Markowitz Risk :
The Investor's Benefit

Dr Amarjeet S Khalsa

Dr Khalsa is Professor & Dean (Academics),
Institute of Professional Education & Research(IPER), Bhopal-462026

Abstract

Buying or sacrificing something today, with the intent of creating a stream of wealth in the future or preventing wealth destruction in the future is Investment. For the individual, it is the exchange of the money or cash for a future claim on money or the purchase of a security of a promise to pay at a later date along with a regular income as in the case of a share, bond, debenture etc. Purchase of assets like shares and securities can be for either investment or speculation or both. Investment is long term in nature. While speculation is short term. Investment aims at income and normal long term capital growth while speculation aims only at short term trade gains through buying and selling. Hence, it becomes a matter of risk exposure or tolerance of an individual. Basically both aim at income and capital appreciation. But the difference is in motives and objectives. All investments are risky to some extent but speculation is more risky as it involves short term trading, buying and selling which may lead to profits some times and losses at other times.

Capital Market

Efficient financial systems are indispensable for speedy economic development. The more vibrant and efficient the financial system of a country, the greater is its efficiency of capital formation. The more diversified and broad based the institutional structure of the financial system, the more active and vibrant is the financial system. The nature and scope of financial intermediaries, their investment policies and operations affect the process of capital formation in the country. They facilitate the flow of savings into investments by overcoming the geographical and technical limitations. The organised part of the Indian financial system can be classified from the point of view of regulatory authority as:

- Reserve Bank of India regulating Commercial Banks, Foreign Exchange Markets, Financial Institutions and Primary Dealers .Commercial banks include Public Sector banks, Private banks and Foreign Banks. Financial Institutions may be of all India level like IDBI, IFCI, ICICI, NABARD or sectoral financial institutions like EXIM, TFCIL etc. Primary Dealers are registered participants of the wholesale debt market and bid at auctions for Government Debt, treasury bills.

The Capital Market deals in financial assets. Financial assets comprises of shares, debentures, Mutual funds etc. Although stock market and money market are two basic components in our country, capital markets are generally known as security market .Indian capital market can be broadly classified into the following:

- Money Market : It is a market which deals in short term securities such as treasury bills, certificate of deposits etc.
- Debt Market : It is market dealing in debt securities such as debentures, bonds etc.
- Security Market : It is a market dealing in equity and equity linked securities. This market comprises of **Primary Market and Secondary Market.**

- **Primary Market:**

A market where new securities are bought and sold for the first time is called the New Issues Market or the IPO market. In other words the first public offerings of equity shares or convertible securities by a company, which is followed by the listings of

a company's shares on a stock exchange, is known as an Initial Public offerings (IPO). The primary market also includes issue of further capital by companies whose shares are already listed on the stock exchange.

- **Secondary Market / Stock Exchanges:**

The stock exchange is one of the most important institutions in the capital Market, which includes term lending institutions, banks, investors, companies and just about anybody and everybody who are engaged in providing long term capital, whether share capital or debt capital, to the industrial sector.

Objectives of the study

- To Study the Concept of risk in Portfolio Management.
- To Study Markowitz Theory in relation to risk in Portfolio Managements.

Methodology

The study has been based on the secondary data collected from NSE. Reliance Industry was taken as the base stock. The underlying assumption behind this was the volumes this stock generated during the last one year on NSE. This shows that RIL is the most traded stock in the market. Thus, the combinations of RIL were made with the different stocks available from the various sectors of the economy. The base of selecting the stocks of the various sectors were both technical and the fundamental performance in the last one year.

The correlations of RIL with different sectoral stocks were calculated. It was further grouped on the basis of negative and positive correlations and different combinations were made. Then the formulae to calculate the risk was applied as suggested by Markowitz and were further analysed on the basis of the proportion of each stock in the portfolio where the level of the risk was minimum.

Limitations:

The present study is a typical case as it includes only two security cases. It does not consider the multiple security case. The selection of the securities may be bias.

Concept Of Risk

Any rational investor, before investing his or her investible wealth in the stock, analyses the risk associated with the particular stock. The actual return he receives from a stock may vary from his expected return and the risk is expressed in terms of variability of return. "Uncertainty in Probability of return is known as Risk". The downside risk may be caused by several factors, either common to all stocks or specific to a particular stock. Investor in general would like to analyse the risk factors and a thorough knowledge of the risk helps to plan the portfolio in such a manner so as to minimise the risk associated with the investment.

Risk normally has two dimensions i.e. the quality of risk and the quantity of risk. Quality of risk is essentially the probability of the risk turning into an actual loss. Quantity of risk is the financial effect of the risk turning into a loss. Both these dimension are extremely difficult to measure, primarily because it is an estimation of the future, which is highly uncertain. Risk Management is the strategic tool, which helps in Identifying, Quantifying, Monitoring and Controlling risks. Ris. To understand Risk Management it is extremely important to understand the various types of risks, their characteristics and their inter-relationships. Risk consists of two components, the systematic and unsystematic risk.

The systematic risk is caused by factors external to the particular company and uncontrollable by the company. The systematic risk affects the market as a

whole. The systematic risk affects the entire market. Often we read in the news paper that the stock market is in the bear hug or in the bull grip. This indicates that the entire market is moving in a particular direction either downward or upward. The economic conditions, political situations and the sociological changes affect the security market. The recession in the economy affects the profit prospect of the industry and the stock market. It drives home the point that the systematic risk is unavoidable. The systematic risk is further sub divided into:

(1) Market Risk.

(2) Interest Risk.

(3) Purchasing Power Risk.

- Market Risk Jack Clark Francis has defined market risk as that portion of total variability of return caused by the alternating forces of bull and bear markets. When the security index moves upward haltingly for a significant period of time it is known as bull market. In the bull market the index moves from a low level to the peak. Bear market is just a reverse to the bull market; the index declines haltingly from the peak to a market low point called trough for a significant period of time. During the bull and bear market more than 80 % of the securities prices rise or fall along with the stock market indices. (http://www.moneycontrol.com)

- Interest Rate Risk Interest rate risk is the variation in the single period rates of return caused by the fluctuations in the interest rate. Most commonly interest rate risk affects the price of bonds, debentures and stocks. The fluctuations in the interest rate are caused by the changes in the government monetary policy and the changes that occur in the interest rates of treasury bills and the government bonds. The bonds issued by the government and quasi-government rate are considered to be risk free. If higher interest rate is offered, investor would like to switch his investments from private sector bonds to public sector bonds. If the government to tide over the deficit in the budget floats a new loan/bond of a higher rate of interest, there would be a deficit shift in the funds from low yielding bonds and from stocks to bonds.

- Like wise if the stock market is in a depressed condition, investors would like to shift their money to the bond market, to have an assured rate of return. The best e.g. is that in April 1996, most of the initial public offerings of many companies remained undersubscribed but IDBI and IFC bonds were oversubscribed. The assured rate of return attracted the investors from the stocks market to the bond market. The rise or fall in the interest rate affects the cost of borrowing. Most of the stocks traders' trade in the stock market with the borrowed funds. (http://in.rediff.com/money/perfin.html)The increase in the cost of the margin affects the probability of the traders. This would dampen the spirit of the speculative traders who use the borrowed funds. The fall in the demand for securities would lead to a fall in the value of the stock index.

Interest rate not only affects the security traders but also the corporate bodies who carry their business with borrowed funds. The cost of borrowing would increase and a heavy outflow of profit would take place in the form of interest to the capital borrowed. This would lead to a reduction in earnings per share and a consequent fall in the price of share.

Purchasing Power Risk Variations in the returns are caused also by the loss of purchasing power of currency. Inflation is the reason behind the loss of purchasing power. The level of inflation proceeds faster than the increase in capital value. Purchasing power risk is the probable loss in the purchasing power of the returns to be received. The rise in price penalises the returns to the investor, and every potential rise in price is a risk to the investor. The inflation may be demand pull or cost push inflation. In the demand pull inflation, the demand for goods and services are in

excess of their supply. At full employment level of factors of production, the economy would not be able to supply more goods in the short run and the demand for products pushes the prices upward. The supply cannot be increased unless there is an expansion of labour force or machinery for production. The equilibrium between demand and supply is attained at a higher price level. The cost push inflation, as the name itself indicates that the inflation or the rise in price is caused by the increase in the cost. The increase in the cost of raw material, labour and equipment makes the cost of production high and ends in price level. The producer tries to pass the higher cost of production to the consumer. The labourers or the working force try to make the corporate to share the increase in the cost of living by demanding higher wages. Thus the cost push inflation has a spiralling effect on price level.

Unsystematic Risk

Unsystematic risk is unique and peculiar to a firm or an industry. Unsystematic risk stems from managerial inefficiency, technological change in the production process, availability of raw material, changes in the consumer preference, and labour problems. It differs from industry to industry or company to company. The changes in the consumer preferences affect the consumer products like television sets, washing machines, refrigerators etc. more than they affect the iron and steel industry. Technological changes affect the information technology industry more than that of consumer product industry.

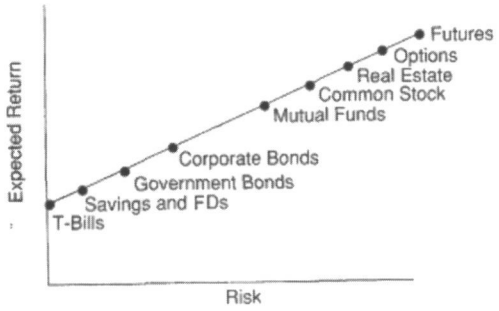
Operational Risk / Business risk It is the risk faced by any organization, arising due to malfunctioning of internal systems, wrong entering of transactional details, wrong interpretation and judgmental errors made by manpower. Operational risk is difficult to quantify and monitor. However certain critical operations or systems have to be identified, the failure of which would raise survival issues for the company. Close and constant monitoring of these systems is an essential part of operational risk management.

Financial Risk It refers to the variability of the income to the equity capital due to the debt capital. Financial risk in a company is associated with the capital structure of the company. Capital structure of the company consists of equity funds and borrowed funds. The presence of debt and preference capital results in commitments of paying interest or prefixed rate of dividend. The residual income alone would be available to the equity holders. The interest payment affects the payments that are due to the equity investors. The debt financing increases the variability of the returns to the common stock holders and affects their expectations regarding the return. The use of debt with the owned funds to increase the return to the shareholders is known as financial leverage.

Risk Return Relationship

Risk and return are the primary ingredients in making investment choices. Expected return must be compared to risk. As risk increases, so must the return to compensate for the greater uncertainty. This is called the risk-return trade-off; namely, that there is greater risk in investment classes that offer potential of higher returns and vice-versa. Therefore, an investor has to choose between higher returns with higher risk versus lower risk accompanied, alas, by lower returns. The risk/return trade-off is crucial. You should seek the highest possible return at the risk level you are willing to accept. In general, the risk/return characteristics of each of the major investment instruments can be displayed in a risk/return graph, as shown below. Although the locations on the diagram are only approximate, it should be apparent that you can pick from a wide variety of vehicles, each having certain risk/return combinations.

Figure 1: Risk/Return Trade-Offs for Various Investment Vehicles



Markowitz Theory

Harry Max Markowitz The contribution for which Harry Markowitz now receives his award was first published in an essay entitled "Portfolio Selection" (1952), and later, more extensively, in his book, Portfolio Selection: Efficient Diversification (1959). The so-called theory of portfolio selection that was developed in this early work was originally a normative theory for investment managers, i.e., a theory for optimal investment of wealth in assets which differ in regard to their expected return and risk. He started with the idea of risk aversion of average investors and their desire to maximize the expected return with the least risk. Markowitz showed that under certain given conditions, an investor's portfolio choice can be reduced to balancing two dimensions, i.e., the expected return on the portfolio and its variance. Due to the possibility of reducing risk through diversification, the risk of the portfolio, measured as its variance, will depend not only on the individual variances of the return on different assets, but also on the pair wise covariance's of all assets.

Hence, the essential aspect pertaining to the risk of an asset is not the risk of each asset in isolation, but the contribution of each asset to the risk of the aggregate portfolio. However, the "law of large numbers" is not wholly applicable to the diversification of risks in portfolio choice because the returns on different assets are correlated in practice. Thus, in general, risk cannot be totally eliminated, regardless of how many types of securities are represented in a portfolio

In this way, the complicated and multidimensional problem of portfolio choice with respect to a large number of different assets, each with varying properties, is reduced to a conceptually simple two-dimensional problem - known as mean-variance analysis. In an essay in 1956, Markowitz also showed how the problem of actually calculating the optimal portfolio could be solved.

Modern Portfolio Theory (mpt)

Modern portfolio theory (MPT)-or portfolio theory-was introduced by Harry Markowitz with his paper "Portfolio Selection," which appeared in the 1952 Journal of Finance. Thirty-eight years later, he shared a Nobel Prize with Merton Miller and William Sharpe for what has become a broad theory for portfolio selection. Prior to Markowitz's work, investors focused on assessing the risks and rewards of individual securities in constructing their portfolios. Standard investment advice was to identify those securities that offered the best opportunities for gain with the least risk and then construct a portfolio from these. Following this advice, an investor might conclude that railroad stocks all offered good risk-reward characteristics and compile a portfolio entirely from these. Intuitively, this would be imprudent. Markowitz formalized this intuition. Detailing mathematics of diversification, he proposed that investors focus on selecting portfolios based on their overall risk-reward characteristics instead of merely compiling portfolios from securities that each individually has attractive risk-reward characteristics. In a nutshell, investors should select portfolios not individual securities.

Markowitz Diversification

Most people would agree that a portfolio consisting of two stocks is probably less risky than one holding either stock alone. However, experts disagree with regard to the "right" kind of diversification and the "right" reason. The discussion that follows introduces and explores a formal, advanced notion of diversification conceived by the genius of Harry Markowitz. Markowitz approach to coming up with good portfolio possibilities has its roots in risk return relationships. This is not at odds with traditional approaches in concept. The key differences lie in Markowitz assumption that investor attitudes toward portfolios depend exclusively upon (1) expected return and risk, (2) quantification of risk and risk is by proxy, the statistical notion of variance or, standard deviation of return. Markowitz postulated that diversification should not only aim at reducing the risk of a security, by reducing its variability or standard deviation, but by reducing the covariance or interactive risk of two or more securities in a portfolio. As by combination of different securities it is theoretically possible to have a range of risk varying from zero to infinity.

Parameters of Markowitz Diversification

Markowitz has set out guidelines for diversification on the basis of the attitude of investors towards risk and return and on a proper quantification of risk. The investments have different types of risk characteristics, some called systematic and market related risks and the other called unsystematic or company related risk. Markowitz diversification involves a proper number of securities, not too few or not too many which have no correlation or negative correlation. The proper choice of companies, securities or assets whose returns are not correlated and whose risks are mutually offsetting to reduce the overall risk. Parameters as laid down by Markowitz are:

(1) Expected Return The mean or average outcome calculated by weighting each of the possible outcomes by the probability of occurence and then summing the result

(2) Standard Deviation A measure of the variation in a distribution, equal to the square root of the arithmetic mean of the squares of the deviations from the arithmetic mean, ie. the square root of the variance.

When you say that an investment like a stock market index fund has an expected return of 9%, you're saying that in any year there is a chance that your return will be better than 9% and a chance that it will be worse. To get more specific about your chances, you need to specify the expected volatility of the investment, as well as its expected return. The volatility of an investment is given by the statistical measure known as the standard deviation of the return rate. You can just think of standard deviation as being synonymous with volatility. An S&P 500 index fund has a standard deviation of about 15%(Douglas Hearth & Janis K. Zaima & Brealey Myers) a standard deviation of zero would mean an investment has a return rate that never varies, like a bank account paying compound interest at a guaranteed rate.

(3) Covariance If two or more quantities vary in sympathy so that movements in one tend to be a accompanied by corresponding movements in the other, then they are said to be correlated.

When for every value of a variable X we know a corresponding value of a second variable Y , then we are interested in the relationship of these two variables. If a change in one variable is accompanied a change in other variable and vice versa, then the two variables are said to be correlated and this relationship is known as correlation or co variation. Correlation works fairly simply, and a basic

understanding of it will be needed for the purposes of the relationships. If two asset classes are perfectly co-related they are said to have a correlation of '+1'. They would move in lockstep with each other, either up or down. A completely random correlation - a relationship wherein one asset's chance of going up is equal to the chance of dropping if the other asset rises or falls - is said to be a correlation of '0'. Finally if two asset classes move in exact opposition - for every upward movement of one there is an equal and opposite downward movement of another, and vice versa - they are said to be perfectly negatively correlated, or have a correlation of '-1'.

The correlation coefficient, in this context, measures the association between the returns of two securities. It ranges in value from 1 to -1. If one security's returns are higher than its average return when another security's returns are higher than its average return, for example, the correlation coefficient will be positive, somewhere between 0 and 1. Alternatively, if one security's returns are lower than its average return when another security's returns are higher than its average return, then the correlation coefficient will be negative. The correlation coefficient, by itself, is an inadequate measure of covariance because it measures only the direction and degree of association between securities' returns. It does not account for the magnitude of variability in each security's returns. Covariance captures magnitude by multiplying the correlation coefficient by the standard deviations of the securities' returns.

Markowitz Portfolio Selection

Markowitz showed that a portfolio's expected return is simply the weighted average of the expected returns of its component securities. A portfolio's variance is a more complicated concept, however. It depends on more than just the variances of the component securities. The variance of an individual security is a measure of the dispersion of its returns. It is calculated by squaring the difference between each return in a series and the mean return for the series, then averaging these squared differences. (The square root of the variance, or the standard deviation, is often used in practice because it measures dispersion in the same units the underlying return is measured in.)

Variance provides a reasonable gauge of a security's risk, but the average of the variances of two securities will not necessarily give a good indication of the risk of a portfolio comprising these two securities. The portfolio's risk depends also on the extent to which the two securities move together - that is, the extent to which their prices react in like fashion to a particular event.To quantify co-movement among security returns, Markowitz introduced the statistical concept of covariance. The covariance between two securities equals the standard deviation of the first times the standard deviation of the second times the correlation coefficient between the two. From this formulation of portfolio risk, Markowitz was able to offer two key insights. First, unless the securities in a portfolio are perfectly inversely correlated (i.e., have a correlation coefficient of 1), it is not possible to eliminate portfolio risk entirely through diversification. If we divide a portfolio equally among its component securities, for example, as the number of securities in the portfolio increases, the portfolio's risk will tend not toward zero but, rather, toward the average covariance of the component securities.

Second unless all the securities in a portfolio are perfectly positively correlated with each other (a correlation coefficient of 1), a portfolio's standard deviation will always be less than the weighted average standard deviation of its component securities. Consider, for example, a portfolio consisting of two securities, both of which have expected returns of 10 percent and standard deviations of 20 percent and which

are uncorrelated with each other. If we allocate portfolio assets equally between these two securities, the portfolio's expected return will equal 10 percent, while its standard deviation will equal 14.14 percent. The portfolio offers a reduction in risk of nearly 30 percent relative to investment in either of the two securities separately. Moreover, this risk reduction is achieved without any sacrifice of expected return.

It is noted that proper diversification and the holding of a sufficient number of securities can reduce the unsystematic component of portfolio risk to zero by averaging out the unsystematic risk of individual stocks. Systematic risk which, because it is determined by the market (index), cannot be eliminated through portfolio balancing. Thus, the Markowitz model attaches considerable significance to systematic risk and its most important measure, the coefficient of correlation. According to the model, the risk contribution to a portfolio of an individual stock can be measured with the other stock with the help of coefficient of correlation. Because efficient portfolios eliminate unsystematic risk, the riskiness of such portfolios is determined exclusively by market movements. Risk in an efficient portfolio is measured by the portfolio standard deviation. It is easy to see the central role played by the correlation coefficient in the determination of expected return and risk for stocks as well as portfolios. Some analysts have proposed using correlation coefficients to approach the problem of stock selection. In this approach the outlook for the market is assessed.

Formula for Markowitz Theory

$\square P = \{(X^2_x \square^{\square}_x + X^2_y \square^{\square}_y + 2X_x X_y (r_{xy} \square_x \square_y)\}^{½}$

$\square_P$ = Risk based on Standard Deviation

X_x = Percentage of total portfolio value in Stock X.

X_y = Percentage of total portfolio value in Stock Y.

$\square_x$ = Standard deviation of stock X.

$\square_y$ = Standard deviation of stock Y.

r_{xy} = Correlation coefficient of X and Y.

Assumptions of Markowitz Theory

The Modern Portfolio theory of Markowitz is based on the following assumptions:

1. Investors are rational and behave in a manner as to maximise their utility with a given level of income or money.
2. Investors have free access to fair and correct information on the returns and risk.
3. The markets are efficient and absorb the information quickly and perfectly.
4. Investors are risk averse and try to minimise the risk and maximise return.
5. Investors base decisions on expected returns and variance or standard deviation of these return from the mean.
6. Investors choose higher returns to lower returns for a given level of risk.

Case Study On Markowitz Theory

The sectors and the companies chosen for the study is based on their performance in the capital market. The following is the table to show the stock performance of the various companies in the previous year i.e. 2005-06:-

Most Active Securities during 2005-2006

Rank	Name of the Security	Turnover (Rs. crore)	% Share in Total Turnover	Market Capitalisation as on 31.3.2006 (Rs. crore)	% Share in Total Market Capitalisation
1	RELIANCE INDUSTRIES LTD	138736.97	8.84	110832.66	3.94
2	INFOSYS TECHNOLOGIES LTD	60164.44	3.83	81846.93	2.91
3	RELIANCE CAPITAL LTD	51599.66	3.29	10567.12	0.38
4	SATYAM COMPUTER SERVICES	49532.93	3.16	27506.42	0.98
5	STATE BANK OF INDIA	47645.92	3.04	50972.05	1.81
6	TATA STEEL LIMITED	37915.43	2.42	29693.82	1.06
7	TATA MOTORS LIMITED	29226.86	1.86	35547.47	1.26
8	OIL AND NATURAL GAS CORP.	28686	1.83	186989.85	6.65
9	TITAN INDUSTRIES LTD	24457.85	1.56	3712.79	0.13
10	TATA CONSULTANCY SERV LT	24070.68	1.53	93726.42	3.33
11	VIDESH SANCHAR NIGAM LTD	22761.02	1.45	13386.45	0.48
12	MARUTI UDYOG LIMITED	22642.79	1.44	25259.41	0.9
13	ITC LTD	22213.78	1.42	73282.32	2.6
14	SRF LTD	20586.79	1.31	2140.98	0.08
15	ICICI BANK LTD.	16713.53	1.06	52406.74	1.86
16	RANBAXY LABS LTD	15441.33	0.98	16103.92	0.57
17	ASTEEL AUTHORITY OF INDIA	15438.21	0.98	34344.28	1.22
18	SUZLON ENERGY LIMITED	13739.56	0.88	37442.34	1.33
19	LARSEN & TOUBRO LTD.	13245.21	0.84	33414.85	1.19
20	INDIAN PETROCHEMICALS COR	12961.66	0.83	6512.2	0.23
21	MCDOWELL & COMPANY LIMITE	12821.04	0.82	4253.46	0.15
22	HINDUSTAN LEVER LTD	12242.72	0.78	59874.92	2.13
23	WIPRO LTD	12030.29	0.77	79698.32	2.83
24	SESA GOA LTD	11890.21	0.76	5056.84	0.18
25	HDFC LTD	11395.92	0.73	33346.23	1.19
26	ASSOCIATED CEMENT CO LTD	10588.95	0.67	14526.95	0.52
27	NTPC LTD	9647.55	0.61	110571.68	3.93
28	RELIANCE ENERGY LTD	9522.76	0.61	12350.48	0.44
29	ZEE TELEFILMS LTD	9267.06	0.59	9858.87	0.35
30	MAHINDRA & MAHINDRA LTD	9174.91	0.58	15053.84	0.54
31	BHARTI TELE-VENTURES LTD	8968.84	0.57	78169.87	2.78
32	PUNJAB NATIONAL BANK	8804.63	0.56	14831.83	0.53
33	CENTURY TEXTILES LTD	8758.2	0.56	4137.74	0.15
34	BHEL	8725.4	0.56	54873.97	1.95
35	INDIABULLS FIN. SER. LTD.	8501.74	0.54	4093.76	0.15
36	BAJAJ AUTO LTD	8391.47	0.53	27787.52	0.99
37	HINDALCO INDUSTRIES LTD	8119.67	0.52	21187.44	0.75
38	INFRA. DEV. FIN. CO. LTD	7999.09	0.51	7475.54	0.27
39	INDUS DEV BANK OF IND LTD	7987.04	0.51	5666.52	0.2
40	GUJARAT AMBUJA CEMENT LTD	7832.39	0.5	13974.39	0.5

41	REL COMM VENTURES LTD	7517.65	0.48	37758.04	1.34
42	GAIL (INDIA) LTD	7360.66	0.47	26934	0.96
43	MAHANAGAR TELEPHONE NIGAM	7179.87	0.46	11573.1	0.41
44	HDFC BANK LTD	7137.59	0.45	24227.94	0.86
45	CIPLA LTD	6978.56	0.44	19858.91	0.71
46	SIEMENS LTD	6796.16	0.43	18805.38	0.67
47	ROLTA INDIA LTD	6683.16	0.43	1751.64	0.06
48	GATEWAY DISTRIPARKS LTD.	6477.77	0.41	2337.81	0.08
49	GRASIM INDUSTRIES LTD	6450.18	0.41	18907.23	0.67
50	I-FLEX SOLUTIONS LIMITED	6400.49	0.41	10096.59	0.36
	Total	**929,433**	**59**	**1,674,730**	**60**

DATA ANALYSIS AND INTERPRETATION

The abbreviations used in the following tables are as follows:

$\square_P$ = Risk based on Standard Deviation

X_x = Percentage of total portfolio value in Stock X.

X_y = Percentage of total portfolio value in Stock Y.

$\square_x$ = Standard deviation of stock X.

$\square_y$ = Standard deviation of stock Y.

r_{xy} = Correlation coefficient of X and Y.

CASES OF NEGATIVE CORRELATION

Case study of RIL & NIPPO BATERY

				RIL	NIPPO BATTERY
X%	**Y%**	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	-0.05	2.43	2.32
0.9	0.1	2.18770533			
0.8	0.2	1.97591255			
0.7	0.3	1.80538843			
0.6	0.4	1.68868162			
0.5	0.5	1.63734083			
0.4	0.6	1.65745154			
0.3	0.7	1.74654728			
0.2	0.8	1.89492227			
0.1	0.9	2.08998914			
0	1	2.32			

Note: Risk will be low at 50% of portfolio in RIL & 50% in Nippo Battery.

Case study of RIL & COLGATE

				RIL	COLGATE
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	-0.14	2.43	2.46
0.9	0.1	2.1662974			
0.8	0.2	1.93736795			
0.7	0.3	1.75685809			
0.6	0.4	1.64082657			
0.5	0.5	1.60333371			
0.4	0.6	1.64974296			
0.3	0.7	1.77347973			
0.2	0.8	1.95995269			
0.1	0.9	2.19321783			
0	1	2.46			

Note: Risk will be low at 50 % of portfolio in RIL & 50 % in Colgate.

Case study of RIL & LARSEN & TURBO

				RIL	L & T
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	-0.09	2.43	2.43
0.9	0.1	2.17861392			
0.8	0.2	1.96093623			
0.7	0.3	1.78931182			
0.6	0.4	1.67793216			
0.5	0.5	1.63912461			
0.4	0.6	1.67793216			
0.3	0.7	1.78931182			
0.2	0.8	1.96093623			
0.1	0.9	2.17861392			
0	1	2.43			

Note: Risk will be low at 50% of portfolio in RIL % 50% in Larsen & Turbo.

Case study of RIL & MARUTI

				RIL	MARUTI
X%	Y%	$\square_p$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	-0.07	2.43	2.48
0.9	0.1	2.18369878			
0.8	0.2	1.97234902			
0.7	0.3	1.808248			
0.6	0.4	1.70509265			
0.5	0.5	1.67418667			
0.4	0.6	1.71943042			
0.3	0.7	1.83520049			
0.2	0.8	2.00934334			
0.1	0.9	2.22821461			
0	1	2.48			

Note: Risk will be low at 50% of portfolio in RIL & 50% in MUL.

Case study of RIL & PIDILITE LTD.

				RIL	PIDILITE
X%	Y%	$\square_p$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	-0.06	2.43	5.47
0.9	0.1	2.22230136			
0.8	0.2	2.17273185			
0.7	0.3	2.29157611			
0.6	0.4	2.55544429			
0.5	0.5	2.92535246			
0.4	0.6	3.36652573			
0.3	0.7	3.85457145			
0.2	0.8	4.37382712			
0.1	0.9	4.91440976			
0	1	5.47			

Risk will be low at 80% of portfolio in RIL & 20% in Pidilite because of Standard deviation of Security Y is high in comparison of X.

5.2 CASES OF POSITIVE CORRELATION

Case Study of RIL & ESSAR OIL

				RIL	ESSAR OIL
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	0.2	2.43	4.28
0.9	0.1	2.31096677			
0.8	0.2	2.27541152			
0.7	0.3	2.32716364			
0.6	0.4	2.46072071			
0.5	0.5	2.66380649			
0.4	0.6	2.92195934			
0.3	0.7	3.22196999			
0.2	0.8	3.55325169			
0.1	0.9	3.9078597			
0	1	4.28			

Note: Risk will be low at 80 % of portfolio in RIL & 20% in Essar oil because of Standarc deviation of Essar oil is High in comparison of RIL.

Case study of RIL & BHEL

				RIL	BHEL
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	0.18	2.43	2.35
0.9	0.1	2.24125282			
0.8	0.2	2.08061549			
0.7	0.3	1.95502936			
0.6	0.4	1.87156384			
0.5	0.5	1.83597249			
0.4	0.6	1.85101896			
0.3	0.7	1.91551032			
0.2	0.8	2.02472734			
0.1	0.9	2.17193329			
0	1	2.35			

Note: Risk will be low at 50% of portfolio in RIL & 50% in BHEL.

Case study of RIL & INFOSYS

				RIL	INFOSYS
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	0	2.43	1.93
0.9	0.1	2.19549949			
0.8	0.2	1.98195156			
0.7	0.3	1.79684223			
0.6	0.4	1.64977211			
0.5	0.5	1.55159595			
0.4	0.6	1.51186904			
0.3	0.7	1.53513582			
0.2	0.8	1.61868218			
0.1	0.9	1.75391505			
0	1	1.93			

Note: Risk will be low at 40 % of portfolio in RIL & 60% in Infosys because of low standard deviation in Infosys in compare to RIL

Case study of RIL & KHAITAN ELECTRICAL

				RIL	KHAITAN ELEC.
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	0.12	2.43	4.03
0.9	0.1	2.27088191			
0.8	0.2	2.19198982			
0.7	0.3	2.20196371			
0.6	0.4	2.29964759			
0.5	0.5	2.47467654			
0.4	0.6	2.71211708			
0.3	0.7	2.99717269			
0.2	0.8	3.3175924			
0.1	0.9	3.66411035			
0	1	4.03			

Risk will be low at 80% of portfolio in RIL & 20% in Khaitan Elec. Because of high standard deviation in Khaitan Elec. In compare to RIL.

Case study of RIL & MC DOWELLS

				RIL	MC DOWELLS
X%	Y%	$\square_P$	r_{xy}	$\square_x$	$\square_y$
1	0	2.43	0.1	2.43	0.32
0.9	0.1	2.19043142			
0.8	0.2	1.95143926			
0.7	0.3	1.71326478			
0.6	0.4	1.47630376			
0.5	0.5	1.24125138			
0.4	0.6	1.00944183			
0.3	0.7	0.78375774			
0.2	0.8	0.57150258			
0.1	0.9	0.39495544			
0	1	0.32			

Risk will be low at 0% of portfolio in RIL & 100% in Mc Dowell's Because of low standard deviation in Mc Dowell's in Compare to RIL.

FINDINGS OF STUDY

With the above sample data analysis it has been observed that the risk is low when the portfolio has been comprising of securities having low correlation of returns with each other. The same has been developed in the theory of Markowitz and has been proved in the present study and with following samples.

1. Infosys having a zero correlation and standard deviation of 1.93 and the portfolio risk will be 1.51 with 40:60 proportion with RIL.

2. Colgate with -0.14 correlation and Standard deviation of 2.46 having a portfolio risk is 1.60 with 50:50 proportion with RIL.

3. Essar oil with 0.20 Correlation and 4.28 Standard deviation having a portfolio risk 2.27 with proportion of 80:20 with RIL.

4. Portfolio with Essar oil having the highest portfolio risk because of its standard deviation.

5. Mc Dowell's with 0.32 standard deviation having a least portfolio risk 0.32 and correlation of 0.10 with RIL in proportion of 0:100.

6. Case study of Colgate having a least risk in the negative correlation cases.

Correlation of RIL with other Securities

		Correlation
1	RIL	1.00
2	INFOSYS	0.00
3	L & T	(0.09)
4	NIPPO BATT.	(0.05)
5	MC DOWELL	0.10
6	BHEL	0.18
7	ESSAR OIL	0.20
8	MARUTI	(0.07)
9	COLGATE	(0.14)
10	PIDILITE	(0.06)
11	KHAITAN ELEC.	0.12

Standard Deviation of Different Securities

		Correlation
1	RIL	2.43
2	INFOSYS	1.93
3	L & T	2.43
4	NIPPO BATT.	2.32
5	MC DOWELL	0.32
6	BHEL	2.35
7	ESSAR OIL	4.28
8	MARUTI	2.48
9	COLGATE	2.46
10	PIDILITE	5.47
11	KHAITAN ELEC.	4.03

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