Journal of US-China Public Administration, Mar.-Apr. 2021, Vol. 18, No. 2, 47-67
doi: 10.17265/1548-6591/2021.02.001

# The Impact of the U.S. and China Trade War on Taiwan's IC Industry

Ming-Chang Cheng
National Chung Cheng University, Taiwan
Hui-Chuan Wang
Hsing-Wu University, Taiwan
Yung-Huei Chen
National Chung Cheng University, Taiwan
Tai Hua Chou
National Chung Cheng University, Taiwan

The U.S. and China trade war has captured worldwide attentions from investors from 2017 to 2020. From prior studies, it directly or indirectly proved that the trade war has negative impacts on economies in different regions in the world. As for Taiwan, the integrated circuits (IC) industry plays a vital role in the international supply chain, and the two largest trade partners of Taiwan's IC industry are the U.S. and China. Therefore, this study explores how the U.S. and China trade war impacted Taiwan's IC industry. The event study method and the regression analysis are used in this study to compare the impact on Taiwan's IC industry as a whole, and its sub-industries from different positions of the industry chain. The empirical results present that there was a negative impact on Taiwan's IC industry as a whole after the news of Huawei being restricted was released. When it was reported that the U.S. planned to add Huawei's subsidiaries into the entity list, there was a positive impact on Taiwan's IC industry as a whole, and the impact is more pronounced on IC design firms. When the news of Semiconductor Manufacturing International Corporation (SMIC) also being banned was known by the public, Taiwan's wafer foundries were greatly benefited, but non-wafer foundries were slightly harmed. The above results indirectly proved that Taiwan's IC industry was benefited from the order-transfer effect during the U.S. and China trade war. And this study finds that the order-transfer effect occurs when the restricted company is in the same position of the industry chain with the benefited industry because of their competitive relationships, and the customers of benefited industry in midstream or downstream are also benefited indirectly.

*Keywords:* U.S. and China trade war, IC industry, order-transfer effect, event study

## Introduction

From 2017 to 2020, the trade war between the world's two strongest economies, the United States and the People's Republic of China, has given rise to a worldwide concern on the global supply chain and capital

Ming-Chang Cheng, Ph.D., Professor, National Chung Cheng University, Taiwan.
Hui-Chuan Wang, M.B.A., Lecturer, Hsing-Wu University , Taiwan.
Yung-Huei Chen, Ph.D., Assistant Professor, National Chung Cheng University, Taiwan.
Tai Hua Chou, M.B.A., Graduate Student, National Chung Cheng University, Taiwan.

market. According to the public documents and press release from the U.S. government, the trade war was originated from the initiation of the Section 301 investigation about Chinese firms’ technology transfer, intellectual property rights, and innovation issues, which was announced by the United States Trade Representative (hereinafter USTR) on Aug. 24, 2017. After about seven months of investigation, the USTR officially announced to impose a 25% tariff on Chinese goods because the investigation report showed there were unfair technology transfer and restriction by Chinese firms. During this trade war, not only the U.S. and China have been affected, but other economic regions, such as Europe (Plummer, 2019), ASEAN countries (Setiawan, 2020), emerging countries (Carvalho, Azevedo, & Massuquetti, 2019) were all under the impact of this economic conflict. Due to the extra cost derived from the increasing tariff, and the future uncertainty risk exposing between two countries, many companies changed their supply chain to avoid the larger costs in the future.

As for Taiwan, it plays an important role in the international supply chain, and with the strong R&D capabilities and advanced technologies, the integrated circuits (IC) industry has been the most advantageous industry in Taiwan for its strong market influence and great export contribution. The IC industry has an indicative impact on Taiwan’s stock market. According to data of November 2020 from the Taiwan Stock Exchange (TWSE), the market value of IC stocks accounted for 39.6% of Taiwan stocks. Aside from market value, the IC industry also dominated Taiwan’s exports. According to the data from the Ministry of Economic Affairs and Taiwan Bureau of foreign trade, the IC industry contributed to the main proportion of total export, which accounted for nearly 30% of export in Taiwan. However, the biggest and the second biggest partners of Taiwan’s IC industry are China and the U.S, so the conflict between them brought uncertainties to Taiwan and captured attention from the investors. Therefore, this study focuses on the IC industry in Taiwan and how its stock price reactions to three main events. First, the day when the U.S. Bureau of Industry and Security (BIS) announced to ban Chinese telecom giant Huawei Technologies Co., Ltd. from doing business with U.S. firms. Second, the BIS added 46 affiliates and subsidiaries of Huawei into the entity list. The last event is when the U.S. placed restrictions on Chinese chip giant Semiconductor Manufacturing International Corporation (SMIC). The event study method is implemented in the research to uncover the abnormal return of the IC industry during the trade war, and their relation based on their position in the IC industry chain.

## Literature Review and Hypotheses

### Trade Conflict in History

During the 1920s, under the background of U.S. protectionism to protect domestic farmers due to excess capacity, the United States enacted the Smoot-Hawley act in 1930, imposing a 50% tariff on imported products, and this made many other countries launched the retaliation against U.S. new tariff policy. As a source of uncertainty, the Smoot-Hawley act increased cash flow uncertainty and led to decreasing investment. Archibald and Feldman (1998) used the investment model to prove that the uncertainty surrounded Smoot-Hawley slowed the investment, and it had no relationship between firms’ size and investment behavior, meaning that under the concern of trading policies and retaliation uncertainty, the investors would reduce their investment tendency on all scale of firms. Irwin (1998) investigated how much could the trade loss derived from Smoot-Hawley affect the economy, and it found that there was a 5%-6% increase in import price, and the equilibrium volume felled about 4%-8%. The impact of the Smoot-Hawley plus deflation, caused about 22% of the observed 40% decrease in the U.S. import volume in two years. Irwin (1997) found that the Great Depression brought the changes for the U.S. to adjust their trade policy because the Great Depression raised the barrier of foreign trade, which was an incentive for the U.S. to engage in bargaining.

There was another trade conflict issue which was the U.S. and Japan trade war during the 1980s. At that time, with the blooming of the Japanese economy, it has become the country with the largest trade surplus with the U.S, and Japan was the second-largest economy in the world only behind the U.S. This fact caused the rising protectionism of the U.S. and took a series of actions to pressure Japan's export, including frequent Section 301 Investigation, a high tariff rate on Japanese electronic devices, and also required Japan to solve market access problems of U.S. products. The conflicts ended with the negotiation success of Structural Impediments Initiative (SII). Crandall (1987) investigated the impact of the steel and automobiles industry after Japan's voluntary export restriction. It showed that the restraint in the Japanese automobile industry decreased output in related industries, and increased the prices, which led to lower U.S. economic welfare. However, the investment from Japanese automobile production in the U.S. brought benefits.

**Review of the U.S. and China Trade War**

Tracing back to Aug. 2017, the smoke of this long-lasting trade war of the world's two largest economies began leaking. It was started with U.S. President, Donald Trump, signing the presidential memo on China. Then U.S. trade representative, Robert Lighthizer announced the initiation of Section 301 investigation of the Trade Act of 1974 of China. He stated this investigation is to protect U.S. intellectual property rights from being harmed by China because China was reported to transfer U.S. important technology to Chinese enterprises. Later on, the spokesman of the Ministry of Commerce of the People's Republic of China (MOFCOM) accused the 301 system of its unilateralism features and declared that China will take action to protect its legitimate right if the U.S. damaged bilateral economic and trade rules.

In March 2018, the U.S. President Trump first issued the statement about the decision to order a 25% tariffs on steel imports and 10% on aluminum from all suppliers. Soon after two weeks, Trump proposed to impose the tariff on Chinese goods which are worth at highest \$50-\$60 billion, and to restrict China from investing in the United States based on the investigation of Section 301. However, China gave as good one as it got. On the next day after the US announced the new tariff policy, the spokesman of MOFCOM commented on the U.S. decision as unilateralism and trade protectionism, and China will firmly defend its legitimate right. In response to the U.S. implementation of tariffs on imported steel and aluminum products, China made a two parts list to impose the tariff on the U.S. product which is \$3 billion worth in total, including fresh fruits, dried fruits, and nut products, wines, modified ethanol, American ginseng, and seamless steel pipes in the first part, and pork and its products, recycled aluminum and other products in the second part.

In April 2018, as the secretary of commerce, Wilbur Ross announced that the United States banned Zhongxing Telecommunication Equipment Corporation (ZTE) from importing from the United States for seven years due to ZTE's illegally exporting telecommunications equipment to Iran and North Korea. After this denial of ZTE Corporation, the United States and China had gone through trade talks several times in May, and their issues covered the ZTE case, imposed policy, and trade policy. It seemed the two economics were reaching their agreement that relieves the tension of the trade war.

However, when the situation seemed to become stable, on June 15, USTR announced another list of Chinese products that will be imposed additional tariffs on approximately \$50 billion value of Chinese exports, the list contained soybeans, electric cars, whiskey, salmons, and cigars. Moreover, on June 18, the USTR threatened that they will keep imposing more tariffs on around $200 billion worth of Chinese goods. After the new announcements from the United States, China proclaimed that they had no option but to retaliate against these harmful behaviors. China also determined to impose a 5%-10% tariff on $60 billion worth of U.S. goods on August 3, and $16 billion worth of U.S. goods on August 8 as a defense.

By the end of 2018, U.S. President Trump and China general secretary Xi Jinping met in Buenos Ares, Argentina. They declared the trade truce at the G20 meeting and planned to undertake the trade negotiation mainly on technology transfer and intellectual protection between two economics within 90 days. During the 90 days of truce, the tariff raised from 10% to 25% will be postponed since Jan. 1, 2019, and China accepted to purchase a very substantial amount of U.S. goods immediately. The two sides talked several times on China-US Economic and Trade Consultation from January to April in 2019, but they did not achieve an agreement again for this negotiation. The U.S. Stated that the Chinese backtracked from the most crucial agreements upon already agreed on deals. China claimed that the United States kept increasing their demand, that’s why China had to selectively refuse the conditions to protect Chinese sovereignty.

At midnight of May 6, 2019, U.S. President Trump tweeted that the United States will raise the 25% tariff from 10% on $200 billion worth of Chinese goods, and it will be effected within five days. China retaliated against the U.S. tariff attack by announcing to impose a 5%-25% tariff on $60 billion worth of U.S. goods. On May 15, the United States announced to ban the Chinese biggest telecommunication equipment producer, Huawei Technologies Co. Ltd., and its affiliates, from buying parts and components from U.S. companies. On August 1, Trump tweeted once again that the United States will impose an additional 10% tariff on the remaining $300 billion Chinese goods, and it will be affected in one month. On August 23, China announced the retaliatory 5%-25% tariff on around $75 billion U.S. goods. Later on, Donald Trump tweeted to blame China for imposing a tariff on $75 billion of U.S. products, so he hereby announced that the tariff on Chinese goods are to be raised from 25% to 30% on the existing $250 billion worth of Chinese goods beginning on October 1, 2019, and from 10% to 15% on the remaining $300 billion worth of goods beginning on December 15, 2019.

On January 15, 2020, the United States and China eventually signed their phase one trade agreement, “Economic and Trade Agreement between the United States of America and the People’s Republic of China” in Washington DC, and it was effected on February 14. The trade deal focused on intellectual property rights, technology transfer, agriculture products, financial services, currency, expanding trade, and dispute resolution. Both sides had made a compromise for some level. First of all, China committed to implementing a strict law system to protect intellectual property rights, combating online infringement, pirated, and counterfeit goods. And firms in both China and the U.S. shall not be forced to conduct technology transfer or invested to meet the industrial plans of the countries. Secondly, China promised that they will purchase at a minimum of $200 billion worth of U.S. products, including $32 billion worth of agriculture products, $78 billion worth of manufacturing products, and $52 billion worth of energy products. Thirdly, China will open its financial services markets for foreign companies. Fourth, both sides pledged that they will abide by the terms of the International Monetary Fund, avoiding manipulating their currency for trading competition. Fifth, the United States will reduce by half the tariff rate from 15% to 7.5% he ordered last year. However, they agreed to remain the 25% tariff on $250 billion Chinese goods and the retaliatory tariff on U.S. products over $100 billion.

When the public considered it was the end of the trade war, there came another form of war, and the mass media called it a tech cold war between the U.S. and China. To trace back, it could be originated by Donald Trump’s announcement of banning Huawei technology, but this time Donald Trump tightened the restriction to

SMIC, that is, SMIC could not purchase equipment and machines from the U.S. suppliers without a special license. This was a very huge shock for SMIC that its stock plummeted around 21% on Hong Kong Stock Exchange.

These actions from the U.S. were all targeted at high-tech firms in China, which showed the U.S. had a strong purpose to be dominant in negotiations with China and therefore used aggressive tactics. The uncertainty about what will be the next step of the two leaders is the highlights among investors worldwide.

**The Impact of U.S. and China Trade War**

**The U.S.** Huang, Chen, Liu, & Tang (2019) found that there were heterogeneous market responses in the U.S. to the announcement of the tariff imposing on Chinese goods. It showed that firms with more exposures to Chinese trade in their input or output networks had a lower stock price and higher default risk. Egger and Zhu (2019) used the event study method on exploring the response of the U.S. and China after the tariff-change or implementation announcements. The findings presented that the trade war hurt domestic firms on both sides, but hurt more on the acting side than the retaliating side. That is, the U.S. had taken greater losses during the trade war than China.

To reveal whether the result would be different from industries, Y. H. Chen (2020) investigated the effect of tariffs and export policies under trade war on the service and high-tech industries in the United States. The results presented that the servicing industry had a negative response in the beginning period after the announcement, but the response was weakening gradually. Different from the servicing industry, the high-tech industry and the whole industry had a positive response in the beginning but turned to a negative response afterward. For further analysis, Chen investigated the servicing industry and the high-tech industry in the United States. It reflected that for industries overall, the R&D expense had a significant negative relation to the stock return. However, for the servicing industry, firms with higher R&D expenses had less negative returns than firms with higher R&D expenses in the high-tech industry.

Evidence has proved that the U.S. and China trade war had a comprehensive impact not only on the stock market but also on macroeconomic aspects. Amiti, Redding, and Weinstein (2019) focused on President Trump's administration announcements impacts on U.S. prices and welfare in 2018 by using standard economic methods. With prices of final goods increasing, changes in domestic supply chain networks, and the prices of imported goods increasing, it reduced $1.4 billion of real income per month in the U.S by the end of 2018.

**China.** Huang et al. (2019) also examined the market response of China in the U.S and China trade war, and the same results were found as they studied on the U.S. stock response, that Chinese firms which involved more engagements with U.S. firms of their supplier or customer chains have a lower stock price and a higher default risk. Another finding by Huang et al. was the position of upstream or downstream the firms participated in the supply chain played a decisive role in their stock response, that firms with indirect exposure to U.S.-China trade had more negative returns than firms with direct exposure to trade relationships. Wang, Wang, Zhong, and Yao (2020) studied the impact of U.S. trade tariff announcement on Chinese firms during 2018 and 2019, and it found a very negative response on Chinese firms, especially for the non-state firms with a larger export rate to the U.S., and most losses were generated from direct exposures to the tariff increase.

From literature above indicated, the trade war between the U.S. and China was damaging the economies in both countries, and the trade agreement could be a solution for this lose-lose situation. Freund, Maliszewska, Mattoo, and Ruta (2020) discussed the possible "managed trade" agreement and its impact by the computable general equilibrium model, which only the U.S. and Mexico can be benefited under this policy, but the real income will decline in China by 0.38%. It suggested that China can open its market to all trade partners to reverse the losses, and the income in China will increase by nearly 0.5% higher.

**Taiwan.** Studies have argued that how Taiwan firms would react toward U.S. and China trade war (Chen, 2019; Chang, 2019). Chen (2019) analyzed the relationship between the firm’s financial characteristics and its stock response. The results indicated that listed firms in Taiwan would react negatively toward Trump’s administrative announcements. Among the financial factors analyzed in the study, including profitability, the growth rate of net sales, pretax income, operating cash flow, average collection day, average inventory turnover, operating expense, effective tax rate, other comprehensive income, investing cash flow, and financing cash flow, the results showed that firms with high operating cash flows, high pretax income, and high operating expense under performed. By contrast, Chang (2019) claimed that the cumulative abnormal return would react positively in a 10-day-window after the announcement day. However, the cumulative abnormal return would downturn to a negative result in a monthly window. Chang (2019) researched the impact of the U.S. and China trade war on Taiwan’s firms. The variables tested in the article comprised export rate, industries category, and share holds of mainland China’s firms. It found that only the rate of share holds of mainland China’s firms had a relatively stronger relation to the cumulative abnormal return, which was a negative correlation with the stock return; the export rate of the firms had no significant relation to the CAR, and the industry category had a positive relation to the CAR on March 22, 2018, but no significant relation to the CAR on July 6, 2018.

About the impact on the specific industry in Taiwan, Yeh (2019) and Lee (2019) also investigated related topics. Yeh discussed the impact of the U.S. and China trade war on Taiwan’s networking communication industry, it showed that Taiwan’s networking communication industry reacted negatively toward the trade announcement, but the reaction level was different between announcement day and effect day, that the market tended to react at the first time soon after the announcement but not reacted until the effect day. On the other hand, Lee (2019) studied the impact of the U.S. and China trade war on the electronic parts and components manufacturing industry and the semi-conductors manufacturing industry in Taiwan. In this study, five event days were selected for the reasons that Donald Trump signed a memo, tariff announcements by Trump, and their real effect day. The study found the result that there were electronic parts and components manufacturing industry and semiconductors industry significant negative reaction to the event day. However, there was no significant difference in abnormal return between the electronic parts and components manufacturing industry and semiconductors industry.

Except for the stock market, the IC supply chain (Figure 1) was another thing that has been much affected in the trade war. M. S. Chen (2020) studied the potential influence of U.S. and China technology wars on Taiwan’s high-tech industry from a social science perspective, and this study stated that the market expected the IC design industry was benefited from the Huawei ban due to the order-transfer effect. However, when the U.S. adopted a stricter ban that firms with U.S. partnerships were banned from doing business with Huawei, the order-transfer effect would disappear.

Based on previous studies, those findings made a very clear conclusion about how the tariff announcements from the trade war impacted Taiwan. Nevertheless, those studies neglected the non-tariff factor of the trade war, like the U.S. ban on Chinese technology firms, which made those researches not complete since the origin of the trade war was about U.S.’s concern about technology transfer from Chinese firms, tariffs imposing was only a tactic for the U.S. to bargain. Therefore, this study focuses on the ban on Chinese technology firms and how they affect Taiwan's IC industry.

**Supply Chain of IC Industry**

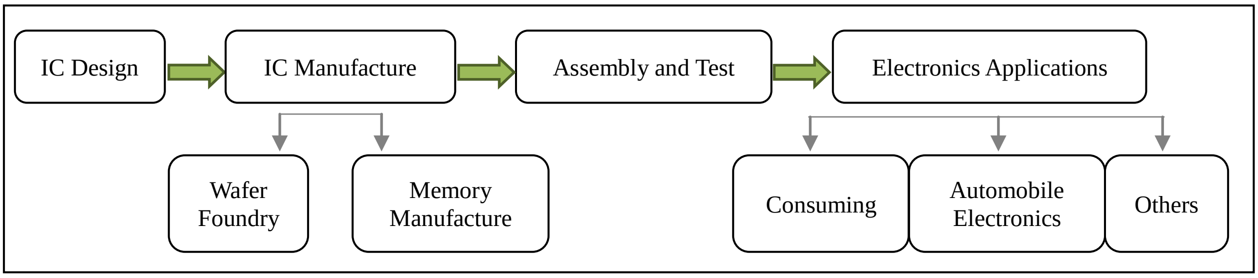


*Figure 1.* The supply chain of IC industry. Source: ITRI.

**Hypothesis**

Many literatures have shown that not only the U.S. and China have been affected during this trade war, but also Taiwan has faced a lot of changes and uncertainty due to this trade war. From previous literature, the hypotheses are developed:

$H_1$: There is a significant abnormal return on Taiwan's IC industry on the "Huawei being banned" event. (May 16, 2019).

$H_2$: There is a significant difference between abnormal return generated from IC-design firms and non-IC design firms on the "Huawei being banned" event (May 16, 2019).

$H_3$: There is a significant abnormal return on Taiwan's IC industry on the "Huawei's affiliates being added into entity list" event (Aug. 19, 2019).

$H_4$: There is a significant difference between abnormal return generated from IC-design firms and non-IC design firms on the "Huawei's affiliates being added into entity list" event (Aug. 19, 2019).

$H_5$: There is a significant abnormal return on Taiwan's IC industry on the "SMIC being banned" event (Sep. 7, 2020).

$H_6$: There is a significant difference between abnormal return generated from wafer foundries and non-wafer foundries on the "SMIC being banned" event (Sep. 7, 2020).

## Data and Methodology

**Data**

To investigate the impact of U.S. restrictions on Chinese technology companies on Taiwanese IC industry, this research collected data of listed firms in Taiwan's IC industries from Taiwan Economic Journal (TEJ). After comparing sample data of three different events, this study collected a total of 149 sample stocks which were exchangeable on TWSE and Taipei Exchange (TPEx), on all three events from both event windows and estimation windows. Additionally, the sample data were grouped based on their position on the industry chain to identify the effect of the industry chain on market response. On the first and the second event, they were grouped into IC design and non-IC design industry, but on the third event were Wafer foundry and non-wafer foundry industry, because of the downstream or upstream difference where the targeted companies are in the key events.

**Event Study**

This study adopts a risk-adjusted returns model of the event study method as the main methodology to analyze the relationship between abnormal return of the electronic industry and the day when the stock market received the news event. The event study method was originated by Fama, Fisher, Jensen, and Roll (1969), and its purpose is to investigate whether it caused significant abnormal return when a specific event occurred. This study focuses on whether the news about Trump's intention to ban Chinese technology firms would result in the stock fluctuation of electronic industries in Taiwan. The process is as follows.

**Key Events.** The first step to implement the event study is to make a clear definition of the event or information, and then define the timing when the market receives this information. This study surveys the impact of the U.S. technology ban during the trade war on the IC industry in Taiwan, and the three main events are listed below in Table 1. The first event is Trump's telecom ban on Huawei in 2019, the second one is the expanding restriction to Huawei's subsidiaries, and the last event is the export restriction on SMIC in 2020. Because there was a lag time between the news about President Trump's intention and the real announcement day, this research chooses the earliest time when there was public information about the policy since the market response tends to be instant and efficient after it gets information.

Table 1

*The Selected Key Events*

| Ban on Huawei | | |
|---|---|---|
| U.S. date | Taiwan date | |
| May 15, 2019 | May 16, 2019 | The US Commerce Department's Bureau of Industry and Security (BIS) added Huawei into Entity List that the goods, software, and technology originating from the U.S. are not allowed to export to Huawei. |
| Ban on Huawei's affiliates | | |
| U.S. date | Taiwan date | |
| Aug. 17, 2019 | *Aug. 19, 2019 | The U.S. took the second step to add additional 27 affiliates of Huawei into Entity List to crack down on Huawei's access to chips. |
| Ban on SMIC | | |
| U.S. date | Taiwan date | |
| Sep. 4, 2020 | *Sep. 7, 2020 | From Reuter exclusive report, Donald Trump was considering blacklisting SMIC. |

* The news was released on the weekend, so this research chooses the next trading day as the Taiwan event day.

**Estimation Window and Event Window.** The estimation window is the interval for estimating normal return. Though most researchers defined the estimation window before the event day, there is no stick stipulation on the estimation window length so far. According to the suggestion from Peterson (1989), if the chosen event would not change the structure of the forecast structure, the estimation window can be before the event. In addition, it would decrease the accuracy of the forecasting model if the estimation window is too short, but it would cause the model unstable if making the estimation window too long. Therefore, this study defined the estimation window from -120 days to -5 days relative to the event day. There is no consistent standard for the event window either. For the daily return data, it is usually between 2 days to 121 days, and the longer the event window, there is more interruption possibility from other factors, which reduces the power of the test. Since the event day has been clearly defined in this research, this study sets the event window from -5 days to 5 days to observe the stock response before and after the event.

**Market Model.** In previous research, the market model is used commonly when conducting event study, and according to Brenner (1979), it is also the most simple tool currently but as sensitive as other estimation models in terms of calculating expected return. This research chooses the market model to estimate the expected return of firms. The equation is as follows:

$$AR_{iE} = R_{iE} - E(\hat{R}_{iE})$$

$$CAR_{(m,n)} = \sum_{E=m}^{n} AR_E$$

Where, $R_{iE}$: The market return of $\mathrm{Firm}_i$; $E(\hat{R}_{iE})$: The expected return of $\mathrm{Firm}_i$ during event windows; $CAR_{(m,n)}$: The cumulative abnormal return during $\mathrm{Event\,Window}_{(m,n)}$.

**One-Way ANOVA**

To further verify Hypothesis 2, Hypothesis 4, and Hypothesis 6, that whether the upstream or downstream the firms are in the IC industry would affect their abnormal return, the research divides IC industry into two categories, IC design and non-IC design on Huawei event, wafer foundry and non-wafer foundry on SMIC event, and compares the abnormal return of two groups on each event. The dependent variable is the AR and CAR of the firms on the event day and during the event window, and the independent variables are the sub-industry based on their position on the industry chain.

## Empirical Results

**Huawei Event**

From Table 2, it presents the result of all firms in the IC industry that on May 16, 2019, which is the day when the United States added Huawei into the entity list, there is a significant negative AR on the event day and a significant negative CAR in the event window. The AR of all firms in the IC industry on the event day was -0.861%, and the CAR of all firms in the IC industry in the event window was -3.4187%, and they are statistically significant in 1% significance level by the traditional method, cross-sectional test, and standardized cross-sectional test. Though the event did not directly hit Taiwanese firms, the negative AR and CAR reflect that investors were pessimistic about Huawei and expected Huawei would decrease orders from IC firms in Taiwan, since Huawei had to cut its product lines to save its revenue because of the block of U.S. market. The negative reaction from the market was a few days earlier than the actual event day because of information leakage. Despite the U.S. government has not announced to block Huawei, the information of Donald Trump's intention to threaten Huawei had been broadly reported via news and articles times to times before to the actual event day, and this made investors sold the stocks in advance based on their expectation of upcoming Huawei's ban. Therefore, $\mathrm{H}_1$: "There is a significant abnormal return on Taiwan's IC industry on 'Huawei being banned' event (May 16, 2019)," holds true.

To verify $H_2$, whether the abnormal return is significantly different between IC design firms and non-IC design firms, this research divides the IC industry into two groups, IC design firms, and non-IC design firms. In Table 3, the AR of IC design firms on May 16, 2019, is -0.6734%, with 10% significance level by the traditional method of statistic test, and 5% significance level by the cross-sectional and standardized cross-sectional method. The CAR of IC design firms during the event window is -2.3684%, and it is statically significant in 10% significance level by the traditional method of statistic test, and 5% significance level by the cross-sectional and standardized cross-sectional method. As for non-IC design firms, which showed in Table 4 their AR on May 16, 2019, is -1.0562% with 1% significance level by traditional method, cross-sectional and standardized cross-sectional method of test statistics. The CAR of non-IC design firms is -4.5122%, which reaches 1% significance level by traditional method, cross-sectional and standardized cross-sectional method of test statistics.

Table 2

*The Statistic Test of AR and CAR of All Firms in Taiwan’s IC Industry on the “Huawei Being Banned” Event (May 16, 2019)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | -0.738 | -3.7331*** | -4.7149*** | -3.6679*** |
| -4 | -0.1837 | -0.9291 | -1.0242 | -2.1608* |
| -3 | -0.992 | -5.0182*** | -4.4402*** | -4.7624*** |
| -2 | 0.522 | 2.6408** | 2.9754** | 3.0621** |
| -1 | 0.5603 | 2.8344** | 3.0058** | 3.2952*** |
| 0 | -0.861 | -4.3553*** | -5.1318*** | -4.4759*** |
| 1 | -0.8962 | -4.5334*** | -4.9712*** | -5.0777*** |
| 2 | -1.433 | -7.2493*** | -6.3783*** | -7.7866*** |
| 3 | 0.4103 | 2.0753* | 2.3722* | 1.8339 |
| 4 | 0.0998 | 0.505 | 0.6607 | 1.1635 |
| 5 | 0.0927 | 0.4687 | 0.4417 | 0.14 |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | -0.738 | -3.7331*** | -4.7149*** | -3.6679*** |
| -4 | -0.9216 | -3.2967*** | -4.018*** | -4.3797*** |
| -3 | -1.9136 | -5.589*** | -6.0001*** | -5.9194*** |
| -2 | -1.3916 | -3.5198*** | -3.667*** | -3.7917*** |
| -1 | -0.8313 | -1.8807 | -2.1214* | -2.1052* |
| 0 | -1.6923 | -3.4949*** | -3.9041*** | -3.486*** |
| 1 | -2.5884 | -4.9491*** | -5.2997*** | -5.1723*** |
| 2 | -4.0215 | -7.1925*** | -7.6147*** | -7.6772*** |
| 3 | -3.6112 | -6.0893*** | -6.5701*** | -6.7724*** |
| 4 | -3.5114 | -5.6172*** | -6.4412*** | -6.4642*** |
| 5 | -3.4187 | -5.2144*** | -5.356*** | -5.5155*** |

*Notes.* Significance level $\alpha = 0.05$, The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3

*The Statistic Test of AR and CAR of Taiwan’s IC Design Firms in IC Industry on the “Huawei Being Banned” Event (May 16, 2019)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | -0.8502 | -2.8913** | -3.7667*** | -2.9183** |
| -4 | -0.0018 | -0.006 | -0.0065 | -0.7859 |
| -3 | -0.7513 | -2.5548* | -2.261* | -2.384* |
| -2 | 0.4195 | 1.4264 | 1.5193 | 1.6089 |
| -1 | 0.4103 | 1.3953 | 1.4553 | 1.782 |
| 0 | -0.6734 | -2.29* | -3.0666** | -2.6676** |
| 1 | -0.9211 | -3.1323** | -3.4461*** | -3.4274*** |
| 2 | -1.4919 | -5.0733*** | -4.1513*** | -4.8464*** |
| 3 | 0.5775 | 1.9638* | 2.4057* | 2.0497* |
| 4 | 0.3599 | 1.2239 | 1.4866 | 1.6699 |
| 5 | 0.5541 | 1.8843 | 1.7929 | 1.6313 |

Table 3 to be continued

| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | -0.8502 | -2.8913** | -3.7667*** | -2.9183** |
| -4 | -0.852 | -2.0487* | -2.5773* | -2.8712** |
| -3 | -1.6033 | -3.1478** | -3.8913*** | -3.4755*** |
| -2 | -1.1838 | -2.0129* | -2.2201* | -2.1217* |
| -1 | -0.7735 | -1.1764 | -1.4218 | -1.2316 |
| 0 | -1.4469 | -2.0087* | -2.3916* | -2.0522* |
| 1 | -2.3680 | -3.0436** | -3.5521*** | -3.3481*** |
| 2 | -3.8599 | -4.6407*** | -5.2596*** | -5.0113*** |
| 3 | -3.2824 | -3.7207*** | -4.1941*** | -4.0705*** |
| 4 | -2.9225 | -3.1427** | -3.9107*** | -3.6706*** |
| 5 | -2.3684 | -2.4284* | -2.7267** | -2.7022** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 4

*The Statistic Test of AR and CAR of Non-IC Design Firms in Taiwan's IC Industry on the "Huawei Being Banned" Event (May 16, 2019)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | -0.6211 | -2.3632* | -2.8601** | -2.2344* |
| -4 | -0.3731 | -1.4195 | -1.5866 | -2.3343* |
| -3 | -1.2426 | -4.7281*** | -4.1896*** | -4.5441*** |
| -2 | 0.6288 | 2.3927*** | 2.9261** | 2.9432** |
| -1 | 0.7164 | 2.7261** | 2.9516** | 2.9134** |
| 0 | -1.0562 | -4.0189*** | -4.1506*** | -3.6880*** |
| 1 | -0.8702 | -3.3111*** | -3.5871*** | -3.8038*** |
| 2 | -1.3718 | -5.2196*** | -5.1257*** | -6.2907*** |
| 3 | 0.2362 | 0.8986 | 0.9471 | 0.5864 |
| 4 | -0.1710 | -0.6505 | -0.9839 | -0.2095 |
| 5 | -0.3877 | -1.4753 | -1.4180 | -1.5045 |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | -0.6211 | -2.3632* | -2.8601** | -2.2344* |
| -4 | -0.9941 | -2.6748** | -3.1114** | -3.3063*** |
| -3 | -2.2368 | -4.9137*** | -4.5673*** | -4.9196*** |
| -2 | -1.6079 | -3.0590** | -2.9624** | -3.3163*** |
| -1 | -0.8915 | -1.5170 | -1.5682 | -1.7719 |
| 0 | -1.9477 | -3.0255** | -3.1206** | -2.9133** |
| 1 | -2.8179 | -4.0525*** | -3.9174*** | -3.9634*** |
| 2 | -4.1897 | -5.6362*** | -5.4761*** | -5.8410*** |
| 3 | -3.9535 | -5.0143*** | -5.1037*** | -5.5849*** |
| 4 | -4.1245 | -4.9627*** | -5.1923*** | -5.5447*** |
| 5 | -4.5122 | -5.1766*** | -4.8695*** | -5.1754*** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Next, this research analyzes the effect of industry chain position on the AR and CAR by one-way ANOVA, the result is shown in Table 5. It reveals that on May 16, 2019, though non-IC design firms have a more negative AR and CAR than IC firms, there is no significant difference in AR and CAR between IC design firms and non-IC design firms. $F$(AR) = 1.304, $p$(AR) = 0.255, and $\eta_{p^2}$(AR) = 0.009; $F$(CAR) = 2.854, $p$(CAR) = 0.093, and $\eta_{p^2}$(CAR) = 0.019. It suggests that the event of "Donald Trump announcing to ban Huawei from doing business with the U.S" has an overall negative impact on the IC industry in Taiwan. The ban on Huawei stopped Huawei from purchasing from the U.S., many suppliers of Huawei were not allowed to continue doing business with Huawei, such as Intel, which is U.S. leading chip maker, and Qualcomm, which designs IC and outsources its fabrications. After the announcement, many telecom channels also claimed they would stop stocking from Huawei. Given that Huawei's annual external procurement amounted to $67 billion, Taiwan's supply chains to Huawei from upstream to downstream were all affected. $H_2$: "There is a significant difference between the abnormal return generated from IC-design firms and non-IC design firms on 'Huawei being banned' event (May 16, 2019)" is rejected.

Table 5

*ANOVA Test of the AR of Day 0 and CAR During (-5, 5) Event Window of Taiwan's IC Design Firms and Non-IC Design Firm on Huawei Event (May 16, 2019)*

| | | AR | | CAR | |
|---|---|---|---|---|---|
| Indus. var. | Samples | Mean | Std. deviation | Mean | Std. deviation |
| IC design | 76 | -0.6734 | 1.9144 | -2.3684 | 7.5722 |
| Non-IC design | 73 | -1.0562 | 2.1742 | -4.5122 | 7.9171 |

| | Groups | *SS* | *df* | *MS* | *F* | *p*-value | $\eta_p^2$ |
|---|---|---|---|---|---|---|---|
| | Indus. var. | 5.457 | 1 | 5.457 | 1.304 | 0.255 | 0.009 |
| AR | Error | 615.222 | 147 | 4.185 | | | |
| | Total | 620.679 | 148 | | | | |
| | Indus. var. | 171.130 | 1 | 171.130 | 2.854 | 0.093 | 0.019 |
| CAR | Error | 8813.398 | 147 | 59.955 | | | |
| | Total | 8984.529 | 148 | | | | |

*Notes.* Significance level $\alpha$ = 0.05. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

**Huawei's Subsidiary Event**

From Table 6, it presents the result of all firms in the IC industry on Aug. 19, 2019. On that day, the U.S. government took a further step to impose sanctions against Huawei. This time, the U.S. added 46 affiliates of Huawei into the entity list, in which 27 entities were added under new. There is significant positive AR on the event day and significant positive CAR in the event window. The AR of all firms in the IC industry on the event day was 0.8652%, and the CAR of all firms in the IC industry in the event window was 3.3933%, and they are statistically significant at 1% significance level by the traditional method, cross-sectional test, and standardized cross-sectional test.

Different from the initial market response to the event, that investors were pessimistic about Huawei and its related supply chain. In the event of Aug. 19, the investors were optimistic about the IC industry in Taiwan because of the order-transfer effect. In the beginning, when Huawei was banned, the order transfer effect was not observed because Huawei could still purchase from its subsidiaries and affiliates, so the U.S. ban on Huawei hurt Huawei's potential sales and markets but not damaged Huawei's supply chain. However, when the U.S. took their second tactic on Huawei, banning more completely on Huawei including its subsidiaries and affiliates, Huawei could no longer access chips from its original supply chain. For this reason, Huawei turned to purchase a big amount of chips from Taiwan's firms. $H_3$: "There is a significant abnormal return on Taiwan's IC industry on the 'Huawei's affiliates being added into entity list' event (Aug. 19, 2019)" holds true.

Table 6

*The Statistic Test of AR and CAR of All Firms in Taiwan's IC Industry on "Huawei's Affiliates Being Added into Entity List" Event (Aug. 19, 2019)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.8785 | 5.0474*** | 4.232*** | 4.5224*** |
| -4 | 0.3299 | 1.8955* | 2.1196* | 2.464* |
| -3 | 0.0539 | 0.3099 | 0.2884 | 0.734 |
| -2 | 0.1389 | 0.7981 | 1.0021 | 1.162 |
| -1 | 0.3195 | 1.8357 | 1.6459 | 1.2164 |
| 0 | 0.8652 | 4.9707*** | 4.1052*** | 3.8959*** |
| 1 | 0.2012 | 1.1558 | 1.0663 | 1.4297 |
| 2 | 0.6656 | 3.824*** | 3.3892*** | 3.8838*** |
| 3 | 0.0826 | 0.4745 | 0.4481 | 0.7533 |
| 4 | -0.267 | -1.5342 | -1.6313 | -0.8973 |
| 5 | 0.1249 | 0.7176 | 0.7665 | 0.7771 |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | 0.8785 | 5.0474*** | 4.232*** | 4.5224*** |
| -4 | 1.2085 | 4.9094*** | 4.8895*** | 5.3756*** |
| -3 | 1.2624 | 4.1874*** | 4.5941*** | 4.7742*** |
| -2 | 1.4013 | 4.0255*** | 4.3277*** | 4.5342*** |
| -1 | 1.7209 | 4.4215*** | 4.5243*** | 4.3965*** |
| 0 | 2.5861 | 6.0655*** | 5.7453*** | 5.57*** |
| 1 | 2.7873 | 6.0524*** | 5.5169*** | 5.4106*** |
| 2 | 3.4529 | 7.0135*** | 6.5903*** | 6.4858*** |
| 3 | 3.5354 | 6.7706*** | 6.33*** | 6.3158*** |
| 4 | 3.2684 | 5.938*** | 6.0276*** | 6.2205*** |
| 5 | 3.3933 | 5.878*** | 5.9368*** | 6.2528*** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

To verify $H_4$, whether the abnormal return is significantly different between IC design firms and non-IC design firms on August 19, 2019, this research divides the IC industry into two groups, IC design firms, and non-IC design firms. From Table 7, the AR of IC design firms on August 19, 2019, is 1.3967%, with 1% significance level by traditional method, cross-sectional and standardized cross-sectional method. The CAR of IC design firms during the event window is 4.6515%, and it is statically significant in 1% significance level by traditional method, cross-sectional and standardized cross-sectional method. As for non-IC design firms, their AR on August 19, 2019, is 0.3199%, but it is not significant by traditional method, cross-sectional and standardized cross-sectional method of test statistics. It indicated that the main contribution to AR on the event day in the IC industry is IC design firms, but not non-IC design firms. And in Table 8, the CAR of non-IC design firms is 2.0834%, which reaches 1% significance level by standardized cross-sectional test, 5% significance level by the traditional method, and cross-sectional of test statistics. It shows that though non-IC design firms were not directly benefited from the event, the order-transfer to IC design firms also lead to the overall growth of the IC industry.

Table 7

*The Statistic Test of AR and CAR of IC Design Firms in Taiwan's IC Industry on "Huawei's Affiliates Being Added into Entity List" Event (Aug. 19, 2019)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.973 | 3.7665*** | 3.1967** | 3.5855*** |
| -4 | 0.0831 | 0.3215 | 0.3328 | 0.252 |
| -3 | 0.0877 | 0.3395 | 0.2922 | 0.7479 |
| -2 | 0.2055 | 0.7955 | 1.1688 | 1.5515 |
| -1 | 0.7102 | 2.7491** | 2.9165** | 2.9719** |
| 0 | 1.3967 | 5.4067*** | 4.2105*** | 4.0523*** |
| 1 | 0.9682 | 3.748*** | 3.3932*** | 3.2952*** |
| 2 | 0.589 | 2.2799* | 2.174* | 2.541* |
| 3 | 0.1151 | 0.4455 | 0.3778 | 0.8929 |
| 4 | -0.471 | -1.8234 | -2.3508* | -2.1843* |
| 5 | -0.0059 | -0.0229 | -0.0264 | -0.0978 |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | 0.973 | 3.7665*** | 3.1967** | 3.5855*** |
| -4 | 1.0561 | 2.8907** | 2.6893** | 3.0084** |
| -3 | 1.1438 | 2.5563* | 2.6458** | 2.8188** |
| -2 | 1.3493 | 2.6116** | 2.7625** | 3.0047** |
| -1 | 2.0595 | 3.5653*** | 3.7271*** | 3.8295*** |
| 0 | 3.4562 | 5.4619*** | 5.1527*** | 5.3393*** |
| 1 | 4.4244 | 6.4734*** | 5.5582*** | 5.5691*** |
| 2 | 5.0133 | 6.8614*** | 6.0248*** | 5.8404*** |
| 3 | 5.1284 | 6.6175*** | 5.6924*** | 5.691*** |
| 4 | 4.6574 | 5.7013*** | 5.2988*** | 5.3825*** |
| 5 | 4.6515 | 5.429*** | 5.0515*** | 5.3128*** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 8

*The Statistic Test of AR and CAR of Non-IC Design Firms in Taiwan's IC Industry on "Huawei's Affiliates Being Added into Entity List" Event (Aug. 19, 2019)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.7802 | 3.361*** | 2.7571** | 2.7766** |
| -4 | 0.5869 | 2.5284* | 3.2663** | 3.5622*** |
| -3 | 0.0188 | 0.0809 | 0.0849 | 0.208 |
| -2 | 0.0696 | 0.2998 | 0.3211 | 0.2158 |
| -1 | -0.0872 | -0.3755 | -0.2917 | -0.3947 |
| 0 | 0.3119 | 1.3434 | 1.2873 | 1.1469 |
| 1 | -0.5974 | -2.5734* | -2.8574** | -2.3384* |
| 2 | 0.7454 | 3.211** | 2.6022** | 2.9356** |
| 3 | 0.0488 | 0.21 | 0.2383 | 0.0402 |
| 4 | -0.0547 | -0.2355 | -0.2101 | 0.2936 |
| 5 | 0.2611 | 1.1247 | 1.0984 | 1.1959 |

Table 8 to be continued

| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.7802 | 3.361*** | 2.7571** | 2.7766** |
| -4 | 1.3671 | 4.1645*** | 4.5989*** | 4.8893*** |
| -3 | 1.3859 | 3.447*** | 4.1099*** | 4.2435*** |
| -2 | 1.4555 | 3.1351** | 3.4201*** | 3.483*** |
| -1 | 1.3684 | 2.6362** | 2.6213** | 2.3802* |
| 0 | 1.6802 | 2.9549** | 2.8824** | 2.5498* |
| 1 | 1.0828 | 1.7631 | 1.9618* | 1.8782 |
| 2 | 1.8282 | 2.7845** | 3.1877** | 3.2296** |
| 3 | 1.877 | 2.6953** | 3.1562** | 3.1318** |
| 4 | 1.8223 | 2.4825* | 3.1305** | 3.357*** |
| 5 | 2.0834 | 2.7061** | 3.2761** | 3.4605*** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Next, this research analyzes the effect of industry chain position on the AR and CAR by one-way ANOVA, the result is shown in Table 9. It reveals that on August 19, 2019, there is a significant difference on AR and CAR between IC design firms and non-IC design firms. $F$(AR) = 6.884, $p$(AR) = 0.01, and $\eta_{p^2}$(AR) = 0.045; $F$(CAR) = 5.187, $p$(CAR) = 0.024, and $\eta_{p^2}$(CAR) = 0.034. It suggests that the event of "adding Huawei's subsidiaries into the entity list" has a relatively stronger impact on IC design firms. This announcement blocked Huawei more completely from obtaining chips from its affiliates. For example, HiSilicon is one of the subsidiaries which was newly added into the entity list on Aug. 19, 2019 announcement. This firm is the largest domestic IC designer in China, and it supported Huawei after it was restricted from doing business with the U.S. However, after HiSilicon was also banned by the U.S., Huawei had to seek other substitutions, and that's why the IC design firms in Taiwan were benefited from Huawei's pulling the supply chain.

$H_4$: "There is a significant difference between the abnormal return generated from IC-design firms and non-IC design firms on the 'Huawei's affiliates being added into entity list' event (Aug. 19, 2019)" holds true.

Table 9

*ANOVA Test of the AR of Day 0 and CAR During (-5, 5) Event Window of Taiwan's IC Design Firms and Non-IC Design Firm on Huawei Event (Aug. 19, 2019)*

| | | AR | | CAR | |
|---|---|---|---|---|---|
| Indus. var. | Samples | Mean | Std. deviation | Mean | Std. deviation |
| IC design | 76 | 1.3967 | 2.8919 | 4.6515 | 8.0274 |
| Non-IC design | 73 | 0.3119 | 2.0698 | 2.0834 | 5.4335 |

| | Groups | *SS* | *df* | *MS* | *F* | *p*-value | $\eta_p^2$ |
|---|---|---|---|---|---|---|---|
| AR | Indus. var. | 43.821 | 1 | 43.821 | 6.884 | 0.01** | 0.045 |
| | Error | 935.685 | 147 | 6.365 | | | |
| | Total | 979.506 | 148 | | | | |
| CAR | Indus. var. | 245.563 | 1 | 245.563 | 5.187 | 0.024* | 0.034 |
| | Error | 6958.641 | 147 | 47.338 | | | |
| | Total | 7204.204 | 148 | | | | |

*Notes*. Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

**SMIC Event**

From Table 10, it presents the result of all firms in the IC industry on September 7, 2020, which is the day when the United States banned SMIC. The AR of all firms in the IC industry on the event day was -0.4312%, but it is not significant in any method of test statistics, which means there was no obvious impact on the whole IC industry. And the CAR of all firms in the IC industry in the event window was 1.8185%, with 10% significance level by the traditional method and cross-sectional method of test statistics, and 5% significance level by standardized cross-sectional test.

However, the result from the above table doesn't mean there was no impact on Taiwan's IC industry. Actually, the positive and negative impact occurred simultaneously on Taiwan's IC industry but different positions of the industry chain after SMIC was banned. For the upstream of Taiwan's IC industry, it was a threat for them that SMIC was restricted. On the contrary, it was an opportunity for the midstream of Taiwan's IC industry. $H_5$: "There is a significant abnormal return on Taiwan's IC industry on the 'SMIC being banned' event (Sep. 7, 2020)" is rejected.

Table 10

*The Statistic Test of AR and CAR of All Firms in Taiwan's IC Industry on "SMIC Being Banned" Event (Sep. 7, 2020)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.9582 | 4.029*** | 4.5897*** | 5.8765*** |
| -4 | -0.3305 | -1.3898 | -1.5509 | -1.9994* |
| -3 | 1.0952 | 4.605*** | 5.0265*** | 5.2256*** |
| -2 | -0.0633 | -0.2663 | -0.2813 | -0.1199 |
| -1 | 0.7461 | 3.1371** | 3.1268** | 4.1806*** |
| 0 | -0.4312 | -1.813 | -1.6363 | -0.928 |
| 1 | -0.546 | -2.2956* | -2.7114** | -2.8934** |
| 2 | 0.693 | 2.9139** | 3.1913** | 4.0107*** |
| 3 | -0.8883 | -3.7351*** | -5.046*** | -6.6823*** |
| 4 | -0.3656 | -1.5373 | -1.659 | -2.6804** |
| 5 | 0.951 | 3.9987*** | 4.0352*** | 4.3215*** |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | 0.9582 | 4.029*** | 4.5897*** | 5.8765*** |
| -4 | 0.6276 | 1.8662 | 1.9482 | 2.4394* |
| -3 | 1.7228 | 4.1824*** | 4.2204*** | 4.7992*** |
| -2 | 1.6595 | 3.489*** | 3.7702*** | 4.5838*** |
| -1 | 2.4056 | 4.5236*** | 4.0584*** | 5.3439*** |
| 0 | 1.9744 | 3.3893*** | 2.9051** | 4.4082*** |
| 1 | 1.4284 | 2.2702* | 2.2138* | 3.5763*** |
| 2 | 2.1214 | 3.1538** | 3.1031** | 4.5791*** |
| 3 | 1.2331 | 1.7284 | 1.6105 | 2.6184** |
| 4 | 0.8675 | 1.1536 | 1.0795 | 1.804 |
| 5 | 1.8185 | 2.3055* | 2.256* | 3.1237** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

To verify $H_4$, whether the abnormal return is significantly different between foundries and non-foundries, this research divides the IC industry into two groups, foundries and non-foundries. From Table 11, the AR of foundries on Sep. 7, 2020, is 4.6382%, with a 1% significance level by traditional method, cross-sectional and standardized cross-sectional method. The CAR of IC design firms during the event window is 5.5604%, and it is statically significant at 5% significance level by the cross-sectional and standardized cross-sectional method. As for non-foundries data in Table 12, their AR on Sep. 7, 2020, is -0.6439% with a 5% significance level by traditional method, and 10% significance level by the cross-sectional method of test statistics. The CAR of non-foundries is 1.6615%, which reaches a 10% significance level by the traditional method and the cross-sectional method, and 5% by the standardized cross-sectional method of test statistics. It is evidence that there was different direction of market response on IC industry in terms of a different positions of the industry chain, for the middle stream, it was an opportunity, but not for the upstream firms.

Table 11

*The Statistic Test of AR and CAR of Wafer Foundry in Taiwan's IC Industry on "SMIC Being Banned" Event (Sep. 7, 2020)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.7796 | 0.5818 | 0.6696 | 0.0775 |
| -4 | 0.1274 | 0.095 | 0.179 | 0.2305 |
| -3 | 0.5449 | 0.4066 | 0.8413 | 0.7187 |
| -2 | -0.9468 | -0.7066 | -1.0805 | -0.9021 |
| -1 | 1.0293 | 0.7681 | 1.2233 | 0.5637 |
| 0 | 4.6382 | 3.4613*** | 3.2768** | 2.6066** |
| 1 | -1.1048 | -0.8245 | -1.314 | -1.4859 |
| 2 | 0.717 | 0.535 | 0.8322 | 1.0144 |
| 3 | -0.6003 | -0.448 | -0.774 | -0.6678 |
| 4 | 0.4694 | 0.3503 | 0.4722 | 0.0959 |
| 5 | -0.0934 | -0.0697 | -0.1012 | 0.3866 |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | 0.7796 | 0.5818 | 0.6696 | 0.0775 |
| -4 | 0.907 | 0.4786 | 0.6989 | 0.3578 |
| -3 | 1.4519 | 0.6256 | 1.2344 | 0.8624 |
| -2 | 0.5051 | 0.1885 | 0.612 | 0.2893 |
| -1 | 1.5343 | 0.5121 | 1.0821 | 0.5135 |
| 0 | 6.1725 | 1.8805 | 3.083** | 2.4389* |
| 1 | 5.0677 | 1.4294 | 2.4284* | 2.1641* |
| 2 | 5.7846 | 1.5262 | 3.0321** | 2.3513* |
| 3 | 5.1844 | 1.2896 | 2.8712** | 2.8845** |
| 4 | 5.6538 | 1.3342 | 2.238* | 2.8526** |
| 5 | 5.5604 | 1.2511 | 2.7529** | 2.9057** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Next, this research analyzes the effect of industry chain position on the AR and CAR by one-way ANOVA, the result is shown in Table 13. It presents that on Sep. 7, 2020, there is a significant difference on AR between foundries and non-foundries. $F$(AR) = 17.232, $p$(AR) = 0.00, and $\eta_{p^2}$(AR) = 0.105. The CAR between foundries and non-foundries during the event window is not significantly different. $F$(CAR) = 0.904, $p$(CAR) = 0.343, and $\eta_{p^2}$(CAR) = 0.006. SMIC as the biggest chip maker in China, it manufactured a huge amount of chips to supply the IC industry in the global IC industry, but the key technology and machines to produce chips were from the U.S. firms. So when SMIC was banned from buying them from the U.S., it could not keep its production capability, which is both good news and bad news for the IC industry in Taiwan. On the hand of good news, because SMIC was restricted, this was the opportunity for its competitors, such as United Microelectronics Corporation (UMC), and Taiwan Semiconductor Manufacturing Company (TSMC) were the main winners in this event. On the other hand, for the IC designers, they are upstream of the IC industry in Taiwan, it turned to be tough for them to find foundries to manufacture their IC, because the foundries in Taiwan were all overloaded. $H_6$: "There is a significant difference between the abnormal return generated from wafer foundries and non-wafer foundries on the 'SMIC being banned' event (Sep.7, 2020)" holds true.

Table 12

*The Statistic Test of AR and CAR of Non-wafer Foundries in IC Industry on "SMIC Being Banned" Event (Sep. 7, 2020)*

| | AR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
|---|---|---|---|---|
| -5 | 0.9657 | 4.0013*** | 4.5361*** | 6.0001*** |
| -4 | -0.3497 | -1.4492 | -1.5879 | -2.0598* |
| -3 | 1.1183 | 4.6336*** | 4.9595*** | 5.1724*** |
| -2 | -0.0263 | -0.1088 | -0.1133 | -0.0319 |
| -1 | 0.7342 | 3.0421** | 2.9786** | 4.1367*** |
| 0 | -0.6439 | -2.6679** | -2.5346* | -1.7864 |
| 1 | -0.5225 | -2.165* | -2.5229* | -2.6474** |
| 2 | 0.692 | 2.8673** | 3.0912** | 3.8816*** |
| 3 | -0.9004 | -3.7308*** | -4.976*** | -6.674*** |
| 4 | -0.4006 | -1.66 | -1.7729 | -2.7183** |
| 5 | 0.9948 | 4.122*** | 4.1051*** | 4.3109*** |
| | CAR | Traditional method | Cross-sectional test | Standardized cross-sectional test |
| -5 | 0.9657 | 4.0013*** | 4.5361*** | 6.0001*** |
| -4 | 0.6159 | 1.8046 | 1.8554 | 2.4132* |
| -3 | 1.7342 | 4.1487*** | 4.1001*** | 4.7372*** |
| -2 | 1.7079 | 3.5385*** | 3.7361*** | 4.5837*** |
| -1 | 2.4421 | 4.5254*** | 3.9703*** | 5.3247*** |
| 0 | 1.7983 | 3.0419** | 2.5682* | 4.075*** |
| 1 | 1.2757 | 1.998* | 1.9197 | 3.3054*** |
| 2 | 1.9677 | 2.8827** | 2.7882** | 4.2899*** |
| 3 | 1.0674 | 1.4742 | 1.3479 | 2.3551* |
| 4 | 0.6667 | 0.8736 | 0.8056 | 1.5367 |
| 5 | 1.6615 | 2.0758* | 1.9926* | 2.8457** |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 13

*ANOVA Test of AR of Day 0 and CAR During (-5, 5) Event Window of Taiwan's Wafer Foundries and Non-wafer Foundries on "SMIC Being Banned" Event (Sep. 7, 2020)*

| | | AR | | CAR | |
|---|---|---|---|---|---|
| Indus. var. | Samples | Mean | Std. deviation | Mean | Std. deviation |
| Foundry | 6 | 4.6382 | 3.4672 | 5.5604 | 4.9475 |
| Non-foundry | 143 | -0.6439 | 3.0378 | 1.6615 | 9.9714 |

Table 13 to be continued

| | Groups | *SS* | *df* | *MS* | *F* | *p*-value | $\eta_p^2$ |
|---|---|---|---|---|---|---|---|
| AR | Indus.var | 160.659 | 1 | 160.659 | 17.232 | 0.00*** | 0.105 |
| | Error | 1370.501 | 147 | 9.323 | | | |
| | Total | 1531.16 | 148 | | | | |
| CAR | Indus.var | 87.533 | 1 | 87.533 | 0.904 | 0.343 | 0.006 |
| | Error | 14241.31 | 147 | 96.88 | | | |
| | Total | 14328.843 | 148 | | | | |

*Notes.* Significance level $\alpha = 0.05$. The *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

## Conclusions

To sum up, this study explores the stock response of the IC industry under the U.S. and China trade war, and how its position in the industry chain interacts with the market response. Different from prior research on Taiwan's stock market which highlighted more on trade tariff announcements, this study focuses on U.S. trade restrictions targeting at China's technology firm around 2019 to 2020, and the order-transfer effect is proved in this study, that firms will be benefited by restrictions on the firm with same position or higher position on industry chain, but will be harmed if the restricted firms are in their lower position of the industry chain. In this study, three key events were picked and the results of each event are organized as follows. For the first event, Huawei being banned by the U.S., a negative impact on Taiwan's IC industry is observed both on the event day and the event window, and there is evidence that all firms from upstream to downstream were victims under that event. For the second event, Huawei's subsidiaries being added into the entity list, the stock return steadily grew on Taiwan's IC industry, but this growth only appeared in the IC design industry, which demonstrates the order transfer effect from Huawei's subsidiaries to Taiwan's IC designers. For the last event, SMIC being banned by the U.S., Taiwan's IC industry remained the same as an overall perspective, whereas the return of wafer foundries increased sharply on the event day. In fact, other than foundries, firms in Taiwan's IC industry gained a negative response towards the SMIC event. This result promotes the evidence that only specific industries could be benefited from the order transfer effect, and it depends on the position where the firm is on the industry chain, and how it interacts with restricted firms.

Findings in this research refute some statements in prior studies. First, in previous research on the impact of the U.S.-China trade war on Taiwan's stock market (Chen, 2019; Chang, 2019; Yeh, 2019; Lee, 2019), studies have shown that there is a negative response no matter in a whole market perspective or specific industry perspective. In fact, a positive response in IC industry is discovered in the study, which manifests Taiwan's advantages under the trade war between the U.S. and China. Second, according to the previous study (M. S. Chen, 2020), the order-transfer effect might disappear if the U.S. used a stricter action, but the evidence from the stock price of Taiwan's IC industry during the trade war has disproved this statement. Actually, the order-transfer effect became even stronger when the U.S. took bans on Huawei's subsidiaries and SMIC.

This study has demonstrated the order-transfer effect by the event study method, and clarified the relationship between the industry chain position and the stock return, which contributed to the industry and researchers a clear understanding of the U.S. and China trade war on Taiwan's IC industry. However, there are some limitations in this study, which are mentioned for future research. First, this study has proved the order-transfer effect by investigating the stock return of Taiwan's IC firms under the U.S. and China trade war, which is indirect evidence. Subsequent analysis of the direct evidence to figure out the supply chain structure of the IC industry before and after the IC industry may create an in-depth research. Second, limited by the small quantities of observations on the third event, that only six samples in the wafer foundry group, the methodology this study used might cause the inaccuracies, and the nonparametric statistics method can be used for future study. Third, this study is limited by event days for two reasons. The first reason is that only three key events can not represent the whole U.S. and China trade war. Another reason is that the results might be contaminated by other events that happened on the same day.

## Reference


Amiti, M., Redding, S. J., & Weinstein, D. E. (2019). The Impact of the 2018 Tariffs on Prices and Welfare. *Journal of Economic Perspectives, 33*(4), 187-210.

Archibald, R. B., & Feldman, D. H. (1998). Investment During the Great Depression: Uncertainty and the Role of the Smoot-Hawley Tariff. *Southern Economic Journal, 64*(4), 857-879.

Boehmer, E., Masumeci, J., & Poulsen, A. B. (1991). Event-Study Methodology Under Conditions of Event-Induced Variance. *Journal of Financial Economic, Elsevier, 30*(2), 253-272.

Brenner, M. (1979). The Sensitivity of the Efficient Market Hypothesis to Alternative Specifications of the Market Model. *The Journal of Finance, 34*(4), 915-929.

Carvalho, M., Azevedo, A., & Massuquetti, A. (2019). Emerging Countries and the Effects of the Trade War Between US and China. *Economies, MDPI, Open Access Journal, 7*(2), 1.

Chang, Y. C. (2019). The Impact of the US-China Trade War on the Firm's Stock Returns. Master thesis, National Chung Cheng University.

Chen, M. S. (2020). The Potential Influence of US-China Technology Wars on Taiwan's High-Tech Industry. Master thesis, National Sun Yat-sen University.

Chen, Y. C. (2019). Taiwan Companies' Stock Price Reaction to US-China Trade War. Master thesis, National Chung Cheng University.

Chen, Y. H. (2020). The Effects of Tariffs and Export Controls under Trade War on the Service and High-tech Industries in the United States. Master thesis, National Chiao Tung University.

Crandall, R. W. (1987). The Effects of US Trade Protection for Autos and Steel. *Brookings Papers on Economic Activity, 18*(1), 271-288.

Egger, P., & Zhu, J. Q. (2019). The U.S.-Chinese Trade War: An Event Study of Stock-Market Responses. CEPR Discussion Paper No. DP14164.

Fama, E., Fisher, L., Jensen, M. C., & Roll, R. (1969). The Adjustment of Stock Prices to New Information. *International Economic Review, 10*(1), 1-21.

Freund, C., Maliszewska, M., Mattoo, A., & Ruta, M. (2020). When Elephants Make Peace: The Impact of the China-U.S. Trade Agreement on Developing Countries. Policy Research Working Paper No. 9173. World Bank, Washington, DC.

Huang, Y., Chen, L., Liu, S., & Tang, H. (2019). Supply Chain Linkages and Financial Markets: Evaluating the Costs of the US-China Trade War. In M. A. Crowley (ed.), *Trade War: The Clash of Economic Systems Endangering Global Prosperity* (pp. 65-72). London: Cepr Press.

Irwin, D. A. (1997). Trade Policy in the 1930s From Smoot-Hawley to Reciprocal Trade Agreements: Changing the Course of U.S. Trade Policy in the 1930s. NBER Working Papers 5895, National Bureau of Economic Research, Inc.

Irwin, D. A. (1998). The Smoot-Hawley Tariff: A Quantitative Assessment. *The Review of Economics and Statistics, 80*(2), 326-334.

Lee, Y. C. (2019). The Impact of the China-United States Trade War on the Stock Prices of the Electronic Parts and Components Manufacturing Industry and the Semi-conductors Manufacturing Industry in Taiwan. Master thesis, National Chiao Tung University.

Peterson, P. P. (1989). Event Studies: A Review of Issues and Methodology. *Quarterly Journal of Business And Economics, 28*(3), 36-66.

Plummer, M. G. (2019). The US-China Trade War and Its Implications for Europe. *Intereconomics, 54*(3), 195-196.

Setiawan, B. (2020). Does US-China Trade War Matter on ASEAN Stock Market: Event-Study Approach. *SIJDEB, 4*(3), 161-174.

Wang, X. Q., Wang, X. Y., Zhong, Z., & Yao, J. N. (2020). The Impact of US-China Trade War on Chinese Firms: Evidence From Stock Market Reactions. *Applied Economics Letters*. DOI: 10.1080/13504851.2020.1764477.

Yeh, H. J. (2019). The Impact of US-China Trade War on the Stock Prices of Taiwan's Networking Communication Industry. Master thesis, National Chiao Tung University.