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Does Brexit Have a Bullish or Bearish Effect on the Taiwan Stock Market?

Jing Long Yu
Doctoral Student, Department of Finance, National Yunlin University of Science and Technology, Taiwan

Tse Mao Lin (Corresponding Author)
Adjunct Lecturer, Department of Finance, National Yunlin University of Science and Technology, Taiwan
Email: tse.mao.lin@gmail.com

Xin Hui Wu
Master, Department of Finance, National Yunlin University of Science and Technology, Taiwan

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Abstract

Using the event study method to analyze one year of daily trading data of formal and Over-The-Counter (OTC) stocks in Taiwan, this study investigates whether the Brexit referendum led to abnormal returns, as well as the financial characteristics of the stocks, and the influential financial variables. The Taiwan stock market had negative abnormal returns on the day of the Brexit referendum. The high-abnormal return group was more significantly affected than the low-abnormal return group. The book-to-market ratio, price-to-earnings ratio, yield rate, average foreign shareholding ratio, and stocks overbought and oversold had a more significant impact on the low-abnormal return group. Abnormal returns were generated mostly in the OTC (Over-The-Counter) market. This event affected financial stocks more significantly than electronics and information technology stocks. The effects on formal stocks, OTC (Over-The-Counter) stocks, and the overall market were the most significant for the turnover rate and stocks overbought and oversold, yield rate, and turnover rate and book-to-market ratio, respectively. The results confirm that the model of the impact of a special event on the behavioral response in the Taiwan stock market can be used to predict changes in stock market prices when a special event occurs in the future.

Keywords: Brexit; Abnormal return; Event study; Financial analysis.

1. Introduction

In today's international society, one change often has a large and significant influence on the world. In finance, the Asian financial crisis in 1997, for example, which originate when Thailand abandoned the fixed exchange rate system, further affected the currencies, stock markets, and other assets of neighboring Asian countries, thus causing severe blows to these economies and leading them into a deep recession. Additionally, the U.S. sub-prime mortgage crisis in 2007, a financial crisis triggered by domestic mortgage defaults and a sharp rise in foreclosures in the US, caused panic to economies worldwide. Even the US-China trade war in recent years also brought tension to the global economy. Hence, lessons should be learned from these major events.

According to an article titled "Taiwan-UK Relations" published on the web page of the Taipei Representative Office in the UK, the UK Trade & Investment (UKTI) listed Taiwan as one of the 14 key global markets that strengthen its export sales since 1998 and has long been actively exploring the Taiwan market through means such as exhibitions and visits by delegations and invitations. On the other hand, Taiwanese business people have also been actively exploring the UK market by visiting sales groups and trade conferences, participating in exhibitions, or setting up operations in the UK.

In 2002, both Taiwan and the UK signed the Agreement for the Avoidance of Double Taxation and the Prevention of Fiscal Evasion with respect to Taxes on Income, while the Taiwan External Trade Development Council also established the Taiwan Trade Centre London to assist Taiwanese business people in exploring the UK market. Since 1991, Taiwan and the UK have been holding bilateral economic and trade consultation meetings. The 23rd edition of these meetings was held in October 2020 and co-chaired by Chern Chyi Chen, Taiwan's Deputy Minister of Economic Affairs, and Greg Hands, the UK's Minister of State for Trade Policy in the Department for International Trade. Such meetings serve as one of the most important mechanisms for economic and trade dialogue between the governments of these countries. According to official statistics from the UK, the total bilateral trade between Taiwan and the UK was US$5.928 billion in 2020, a slight decline of approximately 9.92% from US$6.581 billion in 2019. At the same time, Taiwan is the UK's 30th largest trading partner and 9th largest trading partner in Asia (behind China, Hong Kong, Japan, Australia, India, South Korea, Singapore, and the United Arab Emirates). The outcome of the Brexit referendum lead to changes in EU countries and their trading partners. Does this event affect the Taiwan stock market? It is worth taking a closer look at this question.

As a democratic society, Taiwan has also been actively participating in international affairs in different areas. As Taiwan is surrounded by sea and has an excellent geographic location, trade is an important part of Taiwan's economy. Advancement in the Internet network and the technology industry also enabled constant communication and connection with the international community at all times and access to information ranging from local trivial matters to economic information and stock prices in countries worldwide. Hence, Taiwan's relationship with the international community will only continue to get closer. However, it is indisputable that due to differences in the rule of law, customs, and traditions in each country, it may not be possible to guarantee that each transaction will generate positive returns in such a close-knit community. Brexit has become one of the major international policy changes in recent years. A press release titled "Taiwan-UK Bilateral Economic and Trade Relations" issued by the Ministry of Economic Affairs wrote,

> *From January to July, 2018, bilateral trade between Taiwan and the UK totaled US$3,748.41 million, an increase of approximately 14.69% from US$3,268.35 million in the same period in 2017. Taiwan ranked the 29th partner among the trading partners of the UK and was also the 9th largest trading partner of the UK in Asia. In addition, the UK's Department for International Trade (DIT) has long attached great importance to the Taiwan market as it actively explores the Taiwan market through various means, such as exhibitions and visits by delegations and invitations, while Taiwanese business people have also been expanding into the UK market through various means, such as participating in various international business exhibitions and trade shows or setting up business locations in the UK.*

The UK is one of Taiwan's important international economic and trade partners, and is suffering from the COVID-19 disease. The sequel of Brexit may not be felt in the short term, but it will reflect in life gradually. Using these facts as a starting point, the purposes of this study were as follows. First, this study investigated whether abnormal returns are generated in the Taiwan stock market due to Brexit. This study employed the event study method to observe which abnormal return is most significantly affected by this event between five days before and after this event. Second, this study examined the differences in abnormal returns between the overall stock market, the stock exchange market, and the over-the-counter (OTC) market. By classifying the stock market into these three categories, this study tested financial variables for each and performs various analyses including a multiple regression analysis and group analysis.

2. Literature Review

2.1. Event Study

History repeats itself in that "patterns" of past price behavior will tend to recur in the future. Thus, if through careful analysis of price charts one develops an understanding of these "patterns," they can be used to predict the future behavior of prices and in this way increase expected gains (Fama, 1965).

This study employed the event study method to determine abnormal returns in the Taiwan stock market due to Brexit. Primarily a statistical method, an event study was a common method to study whether an event caused fluctuations in stock prices. Dolley (1933), is the first to employ an event study to research stock price changes during stock splits. Ball and Brown (1968), incorporate the currently use event study method to look into the information content of earnings. On the other hand, Fama *et al.* (1969) explored the information effect of stock splits and dividend distribution, while Brown and Warner (1980) make further revisions to several statistical assumptions.

Hwang and Salmon (2004) approached to the US and South Korean stock markets and find that herding towards the market shown significant movements and persistence independently from and given market conditions as expressed in return volatility and the level of the market return. Macro-factors are found to offer almost no help in explaining these herding patterns. Also find evidence of herding towards the market portfolio both when the market is rising and when it is falling. The Asian Crisis and in particular the Russian Crisis are clearly identified as turning points in herding behavior. Contrary to common belief, these crises appear to stimulate a return towards efficiency rather than an increased level of herding; during market stress investors turn to fundamentals rather than overall market movements. Allen and Gale (2000), argued, financial contagion is modeled as an equilibrium phenomenon, because liquidity preference shocks are imperfectly correlated across regions, banks hold inter-regional claims on other banks to provide insurance against liquidity preference shocks. A small liquidity preference shock in one region can spread by contagion throughout the economy.

Chang *et al.* (2000), examined, the investment behavior of market participants within different international markets (i.e., US, Hong Kong, Japan, South Korea, and Taiwan), specifically with regard to their tendency to exhibit herd behavior. Found no evidence of herding on the part of market participants in the US and Hong Kong and partial evidence of herding in Japan. However, for South Korea and Taiwan, the two emerging markets in the samples, are documented significant evidence of herding. The results are robust across various size-based portfolios and over time. Furthermore, macroeconomic information rather than firm-specific information tends to have a more significant impact on investor behavior in markets which exhibit herding. In all five markets, the rate of increase in security return dispersion as a function of the aggregate market return is higher in up market, relative to down market days (e.g. (McQueen *et al.*, 1996)).

The characteristics of Taiwan's stock price behavior and investigate the magnitude and direction of the impact of important events on fluctuations in stock prices. The analysis and findings can be explained as follows. On the first trading day after an important event, the chance that stock prices fluctuate is greater than that on normal trading days, where there is a 90% reliability for the chance of stock prices experiencing significant fluctuations. On the

other hand, there is a moderate positive correlation between the magnitude and direction of fluctuations in stock prices and the nature of important events (correlation coefficient +0.58). On the second trading day after an important event, stock prices are also susceptible to significant fluctuations, albeit at a 73% reliability, while there is a weak negative correlation between the magnitude and direction of fluctuations in stock prices and the nature of important events. No significant difference in stock price fluctuations is observed between the third trading day after an important event and normal trading days. All the types of events, three of them have important effects on stock prices in Taiwan: change in financial trend, foreign countries' policies toward China unfavorable to Taiwan, and change in economic trend (Yu, 1974).

Lu (2009), in her study titled "The Impact of the Sub-prime Mortgage Crisis in the U.S. on the Taiwanese Stock Market: Event Study," investigate the impact of this major event on the Taiwan stock market. Using listed companies and OTC (Over-The-Counter) companies on the Taiwan stock market as research samples, the empirical results of her study show that: 1. The subprime mortgage crisis brought significant abnormal returns and cumulative abnormal returns to the Taiwan stock market, 2. The impact of the subprime mortgage crisis on the Taiwan stock market varied due to information transparency and disclosure, the electronics industry, debt ratio, shareholding ratios of directors and supervisors, and divergence between voting rights and cash flow rights.

The study titled "Effects of the Catastrophe on Stock Market: The Case of SARS in Taiwan's Financial Industry" empirically find that the severe acute respiratory syndrome (SARS) event brought abnormal returns to stock markets in the financial industry and the levels of abnormal returns varied by industry and according to the firm's financial ratios, which was consistent with the efficient market hypothesis (EMH). Cumulative abnormal returns in all industries exhibited a negative trend, where the event had the greatest impact on bank stocks, followed by insurance stocks, and have a relatively small impact on listed securities firm stocks and financial holding company stocks (Ling, 2004). Similarly, the study titled "The Impact of Foreign Energy Policy Change on Taiwan's Green Energy Industry - The Case of United States Withdrawal from the Paris Climate Agreement" empirically find that concept stocks related to the green energy industry in Taiwan (i.e., renewable energy-related concept stocks, energy saving and energy efficiency improvement-related concept stocks, and both renewable energy and energy saving and energy efficiency improvement-related concept stocks) generated positive abnormal returns when the US announced its withdrawal from the Paris Agreement. The finding shows that despite affecting Taiwan's green energy industry, the international governance system and joint response to climate change are not as restrictive as various laws and policies in Taiwan (Ho, 2018).

Based on the findings of the studies above, it is possible to determine abnormal returns due to different events using the event study method. Taiwan's stock market and industries are indeed affected by various factors, such as major policy changes, disasters, and diseases overseas, thereby causing the Taiwan stock market to generate either positive or negative abnormal returns. However, the degree of the impact on the stock market varies by type of stock and industry.

2.2. Brexit

The Brexit referendum held in the UK on June 24, 2016 was a recent major policy change in the international community. In fact, Brexit had been an issue since the 1970s and 1980s. The referendum resulted not only affected the UK itself, but also caused different effects on the entire international community. The literature on this event was discussed herein.

The study titled "Brexit or Bremain: What Future for the UK's European Diplomatic Strategy?" mentioned that the Brexit referendum held by Cameron (2015) would bring uncertainties to the political foundation laid by the UK government. Several recent analyses on the relationship between the UK and the EU focused on whether a referendum should be held, the new relationship between the UK and the EU, the nature of such a relationship, and the possible referendum results. Whether the UK leaves or remains in the EU, the UK would face changes. From the EU's perspective, the UK's split from the union would not only result in migration flows and economic contraction in the Eurozone, but also lead to other new problems (Whitman, 2016).

According to the article titled "Reasons and Possible Effects of Brexit, References for International Finance," numerous agencies and institutions estimated that Brexit may bring negative effects to the UK economy, albeit to a lesser extent. Brexit may turn the UK into a more conservative and protectionist country with stricter controls on immigration while causing huge uncertainties to companies, thus threatening London's position as an international financial center (Wei, 2015). Meanwhile, the paper titled "Brexit and the Future of the UK-EU Trade Relations" revealed that the Brexit referendum triggered a sharp depreciation of the British pound sterling, which in turn created more problems and uncertainties. On March 29, 2017, the UK officially invoked Article 50 of the Treaty on European Union, which began the process of the country's withdrawal from the EU. Where will the trade ties between the UK and the EU lead? Will it be cooperation or confrontation? These questions concern the rise and fall of the UK and the EU as well as the unity of the West. Brexit is a major international event with far-reaching impact (Horng, 2017).

The study titled "The Influences of Brexit on Taiwan Stock Market" mentioned the event study method to investigate the impact of the announcement of the UK's withdrawal from the EU on the Taiwan stock market from January 1, 2015 to December 31, 2017. It also explored the impact of the stock prices of Taiwan's listed companies and OTC (Over-The-Counter) companies in seven major industries (food and beverage, electronics, construction, plastics, electrical engineering and machinery, steel, and finance) using three event days during the Brexit event. The empirical results show that the UK Parliament's passing of the Brexit motion on the third event day, March 28, 2017,

have a significant negative impact on Taiwan stocks, with more significant effects on finance stocks, electronics stocks, and steel stocks, while the impact of the Brexit event is not significant on other event days (Chen, 2018).

The study titled "The Analysis of Brexit, and its Influences to the Regional Integration and Development" employs document analysis to clarify the relationship between the UK and the EU and the relationships between major European countries in a historical context. Due to the country's geographic location, geographic relations, and external development strategies, the biggest reason the UK joined the EU is to pursue its highest interests. Therefore, whether Brexit is a crisis or a turning point in terms of the country's development and regional integration in Europe is currently a topic of concern to the international community. It will also serve as an indicator for other countries considering taking a route similar to Brexit affect the EU's commitment to expanding regional integration (Chen, 2019).

Based on the results of the studies above, Brexit not only has an impact on the UK at different levels, but also indirectly affects the entire international community and many of the country's trading partners economically. There have also been numerous financial crises at the international level, such as the Asian financial crisis in 1997 and the US subprime mortgage crisis in 2007, that affect the international economy, prompting future generations to take heed and pay more attention to economic issues in the international community. Network models have been considered as an interesting framework for answering some of these questions (Amini *et al.*, 2016).

3. Data and Methodology

3.1. Data Source and Sample Descriptions

All the data in this study were sourced from the Taiwan Economic Journal (TEJ). The samples used in this study comprise common stocks (excluding Taiwan Depositary Receipt (TDR) and F-shares) on the Taiwan Stock Exchange (TWSE). The data cover one year of daily trading data from June 2015 to June 2016. Since this study aims to explore the impact of Brexit on the Taiwan stock market, TDR and F-shares issued by foreign companies are excluded from the sample.

This study examined the book-to-market ratio, closing price, trading volume (thousand shares), trading value (NT$ thousands), turnover rate, market capitalization (NT$ millions), price-to-earnings ratio, price-to-book ratio, price-to-sales ratio, yield rate, and market type to determine which financial data affect abnormal returns. Market type is used to analyze whether an observation is a listed company or an OTC (Over-The-Counter) company. Hence, the results by market type will be calculated separately when performing the regression analysis. This study also examines the foreign shareholding ratio and stocks overbought and oversold to perform a regression analysis, where the data of these two variables are divided into data on June 24, 2016 and the one-year average from June 2015 to June 2016. Therefore, this study uses 15 financial variables.

When data are missing for the financial variables or financial ratios above, the sample is excluded from the analysis. Hence, this study analyzes a total sample of 1,750 observations to calculate abnormal returns. Furthermore, to determine the effects of financial variables on abnormal returns, this study includes only samples with data for the 15 financial variables above. After excluding samples that do not meet the aforesaid criteria, a total of 1,079 samples are used in the analysis of the financial variables.

3.2. Research Hypotheses

The main purpose of this study is to explore the impact of Brexit on the Taiwan stock market. As the UK decided to leave the EU after the referendum, this study observed the referendum results to investigate whether the Taiwan stock market generated abnormal returns due to changes in a foreign country's policy. Hence, this study proposes two hypotheses using the Brexit referendum on June 24, 2016 as the event of this study:

Hypothesis 1: The Brexit event led to abnormal returns to the Taiwan stock market.

Taiwan, a trading partner of the UK, can receive information from all over the world, thanks to advancement in technology and the Internet. According to the (EMH), prices in an efficient market fully reflect all available information. Therefore, the Taiwan stock market is bound to be affected by the results of the Brexit referendum upon confirmation.

Hypothesis 2: Which financial variable significantly affects abnormal returns?

This study tests the overall stock market, the formal stock market, and the OTC (Over-The-Counter) market to observe which financial variable significantly affects abnormal returns.

3.3. Research Design

According to Shen and Li (2000), an event study aims to investigate whether an event in the market brings abnormal returns to stocks, and thus understand whether changes in stock prices are significantly influenced by the event. Hence, many scholars in Taiwan also employ the event study method to explore the impact of different events on abnormal stock returns. This study carries out research on abnormal returns according to the following four steps: 1. Determine the event day, 2. Construct an expected stock return model, 3. Perform testing on abnormal returns, and 4. Analyze the results. The first three steps will be explained in this section, while the analysis of results is provided in Section 4.

This study primarily employs the event study method to investigate whether this event led to abnormal returns to Taiwan stocks, and performs multiple regression analysis to observe which financial variable had the most significant impact on the overall stock market, the formal stock market, and the OTC (Over-The-Counter) market.

3.3.1. Event Day

The day of the Brexit event investigated in this study (t=0) is the day of the Brexit referendum, June 24, 2016 (Taiwan time). The event window is the period between five days before and after the event day. The longer the event period, the more it is possible to understand the impact of the event on stock prices. However, it is also easier for other factors to affect stock prices. Therefore, this study selects the period between five days before and after the event as the event window, and sets the period within 260 days before the event day as the estimation period.

3.3.2. Expected Return Model and Abnormal Returns

To determine whether Brexit led to abnormal returns in the Taiwan stock market, this study adopts the market model, which assumes that there is a linear relationship between individual stock returns and market return, and employs the ordinary least squares (OLS)-based risk adjustment model to calculate expected return. Expected return refers to the average return that investors anticipate under certain risk conditions, which means that the higher the market risks, the higher the expected return. On the other hand, abnormal return is generated when an event in the market causes stock prices to fluctuate. Positive abnormal return means that the event has a positive impact on stock prices, while a negative abnormal return means that the event has a negative impact on stock prices. Abnormal return is calculated by subtracting the expected return from the actual return generated during the event. However, abnormal returns on stocks may be affected by other factors; therefore, Shen and Li (2000) recommended calculating the average value of abnormal returns for the full sample; that is, the AAR(average abnormal returns), to reduce the effects of these factors on stock returns. AAR(average abnormal returns) refers to the average value of all abnormal returns.

In addition, CAAR(cumulative average abnormal returns) can be employed to determine the cumulative impact of a particular event on a company's stock price using abnormal returns. CAAR(cumulative average abnormal returns) is the cumulative sum of the AAR(average abnormal returns) during the event period.

3.3.3. Statistical Tests

This study classifies the stock market into the overall stock market (including both the formal and OTC (Over-The-Counter) markets), the formal stock market, and the OTC (Over-The-Counter) market, and performs a correlation analysis and a group analysis of the financial characteristics of these market categories. The primary test methods used in this study include the t-test[1] and non-parametric test to test whether Brexit significantly affected the Taiwan stock market.

4. Empirical Analysis Results and Discussion

4.1. Abnormal Returns

In the analysis of abnormal returns, this study determines daily abnormal returns within the event period (11 days in total), and then tests the generalized and standardized abnormal returns using the standardized cross-sectional method. A total of 1,750 samples, including those without data for the relevant financial variables, are used to calculate abnormal returns. The generalized results are shown in Table 4-1.

As can be observed from the results of the generalized traditional statistical test in Table 4-1, the generalized AAR(average abnormal returns) is significant at the 0.01 level at t=-5, t=1, and t=2, whereas the generalized CAAR(cumulative average abnormal returns) is significant at the 0.01 level at t=-5 and t=5. Based on the results of cross-sectional statistics shown in Table 4-2, generalized AAR(average abnormal returns) is only significant at the 0.01 level at t=2, whereas generalized CAAR(cumulative average abnormal returns) is significant at the 0.01 level at t=0 and t=5 and significant at the 0.05 level at t=-4 and t=-1.

Abnormal returns are volatile before the event day (t=0). This study refers to the poll results published by The Times and Daily Mail on June 6, 2016. Based on the poll results before the referendum, the number of voters in favor of leaving the EU was very similar to that in favor of remaining in the EU. For instance, the poll results published by The Times showed that 43% of participants would vote to remain in the EU, while 42% would vote to leave the EU. In a poll organized by the Daily Mail, 48% of participants would vote to remain in the EU, while 47% would vote to leave the EU. According to both sets of results, the percentage of Leave supporters was only 1% higher than that of Remain supporters, thus indicating a close fight between both groups. As far as growth rate is concerned, polls at the beginning of 2016 revealed that more voters were in favor of remaining in the EU than in favor of leaving the EU. However, the closer it was to the referendum day, the faster the number of voters in favor of leaving the EU grew. Hence, it was impossible to correctly predict the results before the event day. In conclusion, this event had a more significant impact on generalized CAAR (cumulative average abnormal returns) than AAR (average abnormal returns) according to both the generalized traditional statistical test and cross-sectional statistics.

[1] According to Brown and Warner (1980), the traditional t-test can test whether the AAR during a particular period of an event is significantly different from zero. The calculation model for this test is

$$t = \frac{AAR_t}{\frac{1}{N}\sqrt{\sum_{i=1}^{N} \hat{S}_i^2}} \qquad (3.1)$$

Furthermore, as can be observed from the results of the standardized traditional statistical test shown in Table 4-3, the standardized AAR(average abnormal returns) is only significant at the 0.05 level at t=-4 and t=-2, but is not significant on the event day (t=0). The standardized CAAR(cumulative average abnormal returns) is significant at the 0.01 level at t=5, significant at the 0.05 level at t=0 and t=-4, and significant at the 0.1 level at t=-1. Lastly, based on the results of the standardized cross-sectional test shown in Table 4-4, the standardized AAR(average abnormal returns) is significant at the 0.05 level at t=-4 and t=2 and significant at the 0.1 level at t=-2; whereas the standardized CAAR(cumulative average abnormal returns) is significant at the 0.01 level at t=-4, t=0, and t=5, significant at the 0.05 level at t=-1, and significant at the 0.1 level at t=4.

In conclusion, for either standardized method, the significant impact of this event on the standardized CAAR(cumulative average abnormal returns) is greater than that on the standardized AAR(average abnormal returns). According to the standardized and generalized results, Brexit truly had a negative impact on the Taiwan stock market; hence, Hypothesis 1 is supported.

4.2. Descriptive Statistics

In this section, the stock market is classified into three categories: the overall stock market, the formal stock market, and the OTC (Over-The-Counter) market. Descriptive statistics are employed to observe whether this event had a significant impact on these markets. The research hypothesis in the t-test is H0: mean=0, whereas the research hypothesis in the rank-sum test is H0: median=0.

First, the three stock market categories are observed according to event day. Based on the results for the overall stock market shown in Table 4-5, the t-test and rank-sum test results are significant on the event day (t=0) but the results of the t-test are not significant at t=-4 and t=2. Based on the results for the formal stock market shown in Table 4-6, the t-test and rank-sum test results are not significant on the event day (t=0). Moreover, the results of the t-test are not significant at t=-2, t=2, and t=3, while the results of the rank-sum test are also not significant at t=-4. Lastly, based on the results for the OTC (Over-The-Counter) market shown in Table 4-7, the results of both tests are different from those for the formal stock market on the event day (t=0), where the results of both tests are significant on the referendum day; however, the results of the t-test are not significant at t=-4 and t=-1, while the results of the rank-sum test are not significant at t=1 and t=2.

For the financial variables, the results show that among the 1,079 samples of the overall stock market, average stocks overbought and oversold is not significant in both tests, while the remaining financial variables have a highly significant impact on the overall stock market. Among the 623 samples of the formal stock market, the book-to-market ratio is not significant in the t-test. However, among the 456 samples of the OTC (Over-The-Counter) market, the book-to-market ratio and average foreign shareholding ratio are not significant in the t-test, while the remaining financial variables demonstrate a high degree of significance in both tests.

4.3. Correlation Coefficients

This section continues the analysis of the three market types to observe the strength of the correlations between the 14 variables and abnormal returns after removing the effect of market type. This study employs the correlation coefficient proposed by Magnello (2009), where the value of correlation coefficient ranges from -1 to 1. A correlation coefficient of 1 means that there is a positive correlation between two variables, whereas a correlation coefficient of -1 means that there is a negative correlation between two variables. The related correlation coefficients are listed in Table 4-8.

4.4. Multiple Regression Analysis

For the market types, the results revealed that the event affected both the formal and OTC (Over-The-Counter) stock markets, but the results of the Brexit referendum had a greater impact on the OTC (Over-The-Counter) market, as shown in Table 4-9. In addition, this study examined finance stocks and electronics and information technology stocks, following the empirical results of the study titled “The Influences of Brexit on Taiwan Stock Market” by Chen (2018). The results show that both finance stocks and electronics and information technology stocks were negatively affected on the day of the Brexit event; however, the impact of this event is greater on electronics and information technology stocks. This may be because the upstream, midstream, and downstream sectors of Taiwan’s electronics industry are highly connected internationally. Moreover, the results vary slightly with sample selection and sample size. The related analysis results are presented in Table 4-10.

This study employs multiple regression analysis to explore which financial variable affects abnormal returns for each market category. Since the purpose of including the effect of market type is to determine whether a sample is a listed company or an OTC (Over-The-Counter) stock, this study first removes market type from the multiple regression analysis. The regression results obtained after removing the effect of market type show that among the 623 samples of the formal stock market, trading volume, turnover rate, price-to-earnings ratio, price-to-book ratio, book-to-market ratio, stocks overbought and oversold, and average stocks overbought and oversold have a significant impact on abnormal returns, with turnover rate and stocks overbought and oversold being the most significant. Meanwhile, among the 456 samples of the OTC (Over-The-Counter) market, yield rate and book-to-market ratio had a significant impact on abnormal returns, with book-to-market ratio being the most significant. The related results are presented in Tables 4-11, 4-12, 4-13, and 4-14.

Lastly, among the 1,079 samples of the overall stock market, the results are calculated with and without the effect of market type. The results for both sets of calculations are as follows. In the overall stock market, turnover rate, price-to-sales ratio, yield rate, book-to-market ratio, and stocks overbought and oversold have a significant

impact on abnormal returns. However, market type also has a significant impact on abnormal returns after its effect is included. With or without the effect of market type, turnover rate, yield rate, and book-to-market ratio have the most significant impact on abnormal returns.

5. Conclusions

The main purpose of this study is to investigate the impact of Brexit on the Taiwan stock market. According to statistics from the Ministry of Economic Affairs, Taiwan is one of the UK's trading partners. Hence, this study aimed to determine whether confirmation on the Brexit referendum results affected stock prices in Taiwan. As can be observed from numerous studies on abnormal returns, major disasters or policy changes in foreign countries led to abnormal returns in Taiwan. Nonetheless, the type of abnormal returns varies with the research topic. The empirical results of this study can be explained in the following three points.

i. The results for abnormal returns in this study showed that a negative AAR(average abnormal returns) and negative CAAR(cumulative average abnormal returns) were generated in both the generalized and standardized mode on the day of the Brexit referendum, June 24, 2016 (Taiwan time). This goes to show that the confirmation of the UK's withdrawal from the EU had a negative impact on the Taiwan stock market.

ii. The descriptive statistics showed that among the three market categories of the overall stock market, formal stock market, and the OTC (Over-The-Counter) market, this event had a highly significant impact on the OTC (Over-The-Counter) and overall market on the event day (t=0) in both the t-test and the rank-sum test. For the financial variables, average stocks overbought and oversold had an insignificant impact on the overall stock market in both tests, book-to-market ratio had an insignificant impact on the stock exchange market in the t-test, and the book-to-market ratio and average foreign shareholding ratio had an insignificant impact on the OTC (Over-The-Counter) market in the t-test. The remaining financial variables demonstrated a high degree of significance in both the t-test and the rank-sum test.

As can be observed from the results of group analysis, the financial variables including the closing price, trading volume, trading value, turnover rate, price-to-book ratio, market capitalization, price-to-sales ratio, average stocks overbought and oversold, and foreign shareholding ratio, had a greater impact on the high-abnormal return group; whereas book-to-market ratio, price-to-earnings ratio, yield rate, average shareholding ratio, and stocks overbought and oversold had a greater impact on the low-abnormal return group. In addition, based on observations by market type, this event had a more significant impact on OTC (Over-The-Counter) companies than listed companies. Considering that the OTC (Over-The-Counter) market does not impose a 10% rise or fall limit, this event had a more significant impact on this type of stock market, thereby indirectly affecting the Taiwan stock market.

iii. In the multiple regression analysis, this study investigated which financial variables affected abnormal returns. As can be observed from the regression results, the turnover rate and stocks overbought and oversold on the event day had the most significant impact on the abnormal returns on formal stocks; yield rate has the most significant impact on the abnormal returns of OTC (Over-The-Counter) stocks, and turnover rate and book-to-market ratio had the most significant impact on the overall stock market.

The limitation of this study lies in the legal procedures for Brexit. Many bills were still not fully and officially passed at the beginning of this study. Therefore, this study primarily explores the impact of the day of the Brexit referendum on Taiwan stock prices but does not investigate the impact of significant legal changes that followed suit. With relationships between countries becoming closer in the future, trade is an indispensable part of an island country like Taiwan. Therefore, each trading partner is extremely important to Taiwan. It is hoped that scholars who continue studying related topics can conduct in-depth research on more areas, such as economics, ecology, humanities, and medicine, which will definitely be of immense help to Taiwan in the future.

Table-4.1. Generalized traditional statistics

Event Day	Standardized AAR	p-value	Standardized CAAR	p-value
t=-5	-3.960	0.000***	-3.960	0.000***
t=-4	1.189	0.235	-1.960	0.050**
t=-3	-4.456	0.000***	-4.173	0.000***
t=-2	-1.152	0.2494	-4.190	0.000***
t=-1	4.314	0.000***	-1.818	0.069*
t=0	-1.239	0.1255	-2.165	0.030**
t=1	3.976	0.000***	-0.502	0.616
t=2	3.039	0.002***	0.605	0.545
t=3	-1.261	0.208	0.150	0.881
t=4	-4.448	0.000***	-1.264	0.206
t=5	-5.534	0.000***	-2.874	0.004***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; AAR (average abnormal returns); CAAR (cumulative average abnormal returns).

Table-4.2. Generalized cross-sectional statistics

Event Day	Standardized AAR	p-value	Standardized CAAR	p-value
t=-5	-5.277	0.000***	-5.277	0.000***
t=-4	1.452	0.147	-2.428	0.015**
t=-3	-5.898	0.000***	-5.424	0.000***
t=-2	-1.558	0.119	-5.260	0.000***
t=-1	5.798	0.000***	-2.252	0.024**
t=0	-1.452	0.147	-2.650	0.008***
t=1	4.623	0.000***	-0.590	0.555
t=2	3.860	0.000***	0.710	0.478
t=3	-1.537	0.124	0.177	0.859
t=4	-5.746	0.000***	-1.467	0.142
t=5	-6.582	0.000***	-3.279	0.001***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; AAR (average abnormal returns); CAAR (cumulative average abnormal returns).

Table-4.3. Standardized traditional statistics

Event Day	Standardized AAR	p-value	Standardized CAAR	p-value
t=-5	-4.995	0.000***	-4.995	0.000***
t=-4	1.799	0.0721*	-2.260	0.024**
t=-3	-4.749	0.000***	-4.587	0.000***
t=-2	-1.263	0.2065	-4.604	0.000***
t=-1	5.086	0.000***	-1.844	0.065*
t=0	-0.696	0.4862	-1.967	0.049**
t=1	4.340	0.000***	-0.181	0.856
t=2	1.661	0.0967*	0.418	0.676
t=3	-0.696	0.4864	0.162	0.871
t=4	-5.139	0.000***	-1.471	0.141
t=5	-6.066	0.000***	-3.232	0.001***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; AAR (average abnormal returns); CAAR (cumulative average abnormal returns).

Table-4.4. Standardized cross-sectional statistics

Event Day	Standardized AAR	p-value	Standardized CAAR	p-value
t=-5	-6.355	0.000***	-6.355	0.000***
t=-4	2.102	0.036**	-2.765	0.006***
t=-3	-6.497	0.000***	-5.968	0.000***
t=-2	-1.708	0.088*	-5.880	0.000***
t=-1	6.933	0.000***	-2.373	0.018**
t=0	-0.826	0.409	-2.577	0.010***
t=1	5.112	0.000***	-0.224	0.823
t=2	2.075	0.038**	0.514	0.607
t=3	-0.838	0.402	0.199	0.842
t=4	-6.528	0.000***	-1.799	0.072*
t=5	-7.569	0.000***	-3.933	0.000***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; AAR (average abnormal returns); CAAR (cumulative average abnormal returns).

Table-4.5. Descriptive statistics of abnormal returns in the overall stock market

Event Day	Number	Mean	Median	Standard Deviation	Maximum	Minimum	t-test	Rank-Sum Test
t=-5	1079	-	-0.415	1.450	8.935	-7.591	0.000*	0.000***
t=-4	1079	0.053	-0.121	1.578	9.330	-8.907	0.270	0.025**
t=-3	1079	-	-0.334	1.498	17.228	-5.607	0.000*	0.000***
t=-2	1079	-	-0.202	1.512	9.296	-6.588	0.004*	0.000***
t=-1	1079	0.152	0.120	1.544	10.217	-9.585	0.001*	0.000***
t=0	1079	-	0.012	1.805	11.890	-9.818	0.001*	0.065*
t=1	1079	0.220	-0.018	1.649	9.132	-9.244	0.000*	0.026**
t=2	1079	0.030	-0.185	1.624	9.725	-10.780	0.546	0.002***
t=3	1079	-	-0.275	1.607	8.668	-11.314	0.008*	0.000***
t=4	1079	-	-0.473	1.477	8.991	-5.867	0.000*	0.000***
t=5	1079	-	-0.467	1.616	8.712	-10.380	0.000*	0.000***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively.

Table-4.6. Descriptive statistics of abnormal returns in the formal stock exchange

Event Day	Number	Mean	Median	Standard Deviation	Maximum	Minimum	t-test	Rank-Sum Test
t=-5	623	-0.287	-0.384	1.191	7.204	-4.954	0.000***	0.000***
t=-4	623	0.111	-0.075	1.410	8.747	-8.907	0.050*	0.731
t=-3	623	-0.191	-0.329	1.385	17.228	-4.888	0.001***	0.000***
t=-2	623	-0.026	-0.154	1.332	8.995	-5.319	0.621	0.002***
t=-1	623	0.202	0.141	1.377	10.217	-5.493	0.000***	0.000***
t=0	623	-0.048	0.080	1.501	11.890	-6.598	0.424	0.549
t=1	623	0.223	-0.028	1.475	8.766	-4.293	0.000***	0.087*
t=2	623	-0.084	-0.226	1.395	8.966	-10.780	0.132	0.000**
t=3	623	-0.084	-0.188	1.444	7.746	-11.314	0.147	0.000***
t=4	623	-0.343	-0.505	1.251	8.599	-4.089	0.000***	0.000***
t=5	623	-0.423	-0.433	1.395	7.707	-6.588	0.000***	0.000***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively.

Table-4.7. Descriptive statistics of abnormal returns in the OTC (Over-The-Counter) market

Event Day	Number	Mean	Median	Standard Deviation	Maximum	Minimum	t-test	Rank-Sum Test
t=-5	456	-0.370	-0.457	1.743	8.935	-7.591	0.000***	0.000***
t=-4	456	-0.026	-0.250	1.780	9.330	-4.863	0.756	0.004***
t=-3	456	-0.238	-0.358	1.641	9.241	-5.607	0.002***	0.000***
t=-2	456	-0.283	-0.365	1.718	9.296	-6.588	0.000***	0.000***
t=-1	456	0.083	0.097	1.746	9.687	-9.585	0.311	0.189
t=0	456	-0.352	-0.158	2.142	10.087	-9.818	0.001***	0.001***
t=1	456	0.216	-0.011	1.862	9.132	-9.244	0.014**	0.160
t=2	456	0.186	-0.079	1.883	9.725	-10.758	0.036**	0.739
t=3	456	-0.191	-0.369	1.806	8.668	-10.021	0.025**	0.000***
t=4	456	-0.324	-0.437	1.739	8.991	-5.867	0.000***	0.000***
t=5	456	-0.409	-0.541	1.878	8.712	-10.380	0.000***	0.000***

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively.

Table-4.8. Correlation coefficients between financial variables in the overall stock market (p-value)

Financial Variable	Abnormal Return	Closing Price	Trading Value	Trading Volume	Turnover Rate	Market Capitalization	Price-to-Earnings Ratio	Price-to-Book Ratio	Price-to-Sales Ratio	Yield Rate	Book-to-Market Ratio	Foreign Shareholding Ratio	Stocks Overbought and Oversold	Average Foreign Shareholding Ratio	Average Stocks Overbought and Oversold
Abnormal Return	1	0.279	0.959	0.644	0.000	0.728	0.009	0.044	0.919	0.001	0.000	0.899	0.600	0.742	0.526
Closing Price	0.279	1	0.807	0.000	0.009	0.000	0.513	0.000	0.001	0.002	0.000	0.000	0.713	0.971	0.578
Trading Value	0.959	0.807	1	0.000	0.000	0.000	0.725	0.129	0.800	0.392	0.509	0.000	0.000	0.592	0.428
Trading Volume	0.644	0.000	0.000	1	0.000	0.000	0.596	0.000	0.326	0.397	0.000	0.000	0.000	0.349	0.528
Turnover Rate	0.000	0.009	0.000	0.000	1	0.329	0.014	0.000	0.655	0.000	0.000	0.434	0.328	0.200	0.000
Market Capitalization	0.728	0.000	0.000	0.000	0.329	1	0.498	0.013	0.488	0.904	0.003	0.000	0.000	0.155	0.984
Price-to-Earnings Ratio	0.009	0.513	0.725	0.596	0.014	0.498	1	0.327	0.342	0.000	0.006	0.000	0.483	0.438	0.987
Price-to-Book Ratio	0.044	0.000	0.129	0.000	0.000	0.013	0.327	1	0.000	0.000	0.000	0.000	0.639	0.264	0.831
Price-to-Sales Ratio	0.919	0.001	0.800	0.326	0.655	0.488	0.342	0.000	1	0.001	0.030	0.598	0.658	0.733	0.942
Yield Rate	0.001	0.002	0.392	0.397	0.000	0.904	0.000	0.000	0.001	1	0.003	0.874	0.414	0.500	0.212
Book-to-Market Ratio	0.000	0.000	0.509	0.000	0.000	0.003	0.006	0.000	0.030	0.003	1	0.000	0.686	0.709	0.526
Foreign Shareholding Ratio	0.899	0.000	0.000	0.000	0.434	0.000	0.465	0.000	0.598	0.874	0.000	1	0.000	0.603	0.468
Stocks Overbought and Oversold	0.600	0.713	0.000	0.000	0.328	0.000	0.483	0.639	0.657	0.414	0.686	0.000	1	0.340	0.946
Average Foreign Shareholding Ratio	0.742	0.971	0.592	0.349	0.230	0.155	0.438	0.264	0.733	0.500	0.709	0.603	0.340	1	0.000
Average Stocks Overbought and Oversold	0.526	0.578	0.428	0.528	0.001	0.984	0.987	0.831	0.942	0.212	0.526	0.468	0.946	0.000	1

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively.

Table-4.9. Analysis of abnormal returns by market type

Group	Number	Mean	Median	Standard Deviation	Maximum	Minimum
Listed Companies	623	-0.048	0.08	1.501	11.890	-6.598
OTC Companies	456	-0.352	-0.158	2.142	10.087	-9.818
t-test	0.006***					
Rank-Sum Test	0.005***					

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively.

Table-4.10. Analysis of abnormal returns by industry

Group	Number	Mean	Median	Standard Deviation	Maximum	Minimum
Finance Stocks	29	-0.144	-0.158	1.009	1.864	-2.535
Electronics and Information Technology Stocks	155	-0.3174	-0.153	1.761	3.914	-6.598
t-test	0.449(Finance stocks) / 0.026**(Electronics and information technology					
Rank-Sum Test	0.430(Finance stocks) / 0.078*(Electronics and information technology					

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively.

Table-4.11. Regression analysis of abnormal returns for listed companies (excluding the effect of market type)

Financial Variable	est. coefs	t-test	p-value
α	-0.428	-1.622	0.105
Closing Price	-0.001	-1.052	0.293
Trading Volume	0.000	1.989	0.047**
Trading Value	0.000	1.211	0.226
Turnover Rate	-0.472	-5.579	0.000***
Market Capitalization	-0.000	-0.700	0.484
Price-to-Earnings Ratio	-0.001	-1.760	0.079*
Price-to-Book Ratio	0.128	1.963	0.050*
Price-to-Sales Ratio	0.002	0.211	0.833
Yield Rate	0.034	1.423	0.155
Book-to-Market Ratio	0.559	2.507	0.012**
Foreign Shareholding Ratio	-0.002	-0.493	0.622
Stocks Overbought and Oversold	0.000	2.882	0.004***
Average Foreign Shareholding Ratio	0.001	0.347	0.729
Average Stocks Overbought and Oversold	0.000	2.229	0.026**
R^2	0.063		
F-stat	3.987		

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; est. coefs (estimated coefficient)

Table-4.12. Regression analysis of abnormal returns for OTC (Over-The-Counter) stocks (excluding the effect of market type)

Financial Variable	est. coefs	t-test	p-value
α	-0.849	-2.767	0.006***
Closing Price	-0.000	-0.045	0.965
Trading Volume	-0.000	2	0.171
Trading Value	0.000	0.646	0.519
Turnover Rate	-0.152	-1.608	0.109
Market Capitalization	0.000	0.113	0.910
Price-to-Earnings Ratio	-0.001	-1.355	0.176
Price-to-Book Ratio	0.022	0.234	0.815
Price-to-Sales Ratio	0.014	0.451	0.652
Yield Rate	0.068	2.629	0.009***
Book-to-Market Ratio	0.683	2.802	0.006***
Foreign Shareholding Ratio	0.003	0.358	0.720
Stocks Overbought and Oversold	-0.000	-0.603	0.547
Average Foreign Shareholding Ratio	-0.003	-0.395	0.693
Average Stocks Overbought and Oversold	-0.001	-1.017	0.310
R^2	0.046		
F-stat	2.553		

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; est. coefs (estimated coefficient)

Table-4.13. Regression analysis of abnormal returns in the overall stock market (excluding the effect of market type)

Financial Variable	est. coefs	t-test	p-value
α	-0.648	-3.384	0.001***
Closing Price	-0.000	-0.396	0.693
Trading Volume	0.000	1.286	0.199
Trading Value	0.000	0.464	0.643
Turnover Rate	-0.296	-5.88	0.001***
Market Capitalization	0.000	0.037	0.970
Price-to-Earnings Ratio	-0.001	-2.293	0.022**
Price-to-Book Ratio	0.065	1.356	0.176
Price-to-Sales Ratio	0.004	0.441	0.659

Yield Rate	0.051	2.962	0.003***
Book-to-Market Ratio	0.637	3.993	0.000***
Foreign Shareholding Ratio	0.002	0.354	0.723
Stocks Overbought and Oversold	0.000	2.125	0.034**
Average Foreign Shareholding Ratio	-0.000	-0.066	0.948
Average Stocks Overbought and Oversold	0.000	1.477	0.140
R^2	0.059		
F-stat	5.813		

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; est. coefs (estimated coefficient)

Table-4.14. Regression analysis of abnormal returns in the overall stock market (including the effect of market type)

Financial Variable	**est. coefs**	**t-test**	**p-value**
α	-0.790	-3.812	0.000***
Closing Price	-0.000	-0.460	0.645
Trading Volume	0.000	1.077	0.282
Trading Value	0.000	0.550	0.583
Turnover Rate	-0.285	-5.619	0.000***
Market Capitalization	0.000	-0.052	0.959
Price-to-Earnings Ratio	-0.001	-2.268	0.024**
Price-to-Book Ratio	0.080	1.640	0.101
Price-to-Sales Ratio	0.004	0.421	0.673
Yield Rate	0.054	3.139	0.002***
Book-to-Market Ratio	0.641	4.020	0.000***
Foreign Shareholding Ratio	0.000	0.001	0.999
Stocks Overbought and Oversold	0.000	2.043	0.041**
Average Foreign Shareholding Ratio	-0.001	-0.174	0.862
Average Stocks Overbought and Oversold	0.000	1.413	0.158
Market Type	0.205	1.780	0.075*
R^2	0.061		
F-stat	5.814		

Note: *, **, and *** denote statistical significance at the 0.1, 0.05, and 0.01 level, respectively; est. coefs (estimated coefficient)

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