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Hedging Market Risk with the Index: Experiment Based on Chinese Stock Market

Bicheng Zhan[1,a,*]

[1]*School of Economics, Wuhan University, Wuhan,430000, China*
a. a1596293389@gmail.com
**corresponding author*

Abstract: The index can be seen as a reflection of the market. Index futures, also known as stock index futures, are financial derivatives whose value is based on the performance of the whole market. As a consequence, investors can hedge the market risk by longing or shorting some specific value of index futures. Based on the idea, the paper tried to hedge the market risk and have a deeply look into whether it works and what characteristics it has. The paper chooses 10 stocks from those who are the components of the three main Index in China. The results show that with all the hedging strategies, volatility is effectively reduced and the ROI significantly increased during the period with acute value changes. The paper refined the whole experiment by randomly choosing the stocks with python and comparing the stock selection within the industry. The experiment verify the feasibility and the effectiveness of the hedging strategies based on the Index.

Keywords: index futures, synthetical put options, hedge the market risk, component stocks

1. Introduction

Stock index futures are a type of financial derivative investment instrument that involves trading futures contracts based on the stock price index of the stock market [1-4]. Since 2001, Chinese stock markets have experienced a consistent drop, which made billions of investors suffered a lot. To deal with the situation, the demand for financial instruments such as stock index futures, which provide both hedging and short-selling capabilities, has surged. The stock index futures are essential for enriching and improving China's financial market, mitigating market risks, and participating in international financial market competition [5]. As the stock index future boosted, there is a new focal point of the discussion. Can stock index future reduce the market risk? The main argument against futures trading maintains that the futures market increases stock market volatility because with higher degree of leverage, futures markets are likely to attract uninformed traders. Both the reduction in volatility and the increase in volatility outcomes seem to be possible [6].

The purpose of this paper is to stimulate what the profit of a portfolio shall be like when there are hedging strategies or not. The result will be helpful to find out whether a hedging strategy can make a difference to the investor's profits. Most of the studies done until now relates to the USA [7-10]. Only a small number of recent studies analyse the UK market and very few studies relate to other countries [11]. This paper uses data of Chinese stock market to study on the problem. Since Chinese stock markets are highly influenced by Chinese government, it's interesting to study what effects the hedging strategies have. Given that Chinese government always introduce policies to control the

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volatility of the stock market, it's particularly meaningful to have a deep look into the problem when rapid changes took place.

For the empirical analysis, the volatility will be estimated with EWMA (Exponentially Weighted Moving Average) and GARCH(1,1) model, which is the same econometric technique implemented in most of previous studies.

2. Market and Data

The empirical tests of this work are based on data from the Chinese stock exchange. The Chinese stock market index system has made significant breakthroughs and progress under the promotion of the Shanghai and Shenzhen stock exchanges. The development of index products based on constituent stocks has led to the emergence of truly stylized and investment-oriented index products in the Chinese index market. In major developed countries' stock markets worldwide, widely accepted and market-representative indices are primarily constituent-based indices. However, industry experts point out that the existing index system in China is not yet sufficient to meet the investment needs of the market, and there is an urgent need for index products that cover both the Shanghai and Shenzhen markets [12]. Against this backdrop, the emergence of the SSE 300 Index (Shanghai and Shenzhen 300 Index) took place which consists of the 300 most representative securities with large market capitalization and good liquidity from the Shanghai and Shenzhen markets.

The first part of the experiment chooses 10 stocks from the SSE 300's components to equally weighted create a portfolio. The total value of the portfolio is 10,000,000. Considering the industries, market performance and the continuity of data, we choose Shuanghui Development; Yunnan Baiyao; Bank of China; Kweichow Moutai; Huadong Medicine; China Huaneng Group; Daqin Railway; China Petroleum & Chemical Corporation (Sinopec); Tongrentang; China Unicom; Hailan Home; Oriental Pearl; Baiyunshan Pharmaceutical; Wuliangye; Gree Electric Appliances; CITIC Pacific Special Steel; Wanhua Chemical; Meijin Energy; China Satellite Communications; YTO Express; Gold Mantis; Zoomlion Heavy Industry; Xuzhou Construction Machinery; China Southern Airlines; Greenland Holdings; Poly Developments and Holdings; Yanzhou Coal Mining; Northern Rare Earth; Sany Heavy Industry; CITIC Securities. These 30 stocks will be grouped into 3 portfolios.

The β of each stock can be found through the data base, and Portfolio β = (Weight of Asset 1 * β of Asset 1) + (Weight of Asset 2 * β of Asset 2) + ... + (Weight of Asset n * β of Asset n). since the portfolio is built with equally weight. The β of the portfolio is the average of the β of the 10 stocks.

The portfolio 1: Shuanghui Development - WH Group; Yunnan Baiyao - Yunnan Baiyao Group; Bank of China - Bank of China Limited; Kweichow Moutai - Kweichow Moutai Co., Ltd.; Huadong Medicine - Huadong Medicine Co., Ltd.; China Huaneng Group - China Huaneng Group Co., Ltd.; Daqin Railway - Daqin Railway Co., Ltd.; China Petroleum & Chemical Corporation (Sinopec) - China Petroleum & Chemical Corporation Limited; Tongrentang - Tongrentang Group Co., Ltd.; China Unicom - China United Network Communications Group Co., Ltd. The β of the portfolio is 0.6628.

The portfolio 2: HLA Corporation Limited; Oriental Pearl Group Co., Ltd.; Guangzhou Baiyunshan Pharmaceutical Holdings Co., Ltd.; Wuliangye Yibin Co., Ltd.; Gree Electric Appliances Inc.; CITIC Pacific Special Steel Holdings Ltd.; Wanhua Chemical Group Co., Ltd.; Meijin Energy Group Limited; China Spacesat Co., Ltd.; YTO Express Group Co., Ltd. The β of the portfolio is 0.9448.

The portfolio 3: China Jinmao Holdings Group Limited; Zoomlion Heavy Industry Science and Technology Co., Ltd.; Xuzhou Construction Machinery Group Co., Ltd.; China Southern Airlines Co., Ltd.; Greenland Holdings Corporation Limited; Poly Developments and Holdings Group Co., Ltd.; Yanzhou Coal Mining Company Limited; China Northern Rare Earth (Group) High-tech Co., Ltd.; Sany Heavy Industry Co., Ltd.; CITIC Securities Co., Ltd. The β of the portfolio is 1.1709.

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3. Experiment

The paper adopts the data of the stock market from 2007 to 2022. And the rebalancing period is selected as 7 days in every 90 days, which helps to simulate the volatility. At the same time, the paper considers the transaction costs. The cost is set as 0.3% of the total value traded [13].

3.1. Estimate the Volatility

The paper tried two different approaches to estimate the volatility.

The first model is EWMA who has recently received a great deal of attention in the quality control literature as a process monitoring tool, primarily to detect shifts in the mean level of a process [14]. To estimate the volatility, initially we calculate the portfolio return data for the portfolio above consisting of 10 equally weighted stocks. Then we divide the period from March 3, 2008, to December 2, 2022, into 39 equal parts, which is the time span divided by 90. Estimate the volatility using the return data for each period, and finally calculate the average volatility over that time period. Afterwards, we Utilize the EWMA model for iteration to estimate volatility, using λ=0.94 and in each single period, it shall be iterated 90 times. The figure 1, 2, 3 separately present the volatility of portfolio 1,2,3 estimated by EWMA model.

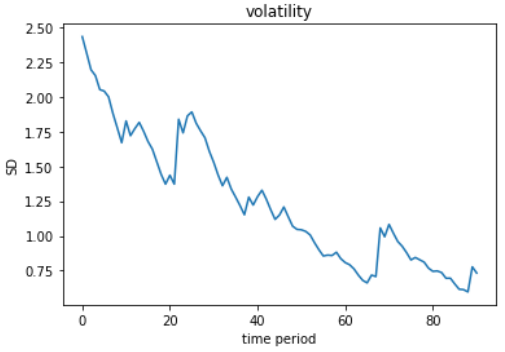

Figure 1: EWMA, portfolio 1

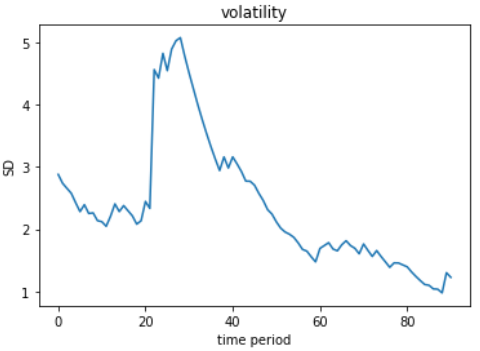

Figure 2: EWMA, portfolio 2

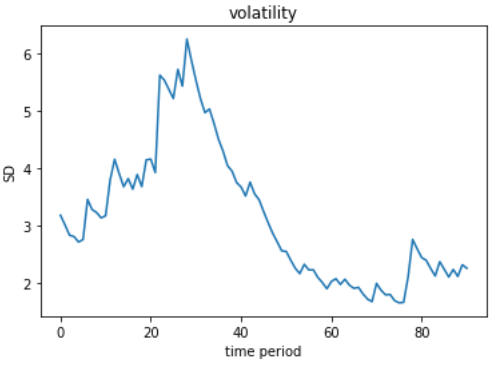

Figure 3: EWMA, portfolio 3

The second model is GARCH(1,1). The GARCH model has been developed by Bollerslev [15] from the ARCH model previously introduced by Engle [16]. We first calculate the equal-weighted portfolio volatility of ten stocks. Then Approximate long-term volatility using the average of squared returns for all samples, allowing for arbitrary selection of past sample averages. After that, divide the period from March 3, 2008, to December 2, 2022, into 39 equal parts, estimate the volatility using the return data within each time segment, and finally calculate the average volatility over that period.

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When doing so, approximate the value of sigma0 (the first volatility forecast) by using the average of squared returns over the past fifty trading days and predict the volatility of the target day using the volatility forecast values from the previous ninety trading days. Figure 4,5 separately presents the volatility of portfolio 1,2,3 estimated by GARCH(1,1) model.

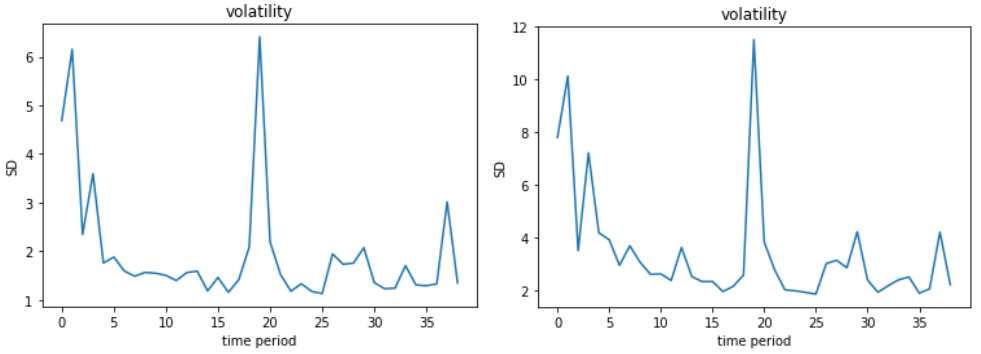

Figure 4: GARCH(1,1), portfolio 1,2

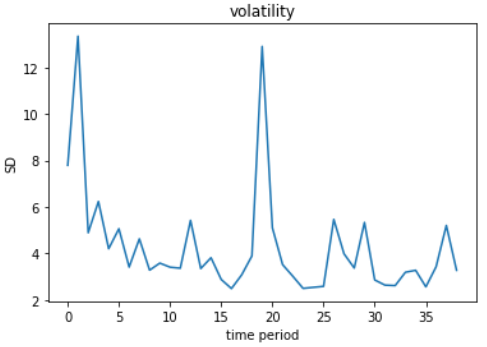

Figure 5: GARCH(1,1), portfolio 3

It's observable that volatility exhibits significant peaks between 2008 and 2010, corresponding to the period of economic crisis, which aligns with the actual situation.

3.2. Stimulation Results

With volatility, it's possible to operate the portfolio to stimulate the profit. The paper tries two ways to rebalance to hedge the market risk. The first approach is that stock index futures can be directly used to hedge a well-diversified equity portfolio. The formula to determine the amount of futures is

$$N^* = \beta \frac{V_A}{V_F} \quad [17]$$

V_A: Current Value of portfolio V_F: Current value of future contract

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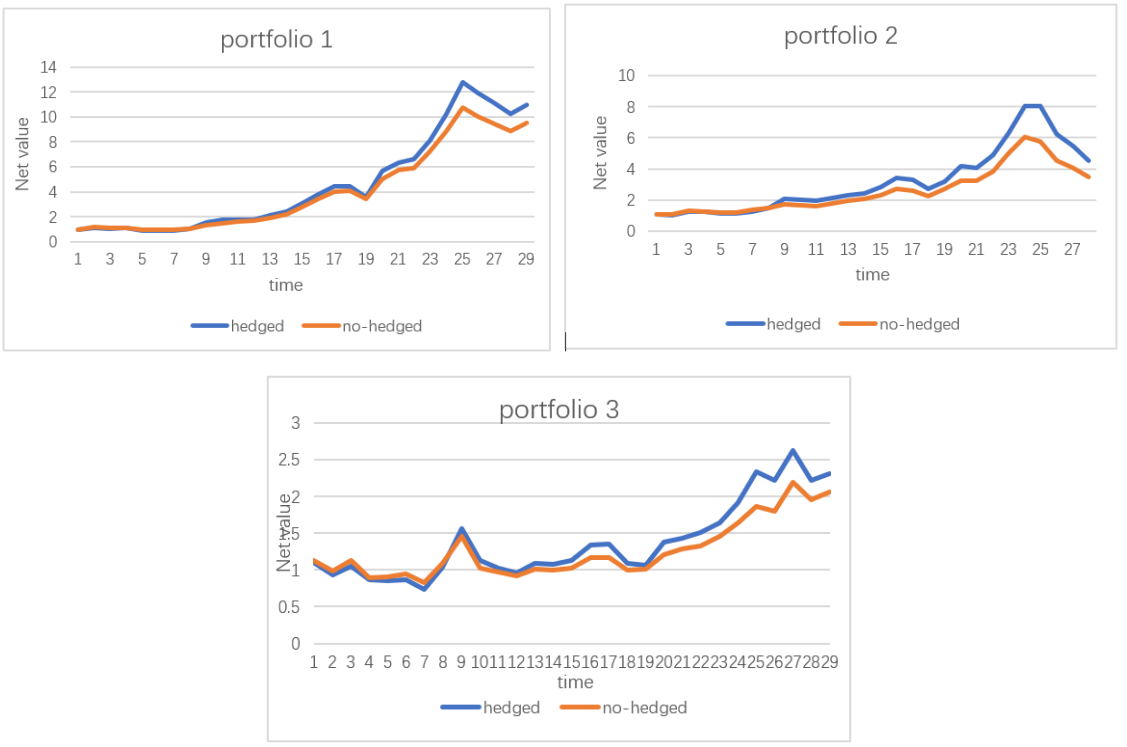

Figure 6: Net Value fluctuates over time

The second approach is using a futures contract is used to achieve a delta-neutral position. We have $H_F = e^{-(r-q)T} H_A$. For a stock index, we set q equal to the dividend yield on the index. And r is the riskless interest.

H_A:Required position in asset for delta hedging.

H_F:Alternative required position in futures contracts for delta hedging [17].

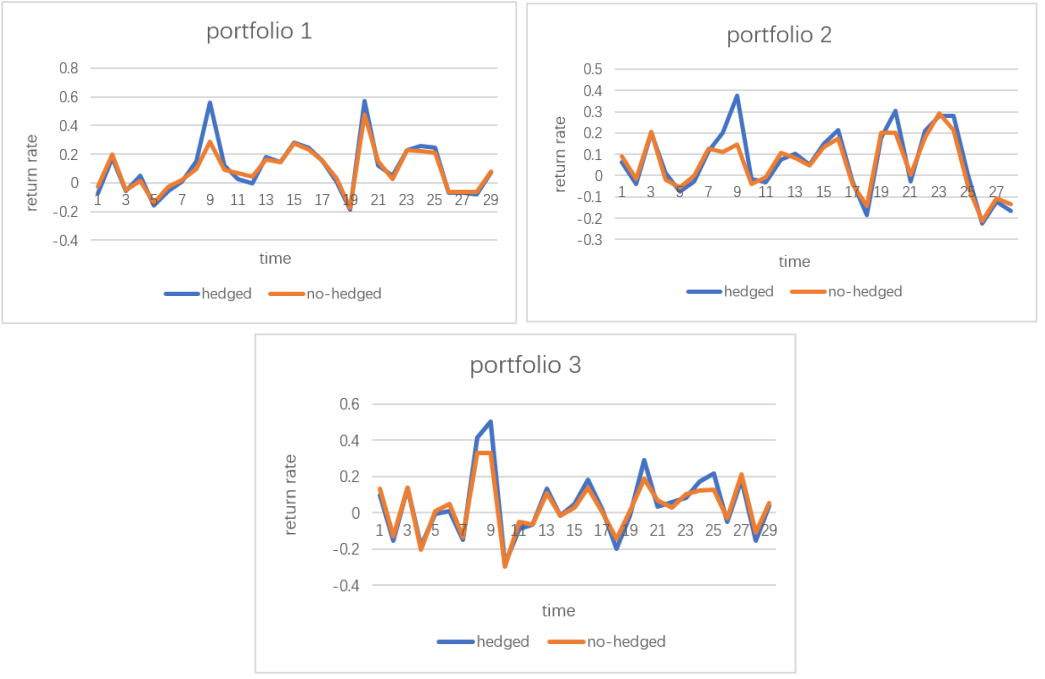

Figure 7: Return rate fluctuates over time

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Figure 6 presents Net Value fluctuates over time while figure 7 presents the return rate. The net asset value (NAV) and performance of three investment portfolios based on the CSI 300 Index, along with their respective hedging strategies. The results of the two different approaches are analogous. The blue line shows the fluctuation of the portfolio with hedging strategies while the orange line shows the result without hedging. Table 1 presents the results.

Table 1: Presentation of results

	Future contract hedging Portfolio 1	Future contract hedging Portfolio 2	Future contract hedging Portfolio 2	delta-neutral position Portfolio 1	delta-neutral position Portfolio 2	delta-neutral position Portfolio 3
Max loss	-13.46%	-21.81%	-25.97%	-18.78%	-22.64%	-26.12%
Max gain	16.30%	21.29%	22.74%	22.72%	27.42%	23.31%
Avg loss	-6.1%	-4.15%	-4.89%	-6.4%	-4.57%	-5.29%
Avg gain	6.7%	4.64%	5.46%	7.21%	5.57%	6.22%
Total gain	49.20%	38.69%	19.34%	46.03%	40.01%	24.17%

4. Testing and Refinement of Experiments

4.1. Randomly Selecting Stocks

In case that the specificity of the stocks constructing the portfolio influent the results, the first testament is to Randomly select 10 stocks and create an investment portfolio using Python. Repeat the process multiple times to observe the results and assess its robustness. The figure 8 presents the results of the return rate when selecting stocks randomly, which is consistent with above conclusions:

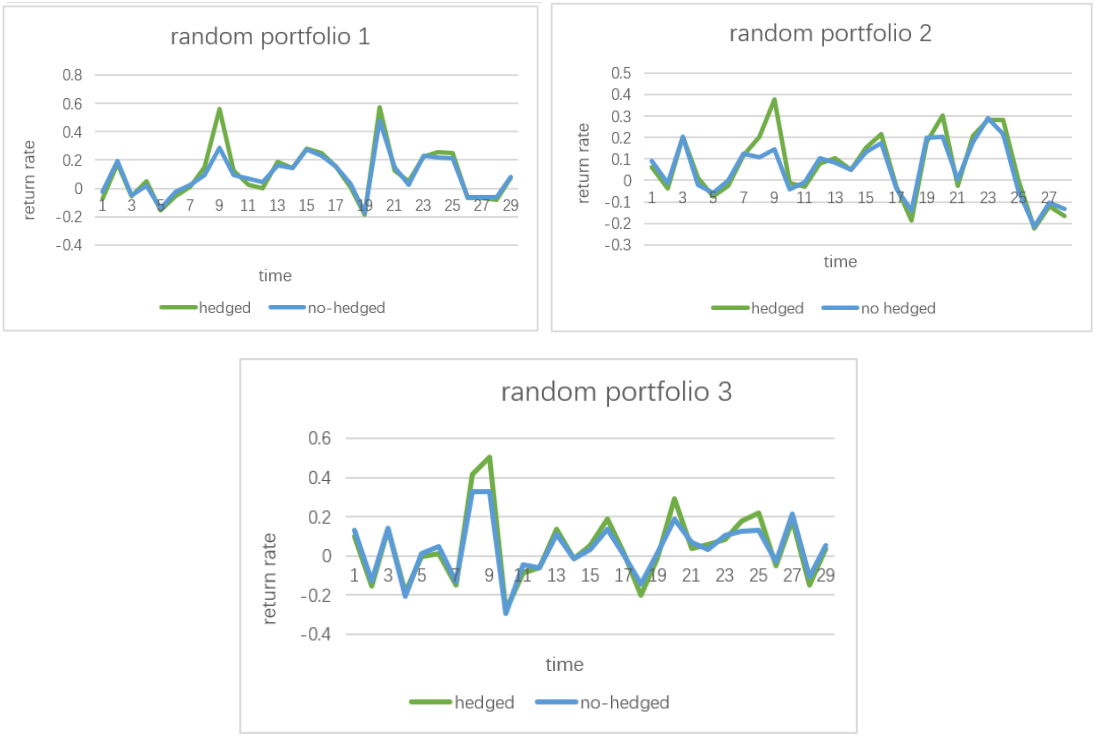

Figure 8: return rate of random portfolio

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4.2. Resisting the Stock Market Crash in 2015.

From June 15th to July 9th, 2015, the Chinese capital market experienced the bloodiest stock market crash in history. The Shanghai Composite Index plunged from 5,174 points to 3,373 points, a decline of 34.8%. The Shenzhen Composite Index dropped from 18,182 points to 10,850 points, a decline of 40.3%. The CSI 500 Index, representing growth stocks, fell from 11,589 points to 6,444 points, a decline of 44.4%. As of July 8th, more than 30% and 50% of listed companies experienced declines of over 30% and 50% respectively, with 2,139 and 1,390 companies being affected, accounting for 77% and 50% respectively. In addition, a significant number of companies, about 1,400, chose to suspend trading to avoid further losses. This crash was characterized as a stock market disaster due to its rapid occurrence within just 18 trading days [18].

We examined the data of five randomly selected portfolios during the period of 125-131 and found that allocating investments to stock index options could mitigate losses and even generate profits during the stock market crash. In the chart below, the portfolio with hedging using stock index options (orange line) mostly remained above 1, while the same portfolio without hedging (blue line) mostly stayed below 1. Therefore, hedging through stock index options proved to be relatively effective in mitigating the impact of sudden and uncertain financial shocks. Figure 9 presents the return rate under the stock market crash.

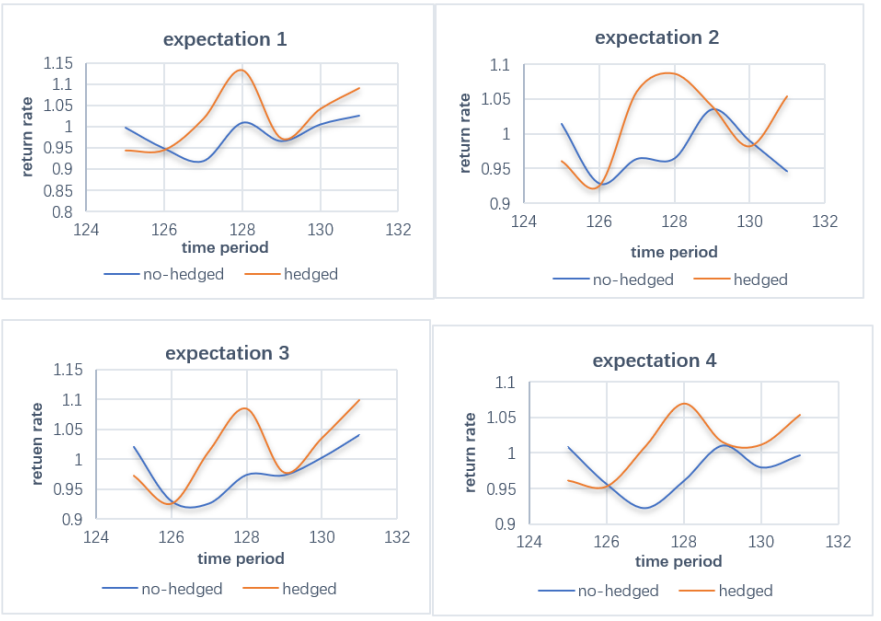

Figure 9: return rate under the stock market crash

4.3. Comparing the Stock Selection within the Industry with the Performance of Market Funds

To test the robustness of using index futures to hedge the market risk of our stock portfolio, we have made changes to the stock composition. We randomly selected ten stocks from the total of 30 stocks and recalculated the volatility. We then tested the hedging capability, calculated the returns, and took into account the presence of index funds in the market. Additionally, we modified the specific stock preferences by focusing on sectors such as the liquor industry (Guizhou Moutai, Wuliangye), the energy sector (Yanzhou Coal Mining, Northern Rare Earths), and the traditional Chinese medicine and healthcare sector (Baiyunshan, Yunnan Baiyao, Tongrentang). By comparing our profitability

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with the returns of funds available on the market, we aimed to enhance the practical significance of our findings.

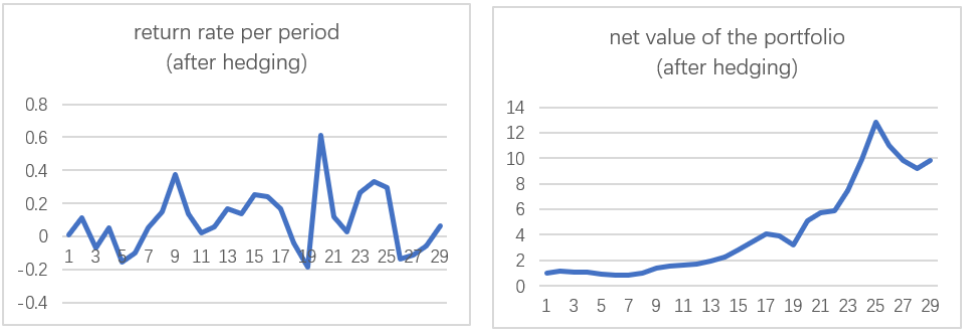

Figure 10: return rate within the industry

Figure 10 shows the return rate when selecting stocks within the industry. Comparing the randomly selected stock portfolio with the sector-specific preference portfolio, it appears that the latter demonstrates improved stability in net asset value (NAV) growth. Additionally, the sector-specific preference portfolio exhibited significant growth in 2020, aligning with the overall performance of the A-share market. The fact that the portfolio's NAV has increased nearly tenfold since 2008 highlights the feasibility of using index futures for hedging.

5. Conclusion

The results of the simulation lead to the main following conclusions. It can be speculated from the graph and dataset that more frequent portfolio rebalancing effectively reduces the volatility of returns within the holding period, but in the long run, the total rate of return is slightly lower due to the impact of transaction costs. The results also support that the returns of a portfolio implementing a hedging strategy and a portfolio without one generally exhibit similar trends, but the hedged portfolio tends to have lower volatility. It's easy to conclude form the graph that there is no significant difference in implementing a hedging strategy during periods of modest gains or losses. Since the differences between the blue and the orange line are minimal. What's more, during periods of significant volatility, the portfolio implementing a hedging strategy outperforms the non-hedged portfolio. The main differences of the performance of hedged portfolio and non-hedged portfolio lie in the periods of rapid upward and downward movements. Finally, the impact of implementing a hedging strategy on portfolio returns is not significant in the short term, but it can lead to better returns in the long term. The conclusions above display the functions of hedging strategies which are helpful in reducing the risk of the market.

References

[1] *CFI Team, 2019, Stock Index Futures, https://corporatefinanceinstitute.com/resources/derivatives/stock-index-futures/*

[2] *Sutcliffe C M S. Stock index futures[M]. Routledge, 2018.*

[3] *Stoll H R, Whaley R E. The dynamics of stock index and stock index futures returns[J]. Journal of Financial and Quantitative analysis, 1990, 25(4): 441-468.*

[4] *Cornell B, French K R. The pricing of stock index futures[J]. The Journal of Futures Markets (pre-1986), 1983, 3(1): 1.*

[5] *Hui Xiao, Jianping Bao, Chongfeng Wu. Research on the price discovery process of stock indices and stock index futures [J]. Journal of Systems Engineering,2006(4):438-441.*

DOI: 10.54254/2754-1169/97/20231564

[6] *Pierluigi Bologna & Laura Cavallo (2002) Does the introduction of stock index futures effectively reduce stock market volatility? Is the 'futures effect' immediate? Evidence from the Italian stock exchange using GARCH, Applied Financial Economics, 12:3, 183-192, DOI: 10.1080/09603100110088085*

[7] *Chang E, Chou R Y, Nelling E F. Market volatility and the demand for hedging in stock index futures[J]. Journal of Futures Markets: Futures, Options, and Other Derivative Products, 2000, 20(2): 105-125.*

[8] *Kumar K K, Bose S. Hedging effectiveness Of cross-listed Nifty index futures[J]. Global Economy Journal, 2019, 19(02): 1950011.*

[9] *Lee H T, Lee C C. A regime-switching real-time copula GARCH model for optimal futures hedging[J]. International Review of Financial Analysis, 2022, 84: 102395.*

[10] *Baur D G, Smales L A. Hedging geopolitical risk with precious metals[J]. Journal of Banking & Finance, 2020, 117: 105823.*

[11] *Zainudin A D, Mohamad A. Cross hedging with stock index futures[J]. The Quarterly Review of Economics and Finance, 2021, 82: 128-144.*

[12] *Zi Long, Hang Shuo. Trend Analysis and Factors Influencing the Performance of the Shanghai Shenzhen 300 Index from 2000 to 2019 [J]. Chinese market,2023(19):1-4.DOI:10.13939/j.cnki.zgsc.2023.19.001.*

[13] *Liu S, Zhu Z. Transaction costs and price volatility: new evidence from the Tokyo Stock Exchange[J]. Journal of Financial Services Research, 2009, 36: 65-83.*

[14] *Stephen V. Crowder & Marc D. Hamilton (1992) An EWMA for Monitoring a Process Standard Deviation, Journal of Quality Technology, 24:1, 12-21, DOI: 10.1080/00224065.1992.11979369*

[15] *Bollerslev, T. (1986) Generalized autoregressive conditional heteroscedasticity, Journal of Econometrics, 31, 307±27.*

[16] *Engle, R. F. (1982) Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation, Econometrica, 50, 987±1007.*

[17] *Hull J C. Options futures and other derivatives[M]. Pearson Education India, 2003.*

[18] *Dong Nan university, 2021, The activities of the Party Day, https://em.seu.edu.cn/2021/1229/c27103a396081/page.html*