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The Influence of Federal Reserve's Interest Rates Hike Cycle on Transnational Corporations

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Abstract: The monetary policy of the United States has a broad and profound impact on the world economy and financial markets. Due to the critical position of the US dollar in the world economy, the US monetary policy will directly affect countries and economies worldwide, and the liquidity of the US dollar is also the foundation of global liquidity. The series of interest rate increases implemented by the Federal Reserve starting in 2022 has led to the appreciation of the US dollar index, which has significantly impacted the import costs and overseas sales of domestic and multinational companies in the United States. This article selects the global multinational technology company Apple and extracts daily closing data from June 2022 to April 2023 and the USD index for the same period. This study applies the VAR model to assess the correlation between both and uses the ARMA-GARCH-X model to analyze the impact of USD index on the volatility of Apple stocks. This study analyzes the impact of interest rate hikes on multinational corporations and provides management and investment advice to their stakeholders.

Keywords: federal reserve monetary policy, transnational corporation, Apple

1. Introduction

As the world's largest economy, the monetary policy stance adopted by the United States has always been a core hot area of concern. Due to the critical position of the USD in the world economy, the United States monetary policy directly affects various countries and economies worldwide [1]. In addition, the federal funds rate and the United States treasury bond rate are the basis for pricing global risk assets, and the USD liquidity is the basis for global liquidity. Every policy-tightening cycle of the Federal Reserve will significantly impact the world economy and financial markets.

Following the COVID-19 outbreak in 2019, in order to address the economic downturn resulting from the pandemic, the Federal Reserve maintained the federal funds rate at historically low levels of 0-0.25%. Additionally, there was a significant expansion in the broad money supply (M2) [2]. The US broad money M2 grew by 40% in just two years, 2020-2021 [3]. Under the influence of the radical fiscal and financial measures of the United States, the total global demand for dollars has been inversely reduced. At the same time, due to the rising domestic price level, fiscal deficit, and the yield rate of US treasury bond bonds, the US CPI has climbed from 2.6% in March 2021 to

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9.1% in June 2022 [4], breaking a new record and approaching the maximum inflation level in the United States during the oil crisis of the last century. Against this backdrop, the Federal Reserve has initiated a rate hike cycle in 2022.

Since the start of the interest rate hike cycle, the USD index has continued to rise, dramatically impacting global trade and exchange rates [5]. For the US mainland, the continuous appreciation of the dollar may increase the cost of imports and curb the purchasing power of local consumers [6]. At the same time, the prices of goods exported from the United States will also rise, and the purchasing power of overseas customers will decrease, which may reduce the company's overseas sales [6]. On the other hand, the appreciation of the dollar may also lower the prices of some raw materials, thereby reducing the production costs of enterprises. In addition, the interest rate hike cycle is often accompanied by significant exchange rate fluctuations, which makes trade settlements between different countries and regions more complex and may lead to unstable capital flows for enterprises, making it difficult to obtain stable profits [7]. Moreover, an increase in interest rates may lead to a shift in funds from the stock market to fixed-income products, such as the bond market, leading to a decline in stock prices. In summary, the Fed's interest rate hike will significantly impact transnational corporations.

Furthermore, the rise in interest rates could result in a capital reallocation from the stock market towards fixed-income assets like the bond market, potentially causing a decrease in stock prices. To summarize, the Federal Reserve's decision to increase interest rates will have a substantial impact on multinational corporations. Apple is a global multinational technology company with products and services sold worldwide. In its Q4 2020 financial report, Apple stated that exchange rate fluctuations led to a decrease of $100 million in global sales [8]. Moreover, Apple's overseas suppliers mainly come from countries and regions such as China, South Korea, and Japan. For example, in 2019, the cost of batteries and accessories purchased by Apple from China exceeded $4 billion [9], and if the RMB depreciates, these costs may increase. Therefore, during the interest rate hike cycle, Apple will mainly face economic risks such as currency exchange rate fluctuations. This article analyzes the returns and volatility of Apple stock during the interest rate hike period, evaluates the impact of the Fed's rate hike on multinational corporations, and provides reasonable suggestions for policymakers and investors, as well as suggestions for portfolio adjustments and designing effective monetary policies.

The remainder of this paper is structured as follows: The second section introduces the sources and processing methods of the data and introduces the VAR and ARMA-GARCH models. Then, the third part models the processed data into the model and analyzes Apple's stock returns and volatility during the interest rate hike period in detail through empirical results. It also elaborates on the impact of the Fed's rate hike on multinational corporations from multiple perspectives. Finally, the article concludes with recommendations and measures for policymakers and investors concerned about multinational corporations.

2. Research Design

2.1. Data Source

Apple has a vast influence and strong market position in the global market and has many suppliers and manufacturers worldwide. Therefore, it can serve as a representative for analyzing the impact of interest rate hikes on multinational corporations. This paper selects the daily closing stock price of Apple (AAPL) and the daily closing price of the USD index from the Choice financial terminal from June 3, 2022, to April 28, 2023. This data is currently in the Federal Reserve's 2022 interest rate hike cycle. Due to the different trading days between the USD index and Apple stock during this period, this study will use the trading calendar of Apple stock with fewer trading days as the

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benchmark to delete data from the USD index that is not within the trading calendar on that day. For a detailed explanation, the daily returns of the USD index and Apple stock will be obtained by dividing the difference between the two-day closing prices by the previous day's closing price. In order to eliminate the influence of heteroscedasticity and make the data more effectively, the data is converted using the formula $\ln(1+x)$ to obtain the log-return series of the USD index and Apple stock.

2.2. Weakly Stationary Test

Firstly, performing ADF testing on the processed data through Stata is necessary to verify its stationarity. Table 1 shows that the p-values of the closing prices of Apple and the USD index are more significant than 0.1. However, in daily returns, all p-values are equal to 0, indicating that the observed data are stationary.

Table 1: Weakly stationary test (ADF).

		T	P
Price series			
	AAPL	-1.796	0.7069
	USD index	-2.513	0.3214
Yield			
	AAPL	-11.448	0.0000***
	USD index	-12.106	0.0000***

2.3. Vector Autoregression (VAR) Model

The Vector Autoregression (VAR) model is a statistical technique employed to capture the linear interrelationships among various time series data. It was first introduced by Sims [10]. it was used to analyze the relationships between key variables in the US macroeconomic system. Afterward, the VAR model was also widely applied in the financial field. This paper uses two dependent variables, $\{f_1, f_2\}$, in two equations, where the explanatory variable is the h-order lag value of these variables. Then construct a binary VAR (h) model:

$$f_{1,t} = \beta_{10} + \beta_{11} f_{1,t-1} + \cdots + \beta_{1h} f_{1,t-h} + \gamma_{11} f_{2,t-1} + \cdots + \gamma_{1h} f_{2,t-h} + \varepsilon_{1t} \quad (1)$$

$$f_{2,t} = \beta_{20} + \beta_{21} f_{1,t-1} + \cdots + \beta_{2h} f_{1,t-h} + \gamma_{21} f_{2,t-1} + \cdots + \gamma_{2h} f_{2,t-h} + \varepsilon_{2t} \quad (2)$$

Merge equations (1) and (2) into matrix form.

$$\begin{pmatrix} f_{1,t} \\ f_{2,t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11}\ \gamma_{11} \\ \beta_{21}\ \gamma_{21} \end{pmatrix} \begin{pmatrix} f_{1,t-1} \\ f_{2,t-1} \end{pmatrix} + \cdots + \begin{pmatrix} \beta_{1h}\ \gamma_{1h} \\ \beta_{2h}\ \gamma_{2h} \end{pmatrix} \begin{pmatrix} f_{1,t-h} \\ f_{2,t-h} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \quad (3)$$

The above equations (1) and (2) represent the log-returns of the Apple stock and the USD index, respectively. To elaborate, the $f_{1,t-h}$ represents the log-return of Apple stock at time t-h, and the $f_{2,t-h}$ represents the log-return of USD index at time t-h, then $\beta_{10} + \beta_{11} f_{1,t-1} + \cdots + \beta_{1p} f_{1,t-h}$ represents a linear function of past lags of Apple stock log-return. ε_{1t} and ε_{2t} are two error terms, representing the part of the model that the lag value of variables cannot explain. Therefore, the Apple stock log-return ($f_{1,t}$) is modeled using the historical values of this variable and the USD index logarithmic return.

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2.4. ARMA-GARCH Model

The ARMA-GARCH model is a time series technique that merges the ARMA and GARCH models to analyze the correlation and volatility of a time series. The ARMA model describes the linear relationships between time series data, including autocorrelation and lag effects, while the GARCH model is used to model the volatility of time series data. Therefore, using this model can simultaneously predict the return and volatility of Apple stock. Next, the model will be divided into two parts for introduction: ARMA and GARCH

2.4.1. ARMA

The general expression for the ARMA model is:

$$y_t = \phi_0 + \sum_{i=1}^{p} \phi_i y_{t-i} + \alpha_i - \sum_{i=1}^{q} \phi_i \alpha_{t-i} \tag{4}$$

where y_t represents the observed value at time t, $\phi_0 + \sum_{i=1}^{p} \phi_i y_{t-i}$ and $\alpha_i - \sum_{i=1}^{q} \phi_i \alpha_{t-i}$ represent AR (p) and MA (q) models, representing the impact of their respective historical values and errors on the current observation values, respectively. In this paper, the AR(p) model utilizes the log-return of Apple stock from June 2022 to April 2023, while the MA(q) model uses an Error term to predict the future.

2.4.2. GARCH-X

The GARCH model was invented by Thomas Bollerslev in 1986 [11], which can better capture heteroscedasticity and have better effects on financial market prediction and risk measurement. The GARCH (p, q) model is formulated as follows:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2 + \gamma_1 \sigma_{t-1}^2 + \cdots + \gamma_p \sigma_{t-p}^2 \tag{5}$$

where the term $\alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_q \varepsilon_{t-q}^2$ is ARCH part and $\gamma_1 \sigma_{t-1}^2 + \cdots + \gamma_p \sigma_{t-p}^2$ represent the GARCH part. This paper selects the GARCH (1,1) model, which is the most used in finance, since it fits many time series well and only requires one lag for analysis [12]. The following is the expression for the GARCH (1, 1) model:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \gamma_1 \sigma_{t-1}^2 + \beta USD_t \tag{6}$$

where USD is an external explanatory variable that explains the impact of the USD index, and β is the coefficient of USD.

3. Model Results and Discussion

3.1. Order Identification: The Vector Autoregression

For the log-return series of the Apple and USD indices, the order selection of the VAR model is performed using the “varsoc” function. The results are shown in Table 2, where the asterisk (*) after the data represents the optimal lag order determined by the respective information criterion or goodness-of-fit test.

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Table 2: Identification.

Lag	LL	LR	p	FPE	AIC	HQIC	SBIC
0	1345.56			1.2e-08	-12.5566	-12.5439*	-12.5252*
1	1347.48	3.8472	0.427	1.2e-08	-12.5372	-12.4991	-12.4429
2	1356.74	18.512	0.001	1.2e-08	-12.5864	-12.5228	-12.4291
3	1357.31	1.1375	0.888	1.2e-08	-12.5543	-12.4653	-12.3341
4	1365.34	16.062*	0.003	1.2e-08*	-12.592*	-12.4776	-12.3088
5	1367.03	3.3763	0.497	1.2e-08	-12.5704	-12.4305	-12.2243
6	1368.66	3.2716	0.513	1.2e-08	-12.5483	-12.383	-12.1393
7	1369.77	2.2128	0.697	1.3e-08	-12.5212	-12.3305	-12.0494
8	1371.17	2.8014	0.592	1.3e-08	-12.4969	-12.2808	-11.9621
9	1373.14	3.9283	0.416	1.3e-08	-12.4779	-12.2364	-11.8802
10	1374.83	3.3838	0.496	1.3e-08	-12.4563	-12.1894	-11.7957
11	1375.61	1.5645	0.815	1.4e-08	-12.4263	-12.1339	-11.7027
12	1376.05	0.8808	0.927	1.4e-08	-12.393	-12.0752	-11.6065

From Table 2, it can be concluded that the optimal lag order is chosen between 0 and 4. When the lag order is 0, the prediction result of the model only depends on the variable value at the current time, without considering the past influence, which will lead to the autocorrelation problem of the Error term, thus leading to excessive error in the parameter estimation of the model. Moreover, LR, FPE, and AIC all exhibit an asterisk (*) when the lag order is 4, so the optimal lag order is 4.

Next, it is necessary to perform stationarity testing on the VAR model with a lag order of 4. Determine the stationarity of the model by conducting unit root tests and drawing a unit circle with the roots. Figure 1 indicates that all roots are within the unit circle, implying that there is no requirement for reselecting the lag order and that the binary VAR (4) model is stable.

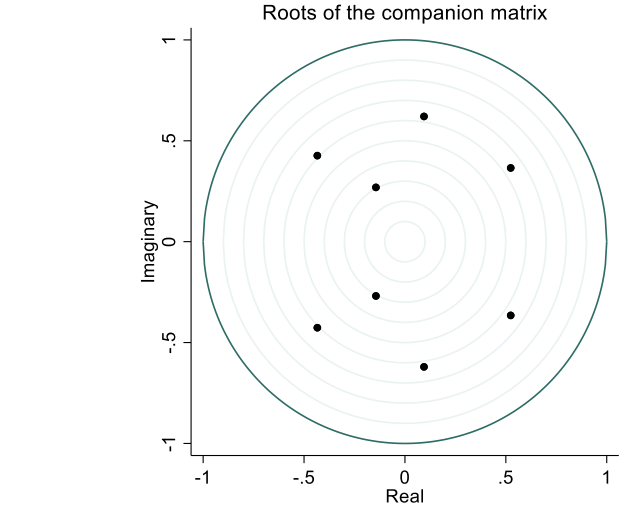

Figure 1: Unit root test.
photo credit: original

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3.2. Impulse Response

Raising interest rates by the Federal Reserve usually leads to an appreciation of the US dollar. This is because an increase in interest rates will increase the return on investment of the US dollar, thereby attracting more international hot money to invest in the US dollar, leading to an increase in demand for the US dollar in the international financial market. In this way, the demand for the US dollar will increase, thereby increasing the exchange rate of the US dollar against other currencies. However, the impact of an increase in exchange rates on Apple may lead to the following economic consequences:

First, referring to the producer theory of microeconomics, this paper assumes that enterprise product prices are rigid in a short period [13]. The authors argue that this is a weak assumption, as exemplified by the difficulty faced by Apple in adjusting its product prices in response to fluctuations in exchange rates within a short time frame. As an illustration, the closure of Apple stores in Russia in 2015 was due to the unfeasibility of adjusting the prices of its products in response to ruble devaluation rather than a deliberate choice. As a large multinational company, Apple's primary revenue and financial reports are all calculated in dollars. The appreciation of the US dollar means that the operating income of companies abroad will depreciate. From this perspective, the Fed's interest rate hike may negatively impact Apple. In addition, an interest rate increase will promote domestic savings in the United States and suppress consumption. This is also one of the bearish factors.

Secondly, increased demand for the US dollar in international financial markets can result in capital inflows into the stock or bond markets, potentially boosting the demand for US equities and bonds and driving their prices. This influx of capital could positively impact the borrowing costs of companies and governments, enhancing their ability to invest and expand. Furthermore, it may stimulate economic growth, increasing job opportunities and making the US stock market more attractive to both domestic and foreign investors.

Thirdly, raising interest rates increases bond yields, prompting investors to shift their investments from the stock market to a relatively safe bond market. This may lead to a general decrease in demand for stocks, leading to a decline in stock prices. Moreover, higher borrowing costs may affect a company's profitability, hindering its investment ability and ultimately suppressing economic activity. Therefore, the US stock market may face downside risks due to the potential transfer of capital to the bond market and the adverse impact of increased borrowing costs on corporate profitability and investment.

Based on the above theoretical analysis, it is difficult for this article to directly determine whether capital flow, consumption suppression, or foreign currency depreciation have a dominant impact on Apple's stock price in the context of the Fed's rate hike. Therefore, other methods are also needed.

According to Fig. 2, the net effect of USD appreciation on Apple stock returns is negative. Specifically, a unit exchange rate shock at t=0 positively affects Apple’s returns at t=1, with a magnitude of approximately 0.2%. However, this effect is soon followed by more significant adverse effects, with the maximum and second-highest magnitudes surpassing 0.3%. The adverse effects then gradually taper off to around 0 after minor fluctuations.

In summary, for Apple, the reduction in foreign income, the inhibitory effect of consumption, and the outflow effect of stock market funds are significantly more significant than the benefits brought by net capital inflows. The interest rate policy adopted by the Federal Reserve to control inflation in the US is, to some extent, at the expense of stock market growth.

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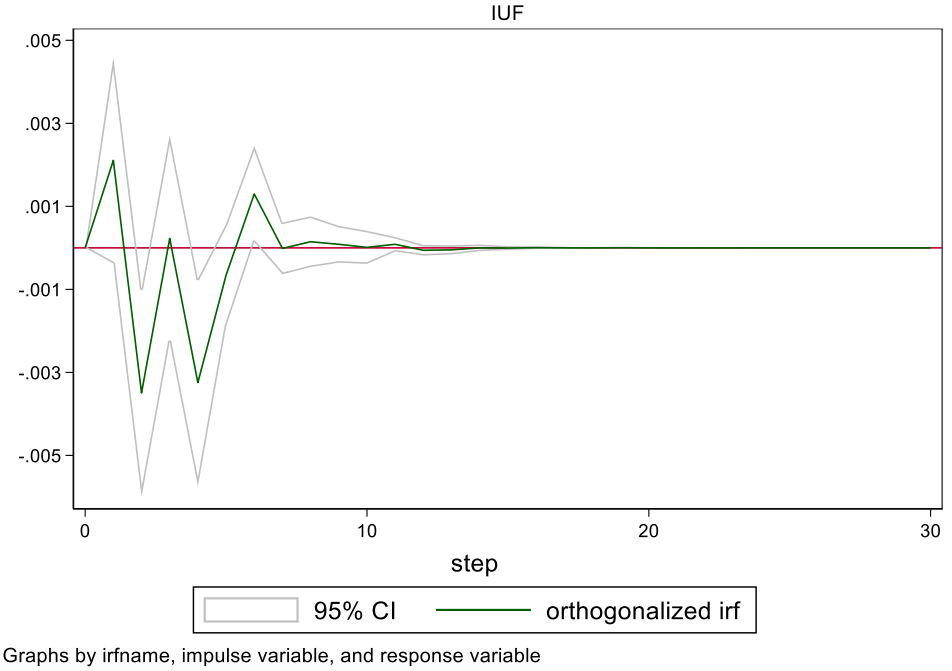

Figure 2: Impulse (USD index) and response (Return of Apple Stocks).
Photo credit: Original

3.3. Order Identification: ARMA (p, q)

Figure 3 determines the lag order of AR(p) and MA (q), guided by the PACF and ACF. The plot shows that the first segment exceeding the critical value is at 4, indicating that both AR(p) and MA (q) have a fourth-order, and the corresponding values for p and q are 4.

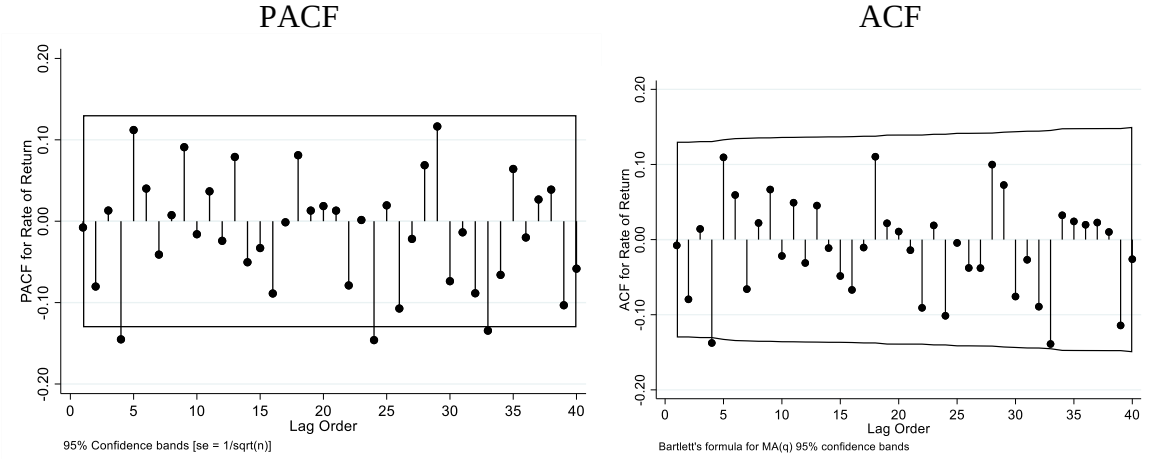

Figure 3: Partial ACF and ACF for ARMA (p, q) identification.
Photo credit: Original

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3.4. ARMA-GARCH-X Model Regression Results

Combining GARCH (1,1) in Section 3.4.2 and ARMA (4,4) in Section 4.3, establish an ARMA-GARCH model using the log-return of the USD index and the log-return of Apple stock.

Table 3 contains the model estimation results and the variance equation. After controlling the autocorrelation of apple stock returns using the mean equation, the ARCH terms of the variance equations in columns (1) to (3) are significant at the 1%, 5%, and 10% levels, respectively, indicating statistically significant heteroscedasticity in apple stock returns.

From the estimation results of external explanatory variables, it can be seen that the increase in the USD index has no significant positive impact on the volatility of Apple's stock price. Based on this, this article believes that the volatility of Apple stocks is not significantly affected by the Federal Reserve's interest rate hike.

Table 3: Regression results of ARMA-GARCH with external explanatory variable

	(1)		(2)		(3)	
	Coef.	p	Coef.	p	Coef.	p
			Mean equation			
AR, L4	-0.3823	0.3850	-0.3630	0.4510	-0.3468	0.3810
MA, L4	0.2759	0.5460	0.2561	0.6080	0.1962	0.6320
Constant	0.0013	0.2650	0.0009	0.4340	0.0000	0.9640
			Variance equation			
USD Index						
L0	-1.6759	0.9080	-2.9760	0.8210	-25.3662	0.1240
L1			10.0085	0.4880	1.3783	0.9380
L2					-69.3585	0.0020
GARCH (1, 1)						
ARCH	0.2743	0.0040	0.2416	0.0110	0.1534	0.0700
GARCH	-0.0917	0.6260	-0.1535	0.4730	0.0521	0.7620
Constant	-8.0194	0.0000	-7.9185	0.0000	-8.1560	0.0000

4. Conclusion

This paper aims to study the impact of the Fed's rate hike cycle on multinational corporations and precisely analyze the relationship between the global multinational technology company Apple stock and the USD index. To this end, VAR and ARMA-GARCH models are introduced. Analyzing the impulse response graph in the VAR model reveals that the upward trend of the USD index has a more negative impact on the return of Apple stock. Specifically, the decrease in foreign income, the inhibitory effect of consumption, and the outflow effect of stock market funds are significantly higher than the benefits of net capital inflows. Afterward, in the ARMA-GARCH model, the variance equation of the model showed statistically significant heteroscedasticity in Apple stock returns. The estimation of external explanatory variables indicates that the increase in interest rates by the Federal Reserve had no significant impact on the volatility of Apple stocks.

According to the research in this paper, policymakers should consider how to make moderate monetary policy adjustments to address risks, such as exchange rates and inflation, to reduce the adverse effects on multinational corporations. At the same time, policymakers can incentivize and support multinational enterprises to increase investment in technological innovation and research and development while operating steadily through appropriate fiscal and tax policies, thereby enhancing their competitiveness and risk resistance.

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The empirical results show that with the Federal Reserve raising interest rates, exchange rate fluctuations will harm Apple's operating performance and financial condition, and the rise of the USD index will have a negative impact on Apple's stock. Therefore, multinational corporations can adopt some coping strategies, such as hedging through financial instruments such as foreign exchange futures and forward contracts, to reduce losses caused by exchange rate fluctuations and mitigate the impact of interest rate hikes on their business and finances. For investors interested in cross-border stocks, it is necessary to closely monitor the latest news on the Federal Reserve's monetary policy to adjust short-term investment strategies.

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