents the median for 16 years from 2008 to 2023.

In the past research, a lot of papers discuss asymmetry and holiday effects in the stock market. Asymmetry effect is detected in stock markets of many countries (for example, see (Black, 1976; Chelley-Steeley & Steeley, 2005; Long, Tsui, & Zhang, 2014; Mazur, Dang, & Vega, 2021)). The holiday effect is discussed from two aspects: (i) one is the holiday effect on the stock return (Ariel, 1990; Bergsma & Jiang, 2015; Pinto, Bolar, Hawaldar, George, & Meero, 2022; Yen & Shyy, 1993) and (ii) another is that on the stock volatility (Andersen, 1996; Tanizaki, 2004; Tsiakas, 2005, 2010; Watanabe, 1999). In addition, McGuinness (2005); Mitchell and Ong (2006); Kuo, Coakley, and Wood (2010) and

[1] SSECI is an abbreviation for the Shanghai Stock Exchange Composite Index. It contains all the stocks listed on the Shanghai Stock Exchange and reflects the price change.

McGuinness and Harris (2011) discuss the impact of public holidays on the stock return. However, very few articles discuss the impact of public holidays on the stock returns' volatility.

In this paper, we analyze the impact of seven major public holiday effects, considering asymmetry and conventional holiday effects on the volatility of the SSECI daily returns using the GARCH (1,1) model. As a result, we find that the asymmetry and conventional holiday effects are detected in the volatility of the SSECI daily returns. The pre-holiday effect only exists for the Qingming and Dragon Boat Festivals. The post-holiday effect exists for all the public holidays except for the Qingming Festival.

The outline of this paper is as follows. Section 2 explains the data used in the study and discusses the research methodology. Section 3 presents and discusses empirical results. Section 4 gives us concluding remarks.

2. DATA AND METHODOLOGY

2.1. Data and Descriptive Statistics

In this paper, the daily closing prices of the SSECI from January 4, 2002, to November 17, 2023 are selected for empirical study. The closing price data of the SSECI are downloaded from Yahoo finance (https://finance.yahoo.com/quote/000001.SS). SSECI daily returns are obtained as $R_t = 100 \times ln\ (P_t/P_{t-1})$, where P_t is the closing price of the SSECI on day *t*. Figure 1 shows the daily closing price of the SSECI on the vertical axis and the day on the horizontal axis. In 2005, the reform of non-tradable shares was carried out (the state-owned shares that could not be listed and circulated before were brought to the market), and therefore the stock prices result in an explosive rise after that (a high value of 6092.06 is recorded on October 16, 2007). After the subprime mortgage crisis in the United States which initiated the global financial crisis, the SSECI has experienced a sharp decline from 6092.06 on October 16, 2007, to 1706.70 on November 4, 2008. Under the active economic policy in 2009, the SSECI reached 80% annual increase. By the central bank's interest rate cut policy, the SSECI recovered to 5166.35 on June 12, 2015. The stock market bubble expanded rapidly due to rampant market speculation and excessive leveraged trading. When the stock market bubble burst, investors became considerable panic and the SSECI fell from 5166.35 to 2927.29 (i.e., about 43% decline) within only two and a half months during the period from June 12, 2015, to August 26, 2015. After the 2015 crash, the stock market in China has been in a slump. To ensure that the SSECI return series is stationary, we conducted the augmented Dickey-Fuller (ADF) test (Dickey & Fuller, 1979). According to Table 2, both the ADF test statistics and p-values indicate that the SSECI return series is stationary.

Table 3 presents the descriptive statistics for the SSECI daily returns. There are 5301 observations of the SSECI daily returns from January 4, 2002, to November 17, 2023. According to Table 3, the skewness is less than 0, and the kurtosis is greater than 3, which implies that the distribution of SSECI daily returns is left-skewed and fat-tailed because the skewness of a normal distribution is 0 and the kurtosis is 3. The Jarque-Bera (JB) statistic tests also indicate that the return series of SSECI does not follow a normal distribution. Moreover, as shown in Figure 2 (the vertical axis denotes the SSECI daily returns, and the horizontal axis denotes the time), We can observe that the SSECI daily returns are heteroscedastic. Therefore, in this paper, we use the GARCH model to analyze the volatility of the SSECI daily returns.

Figure 1. Closing price of the shanghai stock exchange composite index (SSECI).

Figure 2. Shanghai stock exchange composite index (SSECI) daily returns.

Table 2. Unit root test of the shanghai stock exchange composite index (SSECI) daily returns.

Series	ADF T-stat (With intercept)	ADF T-stat (With intercept and trend)	ADF T-stat (Without intercept and trend)
SSEC	-71.482* (0.000)	-71.477* (0.000)	-71.484* (0.000)

Note: * denotes the significance level at 1%. Values in parentheses are p-values.

Table 3. Descriptive statistics of the Shanghai stock exchange composite index (SSECI) daily returns.

Series	Observations	Mean	Std. dev.	Skewness	Kurtosis	Jarque-Bera
SSEC	5301	0.012	1.500	-0.438	8.174	6081.556*

Note: * denotes the significance level at 1%.

2.2. Methodology

Engle (1982) proposed an ARCH (Autoregressive Conditional Heteroskedasticity) process, which allows the conditional variance to vary over time, and Bollerslev (1986) proposed a more flexible GARCH (Generalized ARCH) process.[2] In this paper we estimate the AR (1)- GARCH (1,1) model to analyze the seven major public holiday effects, considering asymmetry and conventional holiday effects on volatility of the SSECI daily returns.

First, we analyze the pre-holiday effect using the GARCH model given by (1) and (2).

$$\textit{Mean equation:}\quad R_t = \alpha + \beta R_{t-1} + \varepsilon_t \qquad (1)$$

$$\textit{Variance equation:}\quad \sigma_t^2 = c + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 \sigma_{t-1}^2 + \pi_1 R_{t-1} + \pi_2 L_t + \sum_{i=1}^{7} \theta_i DBH_{i,t} \qquad (2)$$

for $\varepsilon_t | \psi_{t-1} \sim \mathcal{N}(0, \sigma_t^2)$. ε_t is the error term, and ψ_{t-1} denotes the information set of all the information up to time $t-1$. R_t denotes the SSECI daily returns at time t. σ_t^2 denotes the conditional variance of the SSECI daily returns at time t. $\alpha, \beta, c, \gamma_1, \gamma_2, \pi_1, \pi_2, \theta_i$ for $i = 1,2,\ldots,7$ are the parameters to be estimated.

$DBH_{i,t}$ represents the Day Before Holiday dummy variable at day t and public holiday i, where $DBH_{i,t} = 1$ if day t is the day before the i-th public holiday and $DBH_{i,t} = 0$ otherwise. The subscript i indicates New Year's Day for $i = 1$, Spring Festival for $i = 2$, Qingming Festival for $i = 3$, Labour Day for $i = 4$, Dragon Boat Festival for $i = 5$, Mid-Autumn Festival for $i = 6$, and National Day for $i = 7$ (see Table 1). L_t denotes the number of holidays between two trading days t and $t-1$ (in the representative case, we have $L_t = 2$ when day $t-1$ is Friday and day t is Monday in the next week).

Second, we investigate the post-holiday effect by the GRACH model based on (3) in addition to (1).

$$\textit{Variance equation:}\quad \sigma_t^2 = c + \gamma_1 \varepsilon_{t-1}^2 + \gamma_2 \sigma_{t-1}^2 + \pi_1 R_{t-1} + \pi_2 L_t + \sum_{i=1}^{7} \theta_i DAH_{i,t} \qquad (3)$$

[2] Engle (1982) first proposed the ARCH (Autoregressive conditional heteroskedasticity) model. The model suggests that the variance of the current error term depends on the square of the past error term. Bollerslev (1986) proposed the GARCH (Generalized autoregressive conditional heteroskedasticity) model. The GARCH model based on the ARCH model adds a conditional variance lag term, which allows the model to contain information about the past error term and the past variance.

$DAH_{i,t}$ indicates the Day After Holiday dummy variable at time t and public holiday i, where $DAH_{i,t} = 1$ if time t is the day after the i-th public holiday and $DAH_{i,t} = 0$ otherwise.

3. EMPIRICAL RESULTS AND DISCUSSION

The estimation results are in Table 4 and 5. EViews 12 Student Version Lite is utilized for estimation of the GARCH model shown above. Table 4 presents the estimation results for Equation 1 and 2, where pre-holiday effects are estimated. In Table 4, the constant term and the coefficient β of R_{t-1} are insignificant in the mean equation, which indicates that it is impossible to predict the current period's return from the previous period's return. This result is consistent with the past studies (e.g., Fama (1970)). The coefficient π_1 of R_{t-1} is significantly negative in the variance equation, which indicates that volatility is large when the previous period's return is negative and small when the previous period's return is positive. This implies that there is an asymmetry effect in the volatility of the SSECI daily returns. The coefficient π_2 of L_t is significantly positive, which indicates that the longer holidays result in the larger volatility. This phenomenon is sometimes called the holiday effect. This result is supported by Watanabe (1999); Tanizaki (2004) and Tsiakas (2005).

As for the pre-holiday effect, most of the coefficient estimates given by θ_i, $i = 1,2,\ldots,7$, are statistically insignificant except for the Qingming and Dragon Boat Festivals (see θ_3 and θ_5 in Table 4). The coefficient θ_3 of $DBH_{3,t}$ is significantly negative, which indicates that the stock return volatility is small on the day before the Qingming Festival. People in China worship their ancestors and sweep their tombs on the day of the Qingming Festival. Brown, Chua, and Mitchell (2002) consider the Qingming Festival as "unlucky", because the number "4" sounds like "death" in China (remember that Qingming Festival is scheduled on April 4). People want to avoid trading in Shanghai stock exchange market before and after the Qingming Festival. According to Lamoureux and Lastrapes (1990); Nelson (1991) and Watanabe (2000) the trading volume and the volatility are positively correlated in the case of the stock return. Therefore, we can observe that the volatility is small just before the Qingming Festival. The coefficient θ_5 of $DBH_{5,t}$ is significantly positive, which indicates that the stock return volatility increases on the day before the Dragon Boat Festival in May or June. Because various financial reports in a lot of companies are disclosed in April (i.e., before the Dragon Boat Festival), various information increases before the Dragon Boat Festival and accordingly the stock return volatility also increases.

Table 4. Estimation results of Equations (1) and (2).

Mean equation						
α	β					
0.004 (0.016)	0.013 (0.015)					
Variance equation						
c	γ_1	γ_2	π_1	π_2		
-0.015** (0.005)	0.070** (0.004)	0.921** (0.004)	-0.020** (0.006)	0.069** (0.012)		
θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	θ_7
0.208 (0.135)	0.141 (0.131)	-0.213* (0.104)	-0.095 (0.134)	0.280* (0.136)	0.064 (0.146)	-0.262 (0.146)

Note: * and ** denote the significance level at 5% and 1%, respectively. Values in parentheses are standard errors.

Table 5 presents the estimation results for Equation 1 and 3, where post-holiday effects are estimated. In Table 5, the coefficient π_1 of R_{t-1} is significantly negative in the variance equation, and the coefficient π_2 of L_t is significantly positive (see (Tsiakas, 2005; Watanabe, 1999) for the holiday effect). These results in Table 5 are very similar to those in Table 4. That is, we can see that there are asymmetry and conventional holiday effects in the volatility of the SSECI daily returns.

As for the post-holiday effect in Table 5, the coefficient estimates of θ_1 and θ_5 are insignificant, while those of θ_2, θ_3, θ_4, θ_6 and θ_7 are significantly negative. θ_i represents the holiday effect specific to the i-th public holiday, which is other than the conventional holiday effect shown by the coefficient π_2 of L_t. Because θ_1 and θ_5 are insignificant, the days after New Year's Day and Labour Day have no specific holiday effect other than the conventional one. Because θ_2, θ_3, θ_4, θ_6 and θ_7 are significant, we can see that five major public holidays have the holiday effect specific to each major holiday. Negative effects indicate that five major holidays are less volatile, compared with the conventional holiday effects.

Table 5. Estimation results of Equations (1) and (3).

Mean equation						
α	β					
0.003 (0.015)	0.012 (0.015)					
Variance equation						
c	γ_1	γ_2	π_1	π_2		
-0.047** (0.008)	0.068** (0.004)	0.923** (0.004)	-0.020** (0.006)	0.156** (0.020)		
θ_1	θ_2	θ_3	θ_4	θ_5	θ_6	θ_7
0.060 (0.140)	-0.783** (0.207)	-0.353** (0.105)	-0.400** (0.137)	0.023 (0.141)	-0.299** (0.105)	-1.025** (0.169)

Note: ** denotes the significance level at 1%. Values in parentheses are standard errors.

In Table 6, total post-holiday effects are estimated for each major holiday. Note that the total post-holiday effects are given by $\pi_2 \times L_t + \theta_i \times DAH_{i,t}$ for day t just after the i-th public holiday. Let $\hat{\pi}_2 \times L_t + \hat{\theta}_i \times DAH_{i,t}$ be the estimator of $\pi_2 \times L_t + \theta_i \times DAH_{i,t}$. The variance of $\hat{\pi}_2 \times L_t + \hat{\theta}_i \times DAH_{i,t}$ is easily given by:

$$\mathrm{Var}(\hat{\pi}_2 \times L_t + \hat{\theta}_i \times DAH_{i,t}) = L_t^2 \mathrm{Var}(\hat{\pi}_2) + 2L_t DAH_{i,t} \mathrm{Cov}(\hat{\pi}_2, \hat{\theta}_i) + DAH_{i,t}^2 \mathrm{Var}(\hat{\theta}_i).$$

Thus, the standard error of $\hat{\pi}_2 \times L_t + \hat{\theta}_i \times DAH_{i,t}$ is obtained. The length of holiday L_t is different, depending on the i-th public holiday and the year of day t (i.e., the length of each holiday depends on the year). Therefore, in Table 6 we evaluate L_t at median of the i-th public holiday, where the median of each major public holiday is shown in Table 1. Thus, Table 6 represents total post-holiday effect for each major public holiday. Using the standard error, we can construct the 95% confidence interval, which is equal to the estimate of total post-holiday effect adding or subtracting 1.96 times Standard error. The 95% confidence interval of the Qingming Festival total post-holiday effect is given by [-0.081, 0.311], which indicates no post-holiday effect because this confidence interval includes 0. From Table 4 most of the results are insignificant for the pre-holiday effect, but from Table 6 the total post-holiday effect is significant in all the major public holidays except for the Qingming Festival. Since the stock markets are worldwide and they continue to operate, the stock return volatility is expected to increase significantly when China's stock market opens after the public holidays. Spring festival corresponds to the Chinese Lunar New Year (i.e., the most important festival in China) and the length of Spring festival is quite long.

Therefore, the impact of the post-holiday effect on volatility in Spring festival is the largest of seven major public holidays. As mentioned above, Qingming Festival might be influenced by traditional culture (i.e., remember that people worship their ancestors and sweep their tombs) and negative sentiment (i.e., remember that Qingming Festival is related to "unlucky" or "death"), and accordingly stock return volatility decreases because people avoid trading in stock markets.

On New Year's Day, the total post-holiday effect is large (i.e., 0.528). We can consider that the stock returns are quite volatile, because all the stock markets in the world are closed on New Year's Day. The post-holiday effect of Dragon Boat Festival is also quite large (i.e., 0.491). It might be plausible to consider that various kinds of financial reports are disclosed before Dragon Boat Festival and therefore volatility increases because of a large amount to information.

Table 6. Total post-holiday effect.

Public holidays	Total post-holiday effect $\pi_2 \times L_t + \theta_i \times DAH_{i,t}$	Standard error	95% confidence interval
(1) New year's day	0.528	0.131	[0.271, 0.785]
(2) Spring festival	0.621	0.110	[0.405, 0.837]
(3) Qingming festival	0.115	0.100	[-0.081, 0.311]
(4) Labour day	0.380	0.124	[0.137, 0.623]
(5) Dragon boat festival	0.491	0.128	[0.240, 0.742]
(6) Mid-autumn festival	0.325	0.118	[0.094, 0.556]
(7) National day	0.379	0.111	[0.161, 0.597]

Note: Regarding the estimate of $\pi_2 \times L_t + \theta_i \times DAH_{i,t}$, we evaluate L_t at the median of the i-th public holiday during the estimation period from January 4, 2002 to November 17, 2023. The median is shown in Table 1 for each public holiday.

Finally, the square root of estimated volatility from the estimation results of Equation 1 and 3 is depicted in Figure 3. The horizontal axis indicates the time, and the vertical axis indicates the square root of estimated volatility. In Figure 1, we observe significant declines in the SSECI prices during the financial crisis, i.e., the annual decline in 2008 reached 65%. Furthermore, due to the bubble burst in the stock market, the SSECI fell from 5166.35 to 2927.29 (i.e., 43% decline) between June 12, 2015, and August 26, 2015 within about two and a half months. Compared with Figure 1, in Figure 3 we observe the high volatility generated during the sharp decline of the SSECI prices in 2008 and 2015. This indicates that the stock market usually accompanied a large amount of risk during these periods.

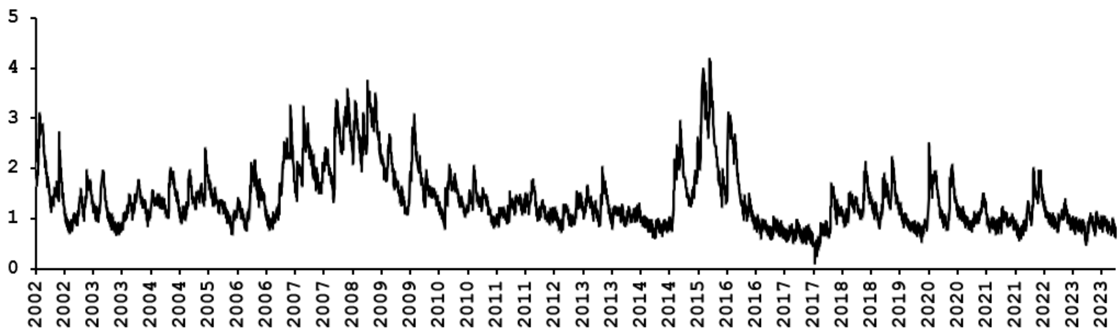

Figure 3. Square root of estimated volatility using Equation 1 and 3.

4. CONCLUSION

This paper aims to investigate the impact of seven major public holiday effects and consider asymmetry and conventional holiday effects on the volatility of the Shanghai Stock Exchange Composite Index (SSECI) daily returns by the GARCH (1,1) model. As in past research, we detect asymmetry and conventional holiday effects in the volatility of SSECI daily returns.

The pre-holiday effect is observed for Qingming Festival and Dragon Boat Festival. Affected by traditional culture and negative sentiment, investors might decrease trading volume, which results in low volatility around Qingming Festival. In contrast, the Dragon Boat Festival is scheduled just after the disclosure of various financial reports in April. Therefore, high volatility might be observed around Dragon Boat Festival.

We investigate the post-holiday effect for each public holiday. The conventional holiday effect is related to the estimate of π_2 in Equation 2 or 3 while the public holiday effect specific to the i-th public holiday is given by the estimate of θ_i. Accordingly, total post-holiday effects are obtained in Table 6. We find that there is a post-holiday effect for all the public holidays except Qingming Festival. The global stock markets in the world are not closed during Chinese holidays in general. Therefore, we can conclude that the day after the major public holidays might generate high volatility without exception. Especially, Spring Festival is China's most important holiday (i.e., Chinese Lunar New Year), which gives us the highest volatility. As mentioned above, the Qingming Festival is affected by negative sentiment, and the results are insignificant.

Thus, in this paper we focus on public pre- and post-holiday effects in Chinese stock returns' volatility, considering the asymmetry effect and the conventional holiday effect (these two effects have been commonly studied in numerous research articles). As a result, we have not observed the pre-holiday effect except special public holidays, while we have observed the post-holiday effect for almost all the public holidays. As for the impact of the post-holiday effect, we find that New Year's Day, Spring Festival and Dragon Boat Festival are larger than Qingming Festival, Labour Day, Mid-Autumn Festival and National Day.

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