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CONSTRUCTION OF OPTIMAL PORTFOLIO USING SHARPE'S SINGLE INDEX MODEL: AN EMPIRICAL STUDY ON INDIAN COMPUTER SOFTWARE INDUSTRY STOCKS

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Abstract

Indian IT services companies are establishing their presence in all major global markets. Accordingly the primary concern of this research is to build an optimal portfolio from Indian Computer Software Industry with the assistance of Sharpe index model. NSE listed top 28 computer software securities on basis of market capitalization have been selected for the present research. Present study covers five years time period from October 1, 2012 to October 1, 2017. Nineteen companies have been selected on the basis of Cut-off point. An investor is getting 2.569172% of Portfolio Return on an average by constructing Portfolio of NSE 19 Computer Software securities, and against it he is bearing 6% Portfolio Risk. All the selected securities except Ramco Ltd and Sasken

Keywords:

Sharpe's Single Index Model; Optimal Portfolio; Cut off Rate; Systematic Risk; Unsystematic Risk;

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Tech Ltd are having beta less than 1, so we can say that they are stable earning securities with low level of risk.It is believed that present study would prove useful to investors for putting their resources optimally into Indian Computer Software Industry and to choose which companies would give most elevated return at low risk.

Introduction

We are living in a society which is increasingly dominated by technology. Digital India and start up Indian initiatives being launched, the domestic market for software services has a bright future ahead. Alert investors on the lookout for big gains will find suitable investment opportunities in companies which go in for technological innovations in a big way. For example, IT services are the major beneficiaries of technological changes.Being very positive on the prospects of Indian Software Companies, establishing their presence in all major global markets, Indian Software industry has been chosen for portfolio construction. In Investment Finance, there are a number of models to construct a portfoilio. Sharpe Single Index Model being comparatively less complicated than Markowitz Model has been apllied to construct the portfolio.

Objective of the Study

The main objectives of the study are:

1. To understand the working of Sharpe's Single Index Model.
2. To construct an optimal portfolio empirically from Computer Software Industry in India using the Sharpe's Single Index Model.
3. To determine return and risk of the optimal portfolio constructed by using Sharpe's Single Index Model.

Collection of Data

NSE listed top 28 computer software securities on basis of market capitalization have been selected for the present research. Present study cover five years time period from October 1, 2012 to October 1, 2017.Monthly adjusted closing prices for the same period for the computer software companies and Nifty 50 have been considered for the calculation of average returns and variance of the stocks and market index. The risk free rate is derived from the return on a risk-free asset i.e. 91 days Treasury Bills issued by RBI. Relevant data have been collected from secondary sources of information. Historical monthly adjusted closing prices have been discovered from Yahoo Finance. Average yield on 91 days Treasury Bills has been discovered from the website www.tradingeconomies.com. Strictly speaking, the market index should represent all the securities trading on the exchange and hence should consist of all the securities. However any standard index can be treated as a surrogate for the market index. Even though NSE- 50 does not use all the scrip's prices to construct their indices, they have been used as a surrogate. Therefore for this purpose NIFTY -50 is taken as the market performance index.

Analysis and interpretation of data

Different Statistical and Financial tools and techniques, charts and diagrams have been used for the purpose of analysis and interpretation of data. *Excel's* regression tools have been used to estimate the alphas and betas of individual securities.

Review of the Literature

Table I: Findings of the studies conducted on Sharpe Index Model

Study	Findings
Kumar, Arun and Manjunatha (2013)	The study selected the portfolio on basis of Sharpe's Single Index Model. Stocks covered in S&P CNX Nifty were taken out for analysis. The yearly data for five years was taken. Out of fifty companies in S&P CNX Nifty only six securities were selected for the optimal portfolio construction. The percentage of investment to be made in the selected securities has been calculated using

	Sharpe's Single Index Model. The study revealed that stock prices and market index move in the same direction.
Nalini (2014) "Optimal portfolio construction using sharpe's single index model - a study of selected stocks from bse"	The study considered 15 stocks of various sectors from S&P index, taking BSE Sensex as market index. It was found that risk can be reduced by diversifying the portfolio. Only four stocks were selected in the optimal portfolio.
Chintan A. Shah(2015)"Construction of Optimal Portfolio Using Sharpe Index Model & Camp for BSE Top 15 Securities"	In this study an effort was made to evaluate the performance of securities of BSE15, rank the optimal portfolio constructed, and compare the performance of BSE15 securities through Sharpe Model. The Descriptive Research Design and Secondary data was used. Based on the study of returns of top 15 BSE securities for past 16 years using Sharpe Model,the results were that an investor can invest in HDFC Bank Ltd, HDFC Ltd., ICICI Bank Ltd.,TCS, TATA Motors.
Nandan & Srivastava (June,2017) "Construction of Optimal Portfolio Using Sharpe's Single Index Model: An Empirical Study on Nifty 50 Stocks"	In this study it is found that out of 50 stocks considered for study, only 24 stocks are chosen for inclusion in optimal portfolio. The 'excess return to beta ratio' of only 24 stocks was above the calculated cutoff rate of .19. 2. Out of 24 stocks selected, the maximum number of stocks is from the banking sector. Stocks of SBI, PNB, IndusInd bank, ICICI bank and Axis Bank are a part of optimal portfolio. Stocks of

	companies like Dr Reddy's Lab, Cipla and Sun Pharmaceuticals from the pharmaceutical sector are also included in the optimal portfolio. Majority of the stocks are found to have their beta less than 1 and hence can be termed as defensive securities. Investors who are risk averse may prefer to invest in such type of securities.
Gopalakrishna, Muthu (2014)	The study considered a sample of 13 actively traded scrips listed in the National Stock Exchange Limited, Bombay (NSE). The secondary data for a period 2004-2008 was used for the study. The study investigated that there were four aggressive stocks having beta coefficient of more than one. It was recommended that among the sample companies all the stocks were undervalued except one stock and thus the investors could pick these stocks to revise their portfolio.
Mallikharjunarao.T(August,2017) Construction of optimal equity portfolio with application of sharpe single index model: a comparative study on fmcg and auto sectors	Two optimal portfolios are constructed by selecting thirty companies, 14 companies from FMCG sector which are constituents of NIFTY FMCG INDEX listed in NSE and 16 companies from AUTO sector which are constituents of NIFTY AUTO INDEX listed in NSE. After calculating the "cut-off "Values for the FMCG sector sample companies out of 14 companies, eleven were selected for the optimal portfolio construction. In the sample of AUTO sector

	companies, out of 16 companies, six were selected for the optimal portfolio construction. In the two portfolios, portfolio with AUTO sector companies offering highest return (4.76%) and bearing highest risk (10.96%). Portfolio with FMCG sector companies offering lowest return (2.57%) and bearing lowest risk (7.32%). From the above remarks it was suggested that to the individual investors and portfolio managers to take investment decisions to invest in FMCG stocks for moderate expected return and risk, while so to invest AUTO sector stocks for high return with high risk. This study helps the investors to minimize their investment risk and maximize the return of their investment. It was suggested to risk aversors to invest in portfolio with FMCG stocks. It was suggested to risk takers; who expect high return with high risk, to invest in portfolio with AUTO stocks.

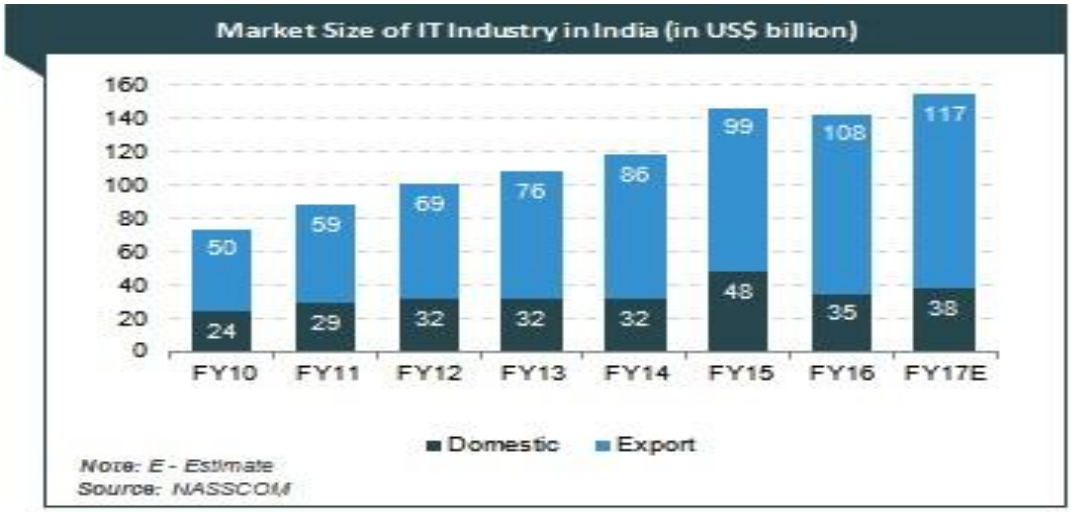
An Overview of Computer Software Industry in India

The **Software Industry**, which is a main component of the Information technology Industry, has brought tremendous success for the emerging economy, India. Software development and IT-enabled services (ITeS) have made India's brand equity a force to reckon with. The new digital technologies like social media, mobility, analytics, and cloud computing (SMAC) have redefined the way Indian Software firms do business. Indian software industry is all set for strong revenue growth.

Interesting Facts about the Software Companies

1. The revenue of the Indian software market reached around 5.2 billion U.S. dollars in 2016. Until 2018, it is expected to increase to nearly 5.8 billion U.S. dollars of annual revenue. Among the global leaders of the enterprise software market are Microsoft, Oracle, and IBM. (www.statistia.com)

2. The global sourcing market in India continues to grow at a higher pace compared to the IT-BPM industry. The global IT & ITeS market (excluding hardware) reached US$ 1.2 trillion in 2016-17, while the global sourcing market increased by 1.7 times to reach US$ 173-178 billion. India remained the world's top sourcing destination in 2016-17 with a share of 55 per cent. Indian IT & ITeS companies have set up over 1,000 global delivery centres in over 200 cities around the world. (Ibef, 2017)



3. Services offered by software companies in India are: Custom Business solutions, Collaborative Content Management, Internet Marketing, Web Branding Services, Database Migration services, Customization Services, Application Development, Outsourcing ERP solutions, Iphone Apps development, Collaborative Commerce, Programming Services, Quality assurance and testing services, Multimedia offering, Consulting. (www.business.mapsofindia.com)

4. India's software services exports have been growing over the year's .According to statistics, in 2014, India exported 52 billion U.S. dollars worth of IT services(www.statistia.com).

5. The Indian government is emphasizing on better technology enabled delivery mechanisms for a multitude of government projects. Further, with the new digital India and start up Indian initiatives being launched, the domestic market for software services has a bright future ahead.

6. State-owned Software Technology Park of India (STPI) has generated 50% of the employment generated by the Indian IT/ITES industry. It is to be noted that out of 56 STPI centres, 48 are located in tier-ii and tier-iii location, benefitting the qualified youth of such locations.

7. Employment potential and prospects in the IT and related sectors are robust and promising. NASSCOM has confirmed that the industry continues to be a net hirer and reports that:

In FY 2017, the industry added 1,70,000 new jobs.2.5-3 million new jobs will be created by 2025.

8. The Indian software sector's value proposition is unmatched in the world. Entry level wages remain 8x-10x lower than in developed nations. The number of global delivery centers (GDC) has increased to about 670 in FY16 in more than 78 countries. India's skilled talent base grew by about 7% YoY in FY16 i.e. by 6.2 million. The digital skilled talent base was about 2, 50,000 and growing rapidly (Software Sector Analysis Report , 2016).

9. India's total software product market grew at 9.5% in FY2017 to reach USD 7 billion. (Exports grew 7.8% to reach USD 2.3 billion.) In comparison, the domestic market grew much faster, at 10.4%, reaching USD 4.8 billion. (Ministry of Electronics & IT , 2017)

10. The domestic revenue of the IT industry is estimated at US$ 38 billion and export revenue is estimated at US$ 117 billion in FY17.

Above facts are clear indicator of how fundamentally strong at software industry in India is. Focuses on innovation, growing talent pool and government support are just some of the advantages of this market segment.

The Single Index Model

William F. Sharpe got the Nobel Prize in 1990 for his contribution in the field of investment finance in Economics. He developed Single Index Model for portfolio construction. Sharpe's Single Index Model has proved very useful to construct an optimal portfolio. Through this model

we can analyze how and why securities should be included in an optimal portfolio. Also it shows their respective weights i.e. proportion to be invested in selected securities, calculated on the basis of some important variables under consideration.

Sharpe Index Model is a simplified model of asset pricing that assumes that the return of a security is linearly related to a single index like the market index. It believes that the relationship between each pair of securities can indirectly be measured by comparing each security to a common factor 'market index' that is shared amongst all the securities. Any movement in the security prices could be understood with the help of the index movement. Further, the Sharpe model needs 3N+2 bits of information as compared to (N(N+3)/2) bits of information needed in Markowitz Model of portfolio analysis. Markowitz's model of portfolio construction although conceptually sound, requires a number of co variances to be calculated. As a result, the burden of calculating large inputs can be reduced.

In Sharpe's Model following data inputs need to be estimated:

- Estimates of Alpha (α) and Beta (β) for each security,
- Estimates of unsystematic risk ($\sigma_{i\,e}^2$) for each security,
- Estimates for expected return on Individual Security(R_i),
- Estimates for expected return on market index(R_m),
- Estimates of variance of return on the market index (σ^2_m).

Due to this simplicity, Sharpe's single index model has gained its popularity to a great extent in the arena of investment finance as compared to Markowitz's model as it relates returns on each security to the returns on a common index.

Table II: Risk and Return Calculation under Sharpe Single Index Model

Estimates	**Equation**	**Explanation**
Expected return on security	$\mathbf{R_i = \alpha_i + \beta_i R_m + e_i}$ Where, $\mathbf{R_i}$ is the expected return on security;	The return of the security is combination of two components: a) A specific return component represented by alpha of the security and

	α_i is the intercept of the straight line or abnormal return or alpha coefficient; β_i is the slope of the straight line or beta coefficient; R_m is the rate of return on the market index; e_i is the error term	b) A market related return component represented by the term
Total risk of individual security	$\sigma_i^2 = \beta i^2 \sigma^2 m + \sigma_{ei}^2$ where; σ_i^2=Variance of Individual Security βi =Beta Coefficient of individual security; $\sigma^2 m$ = variance of market index returns; σ_{ei}^2=Variance of residual returns of individual security.	The risk of a security σ_i^2 becomes the sum of market related component and a component that is specific to the security. Thus, Total Risk = Market Related Risk + Specific Risk

Table III: Steps in construction of Sharpe's optimal portfolio

Step I **Calculation of Excess return-beta ratio**	Excess return-beta ratio $= \frac{Ri - Rf}{\beta i}$ Where, R_i = The Expected return on stock i R_f =The return on a riskless asset such as the rate offered on a government security or treasury bill. βi = The expected change in the rate of return on stock i associated with one unit change in the market return.

	The selection of any stock is directly related to its excess return-beta ratio. Excess return-beta ratio measures the additional return on a security per unit of systematic risk. This ratio provides a relationship between potential risk and reward.
Step II **Ranking of securities**	Rank them on basis of Excess return-beta ratio from the highest to lowest. Portfolio managers would like to include stocks with higher ratio.
Step III **Calculation of C_i for all the securities**	$$Ci = \frac{\sigma_m^2 \sum_{i=1}^{N} \frac{(Ri - Rf)Bi}{\sigma_{ei}^2}}{1 + \sigma^2 m \sum_{i=1}^{N} \frac{Bi^2}{\sigma_{ei}^2}}$$
Step IV **Calculation of cut-off point(C*)**	➢ Cumulative values of C_i start declining after a particular Ci, and that point is taken as cut off point. ➢ Therefore the highest C_i value is the cut-off point i.e. C*. ➢ Stocks ranked above C* have high excess returns to beta than the cut off C* and all the stocks ranked below C* have low excess returns to beta.
Step V **Selection of the securities**	Select those securities whose 'Excess Return -to-Beta Ratio' is greater than the cut off rate.
Step VI **Percentage of funds to be invested in each security**	The proportions are Xi= $\frac{Zi}{\sum_{i=1}^{N} Zi}$ $$Zi = \frac{\beta_i}{\sigma^2_{ei}} \left(\frac{Ri - Rf}{\beta i} - C* \right)$$

	The proportion of investment in each of the selected securities in the optimal portfolio is computed on the basis of beta value, unsystematic risk, excess return to beta ratio and the cut off rate of the security concerned.

Table IV: Average Return and Variance of Market Index, Nifty-50

	Rm	σ^2_m
Nifty-50	1.02000%	0.15055%

Table V: Calculation of Inputs of individual securities for application of Sharpe Single Index Model

Company	σ_{ie}^2	**βi**	**αi**	**R_f (%)**	**R_i (%)**	$\frac{Ri - Rf}{\beta}$
TCS	0.004341	0.234224	0.011703	0.641667	1.409098	3.276489
Infosys	0.006714	0.3209	0.011923	0.641667	1.519469	2.735441
Wipro	0.005691	0.168009	0.011778	0.641667	1.349109	4.210745
HCL Tech	0.00518	0.042002	0.022451	0.641667	2.287943	39.19541
Tech Mahindra	0.006705	0.418419	0.012233	0.641667	1.649908	2.409645
Oracle Fin Serv	0.003281	0.58109	0.003799	0.641667	0.972444	0.569236
MphasiS	0.006645	0.382452	0.010834	0.641667	1.473393	2.17472
Hexaware Tech	0.010427	0.235283	0.021406	0.641667	2.380519	7.390485
Mindtree	0.009157	-0.02587	0.025617	0.641667	2.535322	-73.185
Cyient	0.006034	0.37583	0.017578	0.641667	2.141014	3.989434
Tata Elxsi	0.019383	0.839956	0.037141	0.641667	4.570593	4.677537
Persistent	0.00844	0.707033	0.016347	0.641667	2.355611	2.424136

Zensar Tech	0.008776	0.573867	0.020045	0.641667	2.589682	3.39454
NIIT Tech	0.008956	0.144926	0.015295	0.641667	1.677247	7.145572
Polaris Consult	0.010844	0.348139	0.015508	0.641667	1.905742	3.630944
Hinduja Global	0.012855	0.992657	0.008803	0.641667	1.892517	1.260104
Ramco System	0.0306	1.024597	0.022916	0.641667	3.336307	2.629952
Hinduja Venture	0.008861	0.705753	-0.00111	0.641667	0.608555	-0.04692
Rolta	0.018381	1.375501	-0.00713	0.641667	0.689456	0.034743
Sasken Tech	0.017431	1.204179	0.023071	0.641667	3.534947	2.402699
Infinite Comp	0.011514	0.199788	0.010417	0.641667	1.245393	3.021839
Mastek	0.031335	0.955026	0.02057	0.641667	3.030817	2.501659
63 Moons Tech	0.030824	1.563118	-0.03515	0.641667	-1.92066	-1.63924
3i Infotech	0.053563	0.886813	0.002405	0.641667	1.144726	0.567266
SQS India BFSI	0.022344	0.404967	0.035384	0.641667	3.951334	8.172689
AGC Networks	0.031117	1.24499	-0.00696	0.641667	0.573191	-0.055
Ducon Infratech	0.228072	0.665047	0.12011	0.641667	12.68913	18.11519
Saksoft	0.037337	0.866114	0.000219	0.641667	0.905023	0.304067

Table VI: Calculation of Ci and Proportion to be invested

Company	$\frac{Ri - Rf}{\beta}$	$\frac{(Ri - Rf)Bi}{\sigma_{ei}^2}$	$\sum_{i=1}^{N} \frac{(Ri - Rf)}{\sigma_{ei}^2}$	$\frac{Bi^2}{\sigma_{ei}^2}$	$\sum_{i=1}^{N} \frac{Bi^2}{\sigma_{ei}^2}$	Ci	Zi	Xi
HCL Tech	39.19541	0.133489	0.133489	0.003406	0.003406	0.020086839	3.078257	11%
Ducon Infratech	18.11519	0.351309	0.484798	0.019393	0.022799	0.072738211	0.493898	2%
SQS India BFSI	8.172689	0.599923	1.08472	0.073406	0.096205	0.160976637	1.269171	5%
Hexaware Tech	7.390485	0.392385	1.477105	0.053093	0.149298	0.217494406	1.406532	5%
NIIT Tech	7.145572	0.167575	1.64468	0.023452	0.172749	0.241335346	0.982372	4%
Tata Elxsi	4.677537	1.703548	3.348228	0.364198	0.536947	0.46638472	1.580969	6%
Wipro	4.210745	0.208874	3.557102	0.049605	0.586552	0.492079294	0.949358	3%
Cyient	3.989434	0.934278	4.49138	0.234188	0.82074	0.601827291	1.947947	7%
Polaris Consult	3.630944	0.405892	4.897272	0.111787	0.932527	0.646530805	0.889772	3%
Zensar Tech	3.39454	1.274525	6.171797	0.375463	1.30799	0.776311457	2.22094	8%

TCS	3.276489	0.422064	6.59386	0.128816	1.436806	0.816175737	1.801967	7%
Infinite Comp	3.021839	0.104764	6.698624	0.034669	1.471475	0.825600328	0.524374	2%
Infosys	2.735441	0.419619	7.118243	0.153401	1.624876	0.861038798	1.307632	5%
Ramco System	2.629952	0.902715	8.020958	0.343244	1.96812	0.931555487	0.881044	3%
Mastek	2.501659	0.728472	8.74943	0.291196	2.259315	0.982918528	0.762777	3%
Persistent	2.424136	1.437031	10.18646	0.592801	2.852116	1.072904846	2.032481	7%
Tech Mahindra	2.409645	0.629471	10.81593	0.26123	3.113346	1.108699646	1.504404	5%
Sasken Tech	2.402699	2.001299	12.81723	0.832938	3.946284	1.210491795	1.661961	6%
MphasiS	2.17472	0.478869	13.2961	0.220198	4.166482	1.230135448	1.252103	5%
Hinduja Global	1.260104	0.967029	14.26313	0.76742	4.933903	1.23212216*	0.974183	4%
Oracle Fin Serv	0.569236	0.586683	14.84981	1.03065	5.964552	1.177928598		
3i Infotech	0.567266	0.083307	14.93312	0.146856	6.111409	1.170896877		
Saksoft	0.304067	0.061111	14.99423	0.200978	6.312386	1.157448835		
Rolta	0.034743	0.035817	15.03005	1.030913	7.343299	1.074690626		
Hinduja Venture	-0.04692	-0.02639	15.00365	0.562576	7.905875	1.031317819		
AGC Networks	-0.055	-0.02742	14.97624	0.498499	8.404374	0.995327579		
63 Moons Tech	-1.63924	-1.30094	13.6753	0.79362	9.197993	0.863330955		
Mindtree	-73.185	-0.05351	13.62179	0.000731	9.198725	0.859913047		

*Cut –Off- Point

Portfolio Return

$Rp = N \sum Xi(\alpha i + \beta iRm) = 2.569172\%$

Portfolio Variance

$$\sigma^2_p = \left[\left(\sum X_i \beta_i\right)^2 \sigma^2 m\right] + \left[\left(\sum X_i{}^2 \sigma^2 ei\right)\right]$$

$\sigma_p^2 = 6\%$

Interpretation

According to Sharpe Model,

1. An investor, for the construction of his Computer Software Industry Portfolio, should select 19 companies' securities i.e.of HCL Tech, Ducon Infratech, SQS IndiaBFSI, HexawareTech, NIIT Tech, Tata Elxsi, Wipro, Cyient, Polaris Consult, Zensar Tech, TCS, Infinite Comp, Infosys, Ramco System, Mastek, Persistent, Tech Mahindra, Sasken Tech, MphasiS and Hinduja Global in the proportion as mentioned in the table. Other 9 companies' securities have been excluded from the portfolio construction.
2. These securities give higher addition return i.e. excess over risk free rate of return measured per unit of systematic risk or non-diversifiable risk. According to Excess return to beta ratio, which provides a relationship between potential risk and reward, these selected securities are high rankers.
3. An investor is getting 2.569172%of Portfolio Return by constructing Portfolio of NSE 19 Computer Software securities, and against it he is bearing 6% Portfolio Risk.
4. Maximum investment (11%) is made in DUCON with Beta 0.042002, which shows the stock is less sensitive to market sentiments and is also earning good.
5. All the selected securities except Ramco Ltd and Sasken Tech Ltd are having beta less than 1, so we can say that they are stable earning securities with low level of risk.

Conclusion

With the help of Sharpe Single Index Model, an optimal portfolio has been constructed from Computer Software Industry in India. Investors on the lookout for big gains in the Software Industry are getting 2.569172%of Portfolio Return by constructing Portfolio of NSE 19 Computer Software securities against 6% Portfolio Risk. Sharpe Single Index Model is very simple to apply with very less calculations. Out of a sample of top 28 NSE listed companies on basis of Market capitalization, portfolio comprising 19 companies has been constructed. From the above findings, it has been suggested to the individual investors and portfolio managers to take investment decisions to invest maximum in DUCON for good expected return and moderate risk. This study will help the investors to minimize their investment risk and maximize the return of their investment.

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