

CREATING AND ANALYZING AN OPTIMAL PORTFOLIO WITH BACKTESTING

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BITS Pilani
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**BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
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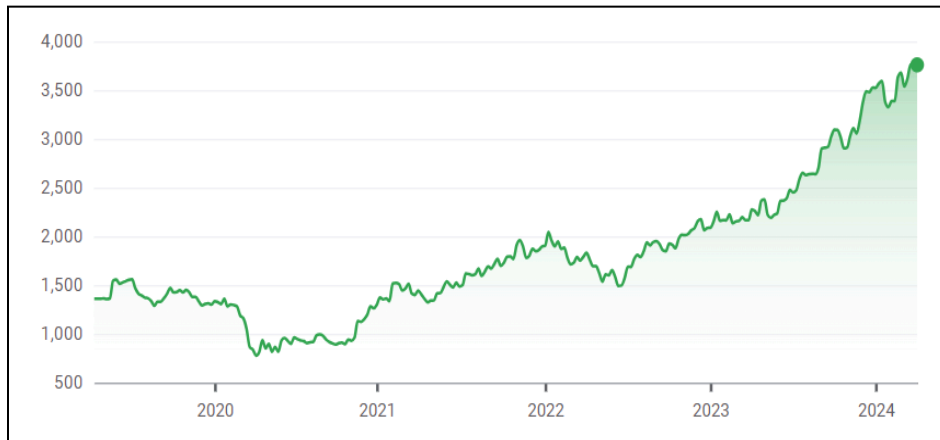
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INTRODUCTION

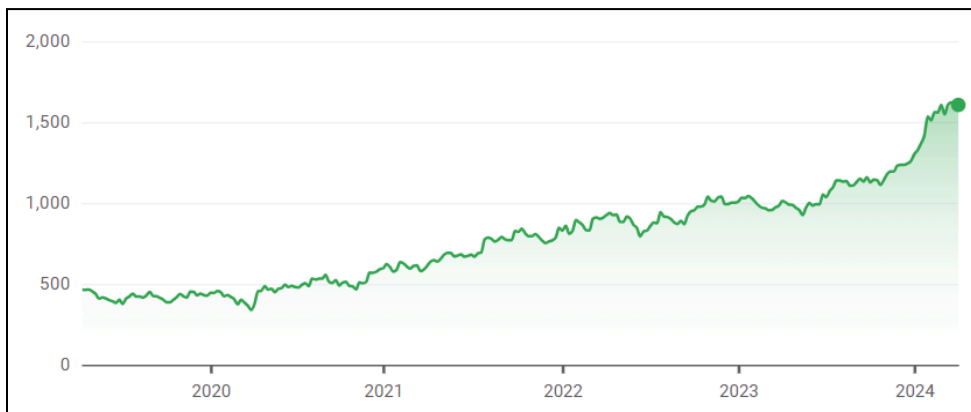
1. Larsen and Toubro Ltd

Headquartered in Mumbai, L&T is an Indian multinational conglomerate with diverse business holdings in engineering, construction, and technology, with its primary holdings in the real estate sector. Founded in 1946 by Kristian Toubro and Henning Holck-Larsen, it was first listed in the BSE in 1952. It has seen steady growth in the past five years despite turbulent economic times during the pandemic.



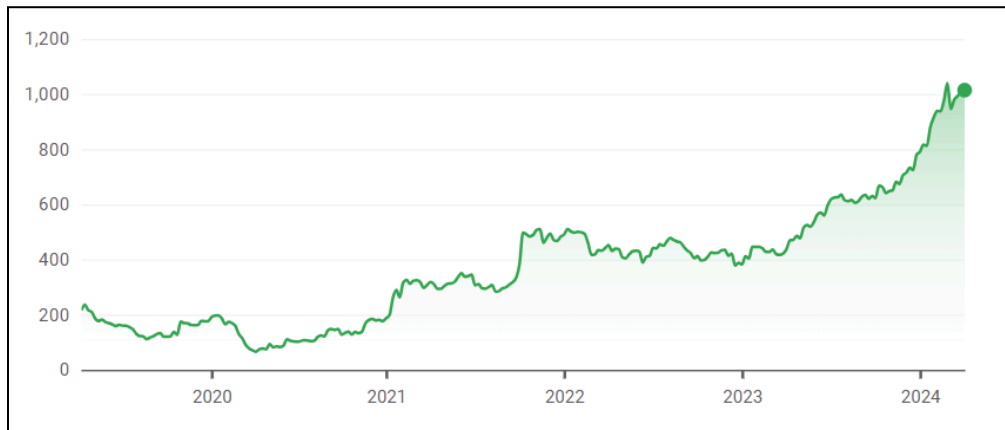
2. Sun Pharmaceutical Industries Ltd

Founded by Dillip Sanghvi in 1983, Sunpharma is an Indian Multinational Company known for manufacturing and supplying pharmaceutical formulations. It was first listed on the stock exchange in 1994, seeing immense growth since its inception. In the past five years, Sunpharma has acquired and partnered with several national and international companies to expand its reach.



3. TATA Motors

Founded in 1945, it is a part of the 100 Billion dollar TATA group. It produces cars, buses, vans, and trucks. It is credited with designing India's first passenger car, the Indica, in 1988, having already been listed in the Indian stock exchange since 1980. Recent news relating to the company has led to a jump in its prices.



4. SBI Inc

SBI is a national public sector bank that is under the supervision of the GOI. It was established before independence but was only listed in 1991. It also has several non-banking subsidiaries, and more than half of its listings are held by promoters. It experienced severe turbulence during the pandemic but has since regained its stability.



STOCKS

PORTFOLIO WITH EQUAL WEIGHTS (2021-2022)

Security	L&T	Sun Pharma	Tata Motors	SBIN
Annualized Returns	0.4931	0.4009	1.6548	0.7010
Weights	0.25	0.25	0.25	0.25
Weighted Returns	0.1233	0.1002	0.077	0.183
Portfolio Returns	0.8125			
Annualized Standard Deviation	0.2494			
Sharpe Ratio	0.7295			

The portfolio return is the average of the annualized returns of each of the individual stocks, due to the lower returns of the remaining stocks, the extreme returns of TATA motors is balanced. In 21-22 the stock market was experiencing a post-pandemic boom, due to which we can see high returns of 80% overall.

OPTIMAL PORTFOLIO

Security	L&T	Sun Pharma	Tata Motors	SBIN
Annualized Returns	0.4931	0.4009	1.6548	0.7010
Weights	0.142	0.158	0.591	0.109
Weighted Returns	0.070	0.063	0.978	0.076
Portfolio Returns	1.1874			
Annualized Standard Deviation	.3456			
Sharpe Ratio	3.2334			

Creating an optimal portfolio by maximizing the Sharpe Ratio, by which we essentially try to maximize our gains while minimizing the risk obtained from the variation in prices. For the year

21-22 we obtain a portfolio with maximum weight given to TATA motors, possibly due to its consistent high returns. Little weight is given to the other stocks due to their comparatively lower returns. The sharpe ratio being greater than 3, this would be considered an excellent portfolio, giving a better risk-adjusted performance as compared to 0.7 Sharpe ratio of the equally weighted sub-optimal portfolio.

BACKTESTING USING OPTIMAL WEIGHTS OF 21-22 FOR 22-23

Security	L&T	Sun Pharma	Tata Motors	SBIN
Annualized Returns	0.127	0.188	-0.207	0.310
Weights	0.142	0.158	0.591	0.109
Weighted Returns	0.018	0.030	-0.122	0.034
Portfolio Returns	-0.041			
Annualized Standard Deviation	.344			
Sharpe Ratio	-0.3215			

Backtesting for the year 22-23 using the optimal weights obtained in 21-22, we see that due to huge fall in the return of TATA motors and also a general decrease in the overall returns due to an unstable and receding market we get a negative return from the portfolio as a whole indicating the ineffectiveness of backtesting and forecasting especially in the case of volatile markets. We also get higher risk and a negative sharpe ratio indicating that risk-free bonds are a better investment.

BACKTESTING WITH ITS OWN OPTIMAL WEIGHTS

Security	L&T	Sun Pharma	Tata Motors	SBIN
Annualized Returns	0.127	0.188	-0.207	0.310
Weights	0	0.411	0	0.589
Weighted Returns	0	0.077	0	0.183
Portfolio Returns	0.260			
Annualized Standard Deviation	0.260			
Sharpe Ratio	0.7295			

Calculating the optimal weights for the year 22-23 itself , we see that the Sharpe ratio, while positive, still indicates a sub-optimal portfolio. Due to negative and low returns from L&T and TATA motors , they are completely omitted from the portfolio even though they were given a high proportion in the previous year. Overall the return then turns out to be positive and give a lower risk value.

INDICES

PORTFOLIO WITH EQUAL WEIGHTS (21-22)

Index	Nifty50	Sensex	NiftyBank	BSE Small Cap
Annualized Returns	0.2375	0.2151	0.1142	0.6213
Weights	0.25	0.25	0.25	0.25
Weighted Returns	0.0594	0.0538	0.0286	0.1553
Portfolio Returns	0.2971			
Annualized Standard Deviation	0.2237			
Sharpe Ratio	1.0151			

Creating a portfolio using equal weights for each index we get an overall positive return of 29.71% and a low standard deviation indicating a lower risk. The Sharpe ratio being just above 1 indicates an acceptable portfolio by industry standard. The higher returns in the BSE Small Cap possibly due to the small firm effect is lowered by the relatively risk-free rates of the other indices.

OPTIMAL PORTFOLIO

Index	Nifty50	Sensex	NiftyBank	BSE Small Cap
Annualized Returns	0.2375	0.2151	0.1142	0.6213
Weights	0.1202	0.1917	0	0.6881
Weighted Returns	0.0286	0.0412	0	0.4275
Portfolio Returns	0.4973			
Annualized Standard Deviation	0.2761			
Sharpe Ratio	1.5477			

Creating an optimal portfolio of the indices we see that the return nearly doubles to 50% with only a small increase in the risk. The Sharpe ratio being slightly higher than the previous case.

Returns have been maximized by omitting the index with the lowest return as well as maximizing the weight of BSEsmallCap as well as Nifty50 which are known to have higher and consistent returns. The standard deviation though has increased with a compensatory increase in the returns.

BACKTEST WITH OPTIMAL WEIGHTS OF 21-22 FOR 22-23

Index	Nifty50	Sensex	NiftyBank	BSE Small Cap
Annualized Returns	0.0413	0.0441	0.2057	-0.0360
Weights	0.1202	0.1917	0	0.6881
Weighted Returns	0.0050	0.0085	0	-0.0248
Portfolio Returns	-0.0113			
Annualized Standard Deviation	0.2848			
Sharpe Ratio	-0.2856			

Using the optimal weights obtained for the year 21-22 and applying it to the same indices we obtain a negative return of 1.13% for the portfolio as a whole and an increased risk. This is due to the increased weight of BSE Small Cap which had a significantly poor performance in the year 22-23 which cannot be accounted for while back-testing. On the other hand NiftyBank improved but was not included in the portfolio due to its performance in the previous year. This again shows that the limited effectiveness of attempting to beat the market by back-testing.

BACKTEST WITH ITS OWN OPTIMAL WEIGHTS

Index	Nifty50	Sensex	NiftyBank	BSE Small Cap
Annualized Returns	0.0413	0.0441	0.2057	-0.0360
Weights	0	0	1	0
Weighted Returns	0	0	0.2057	0
Portfolio Returns	0.2057			
Annualized Standard Deviation	0.5032			
Sharpe Ratio	0.2696			

Backtesting using its own optimal weights we can see that the entire weight is given only to NiftyBank which was previously omitted. However due to having only 1 index in the portfolio there is no risk - mitigation leading to an extremely high risk of 0.5 which is not compensated by the return. The Sharpe ratio is quite low indicating a sub-optimal portfolio.

CONCLUSION

Upon observing backtesting for the next few years we can conclude that back-testing ,while a technical analysis tool, is not efficient while trying to build an optimal portfolio. A major reason for this is the instability and volatility on the Indian Markets especially post the pandemic. A major factor that is not included while calculating optimal portfolio is the macroeconomic situation of the country and future prospects. This often leads to creation of portfolios that prompt high returns in the near immediate future but need active management and continuous re-assigning of weights due to fluctuations in the market. This also prompts us to believe that fundamental analysis is needed while creating portfolios to ensure that all the available and appropriate variables are included while modeling an optimal portfolio.