



Central European Review of Economic Issues

EKONOMICKÁ REVUE



Evidence of the Weekday Effect Anomaly in the Chinese Stock Market

Martina NOVOTNÁ*, Jin ZENG

Department of Finance, Faculty of Economics, VŠB-Technical University of Ostrava, Sokolská třída 33, 70200, Ostrava, Czech Republic.

Abstract

The weekday effect anomaly is considered as a market pricing anomaly which refers to some regularities in the rates of return during the week and thus, is a category of calendar anomalies. This article is focused on the Chinese stock market and its main objective is to assess the presence of the day of the week effect anomaly through examining the SSE and SZSE Composite Indexes. In this study, it is firstly examined whether there are significant differences between Monday and other weekday daily returns using the tests of differences between two means. The following empirical study is focused on the relationship between daily returns and weekdays, which is conducted using binary logistic regression analysis. The overall results indicate that both indexes show the presence of the day of the week effect, and the effect is significantly greater in the Shenzhen stock exchange. In both markets, Thursday daily returns significantly differ from other daily returns, which suggests a specific day of the week effect in the Chinese stock markets.

Keywords

Chinese stock market, logistic regression analysis, calendar anomaly, market efficiency, weekday effect.

JEL Classification: G14, G17, G18

* martina.novotna@vsb.cz (corresponding author)

This paper was supported by the Operational Programme for Competitiveness under Project CZ.1.07/2.3.00/20.0296 and Project SGS SP2016/54.

Evidence of the Weekday Effect Anomaly in the Chinese Stock Market

Martina NOVOTNÁ, Jin ZENG

1. Introduction

This study is focused on the assessment of the occurrence of a day of the week effect anomaly in the Chinese stock markets. A day of the week effect is considered a market pricing anomaly which refers to some regularities in the rates of return during a calendar year and thus, is a category of calendar anomalies. Reilly and Brown (2012) define calendar studies as those that question whether some regularities would allow investors to predict returns on stocks. The knowledge or understanding of the patterns of stock market behaviour can help investors in their decision-making process and an improved assessment of their investment activities. The occurrence of calendar market anomalies varies in different countries. With respect to recent research studies, we can see the effect of market anomalies is stronger in less developed countries, while the effect is very weak or almost absent in well-developed stock markets. For this reason, it is an essential issue to investigate markets with a potential for this effect. Naturally, less developed or emerging countries are the main focus of the current research.

Calendar anomalies are frequently examined using the methods of time series analysis, however, this is not the case in this study. In this article, methods of logistic regression analysis will be used to assess whether there is a relationship between weekly returns and days of the week. The aim of this paper is to examine the effect of a weekday on daily stock returns in the Chinese markets using binary logistic regression, based on stock indexes from the Shanghai and Shenzhen stock exchanges.

2. Literature overview

The research in the area of calendar anomalies includes studies on a monthly effect, a weekend or day of the week effect. If anomalies are proved to be present in the markets, then it means that the markets do not work efficiently. The natural question is how to define anomaly. First, we can start with market efficiency. In this study, market efficiency refers to the informational efficiency which is related to stock prices. There are three stages of market efficiency, strong, semi-strong and weak. The weak form claims that stock prices fully reflect all past market data, in semi-strong markets, prices reflect all publicly available information,

including financial statement and financial market data. Last, in the strong efficient markets, prices reflect all, even hidden or inside information. From a practical point of view, knowledge of the degree of efficiency can substantially influence the investment strategies of investors and the use of major approaches in investing. As Singal (2003) suggested, market efficiency is important to everyone because markets set prices. A mispricing can then be considered as any predictable deviation from a normal or expected return. If it is persistent in the market, then it is called an anomaly. Generally, if a mispricing exists in the market, then smart investors and arbitrageurs should take advantage of it to earn abnormal returns.

Recently, a variety of studies has tested weak-form efficiency in developing countries. In the Asian market, Chan, Gup and Pan (1992) assessed weak form stock market efficiency in Hong Kong, South Korea, Singapore and Taiwan. Liu, Song and Romilly (1997) tested Shanghai and Shenzhen stock indexes which both showed random walk in the Chinese market, and thus indicated weak form market efficiency. In the study of the Latin American stock market, Urrutia (1995) used a runs test to find weak form efficiency which showed that investors cannot develop trading strategies to get excess returns. In the Middle East market, El-Erian and Kumar (1995) found some departures from weak form efficiency but it seems to have little value in forecasting future prices. For the African market, Dickinson and Muragu (1994) found an evidence of weak form efficiency in the Nairobi stock exchange. Olowe (1999) confirmed this finding with a different method. Summarizing, we can see that developing countries are not efficient and there is a space for further investigation of market anomalies.

The existence of calendar anomalies such as seasonal effect, holiday effect and weekend effect seems to violate efficient market hypotheses and provide investors some chances to make abnormal returns. Tversky and Kahneman (1986, p. 252) defined market anomaly as deviations of actual behaviour from the normative model that is too widespread to be ignored, too systematic to be dismissed as random error and too fundamental to be accommodated by relaxing the normative system. The types of market anomalies can be categorized into two groups, time series anomalies and cross-sectional anomalies. The time

series anomalies are also known as calendar anomalies. Among them, the weekend effect shows some evidence that returns on Fridays are higher when compared to Mondays. The presence of the weekend effect has already been examined in different countries. For example, Dubois and Louret (1996) found that returns show a lower trend for the beginning of the week for most European countries, Hong Kong and Canada, though not necessarily on Mondays. On the contrary, Raj and Kumari (2006) did not find any sign of the negative Monday effect on the Indian market, however they found some evidence of regularity in Tuesday negative returns.

The main objective of this study is to examine the presence of a day of the week effect in the Chinese stock markets, with the emphasis on the weekend effect. As mentioned above, the weekend effect anomaly means that stocks tend to exhibit relatively large returns on Fridays followed by negative returns on Mondays. This is called a day of the week effect that specifically links Friday and Monday returns. The pre-weekend positive returns and the post-weekend negative returns are essential in this definition. Singal (2003) stated that the main reason for this effect may be short sellers. Speculative short positions are not hedged and so may need to be closed at any time in case of huge loss. During trading hours, this can be done easily, while non-trading hours can induce special risk as short sellers cannot close the trade. That is, during the non-trading break time, there is a high possibility for short sellers to suffer potential losses due to the release of bad news or stock price movements. For those investors who are risk averse, they prefer to hold positions over non market positions and prefer to close them at the end of the trading days, and reopen them the next trading day. Generally, they close the short position by buying back on Fridays and then reopen by short selling on Mondays, thereby causing higher returns on Mondays and lower returns on Fridays. There are also some alternative explanations for this effect. For example, measurement errors, the timing of corporate news releases after Friday's close, reduced institutional trading and greater individual trading on Mondays. All these factors may cause some contribution to the weekend effect. Depending on the reasons for the weekend effect, it may be possible to come up with a trading strategy to profit from this effect.

The weekend effect has already been investigated and described in various research studies, however the results do not always support a clear relationship between Monday's and Friday's returns. Moreover, some studies show significant differences in returns on other days of the week. The findings are different for different countries and time periods. In general, they support the existence of the day of the week anomaly, primarily in developing countries with less efficient

markets. More than twenty years ago, Cross (1973) firstly pointed out differences in returns across weekdays using the Standard and Poor's Composite index during the period from 1953 to 1970. He found that stock prices tend to decline over weekends in the three-day interval from Friday's close to Monday's close. This phenomenon was, for example, examined by Damodaran (1989) who tested whether this effect is caused by most bad news being released at the weekends so that the prices are relatively lower on Mondays, however the results show a weak connection. Lakonishok and Maberly (1990) conducted a research to show that differential trading returns on Mondays and Fridays are caused by the different trading patterns of institutional and individual investors. There is a range of studies focused on the markets of Western countries, such as the USA and Canada. Gibbons and Hess (1981), Rogalski (1984), Smirlock and Starks (1986), and Flannery and Protopapadakis (1988) all found some evidence of the weekend effect in the USA and Canada market. As this article is focused on the Chinese market, it is advisable to consider some research on selected Asian countries, mainly developing markets. For example, in the Indian market, Ignatius (1992) and Nath and Dalvi (2004) examined the existence of the weekend effect in the Indian market for the period of 1979 to 1990 and 1999 to 2003. In both cases, they confirmed the evidence of weak form efficiency and a weekend effect in the Indian market. Jaffe and Westerfield (1985) found that the Japanese market shows a Tuesday negative effect instead of a Monday one. Kato (1990) also found that Tuesday's returns are usually negative and Saturday's returns are strongly positive in Japan. Wong and Ho (1986) found the existence of a significant weekend effect of the Singapore market during the period 1975 to 1984. They also found that the trading pattern was similar to most Western countries. Kim (1988) reported that the results for Japan and Korea are similar to the findings of Jaffe and Westerfield (1985). Aggarwal and Rivoli (1989) also confirmed the existence of a weekend effect in some Asian markets including Hong Kong, Korea, Taiwan, Japan and Singapore. Using further tests, Wong et al. (1992) confirmed that the weekend effect exists in Singapore, Malaysia, Hong Kong and Thailand.

The Chinese stock market has experienced a rapid growth and has played an important role in the Chinese economy since the launching of the Shanghai and Shenzhen stock exchanges in the early 1990s. Due to its influence over other Western financial markets, Chinese researchers have started to test the existence of the weekend effect. Previous studies have generally confirmed the existence of a weekend effect in China's stock markets. Mookerjee and Yu (1999) came up with anomalies in both the Shanghai and Shenzhen stock

markets which showed some unusual findings such as the highest daily returns occur on Thursdays rather than Fridays. The authors found that the Shenzhen stock market had significant weekend effects, while the Shanghai stock market showed a significant positive effect on Thursday and Friday during the period from 1991 to 1993. Chen, Kwok, and Rui (2001) argued that the weekend effect in China during the 1997 Asian financial crisis may be due to spill over from other countries. Gao and Kling (2005) tested the weekend effect from the period 1990 to 2003 and they found significant evidence that Mondays are considerably weak and Fridays show significantly positive average returns. They provided an explanation that Chinese investors are amateur speculators and they engage in short-term lending before the weekend and invest on the stock exchange. Most of these studies were published before 1997, the year of the Asian financial crisis. After the crisis, most Asian stock markets suffered to a different extent from devaluation. Therefore, subsequent studies tested whether the situation has changed in the Asian markets. Luo et al. (2009) analysed the anomalies and stock returns volatility of the Shanghai and Shenzhen stock markets and tested whether the Asian financial crisis has had any influence on stock anomalies in the Chinese stock markets. The results show that weekend effects and monthly effects exist in the Chinese stock markets, but the pattern persistently changed over different time periods, and was highly dependent on the setting of sub-periods. In this article, we focus on the period of 2000 to 2013 to examine the existence of the weekend effect in the Chinese stock market. The findings of this study can be used to assess whether the efficiency level in the market has increased over the selected period of time.

3. Methodology description

The main focus of this section is the description of methodology used in this study. The presence of the day of the week effect will be examined using logistic regression analysis, which offers a different approach in comparison with previous studies, usually based on time series analyses. Aiming at observing a weekend effect anomaly in the Chinese stock market, the analysis is based on the data of the Shanghai Stock Exchange Composite Index and Shenzhen Composite Index during the period from 2000 to 2013.¹ In order to avoid a holiday effect which may influence the final results, data were adjusted for the days of public

holidays that are not included in the analysis.

The Shanghai Stock Exchange (SSE) is considered to be one of the world's largest stock markets. Until now, the SSE has not been completely open to foreign investors due to controls by the Chinese mainland authorities. There are two types of stocks issued in SSE, A shares and B shares. A shares are quoted in RMB currency, while B shares are quoted in U.S. dollars. The SSE Composite Index is regarded as a stock index of all A shares and B shares traded at the Shanghai Stock Exchange. This index was launched on 15 July 1991 and it tracks the daily price movement of all stocks listed on the Shanghai Stock Exchange. The Shenzhen Stock Exchange (SZSE) is one of China's three stock exchanges, in addition to the Hong Kong Stock Exchange and Shanghai Stock Exchange. The Shenzhen Composite Index is an index of all A-shares and B-shares that are traded on the Shenzhen Stock Exchange.

The data sample comprises open prices and closed prices for each working day from 2000 to 2013. Daily returns are calculated in two ways. Firstly, the opening price and closing price on the same day are used to calculate returns $R_{t,OC}$,

$$R_{t,OC} = \frac{P_{t,C} - P_{t,O}}{P_{t,O}} \quad (1)$$

Similarly, returns $R_{t,CC}$ are computed using closing prices,

$$R_{t,CC} = \frac{P_{t,C} - P_{t-1,C}}{P_{t-1,C}} \quad (2)$$

where the symbol $P_{t,O}$ refers to the opening price at the beginning of the day, $P_{t,C}$ refers to the closing price at the end of the day and $P_{t-1,C}$ denotes the closing price at the end of the previous day.

The daily returns will be compared using two population hypothesis tests. Firstly, this study will be focused on the examination of the weekend effect based on the comparison of Monday and Friday daily returns and for completeness, Monday returns will be additionally compared with all other daily weekday returns. To compare daily returns, tests of the difference between two normally distributed population means will be conducted. Although the validity of these tests depend on the assumption of a normal population, many of the procedures work reasonably well even when the assumptions are not completely met (Norušis, 2012). However, we should also consider nonparametric alternatives for the cases

¹ Source of data: Yahoo! Finance. [Retrieved 2015-04-10] Available at: <https://finance.yahoo.com/quote/000001.SS>, <https://finance.yahoo.com/quote/399001.sz/>

when the normality assumption cannot be made about the probability distribution of the population (Newbold, Carlson and Thorne, 2013).

Finally in this article, logistic regression will be used to study the effect of a weekday on daily returns. The aim is to examine whether there is any association between the weekday and the occurrence of a positive or negative daily return.

3.1 Two sample t-test

Tests of the difference between two normal population means can be considered as parametric tests. These tests are concerned with parameters, for example mean and variance, and their validity depends on a set of assumptions, for example the normality of the distribution of the population.

Supposing we have independent random samples from two normally distributed populations with unknown population variances, then the test will be based on the Student's t distribution. Let μ_x denote the first population mean and n_x a random sample size. Similarly for the second population, μ_y refers to the population mean, n_y to the sample size.

The estimator of the equal population variance is computed using the sample variances s_x^2 and s_y^2 (Newbold et al., 2013),

$$s_p^2 = \frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{(n_x + n_y - 2)}, \quad (3)$$

where s_p^2 is the weighted average of the two sample variances.

The hypothesis test is based on the Student's t statistic for the difference between two means,

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{\sqrt{\frac{s_p^2}{n_x} + \frac{s_p^2}{n_y}}}. \quad (4)$$

where \bar{x} and \bar{y} are the observed sample means. The degrees of freedom for s_p^2 and for the Student's t statistic is $(n_x + n_y - 2)$.

Then, using the sample means we test the null hypothesis,

$$H_0 : \mu_x - \mu_y = 0$$

against the alternative hypothesis,

$$H_1 : \mu_x - \mu_y \neq 0.$$

We reject H_0 if

$$\frac{\bar{x} - \bar{y}}{\sqrt{\frac{s_p^2}{n_x} + \frac{s_p^2}{n_y}}} < -t_{n_x+n_y-2, \alpha/2} \quad (5)$$

or

$$\frac{\bar{x} - \bar{y}}{\sqrt{\frac{s_p^2}{n_x} + \frac{s_p^2}{n_y}}} > t_{n_x+n_y-2, \alpha/2}. \quad (6)$$

3.2 Nonparametric tests

Compared to parametric tests, nonparametric, or distribution-free tests make limited assumptions about the underlying distributions of the data. Thus, if there are serious departures from the necessary assumptions, nonparametric tests provide a suitable alternative. On the other hand, since these tests do not require assumptions about the shapes of the distributions, they are less likely to find true differences when assumptions for parametric tests are met (Norušis, 2012).

In the case of nonparametric tests, the shape of the distributions does not matter, but it must be the same in both groups, therefore the population variances must be the same. The most common nonparametric tests that can be used to test the null hypothesis that the population means are the same for the two groups are known as the Mann-Whitney U test and Wilcoxon rank-sum test.

Mann-Whitney U test

The Mann-Whitney test is based on the Mann-Whitney statistic, U , which approaches the normal distribution as the number of sample observations increases. As Newbold et al. suggest (2013) the approximation is adequate if each sample contains at least 10 observations.

We assume that two population distributions are identical, n_1 is the number of observations from the first population and n_2 from the second population. Then, the two samples are pooled and the observations are ranked in ascending order with ties assigning the average of the next available ranks. The Mann-Whitney U test is based on the statistic U ,

$$U = n_1 n_2 + \frac{n_1(n_1 + 1)}{2} - R_1, \quad (7)$$

where R_1 refers to the sum of the ranks of the observations from the first population.

If the null hypothesis is that the central locations of the two population distributions are the same, then the Mann-Whitney U has the mean

$$E(U) = \mu_U = \frac{n_1 n_2}{2}. \quad (8)$$

The variance can be defined as

$$\text{Var}(U) = \sigma_u^2 = \frac{n_1 n_2 (n_1 + n_2 + 1)}{12}, \quad (9)$$

and the distribution of the random variable for large sample sizes,

$$Z = \frac{U - \mu_u}{\sigma_u}, \quad (10)$$

is approximated by the normal distribution (Newbold et al., 2013).

Wilcoxon rank sum test

This test is similar to the Mann-Whitney U test and both tests provide the same results. However, Newbold et al. (2013) argue that the Wilcoxon rank sum test may be preferred for its ease.

Similarly to the Mann-Whitney U test, the distribution of the Wilcoxon rank sum test approaches the normal distribution as the number of sample observations increases. Let T denote the sum of the ranks of the observations from the first population, then assuming the null hypothesis to be true, the Wilcoxon rank sum statistic, T , has mean

$$E(T) = \mu_T = \frac{n_1(n_1 + n_2 + 1)}{2}. \quad (11)$$

The variance can be defined as

$$\text{Var}(T) = \sigma_T^2 = \frac{n_1 n_2 (n_1 + n_2 + 1)}{12}, \quad (12)$$

and the distribution of the random variable for large sizes,

$$T = \frac{T - \mu_T}{\sigma_T}, \quad (13)$$

is approximated by the normal distribution (Newbold et al., 2013).

3.3 Logistic regression analysis with categorical variables

There are various approaches that can be used for the analysis of calendar anomalies. In this article, the presence of the weekend effect will be examined using the logistic regression, which is an econometric approach typically used to predict a discrete outcome of a categorical dependent variable from a set of variables that can be continuous, discrete, dichotomous, or a mix (Tabachnik and Fidell, 2007). The probabilities describing the possible outcomes of dependent variable are modelled as a logistic function. Thus, the logistic regression model can be seen as a special case of generalized linear model and analogous to linear regression. The simplest binary model contains only one independent variable and a dependent variable with two possible outcome values.

If we consider more than one independent variable in the model with two possible outcomes, then the model is called the multiple, or multivariable logistic regression model. This model can be further modified for the outcome variable with more than two levels, or responses, and it is called a multinomial, polychotomous, or polytomous logistic regression model. Moreover, in the case that the outcome is ordinal scale, we can use ordinal logistic regression.

While binary logistic regression states the situation that a dependent variable has only two possible categories, multinomial logistic regression concerns the situation that an outcome can have three or more possible types. The relationship between the days of the week and the category of daily returns will be modelled using the binary logistic regression in this study. For the purposes of the analysis, the daily returns are categorized into two groups, negative daily returns (coded as 1) and positive daily returns (coded as 0) as outcome variables. In this problem, we estimate the probability that a case will be classified into one of these two categories. The model is based on the logistic distribution and according to Hosmer, Lemeshow and Sturdivant (2013, p. 6-7), it can be expressed as

$$\pi(x) = \frac{\exp(\beta_0 + \beta_{1x})}{1 + \exp(\beta_0 + \beta_{1x})}, \quad (14)$$

where $\pi(x) = E(Y|x)$ represents the conditional mean of Y given x when the logistic distribution is used. Y denotes the outcome variable and x denotes a specific value of the independent variable. The equation (14) can be modified and $\pi(x)$ can be transformed as

$$g(x) = \ln\left(\frac{\pi(x)}{1 - \pi(x)}\right) = \beta_0 + \beta_{1x}, \quad (15)$$

where $g(x)$ is called the logit. It is linear in its parameters, continuous and may range from $-\infty$ to $+\infty$.

To fit the logistic regression model, we estimate the values of parameters which maximize the probability of obtaining the observed set of data. Thus, the method is based on the maximum likelihood. The values of parameters in the equation (15) can be estimated by the method of maximum likelihood as the values that maximize the probability of obtaining the observed set of data. We must first construct the function that describes the probability of the observed data as a function of the unknown parameters. This function is called the likelihood function and the values of parameters that maximize this function are called maximum likelihood estimators.

The used likelihood function is

$$l(\beta) = \prod_{i=1}^n \pi(x_i)^{y_i} [1 - \pi(x_i)^{1-y_i}]. \quad (16)$$

As Hosmer, Lemeshow and Sturdivant (2013, p. 9) suggest, it is easier to mathematically work with the log of the equation above (16) called the log-likelihood,

$$L(\beta) = \ln[l(\beta)] = \sum_{i=1}^n \{y_i \ln[\pi(x_i)] + (1 - y_i) \ln[1 - \pi(x_i)]\}. \quad (17)$$

The simplest dichotomous case can then be extended by considering more than one independent variable or by increasing the number of categorical outcomes. If this is the case, then the multinomial logistic regression is applied. In the process of analysing the relationship between weekdays and return categories through the logistic regression model, we can start with setting the logistic function,

$$\pi(D_n) = \frac{\exp(\beta_0 + \beta_i \cdot D_i)}{1 + \exp(\beta_0 + \beta_i \cdot D_i)}, \quad (18)$$

where D_n refers to the dummy variable indicating the day of the week and $i = 1, 2, \dots, 5$. The logistic function can be used to estimate the probability of a negative daily return occurrence. Accordingly, the term $1 - \pi(D_n)$ can be used to predict the probability of a positive daily result. The logit function can then be transformed by inverting the natural logarithm,

$$g(D_n) = \ln\left(\frac{\pi(D_n)}{1 - \pi(D_n)}\right) = \beta_0 + \beta_i \cdot D_i. \quad (19)$$

As mentioned above, the logistic regression method aims to maximize likelihood yields for the unknown parameters that maximize the probability of obtaining the observed set of data. The first step is to construct a function called the likelihood function, the resulting estimators are those which are closely related with the observed data. The overall significance of the estimated model can be tested by the goodness-of-fit test.

4. Assessment of the day of the week anomaly

This section is focused on the empirical analysis of daily returns in the Chinese stock markets. The main objective is to analyse the relationship between the day of the week and daily returns of the selected stock indices, SSE and SZSE. Using the methodology which was described in section three, both parametric and nonparametric tests of population means will be used to examine if there is a weekend effect anomaly present in the Chinese stock market. However, the main attention will be paid to the estimation of logistic models and the interpretation of results.

4.1 Examination of the weekend effect

Before the logistic regression analysis, the general characteristics of each weekday in the dataset of two stock exchange indexes will be examined. Monday returns are essential here, which are compared to other

weekdays to see whether there are significant differences in daily returns, particularly between Monday and Friday. If there are significant differences between pre- and post-weekend returns, we can conclude there is evidence of the weekend effect on the Chinese stock market.

Mean daily returns, both $R_{i,oc}$ and $R_{i,cc}$ for each stock index and for each weekday are summarized in Table 1.

Table 1 Mean daily returns

	Mon.	Tue.	Wed.	Thu.	Fri.
SSE _{oc}	0.0010	0.0004	0.0015	-0.0008	0.0008
SSE _{cc}	0.0007	-0.0001	0.0010	-0.0013	0.0000
SZSE _{oc}	0.0014	0.0009	0.0021	-0.0008	0.0007
SZSE _{cc}	0.0010	0.0002	0.0014	-0.0013	-0.0002

Daily returns of both stock indices, SSE and SZSE, for the period 2000–2013 are calculated from opening and closing prices using equations (1) and (2). We can clearly see in Table 1 that the daily returns are mostly positive and the highest mean returns occur on Wednesdays.

More detailed summary statistics of the data including the number of observations, median, standard deviation, skewness and kurtosis are shown in the Appendix. Based on the standard deviations, Monday returns indicate a higher volatility when compared to other daily returns. In contrast, Friday average returns indicate the lowest standard deviations. The results undoubtedly provide support for further analysis, which will be conducted using the tests for comparing sample mean differences.

The assumption of normality for each group of data is not met (there are 20 groups in total: 5 groups for each index daily return). The values of skewness and kurtosis suggest the distributions are not normal and the results of the Shapiro-Wilk test of normality confirm that the data are not normally distributed (see Appendix). For this reason, both parametric and nonparametric approaches will be used to compare the mean daily returns between Monday and other weekdays.

Two sample t-test

Monday returns are compared to the other four weekdays in Table 2. It is clearly evident that there are significant differences between Monday and Thursday returns in all cases. For example, with a significance level of 2.89%, the SZSE_{cc} Monday mean return is different from the SZSE_{cc} Thursday mean return.

Table 2 Two sample t-tests

Pair	SSE _{oc}	SSE _{cc}	SZSE _{oc}	SZSE _{cc}
Mon-Tue	0.6789	0.9556	0.4026	0.7071
Mon-Wed	-0.5324	-0.2164	-0.8100	-0.4059
Mon-Thu	2.0053**	2.1339**	2.1583**	2.1876**
Mon-Fri	0.1516	0.7569	0.6334	1.0898

** significant at 0.05 level of significance

Wilcoxon rank sum test

Alternatively, the null hypothesis that the sample means are the same is tested using the Wilcoxon rank sum test (Table 3). According to the results, there are significant differences between Monday and Thursday mean daily returns and this phenomenon is more evident in the case of the SZSE index. Moreover, the test suggests there might be a weekend effect on the Shenzhen stock exchange.

Table 3 Wilcoxon rank-sum test

Pair	SSE _{oc}	SSE _{cc}	SZSE _{oc}	SZSE _{cc}
Mon-Tue	0.683	0.845	0.811	1.224
Mon-Wed	0.422	0.441	0.442	0.746
Mon-Thu	2.801*	2.939**	3.212**	3.380**
Mon-Fri	1.001	1.617	1.747*	2.269**

** significant at 0.05 level of significance

* significant at 0.10 level of significance

To summarize, the main results of the previous analyses suggest the following findings:

- Thursdays have negative returns in both stock exchange markets.
- Wednesdays commonly have the highest positive returns compared to other weekdays.
- Monday returns show the highest standard deviation.
- Friday returns are associated with the lowest standard deviation.
- Monday-Thursday differences are statistically significant.

The main findings suggest that both SSE Composite and SZSE Shenzhen Composite indexes may experience a day of a week effect. Furthermore, the Shenzhen Stock Exchange shows evidence of significant differences based on both types of returns. To conclude, the Shanghai Stock Exchange seems to be more efficient than the Shenzhen Stock Exchange market due to less evidence of the anomaly. This is the reason for a further and more detailed analysis, which will be carried out by logistic regression analysis.

4.2 Modelling the relationship between weekdays and daily returns

The analysis of daily returns is examined using the binary logistic regression analysis. Friday returns are set as a benchmark in this analysis, positive returns are denoted as 0 and negative returns as 1. By means of the binary logistic regression analysis, we aim at the estimation of models which can be used to predict the probability of negative or positive daily returns given the day of the week. The codes of categorical variables for the purposes of the analysis are summarized in Table 4.

Table 4 Categorical variables coding

Day	Frequency	Parameter coding														
		(1)	(2)	(3)	(4)											
Mon.	631	1	0	0	0											
Tue.	661	0	1	0	0											
Wed.	663	0	1	0	Thu.	663	0	0	0	1	Fri.	628	0	0	0	0
Thu.	663	0	0	0	1											
Fri.	628	0	0	0	0											

With respect to the number of indexes and methods of calculations of daily returns, there are four logistic models estimated. The dependent variable is the return category, positive return (0), or negative return (1). The independent variables are trading days of the week, where Friday is the reference category. Thus, there are four independent categorical variables: Monday, Tuesday, Wednesday and Thursday. The estimated coefficients of all four binary logistic models are presented in Table 5. Based on the chi-square values, all models show a significant goodness-of-fit.

Table 5 Coefficients of logistic models

	SSE _{oc}	SSE _{cc}	SZSE _{oc}	SZSE _{cc}
Mon (D ₁)	-0.137	-0.219*	-0.103	-0.231**
Tue (D ₂)	-0.114	-0.269**	-0.117	0.241**
Wed (D ₃)	0.002	-0.173	-0.013	-0.133
Thu (D ₄)	0.202*	0.172	0.213*	0.070
Constant	-0.102	0.019	-0.159	-0.064
Chi-square	11.728*	21.523**	11.466**	12.376**

** significant at 0.05 level of significance,

* significant at 0.1 level of significance

Using the logistic regression models, we can predict the probability of negative or positive returns on each trading day. The estimated probabilities are summarized in Table 6 and Table 7.

Table 6 Estimated probabilities of negative daily returns

	Mon.	Tue.	Wed.	Thu.	Fri.
SSE _{oc}	0.4405	0.4462	0.4750	0.5250	0.4745
SSE _{cc}	0.4502	0.4378	0.4616	0.5476	0.5048
SZSE _{oc}	0.4349	0.4314	0.4571	0.5135	0.5397
SZSE _{cc}	0.4268	0.4243	0.4509	0.5015	0.4840

Table 7 Estimated probabilities of positive daily returns

	Mon.	Tue.	Wed.	Thu.	Fri.
SSE _{oc}	0.5595	0.5538	0.5250	0.4750	0.5255
SSE _{cc}	0.5498	0.5622	0.5384	0.4524	0.4953
SZSE _{oc}	0.5651	0.5686	0.5429	0.4865	0.4603
SZSE _{cc}	0.5732	0.5757	0.5491	0.4985	0.5160

The results indicate that Monday, Tuesday and Wednesday daily returns have a higher probability to be positive. Friday returns do not show any pattern, they are predicted to be both, negative and positive. On the contrary, Thursday daily returns tend to be always negative. To summarize, the day with the highest probability of negative returns is Thursday, both the Shenzhen Stock Exchange and the Shanghai Stock Exchange perform the same results. In addition, the positive returns predominate on Tuesdays in the Shenzhen Stock Exchange market, and on Mondays and Tuesdays in the Shanghai Stock Exchange.

5. Result summary and discussion

The main objective of this paper was to examine the effect of a weekday on daily stock returns in the Chinese markets using logistic regression, based on stock indexes from the Shanghai and Shenzhen stock exchanges. The results of this study suggest there is a presence of calendar market anomalies in the Chinese stock markets. However, it could be called the weekday, or more precisely the Thursday anomaly rather than the weekend anomaly, because the negative returns occur on Thursdays. Moreover, according to the comparison of sample means, there are significant differences between Monday and Thursday daily returns.

General descriptive statistics confirm that for both the SSE Composite Index and SZSE Composite Index, Thursdays usually reach negative average returns, while the highest positive returns usually occur on Wednesdays. Moreover, there are some differences if we distinguish between opening and closing price changes. If returns are calculated only by closing price changes, the average returns are also negative on Tuesdays for the SSE Composite Index and on Fridays for the SZSE Composite Index. In addition, the paired sample tests were conducted to analyse the average return differences. Both the SSE Composite Index and

SZSE Composite Index provide strong evidence that the Monday-Thursday pair is significantly different when compared to other Monday-weekday pairs.

A more detailed analysis of the relationship between the daily returns on both Chinese stock exchanges was carried out using binary logistic regression. Overall, four logistic models were estimated. Using the logistic models, it is possible to estimate the probability of positive or negative daily returns, depending on the day of the week. The results suggest that Monday, Tuesday and Wednesday daily returns have a higher probability to be positive, while Thursday daily returns tend to be negative. Thus, we can conclude that a form of the weekday effect is present in the Chinese stock market. However, the result is different from the traditionally defined concept or situations which have been described in the introductory section. In this study, Tuesday returns show the highest probability of positive returns during the week, while Thursdays show predominantly negative returns. Accordingly, the day of the week effect in the Chinese stock markets can be called a negative *Thursday effect*.

There are several reasons that can cause the day of the week effect in the Chinese stock market. A possible explanation is that the Chinese government prefers to release information on weekends. Investors then react to new information released on weekends by adjusting their investment strategies in the stock market. The second reason may lie in the fact that the history of the Chinese stock market is relatively short. The law framework and regulation system are not yet fully developed and transparent, which may affect the efficiency of the market to some extent. Moreover, we may find a herd behaviour in the Chinese stock markets, that is, an individual in a group will follow the majority of investors and act together without planned direction. This behaviour explains why most investors perform the same investment strategies and preferences during some periods. Lastly, there might be a time lag factor influence present in the Chinese stock market. Investors need some time to digest information released on weekends and take some time to consider what reaction to take. It can explain why returns on Mondays are usually positive and the highest returns are typical on Wednesdays. On Thursdays, information is absorbed by investors, returns change sharply and show negative results.

In addition, when the two Chinese stock exchanges are compared, the SZSE Composite Index shows more evidence to support the existence of the day of the week effect than the SSE Composite Index. It implies that the efficiency form of the Shanghai Stock Exchange market is stronger than that of the Shenzhen Stock Exchange. When these two stock exchanges are

compared, the Shenzhen Stock Exchange indicates a lower ability to absorb new information. Standardization, authenticity, sufficiency and distribution uniformity characteristics of information management in the Shenzhen Stock market differ from other large mature markets, for example the Shanghai Stock Exchange. Moreover, listed companies on the Shenzhen trading market commonly comprise small and medium-sized enterprises, which lack the ability to make stable profitable growth and to handle public information and inside information. Most listed growing companies are weak at resisting risk and undeveloped so that their stock prices rely more on hyping than profit making. Furthermore, the diversification of the participants in the Shenzhen Stock market may also give rise to the differences. Investors can range from large companies to individuals without investment and trading experience. The unevenness of participants' characteristics might make investment activity in the Shenzhen Stock Exchange not always rational.

The overall results suggest that two different types of daily returns lead to different results. Basically, the day of the week effect is more evident when based on data calculated from the closing prices. This phenomenon can be explained by the fact that closing price changes refer to a longer time volatility. It provides longer time for investors to consider their trading strategies. In addition, some corporations prefer to release their information at night, for example, Sinopec usually announced increased oil prices at midnight. In this case, data can be volatile and may cause the day of the week effect in the Chinese stock market.

6. Conclusion

A day of the week effect is considered as a market pricing anomaly which refers to some regularities in the rates of return during a calendar year and thus, is a category of calendar anomalies. Another calendar effect includes a weekend effect, which shows some evidence that returns on weekends or Fridays are higher when compared to Mondays. The aim of this paper was to examine the presence of the weekend effect anomaly in the Chinese stock markets through examining the SSE Composite Index and SZSE Composite Index over the period from 2000 to 2013. In contrast with other studies, the relationship between daily return categories and each weekday was conducted using binary logistic regression in this paper. Firstly, using the tests of comparison of sample means, the overall statistical descriptive analysis was carried out. The results revealed some differences between Monday and Thursday returns and suggested that the highest returns occur usually on Wednesdays in both Chinese stock

exchanges. Then, the analysis of a possible weekend anomaly was examined using binary logistic regression analysis. Setting Friday returns as a benchmark, the aim was to estimate models which can be used to predict the probability of negative or positive daily returns, given the day of the week. Overall, four logistic models were estimated. The dependent variables were daily return categories and the independent variables were trading days of the week.

The overall results indicate that both indexes show the presence of the day of the week effect, and the effect is significantly greater in the Shenzhen stock exchange. In both markets, Thursday daily returns significantly differ from other daily returns, which suggests a specific day of the week effect in the Chinese stock markets. Regarding both stock exchange markets, the regulation of the Shanghai Stock Exchange market is more prudential, and the efficiency form of the Shanghai stock market is stronger compared to the Shenzhen stock market. To make markets more efficient, regulators should further improve the management mechanism which concentrates more on information disclosure and announcement. They should pay more attention to institutional investors, improve and ensure the overall investment environment and sharpen the competitiveness of the market. The aim is to improve the overall education and skills level of investors and increase transparency in the market.

Acknowledgement

This paper was supported by the Operational Programme for Competitiveness under Project CZ.1.07/2.3.00/20.0296 and Project SGS SP2016/54.

References

- AGGARWAL, R., RIVOLI, P. (1989). Seasonal and day-of-the-week effects in four emerging stock markets. *The Financial Review* 24(4): 541–550. <http://dx.doi.org/10.1111/j.1540-6288.1989.tb00359.x>
- CROSS, F. (1973). The behavior of stock prices on Fridays and Mondays. *Financial Analysts Journal* 29(6): 67–69. <http://dx.doi.org/10.2469/faj.v29.n6.67>.
- DAMODARAN, A. (1989). The weekend effect in information releases: A study of earnings and dividend announcements. *Review of Financial Studies* 2(4): 607–623. <http://dx.doi.org/10.1093/rfs/2.4.607>.
- DICKINSON, J.P., MURAGU, K. (1994). Market efficiency in developing countries: A case study of the Nairobi Stock Exchange. *Journal of Business Finance* 21(1): 133–150. <http://dx.doi.org/10.1111/j.1468-5957.1994.tb00309.x>.

- DUBOIS, M., LOUVET, P. (1996). The day-of-the-week effect: The international evidence. *Journal of Banking* 20(9): 1463–1484.
[http://dx.doi.org/10.1016/0378-4266\(95\)00054-2](http://dx.doi.org/10.1016/0378-4266(95)00054-2).
- EL-ERIAN, M.A., KUMAR, M.S. (1995). Emerging equity markets in Middle Eastern Countries. *IMF Staff Papers* 42(2): 313–331.
<http://dx.doi.org/10.2307/3867575>.
- FLANNERY, M.J., PROTOPAPADAKIS, A.A. (1988). From T-Bills to common stocks: Investigating the generality of intra-week return seasonality. *Journal of Finance* 43(2): 431–450.
<http://dx.doi.org/10.1111/j.1540-6261.1988.tb03948.x>.
- GAO, L., KLING, G. (2005). Calendar effects in Chinese Stock Market. *Annals of Economics and Finance* 6: 75–88.
- GIBBONS, M.R., HESS, P. (1981). Day of the week effects and asset returns. *Journal of Business* 54(4): 579–596.
<http://dx.doi.org/10.1086/296147>.
- HOSMER, D.W., LEMESHOW, S., STURDIVANT, R.X. (2013). *Applied Logistic Regression*. Hoboken, N.J.: John Wiley.
<https://doi.org/10.1002/9781118548387>
- CHAN, K.C., GUP, B.E., PAN, M-S. (1992). An empirical analysis of stock prices in major asian markets and the United States. *Financial Review* 27(2): 289–307.
<http://dx.doi.org/10.1111/j.1540-6288.1992.tb01319.x>.
- CHEN, G., KWOK, CH.C.Y., RUI, O.M. (2001). The day-of-the-week regularity in the stock markets of China. *Journal of Multinational Financial Management* 11(2): 139–163.
[http://dx.doi.org/10.1016/S1042-444X\(00\)00047-5](http://dx.doi.org/10.1016/S1042-444X(00)00047-5).
- IGNATIUS, R. (1992). The Bombay stock exchange: Seasonalities and investment opportunities. *Indian Economic Review* 27(2): 223–227.
- JAFFE, J., WESTERFIELD, R. (1985). The week-end effect in common stock returns: The international evidence. *Journal of Finance* 40(2): 433–454.
<http://dx.doi.org/10.1111/j.1540-6261.1985.tb04966.x>.
- KATO, K. (1990). Weekly patterns in Japanese stock returns. *Management Science* 36(9): 1031–1043.
<https://doi.org/10.1287/mnsc.36.9.1031>
- KIM, S.W. (1988). Capitalizing on the weekend effect. *The Journal of Portfolio Management* 15(3): 59–63.
<http://dx.doi.org/10.3905/jpm.1988.409156>.
- LAKONISHOK, J., MABERLY, E. (1990). The weekend effect: Trading patterns of individual and institutional investors. *The Journal of Finance* 45(1): 231–243.
<http://dx.doi.org/10.2307/2328818>.
- LIU, X., SONG, H., ROMILLY, P. (1997). Are Chinese stock markets efficient? A cointegration and causality analysis. *Applied Economics Letters* 4(8): 511–515.
<http://dx.doi.org/10.1080/758536636>.
- LUO, J., GAN, C., HU, B., KAO, T.H. (2009). An empirical analysis of Chinese stock price anomalies and volatility. *Investment Management and Financial Innovations* (6): 199–216.
- MOOKERJEE, R., YU, Q. (1999). Seasonality in returns on the Chinese stock markets: The case of Shanghai and Shenzhen. *Global Finance Journal* 10 (1): 93–105.
[https://doi.org/10.1016/S1044-0283\(99\)00008-3](https://doi.org/10.1016/S1044-0283(99)00008-3)
- NATH, G.C., DALVI, M. (2004). Day of the week effect and market efficiency – Evidence from Indian equity market using high frequency data of national stock exchange. Retrieved from *SSRN Electronic Journal*.
<http://dx.doi.org/10.2139/ssrn.1092765>.
- NEWBOLD, P., CARLSON, W.L., THORNE, B. (2013). *Statistics for Business and Economics*. Harlow: Pearson Education.
- NORUŠIS, M.J. (2012). *IBM SPSS Statistics 19 Guide to Data Analysis*. Upper Saddle River: Prentice Hall.
- OLOWE, R.A. (1999). Weak form efficiency of the Nigerian stock market: Further evidence. *African Development Review* 11(1): 54–68.
<http://dx.doi.org/10.1111/1467-8268.00003>.
- RAJ, M., KUMARI, D. (2006). Day-of-the-week and other market anomalies in the Indian stock market. *International Journal of Emerging Markets* 1(3): 235–246.
<http://dx.doi.org/10.1108/17468800610674462>.
- REILLY, F.K., BROWN, K.C. (2012). *Analysis of Investments & Management of Portfolios*. Australia: South-Western Cengage Learning.
- ROGALSKI, R. J. (1984). New findings regarding day-of-the-week returns over trading and non-trading periods: A Note. *Journal of Finance* 39(5): 1603–1614.
<http://dx.doi.org/10.2307/2327747>.
- SINGAL, V. (2003). *Beyond the Random Walk: A Guide to Stock Market Anomalies and Low-Risk Investing*. New York: Oxford University Press.
- SMIRLOCK, M., STARKS, L. (1986). Day-of-the-week and intraday effects in stock returns. *Journal of Financial Economics* 17(1): 197–210.
[http://dx.doi.org/10.1016/0304-405X\(86\)90011-5](http://dx.doi.org/10.1016/0304-405X(86)90011-5).
- TABACHNIK, B.G., FIDELL, L.S. (2007). *Using Multivariate Statistics*. Boston: Pearson.
- TVERSKY, A., KAHNEMAN, D. (1986). Rational choice and the framing of decisions. *Journal of Business* 59(4): 251–278.

<https://doi.org/10.1086/296365>

URRUTIA, J.L. (1995). Tests of random walk and market efficiency for Latin American emerging equity markets. *Journal of Financial Research* 18(3): 299–309.

<http://dx.doi.org/10.1111/j.1475-6803.1995.tb00568.x>.

Appendix

Table A: Summary statistics of daily returns

		Mon.	Tue.	Wed.	Thu.	Fri.
SSE _{OC}	Obs.	631	660	663	663	628
	Med.	.002	0.001	0.001	-0.001	0.001
	St dev.	0.017	0.014	0.015	0.014	0.013
	Skew.	-0.46	-0.684	0.584	-0.12	0.266
	Kurt.	5.213	7.645	6.716	4.827	4.928
SSE _{CC}	Obs.	631	660	663	663	628
	Med.	0.001	0.001	0.001	-.001	-.0001
	St dev.	0.019	0.014	0.016	0.016	0.014
	Skew.	-0.157	-0.445	0.348	0.122	0.457
	Kurt.	6.192	10.043	6.595	6.378	7.228
SZSE _{OC}	Obs.	630	662	665	666	630
	Med.	0.003	0.002	0.001	-.0001	0.001
	St dev.	0.019	0.016	0.017	0.016	0.015
	Skew.	-0.598	-0.784	0.341	-0.174	-0.100
	Kurt.	4.573	6.497	5.843	4.677	4.591
SZSE _{CC}	630	663	665	666	630	630
	Med.	0.003	0.002	0.002	-.0001	0.0005
	St dev.	0.020	0.016	0.017	0.017	0.016
	Skew.	-0.480	-0.766	0.100	-0.052	-0.027
	Kurt.	5.134	8.337	5.636	5.531	5.736

WONG, K.A., HO, H.D. (1986). The weekend effect on stock returns in Singapore. *Hong Kong Journal of Business Management* 4: 31–50.

WONG, K.A., HUI, T.H., CHAN, CH.Y. (1992). Day-of-the-week effects: Evidence from developing stock markets. *Applied Financial Economics* 2(1): 49–56. <http://dx.doi.org/10.1080/758527546>.

Table B: Shapiro-Wilk test of normality

	W	V	z	Prob>z	
sse_oc1	631	0.96431	14.813	6.547	0.0000
sse_cc1	631	0.95364	19.243	7.182	0.0000
szse_oc1	630	0.96956	12.616	6.156	0.0000
szse_cc1	630	0.96261	15.498	6.656	0.0000
sse_oc2	660	0.93883	26.446	7.97	0.0000
sse_cc2	660	0.91837	35.289	8.672	0.0000
szse_oc2	663	0.94694	23.033	7.635	0.0000
szse_cc2	662	0.92354	33.144	8.52	0.0000
sse_oc3	663	0.94267	24.889	7.824	0.0000
sse_cc3	663	0.94751	22.785	7.609	0.0000
szse_oc3	665	0.95811	18.236	7.068	0.0000
szse_cc3	665	0.96463	15.397	6.656	0.0000
sse_oc4	663	0.97422	11.191	5.878	0.0000
sse_cc4	663	0.96294	16.086	6.761	0.0000
szse_oc4	666	0.97897	9.165	5.393	0.0000
szse_cc4	666	0.97071	12.766	6.2	0.0000
sse_oc5	628	0.97061	12.148	6.064	0.0000
sse_cc5	628	0.95335	19.28	7.185	0.0000
szse_oc5	630	0.98177	7.554	4.911	0.0000
szse_cc5	630	0.96783	13.333	6.291	0.0000