The Impact of the Federal Funds Rate Hike on Chinese and U.S. Financial Markets

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Abstract: On March 16th, 2022, federal funds benchmark rate was increased by 25 basis points, to the range of 0.25% to 0.50%, by the U.S. Federal Reserve (Fed) , after seeing Russia's war on Ukraine as a potential risk producing higher inflation and decreasing both national and international economic activities. The first increase in federal funds rates since 2018 was followed by the immense increase in rate. Until November 2022, the Fed has raised the federal funds rate seven times, leading impacts on many fields, including the financial markets in both U.S. and China. This paper selects two well-known financial indexes, representing the market performance of both China's stock market and U.S. stock market. Since the exchange rate is highly sensitive to interest rates. After the raise in the benchmark of federal funds rate, U.S. dollar has appreciated, and Chinese Yuan has depreciated. This paper introduced the exchange rate as the media to reflect the impact on the Chinese stock market by federal funds rate hikes. After intercepting the stock data from 2 years after the Great Depression till one month before the first federal funds rate hike, this paper constructs ARIMA model to analyze the impact on each stock market by federal funds rate hike, and forecast their further performances, providing suggestions to investigators in the U.S. and China.

Keywords: China, U.S., federal reserve, federal funds rate, stock market, ARIMA

1. Introduction

"With U.S. inflation entrenched, Qualcomm gains could force the Fed to make the biggest rate hike in more than 40 years." That's Nomura Securities' forecast for a rise in the Fed's standard near-term interest rate. The last time the Fed took such aggressive steps was in the early 1980s, another period marked by very high inflation [1]. First of all, what is the Fed raising interest rates? The rate hike by the Federal Reserve refers to the adjustment of monetary policy and the increase of the federal funds rate after the Board of Management of the Federal Reserve System holds an interest rate meeting in Washington [2]. In other words, raising interest rates is one of the contractionary monetary policies, which the Fed employs to respond to the current economy [3]. In general, bank interest rates could be increased by the rise in interest rates, which as a result money supple would be reduced and dollar would be appreciated. Moreover, economy would be affected by an increase in the U.S. dollar exchange rate. For example, the price of gold will decrease as U.S. dollar appreciates and people will be more willing to hold U.S. dollar instead of the currencies of other countries, which leads to their depreciations [4, 5]. The Fed must contend with the imprecise and inconsistent effects of the monetary

policy on its economy as it cools the U.S. economy and tame inflation by raising interest rates. Milton Friedman, Nobel Prize-winning economist, famously argued that "monetary policy actions affect economic conditions only after a long and variable lag [6]." It would take years for the full effect of the policy to emerge; however, and the Fed prefers an incremental approach, gradually adjusting policy while carefully observing economic data for signs of its impact. Nevertheless, in the current state of the economy, the Fed has no room for slow adjustments. Inflation has skyrocketed to unprecedented levels, forcing the Fed to slam on the brakes. This hasty tightening approach increases the risk that Fed officials will overly raise interest rates, which could place the U.S. economy into a deeper recession than needed to avoid inflation [7]. The speed at which the Fed has been raising rates this year is the highest in the past 40 years. Fed Chairman Jerome Powell has said the current pace of tightening is suitable "given the persistence and strength of inflation and the fact that monetary policy started raising rates from a low level" [8].

Fed rate hikes have immense impact on capital markets. Bonds and stocks typically foreshadow Fed actions, especially when those actions are signaled by Fed officials in advance. Bank deposits and bonds become more attractive as interest rates increase. On the contrary, the economy and corporate profits are negatively affected, which results in less investments in stocks. The plummet in the stock market caused the investors to shift to the bond market which as a result bonds have the peak yields since 2007. Two months before the first Fed rate hike in March 2022, the S&P 500 peaked which indicates the prosperity of the bond market [9]. From the perspective of households, the decay in the stock market will decrease personal consumptions due to the shrinkage in personal wealth.

This paper will focus on the stock markets in China and the U.S., using the monthly data of the years before the FFR hike to build a model of the Shanghai Composite Index, NASDAQ Index and the Chinese Yuan to U.S. Dollar exchange rate and then perform 9-step-ahead forecasting on the closing prices of each market. By comparing the predicted results to the actual values on the closing prices, it will be able to explore the effect of the FFR rate hike on the two stock markets.

The subsequent parts of this research thesis are organized as follows: Parts 2 is the research design, which introduces data source, Augmented Dickey-Fuller Test and model specification. Part 3 is empirical results and analysis, including model order estimation, testing, forecasting and analysis for NASDAQ Index, SSEC Index and U.S. Dollar to Chinese Yuan exchange rate respectively. Part 4 is the conclusion.

2. Research Design

2.1. Data Source

This paper used NASDAQ Index (monthly), SSE Composite Index (monthly), and the Chinese Yuan to U.S. Dollar exchange rate (monthly) to reflect the consequence of the FFR hikes on the U.S. and Chinese financial markets as well as the exchange rate respectively. The data were manually collected from Yahoo Finance and fxtop [10, 11]. The closing prices from January 2010 to February 2022 are selected to eliminate the impact of the Great Recession and aimed to reflect the stock price fluctuations after the first FFR hike on March 16th, 2022 as a data source for empirical analysis to study the impact of the FFR hikes on multiple markets.

2.2. Augmented Dickey-Fuller Test

After extracting the desired data points, a unit root test (stationary test) is performed on the data, where the null hypothesis is that the data is not stationary. As shown in Table 1, the p-values for the logarithm transformations are greater than 0.05. Therefore, the alternative hypothesis is not concluded due to the lack of evidence. After keeping pre-processing the data points, more specifically, using the first-order differencing, all the p-values equal to 0. Therefore, rejected the null hypothesis is rejected.

For further modeling process, this paper will use the differenced data points since stationarity is reached.

Table 1: ADF test.

Variables	t-statistic	p-value
Raw		
Nasdaq	-2.926	0.1539
SSEC	-3.044	0.1202
Exchange rate	-2.387	0.3867
Return		
Nasdaq	-9.483	0.0000***
SSEC	-8.774	0.0000***
Exchange rate	-6.445	0.0000***

2.3. ARIMA Model

The autoregressive integrated moving average (ARIMA) model could be implemented, since the paper selected multiple time series data to make future predictions. There are three components within ARIMA: Auto-Regressive Regression (AR(p)), Integrated (I(d)), and Auto Regressive Moving Average (MA(q)).

The general p order AR (p) is:

$$y_t = c + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_p y_{t-p} + \varepsilon_t \tag{1}$$

where ε_t is white noise.
The general q order MA (q) is:

$$y_t = c + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \tag{2}$$

where ε_t is white noise.

Combining AR (p), MA (q) and differencing, this part obtains an Auto-Regressive Integrated Moving Average Model (ARIMA (p, d, q)). The model can be written as:

$$y_t^{'} = c + \phi_1 y_{t-1}^{'} + \cdots + \phi_p y_{t-p}^{'} + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \tag{3}$$

where the y_t' is the differenced series. The right-hand side of the equation includes both lagged errors and lagged values of y_t, while p is the order of the autoregressive part, d is the degree of the first differencing involved, and q is the order of the moving average part.

3. Empirical Results and Analysis

3.1. Model Order Estimation

It is first necessary to determine the orders of p and q in each model using the PACF and ACF plots, the results of which are shown below.

PACF   ACF

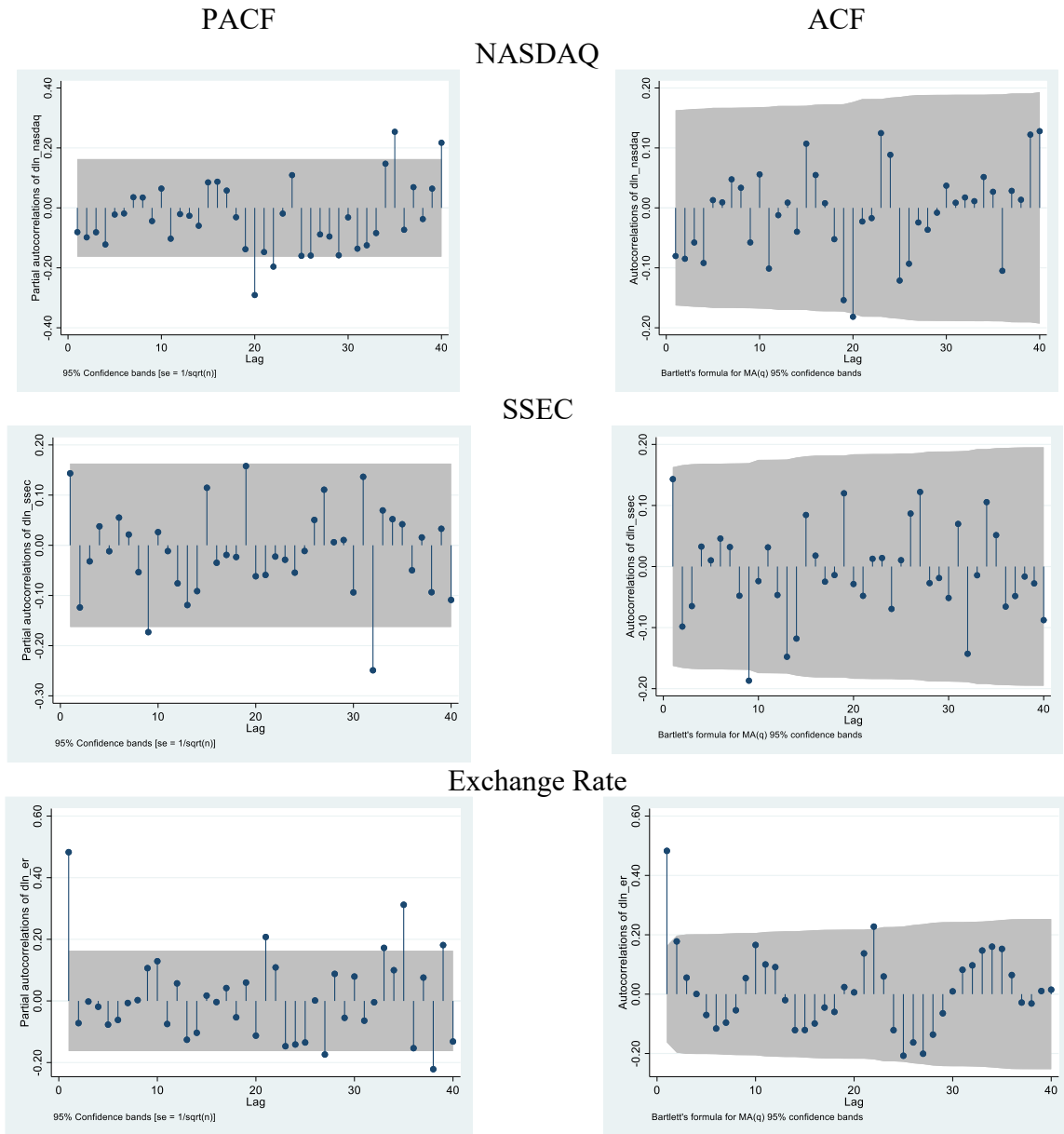NASDAQ

SSEC

Exchange Rate

Figure 1: PACF and ACF Plots.
Photo credit: Original

From both the PACF and ACF plots shown in the first row of Figure 1, the most significant mutations happened at Lag 20. Therefore, the values of p and q are 20 for the COMP ARIMA model, i.e., AR (20) and MA (20).

From both the PACF and ACF plots shown in the second row of Figure 1, the most significant mutations are at Lag 9. Therefore, the values of p and q are 9 for the SSEC ARIMA model, i.e., AR (9) and MA (9).

From the PACF and ACF plots shown in the third row of Figure 1, the most significant mutation in the PACF plot is at Lag 21 and the most significant mutation in the ACF plot is at Lag 1. Therefore, the value of p and q should be 21 and 1 respectively for the Exchange Rate ARIMA model, i.e., AR (21) and MA (1).

3.2. Testing, Forecasting, and Analysis

After constructing the ARIMA (20,1,20) model for NASDAQ Index, ARIMA (9,1,9) model for SSEC Index and ARIMA (21,1,1) model for the exchange rate, the residual test is performed to examine the empirical feasibility. The collected testing results are shown in the table below.

Table 2: Residual test.

Model	Portmanteau (Q) statistic	Prob > chi2
NASDAQ	33.8536	0.7423
SSEC	34.5525	0.7135
Exchange Rate	46.2993	0.2284

The null hypothesis states that the residuals are not correlated, and they look like white noise (please see Table 2). For all 3 models, the resulted p-values are greater than 0.05, which means there is enough statistical evidence to accept the null hypothesis. Therefore, the model set-ups are feasible. This paper will conduct further forecasting using ARIMA (20,1,20), ARIMA (9,1,9), and ARIMA (21,1,1) models.

3.2.1. NASDAQ Index

Based on the forecasting model ARIMA (20,1,20), this paper visualized the fluctuations in the stock price for the NASDAQ Index, shown in the figure below.
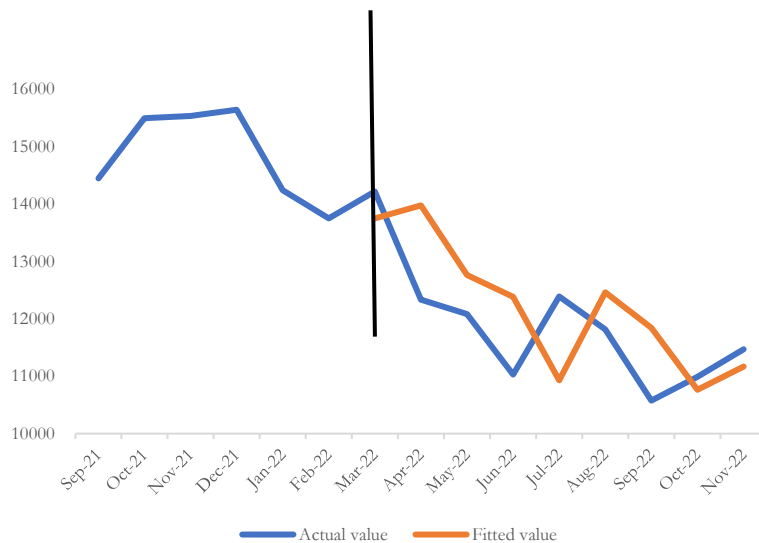

Figure 2: Nasdaq.
Photo credit: Original

The black vertical line on the plot above (Figure 2) is used to indicate the time node of the first FFR hike in 2022. From the results, the fitted value line is above the actual value line from April 2022 to mid-June 2022, and from August 2022 to October 2022. The rest months have the actual value line above the fitted value line. This paper takes the fitted value line as the baseline. By comparison, the short-term fluctuations indicate that the FFR hike didn't have a constant impact on the U.S. financial market in 2022. More specifically, if the Federal Reserve didn't increase the FFR on March 16th, 2022, then the actual values will be highly likely to follow the predicted fitted values. However, the

gaps denote a univariate impact of the FFR hike. From April to mid-June and August to October 2022, the FFR hike decreased the stock prices in the U.S. stock market. From mid-June to August, and October to November 2022, the FFR hike increased the stock prices in the U.S. stock market. Most notably, besides the time duration of mid-June to August, the actual value line and the fitted value line are somehow parallel. Overall, this paper concludes the FFR hike will negatively impact the U.S. stock market.

3.2.2. SSE Composite Index

Then, this paper used the same forecasting method to visualize the effect of the FFR hike on China's stock market (Figure 3).

Figure 3: SSEC.
Photo credit: Original

March 16th, 2022 is represented by the black vertical line as before. The actual value line and the fitted value line have 3 intersection points, splitting the graph into 4 parts. From March to May and July to mid-October, 2022, the fitted value line is above the actual value line. From May to July and mid-October to November, 2022, the fitted value line is below the actual value line. Same as before, if the FFR didn't hike on March 16th, 2022, then the short-term fluctuations wouldn't be this significant. From March to May and July to mid-October, 2022, the FFR hike had negative impacts on China's stock market while from May to July and mid-October to November, 2022, the FFR hike has positive impacts on China's stock market. Besides the last time duration from mid-October to November, the actual value line and the fitted value line have some levels of parallelism. There are 6 and half months with negative impact and 2 and half months with positive impact obtained after applying 9-step-forward forecasting. Thus, this paper generally concludes the FFR hike has a negative effect on the stock market in China.

3.2.3. Exchange Rate

With the same 9-step-ahead forecasting process, this paper constructed a comparison plot between the actual price and the fitted value of the Chinese Yuan exchange rate to the U.S. Dollar (please see Figure 4).

Figure 4: Exchange rate.
Photo credit: Original

Only two intersection points in June and November this time are observed. Overall, the actual value line is always above the fitted value line, meaning the FFR hike has a positive and constant impact on the exchange rate. From March to mid-June, 2022, the impact was significant, accompanied by a dramatic deviation from the fitted value line. From mid-June to August 2022, the level of impact decreased. Then from August to November, the deviation from the fitted value line started to enlarge again and finally intersect. The effect of the FFR hike on the exchange rate is always positive, but the degrees of impact are not constant.

4. Conclusion

This paper aims to examine the way different financial markets, Chinese market and U.S. market, have been impacted in the short-term respectively under the context of the FFR hike. Considering the indirect impact and direct impact, the exchange rate between U.S. Dollar and Chinese Yuan is introduced as a media, transforming the impact of FFR hikes into the stock market in China. The ARIMA model is the selected forecasting model in this paper, given its interpretability and forecast ability. The desired data is integrated to examine the stock price fluctuations by applying a 9-step-ahead forecast. The impact on each market is not constant, but generally, after the Federal Reserve raised the FFR, the stock markets in China and the U.S. will be negatively impacted.

To conclude, the FFR hike on 16th March, 2022 had negative impacts on the stock market in China and the United States, and a positive impact on the U.S. Dollar to Chinese Yuan exchange rate. The duration of the negative effect on the U.S. stock market is longer than which in the Chinese stock market, and the degree of the impact is more substantial due to the bigger deviations. By comparing the two stock markets, the stock price in both markets presented an unexpected return after the plummet. However, zoom-in on October of the stock market in China, the stock price didn't follow the predicted decreasing trend but experienced a significant unexpected return again. While giving all the preliminary data in the Shanghai stock market, the estimating model was unable to predict another stock price recovery as it did to the U.S. stock market.

Meanwhile, regarding the effect on the stock market in the U.S. is more long-lasting and tremendous, the impact of FFR hike on U.S. Dollar to Chinese Yuan exchange rate should be considered. The FFR hike had direct impacts on the U.S. stock market during open market operations, while the impacts on China's stock market are indirect, considering exogenous factors including international trading, exchange rate, and trade conflict. In mid-June, the fitted value and the actual value of the exchange rate are the same, as well as in November. In China's stock market, also in mid-June, the fitted value and the actual value of the stock price intersected, stating the end of the positive impact and bringing the price to decrease again. Afterward, the deviation on the exchange

rate started to diverge, as well as the deviation on the SSEC Index. In May 2022, the gap between line of actual values and line of fitted values in the exchange rate is the most significant before mid-June, which also indirectly reflects on the first interaction of actual values and fitted values in the SSEC Index. The impact of the FFR hike on stock prices in China's stock market began to become positive as the effect of the FFR hike on the exchange rate was large.

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