Long-term General Asset Allocation for individual investors in Chinese securities market

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Abstract. Facing the boom of online transaction applications in Chinese securities market, individual investors in China vacillate between different assets while allocating assets. On account of the individual investors' inferior ability to take risk, portfolio will be their best choices. However due to their unacquaintance to modern portfolio theory, individual investors need some instructions. As proved by Brinson in 1986, over 90% of the success of a portfolio owe to general asset selection. Hence, this paper primarily focused on providing suggestions to individual investors on general asset selection to help them to construct a portfolio in China securities market at present. Initially, this paper utilized the Mean-Variance model and CML approach to depict the market and analyzed the long-term asset allocation of multi-asset for individual investors. Based on the results, this paper suggested that individual investors should focus more on bond asset: with a portfolio of 97.37% of bond asset and 2.63% of stock asset, investors will be able to acquire a yield of 4.54% (annualized). And through this study, this paper found that Chinese securities market is not mature enough and teemed with regulations, making it to be competent than other mature market.

Keywords: Asset Allocation; Mean-Variance Model; Quantitative Investment; Sharpe Ratio.

1. Introduction

As Chinese market is turning more and more mature, like in other mature markets, Chinese investors reveal preference for those investments with long-term and solid returns. How to find out a way to retrieve a stable yield as an ordinary individual investor? To answer this question, the concept of wealth management should be discussed.

Wealth management consists two essential parts: assets management and asset-liability management. Both of these two parts contains an important part, the asset allocation, which can be interpreted as a process of choosing market, deciding on assets and making investment. Among the steps mentioned, the investment policy accounts for more than 90% of a certain portfolio's performance [1]. Thus, this paper can infer that the asset allocation is of essential in achieving our goal in this paper.

This paper has selected the securities market as our choice. Nowadays, securities markets are teemed with online transaction applications that facilitate individual investors to make their own investment. Solely with WIFI and mobile phones, individual investors can accomplish their deals in a coach. However, even with the help of these applications, individual investors are frequently confused by jargons or terms in securities market. Only knowing part of the differences between the stock and the fund, wavering between seemingly profitable assets, these most "naïve" investors are prone to experience property loss by taking a wrong strategy. To help these "naïve" investors out, this paper will focus on figuring out the best strategy for these "naïve" investors to invest in long-term with a multi-asset portfolio.

To choose an optimal portfolio with long-term solid yield from multiple assets, this paper regarded each single genre of asset as a whole to describe the overall performance of certain asset from 2011/01/01 to 2021/12/31 by taking the data from the general index, such as CSI300 and Index Fund.

In this paper, this paper firstly presented the previous studies in this field and discussed the research gap that filled by this paper in section2. Then in section 3, this paper introduced the method which consulted in this paper: the Mean-Variance model and CML. To present the circumstances of Chinese market, this paper depicted the data that this paper utilized and big event of market happened in this period in section 4. This paper took advantage of the MV model and CML approach to analyze the

long-term asset allocation of multi-asset for individual investors in section 5. The empirical results suggest that asset bond will be the optimal choice.

2. Literature Review

2.1 Global study in this general asset allocation

From the equally-weighted portfolio in Hammurabi' s Code to 60/40 portfolio in 1930s, it has been long time that numerous portfolio strategies were put forward and applied in real time situation investment to help the economists, bankers and portfolio managers to maximize their choices. In 1950s, the Mean-Variance Model by Markowitz has converted asset allocation in a new phase — a theoretical analysis one. Using expectation and standard deviation to depict the return as well as risk of the investment, Markowitz's underlines the importance of risk dispersion.

However, the opinion, regarding the efficient general asset allocation as the cornerstone of the successful investment, did not arise until 1986. In this paper, Brinson et al [2] measured the effect of asset allocation strategy to the expected return of investment and stated the strategy adopted explains more than 90% of the portfolio performance. In 2000, Ibbotson & Kaplan [3] confirmed the reliability of the former conclusion and presented a more comprehensive one.

2.2 Previous study applied in China

It has been only 30 years since Chinese scholars had put the Mean-Variance portfolio maximization theory [4] into practice in Chinese market. Previous studies have proved the utility of Markowitz's to optimize stock portfolio in Chinese stock market [6], and compared the efficient frontier of Chinese stock market with that of US stock market.

US is the first country who aims at integrating the general asset analysis in practice. By contrast, China is still on its way of development and lacks the support of viable quantitative models [7].

3. Methodology

3.1 Mean-Variance theory

Markowitz's theory relies heavily on the assumption that rational investors make security buying decisions out of personal balance of the expected return and risk. The expected return, or anticipated return here refers to the expected price change over the time period selected. And the risk is presented by the variance (average squared deviation) of returns. Knowing these concepts, the MV theory or MV optimization can be described as follow:

Suppose there are N assets existing in the market to invest in. The assets' returns $\boldsymbol{R} = (R_1, R_2, \cdots, R_N)$, where N here represents N-th asset, have expected returns $\boldsymbol{\mu} = (\mu_1, \mu_2, \cdots, \mu_N)$ and a covariance matrix Σ can be depicted as:

$$\boldsymbol{\Sigma} = \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1i} \\ \vdots & \ddots & \vdots \\ \sigma_{i1} & \cdots & \sigma_{ii} \end{bmatrix} \tag{1}$$

(σ1N refers to the covariance between first asset and the N-th asset)

Following the assumption that all the security returns should be jointly normally distributed, the overall return Rw is also normally distributed:

$$\mathrm{R}_w \sim N(w'\mu, w'\Sigma w) \tag{2}$$

($\mu_w = w'\mu$ represents the expected return of the overall return of specific portfolio, $\sigma_w^2 = w'\Sigma w$ denotes the variance of a specific portfolio)

Suppose the portfol`io weights of this N assets are described in a vector $\boldsymbol{w} = (w_1, w_2, \cdots, w_N)$, there exist w_i which can be interpreted at the weight of the i-th asset. More precisely, this vector w also follows a constraint:

$$\sum_{i=1}^{N} w_i = 1 \tag{3}$$

Under circumstances above, our target to minimize the risk can be described as:

$$\begin{gathered} \min_w = \sigma_w^2 = w'\Sigma w \\ s.t.\ \mu_w = r^* \\ and\ w'\iota = 1, \iota' = [1, 1, \cdots, 1] \end{gathered} \tag{4}$$

Taking advantage of Lagrange multipliers, this problem can be transferred to a risk minimization formulation by using two vectors (Sergio and Frank, 2004):

$$\boldsymbol{w} = \boldsymbol{g} + \boldsymbol{h}\mu_0 \tag{5}$$

The vector g and h can be interpreted as:

$$\begin{aligned} \mathrm{g} &= \frac{1}{ac - b^2} \cdot \Sigma^{-1}[c\boldsymbol{\iota} - b\boldsymbol{\mu}] \\ \mathrm{h} &= \frac{1}{ac - b^2} \cdot \Sigma^{-1}[a\boldsymbol{\mu} - b\boldsymbol{\iota}] \end{aligned} \tag{6}$$

And a, b, c satisfy:

$$\begin{aligned} a &= \boldsymbol{\iota}'\boldsymbol{\Sigma}^{-1}\boldsymbol{\iota} \\ b &= \boldsymbol{\iota}'\boldsymbol{\Sigma}^{-1}\boldsymbol{\mu} \\ c &= \boldsymbol{\mu}'\boldsymbol{\Sigma}^{-1}\boldsymbol{\mu} \end{aligned} \tag{7}$$

3.2 Capital Market Line

In the Markowitz's efficient frontier mentioned above, the primary focus is a trade-off between variance and risk in a market without risk-free rate. Under this circumstance, the optimal choice is depending on investor's personal preference. However, to construct CML, a risk-free rate needed to be introduced, at which investors can borrow and lent freely, a rate that will change the frontier mentioned above.

Suppose investors invest w_f in risk-free asset and w_M in market portfolio, and

$$w_f + w_M = 1 \tag{8}$$

(w represents the percentage of the total investment).

Under this assumption, the expected return of the portfolio E(Rp) can be described as:

$$E(R_P) = w_f R_f + w_M E(R_M) \tag{9}$$

Then, introduce (7) in formula (8), which can be simplified as:

$$E(R_p) = R_f + w_M [E(R_M) - R_f] \tag{10}$$

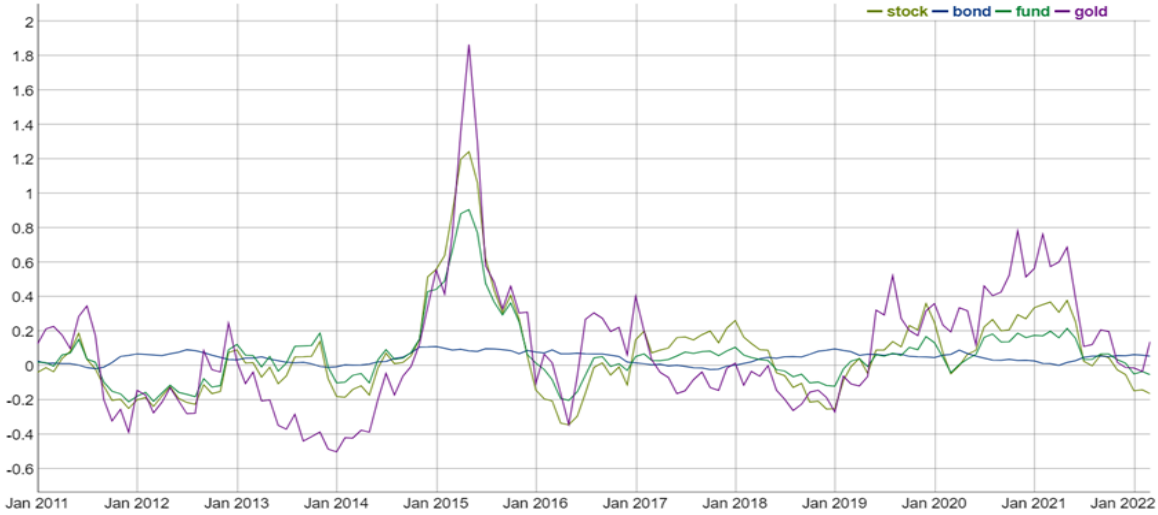

Figure 1. Overview of the Assets' Yield

And since the risk-free asset's risk is virtually zero, the variance of the portfolio that contains risk-free asset can be interpreted as:

$$\sigma_p^2 = var(R_p) = w_M^2 \sigma_M^2 \tag{11}$$

Based on the definition of the standard deviation, this can be inferred:

$$w_M = \frac{\sigma_p}{\sigma_M} \tag{12}$$

Using all the result above, an explicit conclusion can be made on the formula of CML:

$$E(R_p) = R_f + \left[\frac{E(R_M) - R_f}{\sigma_M}\right]\sigma_p \tag{13}$$

4. DATA

Aiming at observing the overall situation of securities market, this paper selected four genres of assets to be the most popular choices among Chinese individual investors. They are stock, bond, fund and gold (due to Chinese special fond of gold, the asset gold is the representatives of futures).

4.1 Data Source

To indicate assets' performance during this period, this paper chose different indices as their representatives. The stock asset is represented by the CSI300 index (000300), the bond asset is denoted by CSI Aggregate Bond Index(H11001), the fund asset is denoted by Index Fund (000011), and the gold is denoted by Gold index (882415.WI). The annual yield of these four assets was obtained in the database WIND.

Additionally, this paper used the one-year treasury bill yield to be a simulation of the risk-free rate in market. This paper collected this data from www.chinabond.com and used its arithmetic mean to serve as a fix rate in our study.

Table 1. Data Source

Assets	Index selected	Source
Stock	CSI300 000300.SH	WIND
Bond	CSI Aggregate Bond Index H11001	WIND
Fund	Index Fund 000011	WIND
Gold	Gold 882415.WI	WIND
Risk Free Rate	One-year Treasury Bill	www.chinabond.com

4.2 Data Presentation

This paper presented the yield of four different assets in figure 1. In which, this paper observed a similarity between the trend of stock, fund and gold, in which a similarity in their overall status might be inferred. This paper concluded that these three assets are jointly influenced in the market but to different extent. Among which, the gold fluctuates and shows the greatest range of value, probably denoting its extremely risky character.

Meanwhile, the blue line (bond asset) constantly presents a character of stability contrast to the three assets mentioned. This line merely drops beneath the x-axis and seemingly even when other assets fluctuate, suggesting that it may be a good choice to balance our portfolio.

4.3 Data Examination

To examine the viability of our method to our data, this paper examined the correlation between assets and data's coherence with the normal distribution.

In Figure 2, in which the darker color denotes the closer relation is, this paper found that the fund and the stock are highly related to each other. But the correlation of stock-bond, bond-fund and bond-gold are extremely close to zero, illustrating the highly unrelated nature between these assets. According to Modern Portfolio Theory,

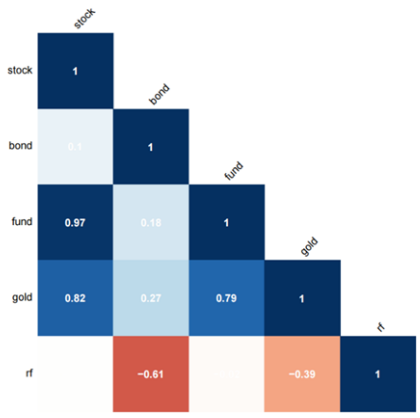

Figure 2 Correlation

According to the assumption of MV theory, the assets need to satisfy the normal distribution. This paper took their mean and standard deviation as their parameters of normal distribution, and presented them in a bar chart. Generally, all the assets are in the shape of their normal distribution.

Additionally, this paper also checked the extreme values in the return rate of our assets. So, this paper standardized all the return rate and presented them. This paper assumed the -250~250% is the normal value and observed that only a few rates during a specific period have surpassed the extreme value boundary. Thus, this paper concluded that our data generally satisfy the requirement of normal distribution.

5. Result and discussion

5.1 Data Overview

5.1.1. Expected return & risk of assets

Initially, to get an outlook of our data, this paper calculated and presented the expected return rate and the risk of the four assets that this paper has chosen. The expected return rate and risk here are respectively in terms of mean and standard deviation of each asset:

Table 2. Expected Return & Risk of asset

Assets	Expected Return	Risk
Stock	0.07002450	0.26767961
Bond	0.04477827	0.03301538
Fund	0.06131681	0.18761345
Gold	0.08837658	0.36692320

From the table 2, this paper could find that the asset gold is of high risk and high return, with 8% annual yield on average and a risk of 0.36 in terms of standard deviation, both of which are the highest among all the assets. While the asset bond may serve as a final protection to investors with stable return – a rather low return but with a similar rather small risk. In Modern Portfolio Theory, by combining assets of different return rate and risk, this paper can obtain a better choice than any single asset.

5.1.2. Sharpe Ratio of assets

To get a better view of the assets, this paper also interpreted the Sharpe Ratio of these four assets as follow:

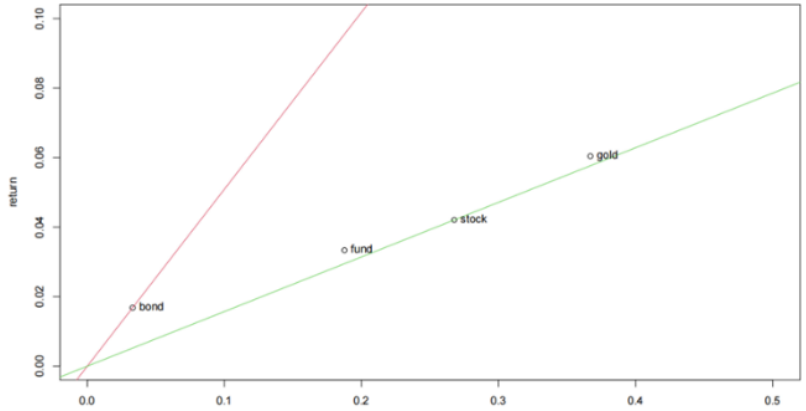

Figure 3 Sharpe Ratio plot

Table 3. SR Value

SR	Assets
0.1570992	stock
0.5090363	bond
0.1777302	fund
0.1646239	gold

In the figure 3, this paper here included the mean of the one-year treasury bill as the risk-free rate for the whole market. The green line represents a line passing through the origin with a slope of the Sharpe ratio of asset stock, while the red one is with a slope of the SR of asset bond. The Sharpe ratio of the fund, stock and gold nuance with each other, while the SR of bond is far higher than others.

The Sharpe Ratios here represent the situation of single asset performance under certain risk-free rate. This paper here interpreted that the asset bond may be the optimal choice if this paper chooses to invest in only one asset. Based on what figure 3 presents, this paper generally referred that invest in asset bond will be more efficient than any other asset.

5.2 Portfolio Construction

Given the Chinese stock market limit — short selling is forbidden, so this paper assumed the wi> 0. And based on the expected returns and risk calculated to construct the efficient frontier.

Our results were conducted without considering neither investors' risk appetite nor their asset preference and based entirely on the MV model and Sharpe Ratio.

5.2.1. Efficient frontier

The figure 4 presents the efficient frontier of our portfolio in the long only market, consisting of these 4 assets, at the risk-free rate of 2.79%. Our results were conducted without considering neither investors' risk appetite nor their asset preference and based entirely on the MV model and Sharpe Ratio.

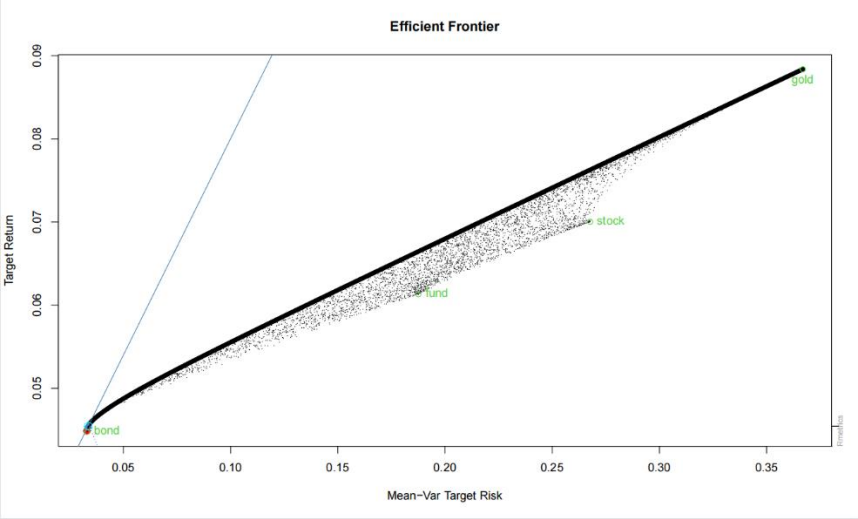

Figure 4 Efficient Frontier

The green points labeled with asset name illustrates the situation that investors buy 100% of a single asset. The red round dot depicts the portfolio with minimum risk, while the blue triangular point accounts for that with the maximum Sharpe Ratio. All the black dots in the graph are the feasible portfolios investors can achieve under the real market situation. The black line in bold is the upper boundary of all the possible portfolios – the Efficient Frontier, all the portfolio on this boundary is the maximum return that investors can obtain under certain level of risk (decide by the x-axis). The blue line is the Capital Market Line (CML), which is tangent to the Maximum Sharpe Ratio portfolio on the efficient frontier.

Due to the forbid of short selling in Chinese market to individual investors, the efficient frontier appears to be a straight line that links the asset bond and asset gold. And the nuance between the asset gold, bond and stock makes our optional portfolio area a quiet narrow one. As what this paper have calculated in table 2, the risk of asset bond is the lowest among all the assets. The minimum risk portfolio thus will be largely composited by asset bond and situated quiet near to the asset bond. This paper also observed that the maximum SR point is also quiet near to the asset bond due to the high SR of bond.

In the following part, this paper would figure the precise weight of two portfolio and explain the suggestion to individual investors.

5.2.2. The minimum risk portfolio

The minimum risk portfolio (red round dot) was presented as the pie chart in figure 5 illustrated. With an investment of 99.66% of bond asset and 0.34% of stock asset, investors will be able to get an expected return slightly inferior to the single bond asset but also a slightly lower risk.

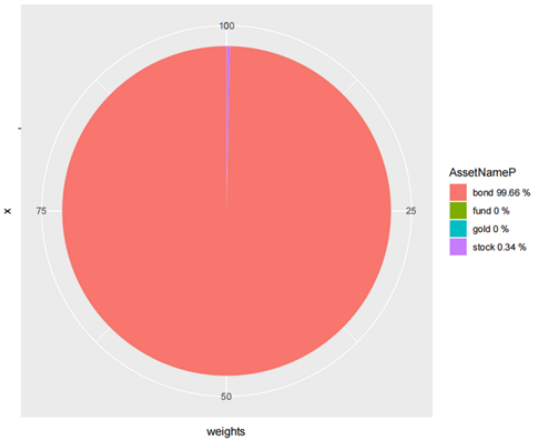

Figure 5 Weights of the min-risk portfolio

Table 4. Expected return and risk of min-risk portfolio

Min-risk Portfolio	
Return (mean)	0.0449
Risk (s.t.d.)	0.03300269

So here, based on the charts above, this paper advise individual investors to invest largely in bond asset to minimize the risk. As bond is the safest asset among all. The result of minimum risk portfolio is similar to that of the single bond asset.

5.2.3. Weights of the max-SR portfolio

The minimum risk portfolio (red round dot) was presented as the pie chart in figure 8. With an investment of 97.37% of bond asset and 2.63% of stock asset, investors will be able to get an expected return inferior to the single bond asset but also a higher Sharpe Ratio.

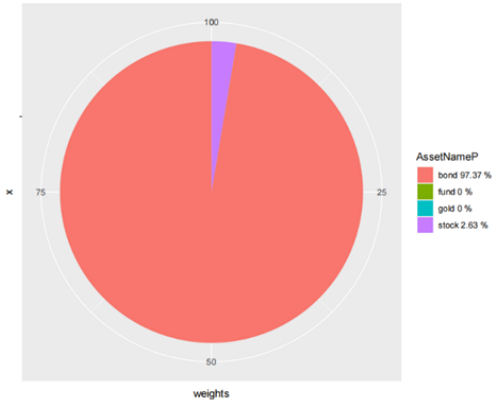

Figure 6 Weights of the max-SR portfolio

Table 5. Expected return and risk of max-SR portfolio

Min-risk Portfolio	
Return (mean)	0.0454
Risk (s.t.d.)	0.0336

Hence, based on the charts above, this paper advises individual investors to combing the asset bond and stock to get the highest SR, which denotes the efficiency of an asset (highest return per unit of risk). So, this paper generally assumes this portfolio to be the optimal to achieve.

Admittedly, strange phenomena exist in the results that this paper has conducted: the similar SR value among the stock asset, bond asset and fund asset, the dominance of the bond asset in the optimized portfolio…This paper concluded there are several reasons for that:

Firstly, Chinese market is not an entirely open market. This is the reason why the efficient frontier of our study is in a strange narrow shape. There are numerous limits that are imposed on investors. For example, the short selling constraints have limited part of our ability to use multiple assets portfolio to hedge risks.

Secondly, Chinese securities market is not mature enough. As an emerging strength in financial world, China is still under the route of development. Nowadays, instead of capital market-oriented market, the overall Chinese financial system shows traits of financial restraint and bank-oriented. Even though the market share has been gradually open to non-bank institutions since 2009, banks are still dominant in Chinese market, leading to weak capacity to improve the returns in stock market. Taking stock market as example, the critical point of US stock market is superior to that of China stock market, 2.5% to 0.3% (Peng and Li, 2012), stating the China market is less competent than US market.

Finally, MV models has its limitations and weakness. Raised by Markowitz in 1952, MV model have gone through decades with optimization and adjustment by lots of economists. This model has certainly received some critics though. One primary weakness is the estimation errors that happens when this paper tries to anticipate the mean and the covariance. This error may lead to that frontier this paper calculated is far from what in the reality. Scholars are eager to solve this problem with more accurate estimation method, such as the Black-Litterman framework introduced in 1990s. This kind of extreme portfolio problem happens mostly under occasion of extreme longs and extreme shorts. Thus, this paper concluded this error can only explain a small part of our result.

5.3 Suggestions to Individual Investors

According to the results that this paper obtained, individual investors should invest more on the bond asset for permanent investment to get a better personal asset allocation. With an investment of 97.37% of bond asset and 2.63% of stock asset, investors will be able to acquire a yield of 4.54% (annualized) under the risk level of 3.36%. This is a general advice to all the individual investors.

6. Conclusion

In this paper, this paper reviewed previous study in asset allocation for multi-asset…

Then, this paper introduced the Mean-Variance model and the Capital Market Line, and apply this to the 4 assets that this paper has chosen: fund, gold, stock and bond. The empirical results illustrated that to maximize the yield per unit of risk, investors need to invest more in bond and only a small part in stock. This will allow individual investors to gain a yield of 4.54% (annualized) under a rather small risk level, conforming to the demand of individual investors to long-term investment.

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