The Time-Varying Impact of Exchange Rate Changes on Disney Stock Returns and Volatility: Evidence from the Fed's Rate Hike

Shuxin Deng

Department of BAEcon, University of Manchester, Manchester, M13 9PL, UK

shuxin.deng@student.manchester.ac.uk

Abstract. In the world economy and financial markets, exchange rates fluctuate continuously over time. This paper assesses the effects of exchange rate fluctuations on the return and volatility of Disney's stock. A VAR model and an ARMA-GARCH model were developed to analyze the changes in stock prices in terms of value and volatility. This paper finds that changes in exchange rates have a limited impact on Disney stock prices and have no significant effect on the daily volatility of its returns. However, because the appreciation of the U.S. dollar triggered by the Fed's rate hike will offset this positive and negative effect, investors should keep their perspective elsewhere without caring about the volatility of Disney stock prices due to exchange rate changes.

Keywords: Fed’s rate hike; exchange rate; Disney stock.

1. Introduction

The COVID-19 epidemic that occurred in 2020 had a major impact on the global economy, and financial markets in the United States and around the world fell sharply. Zhu Min argues that the three sharp declines in global stock markets in 2020 were rational adjustments within the market rather than panic selling influenced by the information from outside the market; panic selling was caused by extra-market information [1]. The first stock market decline was affected by China and Asia. The first decline was affected by the China and Asia epidemics, which were localized problems with low volatility; the second and third declines were caused by the rapid development of the global epidemic, which led to a change in market expectations for the global economic adjustment expectations have changed. The economy entered recession and financial turmoil with the rapid spread of the epidemic. The decline in oil prices and geopolitical risks are intertwined.

The Fed's raising interest rates is a way to mitigate the global financial crisis [2]. The Federal Open Market Committee, which decides how to adjust monetary policy, is the organisation that makes monetary policy decisions for the Federal Reserve, the country's central bank. The Fed bases its interest rate choices mostly on the direction of the US economy. In general, the Fed's policy goal is to keep prices stable and increase employment. When prices are under pressure and the central bank anticipates that the economy might decline in the future, it is likely to adopt a more accommodating monetary policy, such as interest rate cuts, etc., and vice versa, it may adopt policies such as interest rate increases to tighten the money. A Fed rate increase is a decision by the Federal Reserve Board of Governors to modify monetary policy by raising the federal funds rate following a rate meeting in Washington.

The Fed's interest rate hike will inevitably lead to a massive capitulation, which will also have different impacts on different countries. According to Jiang Jiayu, the Fed's interest rate hike has different impacts on each of three types of countries: developing countries with a single economic structure, developed countries with a diversified economic structure, and China with a robust economy [3]. Developing countries with a single economic structure or heavy reliance on foreign investment and external demand, such as Venezuela, South Africa, and Indonesia, generally rely heavily on foreign investment and external demand markets, so their stress resistance is necessarily weak. For example, African countries rely heavily on the export of a single resource industry, once the Federal Reserve rate hikes, external investment, and external demand will shrink. The economic pressure on the country is also bound to be very large, so it is also easy to fall into the economic crisis.

The situation will be different for developed countries with diversified economic structures, such as the EU and Japan. These countries have stronger economies and so are more resistant to stress. Unlike some developing countries, which rely on external demand markets and a single economic structure, they have a diversified economic structure, so the Fed's interest rate hike has an impact on them but does not necessarily affect their macro policies and the direction of their economic development. As for China, which has a robust economy, although the Fed's interest rate hike will constitute capital outflow pressure to some extent, the impact is not great in terms of China's macroeconomic situation. China does not need to move the benchmark interest rate when the macro economy needs to be stable, and the adjustment of prices can be fine-tuned through the interbank market. So for China, although the Fed rate hike will bring some pressure because China's transformation and upgrading have also achieved some results, the "One Belt, One Road" strategy is being implemented to promote, can hedge these pressures [4].

Li Mengfei believes that there is a theoretical basis for interest rate policy changes to affect exchange rate movements [5]. For example, the interest rate parity theory suggests that the exchange rate between two countries reflects the relative prices of monetary assets in both countries. The difference between the forward and spot exchange rates between the two countries is mainly influenced by the direction and size of capital flows, which are driven by differences in domestic and foreign interest rates. Thus, changes in the level of interest rates between countries can explain movements in the exchange rates of their currencies. Furthermore, according to Kong Deyu, there is another theoretical support for interest rate policy to affect the exchange rate-the balance of payments theory [6]. The balance of payments theory evolved from the international lending theory, which holds that the level of the exchange rate between two countries is determined by the supply and demand of the two currencies in the foreign exchange market, while the balance of payments determines supply and demand in the foreign exchange market. Only the balance of payments at the payment stage may impact supply and demand in the foreign currency market. When a country's revenue exceeds its spending, the foreign exchange market in the local currency demand is high, resulting in local currency appreciation; when the country is in the payment stage of income, where income exceeds expenditure, the foreign exchange market in the foreign currency supply is greater than demand, resulting in local currency depreciation.

Zifeng Xiu also argues that, according to the interest rate parity theory, high-interest rate currencies are discounted forward and appreciated shortly [7]. Before the Fed's interest rate hike, the dollar's interest rate was at a low level among most countries in the world, and through the Fed's interest rate hike policy, although the dollar's interest rate is not higher than other countries, it is nevertheless relatively higher. Therefore, in the short term, it is bound to lead to the appreciation of the dollar. Moreover, for China, as an emerging economy, the yuan is inevitably subject to the strong dollar cycle. A Fed rate hike would compress China's monetary policy options, leading to a fall in the RMB exchange rate and increased external pressure.

Exchange rate fluctuations due to the Fed's rate rise will have an impact on international corporations. According to Wei Shiqin, the higher a company's overseas net assets or liabilities, or its comparatively high net income or net costs, the more vulnerable it is to swings in foreign currency exchange rates [8]. There are three categories of exchange rate risk in general. The first is exchange rate risk, which is the change in exchange rates that happens at the end of the fiscal year when abroad revenue or costs must be converted to local currency, resulting in a drop in income or a rise in expenses; firms with significant international cash flows are particularly vulnerable to exchange rate risk; and the second is accounting translation risk, which is the change in accounting translation. Companies with significant responsibilities or assets in other countries are especially sensitive; the third is the artificial risk of operations.

The subject of this paper, Disney, is one of the typical multinational companies. It was founded in 1923, is headquartered in Burbank, Los Angeles, California, USA, employs 175,000 full-time employees worldwide, and is the largest entertainment media company in the world. There are four main businesses: film and television entertainment, media networks, theme park resorts, and consumer products. So, will a multinational company of this magnitude be affected by the exchange rate fluctuations brought about by the Fed's rate hike?

The rest of this paper is organized as follows: part 2 is research design, which includes data sources, unit root test, and model specification; part 3 is empirical result and analysis, which includes model order selection, impulse response, and model results.

2. Research Design

2.1 Data Source

The data for the RMB/USD exchange rate and the daily closing price of Disney Company in this article was obtained from Choice Financial Terminal. It is a professional financial data analysis and investment management programme, dedicated to providing quality financial data and related services to financial institutions, academic research institutions, and professional investors. The terminal covers stocks, fixed income, funds, commodities, foreign exchange, macro industries, and other fields. It provides an Excel plug-in, a quantitative interface, portfolio management, and other application tools, integrating information query, statistical analysis, and application, and is an essential tool for financial market participants. This paper selected data after 2022 and matched exchange rate and stock price data by date. Because stock prices only fluctuate on trade days, the study excludes non-trading day data and sorts and renumbers the remaining data by date. Stata was the most regularly utilised tool in this study to handle challenges identified throughout the study's subsequent examination.

2.2 Unit Root Test

The unit root test is used to assess if a time series is stationary. The vast bulk of quantitative time series analysis is based on the assumption that the time series is stationary. Therefore, the data stationarity must be validated before proceeding with the inquiry. If it is revealed that a series is non-stationary, possible modifications must be investigated.

When doing a unit root test, the time series xt can be expressed as:

$$x_t = c_t + \beta x_{t-1} + \sum_{i=1}^{p-1} \phi_i \Delta x_{t-i} + e_t \tag{1}$$

The null hypothesis of the test is that the coefficient $\beta = 1$, indicating that the series has a unit root and is not stationary, whereas the alternative hypothesis is that $\beta < 1$, suggesting the series under test is stationary.

Table 1 shows the raw data test results along with the processed series:

Table 1. ADF-test

Variables	t-statistic	p-value
Price		
Exchange rate	-1.961	0.6226
Disney	-2.366	0.3978
Yield		
Exchange rate	-7.273	0.0000***
Disney	-8.455	0.0000***
Note: The thresholds for z-value are - 3.982 (1%), - 3.422 (5%), - 3.130 (10%). ***, **, and * indicate the level of significance of 1%, 5%, and 10%, respectively.		

From the results, it is found that the data series perform well in stationarity tests, and the stationarity conditions for exchange rates and stock prices can be trusted within 99% confidence intervals. Based on these results, the following model can be built in this paper using these stationary series.

2.3 VAR Model Specification

The vector autoregressive model (VAR) was introduced by Sims in 1980 [9]. It is a highly effective statistical model for investigating the link between numerous time series across time. Based on the premise that each variable is influenced by other factors, the VAR model includes these variables into a system that predicts this multivariate time series as a whole, rather than developing a model for each variable, as the ARMAX model does. It does not need to distinguish between endogenous and exogenous variables, and it is easy to predict because the explanatory variables are lagged. Of course, there may be more parameters to be estimated. This model is usually used to estimate the dynamic relationship of joint endogenous variables. It is achieved by autoregression of all current period variables in the model on several period lags of all variables. For example, a VAR (3) is as follows:

$$Y_t = \alpha_1 + \phi_{11}Y_{t-1} + \cdots + \phi_{1p}Y_{t-p} + \beta_{11}X_{t-1} + \cdots + \beta_{1p}X_{t-p} + \delta_{11}Z_{t-1} + \cdots + \delta_{1p}Z_{t-p} + e_{1t} \tag{2}$$

$$X_t = \alpha_1 + \phi_{21}Y_{t-1} + \cdots + \phi_{2p}Y_{t-p} + \beta_{21}X_{t-1} + \cdots + \beta_{2p}X_{t-p} + \delta_{21}Z_{t-1} + \cdots + \delta_{2p}Z_{t-p} + e_{2t} \tag{3}$$

$$Z_t = \alpha_1 + \phi_{31}Y_{t-1} + \cdots + \phi_{3p}Y_{t-p} + \beta_{31}X_{t-1} + \cdots + \beta_{3p}X_{t-p} + \delta_{31}Z_{t-1} + \cdots + \delta_{3p}Z_{t-p} + e_{3t} \tag{4}$$

2.4 ARMA-GARCH Model Specification

Most economic research before Engle's 1982 proposal of the autoregressive conditional heteroskedasticity (ARCH) model was predicated on the notion that a series' variance is constant and mostly unchanging, following the rules of stochastic processes [10]. However, because market risk cannot be constant, variation in real-world market data reveals the risk associated with an asset, and variance changes over time are constant. The ARCH model, which uses autoregressive logic to forecast future variance, assumes that if a time series' variance was high in the previous period, it could also be high in the next period. The ARCH(p) model may often be expressed as:

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \cdots + \alpha_p\varepsilon_{t-p}^2 \tag{5}$$

Where σ_t^2 is the predicted variance in period t. εt is the real variance in period t. And α_0 is constant.

Bollerslev introduced the most fundamental and effective model for time series analysis in 1986 by adding a GARCH component to the original ARCH model. This improved the ARCH model, transforming it into the generalised ARCH (GARCH) model. Similar logic can be observed when changing an AR model to an ARMA model, which reduces the number of coefficients that must be calculated in the ARCH model. To illustrate, consider the expression GARCH (1,1). A three-term GARCH (1,1) may be written as:

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \beta_1\sigma_{t-1}^2 \tag{6}$$

If keeping putting GARCH equation for σ_{t-1}^2, σ_{t-2}^2 ,… into the equation, it can eventually be expressed as:

$$\sigma_t^2 = \alpha_0 + \alpha_1\varepsilon_{t-1}^2 + \alpha_2\varepsilon_{t-2}^2 + \cdots + \alpha_p\varepsilon_{t-p}^2 + \cdots \tag{7}$$

This is an ARCH (∞) model with endless terms.

In broader terms, a GARCH (p, q) model can be stated as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_p \varepsilon_{t-p}^2 + \beta_1 \sigma_{t-1}^2 + \cdots + \beta_q \sigma_{t-q}^2 \quad (8)$$

Given that market returns are strongly connected with the risk they include, risk is almost the most essential quality of a market or sector. An ARMA-GARCH model was created to examine the volatility of AAL stock prices in order to focus on risk. The ARMA-GARCH model consists of two value and variance equations. Although the value is also examined in the ARMA section, judgments on market risk should be drawn from the GARCH section.

3. Empirical Result and Analysis

3.1 VAR Order Selection

In this section, this paper places 2 stationary series: the Disney stock price and the exchange rate, into our vector autoregressive system. In modeling the VAR model, it is necessary to determine the number of variables N that have interactions and how many lags are needed to explain the endogenous variables k that have interactions. if k is too small, it will lead to the autocorrelation of the error term, which may result in excessive errors in the model parameter estimates. If k is excessively big, the model's degrees of freedom are reduced, which directly impacts the validity of the model parameter estimations. There are many kinds of fixed-order methods, such as LR, FPE, AIC, HQIC, and SBIC. In this paper, to determine if the maximum lag order k obtained is modest based on the correlation between the LR statistic and the critical value, the Great Likelihood Estimation for Logistic Regression is used. The formula for the LR statistic is as follows:

$$LR = -2(LogL_k - LogL_{k+1}) \quad (9)$$

Where the $\mathrm{LogL_k}$ is the logarithmic rate of return series.

When the sample size is high enough in comparison to the number of parameters being estimated, LR asymptotically follows a chi-square distribution with degree of freedom N^2, i.e., $LR \sim \chi^2_{(N^2)}$.

When the LR statistic is smaller than the crucial value, the lag order of the VAR model is deemed mild. When the LR statistic exceeds the critical value, the lag order is regarded insufficient, and extra lagged variables must be added as explanatory variables. When the sample size is not sufficiently large compared with the number of parameters being estimated, the finite sample distribution can differ significantly from the asymptotic distribution of LR. The results are shown in Table 2 and indicate that 12 orders of VAR can be considered.

Table 2. VAR identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
1	784.997	7.3368	4	0.119	5.0e-09	-13.431	-13.3732	-13.2886
2	786.86	3.7263	4	0.444	5.2e-09	-13.3941	-13.2978	-13.1568
3	787.244	0.76666	4	0.943	5.6e-09	-13.3318	-13.1969	-12.9995
4	788.699	2.9101	4	0.573	5.8e-09	-13.2879	-13.1145	-12.8606
5	792.1	6.8035	4	0.147	5.9e-09	-13.2776	-13.0656	-12.7554
6	796.315	8.4293	4	0.077	5.9e-09	-13.2813	-13.0308	-12.6641
7	798.008	3.3863	4	0.495	6.1e-09	-13.2415	-12.9524	-12.5294
8	800.315	4.613	4	0.329	6.3e-09	-13.2123	-12.8847	-12.4052
9	803.592	6.5538	4	0.161	6.4e-09	-13.1999	-12.8337	-12.2978
10	805.292	3.4012	4	0.493	6.7e-09	-13.1602	-12.7555	-12.1632
11	807.415	4.2464	4	0.374	6.9e-09	-13.1279	-12.6846	-12.0359
12	816.473	18.116*	4	0.001	6.3e-09	-13.2151	-12.7332	-12.0282

After estimating the model's parameters, this study constructs a VAR (12) model and then use Stata's code-named varstable tool to test the eigenvalue stability requirement. The tool then draws a unit circle to show the results. The eigenvalue dots must all be inside the unit circle to indicate that the VAR estimations are stable. The plot result shown in Figure 1 indicates that the VAR system's stability criteria are met.

As for the stability of a VAR model, this paper analyzes whether the effect of a pulsating shock on the VAR model will fade away over time. If it will gradually disappears, the VAR model is stable, otherwise, it is unstable. Similar to the AR model, the VAR model containing a unit root is non-stationary, i.e., the response of the endogenous variables in the VAR model does not disappear over time when there is a pulsating shock in the new interest.

$$X_t = \sum_{i=1}^{p} \Pi_i X_{t-i} + U_t \tag{10}$$

A sufficient necessary condition for a VAR model to be smooth is that all eigenvalues of the coefficient matrix fall within the unit circle. This condition is essentially the same as the condition for judging the smooth type of the AR model. Therefore, Figure 1 shows that the VAR model is smooth.

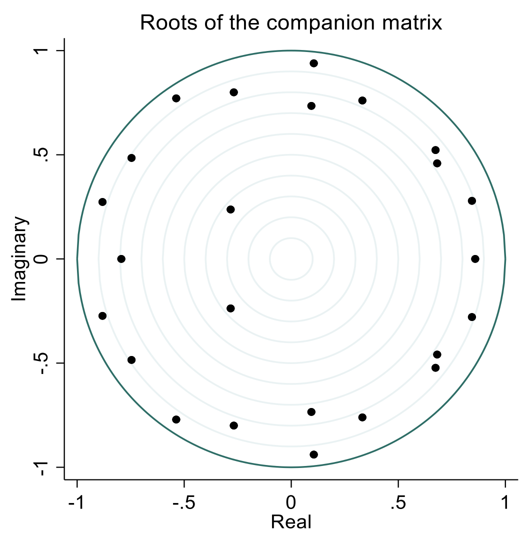

Fig. 1 VAR stability

3.2 Impulse Response

The VAR model's impulse response function aids in the understanding of VAR data. The impulse response function depicts the response of the VAR model's endogenous variables to changes in the error term.

From the estimated results of the impulse responses in Figure 2, the impact of exchange rate changes on Disney stock returns is relatively limited. Specifically, a 1% increase in the exchange rate in the current period, i.e., an appreciation of the U.S. dollar and a depreciation of the RMB, decreases Disney stock returns by about 0.4%, with an impact of 0.1% on Disney stock returns in period t=1. Subsequent shocks are generated with an amplitude of about 0.1%. In terms of time effects, the impact of exchange rate changes on Disney stock returns in the current period lasts for about 20 periods or so and then decays to 0. In summary, the impact of exchange rate changes on Disney stock prices is limited.

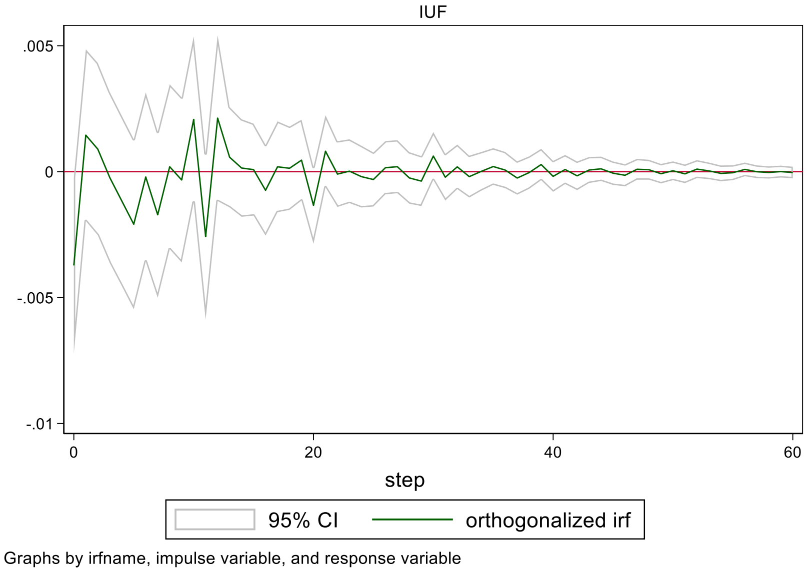

Fig. 2 Impulse and response

3.3 ARMA Order Selection

The partial autocorrelation function (PACF) establishes a partial correlation between a smooth time series and its own lagged values by regressing the values of each shorter lagged time series. It varies from autocorrelation functions in that it takes into account extra delays. Examine the PACF figure in Figure 3; the black rectangle is the benchmark for identifying the statistically significant term in the AR model, and it can be shown that the lag 15 and 34 terms from the original series may have a considerable effect on the current data.

The autocorrelation function (ACF) is the set of autocorrelation coefficients. It is defined as follows:

$$\rho_k = \frac{Cov(x_t, x_{t-k})}{\sqrt{Var(x_t)Var(x_{t-k})}} = \frac{Cov(x_t, x_{t-k})}{Var(x_t)} = \frac{\gamma_k}{\gamma_0} \tag{11}$$

Figure 3 depicts the autocorrelation plot (ACF Plot) generated by Stata. The conclusion indicates that no latency is the best option for the moving average method.

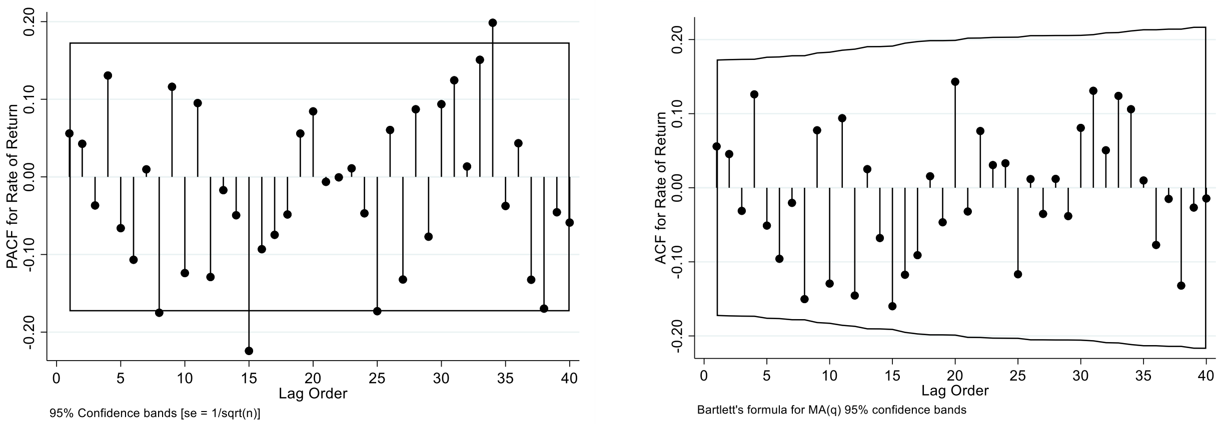

Fig. 3 PACF and ACF

3.4 ARMA-GARCH Model Result

The impulse effect investigates the influence of exchange rate fluctuations on Disney stock returns, and this part investigates the effect of exchange rate changes on stock return volatility using an ARMA-GARCH model. According to the estimate results, none of the coefficients of the exchange rate log returns are significant, implying that exchange rate fluctuations have no meaningful influence on the daily volatility of Disney stock returns.

Table 3. ARMA-GARCH estimation results, variance equation

	(1)	(2)	(3)
Exchange rate			
T=0	42.9882	43.6019	48.1123
	(27.4141)	(27.8186)	(36.2430)
T=-1		11.3817	41.4826
		(45.8280)	(59.2346)
T=-2			51.3292
			(56.6367)

4. Discussion

According to this paper, the influence of exchange rate changes on Disney stock returns is rather restricted in the VAR model, and there is no substantial impact of exchange rate fluctuations on the daily volatility of Disney stock returns in the ARMA-GARCH model. From the theoretical analysis, the Fed's rate hike will certainly lead to higher demand for dollars from international lenders and international financial markets and further lead to higher exchange rates. However, the impact of the higher exchange rate on the firm has two directions of impact. First, this paper assumes that there is rigidity in the short period of the firm's product price, i.e., it is difficult to adjust. Disney, as a large multinational company operating globally, has its major revenues, financial reports, etc. in US dollars. A stronger dollar means that operating income abroad will depreciate, and from this aspect, a Fed rate hike could be a negative for Disney. But on the other hand, the international financial market has increased its holdings in U.S. dollars, and some of this money may flow into the stock market or bond market, increasing the demand for stocks. Based on the above analysis, it is not possible to directly determine the net effect of the Fed's interest rate hike on the impact of Disney's stock price or return. Starting from the model results, this paper finds that the appreciation of the U.S. dollar triggered by the Fed's rate hike will essentially cause such positive and negative effects to cancel each other out. Therefore, investors need not pay too much attention to the volatility of Disney stock price due to exchange rate changes and should focus their perspective on other aspects.

5. Conclusion

This paper investigates the influence of fluctuations in the RMB/USD exchange rate on the value and volatility of Disney's stock price. The data indicate that exchange rate fluctuations have a minimal influence on Disney stock prices and have no meaningful impact on the daily volatility of Disney stock returns. And the gain of the US currency caused by the Fed's rate rise will effectively cancel out both the positive and negative effects. Therefore, investors need not pay too much attention to the volatility of Disney stock price due to exchange rate changes and should focus their perspective on other aspects.

References

[1] Zhu Min. Impact of the New Coronary Pneumonia Outbreak on the Global Economy and Financial Markets. International Finance, 2020(04):3-5.

[2] Li Han, Bian Ruijuan. Analysis of the Federal Reserve rate hike. Trade and Economy Report, 2016(09):9-11.

[3] Jiang Jiayu. Micro Interpretation of the Fed's Federal Funds Rate Increase - The Impact of the Fed's Rate Hike on the US Dollar Index and Financial Markets of Various Countries. Modern Business, 2017(17): 86-87.

[4] Li Deng, Yu Hongxia. Analysis of the "One Belt, One Road" strategy and its impact on China. China Market, 2016 (33): 49+65. DOI: 10.13939/j.cnki.zgsc.2016.33.049.Fangfang. Research on power load forecasting based on Improved BP neural network. Harbin Institute of Technology, 2011.

[5] Li Mengfei. Analysis of interest rate and exchange rate correlations between the US and China - based on interest rate parity model. Times Finance, 2014 (11): 21-22.

[6] Kong Deyu. Study on the impact of the Fed's interest rate hike on the movement of RMB exchange rate. Dongbei University of Finance and Economics, 2019. DOI: 10.27006/d.cnki.gdbcu.2019.000682.SHI Biao, LI Yu Xia, YU Xhua, YAN Wang. Short-term load forecasting based on modified particle swarm optimizer and fuzzy neural network model. Systems Engineering-Theory and Practice, 2010, 30(1): 158-160.

[7] Zifeng Xiu. Analysis of the impact of the Federal Reserve's interest rate hike policy. Industrial Innovation, 2019(05): 74-75. Amjady N. Short-term hourly load forecasting using time series modeling with peak load estimation capability. IEEE Transactions on Power Systems, 2001, 16(4): 798-805.

[8] Wei Shiqin. The Impact of Exchange Rate Changes on Multinational Corporations. Manager' Journal, 2014 (1X): 2.

[9] Sims C A. Macroeconomics and reality. Econometrica: journal of the Econometric Society, 1980: 1-48.

[10] Engle R F. Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: Journal of the econometric society, 1982: 987-1007.