The Impact of Fed Rate Hikes on Tech Company Stock Prices: Microsoft as an Example

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Abstract. This paper analyzes, from a third-person perspective, the impact of the fiscal and monetary policies adopted by the United States since the outbreak of the COVID-19 epidemic in 2020 on the international financial market and the stock prices of large, listed companies, with a particular focus on the impact of the Fed's interest rate hike on the stock price of Microsoft Corporation. Through time series analysis methods, including ARIMA model, the study reveals the short-term effects of the interest rate hike policy on the U.S. dollar exchange rate and Microsoft's stock price. The results show that the interest rate hike significantly affects Microsoft's stock price, demonstrating the profound impact of macroeconomic policy changes on the micro market. This study not only fills the gap of specific case studies on the impact of the Fed's interest rate hike but also provides new perspectives for understanding the impact of macroeconomic policies on individual firms' stock prices. The study emphasizes the need for investors and policymakers to consider the potential impact of macroeconomic policy changes on the stock market. For investors, this means considering future trends in monetary policy when making investment decisions, and for policymakers, taking into account the impact of policy adjustments on the stability of international financial markets, particularly on the stock prices of major global firms, when adjusting policies to promote the healthy development of the global economy.

Keywords: Federal Reserve interest rate hike, international financial market, Microsoft Corporation stock price, time series analysis, macroeconomic policy impacts.

1. Introduction

The Federal Reserve (Fed) is the central banking system of the United States, which implements monetary policy by adjusting the benchmark interest rate, managing the money supply, and influencing the exchange rate of the U.S. dollar [1], which in turn has a far-reaching impact on a global scale. When the Fed decides to raise interest rates, it not only raises the dollar exchange rate [2] and attracts global investors to increase their investment in U.S. assets, but it may also lead to the reallocation of global funds, which can have an impact on the financial markets of other countries [3]. At the same time, through the implementation of quantitative easing, that is, the purchase of government bonds to increase the money supply, the Federal Reserve has increased the liquidity of the global financial market and promoted the activity of the global market. These monetary policy adjustments directly affect the dollar exchange rate and indirectly affect global trade and capital flows [4]. Given the significant influence of the Fed's interest rate hike [3], this article aims to data-driven analysis and prediction of the changes in the global financial markets, including the stock price of a large multinational corporation-Microsoft before and after the interest rate hike, through a time series.

1.1. Background and Importance of the Study

Since the COVID-19 epidemic in early 2020, To stimulate the economy, the U.S. implemented unprecedentedly loose fiscal and monetary policies. The Federal Reserve quickly lowered the federal funds rate to 0-0.25% and initiated massive quantitative easing, expanding its balance sheet from about $4 trillion to over $8 trillion [5]. Fiscal policy, with a federal deficit of 15% of GDP in 2020, stimulated the economy primarily through direct monetary grants to low- and middle-income households. These policies helped the U.S. economy recover quickly from the epidemic-induced

recession, contracting by 3.4% in 2020 and achieving 5.6% growth by 2021. However, rapid economic growth and consumer recovery led to rising inflation, with CPI growth reaching a 40-year high of 7.9% year-over-year in February 2022[6, 7]. In this context, the Federal Reserve was forced to accelerate the tightening of monetary policy, announcing an interest rate hike in March 2022 and planning to continue to raise interest rates during the year, with the federal funds rate expected to reach 1.75-2.0% by the end of the year [8].

Historical experience has shown that Fed interest rate hike cycles tend to create significant turbulence in international financial markets. For example, the Latin American debt crisis in the 1980s and the Southeast Asian financial crisis in 1997 were preceded by sustained interest rate hikes by the Fed [9]. Interest rate hikes usually narrow the differential between the United States and emerging markets, causing capital to flow back to the United States from emerging markets. This may lead to emerging markets facing problems such as falling asset prices, currency depreciation, and increased pressure on external debt. It is worth noting that before the bursting of the Internet bubble in 2000 and the real estate bubble in 2007, the Federal Reserve also carried out several interest rate hikes, indicating that interest rate hikes may depress excessive asset valuations and trigger financial crises. Consecutive interest rate hikes from 2015 to 2017 also led to a significant decline in the U.S. stock market in 2018 [10]. Therefore, the Fed's interest rate hike cycle in 2022 could pose a significant shock to both emerging and U.S. financial markets, especially given its intertwined impact with other global uncertainties, such as the Russia-Ukraine conflict, which could lead to more complex challenges for the global economy.

1.2. Literature Review

Most studies today explore the overall impact of the Fed's interest rate hike on international financial markets, and the analysis is subjective and ordinarily speculative. Literature using time series to analyze the impact on exchange rates and stock prices before and after the Fed's rate hike is scarce, mainly due to the lack of specific case studies on technology and financial giants such as individual large companies. This study builds on the macro-level framework to create a data-supported forecast and analysis of micro-market variables, refining the research theme.

1.3. Purpose of the study

This article aims to data-enable the analysis and forecasting of changes in the global financial markets, including the share price of a large multinational corporation, Microsoft Corporation, before and after an interest rate hike, through a time series. In particular, the ARIMA model is used to analyze the short-term impact on the U.S. dollar exchange rate and Microsoft Corporation's stock price before and after the Fed's interest rate hike by collecting and organizing the data on the change of Microsoft Corporation's stock price from December 31, 2009, to December 31, 2023. This study is based on the characteristics of the time series analysis method by observing the past data to predict future data and combining these data variables with specific events to provide the indirect of the Fed's interest rate hike on the turbulence of the international financial market based on analyzing and predicting the data.

1.4. Research Structure of this Paper

Information about the data sources, data stability, and the model in this paper is presented in Section 2. This is followed by Section 3, which provides a comprehensive discussion of the results of ARMA models and additional analyses of stock returns, stock volatility, and the behavior of market participants. Next, this study's focus, purpose, and importance are discussed. Finally, Part V briefly reiterates the conclusions.

2. Research Design

2.1. Data Sources

As a famous software developer worldwide, Microsoft Corporation has a vast amount of available data. As one of the five largest information companies in the United States, its data can be a representative and case study of the impact of the Federal Reserve's interest rate hike on stocks. The study extracted the daily and weekly closing prices of Microsoft Corporation (MSFT) from yahoo finance's historical Data from 2010-01-04 to 2023-12-29. The currency is in USD, and the daily real-time price is still being recorded. The study processed this data to calculate the volatility and impact on the stock returns of Microsoft Corporation since the Fed's interest rate hike.

2.2. Unit root test

Before proceeding with the study, this part must perform a unit root (smoothness) test on the data. The Augmented Dickey-Fuller test is performed using Stata for daily and weekly closing prices, respectively, and the null hypothesis is that the tested data model is not smooth. According to Table 1, it can be concluded that the P-values of both daily and weekly models are not less than 0.1, so the null hypothesis is not rejected, which means that the two original models are not smooth. After the first order difference, the P-value is 0, less than 0.1. Therefore, the model after the first-order difference is smooth. In other words, the daily and weekly models after the first-order difference are feasible and smooth.

Table 1 Weak stationarity test

	t-statistic	p-value
Daily Data		
Ln value	-2.993	0.1341
1st order difference	-41.128	0
Weekly Data		
Ln value	-2.846	0.1805
1st order difference	-19.467	0

2.3. ARIMA Model

After unit root test it can be found that the original series of daily and weekly are not smooth, so it is not possible to construct an ARMA model. When the difference order is 1, the differenced series is smooth, then ARMA modeling can be performed, at this time the model is ARIMA.

$$x_t = \emptyset_0 + \sum_{i=1}^{p} \emptyset_i x_{t-i} + \alpha_i - \sum_{i=1}^{p} \theta_i \alpha_{t-i} \quad (1)$$

Expression (1) above is the ARMA model for the 1st order post-differential series. One part of the expression is the AR(p) model, which is a prediction of the future closing price of the stock without the effect of the Fed rate hike using past daily/weekly stock data of Microsoft Corporation. The other part is MA(q). And MA(q) is the error term predicting the future.

2.4. ARMA Specification

Regarding this part of the article, it was decided to use PACF and ACF to order the log orders of daily stock returns and weekly stock returns, respectively. PACF and ACF can help to derive the lagged orders of AR(p) and MA(q). The results are shown in Figure 1.

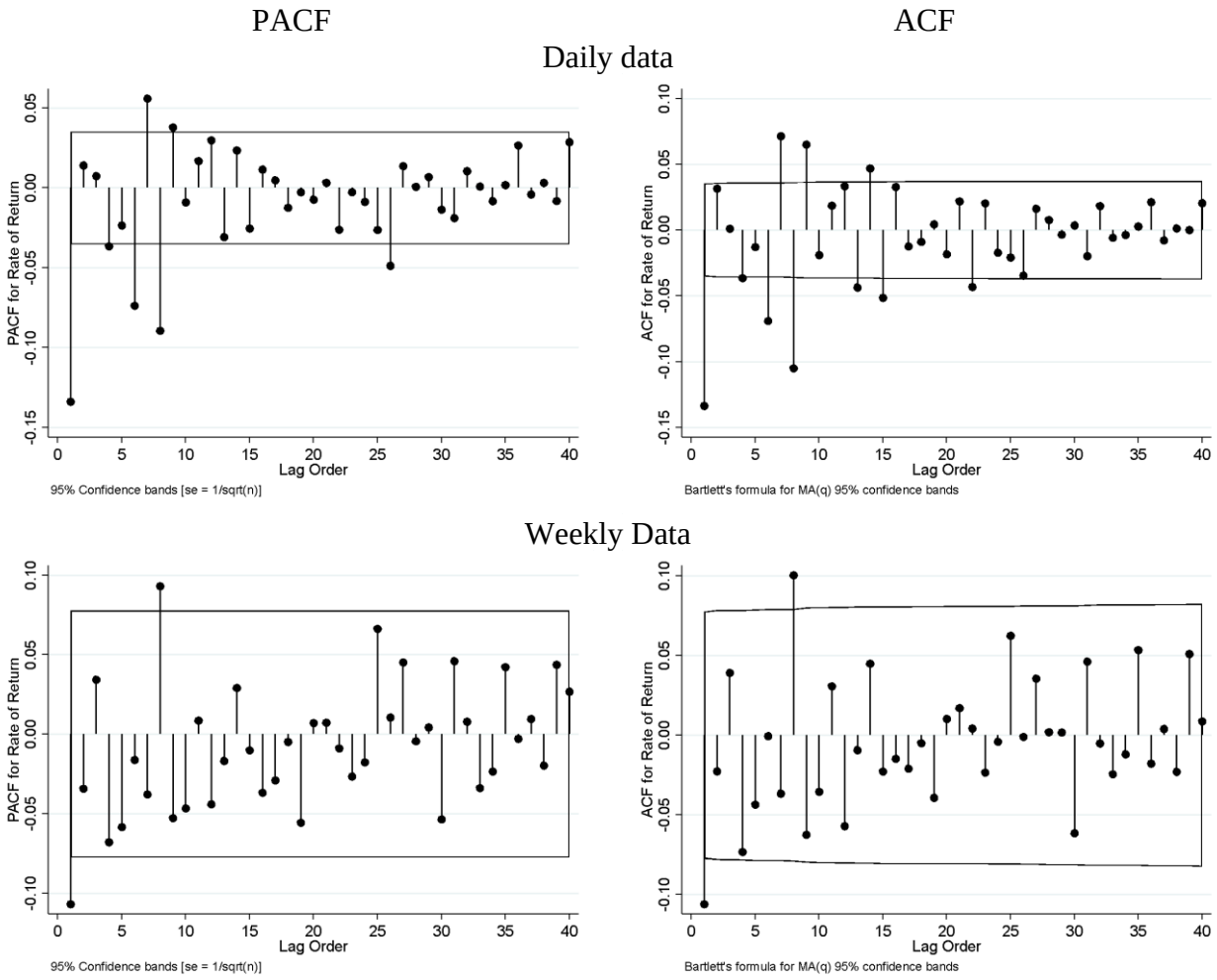

Figure 1 ARMA (p, q) identification
Photo credit: Original

Firstly after passing the unit root test it was found that the original series for both weekly and daily were not stable, so it was not possible to carry out ARMA modeling of the original series. So before building the ARMA model, this part performs first order differencing on the original series and the result after differencing shows that it is smooth and can be modeled with d of 1.

From the PACF and ACF results on the logarithm of daily stock returns in the image. Since empirically, orders greater than 10 are not reliable. Hence AR(p) is of order 8 and MA(q) is of order 9. Thus Daily data - ARIMA (8,1,9).

Next the PACF and ACF results are shown for the logarithm of weekly stock returns.AR(p) is of order 8 and MA(q) is of order 8. Thus weekly data - ARIMA (8,1,8).

Table 2 Residual test

Model	Portmanteau (Q) statistic	Prob > chi2
Daily data -ARIMA (8,1,9)	50.1404	0.1307
Weekly data-ARIMA (8,1,8)	19.5182	0.9974

The null hypothesis for daily stock returns and weekly stock returns respectively is that the series is white noise. The results through Table 2 show that they have p-values of 0.1307 and 0.9974 which are both greater than 0.1 and hence the null hypothesis is not rejected which means white noise.

3. Forecast Results and Interpretation

The data covers the period January 24, 2022, to May 9, 2022 and includes daily (Figure 2 and Table 3) and weekly (Figure 3 and Table 4) stock price data for Microsoft. Actual stock prices and forecast prices (presumably predicted by the model prior to the rate hike) are presented along with absolute and percentage differences. This information is critical to understanding the accuracy of forecasts and the actual impact of interest rate decisions.

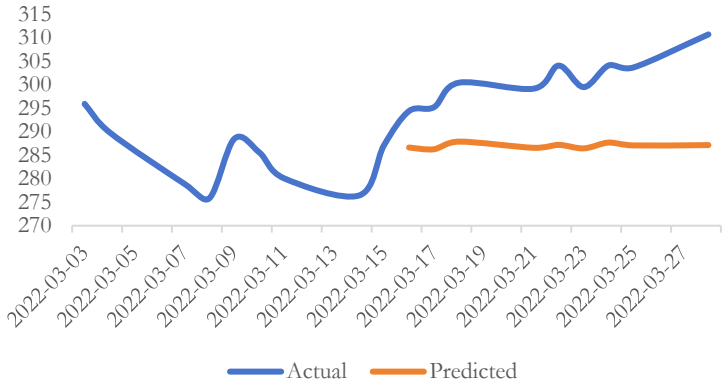

Figure 2 Actual value and predicted value, daily data
Photo credit: Original

Daily data shows a period of volatility, especially after March 16, 2022 Initially, actual share prices outperformed forecasts by 2.70% to 8.20%. This could indicate investor optimism or that the market had not yet fully digested the consequences of the rate hike. However, this trend reversed sharply as the weeks progressed and the lagged effects of market efficiency and monetary policy disappeared [11, 12]. By April 11, actual prices were significantly lower than forecasts, with a significant variance of -27.03566, a drop of 8.81% [1]. This trend continued, culminating in a -17.12% variance by May 9, indicating a strong negative reaction to the rate hike as the reality of a more expensive borrowing environment set in [13].

Table 3 Actual and predicted value, daily data

	Actual	Predicted	Difference	Difference (%)
2022-03-03	295.92			
2022-03-04	289.86			
2022-03-07	278.91			
2022-03-08	275.85			
2022-03-09	288.5			
2022-03-10	285.59			
2022-03-11	280.07			
2022-03-14	276.44			
2022-03-15	287.15			
2022-03-16	294.39	286.63865	7.75135	2.70%
2022-03-17	295.22	286.26996	8.95004	3.13%
2022-03-18	300.43	287.89266	12.53734	4.35%
2022-03-21	299.16	286.57757	12.58243	4.39%
2022-03-22	304.06	287.19933	16.86067	5.87%
2022-03-23	299.49	286.45113	13.03887	4.55%
2022-03-24	304.1	287.69164	16.40836	5.70%
2022-03-25	303.68	287.08631	16.59369	5.78%
2022-03-28	310.7	287.15584	23.54416	8.20%

The weekly data follow a similar pattern and cover the period from January 24, 2022 to May 9, 2022. This longer timeline provides a broader view of stock performance around the time of the Fed's rate hike. Forecasts initially remained stable, but from April 4 onwards began to deviate significantly from actual prices. This deviation became increasingly negative, suggesting that the forecasts did not anticipate the full scope of the Fed's impact on stock prices.

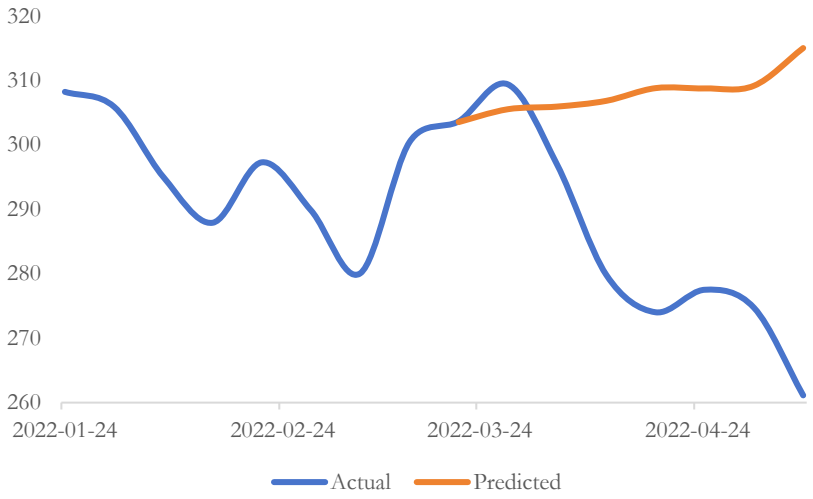

Figure 3 Actual value and predicted value, weekly data
Photo credit: Original

The difference between predicted and actual stock prices following an interest rate hike illustrates the challenge of predicting the market's reaction to such events. Initially, the model's forecasts were closely correlated with actual prices, suggesting that the immediate market reaction may have waned or that other factors were at work to offset the negative impact of rising interest rates. Over time, the gap between predicted and actual stock prices grows wider, which may be due to several factors. For example, interest rates may be raised more sharply or more frequently than expected, leading to higher borrowing costs and lower consumer spending. Alternatively, investor sentiment may change more dramatically than the model explains, leading to a rapid revaluation of stocks.

Table 4 Actual and predicted value, weekly data

	Actual	Predicted	Difference	Difference (%)
2022-01-24	308.26			
2022-01-31	305.94			
2022-02-07	295.04			
2022-02-14	287.93			
2022-02-21	297.31	s		
2022-02-28	289.86			
2022-03-07	280.07			
2022-03-14	300.43			
2022-03-21	303.68	303.55854	0.12146	0.04%
2022-03-28	309.42	305.56032	3.85968	1.26%
2022-04-04	296.97	305.97158	-9.00158	-2.94%
2022-04-11	279.83	306.86566	-27.03566	-8.81%
2022-04-18	274.03	308.83842	-34.80842	-11.27%
2022-04-25	277.52	308.79238	-31.27238	-10.13%
2022-05-02	274.73	309.20425	-34.47425	-11.15%
2022-05-09	261.12	315.06056	-53.94056	-17.12%

Empirical data during the Fed's rate hike period suggests that forecasting models significantly underestimated the impact of the rate hike on Microsoft's stock price. While such models can account for historical trends and known variables, they struggle to adequately account for the complexity of market psychology and the simultaneous impact of multiple macroeconomic factors. Clearly, the Fed's actions have had a profound impact on the stock market, and forecasting models must continue to evolve to better understand and predict these effects.

4. Discussion and Prospect

The Federal Reserve's recent interest rate hikes have not only wreaked significant havoc on the U.S. banking sector, for example, the recent collapse of Silicon Valley Bank, but have cast an even more giant shadow over the global economy [10,14]. When one considers the broader implications for international finance, trade, and manufacturing, the dramatic changes in the domestic banking sector are only a visible part of a much more giant iceberg.

The results of this study highlight the significant impact of U.S. monetary policy on the global stage due to the status of the U.S. dollar as the primary reserve currency. First, rising interest rates, reduced global liquidity and increased volatility in foreign exchange markets could affect trade by altering the value of currencies and capital flow patterns. Specifically, such market volatility could reverse the flow of investment back to the United States at the expense of emerging markets and other economies. So, a comprehensive understanding of these dynamics is critical to managing global capital reallocation and mitigating financial instability outside the United States. In addition, the dollar's appreciation due to interest rate hikes has placed a heavy burden on exporters and exacerbated trade imbalances. At the same time, higher interest rates lead to higher borrowing costs, resulting in higher costs of financing international trade, affecting cross-border trade and potentially exacerbating trade tensions. This situation could lead to the creation of higher trade barriers and reshape the global trade framework. Trade barriers can affect both importers and exporters, with importers setting up higher trade barriers such as tariffs, quotas, and subsidies that raise the prices of domestic products. While trade barriers may provide respite for import-competing domestic industries and secure employment for workers, they do so at the expense of a portion of the consumer surplus. On the export side, higher tariffs and quotas reduce the volume of exports, and producer surpluses are reduced to face higher costs.

Driven by these policy shifts, the manufacturing sector also feels the pinch as raw material and production costs escalate. In particular, those manufacturers that rely on exports and imports face greater currency risk and cost pressures. These findings urge firms, especially those with substantial financial leverage, to adopt more proactive financial management strategies to cope with the uncertainty associated with macroeconomic changes. In sum, the Fed's recent rate hikes are a sharp reminder of the inherent volatility and interconnectedness of the international economic system. They underscore the need for firms to optimize their trade and production strategies, move towards quality competition rather than price competition, and for policymakers to nurture a more diversified and robust international economic framework. The aim was to protect domestic interests and contribute to sustainable growth and stability in the global economy.

5. Insights from the Fed's Interest Rate Hike

For policymakers, the conclusions drawn from the study of the Fed's interest rate hike and its impact on Microsoft's share price are a clear reminder that the impact of monetary policy is far-reaching and can have a ripple effect in unforeseen ways, affecting not only the domestic economy but also the global economy. Policymakers need to understand that while interest rate hikes are a tool in the fight against inflation, they can destabilize financial stability, as evidenced by the failures of Silicon Valley Bank. Research suggests that the Fed's actions could lead to reduced global liquidity, increased foreign exchange volatility, and potential financial crises elsewhere. This knowledge can

guide policymakers to take a more cautious approach, implementing gradual interest rate changes or preparing more apparent communication strategies to mitigate market shocks. On the other hand, investors can use these findings to refine their investment strategies. The markets reacted more negatively than expected to the Fed's interest rate decision, suggesting that traditional models may not be able to explain the full extent of investor behavior or external macroeconomic factors. Investors may take a more defensive stance in anticipation of a rate hike by investing in less sensitive assets to changes in interest rates or using financial instruments to hedge against stock price volatility.

In addition, given that interest rate hikes can affect the competitiveness of exporters and increase the cost of financing international trade, investors may re-evaluate their stakes in firms with greater exposure to international markets or manufacturing firms, which may be exposed to increased costs and currency risk. Ultimately, the study concludes that a nuanced understanding of international finance, trade dynamics, and manufacturing costs is critical for policymakers and investors. By recognizing the interconnectedness of these areas, they can better prepare for and respond to changes in the economy brought about by the Fed's interest rate policy.

6. Conclusion

This paper investigates the implications of the Federal Reserve's interest rate hike on stock returns through a comprehensive study of Microsoft's stock price. The study selected the data from January 4, 2010, to December 29, 2023, and analyzed the data in depth through unit root test, ARIMA model building, and residual test. The results showed that the original data series reached a steady state after first-order differencing, thus making ARIMA modeling possible. The validity and stability of the model are confirmed by estimating the parameters of the ARIMA model for daily and weekly data and its subsequent residual tests.

Further analysis reveals that the Fed's interest rate hike significantly impacts Microsoft's stock price. Although the model initially predicted the stock price movement better, the difference between the actual stock price and the predicted stock price began to emerge. It gradually widened as the interest rate hike was implemented. This trend suggests that although statistical models can capture specific historical data patterns and trends, they have limitations in predicting market volatility caused by macroeconomic policy changes. In particular, the models need to adequately account for the impact of interest rate hikes on investor sentiment, borrowing costs, and overall economic activity.

The empirical results of this study emphasize the importance of considering macroeconomic factors when constructing forecasting models. Although the ARIMA model is often effective, its predictive ability in the face of significant economic policy still needs to be improvised. This suggests that future research needs to explore more sophisticated models that can integrate more macroeconomic variables and market psychology factors to improve the predictive accuracy of the impact of major policy events. In conclusion, the research in this paper suggests that while statistical models can provide valuable insights into understanding stock market behavior, they have limitations in explaining and predicting complex market dynamics triggered by macroeconomic policy changes. Therefore, future research should strive to develop more refined and comprehensive models to better understand the impact of macroeconomic policy changes on the stock market.

Author Contribution

Siyuan Zheng is tasked with the authorship and citation for Chapters 1, 4, 5, and 6, as well as overseeing data processing, overall structure and format review of the paper.

Zhenyu Shao is assigned the responsibility of composing Chapters 2 and 3, in addition to overseeing data processing and modeling.

The above two authors have the same contribution and are considered as co-first authors.

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