A Research of the Interest Rate’s Role in the Tech Sector

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Abstract. High-tech industry has always been the focus of the world. It not only accompanies the daily life but also plays an essential role in economy. In March 16th 2022, in response to looming inflation expectations, the Federal Reserve began raising interest rates. In order to observe the effect of raising rate on high-tech industry, this paper utilizes autoregressive integrated moving average (ARIMA) model to predict the short term value of the data set after the date of raising rate as if it never happens. ARIMA is one of the most popular model for analyzing time series data. It solely needs the historical data and utilizes the lagged moving average to smooth the time series data. By comparing the expected value and the real data, the impact of FED will be obvious. This paper tests the stereotype that raising rate could be destructive to an industry, and will only focuses on high-tech industry, more specifically, the telecommunication, Internet, and computer technology.

Keywords: High-tech industry; Interest rate; Time series analysis.

1. Introduction

Numerous economic crises throughout history have demonstrated the importance and necessity of a central economic governing body. Therefore, the federal reserve board was born, controlled by board of governors of the federal reserve system. After annual meetings, the federal reserve decides changes in monetary policies and federal funds rates based on many indexes, such as annual expected inflation rate and total exports. Generally, raising the rate is a contracting monetary policy. It will directly impact the bank interest rate, and decrease the money supply. As a result, American dollar will appreciate; other countries’ currencies will depreciate; price of some financial derivatives such as gold will decrease as well. The first increase of the rate took place in 1980. In 1982, short-term interest rates began to follow inflation down. Several episodes of rising short-term rates have interrupted this longer-run trend, however [1]. People in United States suffered from the long-lasting high inflation, and several consecutive presidents tried to fix this problem but failed. The prices of food and oil have gone up. The U.S. government ultimately solved the economic crisis at the cost of a recession, and the high unemployment rate.

From 2016 to 2018, the Fed adjusted rates many times. Its variation fluctuated from 0.5% to 2.5%. In 2016, the American economy has expanded steadily. Market and family expenditures got strengthened, but the investment expenditure was weak. In general, inflation was increasing. The Fed increases the fund rate three times in the following year. The rate raising focused on in this paper happened in March 16th 2022. Comparing to other dates of raising the rate, this one underwent the impact of several global events. Since 2018, the United States has criticized China for unfair trade and intellectual property rights violations, and has imposed tariffs of 10 or 25 percent on a wide range of Chinese imports. China has proposed equal tariff increases against the United States. As the trade war intensifies, the value of China's currency has plunged. The import and export trade between China and the United States has been seriously affected. The good’s price level surged and consumers in both countries were forced to pay for it. The situation has worsened since the 2020 pandemic. The supply chain had been endangered. In China, the lockdowns caused sharp contractions in production and exports, which eventually spilled over to the US [2]. Meanwhile, Economic Impact Payments from the American Rescue Plan was passed [3]. The government was trying to lift people out of the gloom and misery of unemployment. It tried to promote consume goods by providing money directly which directly relates to the increase of inflation. Moreover, on February 24, 2022, the Russian-Ukrainian war broke out. There have been hundreds of thousands of casualties and millions of
displaced people. These two countries are rich in natural resources and occupy important geographical positions on the European continent. Coupled with the impact of the war, the price of oil and food has risen sharply as a core material in a war. Considering aforementioned factors, the think tank’s global inflation expectations are constantly increasing. Therefore, the Fed passes the order to increase the fund rate, and trying to keep the economy away from depression. Kang suggests the shifting stance of the central bank, and it could directly result into the volatility of the stock market, capital inflow, and the bearish commodity market [4]. Li views that investors could feel apprehensive and more people may turn to buy 10 year treasury bond [5]. This research paper focuses on exploring the actual effect of raising rate on the economy, specifically high-tech industry.

2. Methodology

2.1. Data Selection

This paper focuses on the rate change happened in March 16th 2022, and explores its potential influence on high-tech industries. Therefore, several representative indexes’ closing price related to this field were collected, including NASDAQ Internet, NASDAQ Telecommunication, and ARCA Computer Technology. These data are collected directly from Investment.com, one of the three largest financial websites in the word. The data set for each index includes all data from 2010 to 2023, 5112 observations in total in a 12 month cycle. In order to more intuitively see the short-term impact of the Fed’s interest rate hike on the industry, this paper further categorizes and analyzes each data set in daily and weekly bases. By importing the data and setting the time of the Fed rate hike to t0, this paper starts the time series model and ARIMA analysis based on the following equation.

\[ y'_t = c + \phi_1 y'_{t-1} + \cdots + \phi_p y'_{t-p} + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q} + \varepsilon_t \] (1)

2.2. Modelling

By skimming through the data collected, the range of data is so large that the largest price could be 10 times of larger than the smallest price. In order to confine the data into a smaller scope, it takes this time series data and convert the raw data into logarithmic data and Logarithmic return series. Mathematically, this transformation keeps the data’s properties, but flatten the data set. This paper uses ARIMA to forecast the result which requires the time series data to be periodicity if it can and stationary, or its properties stay unvaried as the change of time. Therefore, other than providing logarithmic calculation, data set is furthered operated through first order difference and second order difference in order to minimize the potential seasonal trend and cyclicality (see Table 1).

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<thead>
<tr>
<th>Table 1. Weak stationarity test</th>
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<td>Computer technology, daily</td>
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<td>1st order difference</td>
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<td>Internet, daily</td>
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<td>1st order difference</td>
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<tr>
<td>Telecommunication, daily</td>
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<td>Ln index</td>
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<td>1st order difference</td>
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<td>Computer technology, weekly</td>
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<td>Internet, weekly</td>
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ARIMA model usually is written as ARIMA(p,d,q). It can be viewed as the generalization of ARMA model, or the combination of autoregression model (AR) and moving average model (MA).

Fig. 1 ARMA (p, q) identification, daily data (Photo/Picture Credit: Original).
Its parameter p, d, and q represents the non-negative integers: number of lags in autoregression, number of orders of difference of the data, number of order of the moving average model. In order to provide an accurate ARIMA model fits in the data, these parameters are found through ACF and PACF, as shown in Figure 1 and Figure 2. Consequently, the following models are obtained: computer technology daily data ARIMA(8,1,3), Internet daily data ARIMA(10,2,1), telecommunication daily data ARIMA(10,2,1), computer technology weekly data ARIMA(10,1,5), Internet weekly data ARIMA(8,2,1), telecommunication weekly data ARIMA(11,1,5). Then, through residual test, these methods are reconfirmed (see Table 2).

### Table 2. Residual test

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<thead>
<tr>
<th>Model, daily data</th>
<th>Portmanteau (Q) statistic</th>
<th>Prob &gt; chi2</th>
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<tr>
<td>Computer tech-ARIMA(8,1,3)</td>
<td>11.8965</td>
<td>1.0000</td>
</tr>
<tr>
<td>Internet-ARIMA(10,2,1)</td>
<td>36.7624</td>
<td>0.6168</td>
</tr>
<tr>
<td>Telecom-ARIMA(10,2,1)</td>
<td>129.1793</td>
<td>0.0000</td>
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<table>
<thead>
<tr>
<th>Model, weekly data</th>
<th>Portmanteau (Q) statistic</th>
<th>Prob &gt; chi2</th>
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<tbody>
<tr>
<td>Computer tech-ARIMA(10,1,5)</td>
<td>33.8192</td>
<td>0.7436</td>
</tr>
<tr>
<td>Internet-ARIMA(8,2,1)</td>
<td>39.1858</td>
<td>0.5067</td>
</tr>
<tr>
<td>Telecom-ARIMA(11,1,5)</td>
<td>25.0936</td>
<td>0.9684</td>
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### 3. Empirical Results

As the ARIMA forecasting data compiled in Figure 3 as shown below, the prediction curves appear differently for each data sets.
The ARCA Computer Technology, and NASDAQ Internet daily data indexes show similar pattern with each other. Both of these indexes shows an increasing trend after the drop happened in the beginning of 2021 December. Then, after the hike of the rate, both of these two indexes show a jump comparing to the ARIMA model forecasting value. After the jump, the industry enters the decreasing trend with a brief upturn in the middle. Differently, NASDAQ Telecommunication index appears about the same with my predicted value with small fluctuation. For weekly data, all three indexes shows similar pattern. After the raise of rate, the real data dropped comparing to the predicted value. This outcome is different from the daily data result. Therefore, it can be concluded that these data are with high volatility. Due to the excessive fluctuations, the weekly data will be inaccurate. Therefore, the following sections will mainly focus on the result of the daily data.

Overall, the empirical result appears differently with my intuition. As introduced in the introduction, raising the rate is one of the contractors monetary policy. Typically, a Fed rate hike is followed by an economic slump. A huge jump shown in the graph is abnormal. One possible explanation could be the increasing rate has already played its role in the industries. However, there is another factor that influenced the data much greater than the rate increment. Under the coronavirus epidemic, much more people started to stay at home. New terms, such as “distance learning”, “virtual
working”, appeared. The need for telecommunication, computer technology, and Internet-related product surged. However, digital commerce and technology have been raised in this discussion. This is one of the most prominent sectors. Online gaming, radio, and digital media subscriptions, and the over-the-top (OTT) media service platform are largely increased in this pandemic situation. They may provide more revenues in the upcoming years [6]. Other researchers share the similar thoughts. Subudhi and Palai provide data example in India which can be viewed as the epitome of the world. According to OpenVault’s Broadband Insight Report showed the first quarter of the 2020, the average broadband consumption increased to 402.5GB from the 273.5GB during the last year 2019 that’s around 47 percent [7]. Besides these facts based on common people’s need, tech-sector is also promoted by the governments. Many of them published the legal documents to view developing industries such as telecommunication, computer technology, Internet as their economic goals [8]. The COVID-19 pandemic further accelerates the development of digitalized economy. In the study of European countries Union and non-EU countries economy in the pandemic of COVID-19 years, the digitalization of the economy is the factor with the greatest influence on the macroeconomic stability of those countries [9]. Workers from variety of industries can work and cooperate at home. People in international companies do not need to leave their home country anymore. Workers’ time could be much more flexible as well. However, the prerequisite of all these advantages is telecommunication, computer technology and Internet. In recent years, the biggest positive in the telecom industry is 5G breakthrough. However, it has already increased already. Within the scope of research, this technology has entered the phase of steady development. In contrast, with the development of quantum computing and blockchain, the Internet and computer technology are still hot plates. They still have a lot potential and opportunities to discover new researches. Therefore, the telecommunication cannot increase as much as the other two industry.

4. Discussion

In today's information age, everything are developing in an unprecedented speed and everything is about technologies. The most valuable companies, such as Apple, Google, Amazon, and so on, all highly rely on technology. In the specifically selected field, telecommunication appears uninfluenced by the FED decision. A telecommunication company generally needs to pay their advertisement fee to attract more users and maintenance charge to keep their base stations and databases up and running. One representative example is Verizon. The year the Fed raised rates, the company's total expenses did rise significantly because of its increasing cost as shown in Figure 4 below.

![Verizon Communications' capital expenditures from 2016 to 2022 (in billion U.S. dollars)](image)

**Fig. 4** Verizon communications’ capital expenditures from 2016 to 2022 (in $billion) [10].
But in the context of the epidemic, people’s dependence on telecommunications companies is also growing. In the existing market share, the number of users still has a small increase corresponding to the slow upward trend of the overall telecom industry shown in NASDAQ Telecommunication index. Google has become the largest Internet company in the world through alphabet Inc., and has surpassed in market capitalization with other Internet companies. Corresponding to the NASDAQ Internet index, it shows an increase in its revenue (see Figure 5), so does its research and development expenditure which brings burden to the company as the interest rate is increased. These companies’ data follow the index value well. It is easy to have the intuition that these data should have a downward trend. However, it could help the companies.

![Digital content and hardware revenue generated by Google from 2001 to 2023 (in $million)](image)

**Fig. 5** Digital content and hardware revenue generated by Google from 2001 to 2023 (in $million) [10].

5. Conclusion

Based on aforementioned analysis and the ARIMA model, this paper finds that FED raising the interest rate helps some of the high-tech industries. However, this paper’s method is not perfect. As mentioned in introduction part, this rate change happened in a complex background. There was a tension between China and United States, Ukraine and Russia. The COVID-19 pandemic was also raging across the globe. These factors have greatly affected the economic development of various industries around the world. Therefore, although this paper has used logarithm transformation, first order difference, and second order difference to make the data set stationary, it is possible that the impact of wars and epidemic is not completely eliminated because of the severity of these factors. Also, the high-tech industry includes but is not limited to industries, such as telecommunication, computer technology, and Internet. To improve the broader view of the high-tech industry, it would be useful to collect more data from various indexes, and also analyze representative giant companies, small companies and so on. Moreover, while deciding the parameters of ARIMA model, numbers are chosen subjectively with foundation of statistic knowledge. Therefore, the model could be imperfect. In the future, the Fed could ease concerns about the tech sector when it raises rates, or this level of hike of rate is safe for tech sector.

References


