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# An Empirical Study on The Calendar Effect of The Shanghai Index in China

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**Abstract:** The premise of traditional financial theory is efficient market theory and rational man hypothesis, while the market anomaly which can not be explained by traditional financial theory such as the calendar effect poses a great challenge to traditional financial theory. This paper uses the daily closing price data of the Shanghai Composite Index from December 19, 1999, to May 6, 2022, to investigate the calendar effect of the logarithmic return of the Shanghai Composite Index. The research results show that China's Shenzhen stock market is inefficient and has a negative Tuesday effect, which empirically proves the non-efficiency of China's stock market and the calendar effect in behavioral finance in China's stock market.

**Keywords:** Intra-week effect, Efficient markets, Calendar effect, Shanghai Composite Index.

## 1. Introduction

In 1970, Yuri Fama (Fama) proposed the efficient market hypothesis[1], which provided the theoretical basis for many traditional financial theory studies. However, as scholars continue to explore and the securities market develops, they have used a series of research results to show that there are still many anomalies in the market. The calendar effect is one of the typical representatives of these anomalies, questioning the efficient market hypothesis, and has been demonstrated in many well-developed securities markets, such as those in Europe and the United States. This paper takes the intra-week effect, one of the calendar effects, as a starting point to analyze whether there is an intra-week effect in the Chinese stock market. The analysis of the manifestation of the intra-week effect in the Chinese stock market deepens the understanding of the market operation rules, provides theoretical support for the existence of market anomalies, and provides a reference for investors' investment decisions. The calendar effect, as a typical stock market anomaly, refers to the phenomenon that abnormal returns can be obtained through trading at certain periods in the stock market, mainly including intra-week, holiday, and month effects. The discovery of the calendar effect indicates that the stock market is non-effective, and investors can obtain excess returns by analyzing the calendar effect pattern. There is a wealth of research on the calendar effect by global scholars, and it is generally agreed that the calendar effect exists in the Chinese A-share market.

## 2. Literature Review

The earliest verification of the intra-week effect by scholars can be traced back to a 1931 article entitled "Stock Price: A Problem in Verification" by Fields, which first mentioned the intra-week effect and analyzed the intra-week effect of the market and received wide attention from scholars [2]. This article first mentioned the intra-week effect and analyzed the intra-week effect of the market, which received a lot of attention from scholars [2]. The discovery of the intra-week effect implies that there may be room for arbitrage in the market due to the presence of a large number of excess return seekers in the market. Subsequently, more researchers continued to study the market anomalies based on Fields' analysis, further enriching the theories related to stock market anomalies. cross (1973) found negative Monday effects and positive Friday effects in the U.S. market using the S&P 500 index returns from 1953-1970 as a sample [3]. french (1980) selected new French (1980) again verified the validity of the U.S. stock market by selecting new data, with the same conclusion as Cross [4]. Meanwhile, intra-week effects have been shown to exist in different markets one after another, but the manifestation of intra-week effects may vary among countries depending on the cultural background and the degree of stock market development. Aggarawal and Rivoli (1985) find that emerging markets such as the Philippines have negative Monday-Tuesday abnormal returns [6]. This shows that there are differences in the manifestation of intra-week effects in different periods and markets. With the continuous development of the Chinese securities market, a large number of scholars have likewise conducted research and analysis on the anomalies in the Chinese stock market. Due to certain differences between the Chinese cultural background and institutional system and foreign countries, the Chinese stock market has its unique characteristics and therefore differs in the manifestation of the intra-week effect. Yu, Qiao (1994) analyzed the returns of Chinese SSE and SZSE, selecting data from 1990 to 1994 and applying econometric methods to the analysis for the first time, and found that the average return of Shanghai stocks was negative and the lowest on Monday, and then gradually increased, reaching the highest point in the week on Thursday, while a similar situation existed for SZ stocks [7]. Feng, L. Cheng (2000) analyzed Shanghai and Shenzhen markets separately and found a significantly negative Tuesday effect and a significantly positive Friday effect in Shanghai, supported by strong evidence. The situation is similar for the Shenzhen market, but the evidence is weaker in support [8]. Chao Chen and Ping Qian (2002) analyzed Feng Licheng's study and concluded that he did not consider the factors comprehensively and ignored the impact of the stop system on the stock market; therefore, they divided the data into two phases before and after the implementation of the stop system as the boundary and found that there was an intra-weekly

effect in Shanghai and Shenzhen markets, but when the data were tested year by year, only the intra-weekly effect existed in Shanghai in 1996, thus arguing that This anomaly was found to be a coincidence [9]. Zhang and Bing (2005) innovated the processing of the data by using a rolling sample test for the first time to bring out the time-varying characteristics of the calendar effect and found that the intra-week effect only appeared in the early years of the Chinese stock market and gradually disappeared with the development of the market, without robustness [10]. Che-Yun Ji (2018) found a significantly negative Thursday effect for the SSE index returns [11]. Lin Xiangyou (2016) conducted a study on the intra-weekly effect from the perspective of the stock index futures market and found that the Chinese stock index futures market has a certain degree of bootstrapping effect on the securities market in terms of the pattern of the intra-weekly effect [12].

# 3. Empirical Results

## 3.1. Data source

We select the SSE Composite Index (SH 000001) from the Guotaian CSMAR for the period from December 19, 1999, to May 6, 2022. We select the closing price index and calculate the returns and perform empirical analysis using stata software:

Table I shows the descriptive statistics of returns for each variable, D1, D2, D3, D4, and D5 denote Monday's return, Tuesday's return, Wednesday's return, Thursday's return, and Friday's logarithmic return, respectively, and r denotes the full logarithmic return.

**Table 1.** Descriptive statistics of log returns

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| d1 | 1508 | 0.0000 | 0.0240 | -0.1400 | 0.2890 |
| d2 | 1539 | -0.0010 | 0.0190 | -0.1790 | 0.1110 |
| d3 | 1547 | 0.0010 | 0.0200 | -0.1130 | 0.2620 |
| d4 | 1542 | 0.0000 | 0.0270 | -0.1120 | 0.7190 |
| d5 | 1529 | 0.0020 | 0.0180 | -0.0770 | 0.1940 |
| r | 7665 | 0.0000 | 0.0220 | -0.1790 | 0.7190 |

## 3.2. Normal distribution test

We draw histograms of log returns, kernel density plots, and QQ plots, respectively. As shown in Figures 1, 2, and 3, determine whether they conform to a normal distribution by statistically calculating their skewness and kurtosis as well as by their p-values:

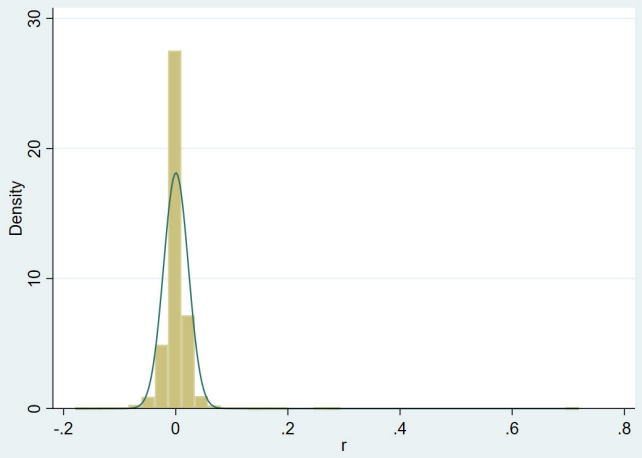


**Figure 1.** Histogram of the logarithmic rate of return r

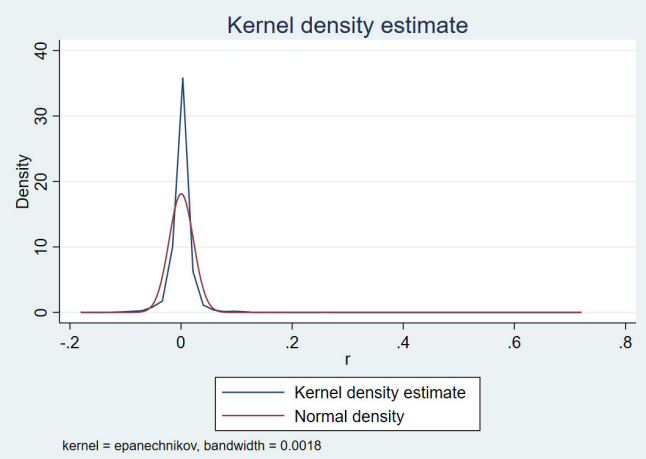


**Figure 2.** Sum-density plot of log returns

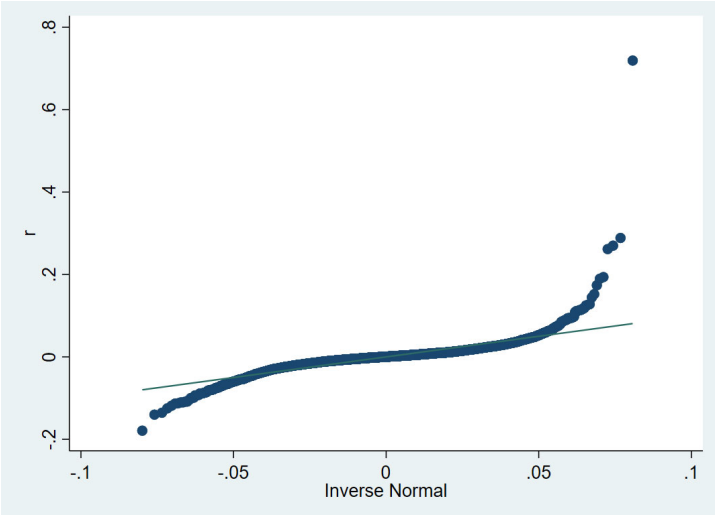


**Figure 3.** QQ chart of log returns

**Table 2.** Normal distribution test

| Variables | Obs | Mean | Std.Dev | Min | Max | Skew. | Kurt. |
|---|---|---|---|---|---|---|---|
| R | 7665 | 0.0000 | 0.0220 | -0.1790 | 0.7190 | 5.3690 | 167.0140 |

For the overall sample analysis, first, there are distribution characteristics of spikes and thick tails. The kurtosis can be used to determine whether the log returns obey a normal distribution, and the kurtosis coefficient K of the normal distribution is close to 3. The K value of the SSE is 167.014 greater than 3, indicating that the returns have the characteristics of spikes and thick tails; the skewness is used to measure whether the probability distribution of the random variable is symmetric around its mean, and the skewness coefficient of the SSE is S=5.369, indicating that there is a long right trailing tail and the series is skewed. Second, the sample corresponds to a significant P-value, from which it is possible that the daily returns of the SSE do not obey a normal distribution and the original hypothesis is rejected. ARCH / GARCH effects may exist.

The comparison of the Monday to Friday samples, as can be seen from Table 2, first, the highest average log return of the Shanghai market occurs on Friday, at 0.002, and the lowest occurs on Tuesday, at -0.001, and the average of the other three trading days are all positive and slightly lower than Friday. As can be seen, by the standard deviation, the maximum standard deviation occurs on Thursday at 0.027, indicating that the Shanghai market is most volatile on Thursday. The smallest occurs on Friday, indicating more stable trading on Friday. The fact that returns and risks are not proportional indicates that there may be market anomalies.

The smoothness test (log-return time series), since the smoothness of the time series is an important prerequisite for time series analysis, is used to test the nature and stochastic structure of the time series using the Augmented Dickey-Fuller (ADF) test. The assumption is that the variables are non-stationary. The results are shown in Table 3: The results significantly reject the original hypothesis, i.e., the logarithmic rate of return r is smooth.

**Table 3.** ADF test

| Variable | Statistic Test | 1% Critical | 5% Critical | 10% Critical |
|---|---|---|---|---|
| Z(t) | -82.5940 | -3.4300 | -2.8600 | -2.5700 |

## 3.3. Regression Modeling

In a general sense, the return of a financial asset is closely related to its risk. The GARCH-M model introduces risk factors into the process of pricing financial assets. In this paper, the following equation is used to study the intra-week effects in the stock market (GARCH - M (1, 1) model).

$$R_t = \alpha_0 + \sum D_n \alpha_n + \varepsilon_t \quad (1)$$

$$y_t = X\beta + \delta \cdot g(h_t) + \varepsilon_t \quad (2)$$

where $R_t$ represents the return at day t, $D_n$ is the weekly control variable, $\varepsilon_t$ is the residual term, $\delta \cdot g(h_t)$ is used to measure the risk factor, and $y_t$ is the expected return.

## 3.4. Regression results

Yields show "clustering" of volatility, with clustering in the magnitude of volatility and clustering in the stability of volatility, indicating that the variance of yields is unstable and in a constant state of flux. All these indicate the ineffectiveness of the Chinese securities market. As shown in Figure 4.

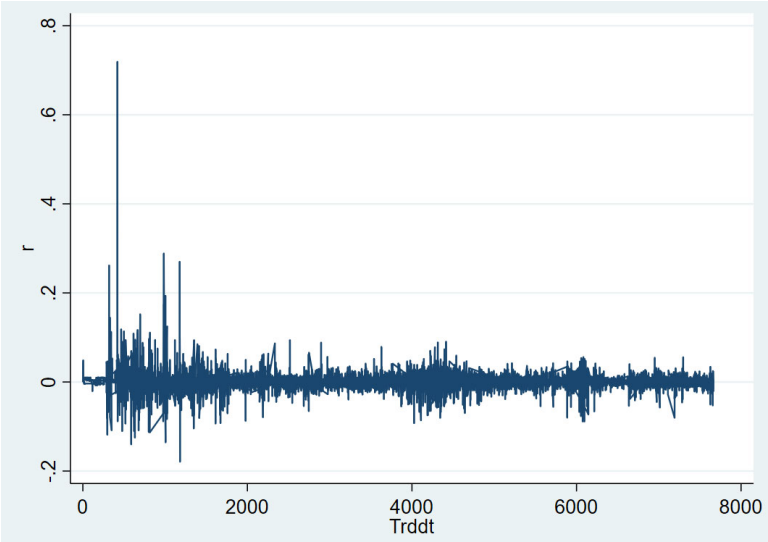


**Figure 4.** Fluctuation chart of yield

As shown in Table 4, the test results indicate that the AR(1) model should be selected, and therefore the AR(1) model is chosen for the OLS estimation.

**Table 4.** Lagged term test

| lag | LL | LR | df | p | FPE | AIC | HQIC | SBIC |
|---|---|---|---|---|---|---|---|---|
| 0 | 18365 | 0.0000 | -4.7970 | -4.796 | -4.7960 | | | |
| 1 | 18377 | 23.9420* | 1.0000 | 0.0000 | 0.0005* | -4.7995* | -4.7989* | -4.7977* |
| 2 | 18377 | 0.1600 | 1.0000 | 0.6890 | 0.0000 | -4.7990 | -4.7980 | -4.7970 |
| 3 | 18377 | 1.1260 | 1.0000 | 0.2890 | 0.0000 | -4.7990 | -4.7980 | -4.7960 |
| 4 | 18378 | 2.4110 | 1.0000 | 0.1210 | 0.0000 | -4.7990 | -4.7980 | -4.7950 |
| 5 | 18378 | 0.0440 | 1.0000 | 0.8340 | 0.0000 | -4.7990 | -4.7970 | -4.7940 |
| 6 | 18380 | 2.3410 | 1.0000 | 0.1260 | 0.0000 | -4.7990 | -4.7970 | -4.7930 |
| 7 | 18381 | 1.9850 | 1.0000 | 0.1590 | 0.0000 | -4.7990 | -4.7970 | -4.7920 |
| 8 | 18382 | 2.4510 | 1.0000 | 0.1170 | 0.0000 | -4.7990 | -4.7960 | -4.7910 |

As shown in Table 5, the test reveals that the coefficients after the 1st-order lag term are significantly non-zero. the following LM test is conducted for the presence of ARCH effects on the OLS residuals.

**Table 5.** Autoregression

| r | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| L | 0.0560 | 0.0110 | 4.9200 | 0.0000 | 0.0340 | 0.0790 | *** |
| L2 | 0.0060 | 0.0110 | 0.5000 | 0.6210 | -0.0170 | 0.0280 | |
| L3 | -0.0130 | 0.0110 | -1.1100 | 0.2680 | -0.0350 | 0.0100 | |
| L4 | 0.0180 | 0.0110 | 1.5800 | 0.1140 | -0.0040 | 0.0400 | |
| L5 | 0.0020 | 0.0110 | 0.2100 | 0.8320 | -0.0200 | 0.0250 | |
| Constant | 0.0000 | 0.0000 | 1.5500 | 0.1210 | 0.0000 | 0.0010 | |

*** p<.01, ** p<.05, * p<.1

As shown in Table 6, ARCH(1)-ARCH(5) all indicate that there is a significant ARCH effect.

**Table 6.** ARCH-LM test

| chi2 | df | Prob>Chi2 |
|---|---|---|
| 3.0910 | 1 | 0.0790 |
| 6.9140 | 2 | 0.0320 |
| 10.6970 | 3 | 0.0130 |
| 21.3810 | 4 | 0.0000 |
| 21.4540 | 5 | 0.0010 |

From the regression results in Table 7, it can be seen that there is a significant negative Tuesday return effect in the Chinese stock market, which is significant at the one percent level with a correlation coefficient of -0.069, while the other trading days are not significant and there is no anomaly. Therefore, it can be seen that there is a significant negative Tuesday effect in the Chinese stock market, confirming the existence of a calendar effect in the SSE stock market.

**Table 7.** GARCH-M(1,1) regression

| r | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| d1 | -0.0180 | 0.0150 | -1.2600 | 0.2080 | -0.0470 | 0.0100 | |
| d2 | -0.0690 | 0.0100 | -7.1300 | 0.0000 | -0.0880 | -0.0500 | *** |
| d3 | -0.0140 | 0.0190 | -0.7500 | 0.4520 | -0.0520 | 0.0230 | |
| d4 | -0.0010 | 0.0160 | -0.0800 | 0.9330 | -0.0320 | 0.0290 | |
| d5 | -0.0110 | 0.0190 | -0.5900 | 0.5550 | -0.0480 | 0.0260 | |
| Constant | 0.0040 | 0.0000 | 17.0600 | 0.0000 | 0.0040 | 0.0050 | *** |
| sigma2 | -0.6890 | 0.2300 | -2.9900 | 0.0030 | -1.1400 | -0.2370 | *** |
| L.ARCH | 0.4810 | 0.0130 | 38.1000 | 0.0000 | 0.4570 | 0.5060 | *** |
| L.GARCH | 0.7690 | 0.0050 | 165.2100 | 0.0000 | 0.7600 | 0.7780 | *** |
| Constant | 0.0000 | 0.0000 | 0.8800 | 0.3780 | 0.0000 | 0.0000 | |

*** p<.01, ** p<.05, * p<.1

## 3.5. Proportionality test

In the stock market, the effects of good news and bad news are likely to be asymmetric, and their impacts are often different, and investors often react differently to good news and bad news, with negative information often increasing stock market volatility more than good information. To make the model closer to the real market, we choose the TARCH model to test the leverage effect of the Chinese stock market.

TARCH model:

$$R_t = \alpha_0 + \sum D_n \alpha_n + u_t \tag{3}$$

$$h_t = \gamma_0 + u_{t-1}\gamma_1 + \omega \cdot u^2{}_{t-1} d_{t-1} + \varepsilon_t \tag{4}$$

$u_t^2$ is the variance of the residuals of the yield equation $u_{t-1}^2$ is the lagged term of $\sigma_t^2$; $\mu_{t-1}$ is the lagged term of the residual $\mu_t$.

In this paper, the model does not include the lagged term of returns because, on the one hand, none of the lagged terms of returns are significant in several empirical results of calendar effects based on the GARCH model, and adding the lagged term does not improve the explanatory power of the model well, but consumes the degrees of freedom; on the other hand, past returns are mainly transmitted to the current period through the volatility pooling effect of historical risks, so the relationship between historical returns and current period The relationship between historical returns and current period returns can be extracted by volatility. When volatility proxy variables are already included in the mean model equation, there is no need to include the lagged term of return, otherwise, there is a suspicion of repetition and endogeneity problems will arise.

From the regression results in Table 8, we find that Tuesday is still significant at the one percent level with a coefficient of not -0.054 and a significant TARCH term, confirming the existence of volatility non-mean.

**Table 8.** TARCH model

| r | Coef. | St.Err. | t-value | p-value | [95% Conf | Interval] | Sig |
|---|---|---|---|---|---|---|---|
| d1 | -0.0140 | 0.0140 | -0.9700 | 0.3310 | -0.0420 | 0.0140 | |
| d2 | -0.0540 | 0.0110 | -4.7400 | 0.0000 | -0.0770 | -0.0320 | *** |
| d3 | -0.0160 | 0.0190 | -0.8100 | 0.4160 | -0.0540 | 0.0220 | |
| d4 | 0.0000 | 0.0160 | -0.0100 | 0.9890 | -0.0320 | 0.0320 | |
| d5 | -0.0100 | 0.0190 | -0.5000 | 0.6180 | -0.0470 | 0.0280 | |
| Constant | 0.0050 | 0.0000 | 14.7200 | 0.0000 | 0.0040 | 0.0060 | *** |
| sigma2 | -0.4550 | 0.3260 | -1.4000 | 0.1630 | -1.0940 | 0.1840 | |
| L.arch | 0.3810 | 0.0300 | 12.8400 | 0.0000 | 0.3230 | 0.4390 | *** |
| L.tarch | 0.1980 | 0.0420 | 4.7400 | 0.0000 | 0.1160 | 0.2800 | *** |
| L.garch | 0.7710 | 0.0060 | 135.8300 | 0.0000 | 0.7600 | 0.7820 | *** |
| Constant | 0.0000 | 0.0000 | 1.9400 | 0.0520 | 0.0000 | 0.0000 | * |

*** p<.01, ** p<.05, * p<.1

Friday's volatility was the highest, likely due to investors' risk aversion to the potential policies related to the weekend and some industry regulations, and Tuesday's volatility was the lowest, most likely due to Monday absorbing the news from Saturday and Sunday, with most of the information already reacting in the price. Tuesday's significant negative return is likely due to the herding effect, so that Monday's negative news continues, most of the followers sell resulting in a significant negative return, using this law, fund managers in the long term to open positions can try to choose Tuesday to open positions, in reducing positions should try to avoid Tuesday, to prevent a negative premium return.

# 4. Conclusion

First, this paper takes the daily data of the SSE Composite Index closing price for the period from December 19, 1999, to May 6, 2022, as the sample, with a total of 7665 data, and performs correlation processing and descriptive statistical analysis on the data to test whether the data are normally distributed or not. After that, an ADF test is conducted to test the data for smoothness. Based on satisfying the smoothness, the ARCH model, GARCH-M model, and TARCH model are used to analyze and test the SSE Composite Index (Shanghai) returns respectively, and it is found that there is a significantly negative Tuesday effect in the market. The analysis of the intra-weekly effect in the Chinese stock market can provide

some reference for investors to choose their investment timing and can allow market regulators to more fully understand the current characteristics of the market, which can be useful for both the revision of the stock market regulatory system and the prevention of systemic risks.

Second, by comparing the findings with those of other scholars, it can be found that the findings of this paper are not entirely consistent with previous studies, and the main reason for this phenomenon is that the data selected are different, and the relevant conclusions are often different when using data from different times and markets. However, the intra-week effect has always been present in the development of the Chinese securities market, but with the improvement and development of the market, the expression of the intra-week effect will change. Compared with many developed countries in the West, the Chinese securities market is still in the development stage, and many systems in the securities market are still immature and influenced by policies, so the specific expression of the intra-week effect will take different forms with the development of the market.

Third, for the result of the "significant negative Tuesday effect", a possible explanation is that the market is closed on Saturday, so investors can use this time to analyze the general market trend (historical data) and information about the stocks they are concerned about, while investors have more than enough time to explore quality stocks during this period, and can have a good understanding of the recent Newly released information can be fully analyzed. For example, some institutional investors, as well as some information traders, will make operations and related layouts in advance on Friday, while many policies and some information related to companies that affect stock prices will be announced at the end of the week, and on Monday, information traders, as well as traders who react quickly to information, will make relevant operations on Monday, while on Tuesday, due to the existence of the herding effect and the slow embodiment of information in prices, lagging On Tuesday, due to the herding effect and the slow embodiment of information in the price, the lagging investors sell the stock, thus causing the stock price to fall on Tuesday. From a behavioral finance perspective, the intra-week effect is a market anomaly that reflects the fact that the Chinese stock market does not satisfy the efficient market hypothesis, investors do not satisfy the perfectly rational person hypothesis, and there are a large number of noise traders and arbitrage opportunities.

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