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Testing the Weak Efficient Market Hypothesis of Chinese Stock Market

--Based on the Market Performance of Representative Stock Investment Portfolios in the HS300 Index

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Abstract: China's domestic stock market has developed very quickly overall in the more than 30 years since it was established, but information effectiveness in the Chinese stock market still faces multiple problems, so testing the weak efficient market hypothesis of the Chinese stock market is a good way to test its information quality and give investors relevant advice. This article selected representative stocks from the HS300 index, gathered the stocks' historical data, used the index model to construct an optimal portfolio, and used another part of historical data to test if the portfolio has continuous excess return compared with the market portfolio and risk-free asset. The article finds excess return for the optimal portfolio during a long period and cannot prove that the Chinese stock market is weak and efficient. This result will provide a certain theoretical basis for investors who use technical analysis for stock investment and may also indicate that many issues still need to be addressed in the Chinese stock market, such as information asymmetry, high transaction costs, and insufficient regulation.

Keywords: Chinese Stock Market, Efficient Market Hypothesis, Index Model, Optimal Portfolio

1. Introduction

1.1. Development and Present Situation of Chinese Stock Market

China created the stock exchanges in Shenzhen and Shanghai in 1990, setting a pattern for other socialist nations. China's domestic stock market has developed very quickly overall in over 30 years since it was established. For example, after 2001, the issuance method in the Chinese stock market changed significantly, abolishing restrictions on the number and price of issuances while also requiring mandatory information disclosure, greatly improving the efficiency of the Chinese stock market [1].

However, compared to those well-developed stock markets, the Chinese stock market still has multiple problems. The stock market in China is known for phenomena like abrupt spikes and crashes, protracted bears, and short bulls. Also, the turnover rate of the Chinese stock market is very high, mostly above 200%, and in some years, the turnover rate exceeds 1000% [1]. Many scholars believe that the Chinese stock market still lacks efficiency. They believe that the inefficient listing and delisting of A-shares, coupled with other concerns like poor quality accounting information, combine to create a shortage of stock and extreme information asymmetry, significantly lowering resource allocation effectiveness in the Chinese stock market [2].

1.2. Efficient Market Hypothesis (EMH)

Whether asset prices can accurately reflect all available information is the central question of modern finance, and Fama summarizes the investigation of this question as the "efficient market hypothesis" (EMH). According to the efficient market hypothesis, the stock market can reliably, promptly, and thoroughly reflect information about stocks that are current, historical, and prospective. The market can be classified as a weak form efficient market, semi-strong form efficient market, or strong form efficient market based on the various levels of information reflected in the market. Securities prices in less efficient markets take into account all past data that is accessible. Securities prices in a semi-strong form efficient market take into account all current and past public information that is accessible. Securities prices in a well-functioning, efficient market not only take into account all available historical data but also incorporate up-to-date public information and the potential to represent investors' private data [3].

In this article, the author mainly focused on testing the weak form of EMH, that is, if investors can gain sustainable excess return by establishing a portfolio that contains several stocks in the Chinese stock market and a stock index based on the historical data of the stocks' price. As early as 2016, Zhu Rui from Qilu University of Technology conducted research on the weak efficiency of the Chinese stock market. This article selects the daily logarithmic returns of the Shanghai and Shenzhen 300 Index and conducts a run test based on a random walk model to empirically study the weak form efficiency of the two stock markets in China. The test results show that the two stock markets in China, Shanghai and Shenzhen, are weakly efficient [4]. In recent years, with the volatility of the stock market and the implementation of new policies, the weak efficiency of the Chinese stock market needs to be further tested.

1.3. Index Model (IM)

In this article, the author used the "Index Model" (IM) to create the best portfolio for selected stocks. The index model was created in 1963 by Sharpe, who streamlined Markowitz's model and put out a single index model that connected the portfolio's risk and returns to the market portfolio, offered a fresh viewpoint on portfolio diversification, and drastically decreased the model's computational burden [5]. Since then, a large number of scholars have widely used the Index Model in various investment fields, and nowadays, the model is still a common method for building investment portfolios.

The index model assumes that there is only one macro factor that will create stock return risk in order to facilitate the study. The residual (random), with a mean of zero and a standard deviation σi, is considered to be normally distributed. The model's underlying assumptions state that the return on any given stock can be broken down into three components: the return of macro events that impact the market, the unpredictable makeup of micro-events that only have an impact on the company, and the expectation of the residual return of individual shares (represented by a company-specific factor α [6].

Based on the IM, several statistical characteristics are required. The characteristics and formulas to calculate them are re-listed as follows:

$$Mean: rp = \sum xi * ri \tag{1}$$

$$\text{Standard deviation: } \sigma\ (rp) = \text{sqrt}(\ \sum\ \sum\ xi * ri * Cov(ri, rj)) \tag{2}$$

$$rit - rf = \alpha i + \beta i(rmt - rf) + \varepsilon it \tag{3}$$

2. Method

2.1. The Selection of Representative Stocks

2.1.1. The Selecting Range of Stocks

All stocks selected in this passage are constituent stocks from the Shanghai and Shenzhen 300 Index (HS300). The HS300's constituent stocks are chosen from a pool of stocks with great representativeness in the Chinese stock market, meaning that they can accurately and completely reflect changes in stock prices of large-scale, highly liquid stocks. The index's focus is on displaying the liquidity of the securities market. In addition, the HS300's weight is derived from its free circulation volume—that is, circulation volume after non-circulating share capital is subtracted—and its constituent stocks' weights are established through a hierarchical ranking system, which guarantees the index's legitimacy in the eyes of the market and makes it easier for investors to track and index their holdings. Consequently, investors can receive clear investing guidance from the HS300 by examining this representative stock [7]. Therefore, the HS300 Index can provide investors with clear investment directions, and studying this representative stock index is meaningful.

2.1.2. An Introduction of Stocks Selected

In this article, the author selected 10 stocks in the HS300 index with the highest weight, which means investors have easy access to these stocks and are representative. These 10 stocks are listed in Table 1.

Table 1: 10 representative stocks selected from HS300

Stock code	Abbreviation	Sector (Shenwan level 1)	Symbol
600519.SH	KWEICHOW MOUTAI	Food & Beverage	KCMT
000858.SZ	WLY	Food & Beverage	WLY
300750.SZ	CATL	Electrical Equipment	CATL
000333.SZ	Midea Group	Home Appliances	MIDEA
600276.SH	Hengrui Pharma	Health Care	HRP
600900.SH	CYPC	Utilities (mainly Electrical Equipment)	CYPC
601318.SH	PING AN OF CHINA	Non-banking Financials	PAOC
600030.SH	CITIC Securities Co., Ltd.	Non-banking Financials	CITIC
601166.SH	INDUSTRIAL BANK	Banks	CMB
600036.SH	CM BANK	Banks	INDUB

Among all 10 stocks, there are 2 stocks from the food & beverage sector, 3 from the manufacturing sector, 1 from the service sector, and 4 from the financial sector. These 10 stocks cover multiple industry types and can mitigate risks effectively. The author will use symbols to represent each stock in the following article.

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2.2. Data Gathering

2.2.1. Getting Historical Price Data for 10 Stocks and HS300 Index

In this article, the author used software called "Choice Financial Terminal" to get all the financial data needed. For selected 10 stocks and the HS300 index, the author got the historical daily closing price from June 11, 2018, the first trading date for stock "CATL", to December 8, 2023.

2.2.2. Getting the Risk-Free Rate (RFR)

In recent years, the interest rate benchmarks in global financial markets, especially interbank and financial derivatives, have undergone a major transformation. The original interbank market quoted rates (IBORs) will gradually fade away and shift towards risk-free rates (RFRs) [8]. Assets classified as risk-free have a variance (or standard deviation) of zero and whose returns can be fully forecast within the investor's decision interval. The risk-free interest rate is the completely predictable return on risk-free investments. The absence of default risk, often known as credit risk, which might encompass interest rate, inflation risk, liquidity risk, reinvestment risk, etc., makes risk-free assets risk-free [9].

Using a one-year treasury bond interest rate as the RFR is common in China. This rate is posted daily by the China Foreign Exchange Trading Center and National Interbank Funding Center, and it can also be found in financial terminals such as Choice.

2.3. Data Preprocessing

2.3.1. Risk-Free Rate Adjusting and Creating an "Asset"

The stock market in China operates only on weekdays and excludes holidays, so there are fewer than 250 trading days annually. All stocks have equal trading days, but one-year treasury bonds may be traded on days when stocks are not traded, like September 27 and 28 annually. As a result, these days must be removed before utilizing the interest rate on one-year treasury bonds as the risk-free interest rate for computation. The author used Excel to conduct the comparison and the adjustment.

Because the gaps between two consecutive trading days are not all equal: some are continuous (two consecutive working days), some are two days (in two weeks), and some are more than two days due to the national holiday, it will lead to some problem if the author treats these gaps equally. Thus, the author created a special "asset" containing only this bond. Then, giving the initial money of 1,000, the money in each trading day can be calculated using the formula: $money_{d+1} = money_d * (1 + RFR_d * \frac{(date_{d+1} - date_d)}{242})$. Here, 242 refers to the approximate total trading days each year in the Chinese stock market. After creating this special "asset", treating risk-free rate as other stocks is valid.

2.3.2. Stock & HS300 Price Adjusting

The author split Stock & HS300 price data into two pieces. The former piece, which contains data from June 11, 2018, to June 12, 2023 (about five years), is used as the initial data to establish the Index Model analysis. The latter piece, which is about 6 months, from June 13, 2023, to December 8, 2023, is used to test if the portfolio this study generated can gain excess return in a long period of time. Also, all the price data are time-descending, and the author needed to transfer them to time-advanced in order to perform further calculations.

2.4. Daily Return & Excess Return Calculation

To calculate the daily return, this study can use the formula:

$$return_{d+1} = \frac{price_{d+1}}{price_d} - 1 \quad (4)$$

To calculate the excess return, this study can use the formula:

$$excess_{d+1} = return_d - returnRFR_d \quad (5)$$

2.5. Statistical Characteristics Calculation

Using the formulas (1) ~ (2) discussed above, the author calculated all 10 stocks, HS300, and RFR asset's mean and standard deviation.

Then, with the help of the linear regression functions in Excel, the author used "SLOPE" and "INTERCEPT" functions to apply linear regression to 10 stocks, HS300, and RFR assets. After this step, the author got alpha and beta in formula (3) for each element, in which alpha is annualized by multiple 242.

Finally, using all the statistical characteristics above, the author calculated the annualized residual return standard deviation for each element in the portfolio. First, use the formula $R_r = R_E - \beta \times SPX - \frac{\alpha}{12}$ (6) to get the residual return. Then, use formula (2) to calculate the standard deviation.

2.6. Finding Best Portfolio

Using Excel solver, it is easy to find the best portfolio for 10 stocks and the HS300 index. The question is how to judge which investment portfolio is optimal. Here, the article introduces a measurement called the "Sharpe ratio," which was invented by William Sharpe. Based on Markowitz's contemporary portfolio theory, Sharpe suggests the Sharpe ratio as a risk-adjusted metric for evaluating fund performance. The fundamental tenet of Sharpe's ratio is the belief that logical investors will build and maintain an investment portfolio that best serves their own interests, i.e., an investment portfolio with a specific amount of risk but either maximizing or reducing projected returns [10]. Here is the formula to calculate the Sharpe ratio: $S_p = \frac{E(R_p)-R_f}{\sigma_p}$ (7).

2.7. Back-Testing Portfolio

Use the data set from the abovementioned article in part 2.3.2 to test if the optimal portfolio performs better than HS300 and RFR assets. Each asset (portfolio, index, and RFR) is given an initial money of 1,000 yuan and will be held for a period of time, and its value will be adjusted based on stock price, index fluctuations, and interest rate fluctuations. The result is obtained by subtracting the value of index assets (or risk-free assets) from the value of portfolio assets.

3. Result

3.1. Statistical Characteristics Calculation Results

All calculation results are listed in Table 2:

Table 2: 10 stocks' statistical characteristics calculation results

	HS300	KCMT	WLY	CATL	MIDEA	HRP
Annualized Average Return	0.000	0.001	0.001	0.002	0.000	0.000
Annualized StDev	0.200	0.314	0.391	0.527	0.331	0.367
beta	1.000	1.089	1.417	1.256	1.085	0.950
Annulized alpha	0.000	0.183	0.202	0.477	0.036	-0.067
Annualized residual return std	0.000	0.226	0.269	0.464	0.250	0.314

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Table 2: (continued).

	CYPC	PAOC	CITIC	CMB	INDUB
Annualized Average Return	0.000	0.000	0.000	0.000	0.000
Annualized StDev	0.195	0.280	0.324	0.304	0.274
beta	0.298	1.009	1.241	1.022	0.802
Annulized alpha	0.042	-0.032	0.043	0.056	0.024
Annualized residual return std	0.185	0.194	0.208	0.225	0.222

3.2. Optimal Portfolio

By setting the target, which is to find the maximum Sharpe ratio to the solver, the author can have the optimal portfolio as follows (Table 3):

Table 3: Optimal portfolio

	HS300	KCMT	WLY	CATL	MIDEA	HRP	CYPC
weight	0	0.31135	0.105782	0.542249	0	0	0.040616
	PAOC	CITIC	CMB	INDUB	return	stdev	Sharpe
weight	0	0	0	0	0.338449	0.35341	0.957667

3.3. Excessive return of portfolio

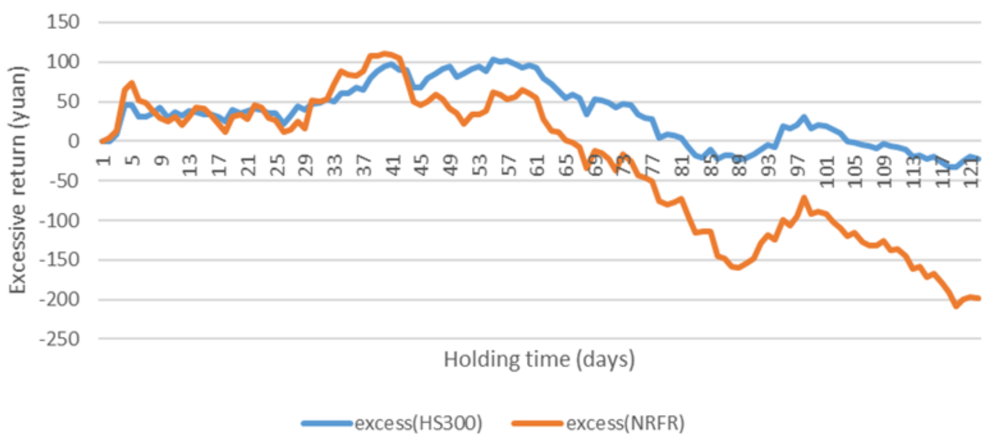

Figure 1: Excessive return of the portfolio (Photo credit: Origin)

In Figure 1, it is clear that the optimal portfolio has excessive return during a time. Compared with HS300, the optimal portfolio has an excess return from day 1 to day 81, with the highest excessive return of over 100 yuan on day 55. Also, when compared with RFR, the optimal portfolio has an excess return from day 1 to day 65, with the highest excessive return of over 100 yuan on day 39.

4. Discussion

4.1. Discussion on Statistical Characteristics Calculation Results

The statistical characteristics calculation shows each stock's average return, standard deviation, and variables needed to construct the index model: alpha, beta, and residual standard deviation. The average returns of 10 stocks are very close, ranging from -0.05% to 0.25%. The difference in standard

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deviation of returns is significant, ranging from 0.195 to 0.527. In constructing subsequent investment portfolios, stocks with higher average returns and smaller variances are often chosen. The alpha and beta values of stocks mainly affect their expected returns in the investment portfolio, while the residual return standard deviation mainly affects the variance of the investment portfolio. These data vary greatly among different stocks. In conclusion, these Statistical characteristics will play an important role in the subsequent construction of the investment portfolio.

4.2. Discussion on Optimal Portfolio

The optimal investment portfolio constructed in the paper only includes four stocks: KCMT, WLY, CATL, and CYPC. Among them, the first two stocks belong to the Food and beverage sector, while the last two belong to the Electrical Equipment sector. Not a single stock comes from the financial sector, indicating that the development of stocks in the financial industry was relatively poor compared to stocks in other industries from 2018 to 2023. CATL has the highest proportion among the four selected stocks, reaching 0.527. This is because CATL, as an emerging company, has a rapid development momentum and has the highest return rate among all stocks. The final constructed investment portfolio has an average return of 0.338, a standard deviation of 0.353, and a Sharpe ratio of 0.958.

4.3. Discussion on Excessive Return of Portfolio

As can be seen, this article successfully constructed an investment portfolio using ten stocks in the HS300 index, and the profitability was superior to the HS300 index and risk-free interest rate for a considerable period of time. If investors hold the investment portfolio for less than 65 days, they will receive returns superior to the market portfolio and risk-free interest rate.

The only problem is how much money investors can have, and the answer to this question is related to the protective trading strategy that investors use. For example, an investor may set a strategy that if the portfolio's excess return compared to the market index is more than 50% lower than the maximum historical excess return, they will sell the portfolio. In his case, he or she will get approximately 25 yuan of excess return. Other protective trading strategies that investors may use are beyond the scope of discussion in this article. Anyway, all the protective trading strategies will lead to a non-negative excess return, which is beneficial for investors.

5. Conclusion

In this article, the author selected 10 representative stocks from the HS300 index, gathered the stocks' historical data, used an index model to construct an optimal portfolio, and used another part of historical data to test if the portfolio has continuous excess return compared with market portfolio and risk-free asset. The result is the optimal portfolio has an excess return for 81 days with the highest excessive return of over 100 yuan compared with the market portfolio and has an excess return for 65 days with the highest excessive return of over 100 yuan compared with RFR. Given the profitability of the investment portfolio, this article cannot prove the weak efficient market hypothesis in the Chinese stock market.

This result indicates that the weak efficient market hypothesis may not always hold true in the Chinese stock market. At least at certain times, investors may still analyze the historical stock prices of stocks through the index model to construct the optimal investment portfolio to obtain returns superior to market portfolios and risk-free assets. This result will provide a certain theoretical basis for investors who use technical analysis for stock investment, such as technical analysis of quantitative trading. The results of this paper may also indicate that many issues still need to be

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addressed in the Chinese stock market, such as information asymmetry, high transaction costs, and insufficient regulation.

This article still has several weaknesses. Firstly, the number of stocks selected in the paper is relatively small, and the time span of historical prices is short, resulting in a lack of universality in the research. Secondly, although the investment portfolio constructed in the paper achieved excess profits within a certain period of time, it still cannot refute the correctness of the weak efficient market hypothesis in the Chinese stock market, as the paper cannot prove whether this result is accidental. Only by constructing a large number of optimal investment portfolios composed of different time periods and stocks, analyzing their excess profits, and conducting hypothesis testing can this study accurately answer the question of whether the weak efficient market hypothesis is valid in the Chinese stock market. The article can only suggest that the weak efficient market hypothesis in the Chinese stock market may not be true for some stocks in some periods and expect further exploration for related research.

References

[1] *Wu, Q. (2020). Analysis of Problems and Countermeasures in the Development of China's Stock Market. Marketing Journal, 34, 46-47.*

[2] *Li, Y. D. (2018). Reflections on the Development of China's Stock Market from the Perspective of Stocks as Commodities. Finance and Accounting Learning, 222-223.*

[3] *Jiang, Y. (2021). Research and Development of Modern Asset Pricing Theory: From the Perspective of Efficient Market Hypothesis and Asset Pricing Model. Modern Management Science, 03, 42-48.*

[4] *Zhu, R. (2018) Empirical Study on Weak Form Efficiency of China's Shanghai and Shenzhen Stock Markets. Times Finance, 20, 198-200.*

[5] *Sharpe, William F. (1963). A Simplified Model for Portfolio Analysis. Management Science, 9-2, 277-293.*

[6] *Jin, M. Z, Lin, Z. X., Yuan, S. K. (2023). Research and Analysis on Markowitz Model and Index Model of Portfolio Selection. Advances in Economics, Business and Management Research, 213, 1146-1147.*

[7] *Chen, Z. L., Dong, H. S. (2023) Analysis of the Trends and Influencing Factors of the Shanghai and Shenzhen 300 Index from 2000 to 2019. Chinese Market, 19, 1-4.*

[8] *Fu, X. G. (2019). Evolution of risk-free interest rates in global financial markets. China Finance, 21, 79-81.*

[9] *Wang, C. (2012). Discussion on risk-free interest rates. China Asset Appraisal, 10, 30-34.*

[10] *Zhou, T. S (2022). Analysis of Stock Investment Portfolio Based on Mean Variance Model. Economic Research Guide, 23, 85-88*