

Fed's Monetary Policy and Dynamic Changes in Stock Prices of Large Supermarket Chain

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Abstract: The U.S. is experiencing the highest inflation in 40 years, and prices have been rising. The Fed adjusts this rate to achieve one goal - to maintain maximum employment and price stability in the United States. But the Fed's sharp rate hikes also raise the risk of a sharp slowdown, especially as new challenges emerge, such as Russia's war with Ukraine and China's capacity problems due to Covid lockdowns. This article assesses the impact of Fed rate hikes on the supermarket stock market. This paper builds a VAR model and an ARMA-GARCH model to analyze changes in stock prices from the perspective of value and volatility. This paper finds that Fed rate hikes unsurprisingly negatively impacted stock returns and increased their volatility, leaving stock prices in an unpredictable situation. The research paper can give the Fed a reference data. When the Fed decides to raise interest rates, it needs to consider the current world economic situation. For example, flu and war will affect the world economy, and will also have some impact when the Fed raises interest rates.

Keywords: Stock Price Fluctuation, Fed's Monetary Policy, Stock volatility.

1. Introduction

At the end of 2019 and the beginning of 2020, the emergence of covid-19 interrupted the development of the whole world, causing the global economic environment to become tense again [1]. The need for massive measures by the Federal Reserve has caused irregular fluctuations in the stock market. Especially in 2013, the Fed said that its future is to gradually shrink its balance sheet. The move also caused turmoil in emerging markets (EM) [2]. Higher interest rates tend to be bad for the stock market. The reason behind it is not difficult to understand. How does the Fed raise interest rates? In fact, if the Federal Reserve sells U.S. Treasury bonds to the market, it can recover the U.S. dollars. When the U.S. dollar flowing in the market decreases, the financing cost of the U.S. dollar will naturally rise, thus realizing the interest rate hike. And the Fed's recovery of dollars may reduce the flow of funds into the stock market, and the stock market will fall accordingly. For example, several pools that are interconnected, like the stock market, bond market, real estate market, and so on. If a portion of the water is withdrawn from one pool, the water level in the other pools will drop accordingly.

Back to the history, Since the 1980s, the United States has had six interest rate hike cycles, with an average duration of 14 months and an average rate hike of 2.8%. The purpose of raising interest rates at the beginning was mainly to curb high inflation, and subsequent interest rate hikes were

more aimed at improving economic fundamentals. In the late 1990s, the United States also experienced unbearably high inflation. To deal with inflation, the Federal Reserve started an interest rate hike cycle [3]. Starting in June 1999, it raised interest rates 6 times in 11 months, totaling 1.75%. At that time, the U.S. stock market was at a high level, and a lot of money poured into companies with the concept of the Internet. On March 10, 2000, the Nasdaq, which is dominated by technology stocks, reached a high of 5,000 points and more than doubled in one year. The interest rate hike cycle punctured the "Internet bubble", and the Nasdaq index plummeted one after another [4]. In the following two years, the market value of \$5 trillion was wiped off, and many companies were liquidated. However, in December 2015, the Fed started another round of interest rate hikes, raising interest rates 9 times in 37 months, with a cumulative rate hike of 2.25%. This time, the stock market has performed strongly, not only repairing the job market, but also easing inflationary pressures. Here's the question, why did a rate hike in 1999 make stocks plummet, but not in 2015? Economists have different explanations for this, with some arguing that there was a bubble in the stock market in 1999, but much less in 2015; others arguing that the 2015 rate hike was longer and slower, without overstimulating the market [5]. As far as the current rate hike cycle is concerned, the stock market has not performed well since the Fed raised rates. The Dow has posted a seven-week losing streak, its longest losing streak in 20 years; the Nasdaq is down more than 20% year-to-date. However, The Fed's sharp increase in interest rates, on the one hand, can effectively curb inflation in the United States and ease the living difficulties of the American people; on the other hand, it will also bring many other problems: 's decline. Also, if U.S. interest rates rise, it may cause global funds to flood into U.S. financial markets, causing dollar assets to rise and other currencies to depreciate. Finally, rising U.S. interest rates may also lead to a sharp drop in the prices of commodities priced in dollars. This could adversely affect commodity exporters. This paper addresses the relationship between Fed hikes rates and stock price fluctuations. How they can affect each other. The paper build VAR model settings and ARMA-GARCHX model settings to analyze the changes of stock price in value and volatility. This paper finds the exchange rate have a negative impact on the stock return and increase its volatility, while the past of stock price has the significant influence on its future values and exchange rate.

It can be seen from the above literature that the Fed's rate hike has had a huge impact on the world economic environment. Since the beginning of 2020, the stock market has begun to gradually decline. Therefore, this article mainly analyzes whether the decline in the stock market is related to the Fed's rate hike. It is relevant, if so, analyze whether it has a positive impact or a negative impact

The remaining parts of this paper are organized by: Part 2 is research design, including data source, unit root test and model specification; Part 3 is Empirical Results and Analysis, including VAR order, VAR order, Impulse and response, ARMA order, and ARMA-GARCHX estimation results; Part 4 is Discussion of the implications of this research and How can investors apply the findings of this article; Part 5 is conclusion of the paper, including relationship between big marketing and fed's monetary policy.

2. Research Design

2.1. Data Source

Data of exchange rate of RMB vs USD is from Investing.com [6]. this website is mainly divided into three functional areas: market dynamics, content, and tools, as well as a customizable personal center to efficiently help users invest in the world. Market dynamics are mainly real-time quotations and calendars, such as: real-time quotations and quotations of financial products such as stocks, stock index futures, foreign exchange, bonds, funds, blockchain (virtual currency), etc. The calendar includes economic calendars and financial report calendars. Focus! Market quotation is the most

distinctive feature of Yingwei Caiqing APP, which contains real-time market data of more than 200,000 financial products around the world! In terms of content, Yingwei Caiqing APP mainly covers news and analysis comments on stocks (mainly US stocks), foreign exchange, futures, cryptocurrencies, crude oil, precious metals, funds, etc. In terms of tools, including stock pickers, Fed observers, currency converters and other investment tools.

Price data for stock Walmart was obtained from the Choice website [7]. One of the most popular financial sites in the world, Choice provides a lot of financial data, especially in the US. This paper selects the historical data of Wal-Mart's closing price and transaction price, and the study can accurately estimate how Wal-Mart's market expectations fluctuate and are affected by the exchange rate of RMB against the US dollar.

2.2. Unit Root Test

The unit root test verifies whether a unit root exists in the sequence since the unit root is a non-stationary time series and can demonstrate that the unit root process's presence in the sequence is unstable. This paper must first determine if the data is stable. In Table 1, the RMB/USD exchange rate and the p-value of the Wal-Mart stock are both equal to zero due to Stata's ADF test, and the rejection variable has a unit root. Additionally, the income series is stationary and the model based on the data is tenable.

Table 1 ADF test

Variables	t-statistic	p-value
Walmart		
Index	-2.609	0.2756
Yield	-11.193	0.0000***
USD-RMB		
Index	-0.928	0.9530
Yield	-13.424	0.0000***

2.3. VAR Model Setting

To find out the relationship between the RMB vs USD exchange rate and Walmart stock, the VAR model was used in this paper, because the VAR model can clearly see the relationship between multiple variables. While some papers have shown the impact of Fed rate hikes on the stock market, few analyses have shown a clear correlation between the two. In this case, the VAR model is chosen, and there will be three independent variables: xt1, xt2, xt3 denoted, and finally a model of three radiation VAR(p) is formed.

$$X_{t,1} = \alpha_1 + \phi_{11}X_{t-1,1} + \dots + \phi_{1p}X_{t-p,1} + \beta_{11}X_{t-1,2} + \dots + \beta_{1p}X_{t-p,2} + e_{1t} \quad (1)$$

$$X_{t,2} = \alpha_2 + \phi_{21}X_{t-1,1} + \dots + \phi_{2p}X_{t-p,1} + \beta_{21}X_{t-1,2} + \dots + \beta_{2p}X_{t-p,2} + e_{2t} \quad (2)$$

$$\begin{bmatrix} X_{t,1} \\ X_{t,2} \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \end{bmatrix} + \begin{bmatrix} \phi_{11} \dots \phi_{1p} \\ \phi_{21} \dots \phi_{2p} \end{bmatrix} \begin{bmatrix} X_{t-1,1} \\ \dots \\ X_{t-p,1} \end{bmatrix} + \begin{bmatrix} \beta_{11} \dots \beta_{1p} \\ \beta_{21} \dots \beta_{2p} \end{bmatrix} \begin{bmatrix} X_{t-1,2} \\ \dots \\ X_{t-p,2} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \quad (3)$$

The paper uses rate of return series to build the modeling, Equation (1) expresses the growth or decline of the exchange rate of RMB vs USD, and Equation (2) the growth or decline of Walmart

stock, however, Equation (3) is a form of proof to show that in Equation (1) $\alpha_1 + \phi_{11}X_{t-1,1} + \dots + \phi_{1p}X_{t-p,1}$, which represents a linear function of the past lag of the exchange rate of RMB vs USD, and $\beta_{11}X_{t-1,2} + \dots + \beta_{1p}X_{t-p,2}$ represents the past lag of Walmart stock, e_{1t} is the error term.

2.4. ARMA-GARCH Model Setting

ARMA-GARCH models that can be divided into two parts: ARMA and GARCH

The reason why using the ARMA-GARCH model because it can assess the volatility of Walmart's stock and can clearly tell people the ups and downs of Wal-Mart's stock growth.

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + \alpha_i - \sum_{i=1}^q \phi_i a_{t-i} \quad (4)$$

From the equation 4 we know that $\phi_0 + \sum_{i=1}^p \phi_i x_{t-i}$ represents AR(p), which uses the history of Walmart stock to predict the future. $\alpha_i - \sum_{i=1}^q \phi_i a_{t-i}$ is MA(q) which uses the error term to make predictions [8].

The GARCH model is built on the basis of the ARCH model, first of all this is the formula of GARCH (p, q):

$$\alpha_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \dots + \gamma_p \sigma_{t-p}^2 \quad (5)$$

In equation 5, $\alpha_1 \varepsilon_{t-1}^2 + \dots + \alpha_q \varepsilon_{t-q}^2$ is the part of ARCH. σ_t^2 is the conditional variance of disturbance ε_t and the t means variance changed over times. σ_t^2 determined on square of disturbance term for p times [9].

3. Empirical Results

3.1. VAR Model

During the modeling process of VAR, it is necessary to determine: The number of variables with mutual influence relationship (N); and how many lagged variables are needed to explain the endogenous variables (k) with mutual influence [10].

If k is too small, it will cause the autocorrelation problem of the error term, which may cause the error of the model parameter estimation to be too large. If k is too large, the degree of freedom of the model will be reduced, which will directly affect the validity of the model parameter estimator. from using Stat, import both data and implement command, we got table 2, However, when using the var model for estimation, two steps need to be done. The first is to put the variables in the var model, and the second decision is to choose the lag order. Once the lag order is obtained, the estimation can begin. After the estimated results are finally obtained, the results need to be evaluated and analyzed to see if they conform to the model settings. The data used in this article is the exchange rate of USD vs. Renminbi, and the logarithmic price and logarithmic return of Walmart's share price between June 2021 and August 2022 to estimate the model.

To determine a reasonable lag order, using the STATA VARSOC command to perform a lag end selection test. Then VARSOC shows the main results of the subsequent lag order selection test. It can be seen from Table 2 that both the likelihood ratio and AIC recommend the tenth-order lag, so this paper chooses the tenth-order lag.

Table 2: VAR model identification.

Lag	LL	LR	df	p	FPE	AIC	SBIC
0	2143.43				1.3e-09	-14.8196	-14.7942*
1	2148.51	10.149	4	0.038	1.2e-09	-14.827	-14.7509
2	2152.57	8.136	4	0.087	1.2e-09	-14.8275	-14.7006
3	2157.13	9.114	4	0.058	1.2e-09	-14.8314	-14.6537
4	2163.31	12.363	4	0.015	1.2e-09	-14.8465	-14.6181
5	2169.81	12.989	4	0.011	1.2e-09	-14.8637	-14.5846
6	2172	4.3906	4	0.356	1.2e-09	-14.8512	-14.5214
7	2183.87	23.733	4	0.000	1.2e-09	-14.9057	-14.5251
8	2185.67	3.5941	4	0.464	1.2e-09	-14.8904	-14.7176
9	2191.48	11.628	4	0.020	1.2e-09	-14.903	-14.4209
10	2197.33	11.701*	4	0.020	1.1e-09*	-14.9158*	-14.383
11	2199.89	5.1194	4	0.275	1.2e-09	-14.9058	-14.3222
12	2202.19	4.6028	4	0.331	1.2e-09	-14.8941	-14.2597

Then, the suitability of the model is determined by testing for the unit root and plotting the unit circle. If all the roots are clearly inside the circles in Figure 1. This shows that VAR (10) is a stable model.

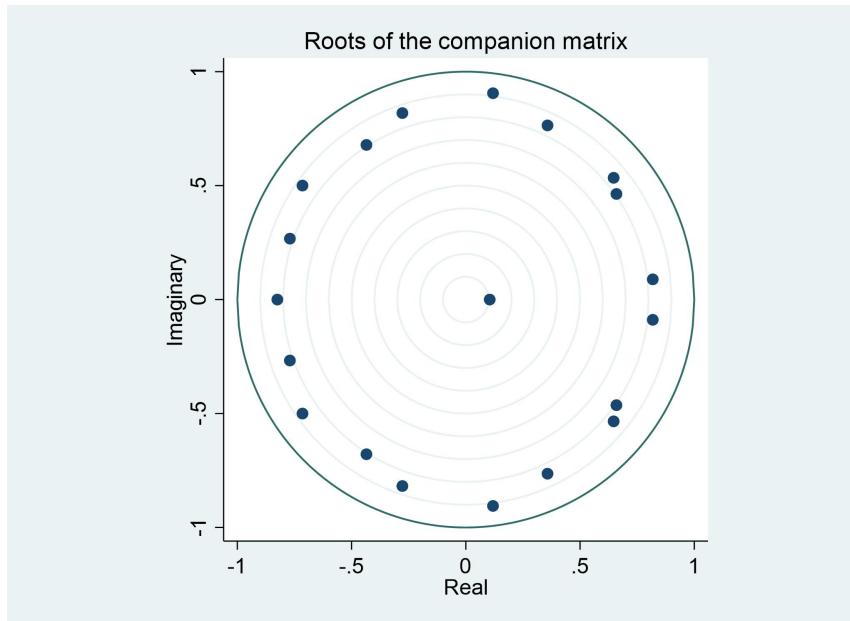


Figure 1: Unit circle test.

Photo credit: Original

3.2. Impulse and Response

It is certain that the Fed's interest rate hike will lead to an increase in the demand for international hot money and dollars in the international financial market, and further lead to an increase in the exchange rate.

But a higher exchange rate has two possible economic consequences for large multinationals:

First of all, this article assumes that the price of the company's products is rigid in the short term, that is, the company cannot adjust the price in the short term. For example, in December 2014 Apple announced that it would temporarily shut down online merchandise in Russia, as the sharp depreciation of the ruble affected its international business. An Apple spokesperson said that the price of the product will be re-set during the offline period, but in fact, before that, Apple has also adjusted the price of the Russian product. Last month, Apple raised the price of the iPhone 6 by 25%. Still, the Russian version of the iPhone is the cheapest in Europe. Because Apple is an American company, when the ruble depreciates and the dollar appreciates, it will affect the devaluation of Apple products, which will lead to the devaluation of Apple's stock prices a large supermarket operating around the world, Walmart's main revenue and financial reports are all calculated in US dollars. The appreciation of the U.S. dollar means that the operating income abroad will depreciate. From this perspective, the Fed's interest rate hike may be bad for Wal-Mart; in addition, the increase in interest rates must mean that savings will increase and consumption will decrease, which is also one of the negative factors.

But on the other hand, the international financial market has increased holdings of US dollars, and this part of the funds may flow into the stock market or bond market, increasing the demand for stocks. This in turn could drive up the price or yield of the stock.

Based on the above analysis, it is difficult to directly determine the net effect of the Fed rate hike on Walmart stock price or yield. If foreign currency depreciation dominates, the net effect of Fed rate hikes on Walmart yields is negative, and vice versa.

Judging from the impulse response graph (Figure 2), it can be basically concluded that the net impact of this round of interest rate hikes on Wal-Mart is negative. Specifically, the largest negative effect of a 1-unit exchange rate shock on Walmart's yield in the period $t=0$ appeared in the period $t=7$, which was slightly larger than 0.3%, and the largest positive effect appeared in the period $t=9$, which was about 0.15%. Furthermore, only a small number of period effects are positive. In the case of Walmart, the reduction in foreign income and the depressing effect of consumption significantly outweighed the gains from net capital inflows.

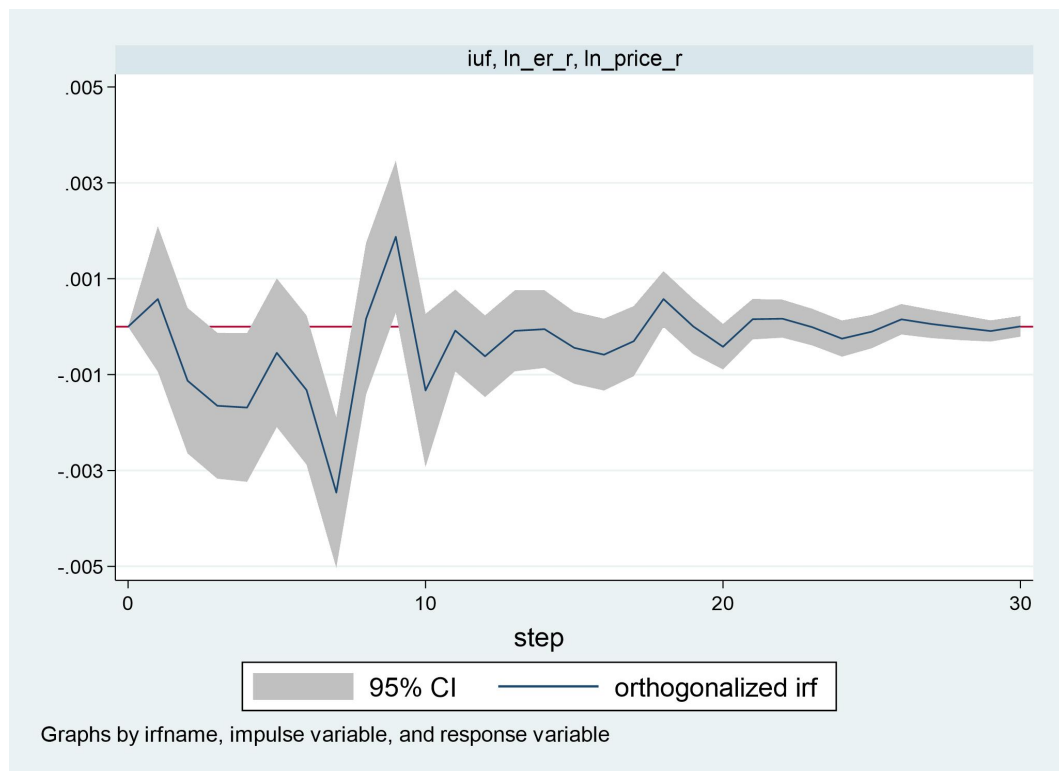


Figure 2: Impulse and response.

Photo credit: Original

The interest rate policy adopted by the Federal Reserve to control inflation in the United States is to some extent at the expense of the growth of the stock market. Also, it's important to note that Walmart stock may face continued downside risks if the exchange rate continues to rise.

3.3. ARMA-GARCH-X Model

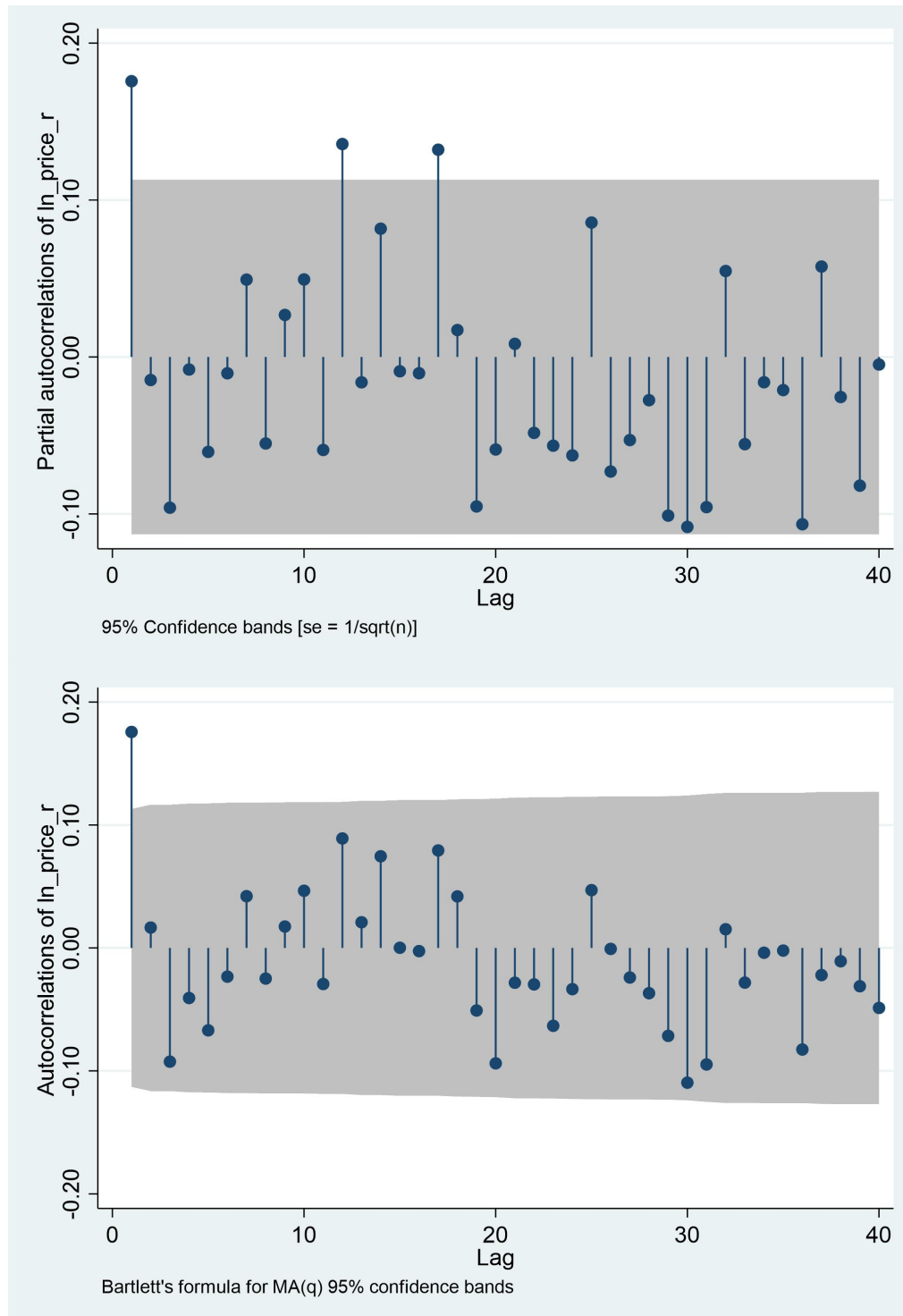


Figure 3: PACF and ACF.

Photo credit: Original

The complete autocorrelation function (ACF), which provides the autocorrelation value for any series with lag values, is the definition of ACF. In other words, it describes how closely the sequence's present value, and its previous values are correlated. The elements of trend, seasonality,

periodicity, and residuals are examples of time series components. While searching for correlations, ACF considers each of these factors. A partial autocorrelation function, often known as a PACF, is what the term refers to. In essence, PACF determines the correlation between the residual and the following lag value rather than a lag, such as ACF, and the current. Consequently, a good correlation is typically found if there is any hidden information in the residuals that may be described by the following lag.

Generally speaking, this paper needs to use the PACF graph and ACF graph (Figure 3) to determine the p and q values. First, this paper needs to use the two graphs of PACF and ACF to determine which model it is. If the ACF graph is trailing and the PACF graph is truncated after p -order, it means that the model is $AR(p)$, if the ACF map is p -order post-truncated and the PACF map is tailing, it means that the model is $MA(q)$, and finally if both ACF and PACF are tailing, it means that the model is $ARMA(p, q)$.

From Figure 3, The PACF can be seen that lag 1, 12 and 17 terms of original series may have a significant impact on the current data. And the ACF can be seen from the result that lag 1 term is a good choice for the moving average process.

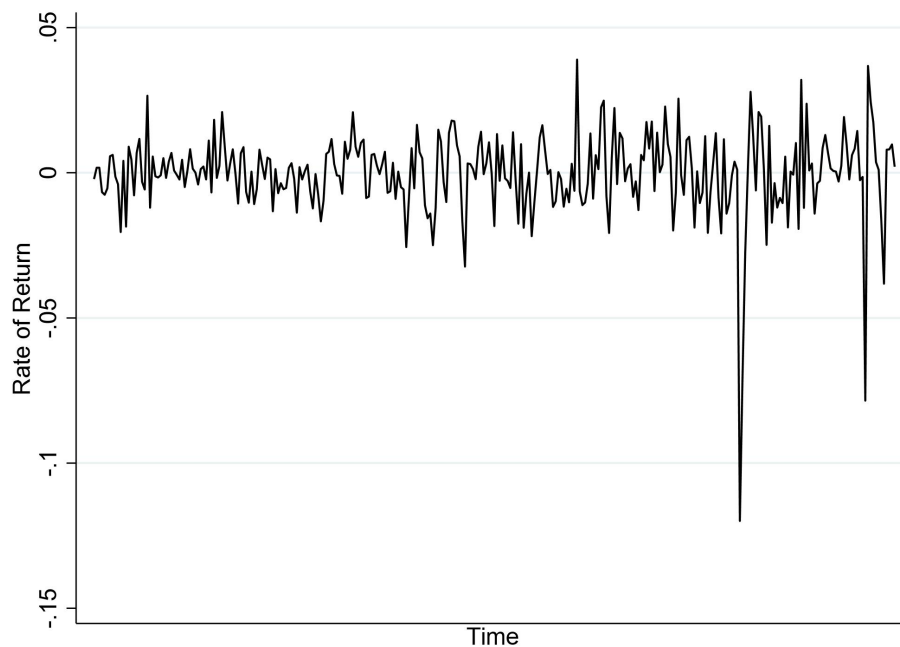


Figure 4: Yield.

Photo credit: Original

From the Figure 4, it can be roughly determined that the returns are clustered.

From the estimation results in Table 3, except for the first column, after the other models control the autocorrelation in the mean equation, the ARCH and GARCH terms in the variance equation are both significant, indicating that there is a statistically significant conditional difference in Walmart's returns. The variance meets the basic conditions of GARCH modeling.

Judging from the estimation results of external explanatory variables, the exchange rate logarithmic rate of return increases by 1 unit, and Wal-Mart's volatility increases by 529.8942 units. The coefficient is significant at the 1% level, and the effect has a lag.

Table 3: ARMA-GARCH estimation results.

	(1)		(2)		(3)	
	Coefficient	p> Z	Coefficient	p> Z	Coefficient	p> Z
Mean equation						
AR, L1	.1019318	0.860	-.0233727	0.962	-.030296	0.955
MA, L1	.0205723	0.971	.1677123	0.729	.1622153	0.757
Constant	-.0001837	0.870	.0002335	0.764	.0001489	0.851
Variance equation						
USD-RMB						
L0	-51.74743	0.403	78.53872	0.838	-90.26341	0.557
L1			529.8942	0.005	490.8836	0.013
L2					-385.5655	0.142
GARCH (1, 1)						
ARCH, L1	.0673709	0.202	.0219206	0.060	.0120948	0.303
GARCH, L1	-.0134592	0.982	.9553123	0.000	.9547099	0.000
Constant	-8.570382	0.000	-13.24804	0.000	-13.16462	0.000

4. Discussion

In the Impact of Exchange Rate on Stock Mark article, it is concluded that the stock price and the Pakistani rupee exchange rate are independent of each other without any Interaction [11]. But the result from this paper is that changes in exchange rates have a certain impact on stocks. For example, when the exchange rate between the name currency and the U.S. dollar changes, it directly affects the stocks of companies engaged in import trade. It is reflected in the share price through its impact on the company's business and profits. Its main manifestations are: First, if a considerable part of the company's products is sold to overseas markets, when the exchange rate rises, the competitiveness of the products in overseas markets will be weakened, and the company will be profitable. Things go down, and the stock price goes down. Secondly, When the exchange rate increases, the cost of imported raw materials decreases, the company's earnings rise, and the stock price of the company tends to grow if some of the company's raw materials are imported, and its goods are primarily sold abroad. Third, if it is anticipated that a certain nation's exchange rate would increase, money will be transferred upward, some money will join the stock market, and the stock market may rise in line with that prediction. In contrast, changes in the exchange rate between the name currency and the U.S. dollar will have no impact on changes in the company's stock if the company does not engage in the business of importing goods.

As can be seen from the data obtained in this article, since Walmart is a global trading company, when the Fed takes certain measures to combat monetary inflation, it will affect the volatility of the stock. When investors invest in a stock, they can first consider whether the company holding the stock is global. If it is global, you should refer to the past fluctuations of the stock before considering whether to invest.

5. Conclusion

To sum up, the Fed rate hike will bring huge changes to the supermarket stock market, and between them, different companies will have different changes. This paper mainly studies the exchange rate changes of RMB and US dollar and the trend changes of Wal-Mart stock. This article focuses on stock returns and examines volatility responses while considering the impact of historical values. The results show that when the Fed raises interest rates, the U.S. dollar appreciates and other currencies depreciate, which in turn leads to a depreciation of the sales price of U.S. dollar-priced goods in other countries, and finally leads to a depreciation of the public stock in which the goods

are located. From the data in this article, it can be concluded that exchange rate changes are negatively correlated with stock returns, which can warn the Fed to consider the current world environment when deciding whether to raise interest rates. Because of covid-19, a series of things will have a negative impact on the Fed raising interest rates. As a result, the value of stocks is depreciated, and finally people's quality of life has not been improved as expected.

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