

Portfolio Analysis for the Retired Population

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Abstract. Based on the realistic needs of retirees, this paper examines the optimal investment portfolio through diversification. Allows retirees to maximize their returns while taking less risk. Stocks include technology, real estate, biopharmaceuticals, education and other industries. In this study, monthly closing prices from October 2017 to October 2020 were selected as data, and the mean-variance model, CAPM model, and FF3F model were used to calculate the maximum Sharpe ratio and the percentage of each stock, respectively. In the mean-variance model, the maximum Sharpe ratio is about 0.35, of which Vanke accounts for 0 and AAPL accounts for the largest share, about 0.5; in the CAPM model, the maximum Sharpe ratio is about 0.11, of which Heng Rui-like accounts for 0 and CSL accounts for the largest share, about 0.353; in the FF3F model, the maximum Sharpe ratio is about 0.11, of which Heng Rui-like accounts for 0 and CSL accounted for the largest ratio of about 0.45. Meanwhile, this paper calculates the covariance and correlation coefficient between each asset. The correlation coefficient of each asset is obtained close to 0, and the correlation degree is low. Heng Rui Pharma is negatively correlated with Vanke, then this use is that the inclusion of AB in the portfolio at the same time will reduce the risk of the portfolio.

Keywords: Retirees; Sharpe Ratio; best Portfolio.

1. Introduction

A group from the Institute of Population Studies at Peking University has studied the EU Economic Policy Committee the EU Economic Policy Committee believes that if member states do not take appropriate action, by 2050 Most member states will see an increase in public spending as a percentage of GDP, which is mainly spent on pensions, health care and long-term care. These expenditures are mainly for pensions, health care and long-term care [1]. After the 08 financial crisis there were many countries that experienced shrinking asset values and significant reductions in pension benefits as a result of pension development. and is accompanied by a trend towards longer life expectancy and lower birth rates [2]. It means that there will be a growing population of retirees, and there is a growing need to invest their savings for returns in order to ensure that their retirement is not affected by surprises such as inflation and longevity risks. Chinese scholar Wang analysed that Chinese residents' real demand for personal pension protection and financial management services is yet to be supplied, long-term demand is yet to be realized, and potential demand is yet to be explored [3]. Juan et al. used integrated accounting, individual life-cycle profiles and general equilibrium models to assess social security expenditures under population aging in Spain [4]. Borger applied a stochastic mortality model to calculate solvency capital requirements for longevity risks with underestimated mortality through the value at risk (VaR) approach [5]. Wang reviews the pension adjustment policy introduced in the United States in the context of the New Hall epidemic, i.e., delaying the age of first pension withdrawal, which treats the symptoms but not the root cause [6]. Liu and Ma indicated that participants tend to make actions such as following the crowd, avoiding decisions and risk aversion when they are insured [7-8]. Because of the complexity of determining the optimal portfolio model, to reduce the burden on retirees, this paper examines how investing in technology, real estate, biopharmaceuticals, education, and other areas can result in less risky sustained returns.

2. Data

Data were obtained from Yahoo Finance (<https://finance.yahoo.com>). The monthly closing prices from October 2017 to October 2021 (5 years) were selected for this study for the stocks AAPL, Hengrui Pharma, Vanke, CSL, and CHGG. Three criteria were used to select the stocks: first, the company is reputable and has a large scale of operation; second, there is a continuous demand for the company in the market; and third, to avoid high correlation, all five stocks are from different sectors. After obtaining the price data, it is processed and converted into a monthly yield, which is the month-end index closing price divided by the month-end index closing price minus one.

3. Method

3.1 Mean-Variance Theory

The mean-variance theory uses the mean and variance to measure return and risk. The mean is the expected return in a portfolio, and the variance is the variance of the portfolio's return. The core of the theory is how to maximize the return of a portfolio when the risk of the portfolio is certain, and the formula is as follows.

$$\text{Max } \sum_{i=1}^N x_i u_i = u_p \quad (1)$$

$$\text{s. t. } \sigma_p^2 = \sum_{i=1}^N \sum_{j=1}^N x_i x_j \sigma_{ij} \leq \bar{\sigma}^2 \quad (2)$$

$$\sum_{i=1}^N x_i = 1 \quad (3)$$

The main objective of this study is to find the optimal portfolio of risky investments, so the method of maximizing the Sharpe ratio is used. The Sharpe ratio has been studied in modern investment theory to show that the magnitude of risk plays a fundamental role in determining the performance of a portfolio.

$$\text{Sharp Ratio} = \frac{E(r_p - r_f)}{\sigma_p} \quad (4)$$

3.2 Capital Asset Pricing Model

Lintner was the first to implement an empirical test of the CAPM by analyzing the excess return of individual stocks [9]. It is an advancement of the mean-variance model [10]. The model established that the risk taken by an asset largely affects the future return of the asset. It laid a thick foundation for the subsequent theory of financial asset prices. The relevant equations are as follows.

$$E(r_i) = r_f + \beta_{im}(E(r_m) - r_f) \quad (5)$$

$E(r_i)$: the expected rate of return on asset i

r_f : risk-free rate

β_{im} : [[Beta coefficient]], which is the systematic risk of asset i

$E(r_m)$: the expected market return of market m

$E(r_m) - r_f$: market risk premium, i.e., the difference between expected market return and risk-free return.

3.3 Fama-French Three-factor Model

Individual stock excess returns that are strongly explained by the Fama-French three-factor model for mature stock markets. Fama [11] tested the three-factor model based on the stock return changes in mature foreign markets and found that the market effect and scale effect are more significant in

most stock markets, indicating that the three-factor model is more advantageous than the CAPM model. The formula is as follows.

$$E(R_{it}) - R_{ft} = \beta_i [E(R_{mt}) - R_{ft}] + s_i^E (SMB_t) + h_i^E (HML_t) \quad (6)$$

R_{ft} denotes the risk-free return at time t ; R_{mt} denotes the market return at time t ; R_{it} denotes the return on asset i at time t ; $E(R_{mt}) - R_{ft}$ is the market risk premium, SMB_t is the simulated portfolio return (Small minus Big) for the market capitalization (Size) factor at time t , and HML_t is the simulated portfolio return (High minus Low) for the book-to-market ratio (Book-to-Market) factor at time t .

4. Results

In this paper, the average monthly return is calculated using the monthly closing price of each stock as the basis for deriving the covariance and correlation coefficient between individual stocks (See Figure 1 and Table 1).

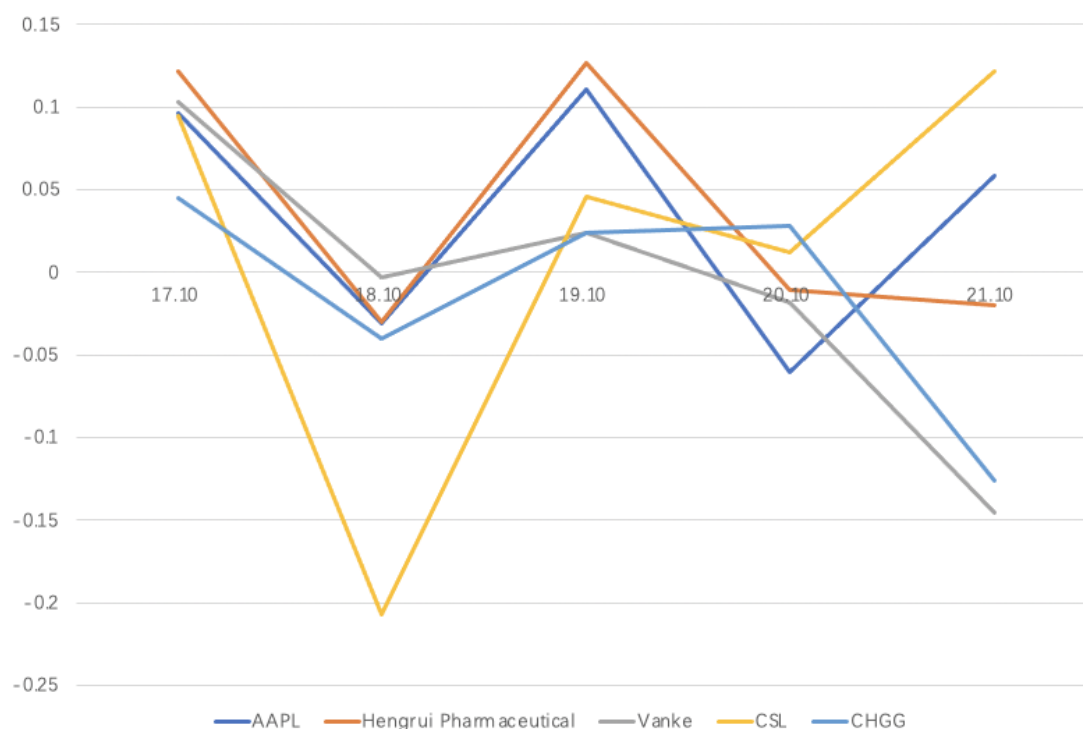


Figure 1. Average monthly returns of stocks.

The data in this figure shows that the highest return occurred in October 2019 for Heng Rui Pharmaceuticals and the lowest return occurred in October 2018 for CSL. the five stocks do not have identical return trends and can be used as a basis for hedging.

Table 1. Covariance between stocks

	AAPL	Hengrui Pharmaceutical	Vanke	CSL	CHGG
AAPL	0.00786537	0.00132496	-0.0003648	0.00271889	0.00404539
Heng Rui Pharmaceutical	0.00132496	0.01134677	0.00217509	0.00016157	0.00230826
Vanke	-0.0003648	0.00217509	0.0078194	-0.0004348	-0.0002743
CSL	0.002719	0.000162	-0.00043	0.006222	0.001277
CHGG	0.00404539	0.00230826	-0.0002743	0.00127727	0.02262393

As the table shows, Vanke is only positively correlated with Heng Rui Medicine and negatively correlated with AAPL, CSL and CHGG. All four stocks except Vanke are positively correlated with each other.

Table 2. Correlation coefficients among stocks

	AAPL	Hengrui Pharmaceutical	Vanke	CSL	CHGG
AAPL	1				
Heng Rui Pharmaceutical	0.14025177	1			
Vanke	-0.0465211	0.23091651	1		
CSL	0.38865659	0.01922884	-0.0623328	1	
CHGG	0.30144049	0.14320222	-0.0204986	0.10700867	1

As shown in the Table 2, the absolute value of the correlation coefficient between each variable is less than 1 and close to 0. It can be concluded that the correlation between each of the variables is low. Consistent with the requirements of the portfolio for this study. Diversifies risk and reasonably reduces the risk of the investment.

Table 3. Arithmetic mean, variance of stocks

	AAPL	Hengrui Pharmaceutical	Vanke	CSL	CHGG
Avg	0.03045279	0.01157609	-0.0012348	0.0235826	0.01892357
Variance	0.00786537	0.01134677	0.0078194	0.00622203	0.02262393
Standard Deviant	0.0886869	0.1065212	0.08842735	0.07887984	0.15041252

From the above table 3, the arithmetic mean of AAPL is the largest, about 0.03, and the arithmetic mean of Vanke is the smallest, about -0.001. It means that among them, AAPL has the largest expected return.

Using the mean-variance model, the portfolio with the maximum Sharpe ratio is calculated and the following results are obtained.

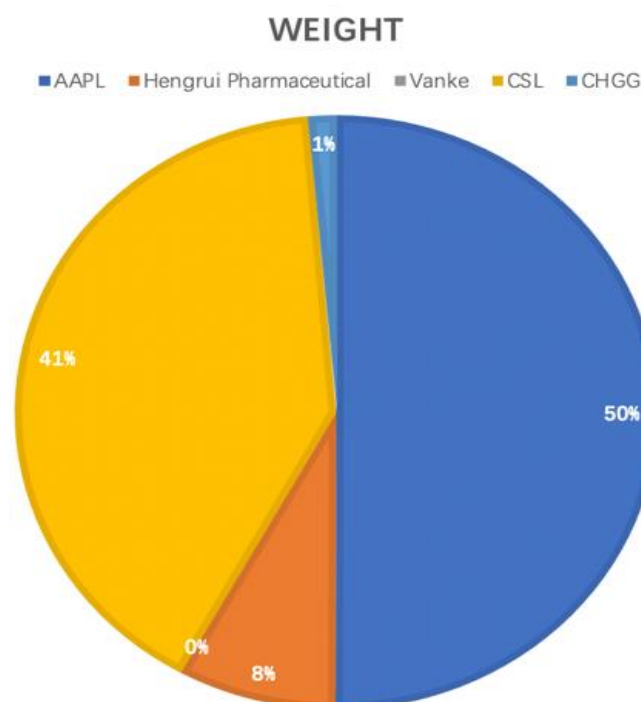


Figure 2. Share weighting of each stock (Mean Variance)

Table 4. Optimization results of the portfolio with maximum Sharpe ratio

	Value
Expected Return	0.02599516
Variance	0.0043669
Standard deviation	0.06608251
Sharp ratio	0.3530675

The largest share is AAPL with a value of 0.5. Vanke has the smallest share of 0. The reason may be that Chinese policies regarding real estate have been relatively restrictive and detrimental to the development of real estate in the past years. However, now that the policies are adjusted, the real estate industry is showing signs of rebound. In addition, this paper also finds the result of the minimum variance combination (See Figure 2 and Table 4).

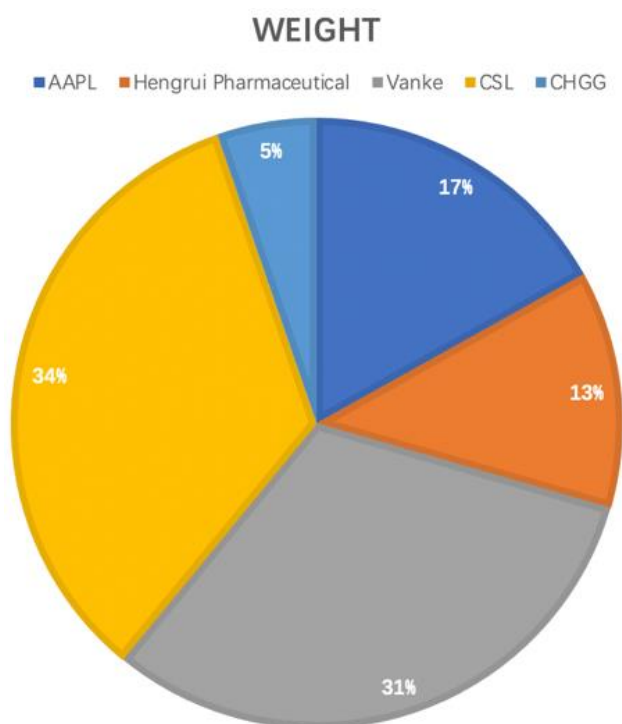


Figure 3. Share weighting of each stock (Minimum variance in mean variance)

Table 5. Results of the minimum variance combination

	Value
Expected Return	0.01517502
Variance	0.002512
Standard deviation	0.05011943
Sharp ratio	0.2496326

The largest weight is CSL at 0.3378 and the smallest is CHGG at 0.0527. CSL has the largest weight, probably because it focuses on the medical-pharmaceutical aspect, which is relatively well developed in the current environment, where there is a great need for such companies to contribute to society (See Figure 3 and Table 5).

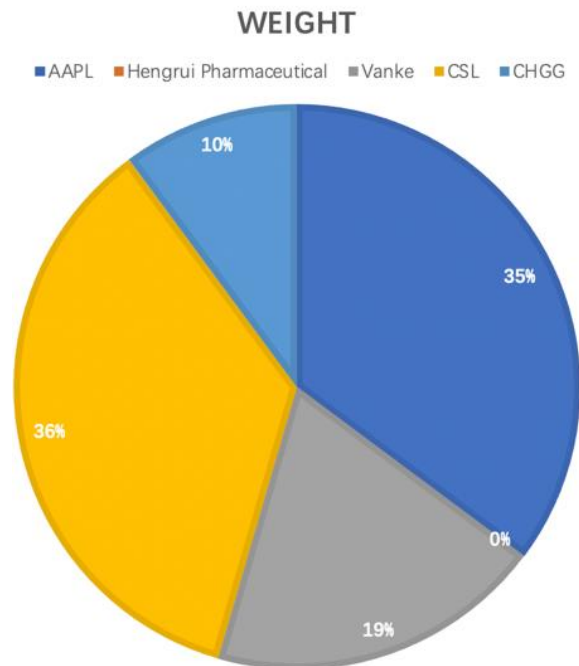


Figure 4. Share weighting of each stock (CAPM)

Table 6. Results of the minimum variance combination

	Value
Expected Return	0.0087761
Variance	0.00321302
Standard deviation	0.05668354
Sharp ratio	0.10783605

Table 6 and Figure 4 show the analysis results of the CAPM model. The Sharpe ratio obtained from the CAPM model is 0.1078. the largest share is for CSL, while the share for Hengrui Pharmaceutical is 0.

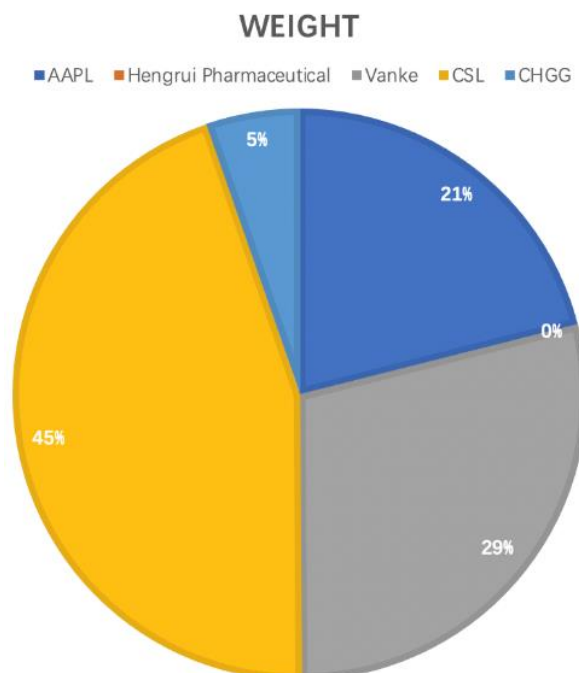


Figure 5. Share weighting of each stock(FF3F)

Table 7. Results of the minimum variance combination

	Value
Variance	0.00281085
Expected Return	0.008254
Standard deviation	0.05301741
Sharp ratio	0.1054397

Table 7 and Figure 5 show the analysis results of the FF3F model. The Sharpe ratio obtained from the CAPM model is 0.1054. the largest weight is CSL, and the weight of Hengrui Pharma remains zero.

5. Discussion

Overall, this paper shares the Sharpe ratios of each of the three portfolio models by calculating them separately. The highest Sharpe ratio is 0.1078 (Figure 7), and the ratio between AAPL and CSL is about 0.35. The reason is that Apple is a technology company, and its business has been growing steadily and rapidly in recent years. CSL, a global biotherapeutics giant, has been on a rebound, although its stock price has fluctuated. The company announced its full-year results for fiscal 2022, with corporate and performance outperforming market expectations, and the company's sales have now rebounded to pre-epidemic levels.

6. Conclusion

This article focuses on a portfolio of stocks suitable for the growing number of future retirees. In the absence of future pension security, savings should be invested in relatively stable stocks to maximize returns. The current research is directed at how multiple of the paper on retiree life security can improve pension policy and retirement insurance. In this study, five stocks with r -squared close to 1, α greater than 0 and β less than 1 were selected as indicators. Then the Sharpe ratios were calculated using mean-variance model, CAPM model and ff3f model respectively, and the maximum value was selected as the best portfolio by comparison.

Monthly closing prices from October 2017 to October 2020 were selected as data, and the maximum Sharpe ratio and percentage for each stock were calculated using the mean-variance model, CAPM model, and FFTF model, respectively. In the mean-variance model, the maximum Sharpe ratio was about 0.35, with Vank and AAPL accounting for the largest percentages, 0 and 0.5, respectively; in the CAPM model, the maximum Sharpe ratio was about 0.11, with Hengrui Xiang and CSL accounting for the largest percentages, 0 and 0.353, respectively; in the FFTF model, the maximum Sharpe ratio is about 0.11, with Hengrui Xiang and CSL accounting for 0 and 0, respectively. At the same time, the covariance and correlation coefficients between the assets were calculated. The correlation coefficients for each asset are close to 0, indicating a low degree of correlation. Hengrui Pharmaceutical and Wanke are negatively correlated, and this use means that including AB companies in the portfolio at the same time will reduce the risk of the portfolio.

There are two shortcomings in this article. One, the stock selection is for the last five years, which is still not comprehensive and not fully representative of future trends. Second, the CAPM model and FF3F model used in this paper cannot take into account all the influencing factors and have limitations.

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