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Portfolio Creation, Optimization & Performance Measurement Using Dynamic Passive & Active Strategies

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Abstract: ***This study starts off by picking up top stocks (from the NIFTY100 market), which have shown good fundamentals like the Capital Structure assessed by Debt-Equity ratio, quick ratio & current ratio, profitability ratio, retention ratio and most importantly the Price to Earnings to Growth (PEG) Ratio. A ranking system was devised to get an overall rank for each stock based on these financial ratios, to get an idea of potentially good performing businesses for the test period of our Portfolio. Markowitz Portfolio Optimization theory was adopted, which uses mean-variance and covariance matrix calculations to obtain the weights or the desired asset allocation and to create the efficient Portfolio, optimized for the maximum Sharpe's Ratio which was possible, given the historical Stock Returns and Volatility and compared with the equal weighted portfolio having naïve asset allocation. The performance of a dynamic passive strategy, which is the Buy & Hold was compared to that of the active- Constant Mix Strategy in the holding period of 5 years with monthly rebalancing, with an objective to outperform the benchmark market index, NIFTY100. The optimal weighted portfolio performed better than both the equal weighted portfolio and the benchmark index under both the Buy-and-Hold and the Constant Mix Strategy. Further, the Constant Mix Strategy exhibited better performance than Buy-and-Hold as was also suggested by the oscillating market in the given time period.***

Keywords: Constant Mix Strategy, Portfolio Rebalancing, Buy & hold Strategy, Markowitz Portfolio Optimization, Sharpe's Ratio

1. Introduction

Every investor and asset manager have to struggle with the same two core problems in the strive for the best attainable relationship between risk and return. The first problem concerns what stocks to choose from hundredths of stocks to hold in an equity market alone while creating the Portfolio and how to distribute the investment amount in each of those. The second is the best possible trading strategy for managing the Portfolio, when to enter a position and how often to reallocate and rebalance. which might seem quite daunting. By combining different stocks, one could either obtain a higher expected return with the same level of risk or reversely, lower the level of risk while having the same expected return. Given a set of individual assets with varying characteristics, the equally weighted portfolio might indeed be considered naïve but might remove the unsystematic risk to a large extent by diversification and adding securities. An asset allocation model like the Markowitz Portfolio Optimization theory tries to find securities with low correlation and allows us to choose appropriate weights to minimize the risk of the Portfolio. Depending on the trend, reversals and sentiments exhibited in the market an appropriate dynamic passive or active strategy needs to be implemented. A Constant Mix Strategy will outperform a comparable buy-and-hold strategy if there are regular reversals and the market is flat but oscillating, which is generally portrayed by NIFTY100, unlike a major move in only one direction which is favored by the but-and-hold strategy. For performance evaluation of the Portfolio, the returns must be standardized to a risk-adjusted measure. This measure as a ratio, will not only focus upon the returns of a portfolio but also adjust for the associated risk. In this analysis between the Constant Mix Strategy (Both Equal Weighted and Optimal Weighted) and simple buy-and-hold Strategy, there was statistical evidence that the optimally allocated portfolio outperformed both the naïve equal weighted portfolio and the benchmark in terms of annualized Sharpe-Ratio.

2. Procedure

2.1 Stock Picking

The NIFTY 100 was chosen as the benchmark market index and the historical data for fundamental ratios was to gathered to screen the good businesses. Though the fundamental analysis may not promise the stock's future performance it can definitely be a good way to measure it. The 5-year average of each of the historical Quick Ratio, Debt-Equity Ratio, Current Ratio, Dividend Payout Ratio and Net Profit Margin and the Price to Earnings to Growth (PEG) Ratio (for the year 2016) was used to give ranks to each of the 100 stocks.

The lower the PEG ratio, the stock is more undervalued and if it also has a higher potential for growth in earnings, revenue and cash flow, it will be more valuable for the investors.

The higher the value of the liquidity ratios such as Current Ratio and Quick Ratio, more easily the company can handle potential downturns and financial setbacks in their business and pay its short-term obligations, by having enough working capital in hand.

Higher debt costs associated with high Debt-Equity Ratio (brings out the company's financial leverage) restricts the firm's flexibility to grow and reducing the profits available to the shareholders.

A smaller value of the Dividend Payout Ratio is a good indicator as then the company tends to have room for further dividend increases and the ability to withstand temporary earnings downturns without having to reduce or eliminate dividend payments and reinvesting back into the capital development of the firm.

Finally, another important metrics is the Net Profit Margin Ratio which talks of the profitability of the company. Higher the ratio, higher is the profit per unit of revenue generated, needed to cover the costs and grow substantially well.

2.2 Risk and Return Calculations

Assigning the ranks to the companies w.r.t each of the above parameters and finding the average rank of the stock, we get the fundamentally undervalued top 10 stocks which are to be included in our Portfolio. After getting the historical price data for these 10 stocks, the individual Annualized Percentage Returns and Annualized Volatility or Total Risk was calculated. For both the Equal Weighted and mean-variance allocated Portfolio, the Annualized Return and Risk was calculated. The average return of a portfolio is the sum of expected returns times the weight invested in each individual security. Let X_i be the weight invested in share *i*, for *i = 1, 2, . . . , n*. R_P be the return on the portfolio, then the expression is given by RP = ∑Xi .Ri. And the Portfolio Risk is given by the square root of its variance.

$$\sigma_P^2 = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} X_i X_j \sigma_{ij} \quad (1)$$

Or,

$$\sigma_P^2 = \sum_{i=1}^{n} \sum_{i=1}^{n} w_i w_j \mathrm{Cov}\left(r_i, r_j\right) \quad (2)$$

Where,

$$\sigma_i^2 = E\left[\left(R_i - E[R_i]\right)^2\right] \quad (3)$$

denotes the variance of stock i , and

$$\sigma_{ij} = E\left|\left(R_i - E[R_i]\right)\left(R_j - E\left|R_j\right|\right)\right| \quad (4)$$

is the covariance between stock i and stock j.

After we move past a two-asset portfolio, it is necessary to use matrix multiplication to determine the optimal asset weights in the portfolio. In excel the following formulas were input to get the Returns and Risk by using the Variance-Covariance Matrix which was calculated.

$$E(r_p) = W^T R = \begin{bmatrix} w_1 & \dots & w_j \end{bmatrix} \begin{bmatrix} E(r_1) \\ \vdots \\ E(r_j) \end{bmatrix} \quad (5)$$

Where, W is the weight of the individual assets (1 through j) in the portfolio and R is the vector of expected returns of the individual assets(1 through j) in the portfolio . The formula in excel is {=mmult(transpose(W), R)}. While the Variance of the portfolio is calculated as -

$$\sigma_p^2 = W^T S(W). \quad (7)$$

The standard deviation of the portfolio is calculated as –

$$\sqrt{\left(W^T S(W)\right)} \quad (8)$$

$$\left[\begin{bmatrix} w_1 & \dots & w_j \end{bmatrix} \begin{bmatrix} \sigma_{11} & \cdots & \sigma_{1j} \\ \vdots & \ddots & \vdots \\ \sigma_{j1} & \cdots & \sigma_{jj} \end{bmatrix} \begin{bmatrix} w_1 \\ \vdots \\ w_j \end{bmatrix}\right]^{\frac{1}{2}} \quad (9)$$

Where S is referred to as the variance-covariance matrix of the covariances between each of the asset's returns in the portfolio. In excel the standard deviation is calculated in excel by-={sqrt(mmult(transpose(W), S), W))}.

2.3 Stock Allocation

While for the Equal Weighted Portfolio, we set the weights equal to 0.1 for each of the 10 stocks, the weights for the optimal weighted portfolio are obtained by maximizing the Sharpe's Ratio (calculated on the basis of the Portfolio Excess Returns over the Risk-free-rate of 6.0% (10Y Govt. Bond) and adjusted for the Risk), by using Excel Add-in Solver by adding the constrain that the sum of weights is zero and they are non-negative.

The Sharpe measure given by $(E(R_P)-Rf)/\sigma_P$ was calculated based on the 7 year historical returns and volatility of the portfolio and the also for NIFTY100 benchmark index, just too see whether the Optimal Weighted Portfolio had better risk and return characteristics than the Naïve allocation Portfolio..

3. Strategy Implementation

3.1 Buy-and-hold Strategy Implementation

Now that the Optimal Risky Portfolio was created, first we moved on to the dynamic passive buy-and-hold strategy, which as the name suggests is simply to invest the initial amount as per the respective weights given by the Optimal Portfolio Model and hold the position until the last day. The holding period was of 5-years (3/2016-3/2021), and the Portfolio and NIFTY100 values for each consecutive month based on the price data on the corresponding dates were obtained. The monthly percentage returns were calculated to get the annualized average returns, the risk and the Sharpe's Ratio.

3.2 Buy-and-hold Strategy Implementation

The Constant Mix Strategy was implemented with the same holding period of 5-years and with monthly rebalancing of the portfolio, firstly taking the naïve allocation of 10% of the Portfolio value and secondly as per the desired allocation from the Optimal Portfolio Model. The initial numbers of stocks were calculated based on their initial allocated value in the portfolio and the initial stock prices and then for each month thereon, the difference between the current allocation in that month and the desired allocation was calculated which got us the amount to rebalance. Conditional statements were put up to indicate Buy and Sell signals whenever the asset allocation deviated from the desired asset allocation. If the current allocation was above the desired allocation, a Sell signal was generated otherwise a Buy signal was generated. The numbers of shares to buy or sell were calculated by dividing the amount to rebalance by the share price

of that stock in that month. For the next consecutive month's rebalancing, the no. of shares in hand was adjusted for the shares traded in the previous month. Again, the current allocation was calculated based on a stock's proportion in the Portfolio value month with the new no. of shares in hand and the share prices for that month. The same process of calculating the amount to rebalance if there were buy or sell signals was followed of all of the 60 months. Once we tabulated the portfolio and NIFTY100 benchmark values on all the 60 dates, we calculated the Annualized Average Risk and Risk and also the Sharpe's Ratio for both kind of Portfolios viz-a-viz the Equal Weighted Portfolio and the Optimal Allocation Model Portfolio.

4. Data

A Python Library, 'FundamentalAnalysis', which pulls the necessary financial ratios of years 2016-2020 from the 'FinancialModelingPrep' API and uses Yahoo Finance to obtain stock fundamentals' data. The 5-year average of each of the historical Quick Ratio, Debt-Equity Ratio, Current Ratio, Dividend Payout Ratio and Net Profit Margin and the Price to Earnings to Growth (PEG) Ratio (for the year 2016) was obtained through the code for all 100 companies. Ranks were given based on each of these ratios and a final rank was obtained by adding individual ranks and sorting them in ascending order, as explained in the Methodology section.

The historical 7-year (3/2014-3/2021) price data for these 10 stocks and NIFTY100 was obtained by using another Python Library 'yfinance' which imported the Adjusted Close Prices from Yahoo Finance. The percentage returns were tabulated, the risk and returns were calculated to be used for the creation of the Portfolio as explained in the Methodology section. All the datasets, tabulations and datasets can be found in the excel file in the drive link attached.
Data_and_Analysis_Excel

5. Analysis and Results

The top 10 fundamentally promising stocks which were screened based on the before-mentioned ranking system were – EICHERMOT, TCS, NAUKRI, WIPRO, BIOCON, BAJAJHLDNG, INFY, DIVISLAB, ADANIPORTS and BAJAJ-AUTO. While the equal Weighted portfolio had 10% of each of these, the Optimal Portfolio, maximized for the Sharpe's measure was suggesting to consider the following weights and not holding WIPRO and BAJAJ-AUTO which were given 0 weights. The Sharpe's ratio clearly suggested that the Portfolio Optimization Model had proven much more efficient historically with a Sharpe's Ratio of 1.27 as opposed to the 1.14 for the naïve equal weighted Portfolio and 0.43 for the benchmark index. This suggested us to go ahead with the Optimum Portfolio with unequal asset allocation.

Table 1: Weights of Stocks for Naïve and Optimal Portfolio

Equal Weighted Portfolio	Weights	Optimal Risky Portfolio	Weights
Eichermot. NS	0.1	1738.7	0.119
TCS. NS	0.1	1106.8	0.129
NAUKRI. NS	0.1	751.4	0.166
WIPRO. NS	0.1	206.9	0.000
BIOCON. NS	0.1	81.3	0.162
BAJAHLDNG. NS	0.1	1403.8	0.121
INFY. NS	0.1	525.7	0.128
DIVISLAB. NS	0.1	971.7	0.153
ADANIPORTS. NS	0.1	238.1	0.022
BAJAJ-AUTO. NS	0.1	2171.4	0.000

Table 2: Historical Performance comparison of three different portfolios

Optimal Risky Portfolio	Equal Weighted Portfolio		Nifty_100 Benchmark
Annual Return	28.6833%	25.32193%	13.50%
Annualized Risk of Portfolio	17.87%	16.88%	17.41%
Risk free rate	6%	6%	6%
Sharpe Ration	1.27	1.14	0.43

The Optimal weights were used for the asset allocation in the buy-and-hold strategy, and during our test period the final value of the Portfolio was 352% of the initial value. Annualizing the monthly percentage returns, we get Annual average returns, SD, and the Sharpe's Ratio which statistically outperformed the benchmark as shown.

Table 3: Buy-and-Hold Strategy final Portfolio Value

Stocks	Stock Allocation	Initial Share Price	Initial Value	No. of Stocks	Final Share Price	Final Value
Eichermot. NS	11.90%	1738.7	11900.92	6.84	2639.9	18070.2
TCS. NS	12.89%	1106.8	12892.64	11.65	3158.6	36790.9
NAUKRI. NS	16.59%	751.4	16589.28	22.08	4158.5	91815.5
WIPRO. NS	0.00%	206.9	0.00	0.00	418.1	0.0
BIOCON. NS	16.24%	81.3	16235.25	199.63	408.5	81539.7
BAJAHLDNG. NS	12.14%	1403.8	12140.82	8.65	3197.2	27650.7
INFY. NS	12.81%	525.7	12805.43	24.36	1385.3	33744.1
DIVISLAB. NS	15.28%	971.7	15282.44	15.73	3584.3	56373.7
ADANIPORTS. NS	2.15%	238.1	2153.21	9.04	710.5	6424.9
BAJAJ-AUTO. NS	0.00%	2171.4	0.00	0.00	3666.7	0.00
Portfolio Current Value			100000.00			352409.754

Table 4: Optimal Allocation Buy & Hold Portfolio Vs Benchmark Performance

Measure	Buy & Hold portfolio	Nifty_100 Benchmark
Annual Return	27.21%	14.87%
Annualized Risk	20.03%	18.694%
Risk free rate	6%	6%
Sharpe Ration	1.059	0.47

To evaluate the performance of our Constant Mix Strategy, we first look at the first rebalancing of the Equal Weighted Portfolio.

Table 5: First month rebalancing of the Equal Weighted Portfolio

Stocks	Current Value	Current Share Price	Current Allocation	Desired Allocation	Amount to Rebalance	Buy/ Sell	No. of Share Traded	No. of Stocks in hand
Eichermot. NS	10311.8	1792.9	10.06%	10.00%	-57.77	Sell	-0.03	5.7
TCS. NS	10296.7	1139.7	10.04%	10.00%	-42.66	Sell	-0.04	9.0
NAUKRI. NS	9807.3	736.9	9.56%	10.00%	-446.75	Buy	0.61	13.9
WIPRO. NS	9757.2	21.9	9.52%	10.00%	496.82	Buy	2.46	50.8
BIOCON. NS	12376.2	100.7	12.07%	10.00%	-2122.24	Sell	-21.09	101.9
BAJAHLDNG. NS	9728.5	1365.7	9.49%	10.00%	525.53	Buy	0.38	7.5
INFY. NS	9963.5	523.8	9.72%	10.00%	290.51	Buy	0.55	19.6
DIVISLAB. NS	10468.5	1017.2	10.21%	10.00%	-214.49	Sell	-0.21	10.1
ADANIPORTS. NS	9590.4	228.4	9.35%	10.00%	663.64	Buy	2.91	44.9
BAJAJ-AUTO. NS	10240.1	2223.5	9.99%	10.00%	13.91	Buy	0.01	4.6
Portfolio Current Value	102540.1							

Tabulating the Portfolio Value in similar way for all the 60 months we see that again this Portfolio has outperformed the benchmark with a Sharpe's ratio of 1.058 vs 0.47.

Table 6: Performance evaluation of Constant Mix Strategy using Equal Weighted Portfolio

Similarly for the Optimal Weighted Portfolio, first rebalancing looks like this –

Measure	Equall Weighted portfolio	Nifty_100 Benchmark
Annual Return	25.39%	14.87%
Annualized Risk	18.31%	18.694%
Risk free rate	6%	6%
Sharpe Ration	1.058	0.47

Table 7: First month rebalancing of the Optimally Allocated Efficient Portfolio

Current Value	Current Share Price	Current Allocation	Desired Allocation	Amount to Rebalance	Buy/ Sell	No. of Share Traded
12272.0	1792.9	11.74%	11.90%	169.62	Buy	0.09
13275.1	1139.7	12.70%	12.89%	203.23	Buy	0.18
16269.5	736.9	15.56%	16.59%	1073.41	Buy	1.46
0.0	201.9	0.00%	0.00%	0.00		0.00
20093.2	100.7	19.22%	16.24%	3120.32	Sell	31.00
11811.2	1365.7	11.30%	12.14%	881.22	Buy	0.65
12758.7	523.8	12.20%	12.81%	628.50	Buy	1.20
15998.4	1017.2	15.30%	15.28%	21.69	Sell	0.02
2065.0	228.4	1.98%	2.15%	186.02	Buy	0.81
0.0	2223.5	0.00%	0.00%	0.00		0.00

104543.0563

Again, tabulating the Portfolio Value & NIFTY100 index Value and returns in a similar way for all the 60 months we see that again this Portfolio has outperformed the benchmark with a Sharpe's ratio of 1.20 vs 0.47.

Table 8: Performance evaluation of Constant Mix Strategy using Optimal Weighted Portfolio

Measure	Optimal portfolio	Nifty_100 Benchmark
Annual Return	28.88%	14.87%
Annualized Risk	19.10%	18.694%
Risk free rate	4%	4%
Sharpe Ration	1.20	0.47

6. Conclusion and Discussion

The ranking system adopted has proven promising while screening the top stocks as we have got substantially outperforming returns and Sharpe's Ratio as compared to the benchmark NIFTY100, and hence we can say that a company with strong fundamentals but undervalued as per the smaller PEG ratio will outperform others in the long run, say 5-years. We observe that creation of the Optimal Weighted Portfolio by the Markowitz Portfolio Optimization Model has proven useful in getting the maximum Sharpe's ratio and minimizing the portfolio risk, which has beaten the naïve allocation Portfolio. Also, the buy-and-hold strategy, usually outperforming when there is a strong trend in upwards direction, gives relatively lower performance than the Constant Mix Strategy with monthly rebalancing, which requires a flat but oscillating market with frequent reversals. Though we see that the Market was not flat during the test period but had appreciated in value, it also had some frequent reversals and hence giving an edge to the Constant Mix Strategy.

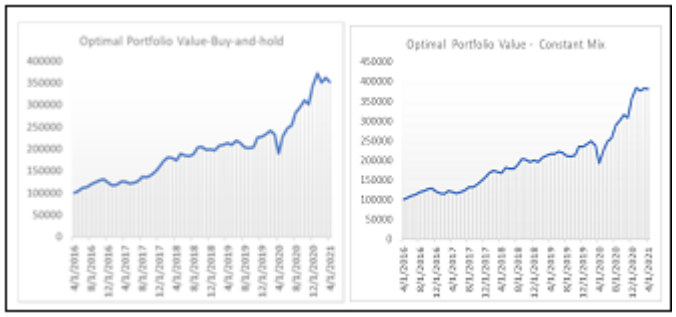

Figure 1: Buy & Hold Portfolio Value vs Constant Mix Portfolio Value over the time period

7. Acknowledgment

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