Performance Evaluation of New Energy Fund Based on Factor Model

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Abstract. In recent years, China's fund industry has developed rapidly, especially in the new energy sector, which has shown highly promising prospects under the promotion of carbon neutral policies. However, due to the late start of China's fund industry and the paucity of research on fund performance in the new energy industry, the performance evaluation of new energy stock funds is particularly crucial. This paper mainly used the Treynor-Mazuy model and the Sharpe ratio of the fund to evaluate the stock selectivity and timing ability of China's new energy stock fund companies. Then, through factor analysis and principal component analysis, a new evaluation index was created to assess the comprehensive ability of fund managers. This research is intended to aid investors in evaluating and selecting funds, optimizing investment decisions, and promoting the rationalization and standardization of the market for new energy stock fund.

Keywords: Factor model; Performance evaluation; Selectivity; Market timing ability

1 Introduction

China's fund industry is developing rapidly, however, compared to mature foreign capital markets, there is a certain information asymmetry in the disclosure of the real performance of equity funds and the deep-seated reasons behind it. Consequently, it is crucial to establish a comprehensive and scientific fund performance evaluation system. Firstly, fund investors often have a limited understanding of the risks and sources of returns associated with the funds they purchase, compared to the returns. Therefore, the evaluation of the fund's performance can help them not only understand the risk and income status of the fund at an early stage, but also judge the actual management ability of the manager and the future performance level of the fund, ultimately achieving the goal of selecting the target investment fund more effectively. Secondly, for fund managers, fund performance evaluation is timely feedback on their investment operation status in the past time period, which enables them to understand the source of the excess

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performance of the funds they manage and whether the investment strategy adopted is effective, thereby providing a solid foundation for them to dynamically adjust their future investment strategies.

New energy equity funds in China have grown rapidly in recent years, and against this backdrop, it has become increasingly important to assess the performance of new energy funds. From the standpoint of performance attribution, scholars gradually achieved the separation of fund performance and discussed selectivity and timing ability separately through the establishment of the CAPM model and later Treynor and Mazuy's T-M model by adding the quadratic term of excess return to the CAPM model. Later, after the improvement of Roy D. Henriksson and Robert C. Merton (1981), the H-M model was further developed. Based on the above-mentioned model and theoretical basis, this paper conducted an objective evaluation and comprehensive analysis of the selectivity of fund managers. According to the evaluation results, investors can enhance their level of decision-making, select an appropriate fund portfolio, and maximize investment returns. On the other side, fund managers could recognize their own management deficiencies and improve the market performance of their managed funds. A reasonable evaluation system for the entire fund market is conducive to the timely and effective supervision and testing of funds by market regulators, promotes the standardization and rationalization of the fund industry, facilitates the realization of the survival law of the survival of the fittest market, and finally encourages more fund managers to enhance their investment capacity.

In recent years, an increasing number of scholars have applied mature foreign evaluation models to fund performance evaluation in China. However, based on the number of publications in the literature, the evaluation reports for the new energy industry are relatively insufficient, and considering that among them, equity funds have the characteristics of less volatile industry indices, lower thresholds, lower tax rates for over-the-counter transactions, and relatively transparent over-the-counter. Hence, this paper selected new energy equity funds for the evaluation of fund selectivity and timing ability, with the intention of enhancing the model methods for fund performance evaluation in China.

This paper empirically illustrated that for the consideration of data volume and data accuracy, 45 new energy equity funds issued in China from 2014 to June 2021 are selected as research targets, and the data uses the monthly return of the fund and the performance of the Shanghai index. Regarding model selection, this paper first combined the CAPM model and the T-M model to determine the external market performance, and then combined the Fama-French 3-factor model and the H-M model to examine the fund manager's timing and selectivity. In terms of model evaluation, the Sharpe Ratio is used to measure the fund manager's weight design capabilities, and it is used together with the excess return construction index to evaluate the selectivity. Lastly, the principal component analysis is utilized to evaluate the fund manager's comprehensive ability. Compared to the typical system of comparing timing and selectivity in previous research, the evaluation system proposed in this study considered the fund's risk-return ratio and the influence of risk variables, thereby constructing a new system for evaluating energy stock funds. It is more rational and can prevent a degree of prejudice in performance evaluation.

The structure of this paper adopts the evaluation structure, narrated through 5 parts, followed by abstract, introduction, related work, method, discussion, and conclusion.

2 Related works

2.1 Related work on New energy equity fund development prospects

According to statistics, from 2014 to June 2021, the industry issued a total of 1,512 equity funds, of which only 45 were for the new energy business. Meanwhile, other industries were significantly larger than the new energy industry; for instance, there were 154 equity funds in the medical industry and 86 in the consumer market. It can be observed from the overall number of equity funds that there is a great potential for the development of new energy equity funds.

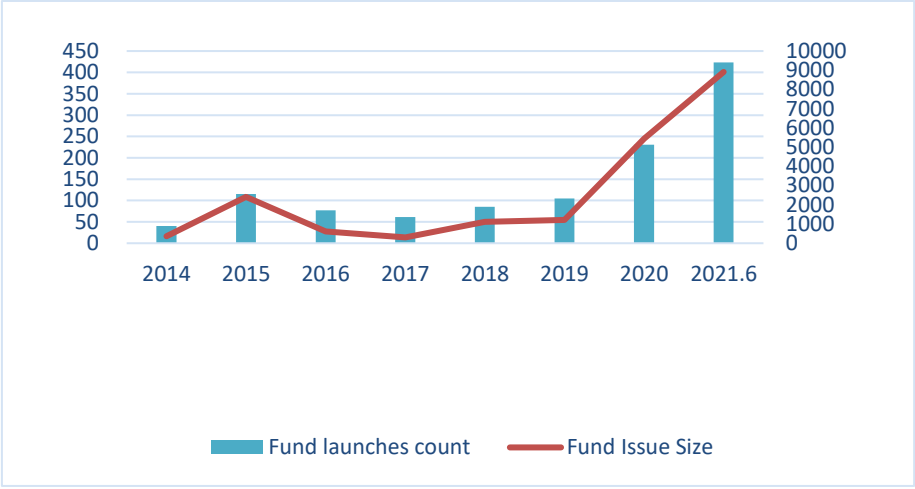

Fig. 1. 2014-2021.6 New Energy Equity Fund Issuance Count and Issuance Scale. (self drawing)

As shown in Figure 1, new energy equity funds exhibited a general upward trend, especially between 2019-2021, the number of new energy funds issued and issue size have achieved exponential growth, which can be concluded that new energy equity funds have a very broad market prospect.

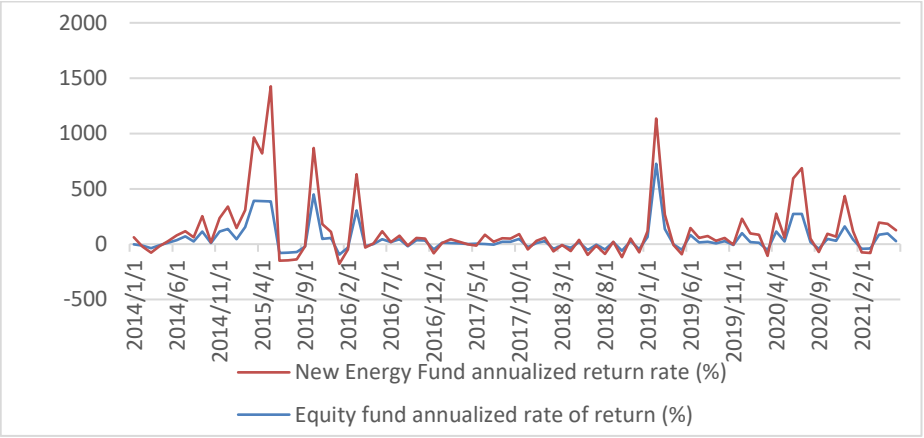

Fig. 2. Comparison of annualized returns of the overall equity funds and new energy equity funds. (self drawing)

As shown in Figures 2, the difference between the annualized returns of the new energy equity funds over the time period 2014-2021.5 is positive for most of the time, representing a better return performance of the new energy equity funds than the overall equity funds, and far outperforming the overall equity funds during the stock market boom period.

2.2 Related work on factor models

Since introducing various advanced mathematical methods, asset pricing has developed rapidly and pricing models for various financial assets have emerged. Among them, Markowitz's portfolio theory and CAPM theory are the basis of various asset pricing theories.

Markowitz introduced the theory of portfolio selection, which pioneered the mean-variance analysis by combining return and risk to construct a portfolio frontier and laid the foundation for the development of later models [1]. Sharpe devised the beta coefficient for evaluating the risk tolerance of individual securities and proposed the famous CAPM model, thus made asset pricing possible [2]. Ross relaxed the overly stringent assumptions of the CAPM model based on the CAPM model and multi-factor analysis, such as all investors can borrow or lend money without restriction at risk-free rates, all investors seek to maximize the expected utility of single-period wealth, and portfolio selection is based on the expected return and standard deviation of each alternative portfolio, etc. The APT arbitrage model was also proposed by Ross sebsequantly [3]. Fama and French proposed the Fama-French three-factor model by combining the CAPM model and the APT model to attribute portfolio returns to the market risk factor, the size factor, and the book-to-market ratio factor [4]. Carhart created the Carhart four-factor model by adding a momentum factor that examines performance persistence to the FF three-factor model [5]. Fama and French added profitability factor and investment capacity factor to the Fama-French three-factor model to construct the Fama-

French five-factor model and tested it empirically [6]. The results pointed out that the performance of the model was less sensitive to the way the factors were constructed and the book-to-market ratio factor became less significant Fama and French further investigated and empirically tested the Fama-French five-factor model, indicating that the factors with stronger explanatory power in the cross-sectional regressions contribute less to the incremental average investment returns and that the maximum Sharpe ratio in the GRS statistical test provides only little information if no restrictions are placed on the portfolio weights [7]. Fama and French empirically tested the Fama-French five-factor model on global markets and showed that the book-to-market ratio factor and the profitability factor had a significant impact on average stock returns in North America, Europe, and Asia-Pacific, while the investment capacity factor was irrelevant, and that average stock returns in Japan were significantly correlated with the book-to-market ratio factor, while the profitability factor and investment capacity factors were not relevant [8].

A series of domestic studies have been conducted on CAPM model and factor model, but due to the late introduction of Fama-French five-factor model, most of the relevant studies are on CAPM model, Fama-French three-factor model and Carhart model, and they mainly study the applicability of the model to China's capital market and explore other influencing factors.

After reviewing the relevant literature, this study found that there is little literature in academia that analyzes the fund market from the perspective of asset pricing models, and only Yang has done an in-depth analysis of the fund company, fund manager, historical performance, and selectivity and timing ability of the Shanghai Investment Morgan Medical Fund. Consequently, the paper first updated and supplemented the previous factor model with data from the post-share reform of China's new energy fund market, and then applied it to new energy funds based on the factor model, which is in line with the research ideas of domestic and international scholars on the theory.

2.3 Related work on fund performance evaluation

Fund performance analysis has been an important area in financial research and an important direction for the practical application of asset pricing models. The early fund performance analysis was mostly the absolute return analysis of funds. In recent years, with the rapid expansion of SME and GEM boards, the new supply is mainly concentrated in emerging industries, while the new energy industry is supported by the state's policy and has become a key investment target for investors.

The current domestic academic literature on the performance evaluation of related funds is also dominated by the CAMP model, where fund managers tend to choose different positions and asset allocations depending on market conditions. This could be manifested as: When the market conditions are good, fund managers want their returns to be higher than when the market conditions are poor. Based on this, this paper adapted the CAPM model to better suit the real situation and reflect whether the fund manager has good timing ability. Based on this, scholars have developed the TM quadratic model and HM binomial model.

Studies on fund managers' timing and selectivity were conducted mainly on the TM quadratic model proposed by Treynor, Mazuy and the simpler HM binomial model proposed by Henriksson, Merton after that. They described the β values in the model by splitting them and using different coefficients in different market environments in order to reflect different market changes [9,10]. After Treynor, Mazuy and Henriksson, Merton, numerous scholars have adopted a similar approach to study the selectivity and timing ability of fund managers based on the CAPM model. The research directions of domestic and foreign scholars are summarized as follows:

First, starting from around 2000, a group of scholars applied the models represented by TM quadratic model and HM binomial model to A-shares to study the timing and stock picking ability of funds investing in China. The data of Shen Weitao and Huang Xing-Twin show that fund managers can achieve market-beating investment performance and have some stock-picking ability [11]. The study by Xuefa Lu and Gujun Yan shows that several evaluation methods are consistent in terms of results, but neither selectivity nor timing ability of fund managers are obvious [12]. Qi, Yue and Sun, Xinming find that funds issued by the top ten fund managers in China have largely failed to invest according to their investment style and generally underperformed [13]. In summary, different studies choose various time periods and fund portfolios, which reflect inconsistent conclusions.

Second, the TM quadratic model and the HM binomial model are combined with other models to develop new models to better study the investment performance evaluation of funds. Chang Rong empirically analyzed the performance of selected funds using HM model to test the dynamic asset allocation ability of fund managers [14]. From the data of the study, the selected sample funds are basically unable to predict the market and grasp the timing, that is, they generally do not have dynamic asset allocation ability. Shi jihua, Yang Leiyuan, and Tsai Zelin analyzed the performance sustainability of equity fund managers, and while in the short run, fund managers can basically achieve sustainable profits, the medium run does not support this result [15]. This reflects the inability of fund managers to consistently outperform the broad market.

Third, the applicability of TM quadratic model and HM binomial model in A-share market and the effectiveness of different evaluation methods are investigated. Zhang Wenzhang and Chen Xiangmin designed more than 500 different methods to explore whether different evaluation methods can affect the final performance evaluation [16,17]. The data show that different evaluation methods produce different performance evaluation results.

It is already evident from many domestic and international studies that the use of timing models, which can visually monitor a fund's timing ability and selectivity, is a more mature approach. From the conclusion, basically all funds lack timing ability, and only some funds have selectivity. From the current practice, some foreign funds have abandoned timing and focused on selectivity, which also reflects the guiding effect of this theoretical research on practice. From the current status of research in China, the domestic theoretical community mainly uses TM model and HM model in combination with other methods to describe the fund’s timing ability and selectivity more accurately. And there is no relevant literature in China to study about the use of factor models in China's new energy fund market. This paper used the TM model and HM model as the

basis to build a reasonable evaluation system for new energy funds, so as to evaluate the business ability of fund managers in a more diversified way, help investors choose fund managers that suit their style, and ultimately promote the long and stable development of the new energy market.

3 Method

Since Sharpe, a variety of methods have been used to evaluate the performance of funds [2]. Most models were developed from the Jensen Alpha model, which is:

$$r_i = \alpha_i + \beta_i(r_m - r_f) + r_f, \quad (1)$$

Where r_f is the risk-free rate of return, α_i is the effect of the fund manager's personal ability on the fund's return during this period, and β_i is the effect of the external environment on just the return during this period. The effect of β_i has been described using a considerable number of models, such as the Fama-French 3-factor model, the Fama-French 5-factor model, and Carhart's 4-factor model, among others. This paper is more concerned with fund returns of r_m component, and there are quite a few measures of individual fund managers' ability [4-6]. In this paper, the Treynor-Mazuy model and Henriksson-Merton model was utilized to measure the fund manager's timing ability and selectivity and use the Sharpe ratio of a fund to measure the fund manager's return to risk [9,10]. Finally, this paper designed an evaluation index that can be used to evaluate the individual ability of existing fund managers.

3.1 Evaluating Timing Ability and Selectivity

According to the model proposed by Treynor and Mazuy to test the fund manager's timing ability, combined with the Capital Asset Pricing Model (CAPM), the return obtained by the fund can be described by the following equation [5]:

$$r_p = r_f + \beta_{1,p}(r_m - r_f) + \beta_{2,p,TM}(r_m - r_f)^2 + \alpha_{p,TM} \quad (2)$$

Where r_p is the fund's return, $\beta_{1,p}$ can measure the impact of the market on the fund, $\beta_{2,p,TM}$ is the fund manager's timing ability, and α_p is used to evaluate the fund manager's selectivity.

Considering the market behaviour, Henriksson and Merton design a new model to measure fund managers' timing ability and selectivity [10].

$$r_p = r_f + \beta_{1,p}(r_m - r_f) + \beta_{2,p,HM}(r_m - r_f)^2 D + \alpha_{p,HM}, \quad (3)$$

where r_p is the fund's return, $\beta_{1,p}$ can measure the impact of the market on the fund, $\beta_{2,p,HM}$ is the fund manager's timing ability, D is 1 when $r_m - r_f > 0$, D is 0 when $r_m - r_f \leq 0$, and $\alpha_{p,HM}$ indicates the fund manager's selectivity.

3.2 Sharpe Ratio

The most used measure of risk factors is the Sharpe ratio. Since its introduction by Sharpe, this metric has been widely used in research and investment. It is calculated as follows:

$$\text{Sharpe Ratio} = \frac{r_p - r_f}{\sigma p}. \tag{4}$$

This metric represents the risk-return ratio of different portfolios. By comparing this metric, the fund manager's ability to design portfolio weights can also be obtained.

3.3 Evaluate overall competence

All variables for this study are listed in Table 1. To reduce the dimensionality of the data, this paper used principal component analysis to reduce the data to three dimensions F_i, $(i = 1,2,3)$. Explained variance ratio of F_i is λ_i. The comprehensive evaluation indicator G can be written as

$$G = \frac{\sum_{i=1}^{3} F_i \lambda_i}{\sum_{i=1}^{3} \lambda_i}. \tag{5}$$

Table 1. Evaluation methods and their index. (self-drawing)

Index	Variables	Description
$f_{1,p}$	$\alpha_{p,TM}$ (T-M model)	Selectivity of fund p in the T-M model
$f_{2,p}$	$\beta_{2,p,TM}$ (T-M model)	Timing of fund p ability in the T-M model
$f_{3,p}$	$\alpha_{p,HM}$ (H-M model)	Selectivity of fund p in the H-M model
$f_{4,p}$	$\beta_{2,p,HM}$ (H-M model)	Timing ability of fund p in the H-M model
$f_{5,p}$	Sharpe Ratio	The ratio of profit to risk of fund p

3.4 Data Sources

The accounting data and returns of all 45 and 1-Year Treasury Bond Yield are obtained from WIND database. Due to the influence of share-structure reform on the Chinese

fund market, there was a clear difference in the performance of the market before and after the reform [17]. Therefore, this paper choses the data from Jan 2014 to Jun 2021. For researches of the Chinese fund market, the SSE index is usually chosen as the market return. However, the SSE index is not suitable for this paper for three reasons. 1) The TM and HM models obey Efficient Market Hypothesis (EMH). However, the components of the SSE are mostly Chinese state-owned enterprises, which usually do not satisfy this hypothesis. 2) For the 45 funds used in this paper, the top 10 holdings in each fund's position accounted for the fund's long position. Among these 450 stocks, 297 stocks were selected to be listed on the Shenzhen exchange, accounting for 66%, while only 151 stocks were listed in Shanghai, accounting for only 34%. 3) As of July 2022, there are 186 new-energy type stocks listed in China, and 118 stocks (63%) are selected to be listed in Shenzhen, while 68 stocks (37%) are selected to be listed in Shanghai. Combining these reasons, this paper selected the SZSE index as the market return.

4 Discussion

Through the third part of the empirical analysis, this paper evaluated the selectivity, timing ability and overall ability of the 45 selected new energy equity funds based on the TM and HM models as shown in Table 2.

Table 2. Selectivity and Timing ability of 45 funds. (self-drawing)

Fund Code	Selectivity TM	Timing TM	Selectivity HM	Timing HM
005669	0.48	-0.31	0.43	-0.40
012445	0.05	0.17	0.20	0.22
009147	0.84	-0.29	0.62	-0.43
⋮	⋮	⋮	⋮	⋮
015048	0.59	-0.16	0.43	-0.07
015196	0.82	-0.60	0.63	-0.85

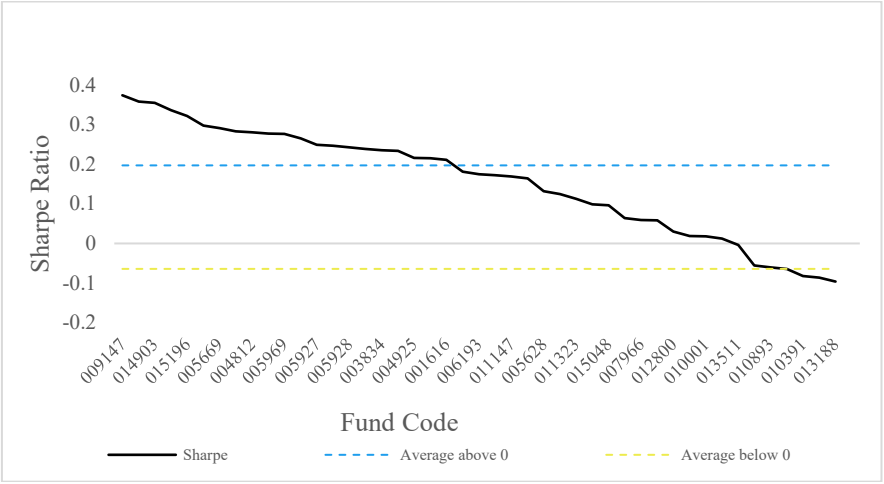

Fig. 3. Sharpe Ratio of 45 funds (self-drawing)

As shown in Figure 3, the Sharpe ratios of most funds are greater than 0, indicating that most new energy equity funds can earn returns while taking risks.

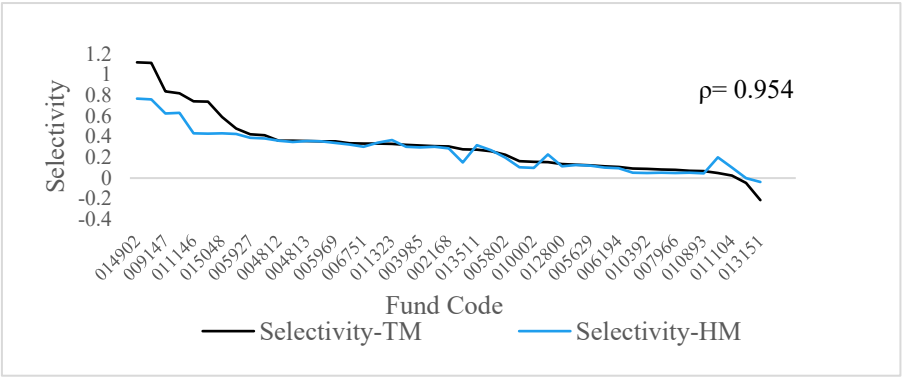

Fig. 4. Selectivity obtained by fitting the TM model and HM model. (self-drawing)

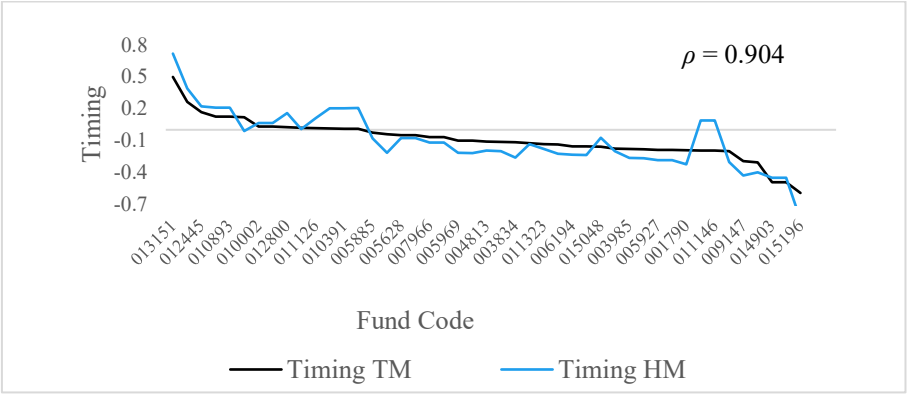

Fig. 5. Timing ability obtained by fitting the TM model and HM model. (self-drawing)

According to Figures 4 and 5, after analyzing the correlation between the TM and HM models on the timing and selectivity of 45 new energy equity funds, it is found that the correlation coefficients of the two models are very high and the trend of the lines in the graph is basically the same, representing that both the TM and HM models can effectively analyze and explain the timing and selectivity of the funds, and there is no big difference between the TM and HM models.

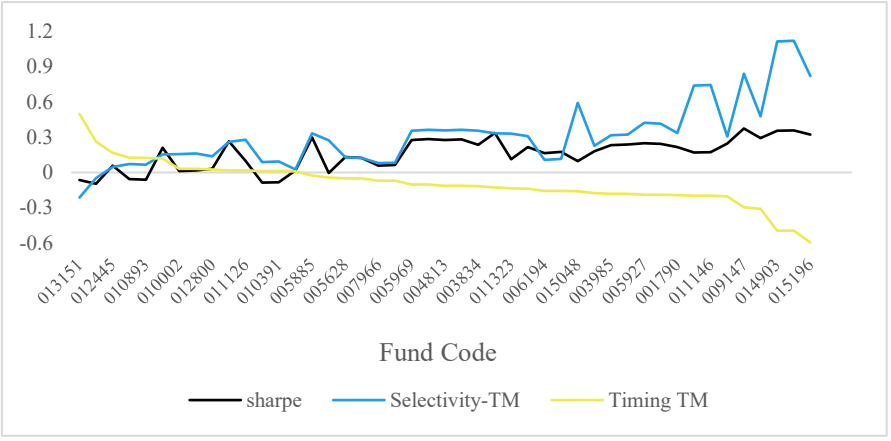

Fig. 6. Sharpe Ratio, Selectivity and Timing ability obtained by TM model. (self-drawing)

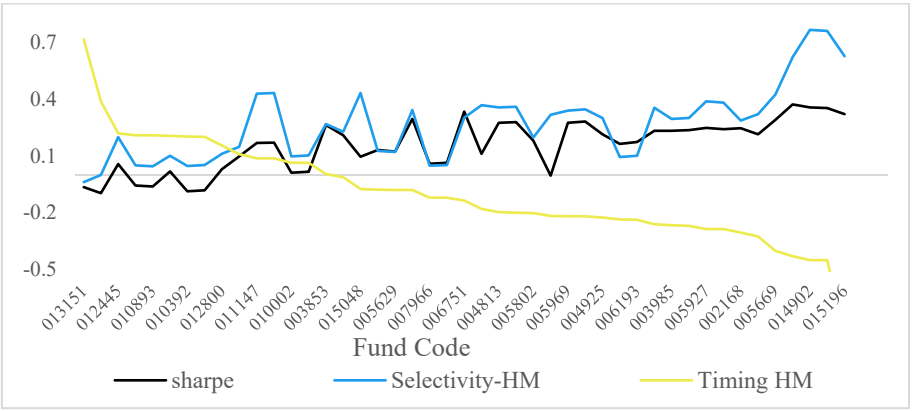

Fig. 7. Sharpe Ratio, Selectivity and Timing ability obtained by HM model. (self-drawing)

As shown in Figure 6 and 7, the two curves representing the timing ability and selectivity of the 45 new energy equity funds in the TM and HM model show opposite trends. The Sharpe ratio curve and the stock picking ability curve are sloping in the same direction, implying that the growth in Sharpe ratio in new energy equity funds is largely related to the growth in stock picking ability.

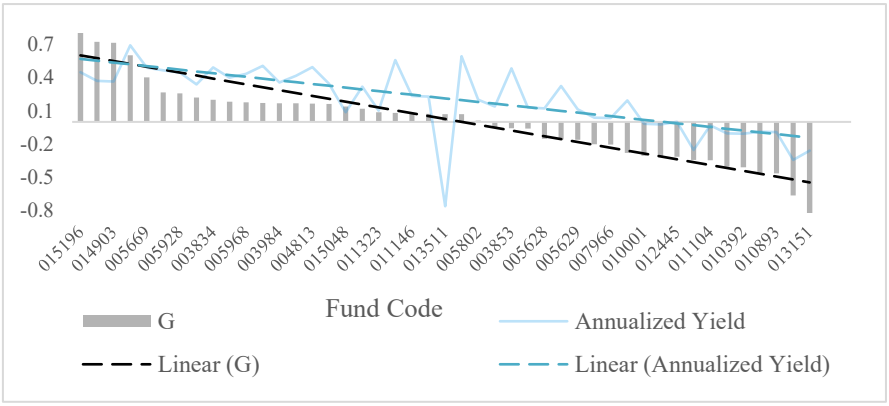

Fig. 8. G indicator and Annualized Yield of these 45 funds. (self-drawing)

As shown in Figure 8, there is a positive relationship between the composite rating curve of a new energy equity fund and its annualized return curve, i.e. the higher the annualized return, the higher the composite rating. The opposite holds true.

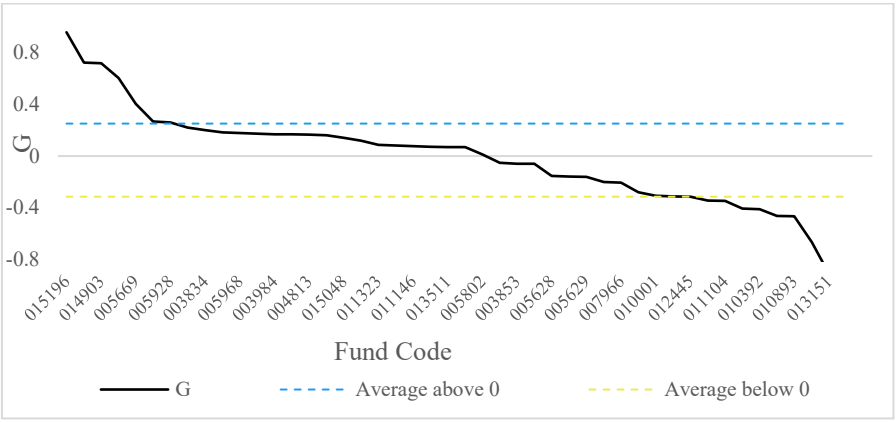

Fig. 9. G indicator of the 45 funds. (self drawing)

As shown in Figure 9, it can be found that only ETF Smart Manufacturing Equity C, Great Wall New Energy Equity Launch A, Great Wall New Energy Equity Launch C and CITIC New Energy Sector Equity A are rated above the average return of in terms of overall capability. However, there are four which are below average return. Most of the funds hovered in the range of 0.5 to -0.5, accounting for 82% of the total funds, while only 16% of the funds had outstanding performance, with 8% performing well and 8% performing very poorly. Based on the above there is not much difference in the performance of most of the fund managers.

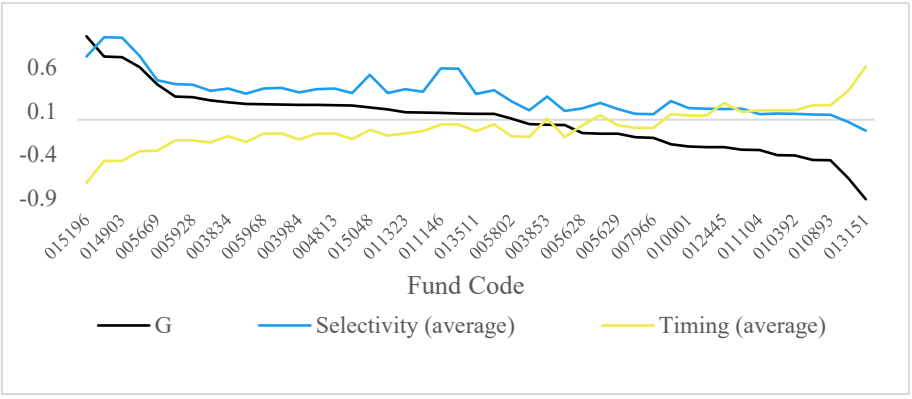

Fig. 10. G indicator, selectivity and timing ability of the 45 funds. (self drawing)

As shown in Figure 10, the curve indicating the overall evaluation ability follows the same trend as the selectivity curve, from which it can be concluded that the evaluation of overall ability is largely determined by selectivity and has little to do with timing ability.

5 Conclusions

This paper further added the risk return ratio of the fund into the evaluation standard, comparing with the system in which the timing and selectivity were only compared in the past studies. Meanwhile, unlike the previous studies, which took the return as the measurement standard of the timing and selectivity, this paper fully considers the impact of market risk factors, further constructs a more comprehensive and objective evaluation system. The conclusions are as follows.

1. The timing ability of fund managers is negatively correlated with their selectivity. Although the majority of fund managers have the capacity to select stocks, just a few have the ability to time the market.

2. The selectivity is positively related to Sharpe ratio, which indicates that the fund manager's stock selection ability plays a role by adjusting risk.

3. The comprehensive evaluation system designed in this paper has a positive correlation with the annual return rate of the fund, which shows the rationality of the system. The comprehensive ability evaluation system is largely determined by the selectivity, and has little to do with the timing ability.

Therefore, in a comprehensive view, although China's new energy equity funds are developing rapidly and have great development potential at present, from the perspective of fund performance level, fund managers fail to take into account the timing ability and selectivity, and the comprehensive ability of most fund managers is general and not much different. Based on the above analysis, this paper suggests that fund managers should improve their comprehensive ability. For fund investors, the fund income can be compared with the fund manager's timing and selectivity according to the evaluation system in this paper, and the performance of the fund manager can be truly evaluated, to have a certain independent analysis and judgment when selecting funds.

Acknowledgments

Wenshan Bai, Jiayi Chen, Yixiao Chu and Tianyu Shi contributed equally to this work and should be considered co-first authors. Names are sorted alphabetically by Chinese last name.

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