

Analysis of Financial Investment Strategy of Manufacturing Enterprises under ESG System

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Abstract

At present, China is in the context of achieving the goal of "carbon peaking and carbon neutrality". From the perspectives of ESG responsible investment and value investment, this article aims at the investment efficiency of Chinese manufacturing enterprises. The 2018-2022 listed company market data is tested empirically. An efficient frontier is constructed based on Markowitz's theory, and the KMV model is used to measure the credit risk of a portfolio. The research found that: First, the value investment based on the ESG concept has much higher investment benefits than the CSI 300 Index over the same period. Second, corporate social responsibility can be recognized by the capital market, and the credit risk is therefore lower than the market average. The research conclusion of this paper proves that ESG value investment can promote the high-quality development of manufacturing industry. It provides an important policy inspiration for the Chinese government to implement the concept of sustainable development, which will convey the image of a responsible big country to the world.

Keywords

ESG Investment; Markowitz Investment Theory; KMV Model; Quantitative Investment.

1. Introduction

The "Government Work Report" in 2015 first proposed the implementation of "Made in China 2025", insisting on innovation-driven, intelligent transformation, strengthening foundation, green development, and accelerating the transition to manufacturing power [1]. In recent years, "Made in China 2025" has been one of the important keywords running through the Chinese government's work. The manufacturing industry occupies half of the domestic capital market. President Xi Jinping has repeatedly emphasized that "to accelerate the construction of a strong manufacturing country, the manufacturing industry is the lifeline of the national economy". The high-quality development of the manufacturing industry has become an important manifestation of the country's comprehensive strength.

In 2020, President Xi Jinping proposed at the seventh meeting of the Central Finance and Economics Committee to build a new development pattern in which the domestic cycle is the mainstay, the domestic and international dual cycles promote each other [2]. Therefore, Chinese enterprises going overseas is an important part of realizing the "dual circulation". Besides, the manufacturing industry is the main body of the real economy and an important starting point for realizing industrial transformation and upgrading. It is of great practical significance to carry out empirical research on financial investment of listed manufacturing companies and to guide government and social funds to flow into manufacturing enterprises. It

is also the only way to develop advanced manufacturing and strategic emerging industries, which is helpful to realize "Made in China 2025".

In June 2018, China's A-share market was officially included in the MSCI index system, which is an important step for China's capital market to internationalize and invest in value. As an authoritative index system on a global scale, MSCI has a set of evaluation criteria for corporate value investment, and the ESG value investment system is one of them [3]. The corporate ESG responsibility evaluation system refers to the environment, social and governance. In recent years, with the emergence of social and environmental issues such as the virus pandemic and frequent geological disasters, all sectors of society have reached a consensus on whether companies should fulfill their social responsibilities. In the selection process of investment financial products, special attention is paid to the social performance of enterprises [4]. Therefore, if Chinese companies want to go overseas, they must fulfill their social responsibilities.

The innovations of this paper revolve around the following three aspects. First, from the perspective of value investment. Under the background that ESG responsibility performance and corporate social responsibility are gradually being paid attention to. This paper determines the sample for empirical research. Second, in response to the income issue that is widely concerned in the investment process, this paper tracks the CSI 300 Index with the optimal portfolio constructed in the sample, revealing the confidence of the securities market in the constructed portfolio. Third, it measures the credit risk of enterprises in the investment portfolio, and analyzes the relationship between the portfolio return and risk, in order to provide reference for investors' strategy design.

The rest of this paper is structured as follows: the second part introduces the portfolio strategy designed around ESG value investing, the third part measures the credit risk of companies in the portfolio, and the fourth part is the conclusion and policy recommendations.

2. Portfolio Strategy for Manufacturing Enterprises based on Markowitz Theory

2.1. Research Ideas

Markowitz put forward the portfolio theory in 1952, which is to solve the problem of how to reasonably adjust the ratio of holding financial assets to reduce the risk of the portfolio under uncertain conditions [5]. The Markowitz portfolio theory mainly includes two aspects: the mean-variance model and the efficient frontier theory, which are used to reasonably avoid risks and pursue the maximization of expected returns. The goal of investment decision-making is to seek a portfolio with the least investment risk at the same level of return or the maximum return at the same level of risk.

2.2. Stock Selection and Data Extraction

ESG investment refers to incorporating environment, social and governance issues into investment analysis and investment decision-making processes. ESG investment is inextricably linked with sustainable finance, low-carbon finance, climate finance and green finance [6]. ESG information mainly comes from annual reports of listed companies, sustainability reports, social responsibility reports, environmental reports, announcements, corporate official websites, regulatory authorities, etc. The article uses the ESG rating data released by SynTao Green Finance. Its ESG rating system includes a three-level indicator system. The first-level indicators are the three dimensions of environment, social and governance. The secondary indicators are 14 core topics under the environment, social and governance, as shown in Table 1.

Table 1. ESG Rating System

Environment	Environmental policy
	Energy and Resource Consumption
	Emissions
	Climate Change
	Biodiversity
Social	Employee Development
	Customer Management
	Supply Chain Management
	Information Security
	Product Management
	Community
Governance	Governance System
	Business Ethics
	Compliance Management

According to the ESG rating data released in this section, the investment portfolios constructed in this section are identified as the top 6 manufacturing companies with the highest ESG rankings in the CSI 300 Index, namely ZTE, Ganfeng Lithium, Luxshare, Sungrow, Fosun Pharma and Wanhua Chemical. The ESG rating data of them is all A-, which comes from the Wind database. The daily closing prices of 6 stocks from January 2, 2018 to May 30, 2022 are selected as the data of the sample period. The risk-free interest rate is the bank interest rate of fixed deposit and withdrawal for 1 year in China, which is 1.50%. The data comes from Wind database.

2.3. Descriptive Statistics of Data

Figure 1 depicts the changes in the returns of six selected CSI 300 listed manufacturing companies from January 2, 2018 to May 30, 2022.

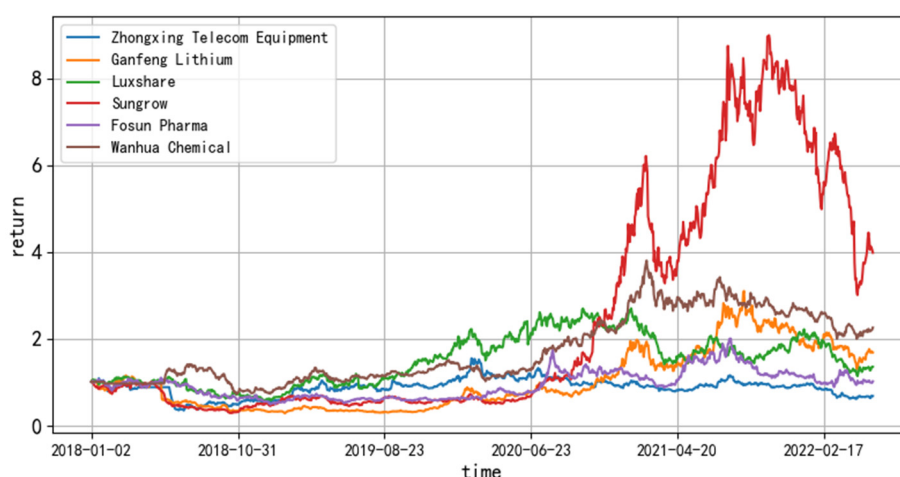


Figure 1. Changes in the returns of 6 stocks of listed manufacturing companies

From Figure 1, it can be observed that the two stocks of Sungrow and Wanhua Chemical have higher returns during the sample period, and are accompanied by higher volatility. ZTE and Fosun Pharma have lower returns during the sample period. The rest of the stocks have positive annual returns except ZTE. The changes in yield and volatility reflected in the picture are consistent with the performance in Table 2.

Table 2. Annualized returns and annualized volatility of 6 stocks in the manufacturing industry

Stock	ZTE	Ganfeng Lithium	Luxshare	Sungrow	Fosun Pharma	Wanhua Chemical
Return	-0.0940	0.1221	0.0700	0.3261	0.0026	0.1915
Volatility	0.4734	0.6132	0.5310	0.6380	0.4992	0.3977

Note: ZTE is short for Zhongxing Telecom Equipment.

Markowitz's Portfolio Theory states that if two securities are not completely correlated, the gains and losses can be offset by holding two securities at the same time, thereby reducing the volatility of portfolio. In this paper, the statistical correlation coefficient [7] is used to describe the correlation between the two securities, and the results are shown in Table 3.

Table 3. Correlation coefficients of 6 stocks in the manufacturing industry

	ZTE	Ganfeng Lithium	Luxshare	Sungrow	Fosun Pharma	Wanhua Chemical
ZTE	1.0000	-	-	-	-	-
Ganfeng Lithium	0.2687	1.0000	-	-	-	-
Luxshare	0.3878	0.2685	1.0000	-	-	-
Sungrow	0.2414	0.4028	0.2666	1.0000	-	-
Fosun Pharma	0.2368	0.2033	0.2263	0.2075	1.0000	-
Wanhua Chemical	0.2904	0.3069	0.3192	0.2467	0.2467	1.0000

Note: ZTE is short for Zhongxing Telecom Equipment.

It can be seen from Table 2 that the correlation coefficient between Ganfeng Lithium and Sungrow is the largest among the 6 stocks, which is 0.4028. Among the 6 stocks in the manufacturing industry that were initially screened, the correlation coefficients are all less than 0.5, which is suitable for investors to diversify Investment. The calculation results of the correlation coefficient suggest that investors should reduce the holding of assets with high correlation when allocating assets, so as to diversify the unsystematic risk of the investment portfolio.

2.4. Portfolio Construction

2.4.1. Efficient Frontier of Portfolio

It has been determined that the portfolio consists of 6 stocks, w_i represents the weight of stock i in the portfolio, and $E(R_i)$ represents the expected return of stock i in the portfolio, then the expected return of the portfolio can be obtained as follows.

$$E(R_p) = \sum_{i=1}^6 w_i E(R_i) \quad (1)$$

Assuming that σ_i represents the return volatility of stock i , and $Cov(R_i, R_j)$ represents the covariance between the returns of stock i and stock j , the return volatility of the portfolio σ_p is expressed as follows.

$$\sigma_p = \sqrt{\sum_{i=1}^6 \sum_{j=1}^6 w_i w_j Cov(R_i, R_j)} \quad (2)$$

In order to find the optimal investment portfolio and efficient frontier that meet the conditions, this paper uses Python to randomly generate 100,000 investment arrays containing different stock weights to calculate the annual average return and annual return volatility of different investment portfolios. The results are shown in Figure 2.

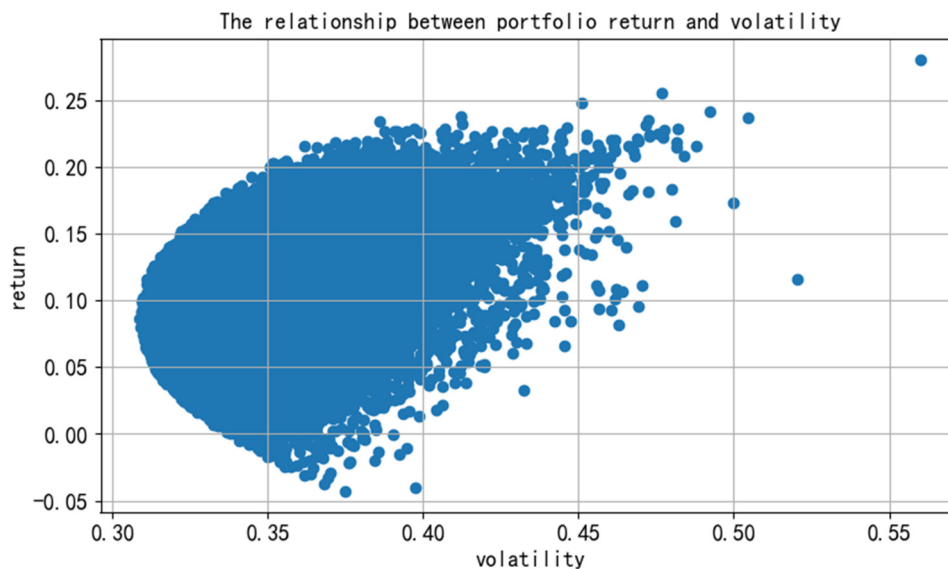


Figure 2. The relationship between portfolio return and volatility under the conditions of 100,000 randomly generated groups of different investment weights

According to the values of portfolio return and volatility simulated by the above method, it can be seen that the highest annual return of the portfolio exceeds 25%, and the highest annual volatility exceeds 0.5.

2.4.2. Determination of Optimal Portfolio Weights

In this paper, the Sharpe ratio [8] is used as the criterion for judging the pros and cons of a portfolio. In the actual investment process, two conditions must be met: ①the sum of the weights of each stock in the portfolio is 1; ②short-selling of stocks is not allowed.

The sample period of using Markowitz portfolio theory to determine the optimal portfolio is selected from January 2, 2018 to January 4, 2021, and the results of asset weighting of the optimal portfolio obtained by using Python tools are shown in Table 4.

Table 4. Asset Weighting of the Portfolio

Stock	Asset weight
Luxshare	9.93%
Sungrow	38.02%
Wanhua Chemical	52.05%

2.4.3. Tracking the CSI 300 Index

In order to test the validity of the constructed investment portfolio, this paper calculates the net value of the portfolio based on the daily closing prices of three stocks during the period from January 5, 2021 to May 30, 2022, and compares the yield changes of the two [9]. Set the net value or closing price of the first trading day on January 5, 2021 as 100 for calculation, and draw a graph to compare the daily net value of the portfolio and the closing price of CSI 300, as shown in Figure 3.

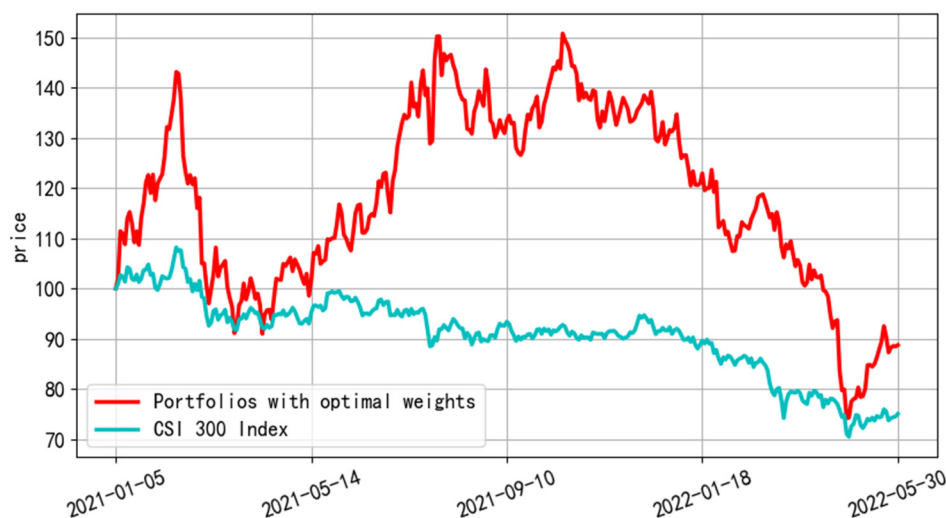


Figure 3. The daily chart of the portfolio with optimal weight allocation and the CSI 300 index

As can be seen from Figure 3, from the perspective of absolute return, the optimal investment portfolio constructed achieved positive returns in most of the time range of the sample period, and the highest exceeded 50%.

From the perspective of relative returns, the return of the asset portfolio allocated according to the optimal weight during the sample period significantly exceeds that of the CSI 300 Index, and the maximum return gap exceeds 60%. In the later stage of the sample, that is, starting from 2022, the gap between the two began to narrow. There are two main reasons. First, the new coronary pneumonia variant is rampant in China, industry was impacted greatly. Second, the Russian-Ukrainian conflict that broke out in February 2022 caused the prices of commodities such as grain and crude oil to rise globally, resulting in a sharp increase in the production costs of manufacturing enterprises. Besides, the continuous fermentation of serious geopolitical events has resulted in restrictions on the export of products of manufacturing enterprises.

3. Credit Risk Measurement of Listed Manufacturing Enterprises based on KMV Model

3.1. Research Ideas

Credit risk is one of several major financial risks faced by listed companies. Changes in credit risk affect investors' investment decisions, leading to changes in the company's cash flow and asset quality, which in turn lead to operational crises. Manufacturing enterprises occupy an absolutely important position in China's capital market. Their ability to resist risks is higher than that of listed companies in other industries, and they have certain core competitiveness. However, the prosperity of China's manufacturing enterprises relies on the improvement of upstream and downstream industrial chains. Once an operational crisis occurs, market investors and financial institutions such as banks will evaluate their credit risks based on the company's financial indicators. This chapter uses the KMV model [10] to analyze the expected default rates of the three listed companies determined by the Markowitz portfolio theory in the previous chapter, as a credit risk measurement tool to help investors determine whether the company defaults during the investment period.

3.2. KMV Model

The KMV model assumes that the market value of a firm is as follows:

$$E = V_a N(d_1) - D e^{-rt} N(d_2) \quad (3)$$

$$\sigma_E = \frac{V_a N(d_1) \sigma_a}{E} \quad (4)$$

$$d_1 = \frac{\ln(V_a / D) + (R_f + \frac{1}{2} \sigma_a^2) \tau}{\sigma_a \sqrt{\tau}} \quad (5)$$

$$d_2 = d_1 - \sigma_a \sqrt{\tau} \quad (6)$$

Among them, V_a represents the market value of corporate assets, E represents the equity value of corporate assets, D represents the debt value of the company, R_f represents the risk-free interest rate, σ_E and σ_a represent the volatility of corporate equity value and the volatility of market value respectively. τ is the debt term, and this paper sets the debt term as 1 year.

The second step is to define the default point. This paper sets the default point as the sum of short-term debt and 50% long-term debt, namely:

$$DP = SD + 50\% \times LD \quad (7)$$

Among them, DP is the default point of the corporate, SD is the short-term debt of the corporate, and LD is the long-term debt of the corporate.

The third step is to estimate the default distance (DD).

$$DD = \frac{E(V) - DP}{E(V) \sigma_a} \quad (8)$$

Finally, to estimate the Expected Default Frequency (EDF) of the corporate, assuming that the value of the corporate's assets follows a normal distribution, then:

$$EDF = N(-DD) = P\left\{-\frac{E(V) - DP}{E(V) \sigma_a} \leq \varepsilon\right\}, \varepsilon \sim N(0,1) \quad (9)$$

3.3. Measurement of Corporate Credit Risk

The equity value of the three companies is selected as the average value of equity from January 2, 2018 to May 30, 2022, and the long-term debt and short-term debt are from the financial statements and balance sheets announced by the companies in the first quarter of 2022. The equity value, long-term debt and short-term debt of the three companies are listed in Table 5.

Table 5. Statistics of long-term debt, short-term debt and equity value of enterprises (unit: CNY)

Stock	Long-term debt	Short-term debt	Equity value (average)
Luxshare	1.1187E+10	6.4684E+10	2.0537E+11
Sungrow	2.6251E+09	2.4112E+10	6.7367E+10
Wanhua Chemical	2.1294E+10	1.0885E+11	2.0172E+11

As can be seen from Table 5, Luxshare and Wanhua Chemical, as the leading enterprises in the manufacturing industry, have long-term and short-term debt reaching billions of dollars, and

their equity value is even more than tens of billions. As a company with high growth potential in the manufacturing industry, Sungrow maintains its debt level at a reasonable level in the industry.

The annual volatility of the three companies has been calculated as follows: 0.5310, 0.6380, and 0.3977. On the basis of Table 5, the company's market value, market value volatility, default point, and default distance are calculated by using MATLAB software. Debt default distance, combined with theoretical methods to calculate the default probability of enterprises, the calculation results are shown in Table 6.

Table 6. Calculation results of KMV model

Stock	Market value/CNY	Market value volatility	Default point/CNY	Default distance	Expected default frequency/%
Luxshare	2.7460E+11	0.3972	7.0278E+10	1.8734	3.05%
Sungrow	9.2397E+10	0.4657	2.5425E+10	1.5563	5.98%
Wanhua Chemical	3.1943E+11	0.2512	1.1949E+11	2.4922	0.63%

3.4. Analysis of Calculation Results

3.4.1. The Market Value of the Enterprise is Significantly Higher than the Value of the Enterprise Equity

Listed companies in the manufacturing industry have different business fields and different capital structures, but the market value calculated according to the KMV model is generally higher than the equity value. To a certain extent, it reflects that China is developing into a manufacturing power, and manufacturing enterprises have good value-added space and development prospects.

3.4.2. The Risk Difference of Listed Companies in the Manufacturing Industry is Relatively Large, and the Overall Risk is Relatively Small

The credit risk measurement results of the three companies calculated by the KMV model show that the default distances of the sample companies are quite different. Only Wanhua Chemical's default distance is greater than 2, and the default risk is the smallest. Based on the existing research results, it is shown that the overall credit risk of China's manufacturing enterprises is relatively small. But some enterprises have insufficient market confidence due to the short-term business crisis because of the influence of the macro economy.

4. Conclusion

As the concept of sustainable development is deeply rooted in the hearts of the people, ESG value investment is increasingly recognized by people. Besides, institutional investors tend to invest in socially responsible listed companies. Using the transaction data of CSI 300 listed manufacturing companies from January 2, 2018 to May 30, 2022, this paper empirically studies the investment value of the portfolio and finds that the investment benefit is much higher than that of the CSI 300 index over the same period. And the KMV model is used to test the credit risk of the portfolio, and it is concluded that the credit risk of listed manufacturing companies is lower than the overall credit risk.

The empirical research in this paper provides effective policy implications for developing ESG investment and promoting high-quality development. In the context of China's "dual carbon" goal, the active performance of social responsibilities by manufacturing enterprises has a positive incentive for the country to implement the "dual carbon" goal. The results of this paper are helpful for investors to design investment strategies, which also provide a theoretical basis

for relevant government departments to formulate industrial policies and implement sustainable development strategies.

Acknowledgments

This work is supported by the College Student Innovation and Entrepreneurship Training Program of Anhui University of Finance and Economics (No. 202110378024).

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