

Dynamic Changes in Disney Stock Return under the Uncertain Situation

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Abstract. As the Federal Reserve raises the key interest rate, the exchange rate and the financial market will change. This paper studies how exchange rate change will influence one of the largest entertainment companies' stock returns. This paper builds VAR model and ARMA-GARCH model to show the influence and finds that the stock return will increase in the short term but significantly shows fluctuations in response to exchange rate changes. So, the paper gives some suggestions for this discovery. The policymakers of the central bank should treat the volatility seriously and think carefully about adjusting the interest rate and the Disney company should create more good products to attract consumers and investors to keep the increase of the return and avoid loss of revenues because of exchange rate changes and fluctuation of the stock return. Investors should also treat the changes in money and financial markets carefully to avoid losses. This research provides some methods to predict the stock return in the future and find the influence of several variables, which can be used in many areas.

Keywords: The Federal Reserve raises the interest rate; fluctuation in stock return; changes in exchange rate

1. Introduction

The Federal Reserve is a privately owned central bank and fulfills the duties of the central bank of the United States. The Federal Reserve System of the United States consists of the Federal Reserve Board in Washington, D.C., and 12 regional Federal Reserve banks in major cities around the country. The Federal Reserve sets monetary policy and supervises financial institutions in the United States [1]. As the central bank of the United States, the independence of the Federal Reserve is important. It should keep monetary policy decisions free of electoral politics [2].

Increasing interest rate is the action of the central bank of a country to raise the interest rate. It's also an open market operation. So commercial banks' borrowing costs from the central bank increase, and then force the market interests to increase. The purposes of raising interest rates include reducing money supply in the market, suppressing inflation, encouraging savings, influencing the exchange rate, and so on [3].

In the past 40 years, the United States of America has experienced 6 rate-hike cycles. The Fed announced the target range for the federal funds rate increases to between 0.25% and 0.5% on March 16, 2022. And it was raised to between 1.5% and 1.75% on June 15, 2022. It was the Fed's biggest increase since 1994, signaling the urgency of controlling inflation [3].

As a contractionary monetary policy, it influences the whole macroeconomy in America and because the dollar is an international currency, the policy also influences the exchange rate. When the interest rate increases, there is less currency in the market, and the demand for dollars increases, the demand curve for dollars shifts to the right and the dollar appreciates. As the dollar appreciates, it influences the export of American goods because it's more expensive to buy them. What's more, monetary policy announcements have a big impact on not only the macro economy but also on the financial market [4]. So, since the policy will influence almost everyone, it's of great importance, especially for policymakers, researchers, and investors to understand the effects of unconventional monetary policy [5].

To analyze how exchange rate changes will influence the stock market. In general, if there's less money in the market, it will slow down market speculation. So, it's not good for the whole stock market. And classic ideas show that investors risk aversion most of the time and are less able to bear

risk after economic shocks such as changing policies, exchange rate fluctuations, and the high volatility of stock returns. So, there's a large drop in the aggregate stock market [6]. And most research analyzes the stock market as a whole or analyzes a specific industry like how the change in the exchange rate will influence the tourism industry. They seldom analyze a specific stock.

In this paper, the author chooses to analyze the stock price of Walt Disney Company. It's a representative listed stock because first, Disney belongs to the entertainment industry. It's like all the tertiary industries that are related to goods and services. So, the value of money, which is related to the change in exchange rate, will significantly influence people's consumption and investment choices. Second, Disney is a big and international incorporated company, together with its subsidiaries and affiliates. It's a leading diversified entertainment and media enterprise that includes Disney Parks, Experiences and Products; Disney Media & Entertainment Distribution; and four content groups—Studios, General Entertainment, Sports, and International [7]. As a transnational corporation, revenues come from all over the world and are related to the exchange rate closely and so do the stock price and return.

So next, two reasonable assumptions can be made. First of all, Disney is one of the biggest entertainment companies in the world and its film and theme park businesses, which are exported around the world, account for a significant proportion of its revenues. Assuming that the firm's product price is rigid in a short period, that is, it is difficult to adjust. As a large multinational corporation operating worldwide, Disney's main revenues and financial reports are calculated in US dollars. To the extent that a stronger dollar means lower earnings earned abroad, a Fed rate hike could be a bad thing for Disney. However, on the other hand, as the dollar appreciates, the international financial market holds more dollars, which may flow into the stock market or bond market, increasing the demand for stocks. The stock price will increase.

Based on the above analysis, it is not possible to directly determine the net effect of the Fed's interest rate hike on Disney's stock price or yield. So, the rest of this paper is organized as follows to find which assumption works well: Part 2 is research design, which includes data sources, unit root test, and identification strategy; Part 3 is the results and analysis, and comes to Part 4 and Part 5, which shows the conclusion and discussion.

2. Research Design

2.1 Data source

Disney stock price and USD-RMB exchange rate come from Choice Financial Terminal website [8]. It's a professional software that covers data on stock prices, foreign exchange rates, funds, bonds, etc. for different companies and organizations. Since the Federal Reserve has announced to increase interest rate several times in 2021 and 2022. When obtaining data from the website, this paper covers the date from September 1st, 2021, to August 1st, 2022. And it uses the central parity rate to measure the exchange rate of USD and RMB.

In the first step, two data sets are made for this research: the stock price for Disney and the exchange rate for two countries. Since the stock market only trades in trading days, to match the date and get accurate analysis, the data set for this research omits the data in non-trading days in the exchange rate data. And then merge two tables into one. The first column is the date. The second and third columns are the stock prices and exchange rates. Also, Stata is used most of the time when analyzing data and doing future predictions.

2.2 Unit Root Test

For time series data, the first step is to check whether the time series data is stationary. A Unit Root Process can be applied to examine. If the time series data is not stationary, it needs some future modification and finds another way to solve the fluctuation. So, this paper examines the stationarity of the logarithmic term data of stock prices, exchange rates, stock return, and the return on exchange rate.

Logarithmic terms of stock return can be calculated as:

$$\ln_{stock\ return} = \ln \frac{stock\ price_t - stock\ price_{t-1}}{stock\ price_{t-1}} \quad (1)$$

The same method to calculate the logarithmic terms of the change rate of exchange rate:

$$\ln_{exchange\ return} = \ln \frac{exchange\ rate_t - exchange\ rate_{t-1}}{exchange\ rate_{t-1}} \quad (2)$$

In Unit Root Test, the time series x_t can be assumed as:

$$x_t = c_t + \beta x_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta x_{t-i} + \varepsilon_t \quad (3)$$

In the test, the null hypothesis of the test is the coefficient $\beta=1$, which indicates that the time series data is not stationary, it has a unit root. The alternative hypothesis indicates that $\beta<1$, the data is stationary.

Table 1 shows the test results of logarithmic term data:

Table 1. ADF-test result

Variables	t-statistic	p-value
Price		
Disney	-3.3010	0.0661*
Exchange rate	-2.6110	0.2747**
Yield		
Disney	-12.1610	0.0000***
Exchange rate	-11.6710	0.0000***

Note: The analysis of the stock prices and the exchange rates are under price and the analysis of the other two processed data is under yield. ***, ** and * indicate the level of significance of 1%, 5%, 10%, respectively.

It can be seen from the chart that logarithmic terms of the stock price and the exchange rate are not perfect in the stationary test, since they just have 10% and 5% significance. However, when testing their yield of them, both returns have 1% significance, meaning that the null hypothesis can be rejected and the conclusion that the two series are stationary. So, the paper uses the logarithmic terms of the stock return and the change rate of the exchange rate in the following analysis.

2.3 Specification of Model VAR

Sims proposed the Vector Autoregression Model (VAR) in 1980 [9]. It's a powerful statistical model to put several variables together as a system and make the predictions mutually consistent. Instead of predicting every variable separately, the VAR model predicts multivariate time series.

The VAR model can be written as follows, when considering two variables (x_1, x_2) and one lag term ($\rho=1$):

$$x_{1,t} = c_{11}x_{1,t-1} + c_{12}x_{2,t-1} + \varepsilon_{x1t} \quad (4)$$

$$x_{2,t} = c_{21}x_{1,t-1} + c_{22}x_{2,t-1} + \varepsilon_{x2t} \quad (5)$$

It also can write as a vector group:

$$X_t = C \cdot X_{Lag} + E_t \quad (6)$$

Where $X_t = \begin{bmatrix} x_{1,t} \\ x_{2,t} \end{bmatrix}$, $C = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}$, $X_{Lag} = \begin{bmatrix} x_{1,t-1} \\ x_{2,t-1} \end{bmatrix}$, $E = \begin{bmatrix} \varepsilon_{x1t} \\ \varepsilon_{x2t} \end{bmatrix}$

In this paper with two variables, the stock return and the exchange rate yield, a VAR (ρ) model can be built:

$$y_t = \Gamma_0 + \Gamma_1 y_{t-1} + \dots + \Gamma_p y_{t-p} + \varepsilon_t \quad (7)$$

where the $y_t = \begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix}$, $\Gamma_0 = \begin{bmatrix} \beta_{10} \\ \beta_{20} \end{bmatrix}$, $\varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}$, $\Gamma_1 = \begin{bmatrix} \beta_{11} & \gamma_{11} \\ \beta_{21} & \gamma_{21} \end{bmatrix}, \dots, \Gamma_p = \begin{bmatrix} \beta_{1p} & \gamma_{1p} \\ \beta_{2p} & \gamma_{2p} \end{bmatrix}$.

Since there are too many variables to be estimated, the impulse response graph is a useful tool to identify the interaction within or between the variables. It can be calculated as:

$$\psi_s = \frac{\partial y_{t+s}}{\partial \varepsilon_{t'}} \quad (8)$$

In this paper, there are 2 time series, the return of stock and the exchange rate. And by using the VAR model, it can put 2 series together and predict the changes as time goes by. And the impulse response can be shown if the exchange rate changes by 1 unit, and how the stock return changes. Also, through the circle the VAR model shows, if all the variables are in the circle, the model is stationary and can predict accurately.

2.4 Specification of ARMA-GARCH Model

It's useful to use squared-residual autocorrelation in detecting nonlinear statistical correlations in the residuals of fitted autoregressive moving average (ARMA) models [10-11]. So, this paper builds an ARMA model to see how the past values and past disturbances influence the future return by analyzing the PACF and ACF. The model can be written as:

$$x_t = \phi_0 + \sum_{i=1}^p \phi_i x_{t-i} + a_t - \sum_{i=1}^q \theta_i a_{t-i} \quad (9)$$

Engle pointed out in 1982 that in time series, a special heteroskedasticity was called Autoregressive Conditional Heteroskedasticity (ARCH) [12]. Before that, economics assumed that the variances of time series were constant. Since ARCH considers the volatility of the variance, it can forecast variance accurately.

An ARCH (p) model can be shown as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \dots + \alpha_p \varepsilon_{t-p}^2 \quad (10)$$

In this equation, α_0 is constant and σ_t refers to the forecast variance in period of t . ε_t is the actual variance in period of t .

In ARCH, if p is large, there are a lot of parameters to be estimated and causing the loss of sample size. Therefore, Bollerslev proposed GARCH model to decrease the parameters [13]. Based on ARCH, plus autoregressive part of σ_t^2 .

Normally, GARCH (p, q) can be written as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \varepsilon_{t-2}^2 + \dots + \alpha_p \varepsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \beta_2 \sigma_{t-2}^2 + \dots + \beta_q \sigma_{t-q}^2 \quad (11)$$

The ARMA-GARCH model can be used in predicting risk in the stock market and can predict the yield of the stock and the stock volatility at the same time.

3. Empirical Results and Analysis

3.1 VAR Order Determination

This paper put two time series, the logarithmic stock yield and logarithmic exchange rate return into the Vector Autoregression system. Through Table 2 below, LR criteria can be a suitable order for VAR (p) model. The table shows that a VAR with 5 orders can be used.

Table 2. VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	1158.1400				8.1e-08	-10.6557	-10.6431	-10.6245
1	1172.9700	29.6530	4	0.0000	7.3e-08	-10.7554	-10.7177*	-10.6620*
2	1173.5300	1.1195	4	0.8910	7.5e-08	-10.7237	-10.6608	-10.5680
3	1176.6600	6.2769	4	0.1790	7.6e-08	-10.7158	-10.6277	-10.4977
4	1178.1600	3.0012	4	0.5580	7.8e-08	-10.6928	-10.5795	-10.4124
5	1192.7000	29.0640*	4	0.0000	7.1e-08	-10.7898	-10.6514	-10.4472
6	1196.8600	8.3225	4	0.0800	7.1e-08*	-10.7913*	-10.6277	-10.3863
7	1198.9500	4.1752	4	0.3830	7.2e-08	-10.7737	-10.5849	-10.3064
8	1202.5600	7.2212	4	0.1250	7.2e-08	-10.7701	-10.5562	-10.2405
9	1204.4800	3.8542	4	0.4260	7.4e-08	-10.7510	-10.5119	-10.1591
10	1207.3600	5.7594	4	0.2180	7.4e-08	-10.7407	-10.4764	-10.0865
11	1209.3500	3.9715	4	0.4100	7.6e-08	-10.7221	-10.4327	-10.0056
12	1210.2300	1.7535	4	0.7810	7.8e-08	-10.6933	-10.3787	-9.9145

After building the VAR (5) model, the research examines whether the system is stable. If all the dots which represent different eigenvalues are in a unit circle, the system can be judged stable. Figure 1 shows all the eigenvalues are in the circle and the system is stable.

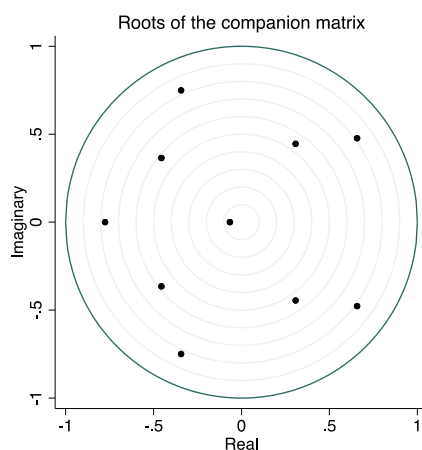


Fig. 1 Unit circle test

3.2 Impulse Responses and Predicted Values of the Stock Price

The VAR model can also predict the return of the stock price in the near future, which is shown in Figure 2. From the figure, the yield has an upward trend. Figure 3 shows the impulse response results of the return of the Disney stock and the exchange rate yield. From the figure, with the exchange rate logarithmic return rate changes by 1 unit, the maximum positive effect of Disney stock return rate is 1%, and the maximum negative effect is about -0.4%. The net effect can be judged to be positive. So, it means when the Federal Reserve raises the interest rate, more money flows into the stock market, and the demand for the Disney stock increases, so the stock return increases in the short term.

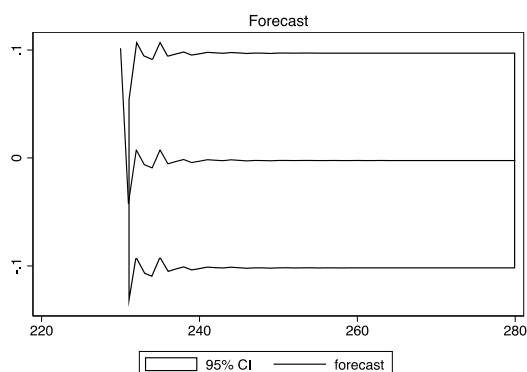


Fig. 2 Impulse and Forecast of Stock Return

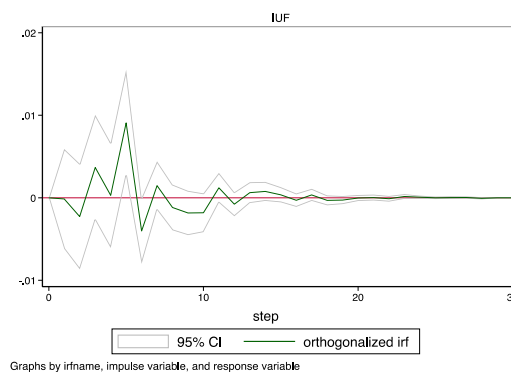


Fig. 3 Impulse and Response of Stock Return and Exchange Rate Yield

3.3 ARMA order identification

To get a suitable ARMA model, the paper first builds an AR and a MA model using the stock return data.

The partial autocorrelation plot (PACF plot) shown below indicates that maybe lags 1 and 27 have a significant impact on the current data. Because through Figure 4, lags 1 and 27 have beyond the rectangle boundaries.

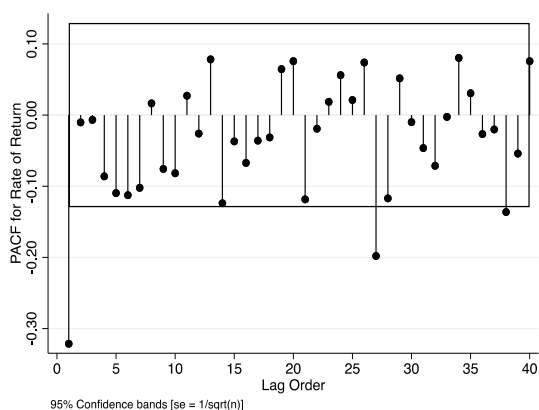


Fig. 4 PACF Plot of Stock Return

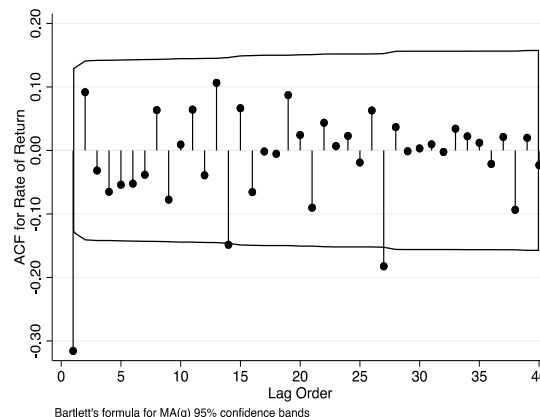


Fig. 5 ACF Plot of Stock Return

Using the same criteria, the autocorrelation plot (ACF plot) is used to determine MA. The lags 1 and 26 are suitable in figure 5.

After testing these models, the paper chooses ARMA (27, 26) with AR terms of lag 26, 27, and MA term of lag 26 to be the results.

Figure 6 shows the stock return changes, it can be concluded that it has some aggregation, but it should be estimated by the statistic model.

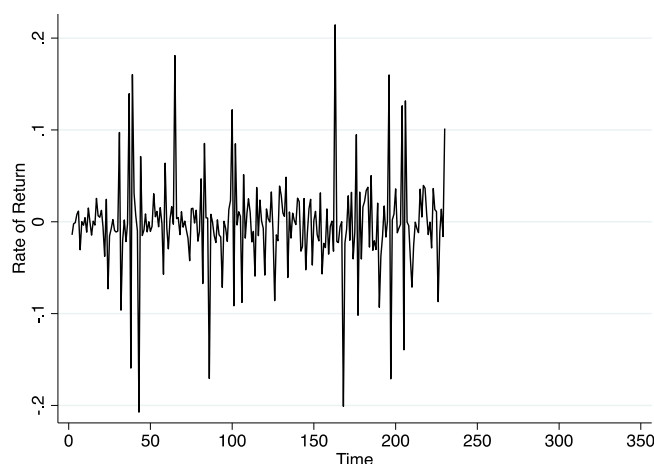


Fig. 6 Yield Trend of Disney Stock

3.4 ARMA-GARCH Model Results

After determining the ARMA model, this paper uses ARMA-GARCH Model to predict the volatility and yield together and put the exchange rate return into the variance equation as an exogenous variable. The results are shown in Table 3.

Table 3. ARMA-GARCH estimation results, variance equation

	(1)	(2)	(3)
Exchange rate			
T=0	1.5684 (2.0298)	2.6241 (2.4344)	91.8003*** (31.2091)
T=-1		20.8207 (15.8985)	19.1293 (95.3864)
T=-2			43.3080 (93.7204)
GARCH (1, 1)			
ARCH (-1)	0.2770*** (0.1061)	0.2770*** (0.1035)	0.1507*** (0.0510)
GARCH (-1)	-0.1457** (0.0681)	-0.1585* (0.0904)	0.6613*** (0.0711)
Constant	-6.1059*** (0.0964)	-6.0919*** (0.1119)	-7.7338*** (0.2958)

From the estimation results of variance equations, the ARCH term and GARCH term in columns (1) to (3) are both significant, indicating that Disney stock return rate has significant conditional heteroscedasticity, which can be used for GARCH modeling. And from the estimation results of exchange rate, in column (3) which is a complete model, after controlling the exchange rate return in the lag period, the current exchange rate increases by 1 unit, and the volatility of Disney stock return increases by 91.8003.

The results show that the change in exchange rate has a significant positive impact on the volatility of Disney stock returns during the period of interest rate hike by the Federal Reserve.

4. Discussion

It can be seen from the prediction that the stock price and stock return will increase in the short term. It's different from the first assumption that the stock price and return will decrease, but it shows the stock return has big fluctuations in the near future as the exchange rate changes.

Policymakers in the US, should carefully make plans and adjust policies in time, especially the decisions to increase interest rates. As a big country, the value of dollars influences the money market and financial market of the world. And the change of policies will cause a series of changes in the market, so it's not good for investors since they can't predict and fear loss. The government and central bank should be responsible for the country and the world. Investors can analyze the trend of the stock market or a specific stock but can't invest blindly. Because the stock market and stock price are not influenced by one factor.

More research could work on what Disney policymakers can do about the fluctuation of the stock price to avoid losses. As a creative company, it can make good films and search for more good ways to encourage consumption and investment. And use technology to create online entertainment and so on.

5. Conclusion

This paper finds that in the short term, the stock return of Disney will increase, but also, as the Federal Reserve increases the interest rate and causes changes in exchange rate, it significantly influences the stock return of Disney. The stock return has big volatility. If it's too unstable, investors will not be willing to invest in the stock, which influences the profits.

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