

Network Analysis of the Chinese A-Share Stock Market

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Abstract

This study investigates the dynamics of the Chinese A-share stock market from January 2021 to December 2022. Utilizing the “baostock” library and network analysis, we explore the relationships between stocks and the dynamic of the stock correlation network across different industry sectors, particularly during the implementation of the Federal Reserve’s interest rate hikes in 2022. Our results reveal a general decreasing trend in index closing prices, negatively correlated with interest rate hikes. The correlation network analysis indicates a nuanced negative correlation between Return on Investment (ROI) and the interest rate hike, observed through a shift in node colors. Also, stocks within the same sector exhibit higher correlations, emphasizing the significance of sectoral considerations in portfolio management.

1 Introduction

The intricate web of global financial markets continually weaves connections that transcend geographical boundaries, creating a complex tapestry of interdependence (Forbes and Warnock (2012), Raddant and Kenett (2021)). Within this intricate network, the Chinese A-share market stands as an influential player, exerting a profound influence on international financial dynamics. As one of the largest stock markets globally, its performance sends ripples across the globe, capturing the attention of global investors and financial systems alike (Carpenter and Whitelaw (2017)).

Central to the flow of global market sentiment are the monetary policy decisions of major central banks, with the United States Federal Reserve wielding significant influence (Fischer (2014)). Changes in interest rates, a tool often used by central banks to manage economic conditions, have far-reaching implications for financial markets worldwide. The Federal Reserve’s strategic move to initiate a gradual increase in interest rates at the outset of 2022 stirred a heightened sense of scrutiny among market participants and observers alike (Arteta et al. (2022)).

This research endeavors to answer the following research questions:

1. How have changes in major Chinese market indices during 2022 related to the Federal Reserve's interest rate policy adjustments?
2. What is the nature of the correlation network based on the ROI of different stocks among the top 500 companies by market capitalization in the Chinese market in 2022?
3. Given the observed market index trends, what is the impact of these changes on the Return on Investment (ROI) across different industries in the Chinese A-share market?

In exploring these questions, our research seeks to contribute to a deeper understanding of the intricate interactions between global monetary policy adjustments and the performance of specific industries within the Chinese A-share market. By shedding light on these complex connections, we aim to provide valuable insights that can inform investment strategies, policy decisions, and further research endeavors in the ever-evolving landscape of international finance.

2 Literature Review

Global Financial Interconnectedness. The interconnectedness of global financial markets has been a subject of extensive research. Scholars have highlighted the transmission mechanisms through which policy changes in one major economy can affect others (Forbes and Warnock (2012)). Notably, the Chinese A-share stock market, given its size and influence, is often seen as both a recipient and a transmitter of these monetary policy changes.

Impact of Federal Reserve Policy on Global Markets. The Federal Reserve's monetary policy decisions have been a focal point in financial literature. Several studies have explored the relationship between global market indices and the Federal Reserve's interest rate policy. For instance, Rey (2013) has emphasized the importance of the U.S. monetary policy on global financial conditions. Rey introduces the concept of the "Global Financial Cycle," highlighting how changes in U.S. monetary policy can lead to spillover effects, affecting asset prices and market conditions across the globe. Also, Eichengreen et al. (2018) indicates that changes in U.S. interest rates can lead to capital flows and impact asset prices in emerging markets. However, previous research often lack a specific focus on the Chinese A-share market, which is distinct in its dynamics and plays a pivotal role in the global financial landscape. The need to understand how this market responds to Federal Reserve policy adjustments remains a significant research gap.

Correlation Networks in Financial Markets. Correlation networks, analyzing the relationships between different stocks, have gained prominence in financial research (Kenett et al. (2015)). Building a correlation network based on the ROI of top companies within the Chinese A-share market provides insights into the co-movements and interdependencies among stocks, shedding light on the underlying structure of the market. While correlation networks in financial markets have been explored (Wang et al. (2017), Wang et al. (2018)), the focus on the Chinese A-share market’s top 500 companies by market capitalization is less common. Existing studies may not provide the depth required to comprehend the intricacies of the market structure in the context of the top 500 companies.

Return on Investment and Industry Dynamics. The relationship between changes in market conditions and the performance of different industries is a critical area of study. Scholars have explored how economic factors, including interest rates, influence investment decisions and ultimately affect the ROI of various sectors (Bossman et al. (2023)). Examining these dynamics within the context of the Chinese A-share market allows for a nuanced understanding of how industry-level variations contribute to overall market performance.

Our research addresses these limitations by providing an analysis of the Chinese A-share market in the context of Federal Reserve policy adjustments. In this study, we focus on market indices, ROI, and correlation networks among most of the top 500 companies of the Chinese A-share market. This study is crucial for enhancing our understanding of the specific mechanisms through which global monetary policy adjustments impact the performance of distinct industries within the Chinese A-share market.

3 Data

In this study, we analyze stock data for Chinese A-share listed companies spanning from January 2021 to December 2022. The dataset encompass stock codes, trading volumes, and prices. Our particular focus is on the monthly Return on Investment (ROI) data for the top 500 companies in China, ranked by market capitalization in 2022. To delve into the intricate relationships between stocks across various sectors or industries, we utilize the “baostock” library, a Python library tailored for analyzing the Chinese stock market. This library sources its data from official market channels such as Chinese stock exchanges and provides industry classification standards specific to the Chinese market, rendering it an ideal tool for our study. Table 1 describes some of the essential attributes we used for analysis.

Furthermore, we gather information on the Federal Reserve’s policy changes in 2022, with a spotlight on the interest rate hikes. The specifics of these policy changes are obtained from the official Federal Reserve website. Table 2 shows the detailed policy

Attribute	Description
Date	Record date for the stock data (Monthly)
Code	Stock code as listed on the exchange
Close	Closing price of the stock at the end of the month
Volume	Number of shares traded during the month
Return	Monthly return, calculated as the percentage change in closing price month-over-month
Industry	Industry sector of the given stock

Table 1: Description of Key Attributes in the Dataset Utilized

implementations in 2022.

Date	Rate Change (bps)	Federal Funds Rate
December 14, 2022	+50	4.25% to 4.50%
November 2, 2022	+75	3.75% to 4.00%
September 21, 2022	+75	3.00% to 3.25%
July 27, 2022	+75	2.25% to 2.50%
June 16, 2022	+75	1.50% to 1.75%
May 5, 2022	+50	0.75% to 1.00%
March 17, 2022	+25	0.25% to 0.50%
January 27, 2022	+25	0% to 0.25%

Table 2: Federal Reserve 2022 Rate Hike Policy Timeline

In addition to the above, we will collect data on key market indices to reflect the overall performance of the Chinese A-share market. Our focus will be on the Shanghai Composite Index and the CSI 300 Index, and we will obtain their data for the years 2021-2022 using the “baostock” library. This dataset will be pivotal in comprehending broader market trends and will serve as the foundation for graphical representations aimed at addressing our research questions.

4 Methodology

We begin by preprocessing the collected data. This step involves filtering out data from companies that do not provide sufficient information. In particular, we will exclude companies for which industry data cannot be obtained during the construction of the industry network analysis, as discussed later in the text. However, these companies’ data will still be retained in the creation of the first network, which is based on different correlations and Return on Investment (ROI). This approach ensures that, when analyzing inter-industry

relationships, we only utilize data from companies with complete industry classification information.

We generally follow the foundational methods outlined in Chi et al. (2010) to construct a network using Chinese A-share stock data relying on the correlations and Return on Investment (ROI), while making adaptations tailored to our specific data analysis focus.

Let $x_i(t)$ be the time series closing price data we are interested in for stock i at time t . The time t is discrete with step size of one month. The ROI of stock i of a specific month t is calculated as

$$r_i(t) = \frac{x_i(t)}{x_i(t-1)} - 1.$$

Let $r_i(t)$ be the ROI for stock i for month t . The cross-correlation between stock i and j is calculated as:

$$C_{ij} = \frac{\sum_t [(r_i(t) - \bar{r}_i) \cdot (r_j(t) - \bar{r}_j)]}{\sqrt{\sum_t (r_i(t) - \bar{r}_i)^2 \cdot \sum_t (r_j(t) - \bar{r}_j)^2}},$$

where the summation acts on the selected time range to compute the correlation on the monthly ROI, and in this case it is from January 2021 to December 2022. \bar{r}_i represents the mean value of $r_i(t)$ over the time range computing the correlation. An edge between two nodes(stocks) exist if and only if the cross-correlation between the two nodes are higher than a specified threshold value $\theta = 0.7$.

For network visualization, we first categorize node(stock) colors into three groups based on the rate of ROI (-20%, 0%, and 20%) for each month. Subsequently, we create a dynamic visualization of the constructed network, with node color changes over time. Notably, we focus on color changes and do not alter other properties such as node size or network structure. This approach allows us to visually explore the market's dynamic behavior before and after the Federal Reserve's interest rate policy in 2022. Then, we classify node(stock) colors into various industry-sector groups, illustrating how various sectors interrelate. This network visualization will help us in analyzing the network dynamics, and provide insights for stock portfolio investments.

To visualize these networks, we employ the open-source network analysis and visualization software, Gephi. This tool enables us to generate visualizations of the aforementioned networks, providing a clearer understanding of the relationships and dynamics within the Chinese A-share stock market.

5 Results

To address the first research question, Figure 1 shows the close price change of two important market indices: CSI 300 Index and Shanghai Composite Index. The graph reveals a general decreasing trend in closing prices from 2021 to 2022, although with an obvious small increment from May 2022 to July 2022. This suggests that, with the interest

rate hikes, the closing prices of these indices experienced a consistent decline. The closing price trend exhibits a slight negative correlation with the interest rate hike.

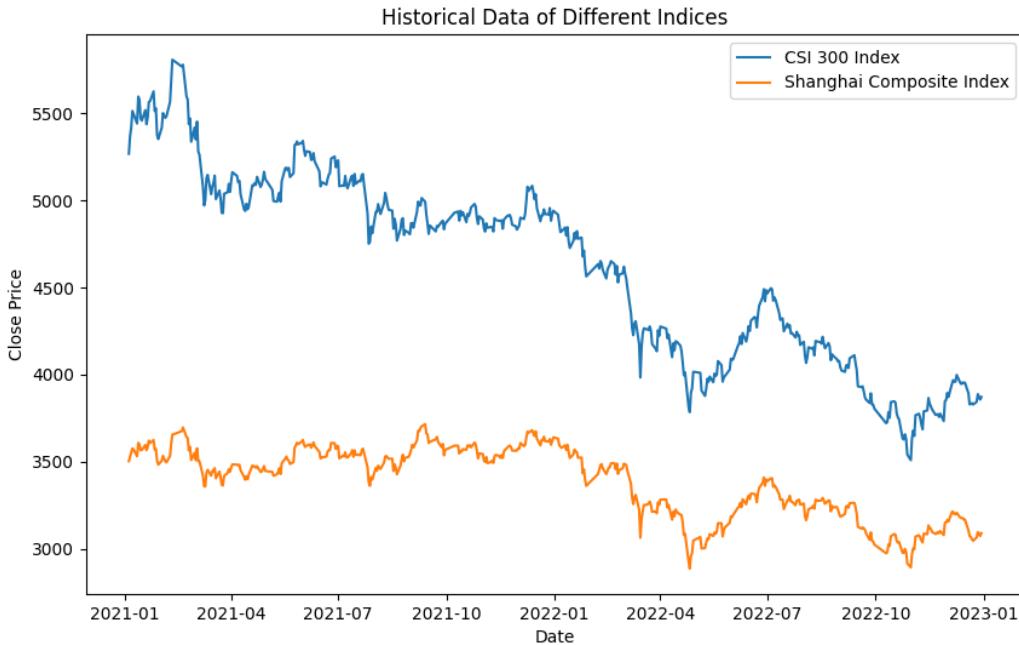


Figure 1: Historical Stock Price on Two Key Market Indices

Moving on to the Federal Reserve's Policy implementation in January 2022, which persisted throughout the year, the correlation network of the Chinese A-share market indices illustrates that most stocks are visually represented in green. However, comparing graphs from March, June, September, and December in Figure 2, we observe an increase in the proportion of green nodes. By December, a small cluster of nodes begins to shift towards blue. This observation aligns with the trend we identified in the index closing prices. Although not overly pronounced, there is a discernible slight negative correlation between the Return on Investment (ROI) of most A-share stocks and the interest rate hike resulting from the Federal Reserve's Policy.

Additionally, the network graph shown in Figure 3 is grouped by different industry sectors. It reveals that stocks within the same sector exhibit a higher degree of correlation. Dynamic changes in the network tend to occur in clusters, where connected nodes experience simultaneous shifts. Applying this to the stock market and portfolio management, particularly during changes in economic policy, focusing on central nodes based on performance can offer valuable insights for guiding investment decisions.

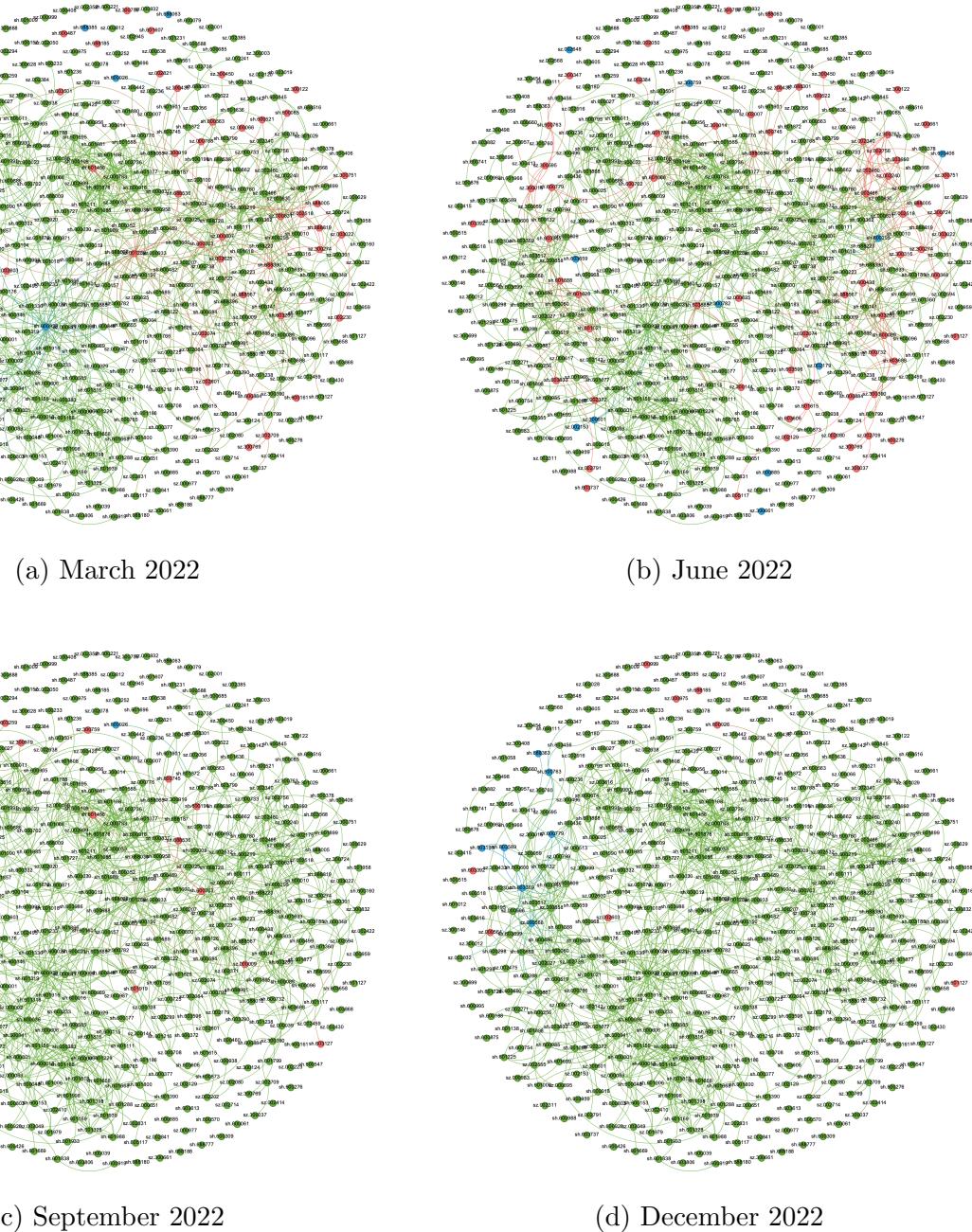


Figure 2: Visualization of the A-share market in 2022. Node color are blue (ROI less than -20%), green (ROI less than 20% and greater than -20%), and red (ROI larger than 20%).

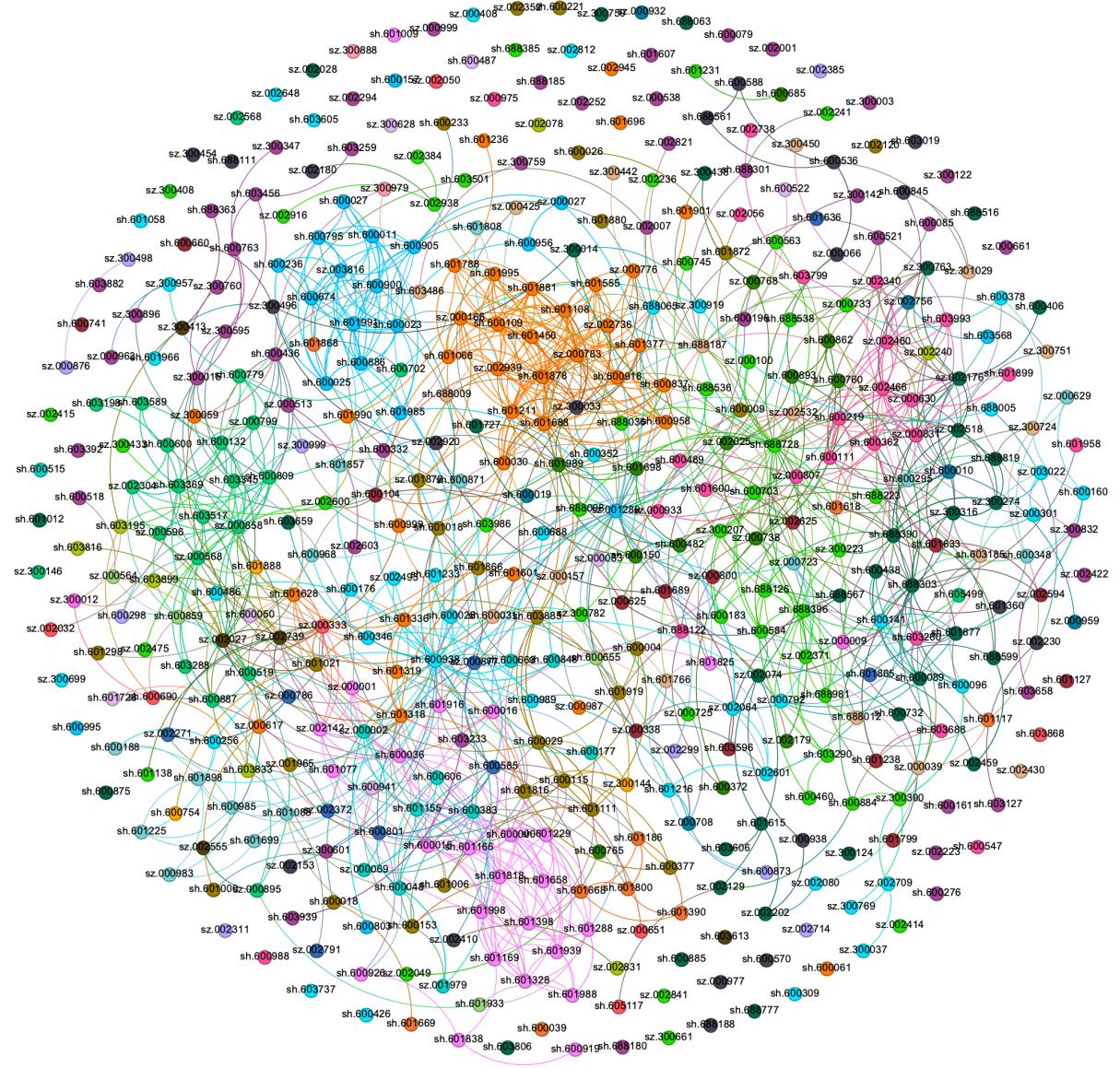


Figure 3: Correlation Network Grouped by Industry Sectors

6 Conclusion

6.1 Discussion

The observed negative correlation between index closing prices and interest rate hikes indicates that the Chinese A-share stock market, and probably also other market participants, are sensitive to changes in interest rates. Businesses and investors should closely monitor interest rate dynamics and adjust their strategies accordingly.

Secondly, the higher correlation (more edges) among stocks within the same sector suggests that sectoral trends play a significant role in the Chinese A-share market. Investors may consider diversifying their portfolios across different sectors to manage risks effec-

tively.

For portfolio management during policy changes, understanding the dynamics of central nodes of a correlation network will be helpful. Investors can focus on key performers within sectors to make informed decisions during economic policy shifts.

6.2 Limitations

Our study also have limitations that can be improved.

Firstly, the study only relies on stock data from January 2021 to December 2022, which is not enough for more comprehensive analysis. Future research could benefit from accessing more data.

Secondly, our construction of the correlation network and the following analysis may oversimplify the complexity of the relationships within the market. Future studies could explore more advanced statistical and machine learning techniques to uncover nuanced patterns and interactions.

Thirdly, this study focuses on the Chinese A-share market, and the findings may not be directly applicable to other markets. Future research could extend the analysis to global markets or specific regional markets to enhance the generalizability of the results.

6.3 Future Directions

Firstly, future research could incorporate additional macro-economic indicators, such as inflation rates and GDP growth, to provide a more comprehensive understanding of the market dynamic changes.

Also, extending the study over a longer period could provide insights into how market dynamics and correlations evolve over time, especially in response to prolonged economic policies and changing market conditions.

Moreover, future research could delve deeper into assessing the specific impacts of policy changes on different sectors and industries rather than only looking at the temporal network dynamic changes. It will offer a more granular perspective on market responses to regulatory shifts.

Code and dataset link: <https://github.com/wang264y/UMICH-SI671-Final-Project>

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