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Portfolio Construction based on AMZN, JPM, CSCO, GM and TSLA

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Abstract: Contemporarily, the sudden and rapid spread of the Newcastle pneumonia outbreak around the world caused stock markets in various countries to experience dramatic volatility in the early stages of the outbreak. The outbreak was an extreme stress test for global capital markets. On this occasion, investors change the risk strategy with high volatility to stable portfolio. On this basis, this paper will select relevant data of five listed companies in the United States in the last seven years through python, covering the period before and after the outbreak of New Canopy pneumonia. The aim of the study is to try to establish an optimal portfolio through CAPM model and asset allocation theory in order to maximize the acquisition return under investment risk diversification, facilitate investors to carry out practical exercises, further analyze the experimental results and discuss the limitations. Overall, these results shed light on guiding further exploration of portfolio construction under pandemic.

Keywords: Portfolio, CAPM, Efficient Frontier

1. Introduction

CAPM is built on the basis of the portfolio selection model developed by Harry Markowitz [1]. Later, the Sharp and others proposed the capital asset pricing model (CAPM) on this basis, which pointed out that under the assumptions of frictionless markets, investors have consistent rational expectations, and all assets can be traded in the market, the two of return and risk exhibit a positive proportional relationship [2], and this conclusion makes it possible to develop reasonable judgments on the corresponding prices of risky asset portfolios, and the model. This conclusion makes it possible to make reasonable judgments about the corresponding prices of risky asset portfolios, and the model is generally respected and recognized by academics because it reflects the nature of economic markets to a certain extent. Effective asset allocation is the key to successful investment. In essence, the most fundamental issue in finance is how to allocate assets. Over the years, practical and theoretical explorations have developed a variety of typical asset allocation strategies, which have realized the transformation from qualitative to quantitative analysis and laid a solid foundation for asset allocation in the context of artificial intelligence era [3].

The difference in the performance of different assets in different economic states stems from the difference in risk exposure of each asset class at the level of different factors, and academic studies

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have continuously started to focus on the factors behind the assets and attempt to conduct asset allocation studies at the level of risk factors. Risk factors can be traced back to market factors in the CAPM model, and then Ross used arbitrage pricing theory to formally demonstrate the relationship between multiple risk factors and asset returns, and proposed a more robust general model that laid the foundation for subsequent risk factor studies [4]. Grinold et al. have contributed in promoting factor strategies from theory to practice [5]. In the field of cross-asset multi-strategy, Fung et al. proposed a seven-factor model to explain the return of hedge funds [6]. With the continuous development of theory and practice, relevant studies targeting factor allocation have been deepened. For example, Greenberg et al. proposed a method to map factor exposures to asset portfolios using six macroeconomic factors (global equity, inflation, real interest rate, commodity, credit, and emerging market risk) to minimize the sum of factor exposure errors and active risk terms for asset portfolios subject to a target factor exposure constraint [7]. Bender et al. use factor simulation portfolios to map assets to various macro and style factors, and later optimize the factor portfolios by forecasting factor returns to obtain asset portfolios, and their empirical analysis based on data from 2011-2016 finds that the approach yields strategy performance with stable Sharpe ratios and low turnover [8]. Swade et al. constructed dozens of macro risk factors in global equity, bond, commodity, and exchange rate markets through a factor simulation portfolio approach, verifying that both asset and style factors have significant exposure at the macro factor level and that markets with negative growth and high inflation can be avoided by constructing portfolios with diversified macro risk factors [9].

This study will implement a model of a stock portfolio of the top five companies through the python programming language. This paper will first describe the data sources and process of building the model. Then, the model results will be described and analyzed, and the potential applications and implications of the study will be discussed. Next, the limitations of this paper's research and the outlook for the future are given, and finally, a conclusion is given.

2. Data & Method

This paper focuses on building optimal portfolios of Amazon, JP Morgan Chase, Cisco, General Motors and Tesla for stock investment. This paper selects the closing price data of the top five stocks from 2014-2021. The data is obtained by crawling the database on Yahoo Finance using python to get historical data.

When calculating portfolio risk, asset returns may have some degree of covariance with one another. A portfolio risk of two assets a and b as:

$$\delta_p = \sqrt{\omega_a^2\delta_a^2 + \omega_b^2\delta_b^2 + 2\omega_a\omega_b Cov_{a,b}} \tag{1}$$

It can illustrate three important things. If the assets are uncorrelated, the last term will be close to zero and the portfolio risk will indeed be close to the weighted sum of the asset risks. If the assets in portfolio have a high degree of covariance, then the last term will be positive and our portfolio risk will be higher than the sum of the individual components. In other words, when one asset as a negative return, the other one is more likely to. If the assets in portfolio have a negative covariance, i.e., when one goes up the other goes down, the portfolio will tend to have a lower risk than the sum of the assets. In addition, it can also be found that the optimal portfolio by maximizing the expected return. The Sharpe Ratio, measures the performance of an investment (e.g., a security or portfolio) relative to a risk-free asset after adjusting for its risk, is defined as:

$$Sharpe\ Ratio = \frac{r_p - r_f}{\sigma_p} \tag{2}$$

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Here, r_p is the expected return of the portfolio; r_f is the risk free rate, σ_p is the standard deviation of the portfolio. Practically speaking in post-crisis times, one will assume the risk free rate is zero. The higher the return is relative to the portfolio risk, the higher ratio value will be. It can be used to compare portfolios. This study will use Python to construct a portfolio of target stocks and use a simple optimization technique to find the efficient portfolio. This study will first get historical data and use daily close price to calculate the daily returns. Subsequently an efficient portfolio is one that minimizes the risk for a given level of expected return or maximizes expected return for a given level of risk. Since it can be found which stocks are in our portfolio, then the only thing that is ambiguous is the weights or relative amount, of each stock in our portfolio. One will basically just try a large number of different combinations of weights, calculate the historical risk and return for each portfolio, and plot them to find the efficient frontier. Afterwards, this paper will evaluate efficient frontier and optimal portfolios and a large number of simulated portfolios are shown. Then, this paper will plot the efficient frontier of portfolios.

3. Results & Discussion

The results of the program are shown in Figure 1, where the horizontal axis represents the portfolio risk and the vertical axis represents the portfolio return. 10,000 portfolio solutions are shown in the scatter plot, where the maximum Sharpe index is about 1.33 and the minimum risk value is about 0.21, which are the red and green points in the plot. The boundary above the green point in the graph is called the efficient boundary, which represents the set of portfolios that obtain the maximum return with the minimum risk. Since the tangent point between the effective boundary and the capital allocation line is the portfolio with the highest Sharpe index, the red point in the figure is the theoretically optimal portfolio. Taking the portfolio with the maximum Sharpe index and the portfolio with the minimum risk as examples, the percentage coefficients of each stock can be found by python.

The optimal portfolio has Amazon at about 35.3%, JP Morgan at about 17.9%, Cisco at about 20.7%, GM at about 0.05%, and Tesla at about 26%. Conversely, when the portfolio is at its lowest risk, Amazon accounts for about 24.5%, JP Morgan Chase for about 31.3%, Cisco for about 37.3%, GM for about 5.5%, and Tesla for about 1.4%. Both Amazon and Tesla have decreased their share, while JP Morgan, Cisco and GM have increased their share, leading to a decrease in investment risk.

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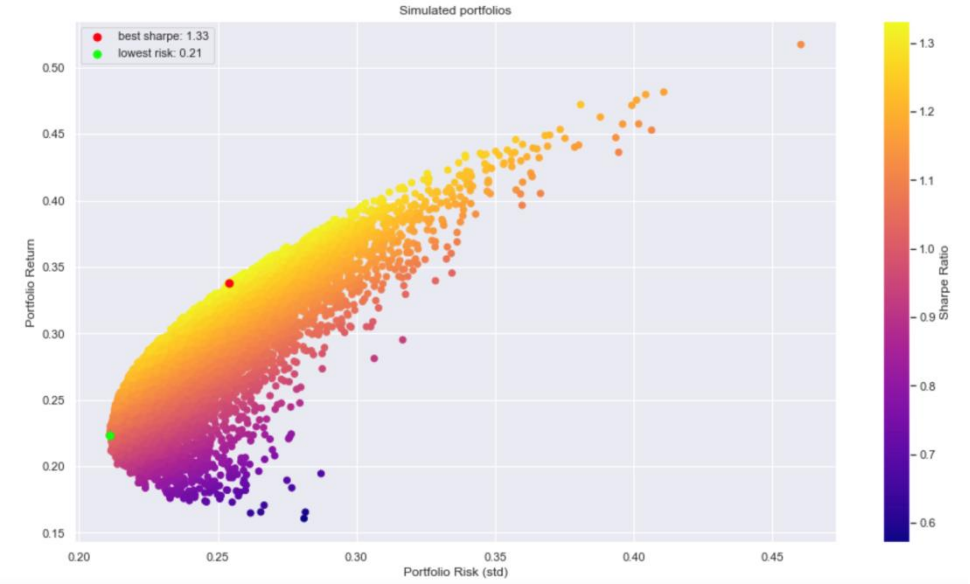

Figure 1: Scatter plot depicting the effective boundary.

Table 1: Variance and Covariance between the underlying assets.

	AMZN	JPM	CSCO	GM	TSLA
AMZN	0.000367	0.000091	0.000124	0.000090	0.000234
JPM	0.000091	0.000294	0.000142	0.000219	0.000143
CSCO	0.000124	0.000142	0.000245	0.000137	0.000136
GM	0.00090	0.000219	0.000137	0000452	0.000200
TSLA	0.000234	0.000143	0.000136	0.000200	0.001169

The variance covariance between the top five stocks can be obtained by python, as shown in Table 1. The table shows that the covariance between stocks is positive, indicating that the returns of the five stocks are trending in the same direction, but because the correlation coefficient is non-negative and not 1, the portfolio has a weak degree of diversification risk, resulting in a loss of portfolio return, reducing the unsystematic risk of investment and minimizing the risk of the portfolio. Such a portfolio with the same trend of movement has a certain risk that both may go up or down in the ever-changing stock market. In summary, when it comes to investing in the above five stocks, the optimal portfolio allocation is about 35.3% for Amazon, 17.9% for JP Morgan, 20.7% for Cisco, 0.05% for General Motors and 26% for Tesla. Amazon is the main investment target for investors, while GM accounts for the least.

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4. Limitations & Prospects

In total, this paper has three limitations. Primarily, the CAPM has failed the test of reality. Fama and French argue that the empirical record of the CAPM is poor enough to invalidate the way it is used in applications [10]. CAPM 's poor empirical performance may reflect theoretical gaps, simplifying assumptions, and the difficulty of implementing valid tests. The model is based on some truly ludicrous assumptions: no commissions, no bid-ask spread, no taxes, investors view stocks only in the mean-variance space suggested by Markowitz, and investors can take any position without affecting the market price. Lai draws a strong but reasonable conclusion that the CAPM is a " tautology rather than an asset pricing model". He uses mathematical reasoning to conclude that the CAPM is useless and doomed for predicting the rate of return in the real world [11]. Efforts to rescue the CAPM did not change the fact that the model is theoretically bankrupt, empirically unsupported, practically useless at best, and misleading at worst.

In addition, the selected variables are all stocks, which lack diversity. There is no selection of some indices, funds or treasury bonds to increase the utility and make the model more applicable. At the same time, more stocks with low cross-industry correlation should be selected to construct the effective portfolio boundary. The returns of the stocks selected in this paper change with the same trend, resulting in slightly less diversification wind, which does not reflect the superiority of the portfolio.

It is hoped that future research will focus on multi-factor pricing models, and that by applying them to the model construction of portfolios, the level of risk-taking in investment behavior will be significantly optimized. The CAPM model would not be able to explain why the market value of a stock can also affect the movement of the stock price (market value effect), nor would it be able to explain the positive relationship between the book-to-market ratio of a stock and the volatility of the stock price (value effect). APT model is a good example of a model that shows that the factors explaining returns are not unique, and that expected returns can be expanded into a structure where multiple factors jointly determine them. This conclusion is closer to people's perception of the market than the CAPM and expands the range of factor selection. Of course, APT itself does not select the factors, and from this perspective, APT is a free model, and any model that can effectively explain the sources of risk is a qualified APT model. In addition, a larger number of more diverse variables can be appropriately selected for model construction to make the results more general and more practical.

5. Conclusion

Stock market shocks can affect the national economy and, most likely, lead to huge economic losses for investors. Analyzing the stability of financial markets, macroscopically it is mainly influenced by the national policies and guidelines, and microscopically it is the behavior of investors that counts as the most fundamental source of risk, so how investors construct optimal portfolios is the most critical. In this paper, the CAPM model and portfolio selection theory are used to construct the effective boundaries of investment in the stocks of five listed companies in the U.S., and the matching coefficients of the optimal portfolio are obtained. AMZN is the main investment object for investors, while GM appears to be the least. However, the CAPM model is weakly practiced, which leads to lower validity of the experimental results. Moreover, the five selected companies' stocks are slightly more correlated and do not reflect the strength of the portfolio. Nevertheless, based on the model, the efficiency of its investment application in the stock market can be found. On the one hand, the model is relatively simple and suitable for general investors to easily get

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started. On the other hand, it can accurately identify the optimal portfolio while controlling the effective boundary of the risky asset portfolio, and if deeper optimization is carried out it will certainly expand its applicability in the global market and benefit retail investors.

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