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An Empirical Study of CAPM's Applicability to Rare Earth Permanent Magnet Material Stocks

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Abstract: China has the world's largest reserves of rare earth elements. Rare earth permanent magnet material has always been one of the popular industries in the investment market. CAPM is the basic asset-pricing model in financial economics. There are a number of studies conducted to examine the applicability of CAPM to stock markets in different industries and to investigate the modification method to improve the model's prediction accuracy. In this study, seven leading enterprises in China's rare earth permanent magnet material industry listed on the A-share market were selected as the research subjects. Based on CAPM, regression analysis was conducted on the monthly data from March 2016 to February 2022. The results demonstrated that using the β coefficient to explain the risk of China's rare earth permanent magnet industry is ineffective. The ultimate benefit was less affected by market indexes but mainly by non-systematic risks. CAPM has low applicability to China's rare earth permanent magnet material industry and requires further improvement. Nevertheless, CAPM still has some guiding significance in making enterprise comparisons and investment decisions.

Keywords: CAPM; Rare earth permanent magnet material; Investment; Stock market; Systematic risk

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1. Introduction

Rare earth permanent magnet material represented by NdFeB is the strongest magnetic material in current technical applications [1,2]. It can be widely used in information communication, consumer electronics, energy-saving household appliances, wind power generation, new energy vehicles, magnetic levitation trains, variable frequency air conditioning, aerospace, and many other fields. It can aid in equipment miniaturization and weight reduction. The market prospect is very broad. China has the most abundant rare earth resources and the largest production of magnet materials in the world. As an important industry for China's national development, rare earth permanent magnet materials are in a period of rapid development. There are a number of recognized listed leading enterprises related to this industry, including Antai Technology, Zhongke Sanhuan, Yinhe Magnet, Zhenghai Magnet, etc. They not only play an important role in enhancing the core competitiveness of China's magnet materials industry, but also bring benefits and investment returns to investors. The rare earth permanent magnet material industry has always been one of the popular industries in the investment market.

The CAPM (capital asset pricing model) was proposed by American economist Sharpe in 1964 [3]. It studies the relationship between the expected rate of return of a single asset and the rate of return of capital market portfolio. It states that the return on each risky security or portfolio is the risk-free rate plus a risk premium for investing in the risky security. Although the establishment of CAPM has a series of additional assumptions resulting its empirical flaws, CAPM remains popular due to its simplicity and utility in various

situations. There are a number of empirical studies examining the applicability of CAPM in China's stock market. Most of them conclude that CAPM is not fully applicable and requires further improvement. Wang summarized the general statistical test methods, hypothesis conditions, and common indicators for the systematic discussion of CAPM [4]. Gao compared the differences in using SSE Composite Index and GDP as the market return index in different industries [5]. Zhu pointed out that the empirical study showed different results in different time periods, which reflects the particularity of China's capital market – immature, retail investors as the main body, strong short-term speculation by investors, lack of market exit mechanisms, and strong influence of government policies [6]. More detailed empirical studies have been conducted in recent years. In another study [7], 50 stocks on Shanghai A-share market were selected, and the study concluded that CAPM is not applicable to China's A-share market. Most A-share stocks listed in Shanghai Stock Exchange are offensive stocks, which are suitable for risk-seeking investors. Wang and Chen tested the model using the data of more than 20 liquor enterprises, and showed that other non-market factors greatly affect the individual stock benefit [8,9]. Empirical studies on China's semiconductor and transportation logistics enterprises were conducted, respectively, and the studies concluded that β coefficient has little explanatory power to the risk, while non-system risk plays a significant role; therefore, CAPM is not suitable for evaluating the performance of semiconductor or transportation logistics stocks [10,11]. In view of the inaccuracy of CAPM in asset pricing, research has been carried out to examine the model's modification and improvement methods from different perspectives [12], which has become another popular research topic.

This is an empirical study on the applicability of CAPM to the stocks of rare earth permanent magnet materials industry. Seven leading enterprises listed on the A-share market were selected as the research subjects. The monthly frequency data from March 2016 to February 2022 were used for regression analysis based on CAPM to examine its applicability and to determine whether CAPM can effectively conduct investment analysis in this field, as well as to provide reference for model modification in future research.

2. Data and methods

2.1. Measurement model

CAPM describes the relationship between systematic risk and expected return for assets, particularly stocks. Based on a set of additional basic assumptions, CAPM describes a positive linear relationship between the expected return of investment and the related risks in the context of a portfolio.

The equation for calculating the expected return of an asset is as follows:

$$E(Ri) = Rf + \beta i\,[E(Rm) - Rf] \quad (1)$$

E(Ri) is the expected return of investment, *Rf* is the risk-free interest rate, *[E(Rm)−Rf]* is the market risk premium, and *βi* refers to the beta coefficient of the *i*-th asset, which indicates the degree of the systematic risk of investing in an asset. It is used to express the relationship between the return rate of investment in a certain asset and the return rate of market portfolio.

2.2. Source of data and data processing

This study selected seven leading enterprises in China's rare earth permanent magnet material industry listed in the A-share market, including Antai Technology (000969), Zhongke Sanhuan (000970), Zhenghai Magnet (300224), Jinli Permanent Magnet (300748), Ningbo Yunsheng (600366), Yinhe Magnet (300127), and Yingluohua (000795). The monthly closing price data from March 2016 to February 2022 of the aforementioned stocks were taken from Sohu Securities.

The formula for calculating the return rate of individual investment is as follows:

$$Rt = (Pt - Pt-1)/Pt-1 \quad (2)$$

Rt is the return on the security at the end of month *t*, *Pt* is the closing price of the security at the end of month *t*, *Pt−1* represents the closing price of the security at the end of month *t*-1.

The calculation for the market rate of return is as follows:

$$Rmt = (Pmt - Pmt\text{-}1)/Pmt\text{-}1 \quad (3)$$

Rmt is the return rate of market portfolio at the end of month *t*, *Pmt* is the closing price of the market portfolio at the end of month *t*, *Pmt-1* is the closing price of the market portfolio at the end of month *t*-1.

The samples studied were listed in the Shanghai and Shenzhen Stock Exchanges. Hence, the average monthly return rates of Shanghai Composite Index and Shenzhen Component Index corresponding to the same time period were taken as the comprehensive market return rates. The data were taken from Sohu Securities.

As government bonds have no risk of default, this analysis used the average interest rate of one-year treasury bonds from March 2016 to February 2022 of 2.642% as the risk-free rate of return, and the comparable monthly interest rate of 0.2202%. The information was gathered from Investing.com.

3. Empirical study and results

3.1. Basic regression analysis

EViews 8.0 was used to fit the sample data with the OLS method. Based on formula (1), the linear regression equation between the monthly return rate of individual investment and the comprehensive market return rate was established. The correlation results are shown in **Table 1**. **Figure 1** shows the scatter diagram of three representative securities (Antai Technology, Jinli Permanent Magnet, and Yinhe Magnet), showing the relationship between the independent variable (composite market return rate) and dependent variable (return rate of corresponding security).

Table 1. Securities with β coefficient and R square values calculated from March 2016 to February 2022

Stock	Securities	βCoefficient	R Square	Prob (F-statistic)
000969	Antai Technology	1.1033	0.1667	0.0004
000970	Zhongke Sanhuan	0.7778	0.0926	0.0099
300224	Zhenghai Magnet	1.0046	0.0605	0.0387
300748	Jinli Permanent Magnet	-2.3652	0.0941	0.0511
600366	Ningbo Yunsheng	0.6354	0.0319	0.1360
300127	Yinhe Magnet	0.5874	0.0309	0.1420
000795	Yingluohua	0.4568	0.0114	0.3764

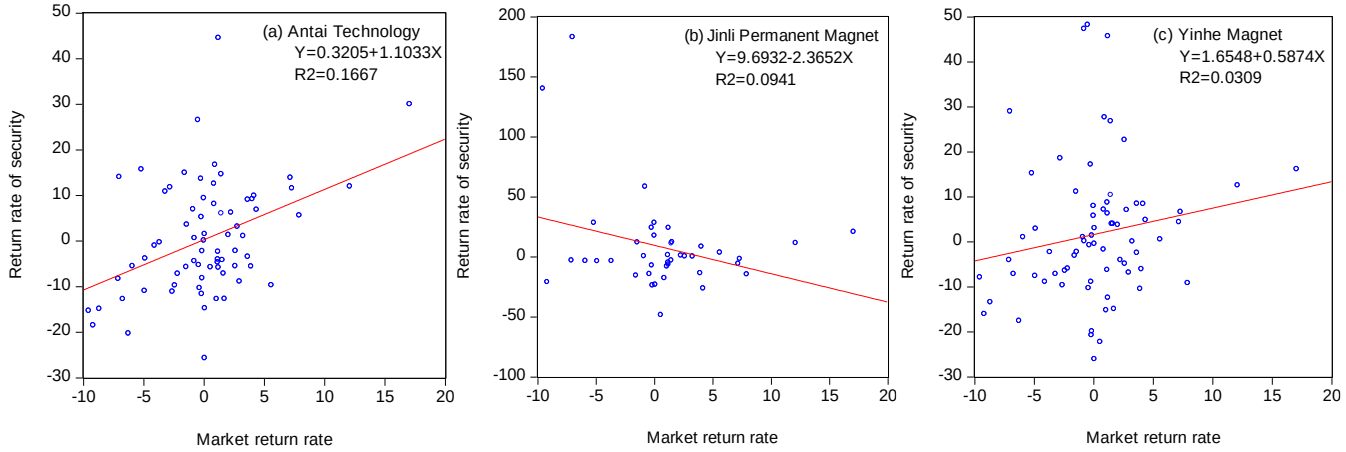

Figure 1. Scatter diagram of three securities from March 2016 to February 2022

In May 2019, the rare earth industry was announced as an important strategic resource in China. The policy has an immediate impact on the profitability of related enterprises. The data on May 31, 2019, showed that although the return rate of the composite market in that month was -6.8035, the overall return rates of the seven stocks were high and well above their average values. The overall return rate of Antai Technology was 14.0485, Zhongke Sanhuan was 26.3415, Zhenghai Magnet was 32.2337, Jinli Permanent Magnet was 183.2068, Ningbo Yunsheng was 33.4333, Yinhe Magnet was 29.0119, and Yingluohua was 91.1638.

In order to compare the market changes before and after the introduction of policies, this study divided the data into two periods (before and after May 2019). OLS was used to fit the sample data of two parts, respectively, and the results are shown in **Table 2**. **Figure 2** shows the scatter diagram of one security (Zhongke Sanhuan) as an example, with monthly data from (a) March 2016 to February 2022, (b) March 2016 to April 2019, and (c) June 2019 to February 2022. The changes in the two periods are clearly shown in the regression results.

Table 2. β coefficient and R square values calculated from March 2016 to April 2019 and from June 2019 to February 2022

Securities	**β**	**R square**	**Prob**	**β**	**R square**	**Prob**
	March 2016 to April 2019			June 2019 to February 2022		
Antai Technology	1.2816	0.2603	0.0011	0.8861	0.0869	0.1015
Zhongke Sanhuan	1.0057	0.1656	0.0112	0.5208	0.0379	0.2851
Zhenghai Magnet	0.7683	0.0562	0.1517	1.2314	0.0583	0.1829
Jinli Permanent Magnet	-	-	-	-0.0916	0.0004	0.9164
Ningbo Yunsheng	1.0578	0.1274	0.0278	-0.0987	0.0005	0.9010
Yinhe Magnet	0.7131	0.0658	0.1199	0.3141	0.0062	0.6686
Yingluohua	0.3889	0.0102	0.5456	0.6077	0.0155	0.4969

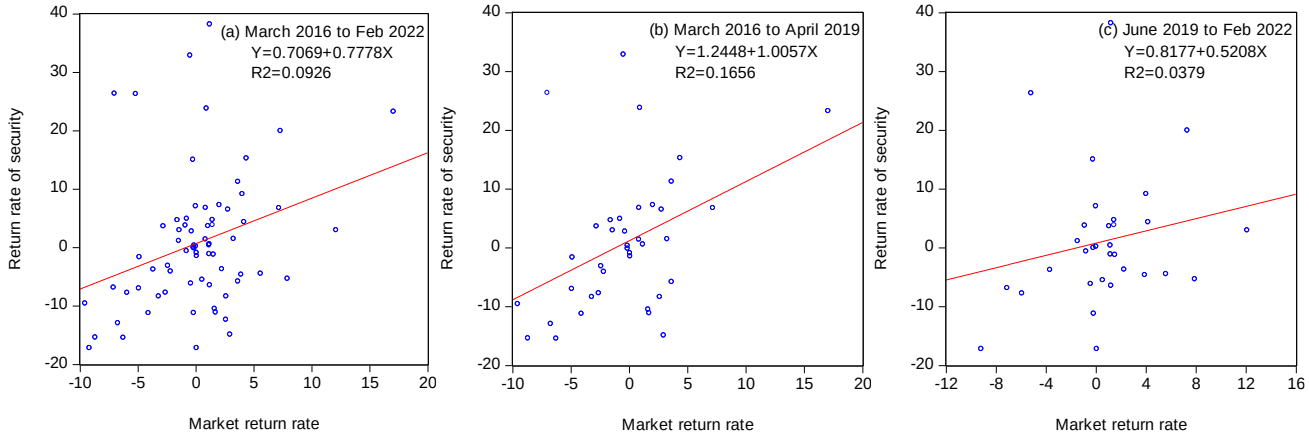

Figure 2. Scatter diagrams of Zhongke Sanhuan in three periods

3.2. β coefficient

Under traditional theoretical assumptions, CAPM uses β coefficient to measure the relationship between the systematic risk of investing in an asset and the change of market portfolio return rate. If $0 < \beta < 1$, it means that the change of return on investment of the asset is smaller than the change of return on market portfolio. The expected return on investment is then lower than the market average. The asset is known as a defensive asset, which carries less risk for investors. If $\beta > 1$, it means that the return on investment of the asset is greater than the return on market portfolio. The expected return on investment in this asset is then higher than the market average. This asset is known as an offensive asset. The change of its price is easily affected by the change in market index. Speculative stocks are suitable for risk-seeking investors.

From **Table 1** and **Table 2**, the β coefficient values of the seven stocks can be seen based on CAPM. However, to verify the practical significance of β coefficient, a linear correlation test of the model is still necessary to determine whether these linear fittings are statistically significant.

3.3. Coefficient of determination, R^2

The coefficient of determination, R^2, measures the goodness of fit of the regression equation and indicates the degree to which the β coefficient can represent the linear relationship between the explanatory variable and the explained variable. Its value determines the proportion of systematic risk in the total risk, which reflects how much the change of stock price is caused by the change of market index.

It can be seen from **Table 1** that the determination coefficients are all relatively low. The highest R^2 value is only 0.1667 (Antai Technology), indicating that the fit of the regression equation is rather poor. Although the linear relationship of the model is significant for three stocks among the seven as discussed above, the low R^2 value (far less than 0.5) indicates that the β coefficient still cannot effectively explain the changes of stock returns. Obviously, there is a high proportion of other factors affecting the stock return rate in the rare earth permanent magnet material industry. Overall, the stock price changes are less affected by market indexes but mainly by non-systematic risks and determined by the company's own operating conditions.

4. Discussion

From the above empirical study results, there are several key findings.

(1) Only a few enterprises can pass the linear relationship test of the CAPM; however, their determination coefficients are all very low, so the β coefficient is not practical for the studied industry, where non-systematic risks play a dominant role. It is biased to use CAPM to evaluate the returns of related stocks in the rare earth permanent magnet material industry in China. In addition to the error factors caused by

the unsatisfied assumptions of the model, the inapplicability is greatly influenced by the changes of national industrial policies and other factors.

(2) The performance of different enterprises varies greatly. Some enterprises show a wider range of fluctuation. For instance, the highest monthly return rate of Jinli Permanent Magnet was 183.2068 in May 2019, which is three times its average level, while some other enterprises show relatively stable performance. In spite of this, the type of enterprise can be roughly distinguished from the β value and other indicators, which have some guiding significance for investment judgment. For example, the β and R^2 values of Antai Technology and Zhongke Sanhuan are both relatively high, and their *p* values pass the significance verification. In that case, their overall performances are possibly more robust than other enterprises. This may be due to the nature of their state-owned enterprises. From this perspective, CAPM still has some guiding significance in making investment decisions.

(3) In light of the existing lack of model applicability to China's rare earth permanent magnet material industry, greater attention should be paid to the influence of non-market factors, especially for those enterprises where all the indicators are irregular. In investment decisions, it is necessary to measure the non-systematic risks, including the timely grasp of industrial policy changes, and the insight into the enterprise's own development capabilities, the nature and operation characteristics, credit risk, financial risk, and so on.

5. Conclusion

In conclusion, the CAPM has low applicability to China's rare earth permanent magnet material industry. The influencing factors are the non-systematic factors of the enterprise's own operating conditions, as well as from the industrial policy level and other complex aspects contrary to the assumptions of the model. Modifying the model to improve its predictive accuracy is challenging for future research work. Nevertheless, by comprehensive analysis and reference of various indicators, CAPM is still of some guiding significance in making enterprise comparisons and investment decisions.

Disclosure statement

The author declares no conflict of interest.

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