Research on Optimizing Pension Planning Allocations

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Abstract: This article examines two ways of pension allocation, choosing the best opportunity mix based on Fama and the French three-factor model to maximize returns while satisfying each portfolio category and other investment conditions. The database used by the author is based on the excess returns of 8 different stocks from October 2018 to January 2022. This article studies the relationship between different stocks by calculating the variance, standard deviation and covariance of different stocks, and divides stocks into large-cap stocks, small-cap stocks, value stocks, and growth stocks. The author calculated the optimal Sharpe ratio. Empirical results show that the sharpe ratio value obtained from the investment portfolio can be concluded that when people live for more than 20 years after retirement, they can choose to receive pensions every year. If your life expectancy after retirement cannot reach 20 years, it is recommended to withdraw your pension in one lump sum. However, this article shows that results change when using different portfolio approaches because of data limitations.

Keywords: Pension Investment, Portfolio Optimization, Fama And the French Three-factor Model

1. Introduction

Due to advances in medicine, human lifespan has been extended. The population over 60 years old will increase to approximately 1.4 billion in 2030 [1]. The aging of the population is a serious problem now, because the proportion of old people in society has increased and the proportion of young people has decreased, which has increased the pressure on the government to distribute pensions [2]. The government needs more funds to support pension expenditures because the proportion of elderly people is increasing [2]. However, as the proportion of young people decreases, the tax burden increases, so it is very important to pay attention to pension planning and pension allocation [2]. In affluent nations, the aging of the population is also becoming a major problem for providing public pensions [3]. Governments often discount payments in social security changes to solve this issue, which might stimulate private investment in pension plans [3].

Everyone will face the problem of pension distribution as they age. Because people no longer have wages after retirement, and the source of people's life security is the return from retirement accounts [4]. People should be orderly when withdrawing their retirement funds. Planned withdrawals can prevent you from depleting your retirement savings prematurely [5]. In this article, two ways of withdrawing pensions are studied. The first is to receive a lump sum pension at retirement, and the second is to receive a fixed pension every year, plus a 3% per annum cost of living increase until death. Then in the case of one-time withdrawal of pension, pension investment will become a

common problem we face. Therefore, how to construct a pension investment portfolio has become an urgent problem to be solved.

The research value of this article is to provide optimization suggestions on pension management and help pension managers determine the optimal investment portfolio. It is suggested that planning pensions can enhance financial markets.

In this article, the structure is as follows. In Section 2, this article classifies 8 stocks and makes a summary according to different categories. The different Sharpe rates produced by different retirement lifespans were calculated and compared, and the Fama and French three-factor models were introduced. In Section 3, the calculation results are analyzed, and the variance and standard deviation are calculated for each stock to estimate investment risk. The correlation between each stock is described by calculating the covariance. The goal of this article is discussed in Section 4, which is to create an optimal portfolio that ensures financial security while pursuing growth. Finally, results are drawn in Section 5.

2. Data and Method

2.1. Data

Sample description. In this article, I use the monthly returns from October 2018 to January 2022, for a total of eight stocks. This article creates a portfolio specifically for the one-time payment option, and the stock data in this article is historical stock data extracted from Yahoo Finance. The carefully selected mix of asset types in this portfolio is designed to balance risk and return [6]. Stocks in this article's portfolio include XOM, GM, EXTR, UAL, DAR, TZOO, AVALX, and RMQAX. Among them, Xom and GM are value stocks, EXTR is a growth stock, UAL DAR is a large-cap stock, and TZOO is a small-cap stock. The widely recognized financial theory, Fama and the French three-factor model, is the basis of the investment method in this article. The Fama and French three-factor model is based on academic and empirical research. The reason why this article chooses FF3F as the basis of the investment method is to diversify risks. According to this model, the important characteristics that affect asset returns are market risk, size and value. Therefore, this article makes investments based on the value and weighting of different stocks. For example, an asset like UAL might represent factors that the model considers critical to expected returns. Each asset type contributes to portfolio diversification and potential returns in unique ways. For example, DAR offers stability, while assets like XOM and UAL offer growth potential. The diversification of the investment portfolio is designed to withstand different market conditions, support the objectives of optimizing pension funds, and is expected to minimize investment risks and maximize investment returns [6]. Therefore, this article will strategically select assets to increase the likelihood that your portfolio will perform well.

When making an investment portfolio, this article considers the impact of different lifespans on investment returns. The possibility of living longer than expected can have a profound impact on people's retirement lives. The source of motivation for investing in the stock market can be a desire to increase retirement savings, and since there may be more time after retirement, people may seek greater control over their investments to ensure continued financial well-being [7]. This article will conduct calculation and analysis from three different lifespans. Pension investments are divided into 25 years, 20 years, 15 years, and one-time withdrawal. Through calculation, this article finds that the Sharpe ratio is the highest when people's life span reaches 25 years after retirement. Because in this case, this article recommends choosing to retain the pension. The Sharpe ratio without pension is the highest when the life expectancy after retirement is less than 25 years, so in this case it is more appropriate to withdraw the pension in one go for investment. The data given in this artical about the case is shown in the table 1.

Table 1: Sharpe ratio in different cases.

	Without pension	with pension(25)	with pension(20)	with pension(15)
Sharpe ratio	0.1287	0.1966	0.1623	0.1049

As this article weighs the options, considerations of increased life expectancy underscore the importance of developing a strategy that matches the number of potential retirement years.

2.2. Method

In 1992, Eugene Fama and Kenneth French designed a statistical model that can describe stock returns. This article is based on their Three-Factor Model. The reason why the Fama and French three-factor models were chosen is because the author Taneja mentioned that the traditional CAPM has limitations in predicting stock market returns, while the Fama and French three-factor model can provide better prediction capabilities [8]. The three-factor model consists of the following, first, a market factor, also known as "market systematic risk", second, a firm size factor, which is a "market capitalization size strategy", and third, a "price-to-book ratio strategy", which corresponds to the value factor [9]. Small Minus Big can be abbreviated as SMB, which is the return from going long on a company with a smaller market capitalization than shorting a company with a larger market capitalization. HML is High Minus Low, which encompasses the return from going long on a company with a high BM and shorting a company with a low BM [9]. This article calculates the data of each stock based on Fama and French three-factor model as shown in the table 2:

Table 2: Fama and French three-factor model data.

	XOM	GM	EXTR	UAL	DAR	TZOO	AVALX	RMQAX
FF3F:								
Rf	0.0027							
Mkt-Rf	0.0068							
SMB	0.0019							
HML	0.0034							
Mkt-Rf Coefficient	0.9154	0.8272	1.4741	1.1251	0.9447	1.6556	1.2301	2.0399
SMB Coefficient	0.5017	1.3687	1.4561	0.7711	0.9086	1.3968	0.2217	-0.1276
HML Coefficient	1.1635	0.7964	0.8039	1.5041	0.4199	1.1729	0.6815	-0.5552
Expected Return	0.0138	0.0136	0.0181	0.0168	0.0122	0.0205	0.0137	0.0143

3. Results

3.1. Correlation analysis

This article observes the size of risk by calculating the variance and standard deviation of each stock, as shown in the table 3:

Table 3: Variance and Standard Deviation for different stocks.

	XOM	GM	EXTR	UAL	DAR	TZOO	AVALX	RMQAX
Variance	0.0111	0.0125	0.0297	0.0189	0.0116	0.0330	0.0093	0.0137
Standard Deviation	0.1055	0.1116	0.1724	0.1376	0.1076	0.1816	0.0962	0.1173

The largest variance of the stock TZOO indicates that it has the highest risk; the smallest variance of the stock AVALX indicates that it has the lowest risk. This article also calculates covariance to study the correlation between each stock. As shown in the table 4:

Table 4: Covariance table for different stocks

	XOM	GM	EXTR	UAL	DAR	TZOO	AVALX	RMQAX
XOM	0.0111	0.0054	0.0081	0.0083	0.0039	0.0100	0.0069	0.0054
GM	0.0054	0.0125	0.0111	0.0093	0.0066	0.0118	0.0064	0.0066
EXTR	0.0081	0.0111	0.0297	0.0142	0.0063	0.0107	0.0093	0.0107
UAL	0.0083	0.0093	0.0142	0.0189	0.0067	0.0137	0.0075	0.0063
DAR	0.0039	0.0066	0.0063	0.0067	0.0116	0.0081	0.0053	0.0060
TZOO	0.0100	0.0118	0.0107	0.0137	0.0081	0.0330	0.0106	0.0112
AVALX	0.0069	0.0064	0.0093	0.0075	0.0053	0.0106	0.0093	0.0077
RMQAX	0.0054	0.0066	0.0107	0.0063	0.0060	0.0112	0.0077	0.0137

As shown in the table, the values of the covariance are all positive, so the returns of these stocks move in the same direction [10]. In the table, the maximum covariance of EXTR and UAL is 0.0142, so the correlation between these two stocks is the strongest. In the table, the minimum covariance of DAR and XOM is 0.0039, so the correlation between these two stocks is the weakest.

In doing so, this article examines people's retirement planning goals, financial plans, and the variables that influence their choices. Research in this article suggests that the lump sum option is more appropriate given increasing life expectancy and the desire for growth. This option provides people with investment control and flexibility consistent with their goals and life expectancy. Finally, this article highlights the importance of matching investment choices with long-term retirement goals.

4. Discussion

For pension portfolios, the focus of this article has shifted to pension supplement options and carefully designed a portfolio to supplement ongoing pension benefits. Our portfolio is carefully crafted from assets such as XOM, EXTR, UAL, DAR, TZOO, AVALX, and RMQAX. The portfolio is designed to balance the steady income of a pension with the potential growth of investments. By selecting assets that match pension income, this article aims to create a harmonious portfolio that ensures financial security while pursuing growth.

5. Conclusion

This article draws the following conclusions by studying the investment portfolio calculations of eight stocks: This article recommends that people have 20 years or more to receive pensions after retirement, and those who have less than 20 years to withdraw their pensions in one go. But these results are due to the way the portfolio is formed. So, you need to be careful when referring to data, as the results obtained will change when the approach to the investment portfolio changes.

References

[1] Philip Davis, E., 'Introduction', Pension Funds: Retirement-Income Security and Capital Markets: An Interna tional Perspective (Oxford, 1998; online edn, Oxford Academic, 22 Mar. 2012), https://doi.org/10.1093/acpro f:oso/9780198293040.003.0001, accessed 26 Sept. 2023.

[2] Amaglobeli, D., Gaspar, V., & Dabla-Norris, E. (2020, March 1). The impact of aging worldwide on pensions and public policy – IMF F&D. IMF. https://www.imf.org/en/Publications/fandd/issues/2020/03/impact-of-aging-on-pensions-and-public-policy-gaspar

[3] Josa-Fombellida , R., López-Casado, P., & Rincón-Zapatero, J. P. (2018, July 11). Portfolio optimization in a defined benefit pension plan where the risky assets are processes with constant elasticity of variance. Insurance: Mathematics and Economics. https://www.sciencedirect.com/science/article/pii/S0167668717306054

[4] U.S. DEPARTMENT OF LABOR. (n.d.). Types of retirement plans. Types of Retirement Plans. https://www.dol.gov/general/topic/retirement/typesofplans

[5] Horneff, W. J., Maurer, R., Mitchell, O. S., & Dus, I. (2006). Optimizing the retirement portfolio: Asset allocation, annuitization, and risk aversion.

[6] Zanjirdar, M. (2020). Overview of portfolio optimization models. Advances in mathematical finance and applications, 5(4), 419-435.

[7] Farhi, E., & Panageas, S. (2007). Saving and investing for early retirement: A theoretical analysis. Journal of Financial Economics, 83(1), 87-121.

[8] Taneja, Y. P. (2010). Revisiting fama french three-factor model in indian stock market. Vision, 14(4), 267-274.

[9] Blanco, B. (2012). The use of CAPM and Fama and French Three Factor Model: portfolios selection. Public and Municipal Finance, 1(2), 61-70.

[10] Cherewyk, P. (2018). Calculating covariance for stocks. Investopedia, Edmonton, AB, 1-5.