

# Empirical Research on Stock Type Fund Quantitative Investment in Chinese Market Based on Enhanced Markowitz Model

Liangyu Min<sup>1</sup>

Capital University of Economics and Business, BeiJing 100070, China

<sup>a</sup>email,

**Keywords:** Stock Type Fund; Quantitative Investment; Markowitz Model

**Abstract:** To construct a portfolio under stock type fund, This paper take the idea of quantitative investment and Markowitz model, but some limitations in current policies urge us revise the traditional Markowitz model. So we develop a noval Markowitz model based on the old one to conform these conditions and take a series of empirical analysis to prove that the noval model is valuable.

## Introduction

Quantitative investment is a new concept which refers totake the principle of mathematical statistics and use powerful computing ability to analyze and compare the data of stocks. Then select optimized portfolio quantitative model. Markowitz(1952) put up a classical mean-variance model, this model is widely used and developed into a basic model in quantitative investment, However, Markowitz model did not take weight limit of invest into account. The default makes Markowitz model hardly play a significant role in the construction of a stock type funds. The paper aim to enhanced classical Markowitz model and applied the new model into stock type funds. In research, R software is a main tool.

## Classic Markowitz Model

According to the rational person hypothesis, each investor is in the pursuit of the maximization of individual utility, and the decision-making process could be simplified as follows:

$$\min_{\omega_i} \sigma^2(R_p) = \sum_{i=1}^N \omega_i^2 \sigma^2(R_i) + \sum_{i \neq j} \omega_i \omega_j (R_i R_j)$$

$$s.t \rightarrow \bar{R}_p = \sum_{i=1}^N \omega_i E(R_i)$$

$$\sum_{i=1}^N \omega_i = 1$$

Use Lagrange equation solve this model, the entire mathematical model is Programming Quadratic, under the given weights of asset, we can get the solution through first order condition.

$$\begin{bmatrix} \sum & 0 & \bar{R} \\ e' & 0 & 0 \\ \bar{R} & 0 & 0 \end{bmatrix} \begin{bmatrix} \omega^* \\ \lambda_1 \\ \lambda_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ \bar{R}_p \end{bmatrix}$$

## Enhanced Markowitz Model

Withthe new rule of stock type funds take effect on 2015-08, the stock fund positions in portfolio cannot be less than 80%, but generally cannot be more than 95%. These provisions make classical

Markowitz model and some related invest strategies no longer applicable. For solving this problem in Chinese market, weight coefficient is introduced and enhanced Markowitz model is constructed, the first order matrix as follows:

$$\begin{bmatrix} \sum & 0 & \bar{R} \\ e' & 0 & 0 \\ \bar{R} & 0 & 0 \end{bmatrix} \begin{bmatrix} \omega^* \\ \lambda_1 \\ \lambda_2 \end{bmatrix} = \begin{bmatrix} 0 \\ weight \\ \bar{R}_p \end{bmatrix}$$

The following empirical research is based on the enhanced Markowitz model.

### Empirical Research

**Selection of Stock Portfolio.** Assume that some constructed stock type funds in A-share market, the portfolio of stocks in this funds are selected by Chinese Sinopec(600028), Dshi Intelligent(002421), Jieshun Tech.(002609), Bank of China(601988), time interval is 2015-07-06 to 2016-06-14. If a suspension happened, we removed these day revenues from stock pool. After stock data processing in R, we could get data as follows:

	ret600028 ↕	ret002421 ↕	ret002609 ↕	ret601988 ↕
2015-01-06	-0.019607843	0.0064011380	0.0532934132	0.031674208
2015-01-07	0.025714286	0.0487632509	0.0011370097	-0.004385965
2015-05-05	-0.029411765	0.1000673854	0.0061199510	-0.049689441
2015-05-06	-0.021464646	0.1001531394	0.0301094891	-0.017429194
2015-05-07	-0.033548387	0.0999443207	0.0510776498	-0.017738359
2015-05-08	0.012016021	0.0999746900	0.0662921348	0.013544018
2015-05-11	0.019788918	0.1000920387	0.0969441517	0.015590200
2015-05-12	0.003880983	-0.5009412257	-0.0403458213	0.004385965
2015-05-13	-0.028350515	0.1001676446	0.0735735736	-0.004366812
2015-05-14	0.009283820	0.1001904762	0.0531468531	-0.002192982
2015-05-15	-0.039421813	0.1000692521	0.0119521912	-0.024175824
2015-05-18	-0.025991792	0.0034623859	0.0999562555	-0.024774775

Fig1. Yields of each stock equity portfolio

Then we would calculate the cumulative yield of each stock in our portfolio within R software. We could get each stock's image of daily returns and cumulative return rate as follows:

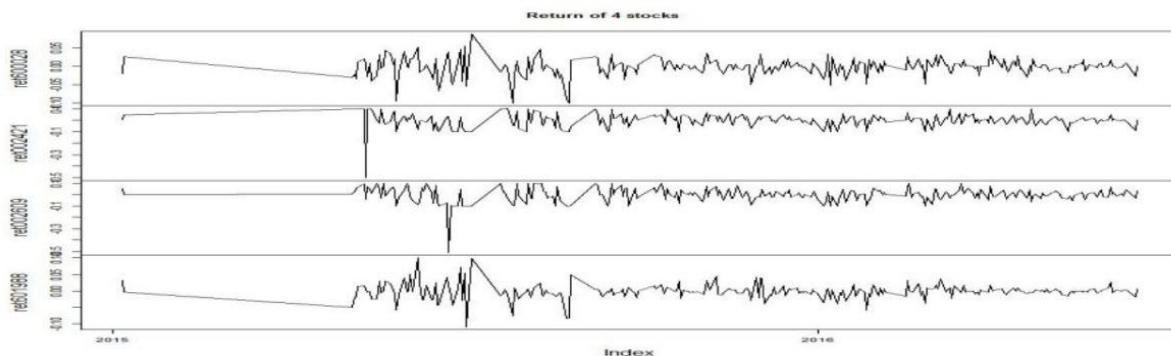


Fig2. Daily return rate image

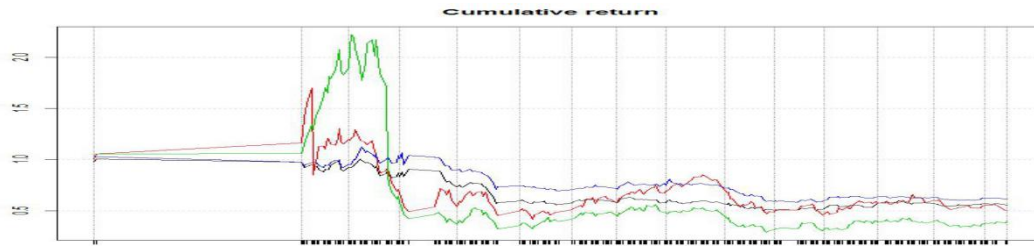


Fig3.cumulative return rate

**Detection for Stock’s correlation.** In order to distribute non-system risk in our stock portfolio, we should detect the correlation between the stock portfolio, if selected stocks show strong correlation, it is assumed that our stock portfolio lacking in ability for distributing non-system risk. In our detection with R, we could get the correlation coefficients matrix as follows:

	ret600028 ↕	ret002421 ↕	ret002609 ↕	ret601988 ↕
ret600028	1.0000000	0.3213027	0.3185278	0.8130420
ret002421	0.3213027	1.0000000	0.5053945	0.1717133
ret002609	0.3185278	0.5053945	1.0000000	0.1878448
ret601988	0.8130420	0.1717133	0.1878448	1.0000000

Fig4.correlation coefficients matrix

It is easy to found that positive correlation between selected stocks. For wise investors, they should solve these matrix to get asset allocated ration for minimize risk in portfolio. Considering stock type funds is being researched, our ration is limited by some rules for investing, and the ration for allocated asset is between 80% and 95%. Based on analysis above, we would take enhanced Markowitz model in effect. Here we set the value of weight 90%, which means investing 90% asset on stock portfolio, and 10% on some fixed-income products, such as bonds(the default risk is zero).

**Take Enhanced Markowitz Model.** Programming in R software, we design risk function as follows, weight would take into function as a parameter named ‘myweight’.

```
min_var_func<-function(asset,goal_ret,myweight){#enhanced Markowitz Model
  n<-ncol(asset);cov<-cov(asset);cmean<-apply(asset,MARGIN=2,FUN=mean)
  La<-cbind(cov,rep(1,n),cmean);Lb<-rbind(c(rep(1,n),0,0),c(cmean,0,0))
  L<-rbind(La,Lb);b<-c(rep(0,n),myweight,goal_ret)
  result<-solve(L,b);weight<-result[1:n]
  ret_mean<-cmean%*%weight;ret_var<-weight%*%cov%*%weight
  return (c(ret_mean,ret_var,weight))
}
```

Calculate the effective frontier of stock portfolio. In the customized risk function, we set the parameter myweight value as 0.9, then draw the effective frontier image as follows:

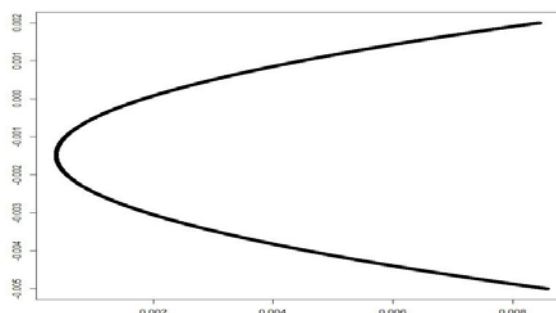


Fig5.effective frontier

From curve above, weak performance showed on Chinese market in time interval. It is widely known that Chinese A-share Market experienced three continuous rounds stock crash between second half in 2015 and 2016.June. At the same period, Chinese economics is not ideal, the GDP index is swagging between 6% and 6.5%. Based on macroeconomic conditions, we take pessimistic attitude for Chinese A-share market. For minimizing risk, our target return rate is -0.0018. Using the enhanced Markowitz model to calculate the ratio of allocated asset.

**Comparison between Training Set and Test Set.** For proving the validity of enhanced Markowitz model, we take model parameters from training set and random set parameters into test set. In the training set,we set May 5 2015 and April 31 2016 as time interval. In the test set, time interval is May 1,2016 to June 14,2016. In the training set, we get asset allocated ration as follows:

ret600028	ret002421	ret002609	ret601988
0.69164439	-0.05672968	0.03534724	0.22973805

Some ratio is negative because of the existence of short selling mechanism. Considering short selling mechanism, random parameters my be negative at the same time. We could use R codes to get random parameters:

```
N<-29;random_wt<-t(sapply(1:N,FUN=function(i){#Model of random parameters
wt<-runif(4,min=-0.1,max=0.9);wt<-0.9*wt/sum(wt);return(wt)}))
```

According to the results above, the image of cumulative return of the training model and random parameters model are as follows:

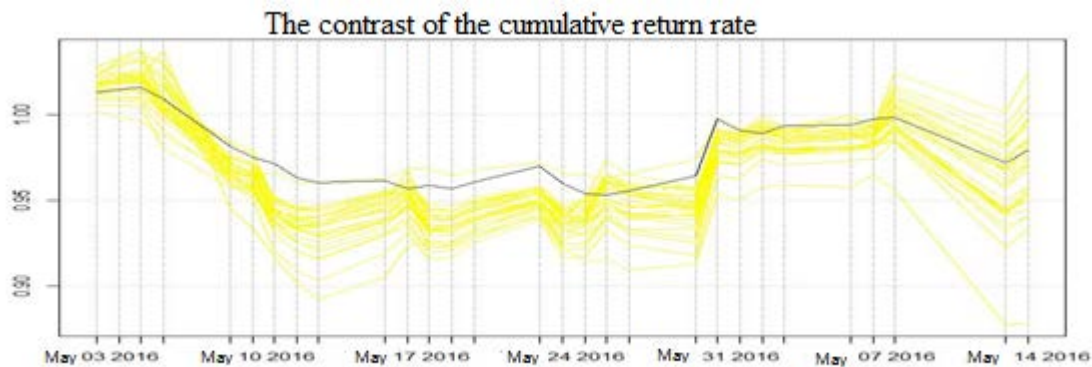


Fig6.Comparison between different parameters

**Results Analysis.** From the figure, Higher cumulative returns(black-line) gained in training set compared with stochastic simulation model(yellow-line). It is reasonable to think that ratios from training set is effective with certain value for investing strategies.

**References**

[1] Amihud Y.Illiquidity and Stock Return;Cross-Section and Time-Series Effect[J].Journal of Financial Markets,2002,(5).  
 [2] Kaufman P J.New Trading System and Methods[M].John Wiley&Sons Inc,2005.  
 [3] Whistler M.Trading Pairs: capturing profits and hedging risk with statistical arbitrage strategies[M].John Wiley & Sons, 2004.  
 [4] Vidyamurthy, G. Pairs Trading: Quantitative Methods and Analysis[M].John Wiley & Sons, 2004.  
 [5] Eillot Robert J, Van Der Hoek, John, Macolm William P.Pairs trading[J].Quantitative Finance, 2005, 5(3).

- [6] Engle, R. and Granger, C. Cointegration and Error Correction: Representation, Estimation and Testing[J]. *Econometrica*, Vol.55, No.2, 1987.
- [7] Zhao Yin, Chang Tan. Model and Analysis of Financial Investment Risk monetary quantification prediction[J]. *Journal of Central University of Finance and Economics* 2013, (7)
- [8] Fu Yongjian, etc. Based on futures portfolio quantization ideas and Black-Litterman model[J]. *Chinese Academy of Sciences University* 2014, (7)
- [9] Yu Liwei, Ningling stock market quantitative investment strategies and empirical test[J]. *Statistics and Decision* 2016, (6)
- [10] Cai Lirui. Quantitative investment in R language as a tool[M]. *Electronic Industry Press*