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Optimum Portfolio and Capital Asset Pricing Model for Equity Market

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Abstract

Risk and return play an important role in making any investment decision. Risk is the chance that an investment's actual return will be less than its expected return. This risk of loss is linked to the expected variability in the investment's return (Neeraj and Anurag, 2014). The study aims at making strategic decisions for the opportunity that is available for investors as per as returns are concerned and the investment of risk thereof while investing in the equity of firms listed in National Stock Exchange (NSE). Diversification of investment helps to spread risk over many securities. Portfolio construction is a widely used concept on how investors can construct investment portfolios to maximise returns and minimise risk. The study comprised of fifteen Nifty FMCG stocks along with Nifty FMCG index and Nifty Fifty index for the period January, 2011 through December, 2021. The optimum portfolio for the sample study investment is P & G Hygiene and Health Care Limited (25.02 per cent), Dabur India Limited (15.20 per cent), Marico Limited (13.72 per cent), Nifty FMCG Index (10.47 per cent), Colgate-Palmolive India Limited (9.16 per cent), ITC Limited (7.58 per cent), Hindustan Unilever Limited (6.74 per cent), Nifty Fifty Index (6.09 per cent), Nestle India Limited (3.04 per cent), Radico Khaitan Limited (2.98 per cent), which has a portfolio mean return of 1.37 per cent per month and with a portfolio beta (β_p) of 0.43 and with a portfolio Treynor ratio of –1.75, with a portfolio Sharpe ratio –22.80 and with a portfolio standard deviation (σ_p) of 3.32 and portfolio variance (σ^2_p) of 0.11. The study has captured Security Market Line (SML) and Security Characteristic Line (SCL) for portfolio allocation decisions.

Keywords : Risk, Return, Optimum portfolio, Nifty FMCG stocks, Nifty FMCG index, Nifty fifty index, Capital asset pricing model (CAPM), Security market line (SML), Security characteristic line (SCL)

Risk is a mixture of 'danger' and 'opportunity' similar to the two faces of a coin. Unexpected portion of an event *i.e.,* what actually happens may (and often does) differ from what is expected can also be termed as risk. Generally, people are extra sensitive to underperformance compared to expectations. Risk is neither good nor bad, but just a fact of life. The question that entities have to address is therefore not how to avoid risk but how best to incorporate it into the decision making (Aswath Damodaran, 2012).

Total risk associated with return can be divided into expected and un-expected portions. Actual return (R) comprises of expected portion E (R) and unexpected portion (U). The unexpected portion is constituted by systematic (M) and unsystematic (E) portions. In any given period, the unexpected portion of a return would be positive or negative; through time, the average value of unexpected portion of a return (U) would be zero.

Systematic risk is the market-wide risk which can not be eradicated, but the degree of its impact may

vary across securities. Unsystematic risk is firm-specific risk which can be reduced by holding a diversified portfolio. Interest rate risk, Market risk and Purchasing power or Inflationary risk generally causes market-wide or systematic risk. Business or liquidity risk, financial or credit or default risk, operational risk in general causes firm-specific or un-systematic risk. Country risk, foreign-exchange risk, political risk, environmental risk, speculative risk and absolute risk are some of the other kinds of risk (David *et al.,* 2021).

Objectives of the Study

1. To study the association of log returns of stock prices of selected nifty stocks using correlation, variance and covariance
2. To find most optimal portfolio for allocating investment funds in different nifty stocks by considering risk-return criteria
3. To construct Security Market Line (SML) and Security Characteristic Line (SCL) for drawing investment decisions

METHODOLOGY

Sample and Data Collection

The study considers ten year monthly stock prices from January, 2011 to December, 2021 of all the fifteen Nifty FMCG stocks *i.e.,* Britannia Industries Limited, Colgate-Palmolive India Limited, Dabur India Limited, Emami Limited, Godrej Consumer Products Limited, Hindustan Unilever Limited, ITC Limited, Jubilant Foodworks Limited, Marico Limited, Nestle India Limited, P & G Hygiene and Health Care Limited, Radico Khaitan Limited, Tata Consumer Products Limited, United Breweries Limited, United Spirits Limited along with Nifty FMCG Index and Nifty Fifty Index which is considered as market index representing the market condition. Monthly log returns of the stock prices was calculated. Ninety day Treasury bill rate issued by the Reserve Bank of India (RBI) from December, 2012 to December, 2021 is collected and mean monthly Treasury bill rate is computed for considering it as a risk-free rate (*i.e.,* r_f = 2.13 per month). Microsoft Excel software was used for analysis.

Analytical Tools and Techniques Employed

Capital Asset Pricing Model (CAPM) was employed by calculating logarithmic return of the stocks. The logarithmic return is the natural log of the ratio of the current stock price to the end-of-the-period stock price.

$$\text{Logarithmic return} = \ln\left[\frac{\text{current period stock price}}{\text{previous period stock price}}\right] \times 100$$

Systematic Risk is measured by Beta (β), which is obtained by dividing co-variance of stock 'i' and market index 'm' with variance of the market index 'm'.

$$\beta_i = \frac{\sigma_{i,m}}{\sigma_m^2} \text{ (or) } \frac{\sigma_i}{\sigma_m} r_{i,m}$$

where,

β_i = beta of stock 'i'

$\sigma_{i,m}$ = co-variance of stock 'i' and the market index 'm'

σ_i = standard deviation of stock 'i'

σ_m = standard deviation of the market index 'm'

$r_{i,m}$ = correlation co-efficient between stock 'i' and market index 'm'

Variability or volatility of expected returns associated with a given investment is the measure of risk. The Capital Asset Pricing Model (CAPM) relates the risk measured by beta to the level of the expected rate of return on a security. The model, also called the Security Market Line (SML), is given as follows:

$$E(r_i) = r_f + \beta_i (E(r_m) - r_f) \text{.....(1)}$$

where,

$E(r_i)$ = the expected return on security 'i'

r_f = the risk-free rate

$E(r_m)$ = the expected return on the market index 'm'

β_i = beta, an index of non-diversifiable (non-controllable, systematic) risk

$\beta_i * (r_m - r_f)$ = risk premium, the additional return required to compensate investors for assuming a given level of risk.

Thus, CAPM (or SML) equation (Eq.1) shows that the expected rate of return on a given security E (r_i) is equal to the return required for securities that have no risk (r_f) plus a risk premium [β_i *(E(r_m) – r_f)] required by investors for assuming a given level of risk.

The key component in the CAPM, beta (β), is a measure of the security's volatility relative to that of a benchmark index or an average security *i.e.,* if β = 0.5, it means the security is only half as volatile, or risky, as a benchmark index or an average security. That is, beta measures the sensitivity of the stock's return to the changes in the market conditions. The higher the degree of systematic risk, the higher the return on a given security. The figure (Fig. 1) below graphically illustrates the CAPM as the Security Market Line (SML).

Security Market Line (SML)

The Security Market Line (SML) graphs the systematic (or market) risk versus the return of the whole market at a certain time and shows under priced and overpriced securities. Securities which are fairly priced plot exactly on the SML. Underpriced securities plot above the SML, whereas overpriced securities plot below the SML (Prasanna Chandra, 2017). If the security's risk versus actual return is plotted above the SML, it is undepriced because the investor can expect a greater return for the inherent risk (the suggested strategy is BUY). A security plotted below the SML is overpriced because the investor would be accepting less return for the amount of risk (the suggested strategy is SELL). The farther the returns from the y-axis, the more riskier the stock is. Therefore, an investor can find a disequilibrium in security price to make a profit by buying the underpriced securities and selling the overpriced securities and based on the risk appetite can choose the securities closer or farther from the y-axis.

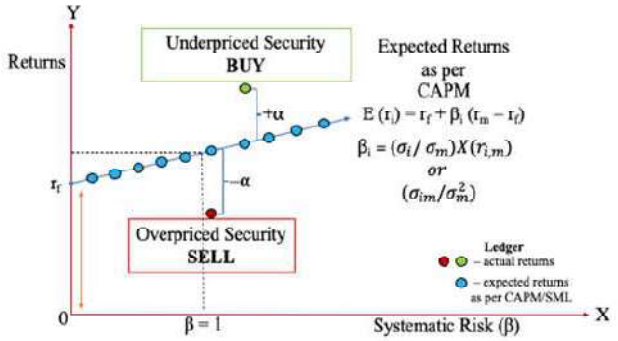

Fig.1: Security market line

Jensen's Alpha (α)

Jensen's Alpha (α) is calculated as the difference between the investment's actual return and its expected return (as per CAPM). Investors would prefer an investment with a high positive alpha.

- α < 0: the investment has earned too little for its risk (or, was too risky for the return),
- α = 0: the investment has earned a return adequate for the risk taken,
- α > 0: the investment has a return in excess of the reward for the assumed risk.

Security Characteristic Line (SCL)

Security Characteristic Line (SCL) is a regression line, plotting the performance of a particular security or portfolio against that of the market index at every point in time for a given period of time. The SCL is plotted on a graph where X-axis is the excess return of the market index 'm' over the risk-free return (r_f) and the Y-axis is the excess return on a security 'i' over the risk-free return (r_f).

The slope of the characteristic line represents the security's Beta (β_i) and the intercept represents its Alpha (α_i).

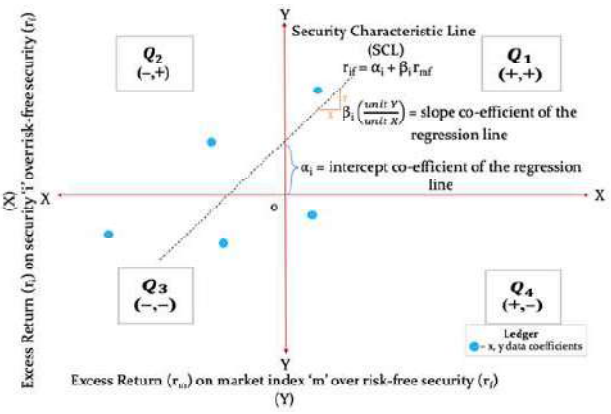

Fig. 2 : Security characteristic line

$$r_{i,f} = \alpha_i + \beta_i r_{m,f}$$

where,

$r_{i,f}$ = excess return on a security 'i' over risk-free security (r_f)

α_i = intercept co-efficient of the SCL's regression line

β_i = slope co-efficient of the SCL's regression line

$r_{m,f}$ = excess return (r_m) on market index 'm' over risk-free security (r_f)

Thus, SCL represents the relationship between the returns of two securities or a security and the market return, over a period of time.

Efficient Frontier Curve (EFC) and Capital Allocation Line (CAL)

EFC graphs all possible combinations of securities portfolios, with all possible weights. Every point on the graph represents highest returns for the risk level and lowest risk for a given return. In other words, given a risk profile, there is no combination of securities that performs better than the efficient frontier.

Capital Allocation Line (CAL) is a line tangent to the Efficient Frontier Curve (EFC) from the risk-free rate (r_f) (Fig.3). The efficient frontier contains all efficient risky portfolios and tangential line from the risk-free rate (r_f) meets it at a point which is the theoretical market portfolio (represented by point M). The market portfolio consists of all efficient securities which cannot be dominated. There is a level of risk for the portfolio in respect of which it gets what is termed as the market return. The market portfolio is well diversified and is the benchmark for

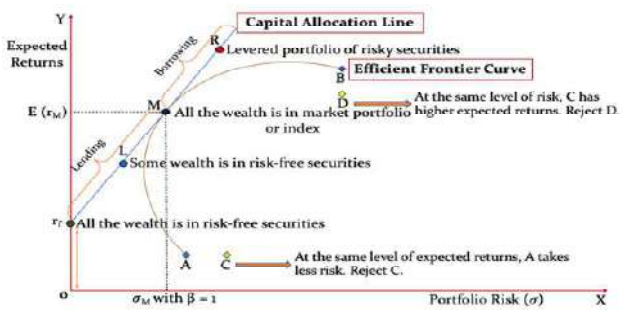

Fig. 3 : Efficient frontier curve and Capital allocation line

other securities. As per the Capital Allocation Line (CAL), an investor has the following choices:

1 – Invest fully in risk-free securities (r_f).

2 – Invest partly in risk-free securities (r_f) and partly in the market portfolio (L) – more risk averse state of investors, between these two points, investor can lend some money to government by buying treasury bills, government bonds and other money in buying risky securities.

3 – Invest fully in the market portfolio (M).

4 – Invest fully in the market portfolio and additionally borrow funds at risk-free rates and invest beyond the point 'M', (R) - less risk averse state of investors where investors borrow funds on risk-free rate for buying risky securities (R).

The return that the investor can expect then is represented as follows:

$$E(r_p) = r_f + \sigma_p \frac{r_m - r_f}{\sigma_m}$$

where,

$E(r_p)$= expected return on portfolio

r_f = risk-free rate of return

r_m = rate of return on the market portfolio 'm'

σ_p = standard deviation of a portfolio

σ_m = standard deviation of market index

One of the most significant and discussed concepts in the field of modern finance is protfolio theory, which is based on the principle that investors can reduce the variability of portfolio returns by holding assests with low or negative return correlations (Eduard and Stefan, 2014). Correlation and variance-covariance matrices are often used in portfolio optimization (Imre and Andras, 2019).

Correlation measures the extent and direction (positive or negative) of the relationship between any two variables (Sowmya *et al.,* 2018 and Aravinda and Umesh, 2020). The correlation between two securities may be negative (correlation, $-1 \leq r < 0$), positive (correlation, $0 < r \leq 1$), no correlation ($r = 0$). There is a perfect positive/negative correlation, if correlation coefficient of 1 or -1 respectively. Whenever there exists a perfectly positive correlation between two

TABLE 1
Correlation coefficients between log returns of nifty stocks

Nifty Stocks	Britannia Industries Ltd	Colgate-Palmolive India Ltd	Dabur India Ltd	Emami Ltd	Godrej Consumer Products Ltd	Hindustan Unilever Ltd	ITC Ltd	Jubilant Foodworks Ltd	Marico Ltd	Nestle India Ltd	P & G Hygiene and Health Care Ltd	Radico Khaitan Ltd	Tata Consumer Products Ltd	United Breweries Ltd	United Spirits Ltd	Nifty FMCG Index	Nifty Fifty Index
Britannia Industries Ltd	1.00	0.31	0.37	0.51	0.36	0.30	0.26	0.32	0.33	0.37	0.27	0.23	0.27	0.38	0.20	0.47	0.37
Colgate-Palmolive India Ltd	0.31	1.00	0.22	0.20	0.31	0.33	0.24	0.24	0.25	0.38	0.33	0.09	0.22	0.21	0.19	0.43	0.28
Dabur India Ltd	0.37	0.22	1.00	0.26	0.33	0.43	0.28	0.39	0.21	0.44	0.14	0.16	0.21	0.37	0.24	0.51	0.37
Emami Ltd	0.51	0.20	0.26	1.00	0.32	0.10	0.31	0.31	0.37	0.22	0.23	0.22	0.34	0.41	0.32	0.40	0.49
Godrej Consumer Products Ltd	0.36	0.31	0.33	0.32	1.00	0.31	0.38	0.41	0.41	0.38	0.19	0.17	0.22	0.27	0.31	0.55	0.40
Hindustan Unilever Ltd	0.30	0.33	0.43	0.10	0.31	1.00	0.24	0.17	0.23	0.40	0.21	0.00	0.20	0.28	0.19	0.60	0.21
ITC Ltd	0.26	0.24	0.28	0.31	0.38	0.24	1.00	0.24	0.33	0.31	0.09	0.12	0.25	0.34	0.35	0.85	0.54
Jubilant Food works Ltd	0.32	0.24	0.39	0.31	0.41	0.17	0.24	1.00	0.22	0.33	0.26	0.33	0.41	0.23	0.15	0.37	0.46
Marico Ltd	0.33	0.25	0.21	0.37	0.41	0.23	0.33	0.22	1.00	0.27	0.14	0.17	0.25	0.34	0.33	0.45	0.38
Nestle India Ltd	0.37	0.38	0.44	0.22	0.38	0.40	0.31	0.33	0.27	1.00	0.27	0.20	0.37	0.24	0.27	0.53	0.33
P & G Hygiene and Health Care Ltd	0.27	0.33	0.14	0.23	0.19	0.21	0.09	0.26	0.14	0.27	1.00	0.01	0.11	0.14	0.02	0.21	0.27
Radico Khaitan Ltd	0.23	0.09	0.16	0.22	0.17	0.00	0.12	0.33	0.17	0.20	0.01	1.00	0.33	0.38	0.33	0.20	0.37
Tata Consumer Products Ltd	0.27	0.22	0.21	0.34	0.22	0.20	0.25	0.41	0.25	0.37	0.11	0.33	1.00	0.33	0.34	0.43	0.59
United Breweries Ltd	0.38	0.21	0.37	0.41	0.27	0.28	0.34	0.23	0.34	0.24	0.14	0.38	0.33	1.00	0.44	0.48	0.46
United Spirits Ltd	0.20	0.19	0.24	0.32	0.31	0.19	0.35	0.15	0.33	0.27	0.02	0.33	0.34	0.44	1.00	0.50	0.46
Nifty FMCG Index	0.47	0.43	0.51	0.40	0.55	0.60	0.85	0.37	0.45	0.53	0.21	0.20	0.43	0.48	0.50	1.00	0.62
Nifty Fifty Index	0.37	0.28	0.37	0.49	0.40	0.21	0.54	0.46	0.38	0.33	0.27	0.37	0.59	0.46	0.46	0.62	1.00

Note: Lesser the correlation co-efficient between the two stocks, greater the benefit of diversification

TABLE 2

Variance and co-variance coefficients between log returns of nifty stocks (in per cent per month)

Nifty Stocks	Britannia Industries Ltd	Colgate-Palmolive India Ltd	Dabur India Ltd	Emami Ltd	Godrej Consumer Products Ltd	Hindustan Unilever Ltd	ITC Ltd	Jubilant Foodworks Ltd	Marico Ltd	Nestle India Ltd	P & G Hygiene and Health Care Ltd	Radico Khaitan Ltd	Tata Consumer Products Ltd	United Breweries Ltd	United Spirits Ltd	Nifty FMCG Index	Nifty Fifty Index
Britannia Industries Ltd	0.51	0.13	0.14	0.35	0.18	0.13	0.11	0.25	0.13	0.15	0.10	0.19	0.18	0.25	0.17	0.14	0.13
Colgate-Palmolive India Ltd	0.13	0.32	0.07	0.11	0.13	0.11	0.08	0.15	0.08	0.12	0.10	0.06	0.11	0.11	0.13	0.10	0.08
Dabur India Ltd	0.14	0.07	0.29	0.13	0.13	0.14	0.09	0.22	0.06	0.13	0.04	0.10	0.10	0.19	0.16	0.11	0.10
Emami Ltd	0.35	0.11	0.13	0.90	0.22	0.06	0.17	0.31	0.20	0.11	0.11	0.24	0.29	0.36	0.37	0.16	0.23
Godrej Consumer Products Ltd	0.18	0.13	0.13	0.22	0.52	0.13	0.16	0.32	0.17	0.15	0.07	0.15	0.14	0.18	0.27	0.16	0.14
Hindustan Unilever Ltd	0.13	0.11	0.14	0.06	0.13	0.34	0.08	0.11	0.08	0.13	0.07	0.00	0.11	0.16	0.13	0.15	0.06
ITC Ltd	0.11	0.08	0.09	0.17	0.16	0.08	0.34	0.15	0.11	0.10	0.03	0.08	0.13	0.18	0.25	0.20	0.16
Jubilant Foodworks Ltd	0.25	0.15	0.22	0.31	0.32	0.11	0.15	1.16	0.14	0.20	0.15	0.41	0.40	0.23	0.20	0.17	0.25
Marico Ltd	0.13	0.08	0.06	0.20	0.17	0.08	0.11	0.14	0.32	0.09	0.04	0.11	0.13	0.18	0.23	0.11	0.11
Nestle India Ltd	0.15	0.12	0.13	0.11	0.15	0.13	0.10	0.20	0.09	0.31	0.08	0.13	0.18	0.12	0.18	0.12	0.09
P & G Hygiene and Health Care Ltd	0.10	0.10	0.04	0.11	0.07	0.07	0.03	0.15	0.04	0.08	0.28	0.01	0.05	0.07	0.01	0.05	0.07
Radico Khaitan Ltd	0.19	0.06	0.10	0.24	0.15	0.00	0.08	0.41	0.11	0.13	0.01	1.33	0.35	0.41	0.46	0.09	0.21
Tata Consumer Products Ltd	0.18	0.11	0.10	0.29	0.14	0.11	0.13	0.40	0.13	0.18	0.05	0.35	0.83	0.28	0.37	0.16	0.27
United Breweries Ltd	0.25	0.11	0.19	0.36	0.18	0.16	0.18	0.23	0.18	0.12	0.07	0.41	0.28	0.87	0.50	0.18	0.21
United Spirits Ltd	0.17	0.13	0.16	0.37	0.27	0.13	0.25	0.20	0.23	0.18	0.01	0.46	0.37	0.50	1.47	0.25	0.28
Nifty FMCG Index	0.14	0.10	0.11	0.16	0.16	0.15	0.20	0.17	0.11	0.12	0.05	0.09	0.16	0.18	0.25	0.17	0.13
Nifty Fifty Index	0.13	0.08	0.10	0.23	0.14	0.06	0.16	0.25	0.11	0.09	0.07	0.21	0.27	0.21	0.28	0.13	0.25

TABLE 3

Portfolio for only minimising risk of nifty stocks (in per cent per month)

Nifty Stocks	Weights (W)	Average returns (r_i)	Beta (β_i) [$\sigma i / \sigma m$] x [$r_{i,m}$]	Individual Risk		Co-efficient of Variance	Individual Treynor Ratio [$(r_i - r_f)/\beta_i$]	Individual Sharpe Ratio [$(r_i - r_f)/ \sigma_i$]
				Individual Standard Deviation (σ)	Individual Variance (σ^2)			
Britannia Industries Ltd	0.00	2.25	0.52	7.14	0.51	317.33	0.23	1.68
Colgate-Palmolive India Ltd	9.15	0.98	0.32	5.70	0.32	581.63	–3.64	– 20.24
Dabur India Ltd	15.19	1.40	0.39	5.42	0.29	387.14	–1.86	– 13.43
Emami Ltd	0.00	1.01	0.92	9.50	0.90	940.59	–1.21	– 11.75
Godrej Consumer Products Ltd	0.00	1.57	0.57	7.21	0.52	459.23	–0.98	– 7.74
Hindustan Unilever Ltd	6.76	1.66	0.25	5.88	0.35	354.21	–1.93	–8.08
ITC Ltd	7.59	0.54	0.63	5.82	0.34	1077.77	–2.55	–27.38
Jubilant Foodworks Ltd	0.00	1.97	0.99	10.80	1.17	548.22	–0.17	–1.51
Marico Ltd	13.68	1.62	0.43	5.72	0.33	353.08	–1.18	–8.92
Nestle India Ltd	3.02	1.37	0.36	5.56	0.31	405.84	–2.13	–13.68
P & G Hygiene and Health Care Ltd	25.05	1.73	0.28	5.32	0.28	307.51	–1.40	–7.44
Radico Khaitan Ltd	2.98	1.69	0.84	11.60	1.35	686.39	–0.52	–3.77
Tata Consumer Products Ltd	0.00	1.54	1.06	9.12	0.83	592.21	–0.56	–6.52
United Breweries Ltd	0.00	0.92	0.85	9.37	0.88	1018.47	–1.43	–12.89
United Spirits Ltd	0.00	0.98	1.11	12.17	1.48	1241.84	–1.03	–9.44
Nifty FMCG Index	10.48	1.13	0.51	4.14	0.17	366.37	–1.97	–24.22
Nifty Fifty Index	6.09	0.88	1.00	5.06	0.26	575.00	–1.25	–24.78
Total Weight	100							

Note : Risk-free rate (r_f) : 2.13 per cent per month is mean monthly t-bill rate from Dec, 2012 to Dec, 2021

securities, there is no need to diversify because it does not reduce the unsystematic risk whereas a perfectly negative correlation (a correlation coefficient of -1) between securities implies that a certain combination of these securities can reduce the unsystematic risk to zero. A compounded portfolio with an overall low correlation is crucial for investors who aim to diversify in order to eliminate unsystematic risk (Logubayom and Victor, 2019). From the previous studies of (Touran, 1993 and Dmitriy *et al.,* 2015 and Hongli, 2021), the strength of correlation can be sorted in the categories of zero correlation (0.00-0.13), weak correlation (0.13-0.30), moderate correlation (0.30-0.70) and strong correlation (0.70-1.00). The lower the correlation between the selected Nifty stocks, the greater the benefit of diversification. The correlation co-efficient between the log returns of stock prices is presented in the Table 1. Among the stocks P & G Hygiene and Health Care Limited has the lowest correlation with all other stocks. Among all the pairs, Radico Khaitan Limited and Hindustan Unilever Limited has shown zero correlation reflecting their independence.

Variance and Co-variance Coefficients between Log Returns of Nifty Stocks

It is evident from Table 2 that United Spirits Limited (1.47), Radico Khaitan Limited (1.33) and Jubilant Foodworks Limited (1.16) has the highest variances whereas P & G Hygiene and Health Care Limited (0.28), Nifty Fifty Index (0.25) and Nifty FMCG Index (0.17) has the lowest variance. United Spirits Limited and Radico Khaitan Limited has the highest co-variance of 0.50 while all the other pairs had smaller covariance values.

Optimum Portfolio for Nifty Stocks

A rational investor's optimum portfolio (proportion of each security in the portfolio) is that portfolio which minimises risk, given the return (*i.e.,* minimise portfolio Standard Deviation) or maximise return, given the risk (*i.e.,* maximise portfolio Treynor Ratio). Technically, it is the tangent point of Capital Allocation Line (CAL) with Efficient Frontier Curve (EFC).

TABLE 4
Portfolio characteristics for only minimising risk of nifty stocks

(in per cent per month)

Portfolio characteristics	Values
Portfolio Mean Returns	1.37
Portfolio Risk :	
Portfolio Variance (σ_p^2)	0.11
Portfolio Standard Deviation (σ_p)	3.32
Portfolio Beta (β_p)	0.43
Portfolio Treynor Ratio [$(r_p - r_f) / \beta_p$]	–1.75
Portfolio Sharpe Ratio [$(r_p - r_f) / \sigma_p$]	–22.80

Portfolio for Only Minimising Risk (*i.e.,* Minimise Portfolio Standard Deviation) of Nifty Stocks

The portfolio of stocks for only minimising risk is presented in Table 3. If the investor's objective is only to minimise the risk, then the ideal portfolio choice is to invest 25.05 per cent on P & G Hygiene and Health Care Limited, 15.19 per cent on Dabur India Limited, 13.68 per cent on Marico Limited, 10.48 per cent on Nifty FMCG Index, 9.15 per cent on Colgate-Palmolive India Limited, 7.59 per cent on ITC Limited, 6.76 per cent on Hindustan Unilever Limited, 6.09 per cent on Nifty Fifty Index, 3.02 per cent on Nestle India Limited, 2.98 per cent on Radico Khaitan Limited.

The portfolio characteristics for only minimising risk shows a portfolio Standard Deviation (σ_p) of 3.32, which is lower than all of the individual stocks (Table 3). Portfolio Mean Return 1.37, which is same as Nestle India Limited (1.37) and higher than Colgate-Palmolive India Limited (0.98), Nifty Fifty Index (0.88) *etc*., However it is much lower than Britannia Industries Limited (2.25), Hindustan Unilever Limited (1.66), Jubilant Foodworks Limited (1.97), P & G Hygiene and Health Care Limited (1.73), Radico Khaitan Limited (1.69) *etc*.

Portfolio Beta of 0.43, which is same as Marico Limited (0.43) and higher than Colgate-Palmolive India Limited (0.32), Dabur India Limited (0.39),

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TABLE 5

Portfolio for only maximising returns of nifty stocks (in per cent per month)

Nifty Stocks	Weights (W)	Average returns (r_i)	Beta (β_i) $[\sigma_i / \sigma_m] x [r_{i,m}]$	Individual Risk		Co-efficient of Variance	Individual Treynor Ratio $[(r_i - r_f)/\beta_i]$	Individual Sharpe Ratio $[(r_i - r_f)/ \sigma_i]$
				Individual Standard Deviation (σ)	Individual Variance (σ^2)			
Britannia Industries Ltd	100	2.25	0.52	7.14	0.51	317.33	0.23	1.68
Colgate-Palmolive India Ltd	0	0.98	0.32	5.70	0.32	581.63	–3.64	–20.24
Dabur India Ltd	0	1.40	0.39	5.42	0.29	387.14	–1.86	–13.43
Emami Ltd	0	1.01	0.92	9.50	0.90	940.59	–1.21	–11.75
Godrej Consumer Products Ltd	0	1.57	0.57	7.21	0.52	459.23	–0.98	–7.74
Hindustan Unilever Ltd	0	1.66	0.25	5.88	0.35	354.21	–1.93	–8.08
ITC Ltd	0	0.54	0.63	5.82	0.34	1077.77	–2.55	–27.38
Jubilant Foodworks Ltd	0	1.97	0.99	10.80	1.17	548.22	–0.17	–1.51
Marico Ltd	0	1.62	0.43	5.72	0.33	353.08	–1.18	–8.92
Nestle India Ltd	0	1.37	0.36	5.56	0.31	405.84	–2.13	–13.68
P & G Hygiene and Health Care Ltd	0	1.73	0.28	5.32	0.28	307.51	–1.40	–7.44
Radico Khaitan Ltd	0	1.69	0.84	11.60	1.35	686.39	–0.52	–3.77
Tata Consumer Products Ltd	0	1.54	1.06	9.12	0.83	592.21	–0.56	–6.52
United Breweries Ltd	0	0.92	0.85	9.37	0.88	1018.47	–1.43	–12.89
United Spirits Ltd	0	0.98	1.11	12.17	1.48	1241.84	–1.03	–9.44
Nifty FMCG Index	0	1.13	0.51	4.14	0.17	366.37	–1.97	–24.22
Nifty Fifty Index	0	0.88	1.00	5.06	0.26	575.00	–1.25	–24.78
Total Weights	100							

Note: Risk-free rate (r_f) : 2.13 per cent per month is mean monthly t-bill rate from Dec, 2012 to Dec, 2021

Hindustan Unilever Limited (0.25), Nestle India Limited (0.36), P & G Hygiene and Health Care Limited (0.28) *etc*. and lower than Britannia Industries Limited (0.52), Emami Limited (0.92), Jubilant Foodworks Limited (0.99), Tata Consumer Products Limited (1.06), United Spirits Limited (1.11) *etc*.

Treynor ratio which reflects excess return of a security 'i' or portfolio 'p' over the risk-free security (r_f) per security's systematic risk (β_i) or portfolio's systematic risk (β_p) respectively was computed. The Portfolio Treynor ratio (–1.75) is higher than Colgate-Palmolive India Limited (–3.64), ITC Limited (–2.55), Nestle India Limited (–2.13) *etc.* and lower than Britannia Industries Limited (0.23), Jubilant Foodworks Limited (–0.17), Radico Khaitan Limited (–0.52), Tata Consumer Products Limited (–0.56), etc.

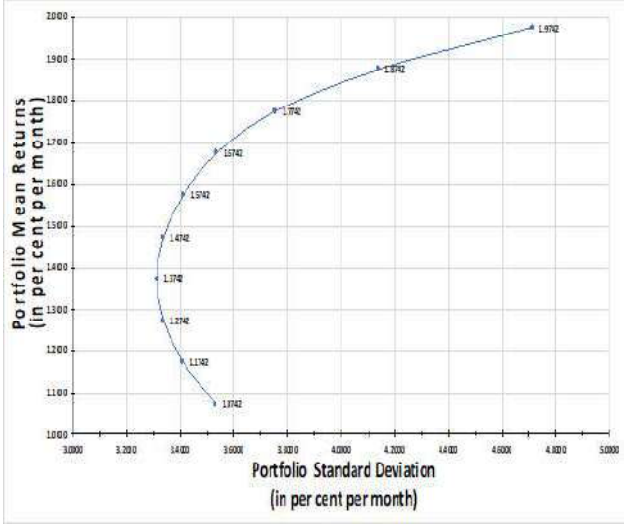

Fig. 4 : Efficient frontier curve of nifty stocks

Sharpe ratio which reflects excess return of a security 'i' or portfolio 'p' over the risk-free security (r_f) per security's total risk (σ_i) or portfolio's total risk (σ_p) respectively was computed. The portfolio Sharpe ratio (–22.80) is higher than ITC Limited (–27.38), Nifty FMCG Index (–24.22) and Nifty Fifty Index (–24.78) and lower than Colgate Palmolive India Limited (–20.24), Nestle India Limited (–13.68), Dabur India Limited (–13.43), United Breweries Limited (–12.89), Emami Limited (–11.75) *etc*.

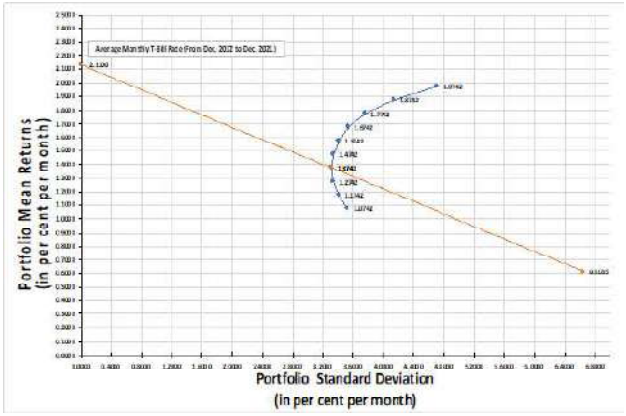

Fig. 5 : Optimum portfolio of nifty stocks

Portfolio for Only Maximising Return (*i.e.*, Maximise Portfolio Treynor Ratio) of Nifty Stocks

The portfolio of stocks for only maximising returns is provided in Table 5.

The results shows that if the objective is only to maximise the returns, invest 100 per cent on Britannia Industries Limited individual nifty stock. Results shows that portfolio characteristics are almost as same as Britannia Industries Limited individual nifty stock.

Portfolios of Nifty Stocks to Construct Efficient Frontier Curve

The optimum portfolio for estimating efficient frontier curve was computed by parametrising portfolio mean returns.

TABLE 6
Portfolio characteristics for only maximising returns of nifty stocks

(in per cent per month)

Portfolio characteristics	Values
Portfolio Mean Returns	2.25
Portfolio Risk :	
Portfolio Variance (σ_p^2)	0.51
Portfolio Standard Deviation (σ_p)	7.11
Portfolio Beta (β_p)	0.52
Portfolio Treynor Ratio [$(r_p - r_f) / \beta_p$]	0.23
Portfolio Sharpe Ratio [$(r_p - r_f) / \sigma_p$]	1.69

TABLE 7

Nifty stock weights and characteristics of different portfolios

(in per cent per month)

Nifty Stocks	1	2	3	Optimum Portfolio (4)	5	6	7	8	9	10
Britannia Industries Ltd	0.00	0.00	0.00	0.00	0.00	3.49	7.85	19.04	32.68	48.66
Colgate-Palmolive India Ltd	19.23	15.93	12.66	9.16	5.51	1.93	0.00	0.00	0.00	0.00
Dabur India Ltd	13.56	14.40	15.16	15.20	15.19	15.17	15.07	6.39	0.00	0.00
Emami Ltd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Godrej Consumer Products Ltd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hindustan Unilever Ltd	2.14	4.56	7.05	6.74	6.62	10.73	15.10	16.96	15.57	9.98
ITC Ltd	24.03	19.91	15.86	7.58	0.00	0.00	0.00	0.00	0.00	0.00
Jubilant Food works Ltd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	2.31
Marico Ltd	4.52	7.89	11.23	13.72	16.26	18.63	20.69	18.69	14.06	6.75
Nestle India Ltd	3.36	3.52	3.62	3.04	2.38	2.42	1.93	0.00	0.00	0.00
P & G Hygiene and Health Care Ltd	14.21	17.93	21.64	25.02	28.59	31.19	33.02	33.89	33.00	30.45
Radico Khaitan Ltd	0.00	1.02	2.14	2.98	3.90	4.54	4.92	5.01	4.02	1.86
Tata Consumer Products Ltd	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00
United Breweries Ltd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
United Spirits Ltd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Nifty FMCG Index	0.00	0.00	0.00	10.47	20.55	11.90	0.69	0.00	0.00	0.00
Nifty Fifty Index	18.95	14.83	10.66	6.09	0.99	0.00	0.00	0.00	0.00	0.00
Total Weight	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Portfolio Variance	0.12	0.12	0.11	0.11	0.11	0.12	0.13	0.14	0.17	0.22
Portfolio Standard Deviation	3.53	3.41	3.34	3.32	3.34	3.41	3.54	3.76	4.14	4.71
Portfolio Mean Returns	1.07	1.17	1.27	1.37	1.47	1.57	1.67	1.77	1.87	1.97
Portfolio Beta (β_p)	0.53	0.50	0.46	0.43	0.40	0.39	0.38	0.38	0.40	0.43
Portfolio Treynor Ratio $[(r_p - r_f)/\beta_p]$	–1.99	–1.92	–1.85	–1.75	–1.64	–1.44	–1.20	–0.93	–0.64	–0.36
Portfolio Sharpe Ratio $[(r_p - r_f)/ \sigma_p]$	–29.89	–28.02	–25.64	–22.80	–19.65	–16.28	–12.88	–9.47	–6.18	–3.30

TABLE 8

Capital allocation line

(in per cent per month)

Weights (W)	Mean Return	Standard Deviation
0.00	2.1300 (t-bill)	0.0000
1.00	1.3742	3.3153
2.00	0.6185	6.6305

Efficient Frontier Curve of Nifty Stocks

The efficient frontier was obtained by plotting portfolio mean return against respective portfolio standard deviations (Fig. 4).

Capital Allocation Line (CAL)

Monthly mean return and standard deviations were derived for capital allocation line with portfolio weights of 0, 1 and 2, respectively.

Optimum Portfolio of Nifty Stocks

The capital allocation line was plotted along with the efficient frontier curve to obtain most efficient optimum portfolio (Fig. 5).

The most efficient optimum portfolio is at the tangency point of Capital Allocation Line (CAL) with Efficient Frontier Curve (EFC).

TABLE 9

Security market line for nifty stocks

(in per cent per month)

T-bill and Nifty Stocks	Beta (β_i)	Expected Return as per CAPM $[E(r_i) = r_f + \beta_i(r_m - r_f)]$	Actual Return (r_i)	Jensen's Alpha (α)
Risk-free Rate (r_f)	0	2.13	2.13	0.00
Britannia Industries Ltd	0.52	1.48	2.25	0.77
Colgate-Palmolive India Ltd	0.32	1.73	0.98	–0.75
Dabur India Ltd	0.39	1.64	1.40	–0.24
Emami Ltd	0.92	0.98	1.01	0.04
Godrej Consumer Products Ltd	0.57	1.41	1.57	0.16
Hindustan Unilever Ltd	0.25	1.82	1.66	–0.16
ITC Ltd	0.63	1.35	0.54	–0.81
Jubilant Foodworks Ltd	0.99	0.89	1.97	1.08
Marico Ltd	0.43	1.59	1.62	0.03
Nestle India Ltd	0.36	1.68	1.37	–0.31
P & G Hygiene and Health Care Ltd	0.28	1.78	1.73	–0.04
Radico Khaitan Ltd	0.84	1.08	1.69	0.61
Tata Consumer Products Ltd	1.06	0.80	1.54	0.73
United Breweries Ltd	0.85	1.07	0.92	–0.15
United Spirits Ltd	1.11	0.73	0.98	0.25
Nifty FMCG Index	0.51	1.49	1.13	–0.36
Nifty Fifty Index (r_m)	1.00	0.88	0.88	0.00

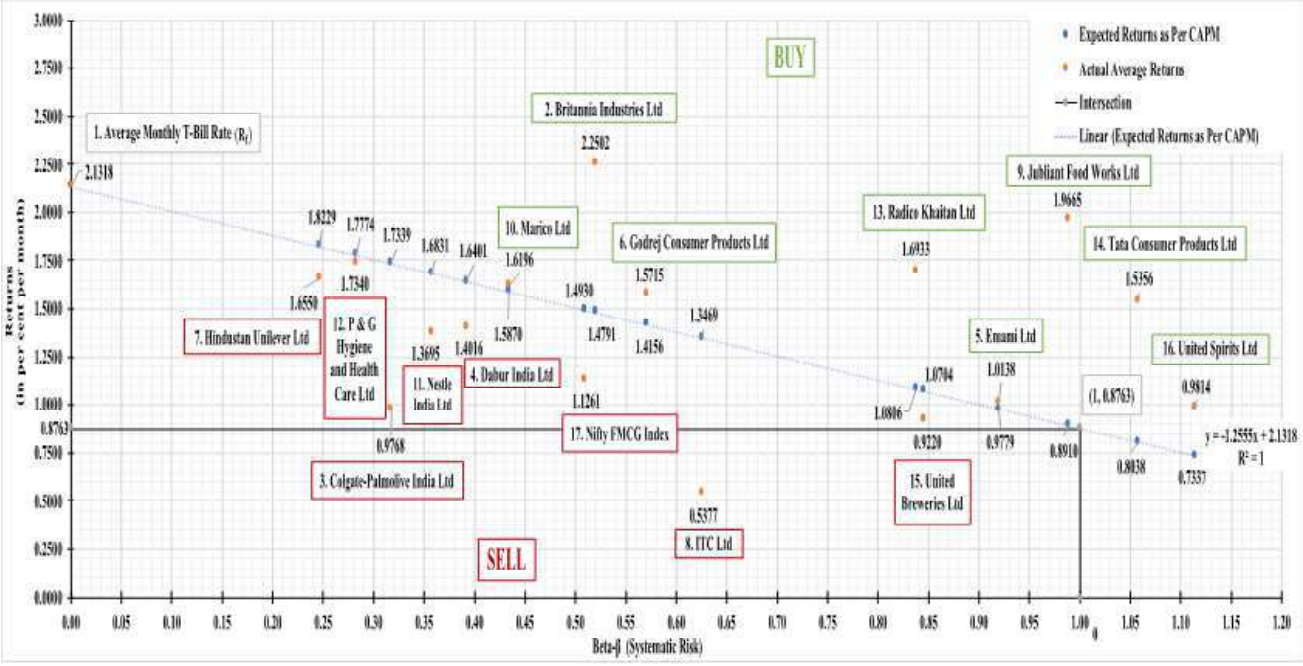

Fig. 6 : Security market line of nifty stocks

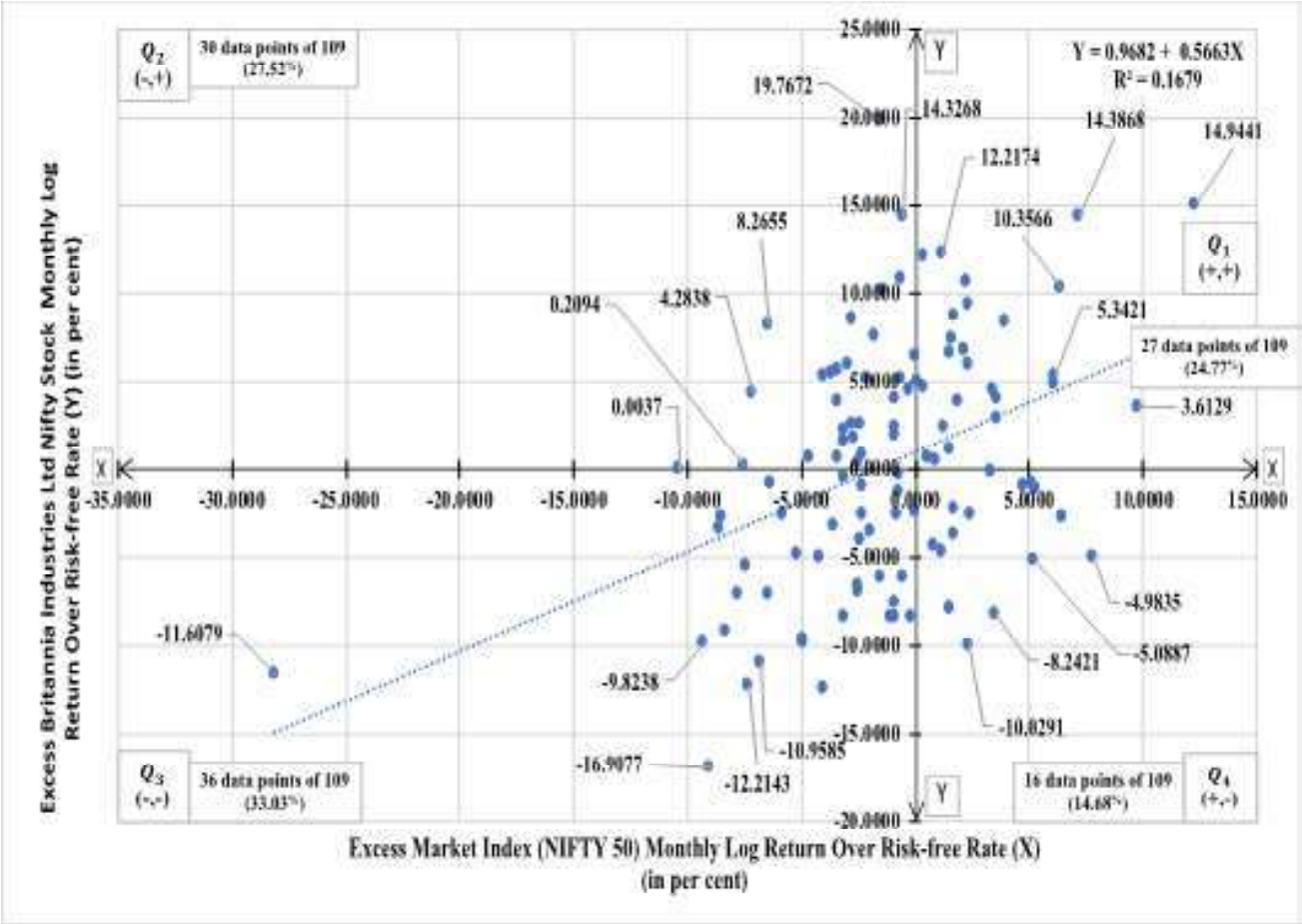

Fig.7: Security characteristic line for britannia industries limited nifty stock with nifty fifty index

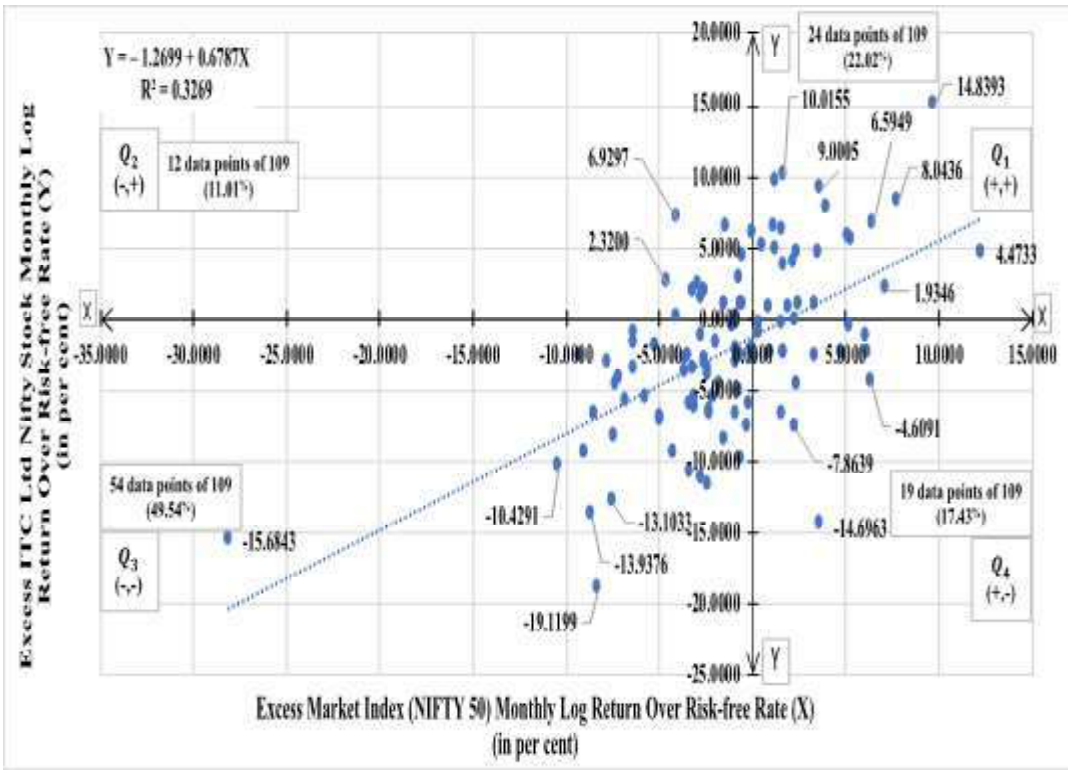

Fig. 8 : Security characteristic line for ITC limited nifty stock with nifty fifty index

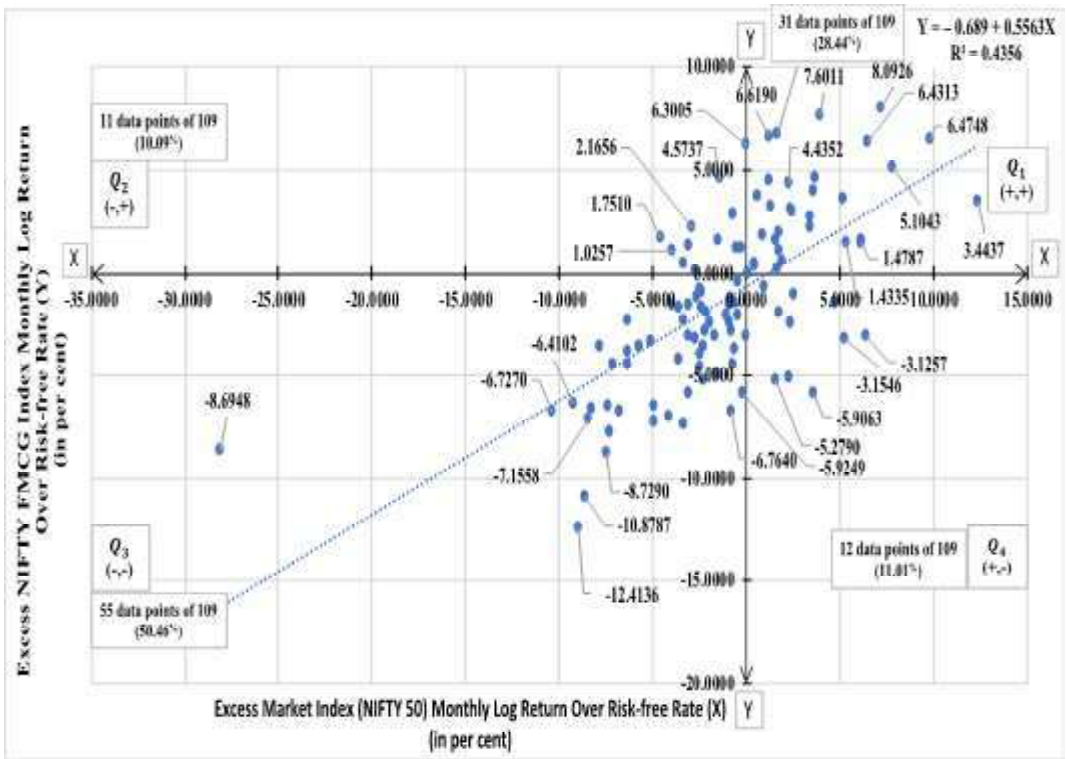

Fig. 9 : Security characteristic line for nifty FMCG index with nifty fifty index

The results shows that the optimum portfolio is to invest 25.02 per cent on P & G Hygiene and Health Care Limited, 15.20 per cent on Dabur India Limited, 13.72 per cent on Marico Limited, 10.47 per cent on Nifty FMCG Index, 9.16 per cent on Colgate-Palmolive India Limited, 7.58 per cent on ITC Limited, 6.74 per cent on Hindustan Unilever Limited, 6.09 per cent on Nifty Fifty Index, 3.04 per cent on Nestle India Limited, 2.98 per cent on Radico Khaitan Limited, which has a portfolio mean return of 1.37 per cent per month and with a portfolio Beta (β_p) of 0.43 and with a portfolio Treynor ratio of –1.75 and with a portfolio Sharpe ratio of –22.80 and with a portfolio standard deviation of 3.32 and portfolio variance of 0.11.

It may be noted here that the optimum portfolio had the portfolio characteristics similar to that of the only minimise risk portfolio (Table 4).

Security Market Line (SML) for Nifty Stocks

Security Market Line (SML) was obtained by using expected return from CAPM equation for all the Nifty FMCG Stocks by considering Nifty Fifty Index as an indicator for market conditions. The SML helps in stock investment decisions by identifying and buying underpriced or under valued stocks.

Results of the Security Market Line (SML) from Table 9 and Fig. 6, shows that Marico Limited (α = 0.03), Britannia Industries Limited (α = 0.77), Godrej Consumer Products Limited (α = 0.16), Radico Khaitan Limited (α = 0.61), Emami Limited (α = 0.04), Jubliant Foodworks Limited (α = 1.08), Tata Consumer Products Limited (α = 0.73) and United Spirits Limited (α = 0.25) are underpriced since their expected returns as per CAPM are lesser than actual returns and can be bought since the investment in these securities has a return in excess of the reward for the inherent risk. Whereas, Hindustan Unilever Limited (α = –0.16), P & G Hygiene and Health Care Limited (α = –0.04), Colgate - Palmolive India Limited (α = –0.75), Nestle India Limited (α = –0.31), Dabur India Limited (α = – 0.24), Nifty FMCG Index (α = – 0.36), ITC Limited (α = –0.81), United Breweries Limited (α = –0.15) are over priced since their expected returns as per CAPM are greater than actual returns and can be sold since the investment in these securities has earned too little for their risk. The greater the difference in Jensen's alpha (α), the greater the overvalued or undervalued, the stock is. The former stocks are more defensive (*i.e.,* less volatile) compared to the latter stocks since their Beta (β_i) values are relatively less. A similar study by Krunal *et al.,* 2017 has also categorised the FMCG stocks into defensive and aggressive ones based on the calculated Beta (β_i) values relative to CAPM Beta (β_i) values.

It can be observed from the results that it is better to buy t-bill since it gives a mean monthly return of 2.13 per cent, which is higher than mean monthly optimum portfolio for the sample (1.37) and of every individual Nifty FMCG Stocks of the sample, Nifty FMCG Index (1.13) and Nifty Fifty Index (0.88), but it is less than Britannia Industries Limited stock which has been giving a mean monthly return of 2.25 per cent.

Security Characteristic Line (SCL) for Britannia Industries Limited, ITC Limited and Nifty FMCG Index with Nifty Fifty Index

Security Characteristic Line (SCL) for Britannia Industries Limited, ITC Limited and Nifty FMCG Index with Nifty Fifty Index is presented in Fig. 7-9.

Security Characteristic Line (SCL) data points in Quadrant (Q_1) shows the returns during which both index (x-coefficient) and stock (y-coefficient) has performed well; Quadrant (Q_2) shows the returns during which Nifty Fifty Index (x-coefficient) has performed badly while the Britannia Industries Limited, ITC Limited and Nifty FMCG stocks (y-coefficient) has done well; Quadrant (Q_3) shows the returns during which both the index (x-coefficient) and stock (y-coefficient) has performed badly; Quadrant (Q_4) shows the returns during which the Nifty Fifty Index (x-coefficient) has performed well while Britannia Industries

Limited, ITC Limited and Nifty FMCG stocks (y-coefficient) has done badly (Fig. 7-9).

Every investment return comes with a risk. So, the question that entities have to address is therefore not whether to avoid risk but how best to incorpo rate it into the decision making. Diversification only reduces firm-specific risk, but not systematic (or market-level) risk.

In general, a typical investor tries to maintain a diversified portfolio. So, efficient markets reward for only systematic risk (β_p) which effects the whole market but the degree of its impact would vary across the securities.

A rational investor's optimum portfolio (proportion of each security in the portfolio) is that portfolio which minimises risk, given the return (*i.e.,* mini mise portfolio standard deviation) or maximises return, given the risk (*i.e.,* maximise portfolio Treynor ratio). Technically, it is the tangent point of Capital Allocation Line (CAL) with Efficient Frontier Curve (EFC).

For the sample with individual NIFTY FMCG stocks and NIFTY FMCG Index and NIFTY Fifty Index, optimum portfolio is at a proportional weights of 25.02 per cent on P&G Hygiene and Health Care Limited, 15.20 per cent on Dabur India Limited, 13.72 per cent on Marico Limited, 10.47 per cent on NIFTY FMCG Index, 9.16 per cent on Colgate-Palmolive India Limited, 7.58 per cent on ITC Limited, 6.74 per cent on Hindustan Unilever Limited, 6.09 per cent on NIFTY Fifty Index, 3.04 per cent on Nestle India Limited, 2.98 per cent on Radico Khaitan Limited, with a portfolio mean return of 1.37 per cent at a portfolio standard deviation of 3.32 and a portfolio beta (β_p) of 0.43 and with a portfolio Treynor ratio of –1.75 and a portfolio Sharpe ratio of –22.80.

Security Characteristic Line (SCL) helps investors track, identify and study the underlying reasons of a security's behavior relative to that of a given market index or a security at every point in time for a given period of time.

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