Portfolio Construction and Management

- Active vs. Passive Management

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1. Introduction

A common goal of portfolio investors is to seek for a higher risk adjusted return. However, according to Samelson (1965) and Farma (1970), the stock market is efficient and the market prices incorporate all information, which leaves no possibility for investors to achieve abnormal returns (Hilsted, 2012). There are various factors under the real world financial market, nevertheless; prevent the market from achieving its efficiency and thus leave room for arbitrage opportunities. The superior performance comes from factors such as market timing, economic environment, stock selection, trading and etc. In our project, we are interested in exploring the effect of active portfolio management strategy on portfolio performance.

we used mean-variance optimization method to construct various portfolios of nine stocks that we have chosen from five different industries. More details of these nine stocks will be demonstrated in section 2. The two main optimization method we employed were minimization of risk with and without given expected return level. Then we utilized three strategies to invest and managed our portfolio, one passive strategy and two active strategies. The passive strategy would use the weights calculated from first year historical returns and fix the number of shares of each stock for next 4 years. The active strategies enable investor change the weights invested in each stock frequently: one allowed them change every year and the other allowed changing every quarter. We would employ mean-variance optimization method on a rolling basis in active strategies. To evaluate these three management strategies, we apply them to three-month intervals from 2012 to first quarter of 2016 and compare values of these portfolios during this period.

In section 2, mean-variance optimization method will be explained, including risk-return tradeoff and efficient frontier, followed by details of rolling analysis of our portfolios. In section 3, we will present our results of portfolio constructions under two different optimization restrictions. Then the performances of passive strategy and two active strategies will be compared in terms of value of portfolio. In addition, we will explain limitations of our project and demonstrate future work that could be done to improve our findings.

2. Methodology

2.1 Data

We chose nine stocks from different industries: Verizon, P&G, Starbucks, Coca Cola, UPS, Toyota, J. P. Morgan, MetLife and IBM. In our study, we used daily adjusted close price from Jan 1st 2011 to Mar 30th 2016 to do analysis and construct various portfolios. All historical data were downloaded from Yahoo. Finance. In **Figure 1**, the equity curve measures the growth of one-dollar initial investment on nine stocks. From this equity curve we can see that Starbucks (grey line) gives the highest growth. And it confirms later in our project that the optimal weight on Starbucks calculated was the highest one. According to the correlation graph in **Figure 2**, J. P. Morgan and MetLife have a relatively higher correlation. In general, this graph shows that each two stocks are not perfectly positively related to each other which serves the purpose of diversification when we select our stocks.

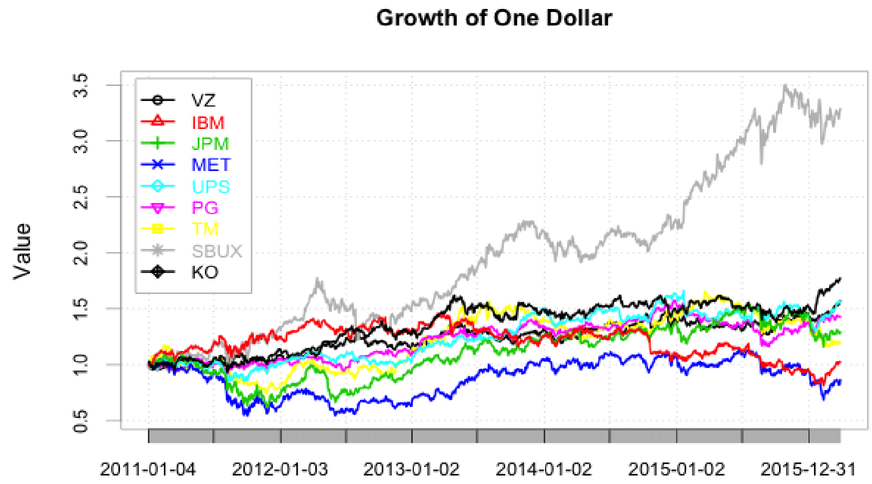

Figure1. Equity Curve.

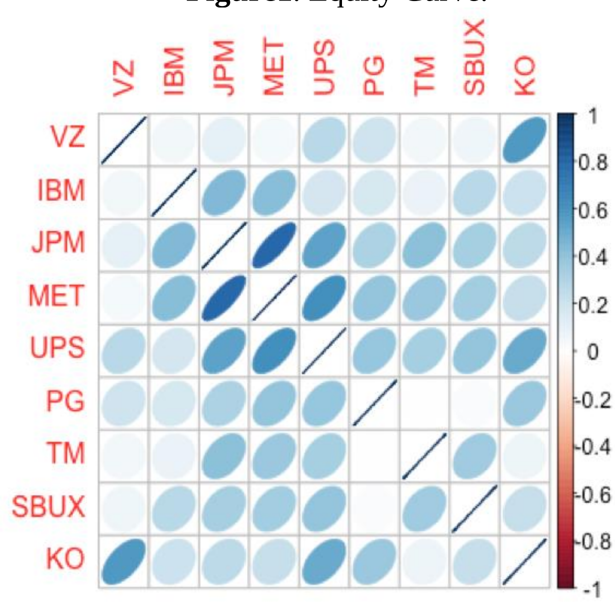

Figure 2. Correlations between two stocks

2.2 Mean-Variance Analysis

Mean-Variance Analysis (or named Modern Portfolio Theory) was introduced by Economist Harry Markowitz in 1952. The idea was proposed to solve the problem of weight allocation when the selection in different criterion. In our project, we used two criterion to construct our portfolios. First we tend to construct portfolios with least standard deviation (minimum risk), i.e. minimized σ_p^2 with restrictions $\sum_i w_i = 1$. Secondly we would construct portfolios with minimum risk given a daily expected return level 0.08%, i.e. we minimized σ_p^2 with an additional restriction that is $E(R_p) = 0.08\%$.

In general:

Portfolio expected return:

$$E(R_p) = \sum_i w_i\, E(R_i)$$

where R_p is the return on the portfolio, R_i is the return on asset i, and w_i is the weight of component asset i, and $\sum_i^n w_i = 1$

Portfolio return variance:

$$\sigma_p^2 = \sum_i \sum_j w_i\, w_j \sigma_i \sigma_j \rho_{ij}$$

where ρ_{ij} is the correlation coefficient between the returns on asset i and j, and $\rho_{ij} = 1$ for $i = j$

Portfolio return volatility (standard deviation):

$$\sigma_p = \sqrt{\sigma_p^2}$$

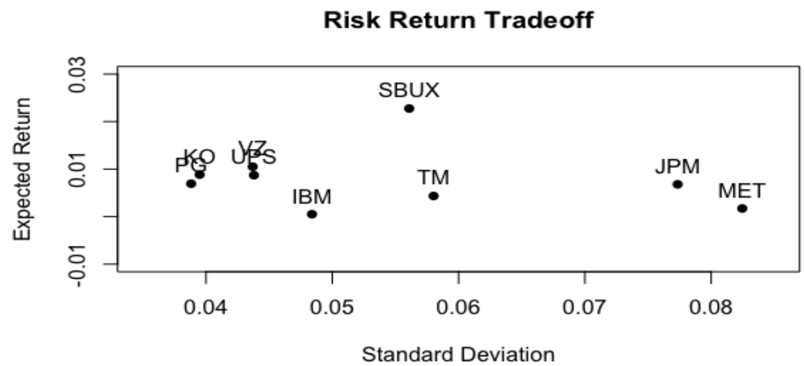

Figure 3: Risk return tradeoff

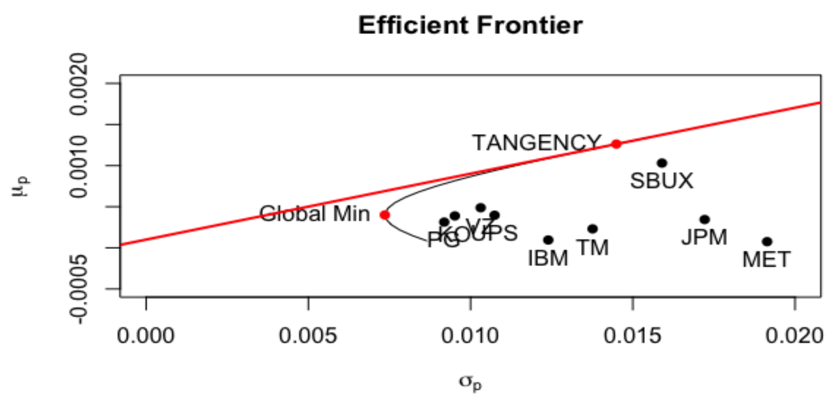

Figure 4. Efficient portfolio frontier and risk free asset (0.01%)

Figure 3 indicates that J. P. Morgan and MetLife perform poorly because they both have higher volatilities and lower expected return. However, Starbucks performs well. It has a relatively higher expected return and lower risk. **Figure 4** shows the efficient frontier of our stocks. If we set daily risk-free rate equals to 0.01%, we can find the tangency portfolio.

In our study, given expected return, we want to find the weight that minimize portfolio standard deviation. We used Lagrange Multiplier to solve for the optimal weight and set the constraint that all the weights will add up to one. In addition, we allow weights to be negative which means short selling is allowed in our study.

2.3 Rolling Analysis

In real industry, asset management firms apply both strategic and active management strategies on their portfolios. Strategic asset allocation is a stable strategy while active asset allocation is more adjustable. We applied the ideas and constructed 3 strategies, combined with 2 portfolios construction method as described in 2.2 and evaluated their performances. By applying Passive strategy, we purchased fixed number of shares as our portfolio, according to the weight calculated based on first year's data, and fix number of shares for next 5 years. While in Active 1 and Active 2 strategy, we used rolling method, which adjusted our portfolio weights every year and every 3 months respectively. To do so, we recalculate the weights of each stock using 1-year and 3-month historical returns every year and quarter and apply the allocation in next 3 month period.

Strategy Name	Property	Weight Decision Principle
Passive	Fixed number of shares	Based on the first year
Active I	Rebalanced every 3 months	Based on previous 1 year
Active II	Rebalanced every 3 months	Based on previous 3 months

Table 1. Three Different Strategies in Asset Allocation

In order to evaluate the performances of our strategies, we made the initial investment same, which is \$100,000 in all cases. We introduced the concept of portfolio value to compare the performances of each portfolio under each strategy.

$$Value\ of\ portfolio = \sum_{i=1}^{n} \frac{Initial\ investment * W_i}{Initial\ stock\ price_i} * \text{current stock price}_i$$

4.1 Results

For the mean variance portfolio, we calculated the portfolio values in 5 years using 3 different strategies. The black, red and green line represent Passive, Active 1 and Active 2 strategies separately. We can see from the graph that general trends for 3 lines are all going up, which means on all the strategies, if applied, could help us make money in that period. To compare among strategies in a more detailed way, we calculated the annualized daily average and volatility for log returns. By using the criteria that 'given expected return, we tend to choose the strategy with lowest volatility', we found that in this case, active management outperforms passive management here and there is a trade-off between Active I and Active II and the decision rule is based on investors' risk attitudes.

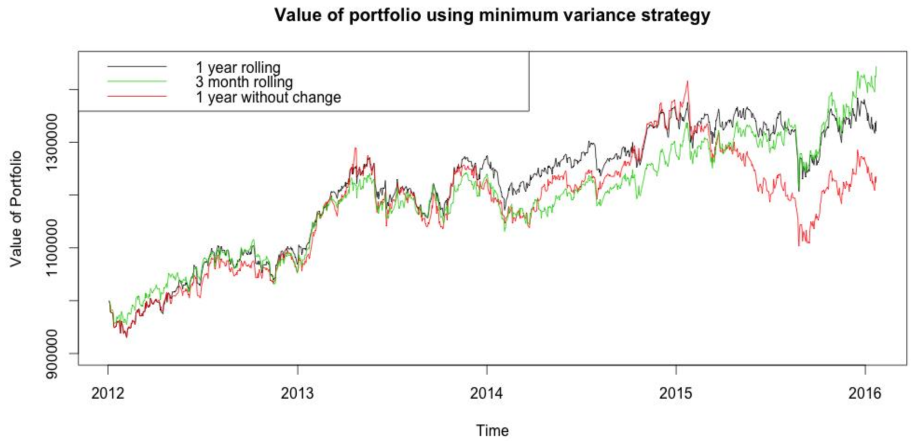

Figure 5. value of portfolio using minimum variance strategy.

Name	Annual Return	Annual Volatility
Active 1	0.07191131	0.1151713
Active 2	0.09013849	0.1192859
Passive	0.05190127	0.1251575

Table 2. Annual return and volatility with minimum variance strategy

Similarly, for the minimum variance portfolio given expected return is equal to 0.08% per month, we calculated the portfolio values under 3 strategies. On average, this portfolio offers higher standard deviation than last portfolio no matter the strategies by adding the constraints. From the graph, we found that Active II outperformed the other two strategies in this case. The descriptive statistics results showed that Active II strategy is better by offering a relatively higher return but lower volatility.

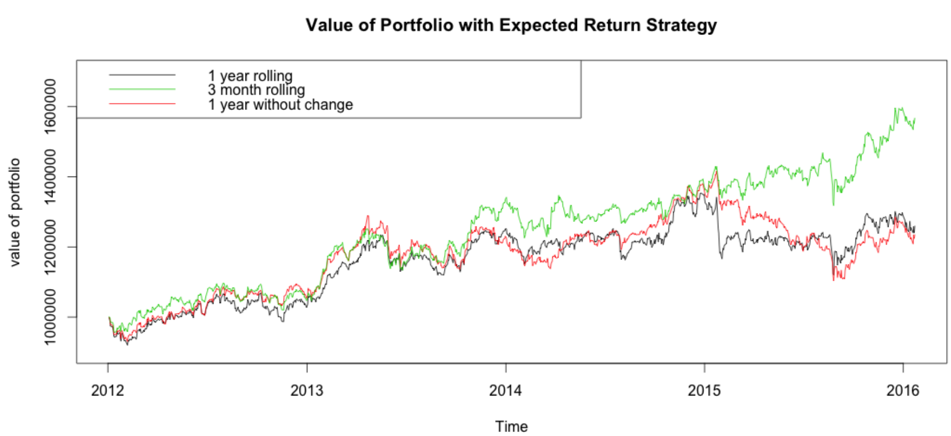

Figure 6. value of portfolio with expected return strategy

Name	Annual Return	Annual Volatility
Active 1	0.0567587	0.1309556
Active 2	0.1103522	0.1260864
Passive	0.0442522	0.1236276

Table 3. Annual return and volatility with expected return strategy

4.2 Limitations and Furture Work

According to the example we may find that active management is always superior to passive management. However, our research has limitations when it comes to the real investment universe. Active management cannot be implemented easily and freely due to huge transaction cost initiated each time portfolio weight is changed. Moreover, asset management firms may also need to satisfy clients' needs such as constraints put on weights, short-selling conditions and specification of risk attitudes. Looking at the real industry, 90% of return variation over time is explained by strategic asset allocation, which means fixed-weight allocation works most of the time. While the fact that over 80% of US MFs and over 50% of institutional mandates are actively managed illustrates that active management still is favored by practitioners and plays an important role.

Besides the limitations in real industry, our research deserves more research for the drawback of the framework of Mean-Variance Analysis by Makrowitz in 1952. He and Litteman (1999) mentioned that the optimal weights calculated using the traditional method were unstable and not particularly intuitive in its huge subject to little change of the benchmark returns. They proposed Black-Litterman's model to quantify investors' views into their portfolio using Baysian method in 1999 to solve the problem of extreme weights. Also, bootstrap can be applied to get a more robust result.

5. Conclusion

We constructed three portfolios each under two scenarios based on the the nine stocks that we picked from different market sectors, including Verizon, P&G, Starbucks, Coca Cola, UPS, Toyota, J. P. Morgan, MetLife and IBM. By comparing the Annual returns and annual volatilities among all three portfolios under each scenario, we found that actively managed portfolios (active I and active II) generally performed better than the passively managed portfolio. However, solely based on the results from the above analyses would not lead us to the conclusion that active portfolio management strategy is superior to the passive portfolio management strategy. Limitations of this project include the discard of transaction costs calculation, the simplification of constraints on weights as well as the drawbacks of Makrowitz's framework. For future work, we would introduce Black-Litterman's model and bootstrapping method on VaR to deepen our analyses.

Works Cited:

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