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US-China Trade Conflict and the Dynamics of Chinese Semiconductor Companies' Stock Prices

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ABSTRACT
Beginning in the spring of 2018, the U.S.-China trade conflict officially began. This paper focuses on the impact of several U.S. tariff increases on China on Chinese exports in this context. As the U.S. stopped supplying chips to China and clamped down on Chinese semiconductor industry sales in the U.S., it led to a stock market shock in the Chinese semiconductor industry. Using the empirical results in the daily stock indices so far in 2018, it can be concluded that the impact of the U.S. tariff hikes on China's semiconductor industry is temporary and, on the contrary, may have a greater impact on the U.S. import and export trade. Not only that, this action could activate the development of Chinese national technology in the short term. The U.S. sanctions against China also further illustrate that China, as the second-largest economy in the world, has threatened the economic position of the U.S., and therefore the tariff increase is nothing more than a threat to control China.

Keywords: *U.S.-China trade conflict, semiconductor industry, stock yield volatility, tariff hikes*

1.INTRODUCTION

In recent years, with the deepening of trade between China and the United States, some Chinese products have seized the U.S. market. Undeniably, low-priced Chinese products with better quality are more popular. Putting the U.S. in a passive situation with a trade deficit. This makes the U.S. side that this is not fair reciprocity in trade, and therefore to increasingly occupy the U.S. market of Chinese products to take certain measures to maintain the U.S. intellectual property. The U.S. side wants to continue to dominate the downstream industries so the U.S. began imposing tariffs on China. On March 22, 2018, the United States first decided to impose tariffs on nearly $60 billion in imports from China. Subsequently, the United States continued to impose four tariffs on China. China has done the same to the U.S. side to resist this U.S. action.

From a general perspective, according to China Customs statistics in 2018, the total value of China's foreign trade imports and exports was ￥30.51 trillion, up 9.7% from 2017. Of which exports accounted for 53.9%, up 7.1% year-on-year, with a trade surplus of ￥2.33 trillion. It’s clear from Fig.1, China's exports, as well as its trade balance, were affected by the tariffs imposed by the United States on Chinese goods, and in March 2018 China's trade balance was negative.

On the other hand, The U.S.-China trade conflict also puts the U.S. in a trade deficit situation, and in 2018 the U.S. trade deficit amounted to $872.047 billion more than the previous year by about 10.05%, of which the U.S. trade deficit with China was 4,189.45, which can be seen as one of the main sources of the U.S. trade deficit. It is undeniable that the US-China trade conflict will have a negative impact on trade between the two countries. After several negotiations and four tax increases, the situation gradually eased in 2019. However, from a long-time perspective, a growing number of experts believe that the trade conflict between China and the United States will be difficult to eradicate will always exist.

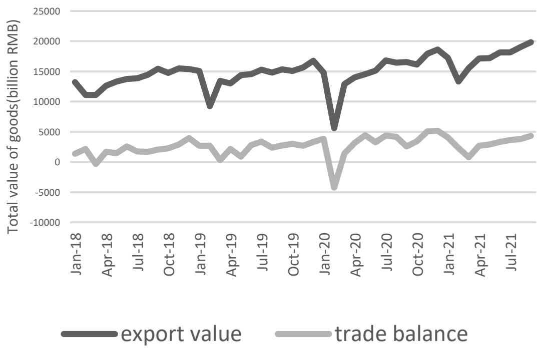

Figure 1 The value of China's exports and trade balance since January 2018

In the face of the continuous development of the information age, the semiconductor industry came into being. Semiconductor industry which is the upstream industry, and belongs to the Chinese industry gap so China needs to import a large number of semiconductor chips in the United States, this behavior China is in a passive situation.

So far, the semiconductor industry has experienced three industry shifts. The semiconductor industry originated in the 1930s, and the existence of semiconductors was not recognized by academia until the purification of materials was improved. In the 1940s opened the third industrial revolution of mankind, some research institutions, military, and universities in the United States began to pay attention to the application of semiconductor materials and research. In addition, the national policy support and economic boom also greatly boosted the semiconductor industry. The advent of computers during the third industrial revolution was a turning point for semiconductor materials. Computers have always been too large and inconvenient to handle because the advent of the chip made the size of computer components much smaller. In the 1960s， this demand has given rise to the semiconductor industry. In the 1970s to 1980s, the semiconductor industry grew rapidly in Japan, resulting in the emergence of many top-tier chip makers. The last industrial shift occurred in the early 21st century when China gradually took over the semiconductor industry.

According to the existing research: mainly through the semiconductor history, the details of the instruments taken by the U.S. government against the semiconductor industry in the past 40 years and the socio-economic impact on the society are presented. And the fluctuations caused by the US-China trade conflict on China's imports and exports are summarized [1]. There are now also studies on the impact of the US-China trade conflict on the Chinese stock market. Most of the research is about the impact of the US-China trade conflict on the Chinese stock market as a whole. The study analyzes the impact on various Chinese industries in terms of the timing of several U.S. tariff increases on China. An empirical study is made on whether the trade conflict between the U.S. and China is a ‘contagious effect’ or a ‘present value effect’ on the Chinese stock market, and it is concluded that it is mainly a ‘contagious effect’ [2]. The above literature has laid a deep foundation for the study of this paper. At this stage, however, there are relatively few studies on the impact of the U.S.-China trade conflict on the stock price volatility of the Chinese semiconductor industry, so this paper will use an empirical study to add to the field by addressing the reflection of this industry in the U.S.-China trade conflict.

The following part of the paper is organized as follows: Section 2 is the background of U.S.-China trade conflict and the semiconductor industry stock prices (for one company: SMIC); Section 3 contains time series models and econometric models; Section 4 contains the impact of the tariff increase on the stock price volatility of the Chinese semiconductor industry which is based on the time points of the five tariff increases imposed by the U.S. on China; Section 5 is the conclusion.

2. BACKGROUND AND DATA

2.1. Background

On March 22, 2018, the US President signed a memorandum in the White House deciding to impose the first tariffs on China, a move that officially opened the trade conflict between the US and China as well. So far, the U.S. has imposed five tariffs on China, the U.S. and China had agreed to a pause in the trade conflict, though the U.S. has continued to impose tariffs on China. Not only that, but on June 16, 2018, it announced a tariff increase to 25% on China. Immediately thereafter, China retaliated by resuming tariffs on the United States. According to Table 1, the tariff escalation has had a huge impact on U.S. companies that import raw materials from China, a fourth round of Section 301 tariffs was threatened before the truce [3].

Table 1 Section 301 Tariffs on Imports from China: Actual and Threatened Tariff Hikes.

Date	Import Value	Tariff Hikes	China’s Reaction
July 6,2018	$34 Billion	25%	Full retaliation
August 23,2018	$16 Billion	25%	Full retaliation
September 24,2018	$200 Billion	10%(increased to 25% on 1/1/2019)	5-10% tariff hikes on $60 billion worth of imports
After trade talks deadline	$267 Billion		
Total	$517 Billion		

Note: The table uses the data from Steinbock D.'s paper

Then in 2019, the U.S. began to crack down on China's technology industry, and in communications Huawei became a key target of U.S. crackdowns, placing Huawei on the U.S. regulatory blacklist on May 15. And China responded to this U.S. move in June by raising tariffs on $60 billion worth of U.S. goods from 5% to 10%. China's semiconductor industry is strongly dependent on U.S. core technology, and Huawei is one of the largest potential customers for U.S. technology companies. Huawei purchases about $110 billion of semiconductor products every year [4]. Therefore, this fact has also caused a huge shock in the stock market of the Chinese semiconductor industry. But it has also prompted the development of China's national technology industry, and to break away from the dependence on U.S. chip technology, Chinese companies have invested in independent research and development.

2.2. Data

The data in this paper is sourced from the General Administration of Customs of China database, which reflects the total volume of China's exports from January 2018 to date as well as the trade surplus. The stock data of semiconductor companies (semiconductor manufacturing international corporation) for the empirical part are obtained from Yahoo Finance (from December 22, 2017, to November 8, 2021). This paper uses log returns to calculate the volatility of the stock index (represented by a semiconductor company) following the U.S. tariff increase on China. The dataset contains all include data from the first tariff increase on March 22, 2018, to the fifth tariff increase on August 1, 2019, providing a complete picture of the impact of the U.S.-China trade conflict on Chinese semiconductor companies.

3. EMPIRICAL RESULTS AND ANALYSIS

3.1. Research design

This section focused on the time series analysis of the logarithmic statistics of the daily stock data obtained to test whether their log prices, as well as log returns, were stationary. This was followed by a unit root test using the log returns, and the log returns were ordered using the partial autocorrelation function (PACF). The mixed autoregressive moving-average model (ARMA) was constructed to determine the order of the autoregressive model (AR) and moving-average model (MA) components separately. Dummy variables were added around the time of the five tariff increases to determine the volatility of stock prices.

3.2. Constructing the model:

3.2.1. Unit root test

The stationarity of the time series data can be easily derived from the unit root test to perform cointegration analysis. If there is a unit root in the time series data, the data set is non-stationary. Generally, the data can be made smooth by differencing it. In this paper, we mainly use the ADF test in the unit root test.

According to the unit root test, we can use the following two models[5]:

$$p_t = \phi_1 p_{t-1} + e_t \tag{1}$$

$$p_t = \phi_0 + \phi_1 p_{t-1} + e_t \tag{2}$$

where e_t is the error term, considering the $H_0: \phi_1 = 1$ and $H_1: \phi_1 < 1$. This is a unit root test. ordinary least square (OLS) method is mainly used for parameter estimation of linear regression. Specifically, the minimum value of the sum of squares of the difference between the actual value and the estimated value is found, and let this value be used as the estimate of the parameter. The principle of OLS linear regression is that the best-fit curve should minimize the sum of squares of the residuals from each point to the straight line. From the ordinary least square method, we know that

$$\hat{\phi}_1 = \frac{\Sigma_{t=1}^{T} p_{t-1} p_t}{\Sigma_{t=1}^{T} p_{t-1}^2} \tag{3}$$

The smoothness of the time series data is determined by the unit root test (ADF test). The p-value in the ADF test is used to determine whether the original hypothesis is accepted and thus whether the time series data are stationary. To assign an order to the mean equation, we use a partial autocorrelation function(PACF) to obtain the following equation.:

$$r_t = \phi_{0,1} + \phi_{1,1} r_{t-1} + e_{1t}$$
$$r_t = \phi_{0,2} + \phi_{1,2} r_{t-1} + \phi_{2,2} r_{t-2} + e_{2t}$$
$$r_t = \phi_{0,3} + \phi_{1,3} r_{t-1} + \phi_{2,3} r_{t-2} + \phi_{3,3} \gamma_{t-3} + e_{3t}$$
$$\ldots\ldots \tag{4}$$

until $\phi_{n,n}$ of some order is not statistically different from 0 ($\hat{\phi}_{n,n}$converges to 0).

The number of lags of the ARMA model can be obtained by a unit root test. Based on the unit root test we can conclude whether the price, as well as the return of the stock, is stable or not.

3.2.2. ARMA-GARCH model

In this section, the ARCH-GARCH model is used to better predict stock prices and effectively derive the trend of stock returns compared to traditional models. In addition, ARMA can explain the linear part of the ARMA-GARCH model while the nonlinear part is modeled by the GARCH model when studying the impact of stock price volatility.[6]

To observe the single stock return volatility, an ARMA model is first developed. The model is as follows:

$$r_t = \phi_0 + a_t + \sum_{i=1}^{p} \phi_i r_{t-i} + \sum_{i=1}^{q} \theta_i a_{t-i} \tag{5}$$

In (5), r_t represents the log return of a single stock at the selected time and r_{t-1} represents the return in the past period. a is a white noise series with a mean 0 and variance σ_a^2 , representing the external adverse shocks to stock volatility caused by the U.S.-China trade conflict. Then partial autocorrelation function (PACF) is applied to fix the order for the AR model. To find the substantial effect of external disturbances on stock returns, the perpetually smooth MA model is constructed. We find the mean equation of the log return of this stock and the variance equation was obtained by Maximum Likelihood Estimate (MLE).

Engle proposed in 1982 that special heteroskedasticity also exists in time series data i.e. autoregressive conditional heteroskedasticity[7]. In general, if the current or past stock price fluctuations are high, the likelihood of higher stock price fluctuations in the future is also higher. In this part, we use the GARCH model can adequately describe the change in the volatility of asset returns. In this case, the GARCH model can better predict the impact of stock price fluctuations of one semiconductor company on the stock market of the entire semiconductor industry. This model is set as follows:

$$a_t = \sigma_t \varepsilon_t \,,$$

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i a_{t-i}^2 + \Sigma_{j=1}^{s} \beta_j \sigma_{t-j}^2 + \gamma \qquad (6)$$

In (6), a_t denotes innovation at time t. $\{\varepsilon_t\}$ is the standard normal distribution, which represents a sequence of random variables. The degree of disturbance of the tariff increase on the SMIC stock volatility can be known based on the effect of the disturbance on the return.

3.2.3. Add dummy variables to the ARMA-GARCH model

To further understand the effect of external conflicts on the series we decided to add dummy variables to the ARMA-GARCH model. Dummy variables are included to impose additional constraints on the parameters of the regression equation, allowing factors that are not dependent variables to be taken into account in the regression. In traditional regression analysis, the dependent variable estimates are not necessarily unbiased may have some errors, and adding dummy variables can effectively reduce such errors [8]. To fundamentally obtain the impact of the tariff increase in the US-China trade conflict on the semiconductor industry, the inclusion of dummy variables allows for a more accurate regression analysis to derive trends in stock price volatility.

4. EMPIRICAL RESULTS AND ANALYSIS

This section uses the SMIC share price as well as the daily index of share price returns from year-end 2017 to November 2021 and performs an empirical study of the above methodology on this data. First, we perform a unit root test to report the order of the ARMA model and prove the smoothness of the series. We then added dummy variables and kept adjusting the number of dummy variables to infer the next results based on the coefficients and significance of the obtained dummy variables. Table 2 and figure 2 show the results of the unit root smoothness test.

Figure 2 Change in stock price return over time

Note: In this figure, the horizontal coordinate represents time and the vertical coordinate represents the logarithmic return of the stock.

Table 2 Unit root test

Variables		t-Statistic	P-value
Price		-2.562	0.2977
Rate of return		-21.373	0.0000
Test critical values	1% level	-3.960	
	5% level	-3.410	
	10% level	-3.120	

Note: In this table, the results of unit root tests for stock prices as well as stock returns are given.

The p-value of the stock price is greater than 0.05, so the original hypothesis is accepted that there is a unit root the series is non-stationarity. While the p-value (The p-value is 0.000, therefore, it is extremely significant) for the logarithmic stock returns is less than 0.05, and therefore the original hypothesis is rejected i.e. the hypothesis that the series is stationarity holds.

Figures 3 and 4 show the separate orderings for the AR and MA components. Using the autocorrelation function as well as the partial autocorrelation function it is possible to determine a representative process that is sufficiently robust to diagnostic tests and can be used for meaningful parameter estimation [9].

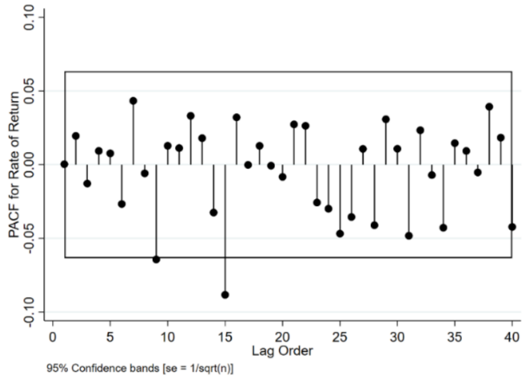

Figure 3 PACF

Note: This figure shows the order of the mean equation, the truncated tail of the partial autocorrelation function at n = 9, and the value of the partial autocorrelation function beyond the restricted domain.

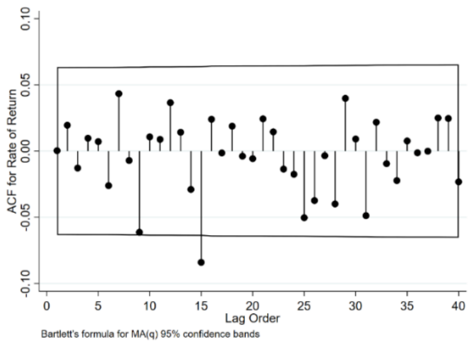

Figure 4 ACF

Note: The results of the autocorrelation function indicate a truncated tail in the autocorrelation coefficient at n=15.

In the ARMA model, we use the autocorrelation function and the partial autocorrelation function to order the log-returns of the stock and thus determine the lag order. The ARMA (9,15) model is fitted to predict the trend of stock price return volatility and the external shocks of the US-China trade conflict.

Next, to analyze the changes in the volatility of this series, we set up an ARMA-GARCH model. The variance model allows to analyze the perturbation of the overall series before and after the occurrence of this external factor, and the use of a multivariate generalized autoregressive conditional heteroskedasticity model allows to parameterize the perturbation brought by the factor. If we want to further investigate the asymptotic nature of the parameters one needs to perform a test of multiple order moments [10]. In Figure 5, the ARMA-GARCH model is described as follows:

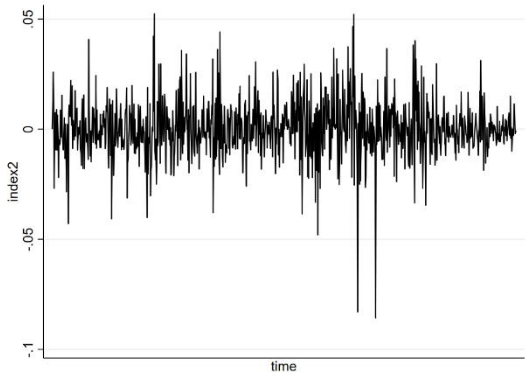

Figure 5 Volatility of return

Note: The index2 variable with horizontal coordinate denoting the time vertical coordinate is the volatility of the logarithmic stock return.

Table 3

Set dummy variables - US announces 5 tariff hikes on China
GARCH model, variance equation

	(1)	(2)	(3)	(4)	(5)
Time points 1 and later	-0.2964	0.4026	0.4074	0.3868	0.3975
	(0.7832)	(1.0673)	(1.0678)	(0.9899)	(1.0106)
Time points 2 and later		-0.5956	-0.7169	-1.0160	-1.0482
		(0.5445)	(1.6990)	(2.0050)	(2.0936)
Time points 3 and later			0.1209	1.2485	1.3021
			(0.9330)	(1.9289)	(2.0165)
Time points 4 and later				-1.0177**	-4.4286
				(0.4337)	(36.6592)
Time points 5 and later					3.4484
					(36.6107)

ARCH	0.0569***	0.0567***	0.0568***	0.0528***	0.0525***
	(0.0069)	(0.0068)	(0.0068)	(0.0067)	(0.0067)
GARCH	0.9366***	0.9369***	0.9368***	0.9393***	0.9399***
	(0.0047)	(0.0047)	(0.0047)	(0.0048)	(0.0048)
Constant	-13.1669***	-13.3432***	-13.3414***	-13.2984***	-13.3284***
	(0.7999)	(0.9336)	(0.9330)	(0.8540)	(0.8750)

Note: Robust standard errors of clusters are reported in parentheses, and the estimated results are rounded-up to 4 digits after the decimal point. ***, **, and * indicate the level of significance of 1%, 5%, and 10%, respectively.

Dummy variables were added from each of the five tariff hikes at the point of time for significance analysis. The results from the estimation of the variance equation show that the coefficients of most of the dummy variables are insignificant, the only result with a significant coefficient is in column (4), but the coefficient is negative and the significance of the period disappears after the inclusion of all the dummy variables.

These results suggest that in the long run, the act of imposing tariffs on China following the U.S.-China trade conflict initiated by the U.S. has little impact on the volatility of stock returns in the Chinese semiconductor industry. Not only that the impact of the U.S.-China trade conflict on long-term Chinese export trade is negligible. According to the General Administration of Customs of China 2021 first eight months trade surplus with the United States was 1.54 trillion yuan, an increase of 16.9%. Therefore, combined with the above basic facts, it can be inferred that the impact of the US-China trade conflict on the Chinese stock market is short-lived and does not affect the long-term healthy development of the Chinese economy.

5. DISCUSSION

This paper finds that it is unrealistic for the U.S. to impose tariffs on China to limit China's trade surplus. While it does produce some adverse shocks in the short run, however, in the long run, China's positive trade trend is largely unaffected by the tariff hike. This is consistent with previous literature concluding that the U.S. action of restricting the actions of the Chinese semiconductor industry in the U.S. is short-sighted and would even hurt the U.S. more than China [11]. At the same time, this disdain for international supply chains greatly affects the global economy. Compared with previous studies this paper focuses more on the analysis of the empirical results, taking a representative semiconductor company as an example to analyze the industry as a whole. Data and time-series models are used and dummy variables are used to replace the external factor of the tariff increase. The volatility of the stock market returns of the semiconductor industry due to the US-China trade conflict is shown more specifically.

This study uses actual daily data to progressively analyze the adverse effects of the conflict on the stock market in the short term. In addition, this paper uses data for a period of time after the end of the tariff increase, which can effectively argue the extent of the long-term impact of the tariff increase.

The future direction of the research is mainly to integrate the existing data and add the stock returns of other representative companies in the semiconductor industry, and we will focus on analyzing the global volatility rather than just one stock. Second, it is possible to explore the long-term effects of trade tensions between the U.S. and China on the level of trade between the two countries.

6. CONCLUSION

The U.S.-China trade war began as a "revolt" by the U.S. government against China's unfair trade practices, but it is essentially a U.S. sanction against Chinese industries that have long-run trade surpluses and dominate the U.S. market. Deeper down, it is a dispute between the two superpowers, China and the United States. There is no doubt that a global bilateral trade war would cause a loss of trade to third parties and would likely prompt an adjustment in Chinese policy in the face of escalating U.S. tariffs against China, which is what is happening. Since the start of the trade conflict between the United States and China, the global trade structure is gradually changing, with far-reaching effects not only on China and the United States but also on the political systems of Europe and other countries in Central Asia. The conflict between the two largest economies in the world is leading to the collapse of global trade[12]. In 2018, the U.S. passed the Export Control Reform Act (ECRA), which became the trigger for the trade conflict between China and the United States. Through the Sino-US trade conflict, China's semiconductor industry has been severely shaken, and the root cause is that China's semiconductor industry is overly dependent on the core technology of the United States. In a way, the US-China trade conflict also promoted the development of national technology. In the study of this paper, the ARMA-GRACH model is applied to study the daily index of SMIC stock returns. The largely plausible conclusion is obtained through a certain time horizon: in the short run, the U.S. tariff increase will cause stock price volatility in the semiconductor industry; however, in the long run, the semiconductor industry will no longer be affected by this

U.S. action [13]. Ultimately, there may be greater losses to the U.S.

A trade conflict between two huge economies, China and the United States, would be extremely detrimental to the entire world economy. China and the United States should take concerted action to find common ground in their trade and raise the world economy to a mutually beneficial level. In the future, it is also essential for both sides to reach an agreement and keep their commitments to enhance the cooperation and mutual benefit of bilateral trade between China and the United States [14]. In addition, the Chinese semiconductor industry should continue to grow through the trade conflict. Developing national core technology and getting rid of the passive situation can essentially contact the U.S. trade restrictions on the Chinese side.

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