Construction of an Optimal Portfolio Using the Single Index Model : An Empirical Study of Nifty50 Stocks

Prakash Basanna [1]
Namita P. Konnur [2]

Abstract

It is Markowitz who introduced for the first time the modern portfolio theory which considers both risk and return for the selection of stocks required for an optimal portfolio. The Markowitz model is highly information intensive, conceptually very sound, and theoretically very elegant. However, it has serious practical limitations due to complexities involved in compiling the expected return, standard deviation, variance, and covariance. William Sharpe developed a model known as the Single Index Model, which is an extension of the model given by Markowitz. It is the simplest and the most widely used one. He simplified the amount and type of input data required in the selection of stocks for the portfolio construction. The model expresses the return on each stock as a function of the return on a broad market index to which the stocks are related. The current study was undertaken to construct an optimal portfolio using the Single Index Model for a sample of 50 stocks included in the NSE Nifty and the Nifty50 as the benchmark index. For the construction of the portfolio, average of daily opening and closing prices of the Nifty50 stocks and Nifty50 index were used for a 4 year period from 1/4/2014 – 31/3/2019 ; 364 days monthly treasury bill rates of the financial year 2014 –19 were used as risk free rate of return. Though as many as 50 stocks were considered for the current study, only few stocks (i.e. eight) were selected for the construction of an optimal portfolio as per the Single Index Model. The stocks selected belonged to consumer non-durables (three), consumer durable (one), finance (three), and agro-based sectors (one). The consumer non - durables and finance companies dominated for the selection of stocks followed by consumer durables.

Keywords : Single Index Model, optimal portfolio, Nifty50, risk and return, beta

JEL Classification : G1, G10, G11, G12, G14, G17

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An optimal portfolio is the collection of stocks, which maximizes return at lowest risk. It is Markowitz who introduced, for the first time, the modern portfolio theory which considers both risk and return for the evaluation of stocks for the optimal portfolio. He developed a model for the construction of an optimal portfolio, which won him the Nobel Prize in 1990. The Markowitz model is highly information intensive, conceptually very sound, and theoretically very elegant. However, it has serious practical limitations due to complexities involved in compiling the expected return, standard deviation, variance, and covariance. It requires a large number of inputs. For instance, if an investor considers 100 securities for the construction of a portfolio, the model requires 100 expected return terms, 100 variance terms, and 4950 covariance terms totaling 5150 inputs. Estimating a large number of covariance terms becomes very difficult, particularly for the institutional investors who consider a large number of securities in their portfolio.

William Sharpe developed a model known as the Single Index Model, which is an extension of the model

[1] *Professor,* Department of MBA, CMR Institute of Technology, #132, AECS Layout, ITPL Main Road, Kundalahalli, Bengaluru – 560 037. (E-mail : yaragolpb@gmail.com)

[2] *Assistant Professor,* Department of MBA, CMR Institute of Technology, #132, AECS Layout, ITPL Main Road, Kundalahalli, Bengaluru – 560 037.

given by Markowitz. It is the simplest and the most widely used one. He simplified the amount and type of input data required in the selection of stocks for the portfolio construction. It requires very less inputs (i.e. $3n + 2$). For instance, for a portfolio comprising of 100 securities, only 302 (i.e. $3 \times 100 + 2$) inputs are required as against 5,150 inputs [i.e. $100(100 + 3)/2$] required in the Markowitz model. The model expresses the return on each stock as a function of the return on a broad market index to which the stocks are related. The return and risk on a security under this model are calculated as shown below :

Expected Return on Security : $R_i = \alpha + \beta_i R_m + ei$

Expected Risk on Security : $\sigma_i = \sqrt{\beta_i^2 \sigma_m^2 + \sigma^2 ei}$

where,

R_i = Return on a security,

α = Constant return (Alpha),

β_i = Beta of a security,

R_m = Return on the market index,

ei = error term (Zero).

Steps in the Construction of an Optimal Portfolio

Before the construction of a portfolio, one has to identify the stocks to be evaluated and index to be used as a benchmark and then obtain returns of the stocks and index and risk - free rate of return.

✥ **Step 1 :** In the Step 1, the excess of return over risk-free rate of return per unit of risk measured by beta [i.e. $(R_i - R_f)/\beta_i$] is calculated for each of the securities chosen for the construction of a portfolio. Then the securities are arranged on the basis of excess return in the order of the highest to the lowest.

✥ **Step 2 :** In the Step 2, for each of the stock, excess of stock return over risk-free rate of return is multiplied by stock beta and then divided by residual variance of the stock, that is, $[(R_i - R_f)\beta_i]/\sigma_{ei}^2$.

✥ **Step 3 :** For each of the stock, stock beta is squared and then divided by its residual variance $[\beta_i^2 \div \sigma_{ei}^2]$.

✥ **Step 4 :** In the Step 4, the values ascertained in the Steps 2 and 3 are cumulated.

$$\sum_{i=1}^{j} \frac{(R_i - R_f)\beta_i}{\sigma_{ei}^2} \quad \sum_{i=1}^{j} \frac{(\beta_i)^2}{\sigma_{ei}^2}$$

✥ **Step 5 :** In the step six, cut-off points (i.e. C_i) are calculated for each of the security as shown below :

$$C_i = [\sigma_m^2 \times \sum_{i=1}^{j} \frac{(R_i - R_f)\beta_i}{\sigma_{ei}^2}] \div [1 + (\sigma_m^2 \times \sum_{i=1}^{j} \frac{(\beta_i)^2}{\sigma_{ei}^2}]$$

Amongst the cut-off points calculated above, the highest cut-off point (C_h) is identified. All the C_i values of the securities increase up to the highest cut-off point and hereafter, they start declining. Then, all those securities which are covered by this highest cut-off point are chosen for the construction of a portfolio (when short sale is not permitted). It means the stocks with the excess return to beta ratio greater than the highest cut-off rate are selected for the optimal portfolio construction.

✤ **Step 6 :** In the Step 6, proportion of the investment (i.e. Z_i) for each of the security selected for the portfolio construction is calculated as shown below :

$$Z_i = (\beta_i / \sigma^2_{ei}) \, [(R_i - R_f)/\beta_i - C_h]$$

Then weights of each of the security are calculated for the optimal portfolio :

$$W_i = Z_i \div \Sigma \, Z_i$$

Optimal Portfolio When Short Sale is Permitted

The procedure used to identify the optimal portfolio when short sale is allowed is more or less similar to the procedure adopted for no short sales, except the cut-off point concept. The sum of C_i values of all the stocks (denoted by C_L) is taken as the cut-off point and all the stocks are considered for the portfolio. The Z_i value has to be calculated for each of the stock chosen for the portfolio. The stocks with positive Z_i values (i.e. the stocks with excess return-to-risk ratio greater than the highest cut-off point C_h) are held long and the stocks with negative Z_i values (i.e. the stocks with excess return-to-risk ratio smaller than highest cut-off point C_h) are sold short.

Assumptions of SIM

The Single Index Model is based on the following assumptions :

(i) All the investors are assumed to have homogeneous expectations.

(ii) A uniform holding period is used for estimating return and risk for each of the stock.

(iii) The error term (ei) is assumed to be zero and a finite variance.

(iv) The error term of a security is not correlated with the return on the market portfolio ($Cov_{ei,Rm} = 0$).

(v) The error term of a security is not correlated with the error term of any other security (i.e. $Cov_{ei,ej} = 0$).

Review of Literature

Nalini (2014) constructed an optimal portfolio using the Single Index Model for BSE Sensex stocks. For this purpose, a sample of 30 stocks during 2005 – 2012 was chosen for the study.

It was found that even companies with high rates of return were not included in the portfolio as the risk involved in such companies was high. It was also proved that SIM has been useful to create an optimal portfolio by diversifying almost all the unsystematic risks. Bilbao, Arenas, Jiménez, Gladish, and Rodriguez (2006) studied construction of portfolio using Sharpe's Single Index Model using fuzzy sets theory. In this study, expert estimations about future betas of each financial asset have been included in the portfolio selection model denoted as 'expert betas' and modelled as trapezoidal fuzzy numbers. In the construction of optimal portfolio, a goal programming model has been used including imprecise investor's aspirations concerning asset's proportions of both, high-and low-risk assets. Semantics of these goals are based on the fuzzy membership of a goal satisfaction set.

Mehta and Turan (2008) examined the applicability of Sharpe's Single Index Model in the construction of a portfolio for the stocks of the Indian stock market. Weekly market prices of 50 shares listed on BSE and 30 stocks of BSE Sensex were collected for a period of 7 years from April 1995 – March 2002. The results of the study indicated that in case of 56.52% – 65.22% of the portfolios, the performance appeared to be superior to the

market. However, it was not significantly superior at the 10% level of significance. Varadharajan (2011) constructed an optimal portfolio using the Single Index Model in banking and information technology. For this purpose, a sample of 19 stocks during April 2006 – March 2011 was chosen for the study. Out of 19 stocks, only five stocks were selected for the portfolio construction: one from IT and four from the banking sector. Debasish and Khan (2012) in their research found that only three stocks constituted the optimal portfolio and these were Asian Paints, Tata Motors, and Hero MotoCorp with ideal proportion of investment of 1.9%, 38.88%, and 58.22%, respectively.

Saravanan and Natarajan (2012) attempted to construct an optimal portfolio using the Single Index Model for the NSE Nifty stocks. For this purpose, daily prices of the Nifty stocks during April 2006 – December 2011 were chosen for the study. Out of 50 stocks, only four stocks were selected for the optimal portfolio giving the return of 0.116. It is also known from the study that return on securities of different portfolios is independent of the systematic risk prevailing in the market. It was concluded that returns on individual securities or on portfolio comprised of securities of different companies listed on Nifty 50 stocks under various sectors were asymmetrical and heterogeneous. Mahabub Basha and Ramaratnam (2017) examined the applicability of Sharpe's Single Index Model in the construction of optimal portfolio for the stocks of Nifty Midcap-150. Monthly closing prices of 150 stocks taken from Nifty Midcap were considered for a period of 5 years from July 2011 – June 2016. The study concluded with construction of an optimal portfolio of 25 stocks out of 150 stocks, which maximized return with least risk.

Objective of the Study

The objective of the current study is to construct an optimal portfolio of Nifty50 stocks using the Single Index Model.

Research Methodology

The current study is considered to be a descriptive study. The data taken for the research is secondary in nature, which were collected from the official website of the National Stock Exchange (NSE). The optimal portfolio is constructed using the Single Index Model for the sample of 50 stocks included in the NSE Nifty and the Nifty50 is used as a benchmark index. For the construction of a portfolio, average of daily opening and closing prices of the Nifty50 stocks and Nifty50 index are used for 4 years period from 1/4/2014 – 31/3/2019 ; 364 days monthly Treasury bill rates of the financial year 2014–19 are used as risk free rate of return.

Analysis and Results

For the construction of an optimal portfolio, Nifty50 stocks are considered for the evaluation, which are given below.

BPCL (Energy), IOC Ltd. (Energy), Titan Company Ltd. (Consumer Goods), HDFC Ltd. (Financial Services), Asian Paints Ltd. (Consumer Goods), Hindustan Unilever Ltd. (Consumer Goods), HDFC Bank Ltd. (Financial Services), Eicher Motors Ltd. (Automobile), Maruti Suzuki India Ltd. (Automobile), Kotak Mahindra Bank Ltd. (Financial Services), Dr. Reddy's Laboratories Ltd. (Pharma), NTPC Ltd. (Energy), Powergrid Corpn. of India Ltd. (Energy), Britannia Industries Ltd. (Consumer Goods), Sun Pharmaceutical Industries Ltd. (Pharma), Bajaj Auto Ltd. (Automobile), ITC Ltd. (Consumer Goods), Hindalco Industries Ltd. (Metal), Nestle India Ltd. (Consumer Goods), Bajaj Finance Ltd. (Financial Services), Mahindra & Mahindra Ltd. (Automobile), Infosys Ltd. (IT), L & T Ltd. (Construction), Bajaj Financial Service Ltd. (Financial Services), Hero MotoCorp Ltd. (Automobile), Tech Mahindra Ltd. (IT), GAIL India Ltd. (Energy), Adani Ports and Special

Economic Zone Ltd. (Services), Reliance Industries Ltd. (Energy), ICICI Bank Ltd. (Financial Services), HCL Technologies Ltd. (IT), UPL Ltd. (Fertilisers & Pesticides), Axis Bank Ltd. (Financial Services), TCS Ltd. (IT), Tata Motors Ltd. (Automobile), Wipro Ltd. (IT), JSW Steel Ltd. (Metals), Vedanta Ltd. (Metals), Bharti Infratel Ltd. (Telecom), Tata Steel Ltd. (Metals), ONGC Ltd. (Energy), Coal India Ltd. (Energy), Ultra Tech Cement Ltd. (Cement), Bharti Airtel Ltd. (Telecom), Cipla Ltd. (Pharma), Grasim Industries Ltd. (Cement), State Bank of India (Financial Services), IndusInd Bank Ltd. (Financial Services), ZEE Entertainment Enterprises Ltd. (Media & Entertainment), and Yes Bank Ltd. (Financial Services).

From the available data, stock returns, market return, risk-free rate of return, beta, residual variance, and alpha are calculated in Excel and presented in Table 1.

Table 1. Stock Return, Beta, Residual Variance, and Alpha

Sl. No.	Stocks	Annul Stock Returns (%)	Beta	Residual Variance	Alpha
1	BPCL	33.48	1.08	2.19	0.041
2	IOC Ltd.	30.19	1.05	2.07	0.033
3	Titan Industries Ltd.	47.28	0.88	1.91	0.088
4	HDFC Ltd.	26.00	1.10	0.76	0.019
5	Asian Paints Ltd.	32.64	0.86	1.00	0.049
6	Hindustan Unilever Ltd.	32.58	0.61	0.83	0.061
7	HDFC Bank Ltd.	34.81	0.82	0.33	0.057
8	Eicher Motors Ltd.	41.40	1.08	2.02	0.063
9	Maru` Suzuki India Ltd.	38.85	1.03	0.86	0.058
10	Kotak Mahindra Bank Ltd.	39.18	0.89	0.83	0.066
11	Dr. Reddy's Laboratories Ltd.	5.77	0.69	1.87	−0.017
12	NTPC Ltd.	6.24	0.81	1.23	−0.021
13	Powergrid Corpn. of India Ltd.	20.26	0.71	0.82	0.022
14	Britannia Industries Ltd.	62.22	0.72	1.33	0.136
15	Sun Pharmaceutical Industries Ltd.	−0.48	0.82	2.37	−0.04
16	Bajaj Auto Ltd.	12.60	0.85	0.91	−0.005
17	ITC Ltd.	9.86	0.80	1.14	−0.01
18	Hindalco Industries Ltd.	17.91	1.58	2.32	−0.025
19	Nestle India Ltd.	26.02	0.54	1.17	0.046
20	Bajaj Finance Ltd.	88.94	1.10	2.14	0.192
21	Mahindra & Mahindra Ltd.	11.52	1.00	1.01	−0.016
22	Infosys Ltd.	20.14	0.69	1.20	0.023
23	L & T Ltd.	17.48	1.23	0.86	−0.01
24	Bajaj Financial Service Ltd.	68.97	0.95	1.79	0.144
25	Hero Motocorp Ltd.	6.18	0.94	1.03	−0.027
26	Tech Mahindra Ltd.	19.56	0.39	1.86	0.035
27	GAIL India Ltd.	18.89	1.00	1.57	0.005
28	Adani Ports	26.41	1.49	1.85	0.002
29	Reliance Industries Ltd.	34.42	1.11	0.89	0.042
30	ICICI Bank Ltd.	18.99	1.52	1.41	−0.02

31	HCL Technologies Ltd.	15.87	0.60	1.49	0.015
32	UPL Ltd.	52.83	1.09	2.23	0.094
33	Axis Bank Ltd.	32.89	1.31	1.35	0.028
34	TCS Ltd.	20.65	0.57	1.05	0.03
35	Tata Motors Ltd.	−19.28	1.51	2.08	−0.124
36	Wipro Ltd.	8.22	0.53	0.97	−0.002
37	JSW Steel Ltd.	34.84	1.19	1.52	0.039
38	Vedanta Ltd.	7.16	1.72	3.23	−0.061
39	Bhar` Infratel Ltd.	18.01	0.57	2.53	0.023
40	Tata Steel Ltd.	12.92	1.48	1.81	−0.034
41	ONGC Ltd.	−5.08	1.07	1.59	−0.064
42	Coal India Ltd.	−2.82	0.77	1.44	−0.044
43	Ultra Tech Cement Ltd.	20.85	1.12	1.01	0.005
44	Bhar` Airtel Ltd.	5.08	0.86	1.65	−0.026
45	Cipla Ltd.	12.20	0.78	1.17	−0.003
46	Grasim Industries Ltd.	14.95	1.01	1.32	−0.006
47	SBI	20.42	1.50	1.70	−0.015
48	IndusInd Bank Ltd.	40.37	1.06	0.80	0.061
49	ZEE Entertainment Enterprises Ltd.	18.06	0.96	1.54	0.004
50	Yes Bank Ltd.	43.47	1.44	4.21	0.051
	Market return	17.15% p.a.			
	Risk-free rate of return	7.15% P.a.			

Source : Calculated using Excel from the data collected from NSE website.

The stock returns are calculated after adjusting the changes in the number of shares on account of bonus issue and stock split as shown in Table 2.

Table 2. Adjustment Factor for Stock Split and Bonus Issue

Sl. No.	Date of Adjustment	Company	Bonus / Stock Split	Rao`	Adj. Factor
1	13/6/2017	Wipro Ltd.	Bonus	1:1	2
2	2/12/2014	Infosys Ltd.	Bonus	1:1	2
3	15/6/2015	Infosys Ltd.	Stock Split	2:1	
4	4/9/2018	Infosys Ltd.	Bonus	1:1	2
5	28/7/2014	Axis Bank	Stock Split	5:1	5
6	4/12/2014	ICICI Bank	Stock Split	5:1	5
7	19/3/2015	Tech Mahindra	Bonus	1:1	4
			Stock Split	2:1	
8	19/3/2015	HCL Tech	Bonus	1:1	2
9	8/9/2016	Bajaj Finance	Stock Split	5:1	10
			Bonus	1:1	
10	21/12/2017	M&M	Bonus	1:1	2
11	4/1/2017	JSW Steel	Stock Split	10:1	10

12	31/5/2018	TCS-bonus	Bonus	1:1	2
13	20/11/2014	SBI	Stock Split	10:1	10
14	21/9/2017	Yes Bank	Stock Split	5:1	5
15	6/10/2016	Grasim	Stock Split	5:1	5
16	8/7/2015	Kotak Bank	Bonus	1:1	2
17	13/7/2016	BPCL	Bonus	1:1	2
18	13/7/2017	BPCL	Bonus	1:2	1.5
19	18/10/2016	IOC	Bonus	1:1	2
20	15/3/2018	IOC	Bonus	1:1	2
21	1/7/2016	ITC	Bonus	1:2	1.5
22	9/3/2017	GAIL	Bonus	1:3	1.33
23	27/3/2018	GAIL	Bonus	1:3	1.33
24	13/7/2017	L&T	Bonus	1:2	1.5
25	7/9/2017	Reliance	Bonus	1:1	2
26	29/11/2018	Britannia	Stock Split	1:2	2
27	6/3/2019	Wipro	Bonus	1:3	1.33
28	15/12/2016	ONGC	Bonus	1:2	1.5

In the Step 1, excess of return over risk-free rate of return per unit of risk measured by beta is calculated for each of the securities chosen for the construction of the portfolio using $(R_i - R_f)/\beta_i$) and presented in Table 3. Then the securities are arranged on the basis of excess return in the order of the highest to the lowest.

Table 3. Excess Return to Beta Ratio and Ranking the Stocks

Stocks	Stocks	$(R_i - R_f)/\beta_i$	Ranking
1	BPCL	$(33.48 - 7.15)/1.08 = 24.47$	14
2	IOC Ltd.	$(30.19 - 7.15)/1.05 = 21.86$	20
3	Titan Industries Ltd.	$(47.28 - 7.15)/0.88 = 45.73$	24
4	HDFC Ltd.	$(26.00 - 7.15)/1.10 = 17.06$	3
5	Asian Paints Ltd.	$(32.64 - 7.15)/0.86 = 29.58$	6
6	Hindustan Unilever Ltd.	$(32.58 - 7.15)/0.61 = 41.95$	32
7	HDFC Bank Ltd.	$(34.81 - 7.15)/0.82 = 33.88$	10
8	Eicher Motors Ltd.	$(41.40 - 7.15)/1.08 = 31.62$	19
9	Maru` Suzuki India Ltd.	$(38.85 - 7.15)/1.03 = 30.74$	7
10	Kotak Mahindra Bank Ltd.	$(39.18 - 7.15)/0.89 = 36.05$	26
11	Dr.Reddy's Laboratories Ltd.	$(5.77 - 7.15)/0.69 = -2.00$	8
12	NTPC Ltd.	$(6.24 - 7.15)/0.81 = -1.12$	48
13	Powergrid Corpn. of India Ltd.	$(20.26 - 7.15)/0.71 = 18.48$	9
14	Britannia Industries Ltd.	$(62.22 - 7.15)/0.72 = 76.10$	5
15	Sun Pharmaceutical Industries Ltd.	$(-0.48 - 7.15)/0.82 = -9.35$	50
16	Bajaj Auto Ltd.	$(12.60 - 7.15)/0.85 = 6.40$	29
17	ITC Ltd.	$(9.86 - 7.15)/0.80 = 3.40$	1
18	Hindalco Industries Ltd.	$(17.91 - 7.15)/1.58 = 6.79$	34

19	Nestle India Ltd.	$(26.02 - 7.15)/0.54 = 34.65$	37
20	Bajaj Finance Ltd.	$(88.94 - 7.15)/1.10 = 74.65$	2
21	Mahindra & Mahindra Ltd.	$(11.52 - 7.15)/1.00 = 4.36$	33
22	Infosys Ltd.	$(20.14 - 7.15)/0.69 = 18.83$	39
23	L & T Ltd.	$(17.48 - 7.15)/1.23 = 8.42$	22
24	Bajaj Financial Service Ltd.	$(68.97 - 7.15)/0.95 = 65.08$	13
25	Hero Motocorp Ltd.	$(6.18 - 7.15)/0.94 = -1.03$	4
26	Tech Mahindra Ltd.	$(19.56 - 7.15)/0.39 = 31.81$	31
27	GAIL India Ltd.	$(18.89 - 7.15)/1.00 = 11.79$	28
28	Adani Ports	$(26.41 - 7.15)/1.49 = 12.95$	43
29	Reliance Industries Ltd.	$(34.42 - 7.15)/1.11 = 24.62$	27
30	ICICI Bank Ltd.	$(18.99 - 7.15)/1.52 = 7.77$	49
31	HCL Tech Ltd.	$(15.87 - 7.15)/0.60 = 14.48$	47
32	UPL Ltd.	$(52.83 - 7.15)/1.09 = 41.89$	23
33	Axis Bank Ltd.	$(32.89 - 7.15)/1.31 = 19.61$	30
34	TCS Ltd.	$(20.65 - 7.15)/0.57 = 23.68$	46
35	Tata Motors Ltd.	$(-19.28 - 7.15)/1.51 = -17.56$	18
36	Wipro Ltd.	$(8.22 - 7.15)/0.53 = 2.01$	45
37	JSW Steel Ltd.	$(34.84 - 7.15)/1.19 = 23.18$	16
38	Vedanta Ltd.	$(7.16 - 7.15)/1.72 = 0.003$	21
39	Bharˋ Infratel Ltd.	$(18.01 - 7.15)/0.57 = 19.03$	40
40	Tata Steel Ltd.	$(12.92 - 7.15)/1.48 = 3.91$	17
41	ONGC Ltd.	$(-5.08 - 7.15)/1.07 = -11.44$	36
42	Coal India Ltd.	$(-2.82 - 7.15)/0.77 = -12.88$	38
43	Ultra Tech Cement Ltd.	$(20.85 - 7.15)/1.12 = 12.26$	25
44	Bharˋ Airtel Ltd.	$(5.08 - 7.15)/0.86 = -2.42$	12
45	Cipla Ltd.	$(12.20 - 7.15)/0.78 = 6.46$	11
46	Grasim Industries Ltd.	$(14.95 - 7.15)/1.01 = 7.74$	44
47	SBI	$(20.42 - 7.15)/1.50 = 8.84$	15
48	Indusind Bank Ltd.	$(40.37 - 7.15)/1.06 = 31.27$	41
49	ZEE Entertainment Enterprises Ltd.	$(18.06 - 7.15)/0.96 = 11.34$	42
50	Yes Bank Ltd.	$(43.47 - 7.15)/1.44 = 25.15$	35

In the Step 2, excess of stock return over risk-free rate of return is multiplied by stock beta and then divided by residual variance for each of the stocks [i.e. $(R_i - R_f)\beta_i \div \sigma^2_{ei}$] and presented in Column 6 of Table 4.

In the Step 3, for each of the stocks, beta is squared and then divided by its residual variance [i.e. $(\beta_i)^2 \div \sigma^2_{ei}$] and presented in Column 7 of Table 4.

In the Step 4, the values obtained and shown in Columns 6 and 7 of Table 4 are cumulated and shown in Columns 8 and 9, respectively.

In the Step 5, cut-off points (i.e. C_i) are calculated as follows using equation $[\sigma^2_m \times Col.8] \div [1 + (\sigma^2_m \times Col.9)]$ and presented in Table 4.

From the cut-off points obtained, 34.30 is identified as the highest cutoff point (i.e. C_h). The C_i values of the

Table 4. Cut-off Points and Other Values

Stocks		R_i	β_i	σ^2_{ei}	$\dfrac{R_i - R_f}{\beta_i}$	$\dfrac{(R_i - R_f)\beta_i}{\sigma^2_{ei}}$	$\dfrac{(\beta_i)^2}{\sigma^2_{ei}}$	$\sum_{i=1}^{j}\dfrac{(R_i - R_f)\beta_i}{\sigma^2_{ei}}$	$\sum_{i=1}^{j}\dfrac{(\beta_i)^2}{\sigma^2_{ei}}$	C_i
	1	2	3	4	5	6	7	8	9	10
1	Britannia Industries Ltd.	62.22	0.72	1.33	76.06	29.95	0.39	29.95	0.39	12.54
2	Bajaj Finance Ltd.	88.94	1.10	2.14	74.62	41.97	0.56	71.92	0.96	24.37
3	Bajaj Financial Service Ltd.	68.97	0.95	1.79	65.07	32.86	0.51	104.79	1.46	30.31
4	Titan Industries Ltd.	47.28	0.88	1.91	45.70	18.49	0.40	123.28	1.87	31.93
5	Hindustan Unilever Ltd.	32.58	0.61	0.83	41.96	18.68	0.45	141.96	2.31	32.96
6	UPL Ltd.	52.83	1.09	2.23	41.91	22.31	0.53	164.27	2.84	33.95
7	Kotak Mahindra Bank Ltd.	39.18	0.89	0.83	36.03	34.26	0.95	198.53	3.79	34.29
8	Nestle India Ltd.	26.02	0.54	1.17	34.62	8.78	0.25	207.31	4.05	**34.30**
9	HDFC Bank Ltd.	34.81	0.82	0.33	33.85	67.66	2.00	274.97	6.05	34.19
10	Tech Mahindra Ltd.	19.56	0.39	1.86	31.82	2.60	0.08	277.57	6.13	34.17
11	Eicher Motors Ltd.	41.40	1.08	2.02	31.62	18.37	0.58	295.94	6.71	34.00
12	IndusInd Bank Ltd.	40.37	1.06	0.80	31.27	44.00	1.41	339.94	8.12	33.62
13	Maru` Suzuki India Ltd.	38.85	1.03	0.86	30.75	37.87	1.23	377.81	9.35	33.31
14	Asian Paints Ltd.	32.64	0.86	1.00	29.58	22.05	0.75	399.86	10.09	33.08
15	Yes Bank Ltd.	43.47	1.44	4.21	25.15	12.47	0.50	412.34	10.59	32.76
16	Reliance Industries Ltd.	34.42	1.11	0.89	24.61	34.06	1.38	446.40	11.97	31.96
17	BPCL	33.48	1.08	2.19	24.47	12.96	0.53	459.36	12.50	31.68
18	TCS Ltd.	20.65	0.57	1.05	23.68	7.30	0.31	466.66	12.81	31.52
19	JSW Steel Ltd.	34.84	1.19	1.52	23.19	21.72	0.94	488.38	13.75	31.02
20	IOC Ltd.	30.19	1.05	2.07	21.86	11.73	0.54	500.11	14.28	30.72
21	Axis Bank Ltd.	32.89	1.31	1.35	19.62	25.00	1.27	525.11	15.56	29.91
22	Bhar` Infratel Ltd.	18.01	0.57	2.53	19.05	2.44	0.13	527.55	15.69	29.83
23	Infosys Ltd.	20.14	0.69	1.20	18.82	7.46	0.40	535.00	16.08	29.59
24	Powergrid Corpn. of India Ltd.	20.26	0.71	0.82	18.49	11.36	0.61	546.37	16.70	29.23
25	HDFC Ltd.	26.00	1.10	0.76	17.06	27.48	1.61	573.84	18.31	28.26
26	HCL Tech Ltd.	15.87	0.60	1.49	14.48	3.52	0.24	577.37	18.55	28.10
27	Adani Ports	26.41	1.49	1.85	12.95	15.47	1.19	592.84	19.75	27.27
28	Ultra Tech Cement Ltd.	20.85	1.12	1.01	12.25	15.13	1.24	607.97	20.98	26.46
29	GAIL India Ltd.	18.89	1.00	1.57	11.79	7.44	0.63	615.41	21.61	26.07
30	ZEE Entertainment Enterprises Ltd.	18.06	0.96	1.54	11.34	6.84	0.60	622.25	22.22	25.70
31	SBI	20.42	1.50	1.70	8.84	11.75	1.33	634.00	23.55	24.82
32	L & T Ltd.	17.48	1.23	0.86	8.42	14.76	1.75	648.76	25.30	23.77
33	ICICI Bank Ltd.	18.99	1.52	1.41	7.77	12.75	164	661.51	26.94	22.86
34	Grasim Industries Ltd.	14.95	1.01	1.32	7.74	5.96	0.77	667.47	27.71	22.47
35	Hindalco Industries Ltd.	17.91	1.58	2.32	6.79	7.33	1.08	674.80	28.79	21.92
36	Cipla Ltd.	12.20	0.78	1.17	6.46	3.39	0.52	678.19	29.31	21.66
37	Bajaj Auto Ltd.	12.60	0.85	0.91	6.40	5.08	0.79	683.26	30.10	21.29
38	Mahindra & Mahindra Ltd.	11.52	1.00	1.01	4.36	4.34	0.99	687.60	31.10	20.78

39	Tata Steel Ltd.	12.92	1.48	1.81	3.91	4.71	1.20	692.30	32.30	20.19
40	ITC Ltd.	9.86	0.80	1.14	3.40	1.89	0.56	694.20	32.86	19.92
41	Wipro Ltd.	8.22	0.53	0.97	2.01	0.59	0.29	694.78	33.15	19.77
42	Vedanta Ltd.	7.16	1.72	3.23	0.003	0.002	0.91	694.79	34.06	19.27
43	Hero Motocorp Ltd.	6.18	0.94	1.03	−1.03	−0.88	0.85	693.91	34.92	18.80
44	NTPC Ltd.	6.24	0.81	1.23	−1.12	−0.61	0.54	693.30	35.46	18.51
45	Dr.Reddy's Laboratories Ltd.	5.77	0.69	1.87	−2.00	−0.51	0.25	692.79	35.71	18.37
46	Bhar` Airtel Ltd.	5.08	0.86	1.65	−2.42	−1.07	0.44	691.72	36.15	18.13
47	Sun Pharmaceutical Industries Ltd.	−0.48	0.82	2.37	−9.35	−2.63	0.28	689.09	36.44	17.93
48	ONGC Ltd.	−5.08	1.07	1.59	−11.44	−8.22	0.72	680.87	37.15	17.39
49	Coal India Ltd.	−2.82	0.77	1.44	−12.88	−5.36	0.42	675.51	37.57	17.07
50	Tata Motors Ltd.	−19.28	1.51	2.08	−17.56	−19.13	1.09	656.37	38.66	16.14

Calculation of Cut-Off Points (C_i)

Sl. No.	Stocks	$C_i = [\,\sigma^2_m \times \text{Col.8}\,] \div [1 + (\sigma^2_m \times \text{Col.9})]$
1	Britannia Industries Ltd.	$[0.5011 \times 29.95] \div [1 + (0.5011 \times 0.39)] = 12.54$
2	Bajaj Finance Ltd.	$[0.5011 \times 71.92] \div [1 + (0.5011 \times 0.96)] = 24.37$
3	Bajaj Financial Service Ltd.	$[0.5011 \times 104.79] \div [1 + (0.5011 \times 1.46)] = 30.31$
4	Titan Industries Ltd.	$[0.5011 \times 123.28] \div [1 + (0.5011 \times 1.87)] = 31.93$
5	Hindustan Unilever Ltd.	$[0.5011 \times 141.96] \div [1 + (0.5011 \times 2.31)] = 32.96$
6	UPL Ltd.	$[0.5011 \times 164.27] \div [1 + (0.5011 \times 2.84)] = 33.95$
7	Kotak Mahindra Bank Ltd.	$[0.5011 \times 198.53] \div [1 + (0.5011 \times 3.79)] = 34.29$
8	Nestle India Ltd.	$[0.5011 \times 207.31] \div [1 + (0.5011 \times 4.05)] = \mathbf{34.30}$
9	HDFC Bank Ltd.	$[0.5011 \times 274.97] \div [1 + (0.5011 \times 6.05)] = 34.19$
10	Tech Mahindra Ltd.	$[0.5011 \times 277.57] \div [1 + (0.5011 \times 6.13)] = 3417$
11	Eicher Motors Ltd.	$[0.5011 \times 295.94] \div [1 + (0.5011 \times 6.71)] = 34.00$
12	IndusInd Bank Ltd.	$[0.5011 \times 339.94] \div [1 + (0.5011 \times 8.12)] = 33.62$
13	Maru` Suzuki India Ltd.	$[0.5011 \times 377.81] \div [1 + (0.5011 \times 9.35)] = 33.31$
14	Asian Paints Ltd.	$[0.5011 \times 399.86] \div [1 + (0.5011 \times 10.09)] = 33.08$
15	Yes Bank Ltd.	$[0.5011 \times 412.34] \div [1 + (0.5011 \times 10.59)] = 32.76$
16	Reliance Industries Ltd.	$[0.5011 \times 446.40] \div [1 + (0.5011 \times 11.97)] = 31.96$
17	BPCL	$[0.5011 \times 459.36] \div [1 + (0.5011 \times 12.50)] = 31.68$
18	TCS Ltd.	$[0.5011 \times 466.66] \div [1 + (0.5011 \times 12.81)] = 31.52$
19	JSW Steel Ltd.	$[0.5011 \times 488.38] \div [1 + (0.5011 \times 13.75)] = 31.02$
20	IOC Ltd.	$[0.5011 \times 500.11] \div [1 + (0.5011 \times 14.28)] = 30.72$
21	Axis Bank Ltd.	$[0.5011 \times 525.11] \div [1 + (0.5011 \times 15.56)] = 29.91$
22	Bhar` Infratel Ltd.	$[0.5011 \times 527.55] \div [1 + (0.5011 \times 15.69)] = 29.83$
23	Infosys Ltd.	$[0.5011 \times 535] \div [1 + (0.5011 \times 16.08)] = 29.59$
24	Powergrid Corpn. of India Ltd.	$[0.5011 \times 546.37] \div [1 + (0.5011 \times 16.7)] = 29.23$
25	HDFC Ltd.	$[0.5011 \times 573.84] \div [1 + (0.5011 \times 18.31)] = 2826$
26	HCL Tech Ltd.	$[0.5011 \times 577.37] \div [1 + (0.5011 \times 18.55)] = 28.10$

27	Adani Ports	$[0.5011 \times 592.84] \div [1 + (0.5011 \times 19.75)] = 27.27$
28	Ultra Tech Cement Ltd.	$[0.5011 \times 607.97] \div [1 + (0.5011 \times 20.98)] = 26.46$
29	GAIL India Ltd.	$[0.5011 \times 615.41] \div [1 + (0.5011 \times 21.61)] = 26.07$
30	ZEE Entertainment Enterprises Ltd.	$[0.5011 \times 622.25] \div [1 + (0.5011 \times 22.22)] = 25.70$
31	SBI	$[0.5011 \times 634] \div [1 + (0.5011 \times 23.55)] = 24.82$
32	L & T Ltd.	$[0.5011 \times 648.76] \div [1 + (0.5011 \times 25.3)] = 23.77$
33	ICICI Bank Ltd.	$[0.5011 \times 661.51] \div [1 + (0.5011 \times 26.94)] = 22.86$
34	Grasim Industries Ltd.	$[0.5011 \times 667.47] \div [1 + (0.5011 \times 27.71)] = 22.47$
35	Hindalco Industries Ltd.	$[0.5011 \times 674.8] \div [1 + (0.5011 \times 28.79)] = 21.92$
36	Cipla Ltd.	$[0.5011 \times 678.19] \div [1 + (0.5011 \times 29.31)] = 21.66$
37	Bajaj Auto Ltd.	$[0.5011 \times 683.26] \div [1 + (0.5011 \times 30.1)] = 21.29$
38	Mahindra & Mahindra Ltd.	$[0.5011 \times 687.6] \div [1 + (0.5011 \times 31.1)] = 20.78$
39	Tata Steel Ltd.	$[0.5011 \times 692.3] \div [1 + (0.5011 \times 32.3)] = 20.19$
40	ITC Ltd.	$[0.5011 \times 694.2] \div [1 + (0.5011 \times 32.86)] = 19.92$
41	Wipro Ltd.	$[0.5011 \times 694.78] \div [1 + (0.5011 \times 33.15)] = 1977$
42	Vedanta Ltd.	$[0.5011 \times 694.79] \div [1 + (0.5011 \times 34.06)] = 19.27$
43	Hero Motocorp Ltd.	$[0.5011 \times 693.91] \div [1 + (0.5011 \times 34.92)] = 1880$
44	NTPC Ltd.	$[0.5011 \times 693.3] \div [1 + (0.5011 \times 35.46)] = 18.51$
45	Dr.Reddy's Laboratories Ltd.	$[0.5011 \times 692.79] \div [1 + (0.5011 \times 35.71)] = 1837$
46	Bhar`Airtel Ltd.	$[0.5011 \times 691.72] \div [1 + (0.5011 \times 36.15)] = 18.13$
47	Sun Pharmaceutical Industries Ltd.	$[0.5011 \times 689.09] \div [1 + (0.5011 \times 36.44)] = 17.93$
48	ONGC Ltd.	$[0.5011 \times 680.87] \div [1 + (0.5011 \times 37.15)] = 17.39$
49	Coal India Ltd.	$[0.5011 \times 675.51] \div [1 + (0.5011 \times 37.57)] = 17.07$
50	Tata Motors Ltd.	$[0.5011 \times 656.37] \div [1 + (0.5011 \times 38.66)] = 16.14$

stocks increase upto 34.30 and hereafter, these start declining. Hence, only the *first eight stocks* are chosen for the construction of the optimal portfolio. These are : Britannia Industries Ltd. (Consumer non-durable), Bajaj Finance Ltd. (Finance), Bajaj Financial Service Ltd. (Finance), Titan Industries Ltd. (Consumer durable), Hindustan Unilever Ltd. (Consumer non-durable), UPL Ltd. (Agro-based), Kotak Mahindra Bank Ltd. (Bank), and Nestle India Ltd. (Consumer non-durable).

Table 5. Calculaon of Z_i Value for the Selected Stocks

Sl. No.	Stocks	$Z_i = (\beta_i \sigma^2_{ei})\,[(R_i - R_f)/\,\beta_i - C_n]$	
1	Britannia Industries Ltd.	$(0.72/1.33)\,[(62.22 - 7.15)/0.72 - 34.30] =$	22.71
2	Bajaj Finance Ltd.	$(1.10/2.14)\,[(88.94 - 7.15)/1.10 - 34.30] =$	20.69
3	Bajaj Financial Service Ltd.	$(0.95/1.79)\,[(68.97 - 7.15)/0.95 - 34.30] =$	16.36
4	Titan Industries Ltd.	$(0.88/1.91)\,[(47.28 - 7.15)/0.88 - 34.30] =$	5.26
5	Hindustan Unilever Ltd.	$(0.61/0.83)\,[(32.58 - 7.15)/0.61 - 34.30] =$	5.63
6	UPL Ltd.	$(1.09/2.23)\,[(52.83 - 7.15)/1.09 - 34.30] =$	3.71
7	Kotak Mahindra Bank Ltd.	$(0.89/0.83)\,[(39.18 - 7.15)/0.89 - 34.30] =$	1.85
8	Nestle India Ltd.	$(0.54/1.17)\,[(26.02 - 7.15)/0.54 - 34.30] =$	0.15
		Total =	**76.36**

Table 6. Proportion of the Investment (i.e. Weights)

Sl. No.	Stocks	Proporon` (%)
1	Britannia Industries Ltd.	$22.71/76.36 \times 100 = 29.75\%$
2	Bajaj Finance Ltd.	$20.69/76.36 \times 100 = 27.10\%$
3	Bajaj Financial Service Ltd.	$16.36/76.36 \times 100 = 21.42\%$
4	Titan Industries Ltd.	$5.26/76.36 \times 100 = 6.88\%$
5	Hindustan Unilever Ltd.	$5.63/76.36 \times 100 = 7.37\%$
6	UPL Ltd.	$3.71/76.36 \times 100 = 4.86\%$
7	Kotak Mahindra Bank Ltd.	$1.85/76.36 \times 100 = 2.42\%$
8	Nestle India Ltd.	$0.15/76.36 \times 100 = 0.19\%$

In the Step 6, after selecting the stocks for the optimal portfolio, the proportion of the investment in each of the stock has to be ascertained. For this, the Z_i value in each of the stock is calculated [using the equation $Z_i = (\beta_i /\sigma^2_{ei})$ $[(R_i - R_f)/\beta_i - C_h]$] assuming short sale is not permitted and presented in Table 5. Then the specific weights of each of the stock are calculated and presented in Table 6.

If short sale is permitted, all the stocks in the Nifty50 are selected for the optimal portfolio. The Z_i values are calculated [using the equation $Z_i = (\beta_i /\sigma^2_{ei})$ $[(R_i - R_f)/\beta_i - C_L]$] and the specific weights of each of the stock are

Table 7. Calculaon of Z_i Value for the Nifty50 Stocks

Sl. No.	Stocks	$Z_i = (\beta_i/\sigma^2_{ei})$ $[(R_i - R_f)/\beta_i - C_L]$
1	Britannia Industries Ltd.	$0.72/1.33$ $[(62.22 - 7.15)/0.72 - 16.14] = 32.59$
2	Bajaj Finance Ltd.	$1.10/2.14$ $[(88.94 - 7.15)/1.10 - 16.14] = 30.01$
3	Bajaj Financial Service Ltd.	$0.95/1.79$ $[(68.97 - 7.15)/0.95 - 16.14] = 26.01$
4	Titan Industries Ltd.	$0.88/1.91$ $[(47.28 - 7.15)/0.88 - 16.14] = 13.62$
5	Hindustan Unilever Ltd.	$0.61/0.83$ $[(32.58 - 7.15)/0.61 - 16.14] = 18.96$
6	UPL Ltd.	$1.09/2.23$ $[(52.83 - 7.15)/1.09 - 16.14] = 12.58$
7	Kotak Mahindra Bank Ltd.	$0.89/0.83$ $[(39.18 - 7.15)/0.89 - 16.14] = 21.27$
8	Nestle India Ltd.	$0.54/1.17$ $[(26.02 - 7.15)/0.54 - 16.14] = 8.60$
9	HDFC Bank Ltd.	$0.82/0.33$ $[(34.81 - 7.15)/0.82 - 16.14] = 43.32$
10	Tech Mahindra Ltd.	$0.39/1.86$ $[(19.56 - 7.15)/0.39 - 16.14] = 3.28$
11	Eicher Motors Ltd.	$1.08/2.02$ $[(41.40 - 7.15)/1.08 - 16.14] = 8.30$
12	IndusInd Bank Ltd.	$1.06/0.80$ $[(40.37 - 7.15)/0 - 16.14] = 20.03$
13	Maru` Suzuki India Ltd.	$1.03/0.86$ $[(38.85 - 7.15)/1.03 - 16.14] = 17.44$
14	Asian Paints Ltd.	$0.86/1.00$ $[(32.64 - 7.15)/0.86 - 16.14] = 11.62$
15	Yes Bank Ltd.	$1.44/4.21$ $[(43.47 - 7.15)/1.44 - 16.14] = 3.09$
16	Reliance Industries Ltd.	$1.11/0.89$ $[(34.42 - 7.15)/1.11 - 16.14] = 10.58$
17	BPCL	$1.08/2.19$ $[(33.48 - 7.15)/1.08 - 16.14] = 4.10$
18	TCS Ltd.	$0.57/1.05$ $[(20.65 - 7.15)/0.57 - 16.14] = 4.08$
19	JSW Steel Ltd.	$1.19/1.52$ $[(34.84 - 7.15)/1.19 - 16.14] = 5.53$
20	IOC Ltd.	$1.05/2.07$ $[(30.19 - 7.15)/1.05 - 16.14] = 2.91$

21	Axis Bank Ltd.	1.31/1.35) [(32.89 − 7.15)/1.31 − 16.14] = 3.37
22	Bharᵗ Infratel Ltd.	0.57/2.53) [(18.01 − 7.15)/0.57 − 16.14] = 0.65
23	Infosys Ltd.	0.69/1.20) [(20.14 − 7.15)/0.69 − 16.14] = 1.54
24	Powergrid Corpn. of India Ltd.	0.71/0.82) [(20.26 − 7.15)/0.71 − 16.14] = 2.03
25	HDFC Ltd.	1.10/0.76) [(26 − 7.15)/1.10 − 16.14] = 1.33
26	HCL Tech Ltd.	0.60/1.49) [(15.87 − 7.15)/0.60 − 16.14] = −0.67
27	Adani Ports	1.49/1.85) [(26.41 − 7.15)/1.49 − 16.14] = −2.57
28	Ultra Tech Cement Ltd.	1.12/1.01) [(20.85 − 7.15)/1.12 − 16.14] = −4.30
29	GAIL India Ltd.	1.00/1.57) [(18.89 − 7.15)/1.00 − 16.14] = −2.76
30	ZEE Entertainment Enterprises Ltd.	0.96/1.54) [(18.06 − 7.15)/0.96 − 16.14] = −3.01
31	SBI	1.50/1.70) [(20.42 − 7.15)/1.50 − 16.14] = −6.47
32	L & T Ltd.	1.23/0.86) [(17.48 − 7.15)/1.23 − 16.14] = −11.03
33	ICICI Bank Ltd.	1.52/1.41) [(18.99 − 7.15)/1.52 − 16.14] = −9.01
34	Grasim Industries Ltd.	1.01/1.32) [(14.95 − 7.15)/1.01 − 16.14] = −6.42
35	Hindalco Industries Ltd.	1.58/2.32) [(17.91 − 7.15)/1.58 − 16.14] = −6.37
36	Cipla Ltd.	0.78/1.17) [(12.20 − 7.15)/0.78 − 16.14] = −6.50
37	Bajaj Auto Ltd.	0.85/0.91) [(12.60 − 7.15)/0.85 − 16.14] = −9.08
38	Mahindra & Mahindra Ltd.	1.00/1.01) [(11.52 − 7.15)/1.00 − 16.14] = −11.69
39	Tata Steel Ltd.	1.48/1.81) [(12.92 − 7.15)/1.48 − 16.14] = −9.97
40	ITC Ltd.	0.80/1.14) [(9.86 − 7.15)/0.80 − 16.14] = −8.89
41	Wipro Ltd.	0.53/0.97) [(8.22 − 7.15)/0.53 − 16.14] = −7.75
42	Vedanta Ltd.	1.72/3.23) [(7.16 − 7.15)/1.72 − 16.14] = −8.58
43	Hero Motocorp Ltd.	0.94/1.03) [(6.18 − 7.15)/0.94 − 16.14] = −15.65
44	NTPC Ltd.	0.81/1.23) [(6.24 − 7.15)/0.81 − 16.14] = −11.47
45	Dr.Reddy's Laboratories Ltd.	0.69/1.87) [(5.77 − 7.15)/0.69 − 16.14] = −6.68
46	Bharᵗ Airtel Ltd.	0.86/1.65) [(5.08 − 7.15)/0.86 − 16.14] = −9.62
47	Sun Pharmaceutical Industries Ltd.	0.82/2.37) [(−0.48 − 7.15)/0.82 − 16.14] = −8.79
48	ONGC Ltd.	1.07/1.59) [(−5.08 − 7.15)/1.07 − 16.14] = −18.53
49	Coal India Ltd.	0.77/1.44) [(−2.82 − 7.15)/0.77 − 16.14] = −15.61
50	Tata Motors Ltd.	1.51/2.08) [(−19.28 − 7.15)/1.51 − 16.14] = −24.39

Table 8. Proportion of the Investment (i.e. Weights)

Sl. No.	Stocks	Proporonᵗ (%)
1	Britannia Industries Ltd.	32.59/81.02 × 100 = 40.23
2	Bajaj Finance Ltd.	30.01/81.02 × 100 = 37.04
3	Bajaj Financial Service Ltd.	26.01/81.02 × 100 = 32.10
4	Titan Industries Ltd.	13.62/81.02 × 100 = 16.82
5	Hindustan Unilever Ltd.	18.96/81.02 × 100 = 23.41
6	UPL Ltd.	12.58/81.02 × 100 = 15.53
7	Kotak Mahindra Bank Ltd.	21.27/81.02 × 100 = 26.25
8	Nestle India Ltd.	8.60/81.02 × 100 = 10.61

9	HDFC Bank Ltd.	$43.32/81.02 \times 100 = 53.47$
10	Tech Mahindra Ltd.	$3.28/81.02 \times 100 = 4.05$
11	Eicher Motors Ltd.	$8.30/81.02 \times 100 = 10.25$
12	IndusInd Bank Ltd.	$20.03/81.02 \times 100 = 24.72$
13	Maruᶜ Suzuki India Ltd.	$17.44/81.02 \times 100 = 21.53$
14	Asian Paints Ltd.	$11.62/81.02 \times 100 = 14.35$
15	Yes Bank Ltd.	$3.09/81.02 \times 100 = 3.82$
16	Reliance Industries Ltd.	$10.58/81.02 \times 100 = 13.05$
17	BPCL	$4.10/81.02 \times 100 = 5.06$
18	TCS Ltd.	$4.08/81.02 \times 100 = 5.03$
19	JSW Steel Ltd.	$5.53/81.02 \times 100 = 6.82$
20	IOC Ltd.	$2.91/81.02 \times 100 = 3.59$
21	Axis Bank Ltd.	$3.37/81.02 \times 100 = 4.16$
22	Bharᶜ Infratel Ltd.	$0.65/81.02 \times 100 = 0.81$
23	Infosys Ltd.	$1.54/81.02 \times 100 = 1.90$
24	Powergrid Corpn. of India Ltd.	$2.03/81.02 \times 100 = 2.51$
25	HDFC Ltd.	$1.33/81.02 \times 100 = 1.64$
26	HCL Tech Ltd.	$-0.67/81.02 \times 100 = -0.83$
27	Adani Ports	$-2.57/81.02 \times 100 = -3.17$
28	Ultra Tech Cement Ltd.	$-4.30/81.02 \times 100 = -5.31$
29	GAIL India Ltd.	$-2.76/81.02 \times 100 = -3.41$
30	ZEE Entertainment Enterprises Ltd.	$-3.01/81.02 \times 100 = -3.72$
31	SBI	$-6.47/81.02 \times 100 = -7.98$
32	L & T Ltd.	$-11.03/81.02 \times 100 = -13.62$
33	ICICI Bank Ltd.	$-9.01/81.02 \times 100 = -11.12$
34	Grasim Industries Ltd.	$-6.42/81.02 \times 100 = -7.93$
35	Hindalco Industries Ltd.	$-6.37/81.02 \times 100 = -7.87$
36	Cipla Ltd.	$-6.50/81.02 \times 100 = -8.02$
37	Bajaj Auto Ltd.	$-9.08/81.02 \times 100 = -11.21$
38	Mahindra & Mahindra Ltd.	$-11.69/81.02 \times 100 = -14.43$
39	Tata Steel Ltd.	$-9.97/81.02 \times 100 = -12.31$
40	ITC Ltd.	$-8.89/81.02 \times 100 = -10.98$
41	Wipro Ltd.	$-7.75/81.02 \times 100 = -9.56$
42	Vedanta Ltd.	$-8.58/81.02 \times 100 = -10.60$
43	Hero Motocorp Ltd.	$-15.65/81.02 \times 100 = -19.32$
44	NTPC Ltd.	$-11.47/81.02 \times 100 = -1416$
45	Dr.Reddy's Laboratories Ltd.	$-6.68/81.02 \times 100 = -8.25$
46	Bharᶜ Airtel Ltd.	$-9.62/81.02 \times 100 = -11.87$
47	Sun Pharmaceutical Industries Ltd.	$-8.79/81.02 \times 100 = -10.85$
48	ONGC Ltd.	$-18.53/81.02 \times 100 = -22.87$
49	Coal India Ltd.	$-15.61/81.02 \times 100 = -19.27$
50	Tata Motors Ltd.	$-24.39/81.02 \times 100 = -30.11$

calculated and presented in Table 7 and Table 8, respectively. The cut-off point of the last stock is taken as C_L, which is 16.14.

Findings and Suggestions

✎ Out of 50 companies selected for the study, all the companies have positive return except for four companies ; Sun Pharmaceutical Industries Ltd., Tata Motors Ltd., ONGC Ltd., and Coal India Ltd. are the companies having negative return.

✎ Out of 50 companies selected for the study, 23 companies have beta value more than 1 and only two companies have beta value equal to 1, and other 25 companies have beta value less than 1. Nearly half of the companies have less than market risk.

✎ Out of 50 stocks, only eight stocks are chosen for the construction of the optimal portfolio as per the Single Index Model. These are: Britannia Industries Ltd. (29.75%), Bajaj Finance Ltd. (27.10%), Bajaj Financial Service Ltd. (21.42%), Titan Industries Ltd. (6.88%), Hindustan Unilever Ltd. (7.37%), UPL Ltd. (4.86%), Kotak Mahindra Bank Ltd. (2.42%), and Nestle India Ltd (0.19%).

✎ The risk and returns calculated are based on the data relating to the financial year from 2014 – 2019. These are subject to change, and hence, the investors are suggested to constantly monitor the changes in the market conditions and revise periodically while selecting the stocks.

Research Implications

Generally, the investors are confused about selection of the stocks for the investment as the returns on the stocks are either not guaranteed or highly volatile. The stocks yielding high return are subject to high risk and the stocks with low risk yield very negligible returns. The current study on the construction of the portfolio using the Single Index Model helps such investors in the selection of stocks with low risk and high return for their portfolio construction.

Conclusion

Though as many as 50 stocks are considered for the current study, only few stocks (i.e. eight) are selected for the construction of an optimal portfolio as per the Single Index Model. The stocks selected belong to consumer non-durables (three), consumer durable (one), finance (three), and agro - based sector (one). The consumer non-durables and finance companies dominate the selection of stocks followed by consumer durables.

Limitations of the Study

✎ The current study is confined to the stocks of Nifty 50 only.

✎ The current study is confined only to the period from 2014 –19, and hence, it may not hold good for the other period as the stock market is so volatile in nature.

✎ Average of the daily opening and closing prices of the stocks are taken for the calculation of returns, which may differ if average of the daily high and low prices are considered.

Scope for Further Research

The study can be extended to other stocks such as the stocks of sector indices, BSE Sensex stocks, and so on. The study can be undertaken for a longer period of 10 years commencing from 2009 – 2019.

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About the Authors

Dr. Prakash Basanna has more than 25 years of teaching experience in various management institutions and has contributed more than 40 research papers in national and international journals and conferences. He has written six books in the finance area and three PhDs have been awarded under his guidance.

Namita P. Konnur has 8 years of teaching experience in various management institutions and has contributed more than 15 research papers in national and international journals and conferences. She is pursuing Ph.D.