

Optimum Portfolio Construction Using Sharpes Index Model - A Study Of Selected Small Cap's Stocks Listed In The Nse

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ABSTRACT

The intention of this study is to raise awareness among investors about portfolio construction. In this research we used historical stock price data of fifteen companies from FMCG, Banking and Services industry listed in the National Stock Exchange and Nifty 50 indices to analyse the performance of the selected stocks and applied the single Index model. These stocks are characterized by their low premiums and often exhibit high volatility, making them an intriguing asset class for portfolio diversification. We found, beta (β) of an individual stock; market variance (σ_m^2); return of individual stock (R_i) and the market (R_m); residual variance (σ_{ei}^2); co-efficient of determination (r^2), C_i and Z_i values. These variables help in indicating investors to take either a short or a long position as suitable to them based on the value derived. Based on the calculations in the model only three stocks were chosen for the optimal portfolio. The findings and suggestions from this study, hold significant value for fund managers and investors.

Key Words: Return, Beta, Market Variance, Residual Variance, Risk, Single Index Model.

I. INTRODUCTION:

Investing involves deploying funds into assets with the goal of generating income or increasing capital value. Every investment carries the potential for both return and risk. The possibility of the actual return varying is referred to as investment risk. To make informed investment decisions, one must possess knowledge in security analysis and portfolio management. A portfolio represents a combination of different securities. Any portfolio, whether assembled by an individual investor or a fund manager, should align with the

investor's objectives. A rational investor seeks to maximize returns while minimizing risk. Therefore, constructing a portfolio typically involves following one of two well-known approaches: the traditional or the modern method. In the traditional approach, an assessment of the investor's income and capital appreciation requirements is conducted, and suitable securities are chosen to align with these needs. On the other hand, the modern approach utilizes the Markowitz model to select securities based on a comprehensive analysis of risk and return. Harry Markowitz laid the foundation for quantifying investment risk, and his contributions are encapsulated in the widely known 'Modern Portfolio Theory.' His work introduced analytical tools for assessing and selecting the optimal portfolio, an achievement for which he was awarded the Nobel Prize in 1990. William Sharpe expanded upon Markowitz's work, incorporating market indexes into portfolio analysis. He simplified the data requirements for portfolio analysis, making the intricate computations necessary for optimizing a portfolio more accessible. Sharpe developed the Single Index Model, which streamlined these calculations and facilitated the construction of an optimal portfolio. Even today, fund managers rely on this model for portfolio analysis and construction.

NEED FOR THE STUDY:

Investors often grapple with uncertainty when it comes to choosing the right securities for their portfolio. There have been many instances across the world where the lack of a good strategy in investing has led to increase stress and loss of life (Wonse Kim, 2021). Additionally, they find themselves in a quandary when deciding how much

of their investment should be allocated to each security (Edward, 2023). To alleviate this confusion and provide a systematic approach, Single Index model can be employed to create an optimal portfolio. The objective of the current study is to demonstrate that by building an optimum portfolio, individuals can maximize returns while maintaining a specified level of risk.

STATEMENT OF PROBLEM:

When an investor contemplates investing in securities, they encounter the challenge of selecting from a vast array of available options and determining how to distribute their funds among these various securities (Bhatt, 2016). The primary obstacle lies in deciding which specific securities to include in their portfolio and in what proportion to allocate their investments among these chosen securities. The Single Index Model simplifies the process by providing a more streamlined approach to portfolio optimization, making it a practical choice for investors seeking efficiency in their decision-making. Therefore, the paper is called “OPTIMUM PORTFOLIO CONSTRUCTION USING SHARPE’S SINGLE INDEX MODEL- A STUDY OF SELECTED PENNY STOCKS LISTED IN THE NSE”

OBJECTIVES:

- To study the risk and return of selected penny stocks.
- To calculate the proportion of money needed to be invested in each stock of the portfolio to have the least risk while maximizing return.
- To construct an optimum portfolio using penny stocks.
- To gain practical knowledge in application of the Single Index Model.

SCOPE OF THE STUDY:

Rational investors are acutely aware of the importance of considering risk when making investment decisions. In their pursuit of sound investment strategies, these investors opt to assemble a group of securities, commonly referred to as a portfolio, as a means to diversify and mitigate risk. Within the realm of investment, there exists a diverse range of avenues, each characterized by its own level of risk. While some investment opportunities carry substantial risk, others may be comparatively less risky or even relatively risk-free. Given this spectrum of investment choices with varying degrees of risk, it becomes imperative to educate investors about the available alternatives and the associated risk-return profiles. As the landscape of investment

opportunities is extensive and encompasses a wide array of risk levels, the focus of the present study centres on the construction of equity portfolios using carefully selected stocks from the National Stock Exchange (NSE) across the FMCG, Banking and Service sectors.

METHODOLOGY

This is a descriptive study based on secondary data collected from NSE. Five companies from the sectors of Banks, Services and FMCG were each selected for this study.

i). Estimate the return on stock. The equation to be used

$$R_i = \frac{P_t - P_o}{P_o}$$

Where,

P_t = current stock price

P_o = previous stock price.

Step 2: Find excess return to beta ratio for each security

$$\text{Excess return to beta ratio} = \frac{R_i - R_f}{\beta_i}$$

Where,

R_i = Expected return of individual stock

R_f = Risk free rate of return

β_i = Systematic risk of individual stock

Step 3: Arrange all the securities in ascending order and then calculate the ‘Cutoff rate’ ‘C_i by using:

$$c_i = \frac{\sigma_m^2 \epsilon \frac{(r_i - R_f)}{\sigma_{ei}^2} * \beta_i}{1 + \sigma_m^2 \epsilon \frac{\beta_i^2}{\sigma_{ei}^2}}$$

Where,

Σ² m = variance of the market index

σ² ei = variance of individual stock ie, unsystematic risk

The cutoff point for selecting securities in the optimal portfolio is determined based on the point at which the cumulative value of C_i (presumably a measure of some characteristic or performance) begins to decline. Securities that have a C_i value greater than or equal to this cutoff point will be chosen for inclusion in the optimal portfolio.

The proportion of each selected security in the portfolio can be calculated using the following formula:

$$Xi = \frac{Z_i}{\sum_{i=1}^N Z_i}$$

$$Z_i = \frac{\beta_i}{\sigma_{ei}^2} \left[\left(\frac{R_i - R_f}{\beta_i} \right) - C \right]$$

While the first expression (Xi) indicates the weights on each security, the second shows the relative investment in each security.

THEORETICAL FRAMEWORK

Various studies have applied different portfolio construction models to select optimal stocks. Rout and Panda (2020) utilized the Single Index model to construct an optimal portfolio from selected 25 BSE stocks, while Mitra and Motwani (2020) focused on creating a Green Portfolio using the S&P BSE Green Ex index. Krishnamoorthy and Mahabub Basha (2022) constructed a portfolio from 30 BSE Sensex stocks, finding only 9 stocks for inclusion. Mistry and Khatwani (2023)

highlighted the superiority of the Sharpe Single Index Model for the Indian mid-cap sector. Gulliksson and Mazur (2020) investigated portfolio creation using a single covariance matrix. Asghar et al. (2019) discussed issues with stock price data from social media and financial websites. Al-Yahyaee et al. (2019) explored diversification using Bitcoin and gold in comparison to crude oil and commodities. Khatwani (2021) mentioned portfolios based on stock fundamentals. S. Sangeetha et al. (2021) used the Sharpe single-index model for a pharmaceutical portfolio. Shreenidhi and Roopesh (2019) emphasized the effectiveness of the Sharpe Single Index Model for an ideal BSE SENSEX portfolio. Vaddula et al. (2020) built a stock portfolio from 20 S&P BSE Sensex companies. Rajesh and Tanuja (2020) identified top-performing companies for their portfolio. Varadharajan (2012) constructed an equity portfolio of large-cap companies, while Varadharajan (2011) applied the Sharpe index model for banking and information technology sectors.

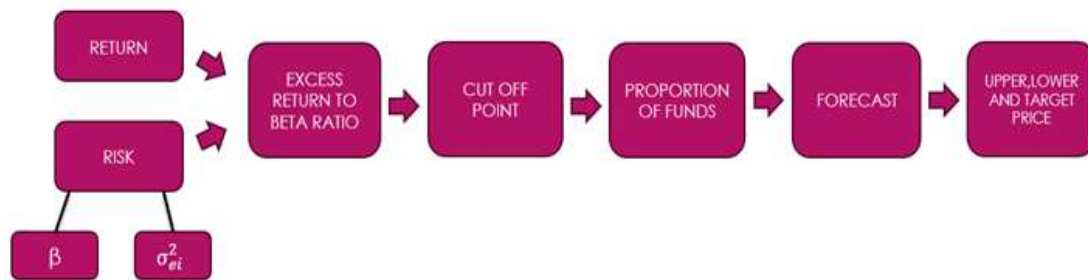


Figure 1. Theoretical framework of an optimal portfolio construction

II. DATA ANALYSIS AND INTERPRETATION

The stocks selected for this research are listed below. For this research stocks from 3 different sectors, namely Banking, Fast Moving

Consumer Goods (FMCG), and Services. The stocks are also chosen based on their market prices as on 8th September, 2023. These stocks are particularly called “penny stocks” in market jargon as their market prices are lesser than Rs.100.

Table 1 The historical stock prices pertaining to the below companies for one year were collected from www.NSE.com.

Sl. No	Stock	MP AS ON 08/09/23	Sector
1	Yes Bank	18.35	Bank
2	Central bank of India	39.3	Bank
3	Punjab National Bank	66.75	Bank
4	Union Bank	88.1	Bank
5	Bank of India	93.1	Bank
6	Bajaj Hindustan Sugar Ltd	27.6	FMCG
7	Kohinoor Foods Limited	35.6	FMCG

8	JHS Svendgaard	26.15	FMCG
9	Umang Industries	13.83	FMCG
10	Nakoda group of Industries	81.5	FMCG
11	Tata Tele Service	95.45	Service
12	Easy Trip Planners	38.8	Service
13	NBCC (India)	59.45	Service
14	IRB Infrastructure	33.5	Service
15	TV18 Broadcast	48.7	Service

The returns of the individual securities and market index are calculated using the following formulae:

$$Security\ Return = \frac{Pt - Po}{Po}$$

$$Index\ Return = \frac{Today's\ index - yesterday\ index}{yesterday\ index} \times 100$$

Nifty 50 is the index selected for the present study. A sample of fifteen companies listed under this index was selected for constructing an optimum portfolio using sharpe's single index model. As a first step, the mean returns of these companies' stocks were computed and returned as under

Table 2 Mean Returns of sample companies

Securities	Ri(%)
IRB Infrastructure	46.21
Bajaj Hindustan Sugar Ltd	100.01
Central bank of India	73.76
Union Bank of India	80.58
Bank of India	66.19
NBCC (India)	56.41
Punjab National Bank	62.21
Umang Industries	20.98
TV18 Broadcast	18.99
JHS Svendgaard	9.51
Yes Bank	10.86
Tata Tele Service	-15.59
Easy Trip Planners	-116.73
Kohinoor Foods Limited	-58.03
Nakoda group of industries	-107.51

Fig.1

The table above illustrates the mean returns of the fifteen companies from three sectors for the purpose of constructing an optimal portfolio using sharpe's model. According to this table, Bajaj Hindustan has produced an excellent return of 100.01%, suggesting a highly profitable investment, while East trip planners has delivered the biggest negative return of -116.73%, showing a huge investment loss.

BETA VALUE ESTIMATIONS

The beta values of sample stock returns were estimated and presented below to determine the market risk faced by each security.

Beta values of the sample companies' stocks

The beta values were calculated by using following formula:

$$\beta = \frac{n\epsilon xy - (\epsilon x)(\epsilon y)}{n\epsilon x^2 - (\epsilon x)^2}$$

Table 3 Beta value of selected stocks

Securities	β
IRB Infrastructure	0.10
Bajaj Hindustan Sugar Ltd	1.21
Central Bank of India	1.21
Union Bank of India	1.68
Bank of India	1.61
NBCC (India)	1.40
Punjab National Bank	1.67
Umang Industries	0.79
TV18 Broadcast	1.27
JHS Svendgaard	0.97
Yes Bank	10.12
Tata Tele Service	1.09
Easy Trip Planners	1.95
Kohinoor Foods Limited	0.95
Nakoda group of industries	0.29

Fig.2

The beta values of the fifteen securities stock returns are shown in the above table. Beta measures the expected movement of a stock relative to the movement in the overall market. A beta greater than 1.0 suggests that the stock is more volatile than the broader market and less than 1.0 indicates a stock with lower volatility. Yes Bank

has an exceptionally high beta of 10.12, signifying extreme sensitivity to market fluctuations, while Bajaj (1.21), CBI (1.21), UBI (1.68), BOI (1.61), and stocks chosen from the FMCG sector have beta values greater than 1 indicating high volatility. In comparison to all chosen securities IRB infrastructure (0.10) and, Nakoda group of industries (0.29) have the lowest volatility.

Table 4 Ranking stocks based on excess beta to return ratio

Securities	$R_i - R_f / \beta$	Rank
IRB Infrastructure	473.13	1
Bajaj Hindustan Sugar Ltd	82.61	2
Central bank of India	61.04	3
Union Bank of India	47.95	4
Bank of India	41.15	5
NBCC (India)	40.17	6
Punjab National Bank	37.18	7
Umang Industries	26.32	8
TV18 Broadcast	14.86	9
JHS Svendgaard	9.74	10
Yes Bank	1.07	11
Tata Tele Service	-14.40	12
Easy Trip Planners	-59.95	13
Kohinoor Foods Limited	-61.33	14
Nakoda group of industries	-376.32	15

Fig 3

The excess return and excess return to beta ratio are shown above. Excess return is the difference between the stock's predicted return and the risk-free interest rate ratio. For this study, the risk-free interest rate is fixed at 7%. The additional return on a security for every unit of market risk is measured by the excess return to beta ratio. The excess return to beta ratio measures the additional return on a security per unit of market risk. The

top-ranked securities (IRB Infrastructure, Bajaj Hindustan, & central bank of India) have outperformed the market in the past, on a risk adjusted basis and the bottom ranked securities (Yes bank, Tata tele service, Easy trip planners and Nakoda group of industries) have underperformed the market in the past, on a risk adjusted basis which means they have generated lower returns than the market, given their level of risk.

Table 5 Sample companies based on their Ranks and Unsystematic Risk

Securities	62ei	(Ri-Rf)β/62ei	Σ(Ri-Rf)β/62ei
IRB Infrastructure	7.82	60.48	60.48
Bajaj Hindustan Sugar Ltd	13.52	6.11	66.60
Central bank of India	7.89	7.74	74.33
Union Bank of India	4.94	9.71	84.04
Bank of India	4.94	8.33	92.37
NBCC (India)	6.01	6.68	99.05
Punjab National Bank	10.28	3.62	102.67
Umang Industries	6.94	3.79	106.46
TV18 Broadcast	6.39	2.33	108.79
JHS Svendgaard	6.97	1.40	110.18
Yes Bank	6.17	0.17	110.36
Tata Tele Service	8.67	-1.66	108.70
Easy Trip Planners	37.66	-1.59	107.10
Kohinoor Foods Limited	12.66	-4.84	102.26
Nakoda group of industries	7.45	-50.52	51.74

Fig. 4

The Above table reveals that out of fifteen companies, Easy trip planners has the highest value of 37.66 and UBI, CBI has the risk of 4.94. As a next step the 'Ci' was computed and tabulated below.

Table 6 CUT OFF POINT CALCULATIONS

Securities	Ri	β	62ei	(Ri-Rf)β/62ei	Σ(Ri-Rf)β/62ei
IRB Infrastructure	46.21	0.10	7.82	60.48	60.48
Bajaj Hindustan Sugar Ltd	100.01	1.21	13.52	6.11	66.60
Central bank of India	73.76	1.21	7.89	7.74	74.33
Union Bank of India	80.58	1.68	4.94	9.71	84.04
Bank of India	66.19	1.61	4.94	8.33	92.37
NBCC (India)	56.41	1.40	6.01	6.68	99.05
Punjab National Bank	62.21	1.67	10.28	3.62	102.67
Umang Industries	20.98	0.79	6.94	3.79	106.46
TV18 Broadcast	18.99	1.27	6.39	2.33	108.79
JHS Svendgaard	9.51	0.97	6.97	1.40	110.18

Yes Bank	10.86	10.12	6.17	0.17	110.36
Tata Tele Service	-15.59	1.09	8.67	-1.66	108.70
Easy Trip Planners	-116.73	1.95	37.66	-1.59	107.10
Kohinoor Foods Limited	-58.03	0.95	12.66	-4.84	102.26
Nakoda group of industries	-107.51	0.29	7.45	-50.52	51.74

Securities	$62m * \Sigma(R_i - R_f) / \sigma^2 e_i$	$\beta^2 / \sigma^2 e_i$	$\Sigma \beta^2 / \sigma^2 e_i$	$1 + 62m * \Sigma \beta^2 / \sigma^2 e_i$	C_i
IRB Infrastructure	27.62	0.00	0.00	1.00	27.60
Bajaj Hindustan	30.41	0.11	0.11	1.05	28.96
Central bank of India	33.94	0.18	0.29	1.13	29.92
Union Bank of India	38.38	0.57	0.87	1.40	27.51
Bank of India	42.18	0.52	1.39	1.63	25.82
NBCC (India)	45.23	0.33	1.71	1.78	25.37
Punjab National Bank	46.88	0.27	1.99	1.91	24.58
Umang Industries	48.62	0.09	2.08	1.95	24.95
TV18 Broadcast	49.68	0.25	2.33	2.06	24.06
JHS Svendgaard	50.32	0.13	2.47	2.13	23.66
Yes Bank	50.39	16.60	19.07	9.71	5.19
Tata Tele Service	49.64	0.14	19.20	9.77	5.08
Easy Trip Planners	48.91	0.10	19.30	9.82	4.98
Kohinoor Foods Limited	46.70	0.07	19.38	9.85	4.74
Nakoda group of industries	23.63	0.01	19.39	9.85	2.40

Fig. 5

The above table represents the C_i of the sample companies. The $\beta^2 / \sigma^2 e_i$ and its cumulative are necessary for the calculation of C_i . The C_i value rises from 27.60 to 29.92 before beginning to fall. As a result, the number 29.92 is regarded as the "cut-off point." securities that arrive after the cut-off point will not be considered for optimum portfolio creation. The C_i is calculated and tabulated as under:

The C_i values in the table above climb constantly to a certain point before declining. At the highest point, known as the cut-off point, stocks over C^* are chosen to be included in the portfolio.

Companies such as IRB Infrastructure (28.8), Bajaj Hindustan (28.96), the Central Bank of India (29.92), the Union Bank of India (27.51), and others trade over their cutoff pricing. The fact that these stocks are currently trading above the cutoff price indicates that the market places a higher value on them. Kohinoor Foods Limited, Yes Bank, Tata Tele Service, Easy Trip Planners, and Nakoda Group of Industries, on the other hand, are trading below their cutoff prices. These stocks are trading below the cutoff price, which might indicate that they are overpriced.

Table 7 Proportion of Funds Invested

Rank	Securities	Ci	Zi	Xi
1	IRB infrastructure	27.60	5.53	37%
2	Bajaj Hindustan Sugar Ltd	28.96	4.72	31%
3	Central bank of India	29.92	4.76	32%
	Total		15.00	

The above table shows the percentage of funds invested in each security. The securities ranked from 1 to 3 are chosen for the best portfolio. The percentage of funds to be invested in each security is represented in figure

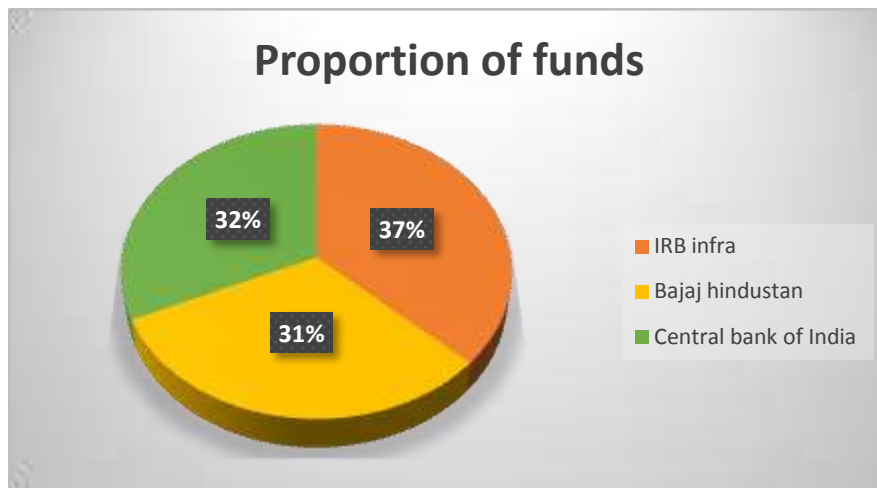


Figure 2: Proportion of investment

Out of fifteen companies three companies have been selected for the optimum portfolio construction by applying Single index model. The above pie chart represents the proportion of investment to be made by the investor to earn maximum returns. The figure shows that 37% or 5.53 units of investment may be made in the IRB Infrastructure (which means majority of the funds is to be invested on this company's stock), 4.72 units or 32% of the investment in CBI and 31% or 4.75 units in Bajaj Hindustan. The investor

allocated a total of 15.00 units across these stocks. This selective allocation reflects the investor's investing goals, risk tolerance, and level of trust in the underlying securities. Understanding that diversification across various investments is a key technique to reduce risk and meet long-term financial objectives is essential. To make sure that the investing plan is in line with the investor's financial objectives, it is advised to frequently examine and adjust the portfolio.

Table 8 ARIMA Model applied to the optimum portfolio

	IRB Infrastructure	CBI	Bajaj Hindustan
Co-efficient	135.485	28.563	-0.043952
Std Error	18.8339	4.12085	0.16067
Z value	7.1937	6.9313	3.2736
P value	0.00143	0.00133	0.01540

The above table shows that the p value for all the selected stocks are less than 0.005 or less than 5% of significance. This indicates that the

stocks have a relationship with past prices to current prices. Thus, we forecast the stock prices for the selected stocks

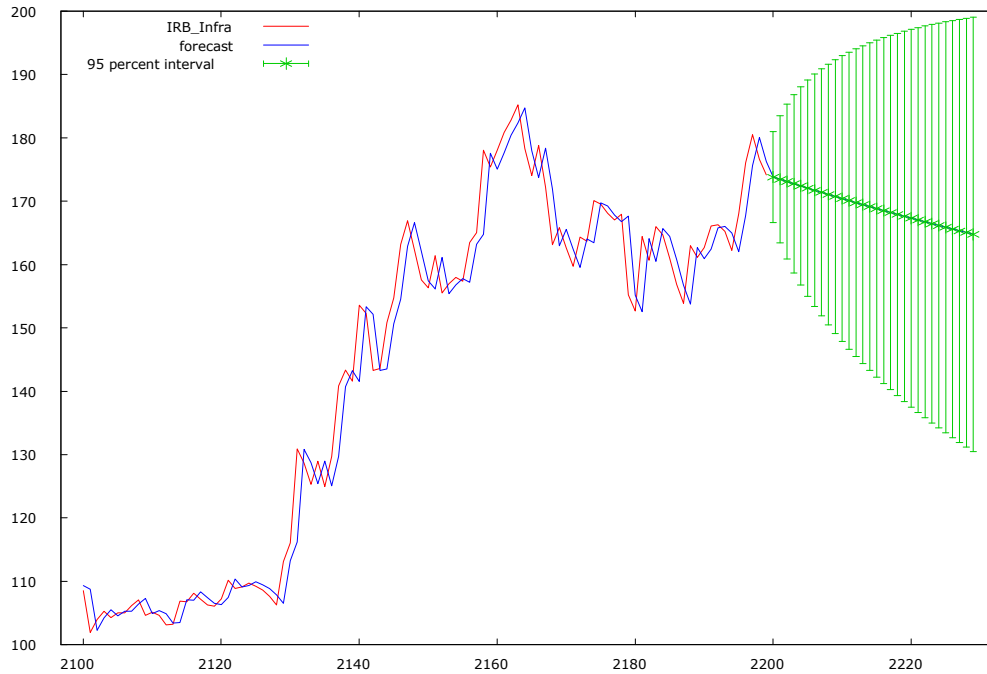


Figure 3 Forecast for IRB Infrastructure

The above graph illustrates the forecasted prices for the period of 3 months with the Upper band at 200 and the Lower band at 130 and a Target

price of 165. This was based on the data collected as of September 2023, the current price of the stock is 175 showcasing that the forecast was accurate.

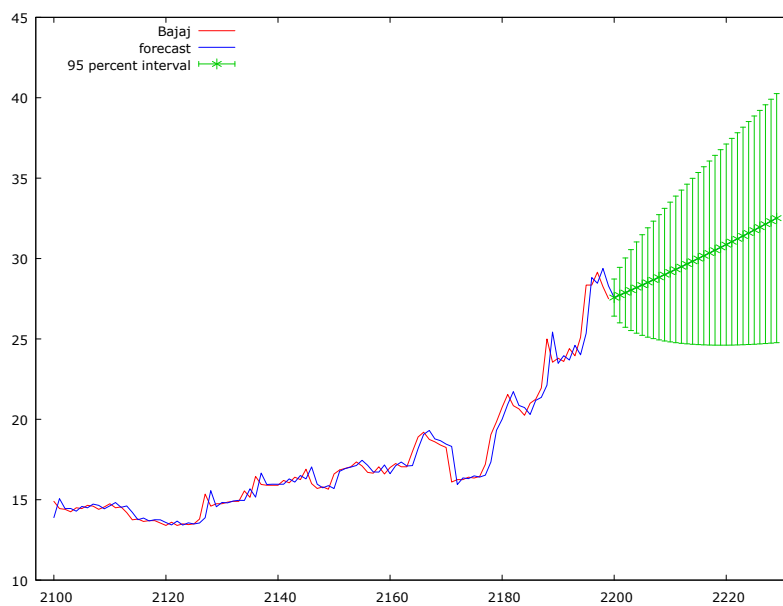


Figure 4 Forecast for Bajaj Hindustan Sugar Ltd

The above graph illustrates the forecasted prices for the period of 3 months with the Upper band at 40 and the Lower band at 25 and a Target

price of 32.5. This was based on the data collected as of September 2023, the current price of the stock is 34.25 showcasing that the forecast was accurate

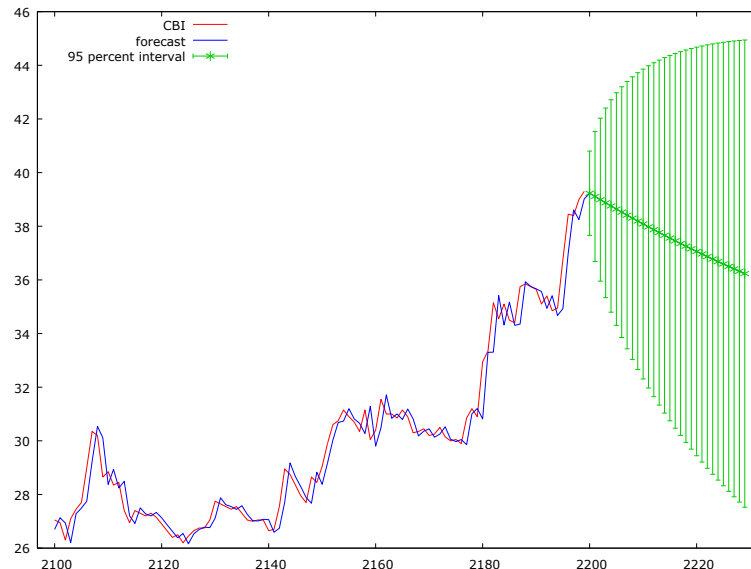


Figure 5 Forecast of Central Bank of India

The above graph illustrates the forecasted prices for the period of 3 months with the Upper band at 45 and the Lower band at 27 and a Target price of 37. This was based on the data collected as of September 2023, the current price of the stock is 44.90 showcasing that the forecast was accurate

quality. The bank has rarely seen a 5% decline in intra-day trading.

III. KEY FINDINGS:

From the above calculations we were able to deduce three stocks, (one from Banking, one from Services and one from FMCG) as part of the optimum portfolio. The overall portfolio return stands at 71.87% while the portfolio risk is 32.75%. These stocks are performing the best while having minimal risk in comparison to other stocks in the same price range. This is because of recent trends in the market and individual stock performances. IRB Infrastructure has seen a 24% surge in its toll collections, which has surged its stock prices as well. Also given the government's plans to increase investment in the infrastructure space across the country. The stock is performing extremely well with very minimal systematic risk. Bajaj Hindustan Sugar Ltd. has also been performing well due to its double-digit revenue growths in the past three years. The company has the potential to return 50% on investment in 12 months. Central Bank of India has been the strongest performer in the past few months. This is mainly due to increase in revenue, government policies such as capital infusion and support to public sector banks and improved asset

However, the stocks considered for this study are not all bad performing stocks, all the stocks in the banking sector chosen for this study have been performing decently well in the market due to government policies and support. Although the same cannot be said for the services industry as they were affected heavily by the pandemic and latest government policies. A few stocks have been performing well in this sector including Bajaj Hindustan as chosen in our portfolio.

FMCG stocks are a mixed bag. The pandemic has had both a positive effect and a negative effect on the sector. Kohinoor Foods and Nakoda Foods are the last two stocks in the ranks based on our calculations. Overall, they are seen as the worst performing stocks in the current selected pool. However, it is important to note that these stocks over the period of 5 years have provided over 500% returns to their investors. The surge in FMCG stocks can be seen due to increasing disposable income, changing lifestyles and rural growth.

Based on the Arima model we found that there is a relation between today and yesterday price, based on these results we forecast the upper and lower bands and fixed a target price for the selected stocks.

IV. CONCLUSION:

Through this study, we were able to shortlist a stock from each sector to build an optimum portfolio, namely, IRB Infrastructure; Bajaj Hindustan; and Central Bank of India. We were also able to find the proportion of investment that would deliver the maximum return from this portfolio with the least risk. We also applied the Arima model and found a relation with today and yesterday's price and forecasted the prices for the next 3 months. Therefore, we can conclude that the Single Index Model is a very powerful tool for investors to decide on an optimum portfolio based on their expectations as it measures the risk and return of a portfolio.

SCOPE FOR FURTHER RESEARCH:

This study has been conducted on just 15 stocks from three sectors that are classified as "Penny Stocks". Further studies can be conducted in the same sectors by adding more stocks which will change the risk and return calculations and render a new optimum portfolio. Further, different sectors can be selected to diversify the portfolio further and mitigate the risk while maximizing returns.

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