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Implementation of Index Rebalance Strategy Based on CSI800

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Abstract: Index rebalancing is an investment strategy that takes advantage of changes in the components of specific indexes. It involves taking long positions when new assets are added and short positions when previous assets are removed. While this strategy has been widely applied in constructing hedge funds, most of the existing applications focus on indexes such as Russel or S&P 500, which primarily cover the US stock market. With the rapid development of the Chinese economy, there is a need for similar applications in the Chinese stock market. This paper selects CSI800, the representative index of the Chinese stock market, as the benchmark and constructs a portfolio based on it. The results of this study are intended to provide insights into the establishment of hedge funds in the Chinese stock market.

Keywords: index rebalance strategy, CSI800, Chinese stock market, hedge fund

1. Introduction

Index rebalancing is a strategy that capitalizes on changes in index components by exploiting the reactions of other tracking strategies to these changes. It involves taking long positions on stocks added to the index and short positions on stocks removed from the index to benefit from arbitrage opportunities [1]. This idea originates from Professor Yeh's CIS course on Quantitative Trading, held on February 12, 2023.

Index rebalancing aims to ensure that an index accurately represents the market by adjusting its components based on changes in constituent stocks. The process involves purchasing underrepresented stocks and selling overrepresented stocks. Exchange-Traded Funds (ETFs) that track specific indexes respond accordingly to changes in the index [2]. As a result, significant changes in demand for the added or removed stocks occur, leading to price and volatility fluctuations, which provide potential arbitrage opportunities.

The trading signal Is straightforward: when a stock Is added to the CSI800 Index, It Is expected to experience an upward price trend and generate positive returns. Therefore, the strategy takes a long position on the stock, represented by a binary signal of 1. Conversely, when a stock is removed from

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the index, it is anticipated to exhibit a downward price trend and generate negative returns. Thus, the strategy takes a short position on the stock, represented by a binary signal of -1. If a stock is neither added nor removed, no action is taken. The position sizing is normalized, with long positions assigned a weight of +1 and short positions assigned a weight of -1.

2. Literature Review

The universe considered in this study is the CSI800 index, which is a combination of the CSI300 and CSI500 indexes [3]. The initial portfolio size is 1 million CNY, with equal allocations to long and short positions. The sizing of positions is determined using the risk weighting method, with historical return volatility serving as the measure of risk. The strategy is evaluated twice a year. In terms of money management, when a stock incurs a 10% loss, a stop-loss is triggered, and the entire position in that stock is sold. The proceeds are reinvested on the same side (long or short). At the end of each holding period, stocks are sold with a stable and unchanged weighting, and the strategy awaits the next signal to appear.

Based on previous research on the CSI300 index rebalance strategy (approximate data), the performance estimates shown in Table 1 were derived. The CSI300 index covers the top 300 companies in the A-share market, while the CSI800 index encompasses the top 800 companies. Due to the higher stock liquidity in the CSI300 compared to the CSI800, the stock prices in the CSI800 index rebalance strategy exhibit greater volatility, offering more arbitrage opportunities. Thus, we anticipate that our system will achieve a higher return, as indicated in the estimates, with an average annual return rate of 3.82%. In the absence of a strategy, investment in short-term treasury bonds yields a yearly return of 2.8%. The standard deviation of returns in previous studies was 0.08502. Considering the expected higher volatility and a larger standard deviation in the CSI800 index rebalance strategy, we project a standard deviation of 0.8. Therefore, the Sharpe ratio for our system is 0.013.

Table 1: Performance estimate of CSI 800.

Index rebalance strategy	Dec-12	Jun-13	Dec-13	Dec-14	Jun-15	Dec-15	Jun-16
Study on CSI 300 [4]	10%	6%	1.5%	2%	0.25%	2.5%	0.5%
Estimate on CSI 800	12%	7%	2%	2%	0.5%	2.5%	1%
	Dec-16	Jun-17	Dec-17	Jun-18	Dec-18	Jun-19	Dec-19
Study on CSI 300	0.05%	N/A	N/A	N/A	N/A	N/A	N/A
Estimate on CSI 800	0.5%	4%	5%	5%	5%	3%	4%

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3. Methodology

3.1. Analysis Methods

3.1.1. Qualitative Analysis

Index rebalancing is a method used to ensure that an index accurately represents the market by adjusting its components and making changes to constituent stocks. This strategy takes advantage of arbitrage opportunities by selling stocks that are in high demand at higher prices and buying stocks that are oversupplied at lower prices. When a new stock is added to the index, ETFs that track the index will adjust accordingly, leading to significant changes in demand for that stock, which can result in price and volatility fluctuations and create potential arbitrage opportunities. The same applies to stocks that are removed from the index.

3.1.2. Quantitative Analysis

Return Calculation:

The daily return during the trading period is calculated as follows:

Trading Period: Daily Return $(R_T) = \frac{\sum \text{Daily Adj. Close Price Difference} \times \text{Volume}}{\text{Notional Amount}}$

Non-trading Period: Daily Return (R_N) = Risk-free Return, which is the return of a 2-3 month treasury bond.

Annual Return $(R) = \frac{\sum R_T + R_N}{\#(R_T) + \#(R_N)} \times 252$, where 252 represents the number of trading days in 1 calendar year.

3.1.3. Risk Assessment

In this strategy, the main consideration is market risk. Historical return volatility is used to measure market risk, and the standard deviation is employed to reflect the uncertainty caused by changes in volatility. Since the universe in this study is the CSI 800, which consists of stocks with good liquidity and high company reputation, credit risk and liquidity risk are considered to be low.

3.1.4. Sharpe Ratio

The Sharpe ratio measures the excess return that can be achieved per unit of risk and indicates the attractiveness of a strategy. It is calculated as follows:

$$\text{Sharpe Ratio} = \frac{R_p - R_b}{\sigma}$$

R_p is the portfolio's annual return, σ is the standard deviation of excess portfolio return, $and\ R_b$ is the benchmark return, which is the average yearly return of 2-3 month treasury bonds.

3.1.5. Success Ratio

The success ratio is determined by the total number of winning trades divided by the number of losing trades. It is used to evaluate the performance and profit-making probability of the strategy.

$$\text{Success Ratio} = \frac{\text{Wins}}{\text{Losses}}$$

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3.2. Data

3.2.1. Universe

The universe for this strategy is the CSI 800, which is a popular stock index in China. The CSI 800 consists of companies from the CSI 300 and CSI 500, representing large, medium, and small market capitalization companies in China. The strategy's universe is determined by adding or removing stocks from the CSI 800 index during semiannual rebalancing.

3.2.2. Shorting restriction

Short selling is typically restricted in the Chinese market, but it can be achieved through securities margin trading or borrowing stocks from brokerage firms and institutional investors. The China Securities Regulatory Commission (CSRC) has gradually relaxed short-selling restrictions since 2016.

3.2.3. Data Sets

The historical data used in this study includes the list of stocks added to or removed from the CSI 800 index and daily stock prices from 2012 to 2022. Additionally, short-term treasury rates are used as the risk-free rate.

3.2.4. Data Source

The data used in this study is obtained from CSMAR (https://cn.gtadata.com/), a research-based database covering major economic and financial fields in China. CSMAR combines internationally renowned databases such as CRSP, Standard & Poor's Compustat, New York Stock Exchange TAQ, I/B/E/S, Thomson, and other well-known databases to develop economic and financial databases tailored to China's national conditions. The stock lists and historical stock prices are sourced from the China Stock Market & Accounting Research Database.

3.2.5. Date Range

The dataset of rebalancing spans from December 2012 to December 2022. The data from December 2012 to December 2019 is considered in-sample data, while the data from January 2020 to December 2022 is regarded as out-of-sample data. This split allows for analysis of eight years of in-sample data and two years of out-of-sample data, following the approximate 1:4 ratio commonly used in relevant research papers.

3.3. Strategy Details

3.3.1. Signal Generation

The universe for this strategy is the CSI 800, and signals are generated semiannually on the announcement day of CSI 800 rebalancing. When a stock is added to the index, it is expected to have an upward price trend and a positive return, leading to a binary signal of 1 for a long position. Conversely, when a stock is removed from the index, it is expected to have a downward price trend and a negative return, resulting in a binary signal of -1 for a short position. Stocks that are neither added nor removed from the index require no action. The signal generation process is expressed as follows:

Let U_t be the universe CSI 800 at time $t \in \mathbb{N}$, and s_i be the stock in U_t for $i \in \{1,2,\dots,800\}$.

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$$\text{Signal } \mathrm{S}(U_t, s_i) = \mathrm{S}(t,i) = \begin{cases} 1, & s_i \in U_t \backslash U_{t-1} \\ 0, & s_i \in U_t \cap U_{t-1} \\ -1, & s_i \in U_{t-1} \backslash U_t \end{cases}.$$

3.3.2. Portfolio Construction

The CSI 800 index is rebalanced semiannually on the next trading day of the second Friday in June and December. The portfolio is constructed at 9:30-9:40 on the first Monday in June and December, which is the announcement day of CSI 800 rebalancing. The initial position is 1 million CNY, with half allocated to long positions and half to short positions. All positions are closed at 14:50-15:00 on the second Friday in June and December, the end of the previous trading day before the change day.

For sizing, each stock is weighted based on its normalized volatility of one-year historical return for each trading period, known as risk weighting.

Assume there are $M(0 \le M < 800)$ stocks to be long (with signal 1) and $N(0 \le N < 800)$ stocks to be short (with signal -1), the portfolio is divided into two parts: $P_{t,+} = \{s_i | \, \mathrm{S}(U_t, s_i) = 1, i \in \{1,2,\dots,800\} \coloneqq \{s_1^+, \dots, s_M^+\}$ for long positions and $P_{t,-} = \{s_i | \, \mathrm{S}(U_t, s_i) = 1, i \in \{1,2,\dots,800\} \coloneqq \{s_1^-, \dots, s_N^-\}$ for short positions. The portfolio at time t is denoted as $P_t = P_{t,+} \cup P_{t,-} \coloneqq \{p_1, \dots, p_{M+N}\}$, where p_j represents each stock:

$$p_j = \begin{cases} s_j^+ & , 1 \le j \le M \\ s_{j-M}^-, & M < j \le M+N \end{cases}.$$

For each $p_j \in P_t$, the volatility is calculated as the standard deviation of its historical annual return from time $t-2$ to time t, representing one year. This volatility is denoted as σ_j. For $1 \le j \le M$, the normalized volatility(weight) of each p_j is calculated as:

$$\tilde{\sigma}_j = \frac{1/\sigma_j}{\sum_{j=1}^{M} 1/\sigma_j}.$$

Similarly, for $M < j \le N$, the normalized volatility (weight) is calculated as:

$$\tilde{\sigma}_j = \frac{1/\sigma_j}{\sum_{j=M+1}^{M+N} 1/\sigma_j}.$$

Finally, each p_j is adjusted by $\tilde{\sigma}_j$, resulting in the adjusted portfolio $\tilde{P}_t = \{\tilde{\sigma}_1 p_1, \dots, \tilde{\sigma}_{M+N} p_{M+N}\}$. This notional-neutral strategy aims to hedge the notional risk. For money management, if a stock incurs a 10% loss rate, a stop loss is triggered, and the position of that stock is closed. The remaining funds are redistributed proportionally to the weights of the remaining stocks on the same side (to maintain notional neutrality) for reinvestment.

3.3.3. Trade Execution

The trading venues are the Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE). The brokerage firm used is Huatai Securities, known for its relatively low commission rate of 0.013% [6].

During limit order executions, transaction fees are incurred, including an auction trading fee of 0.00487% [7], a stamp duty of 0.1% [7](only for the seller), and a commission and transfer fee of 0.002%. The fill cost is assumed to be the bid-ask spread, with approximately 92.6% of stocks having a bid-ask spread of 0.01 CNY per share. Therefore, the total transaction fee for long position

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is $0.013\% + 0.00487\% + 0.002\% = 0.01987\%$ plus 0.01 CNY $\times$ trading volume. For short positions, the total transaction fee is $0.0013\% + 0.00487\% + 0.002\% + 0.1\% = 0.11987\%$, plus 0.01 CNY $\times$ trading volume.

4. Research Results

4.1. Results Overview

4.1.1. PnL Graph

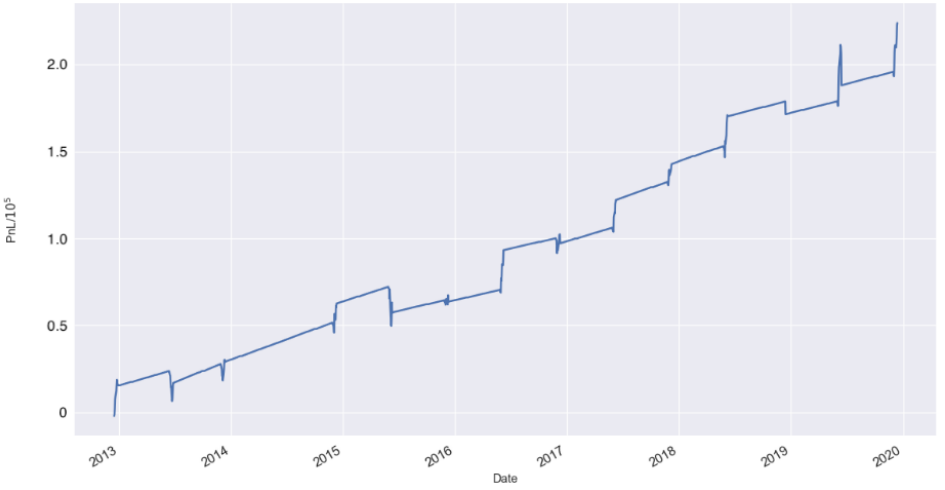

Figure 1: Daily PnL graph for in-sample data.

Figure 1 illustrates the daily profit and loss (PnL) graph for the in-sample data, covering the period from December 2012 to December 2019. The x-axis represents the dates, while the y-axis represents the profit or loss of an initial investment of 1 million CNY.

The graph clearly shows an overall upward trend, indicating the effectiveness of our index rebalancing strategy. Notably, significant fluctuations can be observed at the nodes where the strategy is implemented, demonstrating the impact of the rebalancing process on annual returns. The positive slope and steepness of the line during the implementation of the strategy indicate an improvement in PnL.

4.1.2. Comparison of Estimated and Actual Return

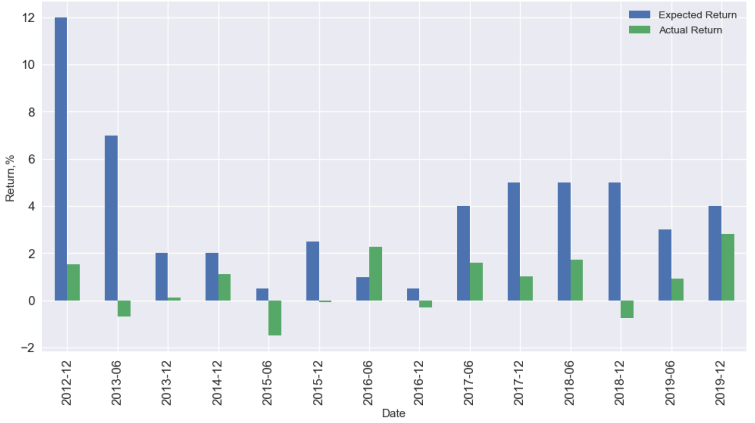

Figure 2: Bar chart for comparison of expected return [8] and accurate return.

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Figure 2 presents a bar chart comparing the expected returns [8] with the actual returns. The chart reveals that there are more periods of positive returns than negative returns, indicating the presence of arbitrage opportunities in today's financial markets through our CSI 800 index rebalancing strategy.

The chart also highlights a significant difference between the actual and expected returns, with the former generally being lower than the latter. We attribute this difference to two factors.

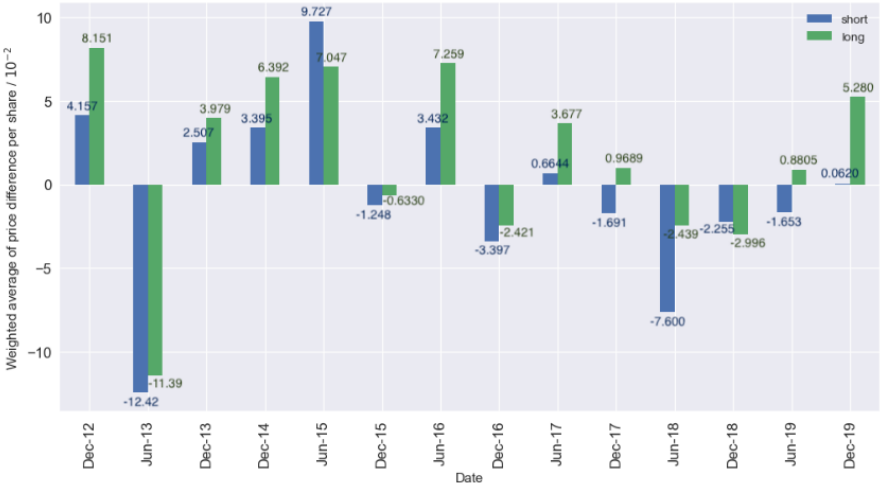

Figure 3: Bar chart for the weighted average of price difference per stock.

Figure 3 showcases a bar chart representing the weighted average of the price difference per stock. One factor contributing to the difference in returns is the underestimation of the overall market's impact on our strategy. In an overheated A-share market, stock prices tend to rise, resulting in increased costs for short-selling stocks and reduced or negative returns. Analyzing the weighted average of price change rates for short-selling stocks during periods of market overheating, we observe positive values, indicating negative returns on short positions. The most prominent example is in June 2015, with a value of 0.0973, the highest among all the sample years. Additionally, the returns generated by ETF behavior for our long positions are partially absorbed by the overheated market since ETFs' demand for index stocks contributes to the market's overheating. Consequently, the positive effect of the overheated market on extended returns may be less significant than its negative effect on short returns, resulting in substantial losses during such periods, as observed in June 2015.

Conversely, the depressed A-share market, the opposite effect occurs. The most notable example is in June 2013. Based on the weighted average of price change rates, the market downturn during this period has a more substantial positive impact on short returns than a negative impact on extended returns. However, as the stocks selected for short and long positions are those being removed or added to the CSI 800 index, it implies that the prices of long positions are higher than those of short positions. This price difference erases the positive impact of the market, leading to a loss in June 2013.

Underestimating transaction costs caused by liquidity is another factor contributing to the difference between expected and actual returns. Compared to the CSI 300 rebalancing strategy, the stocks considered in our strategy have lower liquidity, resulting in greater price volatility and more arbitrage opportunities. While this leads us to have a more positive assessment of our strategy, lower liquidity also means wider bid-ask spreads and higher transaction costs, which can reduce returns and result in a difference between expected and actual returns.

4.1.3. Summary Statistics

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Table 2: Summary statistics for in-sample data.

Trading Period	Annual Return	Standard Deviation of Return	Sharpe Ratio	Success Ratio
10 days*	4.67 %	1.399%	1.21	64.29%

Table 2 provides summary statistics for the in-sample data, including the trading period, annual return, standard deviation of return, Sharpe ratio, and success ratio. The trading period considered is 10 days.

4.2. Difficulties

4.2.1. Complexity in Making Positions Before the Index Announcement Day

Ideally, we aimed to gain an edge over ETFs in the market by predicting the newly added or removed stocks based on the compilation rules of CSI 800, one day before the index announcement date. However, achieving this proved challenging, leading us to simplify the model and choose to act on the index announcement day and the index change day instead.

4.2.2. Additional Rebalance Caused by a Special Event

Typically, CSI index rebalancing follows a twice-yearly cycle with relatively fixed rebalancing times. However, there are abnormal periods, such as October 2019, within the sample year. To ensure the generality of our strategy and avoid overfitting issues, we excluded abnormal periods from our analysis and focused only on typical situations in the model.

4.2.3. Abnormal Announcement Day in Regular Index Rebalance

As previously mentioned, the rebalance announcement day is usually ten working days before the change day. However, an exception occurred in the in-sample data, specifically with the index rebalancing in June 2014, which was announced on the change day. Consequently, there was limited opportunity for arbitrage on that day, leading us to exclude it from our in-sample data.

4.3. Out-of-sample Test

4.3.1. Return and PnL Graph

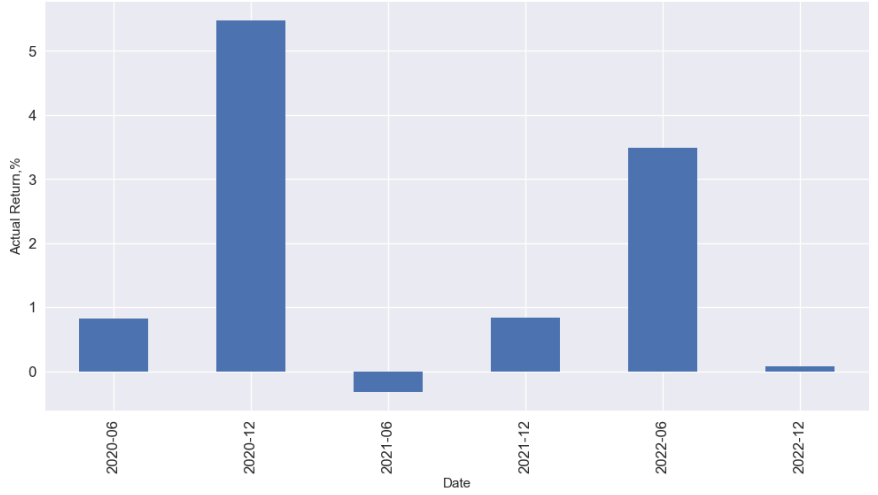

Figure 4: Six months actual return for out-of-sample data.

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Figure 4 displays the actual return of the out-of-sample data over six-month intervals since June 2020. Generally, the sample generates positive returns, except for a negative return observed in June 2021.

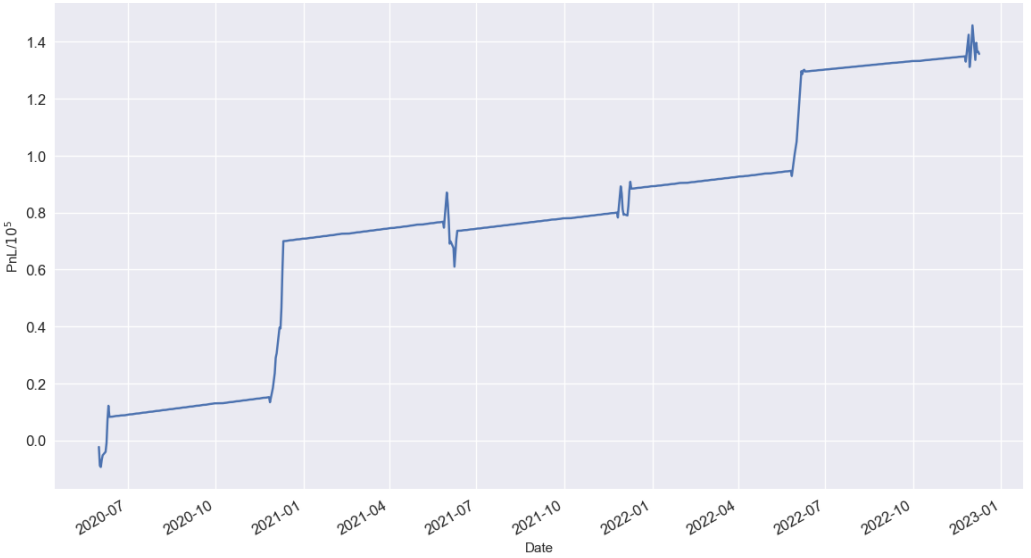

Figure 5: Daily PnL graph for out-of-sample data.

Figure 5 represents the PnL of the out-of-sample data, spanning from July 2020 to January 2023. Overall, the sample generates positive PnL, gradually increasing over time. Compared to the in-sample data, the PnL value of the out-of-sample data consistently shows growth in most periods. However, the return experiences more frequent fluctuations, and the final PnL is smaller than that of the in-sample data.

4.3.2. Summary Statistics

Table 3: Summary statistics for out-of-sample data.

Trading Period	Annual Return	Standard Deviation of Return	Sharpe Ratio	Success Ratio
10 days*	5.40 %	1.444%	2.33	83.33%

Table 3 provides summary statistics for the out-of-sample data, including the trading period, annual return, standard deviation of return, Sharpe ratio, and success ratio. It is evident that the out-of-sample data exhibits a significantly higher annual return and standard deviation of return compared to the in-sample data. Moreover, the Sharpe ratio and success ratio are also higher. In conclusion, the out-of-sample data generates greater returns but is more volatile.

5. Conclusion

The research demonstrates that implementing the CSI 800 index rebalancing strategy can potentially yield significant profits, albeit with considerable risk. Notably, both the in-sample and out-of-sample data exhibit Sharpe ratios greater than 1, and even greater than 2 for the out-of-sample data. Therefore, it is highly recommended to implement this strategy in the Chinese stock market. However, further refinements can be considered to maximize returns.

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To maximize profit potential, it is crucial to anticipate price differences caused by index rebalancing and adjust portfolios before most competitors engage in arbitrage. One approach is to initiate positions before the announcement day by analyzing the rebalancing rules and estimating the list of added and eliminated stocks before the next announcement.

Through our implementation, we observed that our portfolio exhibits beta correlation with the market. When the market performs well, both the CSI 800 and the individual stocks tend to experience upward price trends, even for the eliminated stocks. Implementing beta hedging strategies can help mitigate market risk [9]. In addition to the regular biannual index rebalances, special events can trigger adjustments, such as minor rebalances in March 2021 and a major one in October 2019. These events may result from stock bankruptcies or significant financial events impacting the overall market. Analyzing the impact of these rebalances on index performance can inform whether arbitrage opportunities arise during these periods.

Short selling is restricted in the Chinese stock market [10]. In 2015, the China Securities Regulatory Commission (CSRC) imposed regulations limiting short selling and margin trading due to a market crash. Subsequently, in 2016 and 2017, the CSRC eased restrictions and allowed a few brokerage firms to engage in short selling. Presently, short selling can be accomplished through two methods: regular short selling by borrowing stocks purchased by brokerage firms using their capital, or fast-sale refinancing by borrowing shares from brokerage firms owned by other institutional investors.

Overall, taking these considerations into account and refining the implementation of the CSI 800 index rebalancing strategy can lead to higher returns and reduced risks.

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