Trade Conflict and Dynamic Changes in International Listed Company Stock Price: Evidence from Tesla

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Abstract. The occurrence of Sino-US trade war makes listed companies engaged in import and export trade bear two-way pull. On the one hand, the appreciation of the dollar to attract global capital into the U. S. markets, is a favorable contributing factor to rising stock prices; on the other hand, the trade protection policy of the United States has caused other countries to fight back. The increasing trade barriers have made the revenue of import and export enterprises decline, which is an unfavorable factor for stock prices. This paper selects Tesla, an international listed company, as the research object. The dynamic relationship between Tesla stock price and USD/RMB exchange rate is analyzed without any prior constraint, and then ARMA-GARCH model is constructed to simulate and predict stock return and volatility after introducing exchange rate as external explanatory variable, and based on the empirical results, puts forward reasonable and feasible suggestions for the development of international listed companies.

Keywords: China-US Trade War; Stock Market; Exchange Rate; VAR Model; ARMA-GARCH Model.

1. Introduction

On April 4, 2018. US president Trump placed tariffs on aluminum and steel imports with the intention of containing Chinese production and impose additional tariffs on Chinese goods in response to Beijing's intellectual property policies. It is the start of multiple rounds of tit-for-tat retaliation until nearly all Chinese imports are under U.S. tariff coverage. For the first time in decades, the Treasury Department classified China as a currency manipulator in 2019, and the U.S. Congress enacted legislation strengthening export controls for high-tech goods and enhancing CFIUS's authority.

The US-China trade friction has influenced automobile industry in two main areas: Firstly, in the area of import and export trade where companies like Tesla have long planned its trade strategy to maximize their profits; and secondly, in areas of cross-border capital flows where the United States has become the biggest beneficiary.

It's hard to affirm whether the continuous shift in US-China trade relation and the tension between these two countries will be good or bad for new energy car companies like Tesla, especially their stock market performances.

Considering the positive effect: The Fed's interest rate hike in 2018 in line with the Trump administration's policy of reviving domestic industries led to a rise in the US dollar, which resulted in international capital flows. Investors in the international capital market will increase their holdings of US dollars due to the influence of profits-pursing factor. As the US dollar against RMB exchange rate continues to rise, further short the RMB and go long in US dollar. Through theoretical analysis, the possible consequences of dollar appreciation are as follows: the increase in international capital holdings of US dollars and the large inflow of global hot money into the United States are likely to cause a significant amount of dollars to flow into the stock market or bond market of the US, which means that there is a net inflow of capital in the US, and similarly, there is a net outflow of foreign capital. The immediate economic effect of this action is to raise stock prices or yields in the United States stock markets. From the perspective of negative effect, dollar appreciation means an increase in the purchasing power of the US dollar, which will certainly promote U.S. imports and curb the exports of the U.S. enterprises. Similarly, this will promote the export of foreign enterprises and inhibit China's imports. There are a large number of multinational enterprises in the U.S. markets.

Inhibition of exports will obviously harm the interests of these enterprises, but will promotes the interests of foreign export-dependent enterprises. In addition, as an American company operation globally, Tesla's final income is denominated in dollars. If this paper considers the basic economic assumption that companies can't adjust product prices in the short term, then a stronger dollar will reduce Tesla's operating income in disguised form. From the above possible economic results, it is impossible to directly judge which of the consequences caused by the Fed's interest rate hike is dominant. If the former consequence prevails, then Tesla's share price or yield will increase as the exchange rate rises, otherwise the latter two mechanisms of influence prevail, or these effects cancel each other out.

This paper will take Tesla as a case to study the relationship between foreign exchange market and stock return of listed companies under the background of Sino-US trade war. Tesla is selected as the research object because the automobile industry is one of the industries with the deepest degree of production globalization and trade globalization. Especially for Tesla, China not only plays an increasingly important role in its value chain, but also is the most important part of its overseas market.

The remaining parts of this paper are organized as follows: Part 2 is the literature review, including the causes and impacts of US-China trade war, its impact on the capital market, and the research of the automobile industry and Tesla. The current research and research gaps are summarized in the end. Then, part 3 is research design, including data source, ADF test and model specification. After that, the fourth section will conduct a VAR model analysis using the relevant data obtained, followed by the ARMA-GARCH model analysis. The empirical results will be used to demonstrate the impact of USD/CNY exchange rate on Tesla stock. Finally, this paper draws conclusions and give feasible and innovative suggestions for the future of US-China trade together with listed enterprise development.

2. Literature Review

2.1. Studies Related to US-China Trade War

In March 2018, the United States began to raise taxes on Chinese imports; immediately after, the Chinese government responded. Chong and Li analyze the three main causes of Sino-US trade friction form both economic and political perspectives, which are: long-existing trade imbalance, the U.S. midterm election, and the race between US and China over global economic dominance. They assert that although temporary contributors like the U.S. midterm election will inevitably lose some of their immediate impact, fundamental factors like the economic conflict between the two greatest economies in the world will persist, indicating that Sino-US trade tension won't be addressed in the near future [1]. Analyzing the Sino-US trade friction from the perspective of the US administration (Presidency of Donald Trump). The study proved that the US government overestimated the trade deficits. The reduction of Chinese imports will not create jobs in the US. On the contrary, the US market will lose high-quality and cheap Chinese products and services, and the capital inflow of Chinese investors will also decrease due to policy uncertainty caused by the trade friction. The future of the trade conflict with China show that the US economy would be severely harmed, and fewer employment may be created, which will worsen the nation's economic imbalance [2].

2.2. Studies of Monetary Policy Uncertainty Relating to Trade War and its Influence on Stock Market

A mass of research explains how trade war affects import tariffs, investment, and output. A deterioration of the trade war would reduce China's gross domestic product (GDP) by 1.41 percentage points and the USs by 1.35 percentage points. The trade war has reduced imports and output in almost every industry in both countries [3].

US-China trade-related policy announcements have a noteworthy impact on the investment rate and stock prices of listed companies. Amiti and Weinstein develop a method to quantify the impact of policy announcements on the investment rate. According to their estimates, the tariff action will reduce investment growth by 1.9 percentage points for U.S.-listed companies by the end of 2020 [4].

But most of the scholars on the study of US-China trade friction focus on the import- export market, trade war itself and not take into account the background of China-US trade friction and the change of the economic policy, especially monetary policy.

In fact, monetary policy and capital markets are strongly correlated, for example, the implementation of a moderately easy monetary policy may be conducive to financial stability [5]. The consensus view is that monetary policy shifts are communicated to the stock market via a variety of channels, including changes in the value of individual portfolios, shifts in the cost of capital, and others. Bernanke and Kuttner found that the impact of unexpected monetary policy actions on expected excess returns accounted for the largest part of the reaction of stock prices [6]. In addition, the relationship between stock returns and monetary policy uncertainty is time variant. While there is no relationship between them in the long term, there is a bidirectional and negative relationship existing in the short term [7].

2.3. Studies of Automobile Industry and Tesla

China is playing an increasingly important role in the US automobile supply chain, and US automobile enterprises are gradually relying on importing parts and raw materials from China [8]. For example, Tesla once said that only Chinese Mainland can provide the flake or powder graphite needed by the company to produce batteries in the United States.

The trump administration's decision to impose tariffs on imported cars and auto parts from the United States will affect consumer prices, auto sales and worker employment. Relevant studies have proved that under serious circumstances, the price of cars in the United States may rise by 2750 dollars [9].

2.4. Review

In summary, there have been a lot of thorough studies on the causes, process, and effects of Sino-US trade frictions. In terms of the impact of trade wars on capital markets, existing research is confined to general stock market movements or bullish-bearish views of a single industry. There is still a lack of research on the relationship between the macroeconomic background of Sino-US trade friction and the dynamic changes of stock markets, namely, how does exchange rate affect capital market and stock return.

3. Research Design

3.1. Data Source

This paper uses the Choice financial terminal [10], a platform that is in conjunction with Yahoo Finance, to search and obtain dollar to RMB exchange rate (USDCNY) and stock price of Tesla. The period from September 1, 2017 (six months before the outbreak of the Sino-US trade conflict) to January 24, 2020 was selected as the study period. The original data set was formed by daily close price of Tesla and exchange rate between US dollar and RMB during this period.

3.2. ADF Test

In order to test whether USDCNY and Tesla stock prices are stationary time series, this paper first need to conduct unit root test (smoothness test) [11] for the construction of the following time series model. After simple logarithmic processing of the data, the P-value results of both variables were more than 0.9, which means that the null hypothesis of the existence of unit root could not be rejected. Therefore, I conducted the first difference on the two variables respectively, and the results showed that the P-value was 0, which is less than 0.1, so the original hypothesis could be rejected and the model was proved to be stationary and feasible (please see Table 1).

Table 1. ADF test.

Variables		t-statistic	p-value
Price			
	Tesla	-0.181	0.9919
	USD-RMB	-1.189	0.9126
Yield			
	Tesla	-17.535	0.0000***
	USD-RMB	-16.081	0.0000***

3.3. VAR Model Construction

VAR model is usually used to estimate the dynamic relationship of joint endogenous variables. It is realized by using all current period variables in the model to perform autoregression on several period lag variables of all variables.

Its advantage is that it does not need to distinguish between endogenous variables and exogenous variables, because the explanatory variables are all lagged variables, so it is easy to predict. During the establishment of VAR model, the following shall be determined:

(1) The number of variables with mutual influence. There are two variables in this paper: log return on Tesla stock and USD-RMB exchange rate.

(2) How many lag variables this paper needs to explain the endogenous variable K with mutual influence? The LR likelihood method is usually used to determine the maximum after order k.

One VAR (p) model can be written as:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + e_t \tag{1}$$

Where, c is a constant vector, A_i is a square matrix of orderN, and e_t is an error vector.

3.4. ARMA-GARCH model construction

To better forecast the variance of future stock return and volatility of Tesla stock, the ARMA-GARCH model is next applied in this paper. ARMA-GARCH models mean and variance separately, that is, a random process with mean value satisfying ARMA process and residual value satisfying GARCH process.

$$x_t = \varphi_0 + \sum_{i=1}^{p} \varphi_i x_{t-i} + a_t - \sum_{i=1}^{q} \theta_i a_{t-i} \tag{2}$$

Where, $\{a_t\}$ is a white noise sequence; p and q are both nonnegative integers;

Equation (2) denotes that $\varphi_0 + \sum_{i=1}^{p} \varphi_i x_{t-i}$ represents the AR(p) model, which uses the historical returns of Tesla stock to forecast the future; While $a_t - \sum_{i=1}^{q} \theta_i a_{t-i}$ which uses past volatility to estimate the future and the last part of the model.

GARCH model is set up based on the ARCH model, with the addition of autoregression ofσ_t^2. It is designed to reduce the number of parameters. It can simplify ARCH (p) as GARCH (1, 1) by iteration.

In this paper, three exchange rates are introduced into the equation as external explanatory variables, which are respectively defined asD_t, D_{t-1} andD_{t-2}. And the GARCH (p, q) model is set as:

$$\begin{gathered}\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 + \\ \gamma_1 \sigma_{t-1}^2 + \cdots + \gamma_p \sigma_{t-p}^2 + \beta_1 D_t + \beta_2 D_{t-1} + \beta_3 D_{t-2}\end{gathered} \tag{3}$$

From equation (3), the term $\alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2$ is the ARCH part, σ_t^2 is the conditional variance of the disturbance termε_t^2. The last part of the model $\beta_1 D_t + \beta_2 D_{t-1} + \beta_3 D_{t-2}$ denotes three external explainatory varibles, that is, the exchange rate of USD/CNY, and the impact of adding them on the stock returns of Tesla.

4. Empirical results and analysis

4.1. Model order for VAR

In this paper, the LR criterion is used to determine the model order. When the LR statistic is greater than the critical value, it is considered that the lag order of the VAR model is not high enough, and more lagged variables need to be added as explanatory variables. When LR statistic is less than the critical value, the lag order of VAR model is considered to be moderate. It can be seen from Table 2 that the order should be 18.

Table 2. VAR model identification.

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	3955.41				3.7e-09*	-13.7271*	-13.7212*	-13.712*
1	3959.24	7.6757	4	0.104	3.7e-09	-13.7265	-13.7088	-13.6812
2	3960.22	1.9547	4	0.744	3.8e-09	-13.716	-13.6866	-13.6404
3	3964.78	9.1248	4	0.058	3.8e-09	-13.718	-13.6767	-13.6121
4	3967.95	6.3354	4	0.175	3.8e-09	-13.7151	-13.662	-13.579
5	3969.21	2.5211	4	0.641	3.8e-09	-13.7056	-13.6407	-13.5392
6	3971.06	3.7001	4	0.448	3.9e-09	-13.6981	-13.6215	-13.5015
7	6974.07	6.0121	4	0.198	3.9e-09	-13.6947	-13.6062	-13.4678
8	3976.74	5.3521	4	0.253	3.9e-09	-13.6901	-13.5898	-13.433
9	3977.81	2.1299	4	0.712	3.9e-09	-13.6799	-13.5678	-13.3925
10	3980.77	5.9193	4	0.205	3.9e-09	-13.6763	-13.5524	-13.3587
11	3981.85	2.1598	4	0.706	4.0e-09	-13.6661	-13.5305	-13.3183
12	3983.52	3.3457	4	0.502	4.0e-09	-13.6581	-13.5106	-13.2799
13	3984.29	1.5283	4	0.822	4.1e-09	-13.6468	-13.4876	-13.2384
14	3986.84	5.1113	4	0.276	4.1e-09	-13.6418	-13.4707	-13.2032
15	3987.2	.72196	4	0.949	4.1e-09	-13.6292	-13.4463	-13.1603
16	3988.98	3.5631	4	0.468	4.2e-09	-13.6215	-13.4268	-13.1223
17	3991.09	4.2118	4	0.378	4.2e-09	-13.6149	-13.4084	-13.0855
18	3996.07	9.9653*	4	0.041	4.2e-09	-13.6183	-13.4001	-13.0587
19	3998.28	4.4211	4	0.352	4.2e-09	-13.6121	-13.382	-13.0222
20	3999.34	2.1124	4	0.715	4.2e-09	-13.6019	-13.36	-12.9817
21	4003.57	8.4666	4	0.076	4.2e-09	-13.6027	-13.349	-12.9523
22	4003.83	.52214	4	0.971	4.3e-09	-13.5897	-13.3243	-12.9091
23	4004.93	2.1965	4	0.700	4.3e-09	-13.5796	-13.3024	-12.8687
24	4006.63	1.4015	4	0.844	4.4e-09	-13.5682	-13.2791	-12.827

After completing VAR model estimation, it is necessary to test whether the residuals have autocorrelation and obey normal distribution. As shown in Figure 1, all eigenvalues are inside the unit circle, so the VAR system is a stationary process.

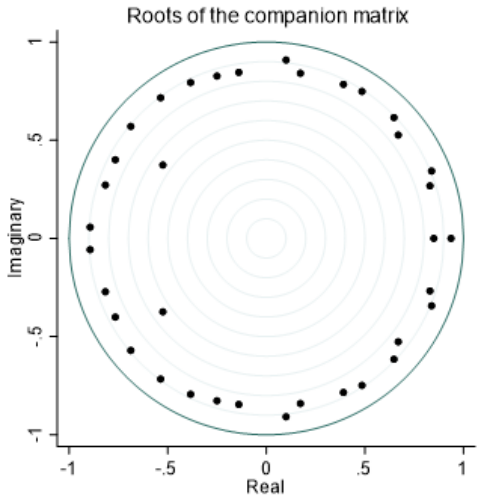

Figure 1. Unit circle test.

4.2. Impulse Response Function

In order to understand the mutual influence between variables and the degree of mutual influence, impulse response analysis is carried out in this paper. According to the estimation results of impulse response in Figure 2, one unit of exchange rate shock in t = 0 period will cause future Tesla yield to fluctuate around 0 value, but it is difficult to determine the net impact from the impulse response diagram alone. Accordingly, this paper further calculates the cumulative response function. As you can see from Figure 3, the cumulative impact of a one-unit exchange rate shock in the t = 0 period on the Tesla yield over the next 30 periods is slightly less than 3 %. Therefore, Tesla is a beneficiary in this round of rate hikes.

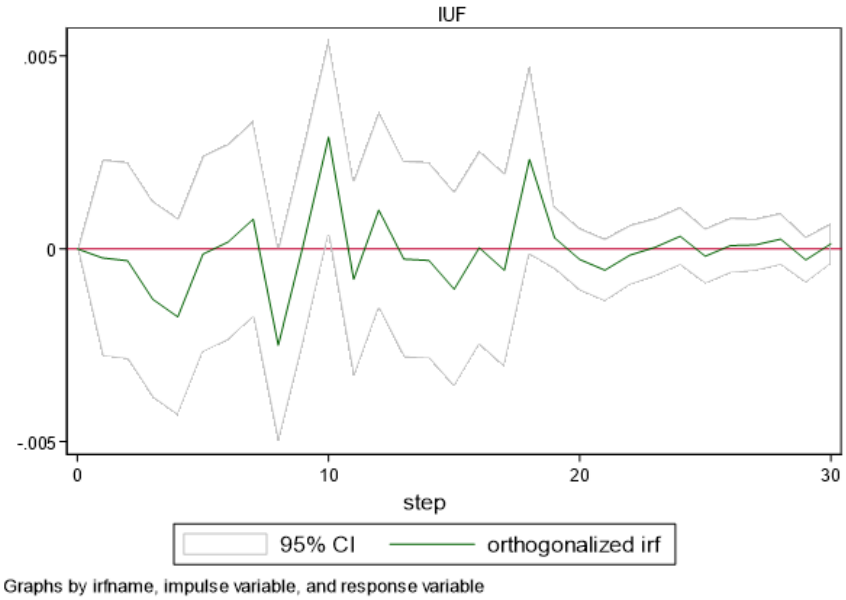

Figure 2. Impulse and response.

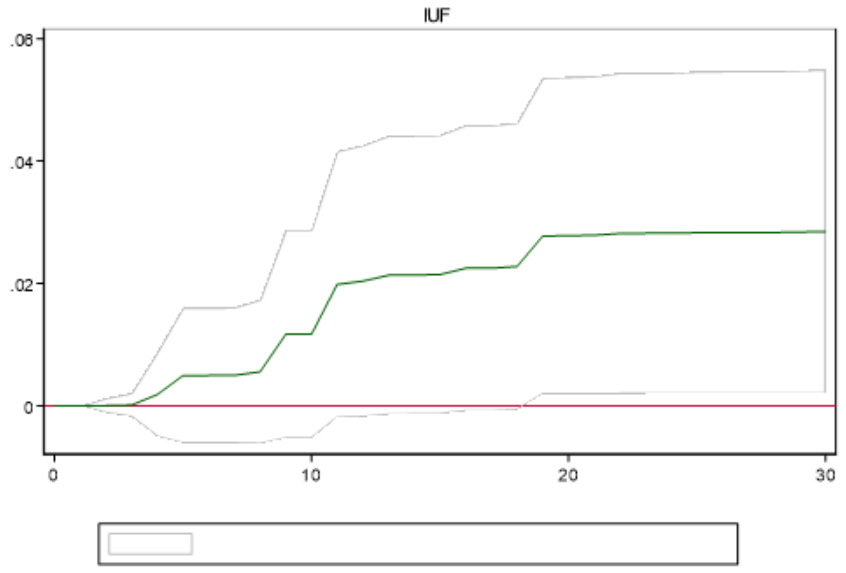

Figure 3. Cumulative response.

There are two mechanisms through which exchange rates affect stock prices, the first is transmission mechanism of financial institutions, which is mainly manifested on inflation, monetary policy, fiscal policy on international communication and effect. While the second is, the entity transmission mechanism, which is realized through the income effect, competitiveness effect, cheap-imports effect, and competitive devaluations effect. The correlation between exchange rate and stock return may be more apparent under the influence of financial system mechanism in the short run, but in the long run, it still returns to the level of entity transmission mechanism.

Taking Tesla as an example, from the perspective of international capital flow, the influx of hot money and global capital into the US market is a positive factor for its stock return. While from the perspective of enterprise operation, increased tariffs and trade barriers in the context of the trade war mean higher production costs, and the appreciation of the US dollar has created an export disadvantage for Tesla, which are negative factors for its stock price. The final result of this paper is that the appreciation of the US dollar is good for Tesla stock in the short term. The reason is that in the short term, the transmission mechanism of financial institutions that exchange rate affects stock returns plays a dominant role.

4.3. Model order for ARMA

In this section of the article, it is first necessary to order the first log-return series using the PACF and ACF pairs, the results of which are shown in Figure 4.

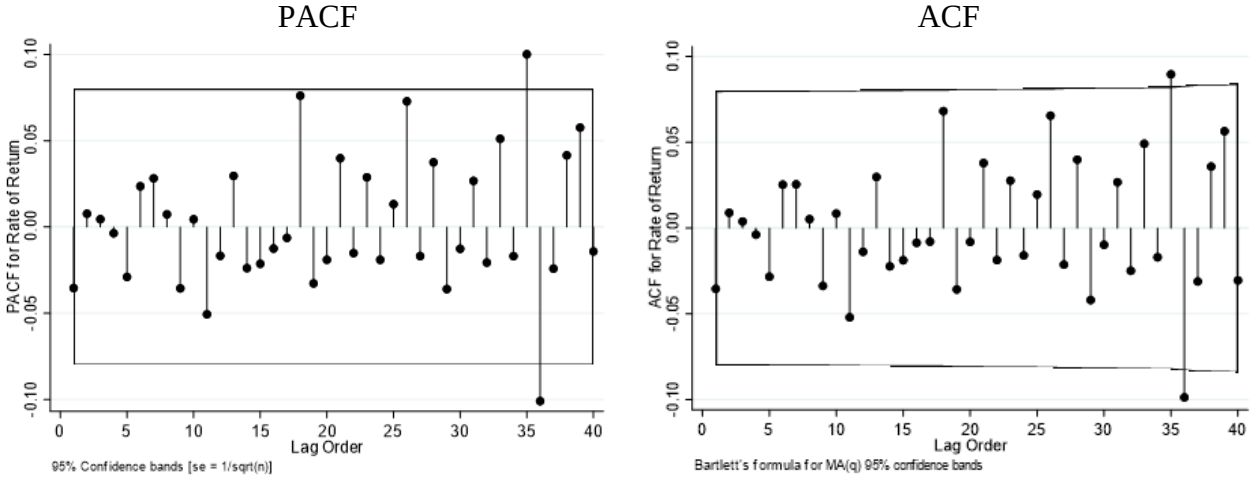

Figure 4. PACF and ACF.

This paper needs to order the log returns of the Tesla stock and present the results in the figure above. From the fixed order result of the two images in the first row in Figure 4, the first part beyond the x-axis is 35, so AR (p) is of order 35, MA (q) is also of order 35. i.e., the value of p and q is 35.

4.4. Estimation of ARMA-GARCH model

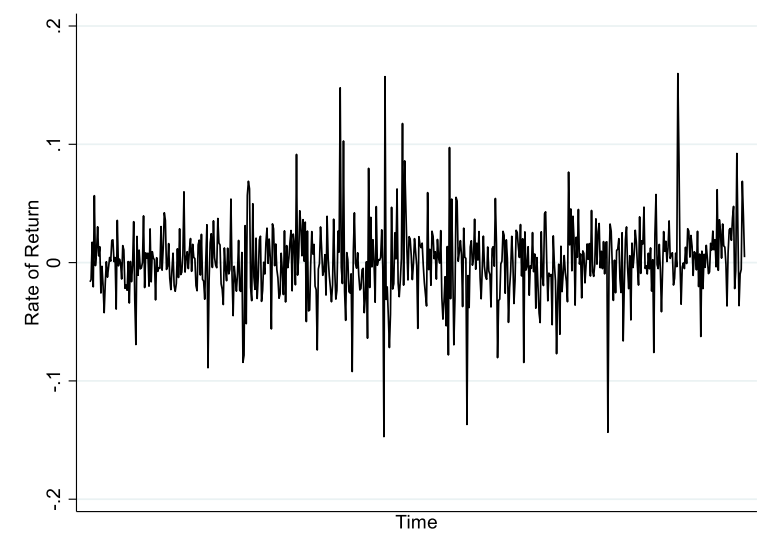

Figure 5. Yield.

From Figure 5, Tesla's return rate has obvious conditional heteroscedastic property, but whether this effect is statistically significant needs to be further empirically tested.

Table 3. ARMA-GARCHX estimation results.

	(1)		(2)		(3)	
	Coefficient	p>|Z|	Coefficient	p>|Z|	Coefficient	p>|Z|
			Mean equation			
AR, L35	.02297	0.972	.9339	0.000	-.2347	0.748
MA, L35	.0632	0.925	-.8961	0.000	.3007	0.678
Constant	.0006	0.640	.0007	0.644	.0008	0.500
			Variance equation			
USD-RMB						
L0	-72.3718	0.010	-124.7184	0.000	-117.5272	0.000
L1			173.6713	0.001	30.2516	0.462
L2					194.6589	0.000
GARCH (1, 1)						
ARCH	.0680	0.001	.0633	0.001	.07692	0.002
GARCH	.0768	.2284	.4173	0.000	1.31	0.192
Constant	-7.0636	0.000	-7.6306	0.000	-7.2259	0.000

According to the estimation results in Table 3, at least one ARCH term and GARCH term in the three-column model are statistically significant, indicating that Tesla's return rate has statistically significant conditional heteroscedastic property, which meets the basic requirements of GARCH modeling. According to the estimation results of external explanatory variables, exchange rate has a significant impact on Tesla volatility, but this impact has a lag.

5. Discussion

5.1. Analysis of the leading factors in the consequences of Federal Reserve rate hikes

The interest rate hike of the Federal Reserve leads to the rise of the exchange rate between the US dollar and RMB. On the one hand, global capital flows into the US financial market, which is a positive and favorable factor for the rise of stock returns. On the other hand, a stronger dollar means that the export advantage of American manufacturing decreases. For highly international listed companies, a series of tariff barriers associated with trade frictions can also lead to a significant increase in costs, which is a negative factor driving stock returns down. According to the empirical research results of this paper, the impact of the appreciation of the US dollar on Tesla's stock price is positive and has a certain lag effect. To some extent, this explains that global capital flows caused by exchange rate fluctuations play a leading role in the US stock market.

5.2. Comprehensive analysis from short term and long term

Empirical research shows that Tesla's stock price is bullish in the short term after the start of the US-China trade war. However, in the long run, trade friction or trade war is bound to reduce global trade and output. With the continuation of China's normalized epidemic prevention and control policy, the US-China friction at both political and economic levels, and the prevalence of global trade protectionism, global trade has shown a shrinking trend. In addition, the impact of exchange rate through the mechanism of financial institutions affecting stock prices will be covered by the entity transmission mechanism over time. How to stabilize global supply chains and global production, it is a big challenge for Tesla, a listed company that relies on the international market.

China, Tesla's largest overseas market, plays a pivotal role in its business layout. It was for this reason that Tesla first applied for a tax exemption in July 2018, which was rejected by the USTR in 2019. The result prompted a lawsuit against the Trump administration, again aimed at preventing the administration from imposing new tariffs on Tesla's imports from China. Tesla set up its first overseas factory in Shanghai, China in early 2020, reflecting its strategic determination to dig deep into the

Chinese market. This move is of great significance to circumvent tariff and trade barriers and implement localization strategies.

6. Conclusion

The occurrence of Sino-US trade war makes listed companies engaged in import and export trade bear two-way pull. On the one hand, the appreciation of the dollar to attract global capital into the U. S. markets, is a favorable contributing factor to rising stock prices; on the other hand, the trade protection policy of the United States has caused other countries to fight back. The increasing trade barriers have made the revenue of import and export enterprises decline, which is an unfavorable factor for stock prices.

Given the high degree of uncertainty in trade policies, trade frictions can significantly reduce global trade and production, and affect the stock returns of listed companies through various channels. This phenomenon has prompted many scholars to analyze how trade policies affect capital markets. This paper chooses Tesla, an American international listed company, as the research object, because of the Sino-US trade background and the global impact of US economic policies. This paper applies VAR model to analyze the dynamic dependence of stock prices and USDCNY exchange rates, and construct ARMA-GARCH model to analyze and predict the return rate and volatility of stock prices. The empirical results show that the exchange rate has a significant impact on Tesla's stock volatility, but this impact is lagging. Tesla benefited from the interest rate hikes and the subsequent appreciation of the US dollar during the study period.

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