FOF Asset Allocation under Specific Risk Control Conditions

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Abstract. Due to the lack of Chinese FOF funds and the corresponding literatures on quantitative analysis, this article attempts to construct a diversified portfolio including multiple asset classes based on quantitative analysis, which comprehensively measures the quality of FOF funds through the three indicators of maximum drawdown, volatility, and Sharpe ratio. Although many empirical analyses of FOF funds await to be carried out, we simulate the quantitative construction of FOF and explore the empirical analysis of FOF funds' investment decision-making. These results offer a guideline for the effectiveness of parameter tuning in FOF portfolio design under the demand of risk control.

Keywords: FOF, Portfolio Design, Risk controlling

1. INTRODUCTION

Contemporarily, the field of FOF funds has developed maturely in western countries. However, the Chinese FOF fund market has taken shape late, and the implementation of policy supervision is slow, i.e., there's still a long way to go in the development of FOF funds in China. There is relatively little research on FOF funds in China, mainly focusing on comparative studies between FOF funds and traditional funds, analysis with the evolution of domestic and foreign policy environment, and qualitative analysis of FOF investment strategies in the context of relevant policies. Quantitative investment strategies possess the advantages of accurately capturing data characteristics and precise execution, which has appealed to increasingly extensive use in the field of financial investment analysis. Nevertheless, due to the lack of Chinese FOF funds and the corresponding literatures on quantitative analysis of them [1], combining with that, most investment management teams of FOF funds are not mature yet, the professionalism of FOF funds investment decision-making and asset structure design remains an unsolved issue. A large number of empirical analyses of FOF funds await to be carried out [2]. Specifically, FOF funds were born out of the use of risk reduction, despite their relatively low

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returns compared with other types of funds. Based on quantitative analysis, we simulate the quantitative construction of FOF and explore the empirical analysis of FOF funds' investment decision-making. Risk control indicators are considered as the main criteria for the judgement of the constructed FOF funds.

2. LITERATURE REVIEW

For the research of FOF funds, domestic and foreign scholars mainly focus on asset allocation strategies and fund screening strategies. In 1952, Markowitz [3] established the well-known mean-variance model, using expectations and variances to characterize the returns and risks of investment, and studying the optimal choice of investors and the equilibrium of the entire capital market from the perspective of effects. It was transformed into an optimization problem from asset selection and formed the basis of quantitative financial analysis. Subsequently, some scholars have continued to promote such research. Greetham [4] proposed the Merrill Lynch clock model, which links asset allocation with industry rotation and economic cycles, and believes that the business cycle should be divided into four stages. Besides, it is pointed out that the best asset classes should be allocated according to the business cycle. Afterwards, a large number of scholars have conducted research on asset allocation strategies based on market timing. Specifically, Breen et al. [5] used short-term interest rates as the market timing standard and investigated the rotation between risky assets and risk-free assets. Besides, Black and Litterman [6] proposed the Black-Litterman (BL) model during their tenure at Goldman Sachs, combining Markowitz's mean-variance theory and Sharp's capital asset pricing theory. It took the equilibrium return of assets as the starting point, allowing investors to combine subjective views with equilibrium returns according to their own judgments. Additionally, it obtained a new model expected returns through the idea of Bayesian estimation and finally using Markowitz's optimization model to obtain the optimal allocation ratio of various assets. Beebower [7] discussed the problem of measuring the effectiveness of market timing and rotation strategies. Asset allocation models are constantly enriched, and practicability has also been greatly improved. The risk parity model proposed by Qian Enping [8], who works for Bridgewater Corporation, seeks to balance the risk weights of the assets in the investment portfolio and seeks the same risk exposure of various assets by controlling the risk contribution in the investment portfolio.

3. RESEARCH AIMS

The FOF funds possess the advantages of better resilience than other funds based on the secondary optimization of investment and diversification of risks. This article starts from the perspective of risk control in two dimensions. On the one hand, this article selects multiple sub-funds with low correlation to diversify risks, choosing active management funds as the sub-funds of asset allocation among different types of assets with better performance and great growth potential. On the other hand, we set the safety margin, the upper and lower limits of one sub-fund's proportion in the investment portfolio, and dynamically adjust it according to the maximum drawdown that investors can withstand, combined with market fluctuations etc. This article attempts to construct a diversified portfolio including multiple asset classes for empirical analysis, which comprehensively measures the quality of FOF funds through the three indicators of maximum drawdown, volatility, and Sharpe ratio. The final effect is that the simulated FOF fund can obtain stable mid-to-long-term returns under the precondition of relatively low non-systematic risks.

4. DATA AND RESEARCH METHODS

4.1 DATA

With the purpose of diversified FOF allocation and the strategy of a combination of growth and balance, 5 funds were selected in this experiment, including 1 mixed fund, 2 equity funds and 2 debt funds. Table I lists the details of those selected funds.

Table 1. The Code, Name and Type of Each Fund

Code	000056	000003	000086	000043	000042
Name	CCB Principal Consumption Upgrade	Zhonghai Convertible Bond Fund C	China Southern Wenli 1 Year Bond Fund	Harvest U.S. Growth Equity Fund QDII	CSI CaitongSustainable
Type	Mixed	Debt	Debt	Equity	Equity

According to the presumed risk management criteria, this paper collects the net value of 5 funds from 2019/01/01 to 2021/06/30 in a total of 606 trading days. All data is obtained from JoinQuant through jqdatasdk and stored in a csv file. The price trends are shown in Fig. 1.

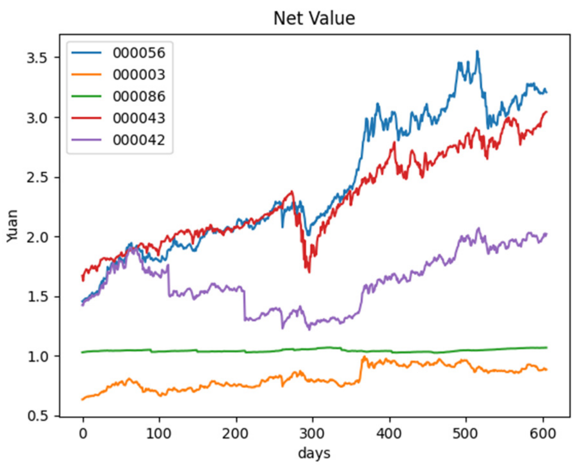

Figure 1. Net Value of Each Fund listed in Table 1

The rate of return, maximum drawdown and volatility of each fund are calculated to facilitate the simulation and calculation of FOF portfolio allocation in the following experiments. The calculation results are summarized in Table 2.

Table 2. Rate of return, Maximum Drawdown, Volatility of Each Fund

	000056	000003	000086	000043	000042	Average
Rate of Return	120.41%	39.72%	3.80%	82.26%	41.99%	57.64%
Maximum Drawdown	44.74%	23.10%	4.28%	40.80%	48.40%	32.27%
Volatility	144.74%	57.28%	4.28%	84.84%	60.01%	70.23%

4.2 Research Methods

Firstly, the paper sets up the portfolio model. Then, by adopting Monte Carlo simulation, 100 random weight combinations are generated with an equal number of the investment targets and sum to 1. In this experiment, there are 5 random weights in a weight group, each representing the proportion of a sub-fund in the FOF.

While the minimum investment ratio of a single fund is set to be constant, this paper examined the model by setting different upper limits for the proportion of a single fund of the portfolio to observe their performance. In the first set of experiments, this paper verified the model and designed an optimal set of parameters of C1, C2, and C3 to obtain the optimal solution of the portfolio model. The optimal solution can make the Sharpe ratio of the FOF as high as possible under current risk management conditions. On this basis, this paper sets the control group parameters to observe the rate of return, maximum drawdown, volatility and Sharpe ratio of each portfolio allocation.

4.3 Formula Description

The portfolio model is built up as below:

$$\max C_1 Ret(\boldsymbol{\omega},\boldsymbol{x}) - C_2 DrawDown(\boldsymbol{\omega},\boldsymbol{x}) - C_3 Volatility(\boldsymbol{\omega},\boldsymbol{x}) \tag{1}$$

$$\begin{cases} SettingLowerLimit_i \le \omega_i < SettingUpperLimit_i \\ \sum_i \omega_i = 1 \\ Ret(\boldsymbol{\omega},\boldsymbol{x}) = \sum_i \omega_i Ret(x_i) \\ DrawDown(\boldsymbol{\omega},\boldsymbol{x}) = \sum_i \omega_i DrawDown(x_i) \\ Volatility(\boldsymbol{\omega},\boldsymbol{x}) = \sum_i \omega_i Volatility(x_i) \end{cases} \tag{2}$$

where C1, C2, and C3 are the weighted coefficients. The lower and upper limits of a single fund are the Setting Lower Limit and Setting Upper Limit in accordance with different risk management criteria design. Ret is the rate of return of a single fund within a period of time. As such, a positive effect can be noted with the growth of Ret. Drawdown and Volatility are the maximum drawdown and volatility of a single fund within a period of time, respectively. As long as the Drawdown and Volatility grows, negative effects can be noted in the model accordingly.

This paper adopts Monte Carlo to simulate the random process in a computer. Each weight fulfils the presumed risk management criteria between a single fund's specified lower and upper limits in this experiment.

According to Table 3, the average volatility is way larger than that of maximum drawdown. Assuming C1, C2, and C3 are equal to 1, volatility will dominate the model's performance, while the impact of maximum drawdown is insignificant. Therefore, this paper defines the 3 variables of the portfolio with impact factors pr, pm, pv as below:

$$mean\_r = 1/5 \sum_i Ret\,(x_i) \tag{3}$$

$$mean\_d = 1/5 \sum_i DrawDown(x_i)) \tag{4}$$

$$mean\_v = 1/5 \sum_i Volatility(x_i) \tag{5}$$

$$pr = (mean\_d + mean\_v)/(mean\_r + mean\_d + mean\_v)$$
$$pd = 1/2(mean\_r + mean\_v)/(mean\_r + mean\_d + mean\_v) \tag{6}$$

$$pv = 1/2(mean\_r + mean\_d)/(mean\_r + mean\_d + mean\_v) \tag{7}$$

where the mean r, mean d and mean v is the average of Ret, DrawDown and Volatility, respectively. The impact factor of each variable equals the sum of the other two impact factors over the sum of the average of the 3 variables. Considering there are 2 negative indicators, the Drawdown and Volatility, but only 1 positive indicator, Ret, the pd and pv are multiplied by 1/2 to come to the final impact factor value.

After the calculation, it's concluded that pr=0.64, pd=0.40, and pv=0.28. With such values as the parameters of C1, C2, and C3, the model can help balance the positive and negative effects of FOF in terms of rate of return, maximum drawdown, and volatility. Theoretically, the proportional allocation of FOF under such parameters normally has a higher Sharpe ratio than the FOF of the controlled group.

With the observation of the balance of rate of return, maximum drawdown, volatility, and Sharpe ratio as the key indicator to evaluate the FOF performance, each experiment can come to the allocation proportion of FOF under each impact factor. The higher the Sharpe ratio is, the higher return-risk can be expected in the FOF.

5. EXPERIMENT RESULT

The first experiment: upper limits of the proportion of a single fund is set to be 40%. This paper conducts the replication experiment in the model. The parameters of the portfolio model are set as [1 0 0], [0 1 0], [0 0 1], representing the only consideration of the rate of return, maximum drawdown and volatility, respectively. The results can be referred to in Table 4 as below.

Table 3. 40% Upper limits - Confirmatory Experiment

Portfolio Parameters		Rate of Return	Maximum Drawdown	Volatility	Sharpe Ratio	Portfolio Proportion
C1	1	89.79%	26.67%	96.57%	0.888	[0.4 0.05 0.05 0.4 0.1]
C2	0					

C3	0					
C1	0	38.05%	11.72%	39.52%	0.861	[0.05 0.4 0.4 0.1 0.05]
C2	1					
C3	0					
C1	0	34.51%	9.48%	36.80%	0.829	[0.05 0.4 0.4 0.05 0.1]
C2	0					
C3	1					

According to the experiment, when the rate of return is the only consideration, the rate of return is maximized, but this results in the highest maximum drawdown and volatility compared with the other two observations. If the maximum drawdown is the only consideration, it can be controlled very well on conditions of low rate of return and high volatility. When the volatility is the only consideration and is well controlled, the maximum drawdown is also at a low level. Still, the rate of return is the lowest among the 3 observations, leading to the lowest Sharpe ratio. The model works well in the portfolio model with the verification results.

Afterward, this paper sets the controlled group parameters of the portfolio model as [1 1 1], [0.6 0.8 0.3], and [0.3 0.8 0.8]. The results can be referred in Table 5 as below.

Table 4. Upper Limits 40%

Portfolio Parameters		Rate of Return	Maximum Drawdown	Volatility	Sharpe Ratio	Portfolio Proportion
C1	1	38.05%	11.72%	39.53%	0.861	[0.05 0.4 0.4 0.1 0.05]
C2	1					
C3	1					
C1	0.6	70.98%	22.44%	80.75%	0.830	[0.4 0.05 0.4 0.1 0.05]
C2	0.8					
C3	0.3					
C1	0.3	34.51%	9.48%	36.80%	0.829	[0.05 0.4 0.4 0.05 0.1]
C2	0.8					
C3	0.8					
C1	0.64	91.06%	27.07%	97.96%	0.889	[0.4 0.1 0.05 0.4 0.05]
C2	0.40					
C3	0.28					

When impact factors, pr, pd and pv, are set as parameters of C1, C2, and C3, the FOF with the optimal proportion portfolio has the highest Sharpe ratio of 0.889 among all controlled groups. The second experiment: upper limits of the proportion of a single fund is set as 30%. The results can be referred to in Table 5 as below.

Table 5. Upper Limits 30%

Portfolio Parameters		Rate of Return	Maximum Drawdown	Volatility	Sharpe Ratio	Portfolio Proportion
C1	1	53.96%	20.97%	55.12%	0.906	[0.05 0.3 0.3 0.3 0.05]
C2	1					
C3	1					
C1	0.6	73.56%	21.67%	78.61%	0.885	[0.3 0.05 0.3 0.3 0.05]
C2	0.8					
C3	0.3					
C1	0.3	39.09%	19.76%	41.37%	0.848	[0.05 0.3 0.3 0.05 0.3]
C2	0.8					
C3	0.8					
C1	0.64	83.62%	24.60%	89.81%	0.887	[0.3 0.3 0.05 0.3 0.05]
C2	0.40					
C3	0.28					

In the experiment, the Sharpe ratio of 0.906 is the highest with parameter [1 1 1], while the impact factors are set as parameters can score the second-highest Sharpe ratio of 0.887. Thus, the experiment results are barely satisfactory and await more observations. The third experiment: the upper limit of the proportion of a single fund is 50%. The results can be referred to in Table 6.

Table 6. Upper Limits 50%

Portfolio Parameters		Rate of Return	Maximum Drawdown	Volatility	Sharpe Ratio	Portfolio Proportion
C1	1	30.50%	8.23%	32.24%	0.822	[0.05 0.35 0.5 0.05 0.05]
C2	1					
C3	1					
C1	0.6	61.52%	20.17%	70.52%	0.816	[0.35 0.05 0.5 0.05 0.05]
C2	0.8					
C3	0.3					
C1	0.3	30.50%	8.23%	32.24%	0.822	[0.05 0.35 0.5 0.05 0.05]
C2	0.8					
C3	0.8					
C1	0.64	95.58%	27.08%	105.08%	0.871	[0.5 0.05 0.05 0.35 0.05]
C2	0.40					
C3	0.28					

The Sharpe ratio of 0.871 is the highest in the experiment, with impact factors set as parameters. The fourth experiment: the upper limit of the proportion of a single fund is 60%. The result can be referred to in Table 7 as below.

Table 7. Upper Limits 60%

Portfolio Parameters		Rate of Return	Maximum Drawdown	Volatility	Sharpe Ratio	Portfolio Proportion
C1	1	27.18%	7.23%	27.91%	0.831	[0.05 0.25 0.6 0.05 0.05]
C2	1					
C3	1					
C1	0.6	49.09%	15.28%	55.17%	0.817	[0.25 0.05 0.6 0.05 0.05]
C2	0.8					
C3	0.3					
C1	0.3	27.18%	7.23%	27.91%	0.831	[0.05 0.25 0.6 0.05 0.05]
C2	0.8					
C3	0.8					
C1	0.64	99.62%	30.09%	112.49%	0.850	[0.6 0.05 0.05 0.25 0.05]
C2	0.40					
C3	0.28					

The Sharpe ratio of 0.850 is the highest in the experiment, with impact factors set as parameters. According to the results, when the impact factors we design are set as C1, C2, and C3, the portfolio model can reach the highest Sharpe ratio as the optimal solution under most circumstances, especially in the situation when the upper limits of the single fund investment proportion are set up high. Meanwhile, when the upper limit of a single fund proportion is set too high, the Sharpe ratio of the FOF will generally decrease. The analysis is consistent with the knowledge of diversified investment strategy and mitigating risk consideration.

From the observation of the experiment results, the specified impact factors tend to generate the allocation of FOF in the mode of the high rate of return, high maximum drawdown, and high volatility, since less impact of high volatility and drawdown can be noted in mid or long term investment portfolio.

We plotted the net value of FOF in the situation of the first experiment with upper limits of 40% and the impact factors as the parameters (seen from Fig. 2).

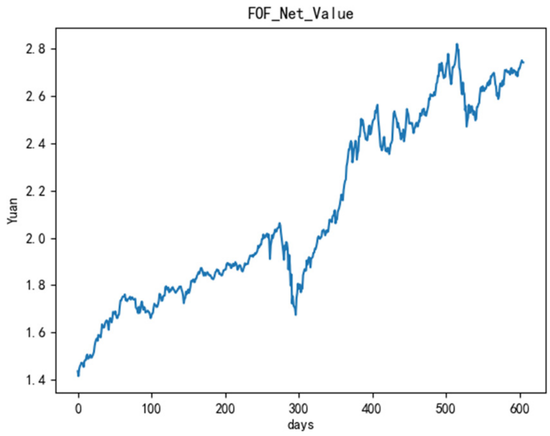

Figure 2. The net value of FOF

The rate of return of the specified FOF portfolio can be 91.06% during the observation period, while the maximum drawdown rate is 27.07%, and the volatility is 97.96%. Therefore, the Sharpe ratio is 0.889. In the same situation, we plotted the relationship of the rate of return, maximum drawdown, and volatility, as depicted in Fig. 3. Each curve consisted of scatters represents the performance of a fund in our selection. As displayed in Fig. 3, it can be concluded that the 3 variables are positively correlated. The higher the return, the greater the drawdown and volatility, which is in line with the portfolio characteristics of high return, high volatility and high drawdown.

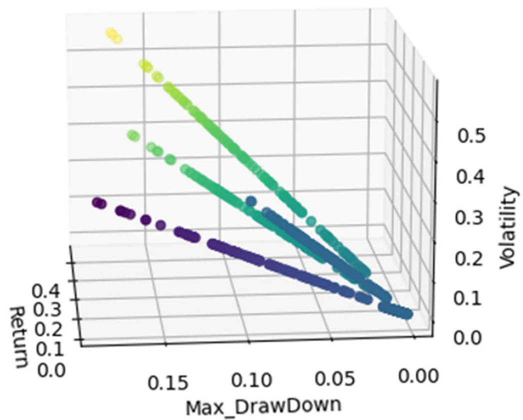

Figure 3. The Relationship of the Rate of Return, Maximum Drawdown, Volatility

6. SHORTAGES AND PROSPECTS OF THE RESEARCH

Although this article's FOF fund quantitative investment strategy has certain feasibility in theory and practice, restricted by time and conditions, the investment strategy studied in this article also has many shortcomings. Therefore, it needs to be improved in the future research process [9]:

(1) The research of this article focuses on the level of micro-empirical case analysis. There are some deficiencies in the research of FOF macro strategy. The possible macro fluctuation factors effects on the investment strategy of FOF funds are not included in this article's scope.

(2) With the Chinese liberalization of public FOF investment restrictions, the market needs a complete asset allocation strategy for large categories, and the optional fund pool should be gradually expanded. This article only selects stock funds, bond funds and hybrid funds to research. There is indeed a lack of sub-funds. Further research should gradually include currency funds, index funds, commodity funds, REITs, etc. These will also provide more diversified allocable possibilities for FOF funds [10].

(3) The model discussed in this article ignored the subjective factors of investors when carrying out asset allocation, nor designed the different weights of asset classes for investors with different risk preferences. Besides, we did not carry out detailed style classification according to different characteristics of investors during fund screening. It is worthy of further enrichment in the future [11].

The model in this paper is based on risk control, through diversified asset allocation of different types and selected fund managers, explores a better solution to the Sharpe ratio, and strives to achieve stable growth of the asset portfolio. The advantage of FOF funds lies in asset allocation, and establishing a high-quality investment portfolio requires more complex and rigorous scientific calculations. Obviously, it is not enough to rely on mankind power alone, which requires a complete set of an investment system that can adapt to market cycles' rotation to carry out dynamic adjustment of positions and model parameter tuning.

In future investment research, more attention should be paid to the quantitative model of multi-dimensional dynamic adjustment, also more accurate analysis and prediction of investment style and the profitability of the sub-funds in the FOF portfolio; continuous and close tracking of portfolio performance, quickly and dynamically adjust portfolio positions; it is necessary to pay more attention to the impact of sudden events, macro-environmental changes, and investors' subjective factors to deal with abnormal market fluctuations and abnormal fluctuations in net worth, or sudden changes in financial regulatory policies etc. [12].

Judging from the decades of development of fund portfolio strategy, quantitative research on FOF portfolio strategy has become a part that deserves more attention. Shortly, FOF funds, an investment product with stable returns, assisted by quantitative investment methods, will shine in the Chinese public fund market, and we can continue to study this meaningful issue in depth.

7. CONCLUSION

Based on presumed specified risk management criteria, this paper builds up a model and to find the optimal FOF allocation at a strategy of balance on relatively high growth and low risks. In the empirical investigation, the paper collects data of the net value of funds from a certain period of time, calculates the rate of return, maximum drawdown and volatility of each fund, and simulates the FOF portfolio allocation with Monte Carlo simulation. In terms of finding the optimal allocation weights under different upper limits of single fund proportion, we obtain the best allocation ratio under risk control conditions. Furthermore, controlled groups are set, with Sharpe ratio as the key indicator to evaluate FOF performance. According to the analysis, when the impact factors designed are set as the parameters, the model can help evaluate the positive and negative effects of FOF in terms of rate of return, maximum drawdown, and volatility to reach a higher Sharpe ratio. These results offer a guideline for the effectiveness of parameter tuning in FOF portfolio design under the demand of risk control.

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