Proceedings of the 2nd International Conference on Business and Policy Studies
DOI: 10.54254/2754-1169/16/20231029

Risk Analysis and Portfolio Design in Stock Investment

Zhengyi Liu[1,†] and Lepeng Lv[2,a,*,†]

[1] Stonybrook University, New York 11720, the U. S.
[2] Southern University of Science and Technology, Shenzhen, 518055, China
a. 12010516@mail.sustech.edu.cn
**corresponding author*
[†]These authors contributed equally

Abstract: Contemporarily, it's common to see unrest in global financial market, so some corresponding analysis on investing risks have made, e.g., CAPM model. For the similar reason, in order to obtain an efficient and safe method to do stock investment in any market environment, we mainly investigate the risks caused during the process of stock investment based on stocks of ten different corporations. This study analyzes people's investment actions in bull market and in bear market, and carry out classifications of possible risks in the stock investment. According to the risk analysis, portfolio is important for reducing risks and then choose stocks of ten famous corporations to do portfolio design. On the test data, linear regression and CAMP model are adopted to obtain the β and get a covariance table of these ten stocks. In terms of these two judgement values, we judge the level of risk and acquire appropriate portfolio by Python. Based on the evaluation, one can get a clear process of risk analysis and this research will have certain guiding significance for future stock investment. These results shed light on guiding further exploration of how to reduce investing risks.

Keywords: risk, stock, portfolio, β coefficient

1. Introduction

There are two different states of global market: bull market and bear market. Bull markets have a declining hazard function although the best market gains come at the start of bull market, while volatility increases with duration in bear markets [1]. As time goes, two different states switch to each other and the market keeps the corresponding economy mode for several years. According to the International Monetary Fund (IMF), considering the usual 30 countries, an average decrease of -3% in GDP is expected in 2020 as shown in Figure 1. This situation was estimated by considering that the outbreak will be under control in approximately 1.5 months. If the process is extended to 3 months, this value is predicted to be more than 6.3%, and if it is extended to 4.5 months, it is more than 10.7 [2]. In this case, there is a tendency that bear market is coming [3].

Nowadays, most of investors know that they should invest those potential stocks though these stocks have more risks in bull market and they would like to do stable investment in bear market [4]. However, due to the lack of the knowledge of economy, they can't do right judgement completely which means they may underestimate the risks of stocks in bull market and hesitate to do stock investment in bear market. Relying too much on their own judgement instead of the analysis of science and technology tools is the reason why they often make mistakes during stock investment.

DOI: 10.54254/2754-1169/16/20231029

In order to get rid of this kind of situation, the study does risk analysis in stock investment by doing classification of risks and using some specific stocks to do portfolio design. It is wished that the methods and results presented here have a guiding significance to investors', especially rookies', stock investment. The rest part of the paper is organized as follows. The Sec. 2 will classify different kinds of risks. The Sec. 3 will do describe the data origination. The Sec. 4 will present the portfolio design which is also an implementation of the risk analysis. The Sec. 5 will discuss the defects and drawbacks of the study as well as present a outlook for further study. Eventually, a brief summary is given in Sec. 6.

Figure 1: Global real GDP growth in 2020 (Economic Growth in 2020-2030 2020).

2. Classifying Risks

As usual, risks in stock investment can be divided into two different kinds [5]. One is called unsystematic risk, which is mostly caused by some microcosmic reasons. This kind of risk includes financial risk, operational risk and some other risks caused by one corporation. For instance, LETV, a corporation from China, whose stock price once peaked at ¥44.7, delisted in 2019 with only ¥0.18 due to business failures [6]. Business failures are factors beyond our control, but they are no doubt part of unsystematic risk, which must be taken into consideration.

The other risk is systematic risk, which consists of many kinds of macroscopic risks, such as policy risks, purchasing power risks and interest rate risks. The decreasing stock price of some corporations like WuXi AppTec (2359.HK) in September, 2022 is the example of systematic risk, because related party companies are sanctioned by the new policy introduced by American government.

As the old saying goes, "don't put all your eggs into one basket", which means if we put all eggs into the same basket, the risks we break more eggs will increase. Therefore, for the unsystematic risk, we can use the same method following the concepts, which is also called portfolio, to avoid risk. However, for the systematic risk, it can't be easily avoided by portfolio, but we can reduce it in portfolio. Portfolio design is also part of risk analysis in stock investment.

3. Data

Ten different corporations are selected in hk.finance.yahoo.com. As illustrated in Fig. 2, they are Ubiquiti, Amazon, Cisco System, Fedex, JPMorgan Chase&Co., General Motors Company, Tesla, Apple Inc., Twitter Inc., and Alibaba Inc. To satisfy the demand of timeliness and universality, the range of stock prices we choose are from 14, September, 2017 to 14, September, 2022, which lasts for 5 years.

DOI: 10.54254/2754-1169/16/20231029

Figure 2: Five-year-round stock prices of ten famous stocks.

4. Results & Discussion

4.1. Calculation of β

The following step on portfolio design is choosing five appropriate stocks from these ten into one portfolio according to two judgement values, β coefficient and covariance. The first step is to calculate and compare β coefficient. β is a coefficient in CAPM model to reflect the correlations between stocks and market index. Low β value means there are small fluctuations in stock prices with the market environment changing [7]. There are two different ways to calculate β coefficient value, and we choose SNP as the market index and the stock of Ubiquiti Inc. (UI) as an example stock. The first way to calculate β coefficient value is using the equation as

$$r_a = r_f + \beta(r_m - r_f) \tag{1}$$

Here, r_a means the mean value of the return of one stock; r_f means risk-free rate, and we consider this variable as zero in our research; r_m means the mean value of the return of the market index. Using this equation and the tools from python, Scatters for the return of the stock(r_a) and the return of the market index(r_m) are as shown in Fig. 3 [8].

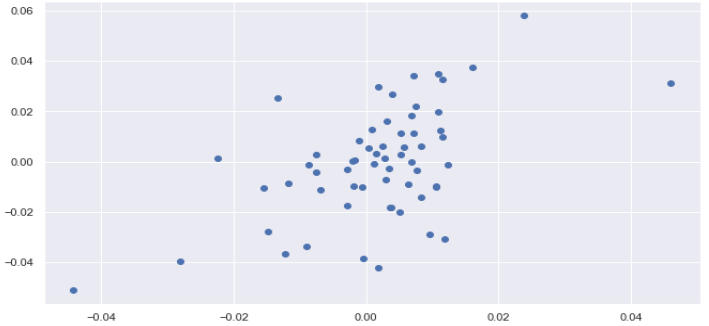

Figure 3: Scatters for the return of the stock(r_a) and the return of the market index(r_m).

In this way, the coefficient we get from linear regression is β. The β coefficient value between SNP and the stock of Ubiquiti Inc. (UI) is 0.969444. The second way to calculate β coefficient value is using the definition of β coefficient. β coefficient is given by the equation [9]:

$$\beta = \frac{Cov(r_a, r_m)}{\sigma_m^2} \tag{2}$$

DOI: 10.54254/2754-1169/16/20231029

The covariance between SNP and the stock of Ubiquiti Inc. (UI) is 0.000149 and variation of the market index (SNP) is 0.000153. Therefore, according to the computational formula of β coefficient, it is easy to get that: β=0.970, which is similar to the result from linear regression. For the rest nine stocks, we can use any of these two methods to calculate. As the results listed in the Table. 1, 5 stocks with smallest β coefficient values and 5 stocks with biggest β coefficient values are found. The smallest β coefficient values are BABA, CSCO, AMZN, FDX and UI, and the biggest β coefficient values are TSLA, GM, AAPL, TWTR and JPM.

Table 1: The results of β coefficient values.

Stocks	β coefficient
UI	1.103
AMZN	1.071
JPM	1.121
CSCO	1.012
GM	1.230
AAPL	1.216
TWTR	1.180
TSLA	1.440
FDX	1.101
BABA	0.950

The second step is calculating covariance to reduce systematic risks which is caused by stocks and stocks. It means that one should make sure there are not two stocks with high correlations existing in a portfolio, because high correlations lead to the similar change between two stocks, and low correlations cam reduce the risk that caused by one stock price changes [10]. For these 10 stocks researching on, we can plot this covariance heatmap as illustrated in Figure 4. One can set a boundary covariance value to judge them. If the covariance between two stocks is larger than the boundary value, it means that these two stocks are not suitable for existing in the same portfolio.

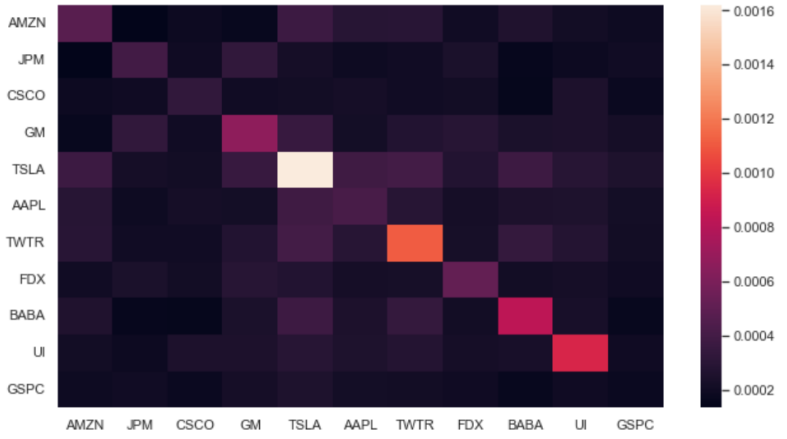

Figure 4: Covariance table of ten stocks.

4.2. Calculating Stock Weights

The final work of portfolio design is calculating stock weights, and we consider bear market as the example market state, which means we choose five smallest β coefficient values. Through the correlation analysis, we selected AMZN, CSCO, FDX, BABA, and UI as our portfolio component stocks.

DOI: 10.54254/2754-1169/16/20231029

Since we have calculated the beta of each stock and the correlation between the constituent stocks in the portfolio, one can calculate the return corresponding to the standard deviation of the portfolio.

An effective portfolio is one that optimizes expected return for a given level of risk or minimizes risk for a given level of return. The aim is to search for an effective frontier because there are numerous optimal portfolios. The weights or relative amounts of each stock in the portfolio are the only information that missed because we are aware of which equities are included in it. To determine the efficient frontier, we will essentially just test a huge variety of weight combinations, compute the historical risk, and return for each portfolio, and visualize those results [11].

As shown in the Figure 5, all the points in the diagram are the risks and corresponding rewards of our portfolio under different weights. However, not every combination is meaningful to us. The formula of the Sharpe ratio is the difference between the return of the portfolio and the return of the risk-free asset divided by the standard deviation of the portfolio. Therefore, Sharpe ratio maximization means maximizing the corresponding return per unit of risk in the portfolio. This is the best Sharpe ratio when the Sharpe ratio of the portfolio is maximized. At the same time, another portfolio that makes sense to us is the portfolio with the lowest risk because it minimizes our losses. Therefore, for these portfolios with different weights, one needs to find the weight of the portfolio in the case of the portfolio with the highest overall Sharpe ratio or lowest risk.

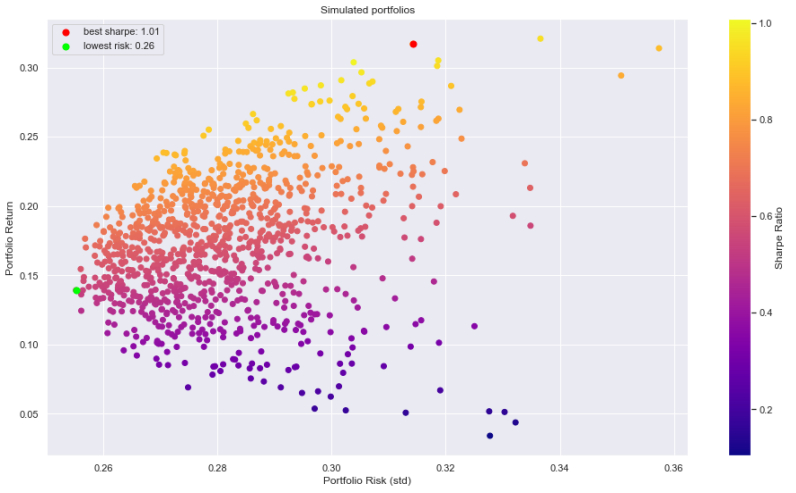

Figure 5: Simulated portfolios with five stocks.

We first use the formula to calculate the Sharpe ratio of the portfolio that is randomly weighted. Next, the max command is utilized to maximize the Sharpe ratio by assigning weights to each stock and limiting the sum of the weights to 1. The investment portfolio corresponding to the Best Sharpe ratio is the red dot in the above part of the Figure 5. The weights of each stock in the portfolio are AMZN 0.456 CSCO 0.0916, FDX 0.00905, BABA 0.0278 and UI 0.416 respectively. Under this circumstance, the α coefficient value is 0.000771.

In order to find the portfolio with the lowest risk, we also need to limit the sum of these stocks to 1. Subsequently, one calculates the total risk of the portfolio, and through the min command. Finally, the portfolio with the lowest risk is derived. The weights of each stock in the portfolio are AMZN 0.193 CSCO 0.424, FDX 0.224 and BABA 0.110 and UI 0.0486, respectively. In this way, we can get portfolios in different market state. Under this circumstance, the α coefficient value is 0.000081.

5. Limitations & Prospects

Although one can get the portfolio, which caters for some certain demands of markets and risks, some limitations still exist. For the covariance table of stocks return, the standard of selecting the boundary

DOI: 10.54254/2754-1169/16/20231029

covariance value is uncertain, which can affect the accuracy of the results. Meanwhile, in the YAHOO. Finance website, we cannot get those corporations which only listed in China market. Therefore, if one wants to add them into our portfolio, this research cannot work. It is wished these results make guiding significance in the future and it is witnessed to change these python codes in the research into API in order to gather them in a convenient software. For the future development of portfolio, searching and popularizing play equally important roles, because only popularizing the knowledge well among investors can we make our research meaningful.

6. Conclusion

In summary, this paper investigates the way to reduce investing risk using a relatively conservative portfolio based on the stocks of ten different famous corporations. According to the analysis, the best way to reduce unsystematic risk is design a proper portfolio by adjusting the proportion of each stock in the portfolio. Besides, β coefficient, which reflects the correlations between stocks and market, should be low to hedge this kind of risk. In addition, high correlation stocks should be avoided existing in the same portfolio. Specifically, the conditions in bull market should be considered in an opposite method. Nevertheless, the standard of selecting the boundary covariance value is uncertain, which can affect the accuracy of results. In the future, we wish more aggregate research will be carried out on risk analysis and some helpful tools can be designed for investors. Overall, these results offer a guideline for investors to balance risks and design a relatively proper portfolio.

References

[1] *John, M. Mu, Thomas, H. M.: Identifying Bull and Bear Markets in Stock Returns, Journal of Business & Economic Statistics, 18(1), 100-112 (2000).*

[2] *Shanmuga, P. S., Erdem, C., Sudhakar K. A perspective of COVID 19 impact on global economy, energy and environment, International Journal of Sustainable Engineering, 14(6), 1290-1305 (2021).*

[3] *Fahad, A., Jiang, X., Ahmet, S.: Downside risk in Dow Jones Islamic equity indices: Precious metals and portfolio diversification before and after the COVID-19 bear market, Research in International Business and Finance, Volume 58, 2021, 101502, ISSN 0275-5319.*

[4] *Shiller, R. J.: Market Volatility and Investor Behavior. The American Economic Review, 80(2), 58–62 (1990).*

[5] *Beja, A.: On Systematic and Unsystematic Components of Financial Risk. The Journal of Finance, 27(1), 37–45 (1972).*

[6] *Wu, Y.: Managerial Overconfidence, Equity Pledge and Interest Transfer—A Case of LETV. 2019 Asia-Pacific Forum on Economic and Social Development (APFESD 2019), 2, 116-121 (2019).*

[7] *Womack, K. L. and Zhang, Y.: Understanding Risk and Return, the CAPM, and the Fama-French Three-Factor Model. SSRN, 481881 (2003).*

[8] *Balteș, N., Dragoe, A. G. M., Ardelean, D. I.: Study Regarding the Assets Evaluation on the Financial Market through the C.A.P.M. Model. Studia Universitatis Vasile Goldiș Arad, Seria Științe Economice, 24(3), 78-87 (2014).*

[9] *Zhang, P., Meng, X. H.: The Market Application Analysis of CAPM Model. Applied Mechanics and Materials, 380–384, 4422–4425 (2013).*

[10] *Adrian, R. P., Schwert, G. W.: Testing for covariance stationarity in stock data, Economics Letters, 33(2), 165-170 (1990).*

[11] *Ivanyuk, V., Berzin, D.: An Algorithm for Constructing an Efficient Investment Portfolio. In: Silhavy, R., Silhavy, P., Prokopova, Z. (eds) Software Engineering Perspectives in Intelligent Systems. CoMeSySo 2020. Advances in Intelligent Systems and Computing, Springer, Cham, 1294 (2020).*