The Impact of the Increased Interest Rate on Nike's Stock Price Based on Stata

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Abstract. In 2022, The Federal Reserve raised its benchmark interest rates three-quarters of a percentage point in its most aggressive hike since 1994, which gets US dollars more expensive to foreigners, and foreign currencies less valuable to the US. But in the meantime, Nike can't rise its price in foreign countries immediately, thus with the same quantity of items being sold, their price decreases due to the exchange rate difference, and their profit diminishes. Since a stock's value represent the ability to profit in the future, when Nike's ability to profit decreases, people tend to sell its stock and when the demand for Nike's stock is smaller than that of supply, its price drops. In addition, as the interest rate increases, the mass is inclined to invest in bonds, and when bonds get more attractive people to invest less in stocks, thus as one of the listed corporations, owing to the demand for Nike's stock price decrease, its stock price decreases. Whereas at the same time as the interest rate increase, more foreign capital is intended to invest in the US, thus the stock price of Nike might also increase. Thus whether the increased interest rate contributes to Nike's stock price is controversial. This paper mainly used a series of statistical models including VAR and ARMA-GARCH models etc. to see the net effect of interest rate on Nike's stock price, and then included the future study needed and limitations of this research.

Keywords: Federal Reserve; ARMA-GARCH; Nike.

1. Introduction

In 2020, due to the covid's impact and following a series of policies such as stay-at-home-order, the US economy was once facing the hazard of recession demand-wise, with a high unemployment rate, pessimistic prediction towards the future, the mass is inclined to withhold their money instead of using it to facilitate the economic cycle, consumption, investment is negatively affected. Supply-wise, with more added procedures and restrictions, the supply chain's expenses increase, thus the suppliers increase their price and get more hesitant to produce and sell stuff, in light of that, export is also affected. In order to alleviate the dilemma, the US Government was forced to give a substantiate amount of subsidies, lower interest rates, and a lower tax rate to stimulate the economy. However, owing to that, the US economy is now experiencing the highest inflation rate (9.1%) since 1981. Which is a lot higher than the target inflation rate of 2%.[1] As a result, to tame the soaring inflation, The US government raised the bank's charge-to-borrow ratio to more than 2.25%, which is a level last seen in 2019 [1].

With the increased interest rate, corporations' stock prices are usually considered to decrease due to the mass' pessimistic prediction about corporations' profitability in the future and increased attraction to investing in the bond market (with a higher interest rate, the bond market gets more lucrative, thus the opportunity cost of investing in the financial market increases). But in the meantime, because the interest rate is been increasing, the asset in America is also appreciating, and more foreign capital will flow into the US economy, which potentially increases the stock price. With those opposing factors, whether the rise in an interest rate increases Nike's stock price gets controversial.

The rest of the paper is organized as follows: Part 2 is a literature review that summarizes the relevant research about the role interest rate plays in the economy and its impact on both helping or dropping industries' stock prices in more detail. Then is followed by part3 and part4, the purpose of the mathematical models being used and the analysis of its results. Finally, this article will compare the other reverent research with itself and eventually sums up its results in a conclusion in part 5 and part6 respectively.

2. Literature review

2.1 American Confidence in the Future

Generally, factories' stock prices are negatively affected due to a pessimistic confidence level(which is caused by an increasing interest rate)Interest rates affect consumer and business confidence. A rise in interest rates discourages investment, it makes firms and consumers less willing to take out risky investments and purchases [2]. In addition, In an economy the interest rate is the income of a lender and the expense of a borrower, thus with a higher interest rate, people and industries are less willing to invest since the cost of borrowing is now raised(people who used to borrow and invest might stop investing).In addition, with a higher interest rate, bonds, and fixed income security will also have a higher coupon rate to attract more buyers, Since buying bonds will reduce people's resources and opportunity to invest in the stock market, the stock market's investment will be further reduced. Owing to that there will be fewer people being willing to invest in Nike's stock, and the demand for its stock is smaller than its supply, thus its stock price is affected [3].

2.2 Profitability of Nike Overseas

In microeconomics, it's believed that due to the fixed price overseas, Nike's stock price will be decreased. When the interest rate is rising, the Exchange rate also changes. As the US dollar gets expensive, other countries' currencies get relatively cheap. At this point, multinational corporations such as Nike which operates overseas should rise it's their price (since its value converted to the US dollar has been increasing) to maintain their profit consumers'. However, with the appreciation of the US dollar, Nike produced domestically will be more expensive to export, thus its export demand will also be decreased, which further reduce Nike's profitability due to consumers' sensitivity to pricing, it's hard to rise prices in the short term [4][5]. In addition, the demand Considering that each sale's profit decreases which is a negative effect on Nike's future expected price. Since now Nike is expected to earn less in the future its stock price will go down because of this factor.

2.3 Reasons for Nike's Stock Price Rise Foreign Investment

In the meantime, there are also factors potentially rising Nike's stock price, higher interest rates increase the exchange rate of a given country's currency which further potentially increase Nike's stock price. When an economy's interest rate increases, inflation is curbed, which results in the appreciation of the currency. And at this point, domestic assets measured by this currency will also appreciate, which attracts foreign funds to invest [6]. As part of the foreign funds will flow into the stock market, as the demand for Nike's stock increases, its price will be positively affected.

2.4 Summary

to sum up, although most of the factors are indicating the fact that an increase in interest rate will negatively affect Nike's stock price. It still can't be determined whether it's negatively or positively correlated due to possible missed factors and the uncertainty about the specific strength of the enactor's impact. Thus, further statistical methods with specific historical data were used to unrevealed those uncertainties

3. Methodology

3.1 Source of Data

This paper uses cn.investing.com [7] as a source of information to obtain the raw historical data on the American dollar index and Nike's stock price. The data included all the close and open stock prices for those variables from 2021-06-01 till 2022-08-30 when the US Federal reserve bank been continuously rising its interest rate to 2.25%. Cn.investing.com is one of the largest websites for investment information which is a reliable information source that provides data for more than 300

thousand financial instruments [8]. To ensure the stationarity of the data, we further obtained the logarithm of Nike's stock price and the logarithm of the US dollar index. The logarithm of Nike's profit and the logarithm of the difference in the US dollar index and used the dfuller test to see its stationarity.

3.2 Unit Root Test

The purpose of the unit root check is to see if the series has a unit root, that is if the data is stationary.

$$x_i = c_i + \beta x_{t-1} + \sum_{i-1}^{p-1} \phi_i \Delta x_{t-i} + e_t \quad (1)$$

$$Here\ we\ use\ a\ null\ hypothesis\ that:\ H_0: \beta = 1 \quad (2)$$

$$And\ the\ alternative\ hypothesis\ is\ that:\ H_1: \beta < 1 \quad (3)$$

$$ADF\ test = \frac{\hat{\beta} - 1}{\hat{\beta}'s\ standard\ deviation} \quad (4)$$

When the result of ADF analysis is too big, the null hypothesis is refused. ADF test results please see Table 1.

Table 1 ADF test

Variables		t-statistic	p-value
Price			
	Nike	-2.448	0.3544
	USD	-2.764	0.2104
Yield			
	Nike	-13.482	0.0000***
	USD	-12.017	0.0000***

3.3 VAR model setting

Var model is the abbreviation of vector autoregressive models, which is a useful tool for time series with many variables. And the function is about a linear function of past lags of itself and past lags of the variables. For instance, if we have three different variables of time series: $x_{t,1}$, $x_{t,2}$, $x_{t,3}$ with a vector autoregressive model of order 1 with VAR (1) is:

$$x_{t,1} = \alpha_1 + \phi_{11} x_{t-1,1} + \phi_{12} x_{t-1,2} + \phi_{13} x_{t-1,3} + w_{t,1} \quad (5)$$

$$x_{t,2} = \alpha_2 + \phi_{21} x_{t-1,1} + \phi_{22} x_{t-1,2} + \phi_{23} x_{t-1,3} + w_{t,2} \quad (6)$$

$$x_{t,3} = \alpha_3 + \phi_{31} x_{t-1,1} + \phi_{32} x_{t-1,2} + \phi_{33} x_{t-1,3} + w_{t,3} \quad (7)$$

And it can be combined into a vector group:

$$X = \Gamma_0 + \Gamma_1 x_{t-1} + \cdots + \Gamma_p x_{t-p} + \varepsilon_t \quad (8)$$

Where $X_t = \begin{bmatrix} x_{1t} \\ x_{2t} \\ x_{3t} \end{bmatrix}, \Gamma_0 = \begin{bmatrix} \beta_{10} \\ \beta_{20} \\ \beta_{30} \end{bmatrix}, \varepsilon_t = \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix}, \Gamma_1 = \begin{bmatrix} \beta_{11} & x_{11} & \lambda_{11} \\ \beta_{21} & x_{21} & \lambda_{21} \\ \beta_{31} & x_{31} & \lambda_{31} \end{bmatrix}, \ldots, \Gamma_p = \begin{bmatrix} \beta_{1p} & x_{1p} & \lambda_{1p} \\ \beta_{2p} & x_{2p} & \lambda_{2p} \\ \beta_{3p} & x_{3p} & \lambda_{3p} \end{bmatrix}$.

In this case with two variables the US dollar index and Nike's stock price, the Var(p) model can be written as:

$$Y_t = C \cdot Y_{Lag} + E_t \quad where\ Y_t = \begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix}, C = \begin{bmatrix} c_{11} & c_{12} \\ c_{21} & c_{22} \end{bmatrix}, Y_{lag} = \begin{bmatrix} y_{1,t-1} \\ y_{2,t-2} \end{bmatrix}, E = \begin{bmatrix} \varepsilon_{y_1 t} \\ \varepsilon_{y_2 t} \end{bmatrix}. \quad (9)$$

In (9), Y_t refers to two response variables in system and ε_t is the error term matrix in period t.

3.4 ARMA-GARCHX model setting

In order to forecast the profitability and fluctuation of the dataset, the ARMA-GARCHX model was used, which is a combination of ARMA and GARCHX models that has characteristics of both models. This paper will then explain the two sub-models. As a combination of the Autoregressive model and moving average model, ARMA's model is expressed as:

$$x_1 = \phi_t x_{t-i} + a_t - \sum_{i=1}^{q} \theta_i a_{t-i} \tag{10}$$

, where a_t is the white noise series with a mean equal to 0 and standard deviation equal to σ_t^2, p and q, are non-negative integers.

Due to Heteroscedasticity, it's needed to use the arch model to satisfy this condition, however, in the ARCH(p)model, many parameters will have to be obtained and lose sample size, which can be a significant drawback. After Bollerslev invented the GARCH model, GARCH(p,q)'s model is designed to be:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \ldots \alpha_q \varepsilon_{t-q}^2 + y_1 \sigma_{t-1}^2 + \ldots + y_p \sigma_{t-p}^2 \tag{11}$$

as it reduced the Parameters to be estimated and gives more accurate predictions for the future conditional variance prediction.

In addition, GARCHX has the quality of including other explanatory variables (the variables need to be weakly stationary) at the same time, which differs from the other ordinary models. and the GARCH (1,1) is:

$$\sigma_t^2 = \alpha_{0+} \alpha_1 \varepsilon_{t-1}^2 \beta_1 \sigma_{t-1}^2 + \gamma USD_t \tag{12}$$

4. Tested results and analysis

4.1 VAR order

In order to observe multiple variants' Dynamic dependency and several variables' forecasts, The var model is used in this research. Owing to its unique quality, it has a flexible style that doesn't rely on economic theories, and it adds other random explanatory variables which makes the parameters predictions relatively easy. Here to obtain the most reliable result, it is the dataset with the smallest p-value that should be obtained [9].

Table 2 VAR model identification

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-832.552				1.3302*	5.9610*	5.9715*	5.98705*
1	-828.923	7.2591	4	0.123	1.3337	5.9637	5.9949	6.0416
2	-827.868	2.1097	4	0.716	1.3620	5.9847	6.0368	6.1145
3	-825.633	4.4701	4	0.346	1.3793	5.9973	6.0702	6.1791
4	-822.153	6.9594	4	0.138	1.3845	6.0010	6.0948	6.2347
5	-820.077	4.1528	4	0.386	1.4037	6.0148	6.1293	6.3004
6	-816.654	6.844	4	0.144	1.4096	6.0189	6.1543	6.3564
7	-816.654	.7465	4	0.945	1.4467	6.0448	6.2010	6.4343
8	-815.922	.71801	4	0.949	1.485	6.0708	6.2479	6.5122
9	-813.566	4.7127	4	0.318	1.5027	6.0826	6.2804	6.5759
10	-813.018	1.0956	4	0.895	1.5404	6.1072	6.3259	6.6524
11	-810.871	4.2938	4	0.368	1.5612	6.1205	6.3600	6.7176
12	-808.394	4.9536	4	0.292	1.5786	6.1313	6.3917	6.7804

13	-805.76	5.2695	4	0.261	1.5945	6.1411	6.4223	6.8421
14	-800.953	9.6141	4	0.047	1.5858*	6.1353**	6.4373*	6.8883*
15	-797.318	7.2696	4	0.122	1.5905	6.1379	6.4608	6.9428
16	-790.875	12.886*	4	0.012	1.5635*	6.1205*	6.4641**	6.9773**
17	-787.347	7.0556	4	0.133	1.5695	6.1239	6.4883	7.0326
18	-786.74	1.2132	4	0.876	1.6088	6.1481	6.5334	7.1087
19	-785.146	3.1873	4	0.527	1.6375	6.1653	6.5714	7.1778
20	-783.783	3.1873	4	0.604	1.6697	6.1841	6.6111	7.2486
21	-782.791	1.9843	4	0.739	1.7070	6.2056	6.6534	7.3220
22	-781.802	1.9764	4	0.740	1.7454	6.2271	6.6957	7.3954
23	-781.512	.58015	4	0.965	1.7937	6.2536	6.7431	7.4739
24	-779.777	3.4712	4	0.482	1.8246	6.2698	6.7801	7.5420

Here according to the graph, the var model with 16 lags has the smallest p-value (0.012).

In addition, to ensure the accessibility and accuracy of the research, it's also needed to test the stationarity of the variables in the var model, if all the characteristic values fall within the cycle, then the variables within this model are proved to be stationary.

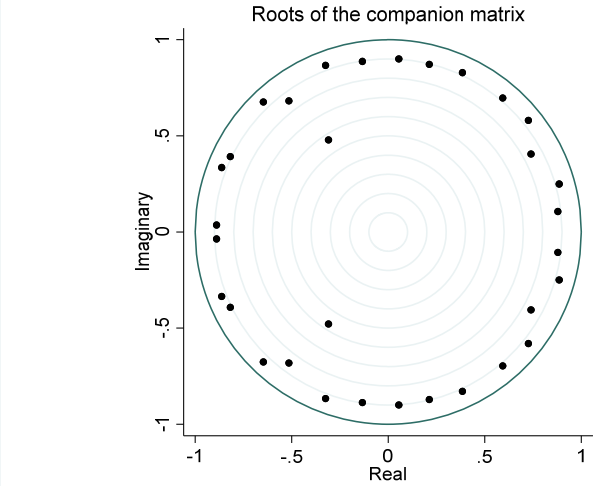

Figure 1 Unit circle test

4.2 Impulse function

According to the literacy review, it can be known that there are multiple opposing effects of increasing interest rates on the price of Nike. Owing to that, it would be difficult to see the net effect of interest rate, but with the help of impulse function, it can be seen the amount of change from one unit's impact on other variables as time changes [10].

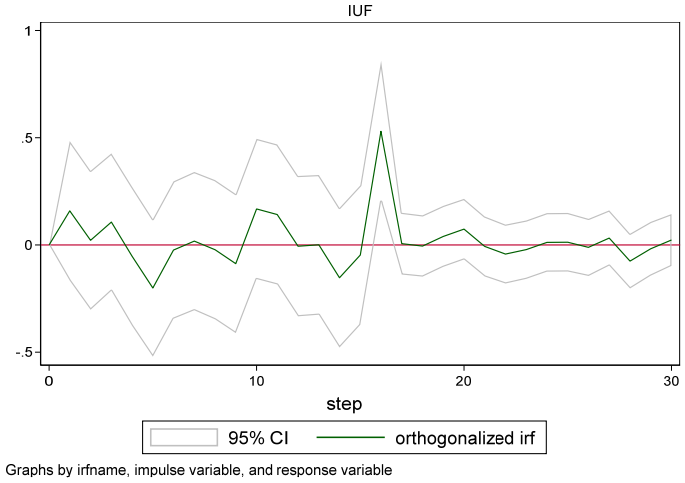

Figure 2 Impulse and response

According to Figure 2, it's seen that there's a positive net effect of American dollars' interest rates rising towards Nike's price. But due to the fact that the appreciation of the US dollar will make Nike's income fluctuate around 0, which makes it hard to see the net effect, owing to that this paper further calculated the cumulative response function. According to the results in figure 3, when t=0, the first unit's exchange rate impact in the future 30 gaps' accumulated influence is around 5%. Thus, the increase in the interest rate of the US dollar is beneficial to Nike's stock price.

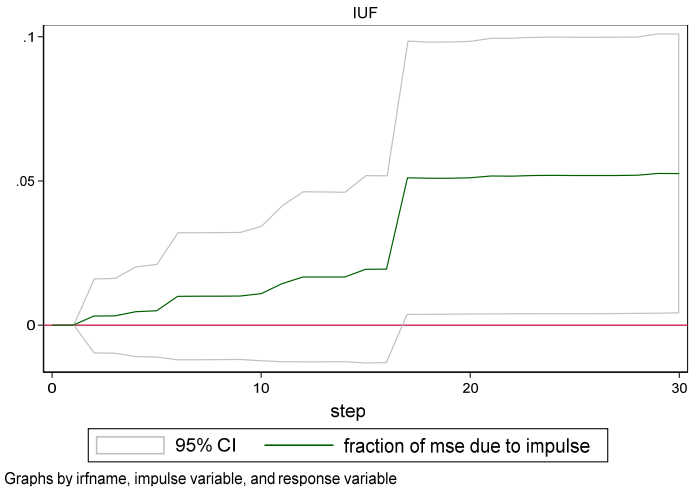

Figure 3 Cumulative response

4.3 ARMA:

In order to see the patterns and check randomness, It's needed to use autocorrelation which involves Autocorrelation Function (ACF) and Partial Autocorrelation Function(PACF)plots which are used to figure out the order of AR, MA, ARMA models. In PACF and ACF models, points beyond the critical values are referred to determine the order [11]. According to the ARMA Model in figure 4.

$$x_1 = \phi_0 + \sum_{i=1}^{p} \phi_i x_{t-i} + a_t - \sum_{i=1}^{q} \theta_i \alpha_{t-1} \tag{13}$$

In 9ths lag, a point went beyond the critical value, thus the order of this data set is 9.

PACF ACF

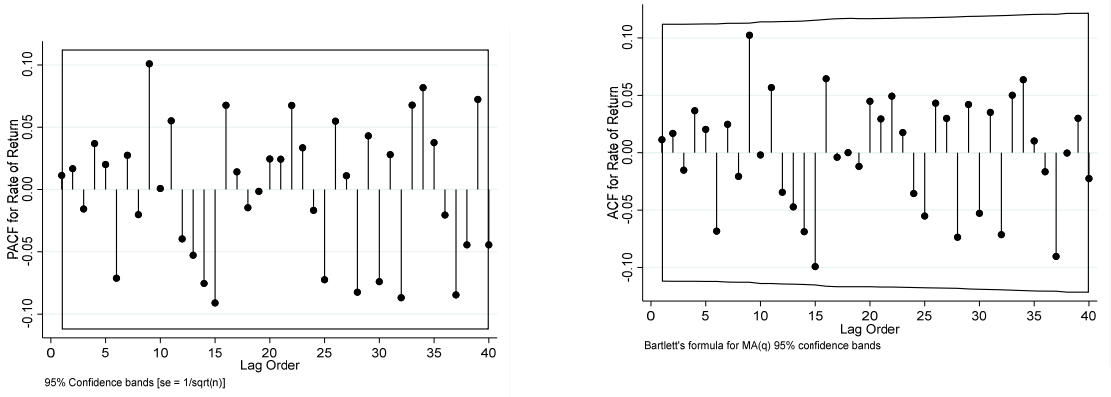

Figure 4 PACF and ACF

4.4 ARMA-GARCHX estimation result

Table 3 ARMA-GARCHX estimation results

	(1)		(2)		(3)	
	Coefficient	p>|Z|	Coefficient	p>|Z|	Coefficient	p>|Z|
USD, L0	0.0862***	0.003	-.5532	0.523	2.0059	0.118
USD, L1			2.2892***	0.000	-.2046	0.776
USD, L2					1.6836	0.309
ARCH, L1	-.0103	0.287	-.0039	0.794	-.0067	0.590
GARCH, L1	-.9563	0.000	.8751	0.000	.8859	0.000
Constant	2.7172	0.000	-.4825	0.609	-.6796	0.298

According to table3's estimation results, 3 columns' GARCH terms are significant at the 1% level, which means Nike's yield is statically significant conditional heteroscedasticity exists and satisfies the condition of GARCH model. According to the estimated results of external explanatory variables, there is a significant positive effect of the appreciation of the US dollar on Nike's volatility, but its hysteresis is also obvious.

5. Discussion

To sum up, the other literature usually only included one factor of influence from the rising of the interest rate and was mainly focused on theoretical discussion economics without using real data and statical methods to further analysis and proof for the assumption and gave a relatively more specific reasoning and economic models to assist their prediction. however, this paper gave a more comprehensive but also more general prediction with all the aspects of influence in macroeconomics (without in-detailed reasoning and economic models) and it does not only analyze the economic factors that might influence the trend of the stock price but also used the mathematical method to analyze the outcome of the appreciation of the US dollars using Stata.

This paper demonstrates the fact that when the exchange rate rises, the attracted foreign investment can also play a dominant role in stock prices.

Considering the outcomes from this paper, policymakers can be more confident about rising interest rates since the stock market won't be affected negatively as expected.

As long-term Stock investors, they can be more optimistic about the stock market during a rising interest rate since despite the short-term fluctuation, they can still profit in the long run. As short-term speculators, they can try to purchase options for the short term on both long and short of Nike's stock and bet on the fluctuation to profit.

6. Conclusion

Since 2021 June, as the federal reserve has been continuously raising its interest rate, an increasing number of investor is been wondering about the impact of the appreciation of the US dollar. Based on the existing economic theories and historical data of Nike and the US dollar index retrieved from cn.investing.com, this article gave a summary of existing economical predictions towards the result, and a statical analysis mainly uses the ARMA-GARCH model to integrate the influence (both profitability and volatility) by examining the inner correlation between historical data of the US dollar index and Nike's stock price since 2021 June till now. Based on the analyzed results it's concluded that the actual result is the opposite of the general prediction based on the existing economic theories that an increase in interest rate has a negative correlation with domestic companies' stock prices. despite the lag, and short-term fluctuation within the short term, there will be an increase in the interest rate of the US dollar is beneficial to Nike's stock price in the long run.

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