Holiday Effects on S&P 500 Index Volatility and Return Rates for Market Efficiency Validation

Zihan Li
School of ACCOUNTING& FINANCE, Hong Kong Polytechnic University, Hong Kong, China

Keywords: Holiday Effect, Market Effectiveness, GARCH.

Abstract: The holiday effect in the financial landscape is important, especially in understanding how market behaviour changes around holidays. This phenomenon has been under-appreciated in the past. This article provides additional evidence for the holiday effect. It analyses whether the volatility and returns in the S&P 500 Index are significantly different between the five trading days before the holiday, and the rest period. Next, the effectiveness of the market is determined through the 'efficient market hypothesis'. The adjusted closing price for the S&P 500 index was calculated for each trading day between December 23, 2013 and December 29, 2023. This work will build a Generalized Autoregressive Conditions Heteroskedasticity model (GARCH) to calculate the volatility of the index through the index returns. Both datasets are tested using the F Test method and T Test method. The results show low volatility and high returns for the five-trading day of the pre-holiday time period. As a result, it indicates that the holiday effect is predominant in S&P 500 Index, which represents by the 500 U.S. companies that are under the control of the S&P 500. Due to arbitrage opportunities, the U.S. Stock Market has low efficiency.

1 INTRODUCTION

In financial market analysis, the "holiday effects" refers to an anomaly in the market (Gama, 2013; Brockman, 1998), a pattern of unusual volatility and returns on the stock market, which often occurs just before a holiday. The stock market performs better than usual in the days leading up to holidays, and rising prices of stocks imply high returns. This suggests that stock returns before holidays are different from other time periods. Short-term returns are usually higher before holidays, which is contrary to the efficient market hypothesis. According to the EMH, stock prices already contain all available information, so investors cannot outperform the market. The data was selected for each trading day from December 23, 2013, to December 29, 2023. This work will build a Generalized Autoregressive Conditions Heteroskedasticity model (GARCH) to calculate the volatility of the index through the index returns. Both datasets are tested using the F-Test method and T-Test method. The results show low volatility and high returns for the five-trading day of the pre-holiday time period. These results indicate that the holiday effect is predominant in U.S. Stock Market, which represents by S&P 500 Index. Due to arbitrage opportunities, the U.S. Stock Market has low efficiency.

In other words, no investor can make exceed profit in an efficient market. This makes sense to a large extent, but everything has two sides. The discovery of the holiday effect challenged EMH by suggesting that the behavior of market participants could be influenced by irrational factors such as investor sentiment or behavioral biases. Such unusual stock performances have attracted the interest of many financial analysts and market participants because they allow investors to earn additional returns on both short-term and long-term trades. Such unusual phenomenon is represented by several markets around the whole world and it is worth exploring whether such phenomenon could have a big impact on major stock indices like S&P 500. Because the U.S. stock market is representative of global equity markets. Investigating the influence of the holiday effect on the S&P 500 and analyzing in depth its role on volatility and returns will greatly assist the understanding of market anomalies in the U.S. stock market. Examining the holiday effect not only challenges traditional financial theories, but also provides insight into the correlation between the S&P 500 and related financial contracts through data

Li, Z.
Holiday Effects on S&P 500 Index Volatility and Return Rates for Market Efficiency Validation.
DOI: 10.5220/0013270300004568
In *Proceedings of the 1st International Conference on E-commerce and Artificial Intelligence (ECAI 2024)*, pages 547-552
ISBN: 978-989-758-726-9

comparisons that reveal the efficiency of the U.S. market as a whole.

Market volatility and returns are widely recognized as important indicators of economic performance and the investment performance of the global financial system. Volatility refers to the magnitude and speed of change in asset prices over time. High-volatility financial products experience significant price changes, reflecting the unpredictability and instability of markets, while low-volatility financial instruments are relatively stable. The performance of the Standard & Poor's 500 Index (S&P 500) is closely related to the volatility of the stock market, especially in the United States (Ang, Hodrick, Xing, & Zhang, 2006). Therefore, its performance can serve as a reliable indicator of market volatility in the United States. In addition, the S&P 500 index represents 500 of the largest and best-known publicly traded companies in the United States, covering different industries such as energy, consumer goods, and technology, reflecting the market capitalization performance of these industries and thus the overall performance of the U.S. economy. As a result, changes in the index can also reflect the overall economic conditions in the United States. In order to effectively explore the anomalies of the U.S. market and help financial market participants manage risks and formulate investment strategies; the selection of the S&P 500 Index is reasonable. In addition, volatility and yield, as important parameters for assessing investment performance, are sensitive to changes in market efficiency. Studying how they are affected, and their intrinsic relationship can make important predictions about market trends and help financial institutions and individual investors make informed decisions.

Since this study more focus on analyzing in depth whether holiday effects exist. This essay will provide a comprehensive understanding of U.S. stock market. It will also examine whether they have an effect on S&P500 volatility and returns. A detailed analysis of this holiday effect will help market participants, risk managers and traders to better understand the market and optimize their trading and risk management strategies. it will also provide richer insights on patterns of market behavior in periods of unusual volatility. This will be useful for understanding and predicting future market direction. The article predicts that the S&P 500 will show a holiday effect in the follow-up experiments. This manifests as lower volatility, higher returns and higher risks during holiday periods.

2 LITERATURE REVIEW

2.1 Holiday Effect Verification

The EMH theory is one of the cornerstones in financial economics. This theory assumes market prices reflect all information available, thus rejecting the possibility that speculators could exploit information to generate excess returns (Fama, 1970). The EMH theory has been widely accepted by professional financial practitioner as applicable to the financial markets. However, there are persistent anomalies that have been observed in actual markets which challenge this theory. Investors may notice anomalies when they look at data and see that a stock has outperformed the market over time in a particular characteristic. One such anomaly is the holiday effect. Before delving into the volatility and returns of the S&P 500 over time, it's important to first determine if the holiday effect exists.

Lakonishok & Smidt (Lakonishok, 1988), in order to explore market anomalies and test for persistent seasonal patterns, conducted pioneering research to test for 90 years of U.S. closing price data for Dow Jones Industrial Average. Lakonishok & Smidt (Lakonishok, 1988), by analysing the data collected, pointed out that there were persistent and abnormally higher returns around certain times, such as weekends, the end of the month, the end of the year, and holidays. Stock returns are significantly higher at these times than they are on normal trading days, which indicates that there may be systematic anomalies in this market. The holiday effect was brought into focus by the challenge to traditional market models.

Kim and Park (Kim, 1994), comparing data from July 1, 1973, to June 30 1987, explore the holiday effect on stock returns. They found that stocks on the three major U.S. stock exchanges (the New York Stock Exchange, the American Stock Exchange, and the NASDAQ) had unusually high returns in the days leading up to the holidays. The study also verified the holiday effect in the UK and Japanese stock markets. The results show that the holiday effect in the UK and Japanese markets is independent of the US market, and that this phenomenon persists even after taking into account the impact of the US holiday effect. This indicates that there is an international linkage to the holiday effect. By comparing stock returns between the holiday season and the next, it was confirmed that all 14 CEE financial market had abnormally high stock return (Gakhovich, 2011). The holiday effect is also present in this case. The holiday effect is

confirmed in multiple locations as Lakonishok & Smidt's findings have been verified.

The holiday effect on the Swedish stock market is missing, according to Eidinejad & Dahlem's (Eidinejad, 2021) analysis of daily price data for the Swiss stock exchange over a 40-year period between 1980-2019. Their results show a significant post-holiday effect in the Swedish Stock Market over the entire sample time period. This is evidenced by significantly higher stock market returns than other times. This is not the same as the holiday effect, which indicates abnormally volatile returns before the holidays. When the sample was broken down by decade, researchers found that the holiday effects were primarily present in the 1990s & 2000s. The effect was not seen in the 1980s & 2010s. The study also found no pre-holiday effects in any period. The article explains why this phenomenon occurs. The rapid development of Internet in 1990s may well have caused investors to pay more attention to the market during holidays. This may have been a reason for the post-holiday effects in 1990s. By 2010, the market might have adjusted to this anomaly. The findings of the Swedish stock exchange support the idea that holiday effects are not always present on the market.

2.2 S&P 500 Volatility Effect

Financial market analysis is not complete without understanding the impact of market volatility on investment returns. The traditional view of investment emphasizes that low-volatility stocks on the market are typically associated with less price fluctuation and may therefore represent lower risk and lower return. This intuitive concept implies higher risk is required for investors to achieve higher returns.

A leading academic quarterly in finance called The Journal of Portfolio Management published an article that suggests a different view. Blitz & Van Vliet (Blitz, 2007) created quartile portfolios based upon historical volatility, and compared performance of different volatility-based portfolios using stock market data from 1986 to 2006. Their research revealed that low volatility portfolios are not only associated with lower risks, but also have higher adjusted returns than high volatility portfolios. It is important that they also analyzed portfolios from other markets. This phenomenon is not limited to one market but is present in many markets around the world, including the U.S.A., Europe, China and Japan. To verify that this phenomenon was not a fortuitous circumstance, the article also explored whether other factors, such as size, value, or momentum, which are known to have financial market effects, could have an effect on this low-risk, but high return, compared to the return of a portfolio with low volatility. The results show that the low volatility is still significant after controlling for all of these factors. This indicates that it is a separate and economically significant effect. This unusual phenomenon brings up an important point: in certain situations, the traditional association between equity market volatility and risk may need to be reevaluated. The article provides new perspectives on practical risk management and asset allocation.

In this context, it is important to analyze changes in volatility and returns for the S&P 500, under the influence of holiday effects. The performance of S&P 500 can be a good indicator of the state of the U.S. stock market. Its performance during a certain time period such as pre-holidays, for example, can give investors important information to make investment decisions. A more detailed analysis of the S&P 500's risk and reward patterns can reveal the nuances in market dynamics when influenced by specific holidays. This can help investors to not only capitalize on trading opportunities over the short-term, but also give them insight into long-term investment strategy development.

3 METHODOLOGIES

3.1 Data Preparation

In contemporary era background, the stock market provides a fair, transparent and cost-effective environment for the investors to make investment on nearly equal condition to foster the healthy development of economic. investors can easily search lots of stock information from some financial website such as wind, yahoo finance and Bloomberg. This article chooses the yahoo finance as data resource. Because this website can be used by public investors to find stock price. Therefore, this article used the adjust closed price of S&P 500.

S&P 500 Index Adj Close: This dataset represents the closing price of a stock at the end of a given trading day, after taking into account factors such as ex-rights and dividends. Its price reflects the true value of the stock. Historical data from 2013-12-23 to 2023-12-29 is included here.

In addition, the calculation of index return rate is the key factor of this research. The volatility this article discuss is also generated from the return rate.

It is essence to use precise quantitative date for the calculation of return rate of S&P 500.

3.2 Model Construction

Since volatility is not directly observable, this paper requires a reliable proxy variable. If the conditional mean is zero, the square of the returns can be used as an unbiased estimate of the underlying volatility process. (Awartani, 2005). Therefore, creating the Specialized models to make prediction by using return rate is the key factor of this experiment.

At the beginning of the experiment, this article wanted to depend on the Autoregressive Conditional Heteroskedasticity (ARCH) which can be used to catching volatility characteristics in financial time series data. However, Zhang (Zhang, 2016) mentioned that this model needs the high amount of data which can lead to a great number of problems in the process of calculate the volatility. For instance, the problem of multicollinearity of the explanatory variables and the inability to ensure that the restriction α is always not less than zero.

Therefore, this article chose the GARCH model (Xu, 2011) to calculate the volatility. Because this model can easily find heteroskedasticity, which suggest that the volatility of the index rate is not always constant in time series. It always changes over the time. In addition, the basic factor of the GARCH model is predicting the future volatility by using the past volatility.

3.3 Test Method

Since this article must judge the significant difference between two data set, this article will use some test to help determined. the F Test and T Test is the best option to make judgement.

3.3.1 F Test

For the F test, it usually is used to compare whether the variances were significantly different between two or more samples.

The basic set of steps is to ensure the null hypothesis H0: The variance of two samples is equal; alternative hypothesis Ha: The variance of two samples is not equal.

The formulas are shown below:

$$S_B^2 = \sum_{i=1}^{k} n_i(\overline{x}_i - \overline{x})\text{^}2/k = 1 \quad (1)$$

$$S_W^2 = \sum_{i=1}^{k} n_i(n_i - 1)S_i^2/N - k = 1 \quad (2)$$

Throughout the experiments, this work decided to use the EXCEL to help simplify the process of calculating the F statistic.

Finally, this article will determine the corresponding p value based on the F statistic. The acceptance of the original hypothesis will be determined by the comparing the p value to the magnitude of 0.05.

3.3.2 T Test

T-tests are commonly used to determine whether the means of two or more samples are significantly different. The basic steps include setting the null hypothesis H0: The means of two samples are equal; alternative hypothesis Ha: The means of the two samples are not equal. If the p-value is less than 0.025, the null hypothesis is rejected.

4 RESULTS AND DISCUSSION

4.1 Calculate The S&P 500 Volatility

For the validation of the existence of the holiday effect. this article first wanted to use the average daily volatility of the S&P 500 based on all of the 2013 to 2023 period shown in Figure 1 to see if there were any unusual fluctuations in it. This essay imported the data in to RStudio and obtained the GRACH model diagram shown in the figure after code programming.

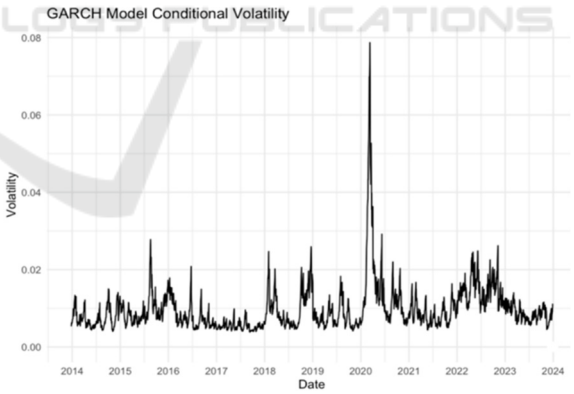

Figure 1: 10 Years Index Volatility (Photo/Picture credit: Original).

4.2 Return Rate Calculation

"The most widely-used statistics in finance are expected return and volatility" (Sakr & Sherif, 2017). The calculation of volatility is derived from the returns. Therefore, this study calculated the returns first. This article can easily calculate the daily returns by using a formula on an EXCEL sheet. The formula

is the ratio of adjusted closing prices of the current trade, minus the adjusted close of the previous day's trading, to the adjusted close of the previous day's trading. The same formula can be used to calculate daily returns after obtaining the daily returns of Index and Futures over the ten-year period.

4.3 F Test

Excel software is used to calculate the F statistics, with significance set at 95%, corresponding to a p-value of 0.05. If the p-value is below 0.05, the null hypothesis is rejected, indicating a significant variance difference between the two groups.

4.3.1 S&P 500 Return Rates

The null hypothesis for this F test is the following: the variance in return rates of the S&P 500 index in the pre-holiday periods equals the variance in return rates of the index in the non-holiday periods.

The alternative hypothesis is that the variances of the S&P 500 return rate in pre-holiday periods are not equal to the variances of the index return rates during non-holiday periods.

$$H0: b1=b2 \quad (3)$$

$$Ha: b1\neq b2 \quad (4)$$

The graph below shows that the F statistic is 1.37493. This means that the p-value is 1.74E-04 which is less than 0.05

There is strong evidence that this article rejects the null hypotheses and accept the alternative hypotheses. proving a significant difference in the variances of the S&P 500 Index return rates between pre-holiday and non-holiday periods.

4.3.2 S&P 500 Volatility

The null hypothesis for this F test is the following: the variance in Volatility of the S&P 500 index in the pre-holiday periods equals the variance in Volatility of the index in the non-holiday periods. The alternative hypothesis is that the variances of the S&P 500 Volatility in pre-holiday periods are not equal to the variances of the index Volatility during non-holiday periods.

$$H0: b3=b4 \quad (5)$$

$$Ha: b3\neq b4 \quad (6)$$

The graph below shows that the F statistic is 2.24308. This means that the p-value is 1.05E-23 which is less than 0.05

There is strong evidence that this article should reject the null hypotheses and accept the alternative hypotheses. This proves that there is a significant difference between the variances of the S&P 500 Index Volatility during Pre-holiday and the variances of the index Volatility during the non-holiday periods.

4.4 T Test

The F Test shows that both return rates and volatility are significantly different between the holiday period and the non-holiday periods. This article chose the T test for two sample heteroskedasticity. Then, this essay will calculate the confidence intervals of both and determine if there is a significant difference in the mean.

4.4.1 The T Test about S&P 500 Return Rates

The null hypothesis for this t-test is that the index returns rates during non-holiday times are equal to the S&P 500' return rates in pre-holiday times. The alternative hypothesis is the S&P 500' return rate in the pre-holiday period does not equal that of the index during the non-holiday period.

$$H0: m1=m2 \quad (7)$$

$$Ha: m1\neq m2 \quad (8)$$

Since this article set the significance at 95% it means that a=0.05. When p value (single tailed critical mass), is less than a/2 =0.025the null hypotheses was rejected. In this test, p value (single tailed critical mass), is 0.008292. This is less than 0.025. there is strong evidence for rejecting the null hypothesis, and it can be concluded that there are significant differences between those two types of mean.

This article established a confidence interval by the information which is gathered from the internet. This article put the follow formula about confidence interval into RStudio

$$(m1-m2) \pm 1.96 * (\sigma / \text{sqrt}(n)) \quad (9)$$

In the end, this article gets the 95% confidence interval for m1-m2 which is between（-0.009473，-0.008196359）

It represents that there is a 95% probability that any S&P 500 return rate from non-holiday period minus any S&P 500 return rate from pre-holiday will be within this interval. Overall, the SP500 return rate from the non-holiday period is less than the SP500 return rate from pre-holiday.

4.4.2 The T Test about S&P 500 Volatility

This t test's null hypotheses H0 are that the index volatility in non-holiday times is equal to the S&P500's mean volatility before holidays. The alternative hypothesis Ha is the S&P 500's mean volatility in the pre-holiday period does not equal that of the index during the non-holiday period.

$$H0: m3=m4 \quad (10)$$

$$Ha: m3 \neq m2 \quad (11)$$

Since this article set the significance at 95% as its regulation, it means that a=0.05. When p value (single tailed critical mass), is less than a/2 =0.025, the null hypotheses was rejected. In this test, p value (single tailed critical mass), is 0.003443. This is less than 0.025. there is strong evidence for rejecting the null hypothesis, and it can be concluded that there are significant differences between those two types of mean.

This article established a confidence interval by the information which is gathered from internet. This essay put the follow formula about confidence interval into RStudio

$$(m3-m4) \pm 1.96 * (\sigma / sqrt(n)) \quad (12)$$

In the end, the 95% confidence interval can be obtained for m3-m4 which is between 0.0002820763 and 0.0012361062.

It represents that there is a 95% probability that any S&P 500 volatility from non-holiday period minus any S&P 500 volatility from pre-holiday will be within this interval. Overall, the SP500 volatility from the non-holiday period is higher than the SP500 volatility from pre-holiday. This is consistent with the domain knowledge about the index holiday effect.

5 CONCLUSIONS

This article analyzes whether the holiday effects exist in the S&P 500. It also verifies the validity of the market. This analysis is used both to determine if the holiday effect has an impact on the stock market, and to verify its validity. This analysis gives investors food for thought as they decide on trading strategies and risk-management strategies. This study used a variety of data analysis techniques throughout the paper, including the GRACH model and T-Test. The GRACH models have been applied to more than 5000 data sets. The predictions are largely confirmed by this research.

The model which is used in this article allowed to calculate volatility of the S&P 500 based on its returns. It verified the holiday effect by experimenting with the volatility and returns of S&P 500. This article analyzed the holiday effect using data analysis concluded that it manifests itself as lower holiday volatility. This is contrary to what this paper initially predicted. The expectations are higher returns and lower volatility. This study can provide a better option for the risk-averse investor who wants to trade stocks. There are also some limitations. For instance, this article successfully verified the existence of holiday effect by studying the return rate and volatility of sp500 index. However, it ignores studying the components. In addition to that, this article cannot make definition about which vacation day is most affected by the holiday effect, which make the analysis of the impact of holiday effect is not precise as expected. This research hope to adopt a more comprehensive approach to analysis in the future to assist investors choose the best investments strategy.

REFERENCES

Awartani, B. M. A., & Corradi, V. 2005. Predicting the volatility of the S&P-500 stock index via GARCH models: the role of asymmetries. International Journal of Forecasting, 21(1), 167–183.

Blitz, D., & Van Vliet, P. 2007. The volatility effect: Lower risk without lower return. Journal of portfolio management, 102-113.

Bollerslev, T., Engle, R. F., & Nelson, D. B. 1994. ARCH models. Handbook of econometrics, 4, 2959-3038.

Brockman, P., & Michayluk, D. 1998. The persistent holiday effect: Additional evidence. Applied Economics Letters, 5(4), 205-209.

Eidinejad, S., & Dahlem, E. 2021. The existence and historical development of the holiday effect on the Swedish stock market. Applied Economics Letters, 29(19), 1855–1858.

Fama, E. F. 1970. Efficient Capital Markets: A review of theory and Empirical work. the Journal of Finance/the Journal of Finance, 25(2), 383.

Gama, P. M., & Vieira, E. F. 2013. Another look at the holiday effect. Applied Financial Economics, 23(20), 1623-1633.

Kim, C., & Park, J. 1994. Holiday effects and stock returns: Further evidence. Journal of Financial and Quantitative Analysis, 29(1), 145.

Lakonishok, J., & Smidt, S. 1988. Are seasonal anomalies real? A Ninety-Year perspective. Review of Financial Studies/the Review of Financial Studies, 1(4), 403–425.

Xu, J., Zhang, Z., Zhao, L., & Ai, D. 2011. The application review of GARCH model. International Conference on Multimedia Technology.