

# Risk Management: The Relevance of Markowitz theory in Portfolio Management

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### Abstract

*A portfolio is a group of financial assets such as stocks, bonds and cash equivalents, as well as their mutual, exchange-traded and closed-fund counterparts. Portfolios are held directly by investors and/or managed by financial professionals. Portfolio management is the art and science of making decisions about investment mix and policy, matching investments to objectives, asset allocation for individuals and institutions, and balancing risk against performance. The present study attempts to identify optimal portfolio which promises maximum returns for given risk by applying the Markowitz model. The study considers securities of Pharmaceutical and automobile industry in India and attempts to understand by applying the model the selection of optimal portfolio.*

### Introduction

A portfolio is a group of financial assets such as stocks, bonds and cash equivalents, as well as their mutual, exchange-traded and closed-fund counterparts. Portfolios are held directly by investors and/or managed by financial professionals. Portfolio management is the art and science of making decisions about investment mix and policy, matching investments to objectives, asset allocation for individuals and institutions, and balancing risk against performance. Portfolio management is all about strengths, weaknesses, opportunities and threats in the choice of debt vs. equity, domestic vs. international, growth vs. safety, and many other tradeoffs encountered in the attempt to maximize return at a given level of risk.

### Process of Portfolio Management

The Portfolio Management is a process which involves six stages. These stages include

1. Identification of goals and objectives of portfolio management.
2. Determination of optimal investment mix.
3. Customization of investment policy
4. Selection of investment
5. Monitoring of progress
6. Assessment of performance.

The first step in the process of portfolio management is identifying the goals and objectives of the portfolio. Each individual investor has his own goal which could be regular returns or capital appreciation. The portfolio mix also depends upon the objectives. The portfolio mix is based on the goals identified. The

### Keywords

*Expected Return, Portfolio,  
Markowitz theory, Risk  
Management*

next process is customizing the policy to the needs of the investment plan. The selection of investment is then

done. Once the selection process is complete the progress is monitored and then the goals may be reassessed.



### Objectives of the Study

1. To understand the optimal portfolio mix based on returns and risk factors.
2. To analyze returns of individual security and portfolio returns.
3. To analyze individual security risk and portfolio risk.

### Research Methodology

The data for the purpose of the study was collected from Bombay stock exchange website. The companies taken in the sample includes four companies two from pharmaceutical namely Dr. Reddy's Laboratories and Sun Pharmaceuticals and other two from Automobiles which include Hindustan Motors and Hero Honda. The study covers five years from 2006 to 2010. The Markowitz model has been used for analyzing individual returns and portfolio returns. The model was also used to analyze individual risk and portfolio risk. The study attempts to understand how individual risk varies with portfolio risk. The study also makes an attempt to analyze how portfolio returns vary from individual returns.

### Review of Literature

Zia Mohiuddin Ansari (2006) applied the theory of Markowitz and CAPM to study the efficient management of portfolio of ships and shipping securities. Marc A. Louargand (1992) Studied largest institutional portfolios on portfolio management practices relating to diversification strategies, risk measurement, and evaluation of investment returns with particular reference to pension funds and real estate portfolios. Chao Chen (2001) in his paper examines three important issues related to the relationship between stock returns and volatility. First, the relationship between individual stock returns and volatility is examined at the portfolio level. Second, the seasonality of the market returns volatility. Lastly, relationship between the size of portfolio returns and symmetrical reaction to the market volatility during business cycles is examined. It is found that the market volatility exhibits strong autocorrelation and small size portfolio returns exhibit seasonality. However, this phenomenon is not present in large size portfolios.

Carlos Castro (2010) in his article applied parametric portfolio policy approach to optimizing portfolios with large number of assets. The study attempts to test the importance of local factors in portfolio optimization. Holger Kraft (2007) works on the assumption that the investor and manager have homogenous expectations about the investment opportunity set.

### Markowitz model

Markowitz provided a conceptual framework for selection of an optimal portfolio. The model shows how an investor can construct an optimal portfolio. The optimal portfolio is constructed based on returns and risk factors. The model is based on the following assumptions.

1. An investor is basically risk averse.
2. The risk of a portfolio is estimated on the basis of variability of expected returns of the portfolio.
3. The decision of the investor for selection of the portfolio is made on the basis of expected returns and risk.
4. An investor attempts to get maximum return from the investment with minimum risk.

The formula for risk that is standard deviation for two securities is as follows

$$s_p = \sqrt{(X_1)^2(s_1)^2 + (X_2)^2(s_2)^2 + 2(X_1)(X_2)(r_{12})(s_1)(s_2)}$$

$s_p$  = Standard deviation of the portfolio return

$X_1$  = proportion of the portfolio invested in security 1

$X_2$  = proportion of the portfolio invested in security 2

$s_1$  = standard deviation of the return on security 1

$s_2$  = standard deviation of the return on security 2

$r_{12}$  = coefficient of correlation between the returns on securities 1 and 2

### Measuring the Expected Return

The expected return on a portfolio is the weighted average of the returns of individual assets, where each asset's weight is determined by its weight in the portfolio.

The formula is:

$$E(R_p) = [W_a \times E(R_a)] + [W_b \times E(R_b)]$$

Where

$E(R_p)$  = stands for expected Return on the portfolio

$W_a$  = Weight of asset n where n may stand for asset a, b...etc.

$R_a$  = Return on asset n where n may stand for asset a, b...etc

The data collected is analyzed by using these formulas and optimal portfolio is designed.

### Data Analysis & Inferences

#### Calculation Of Average Return Of Companies

$$\text{Average return} = \sum R/N$$

Table-1: Dr. Reddy's Laboratories Ltd

Year	Opening share price (P0)	Closing share price (P1)	(P1-P0)	(P1-P0)/ P0*100
2006	986	811.2	-174.8	-17.73
2007	814	735.35	-78.65	-9.66
2008	735	469.75	-265.6	-36.14
2009	475	1143.8	668.8	140.8
2010	1140	1662.55	522.55	45.84
<b>TOTAL RETURN</b>				<b>123.11</b>
<b>AVERAGE RETURN ( <math>\sum R/N</math> )</b>			123.11 / 5	<b>24.61</b>

Dr. Reddy's witnessed negative returns for the first three years from 2006 to 2008. The negative returns were highest for 2008 which was -36.14. The year 2009 has

registered highest returns which was 140.8%. In 2010 however the returns were 45.84%. The average returns of the company were 24.62%.

Table-2: Sun Pharmaceutical Industries Ltd

Year	Opening share price (P0)	Closing share price (P1)	(P1-P0)	(P1-P0)/ P0*100
2006	672	979	307	45.68
2007	985	1222.05	237.05	24.01
2008	1217.9	1064.95	-152.95	-12.56
2009	1070	1507.10	437.10	40.85
2010	1538	484.65	-1053.35	-68.49
<b>TOTAL RETURN</b>				<b>29.49</b>
<b>AVERAGE RETURN ( <math>\sum R/N</math> )</b>			29.49 / 5	<b>5.90</b>

In the year 2006 the returns of the company was 45.68% this has come down to 24.01% in 2007. The company registered a negative return in 2008. In 2009 the returns

were 40.85%. However in 2010 the returns turned negative. The average returns of the company were 5.9%.

Table-3: Hindustan Motors Ltd

Year	Opening share price (P0)	Closing share price (P1)	(P1-P0)	(P1-P0)/ P0*100
2006	30.50	34.00	3.50	11.48
2007	34.45	61.05	26.60	77.21
2008	61.30	13.08	-48.22	-78.66
2009	13.15	23.65	10.5	79.84
2010	24.00	24.40	0.40	1.67
<b>TOTAL RETURN</b>				
<b>AVERAGE RETURN (<math>\sum R/N</math>)</b>			91.54 / 5	<b>18.31</b>

The company registered negative returns only for the year 2008. For all the years the returns were positive. The year 2007 witnessed highest returns. The average returns were 18.31%.

Table-4: Hero Honda Motors Ltd

The company had negative returns for 2006 and 2007. From 2008 onwards the company had positive returns. The highest returns were witnessed for the year 2009. The average returns of the company were 24.91%.

**Measurement of Risk:  
Calculation of Standard deviation**

$$\text{Standard Deviation} = \sqrt{\frac{\text{Variance}}{n-1}}$$

$$\text{Variance} = \frac{1}{n-1} (\sum d^2)$$

Table-5 Dr. Reddy's Laboratories Ltd

Year	Return (R)	Avg. Return ( $R^-$ )	d=(R- $R^-$ )	D <sup>2</sup>
2006	-17.73	24.61	-42.35	1793.52
2007	-9.66	24.61	-34.28	1175.12
2008	-36.14	24.61	-60.76	3691.78
2009	140.8	24.61	116.18	13497.79
2010	45.84	24.61	21.22	450.29
<b>TOTAL</b>				<b><math>\sum d^2=20608.5</math></b>

$$\text{Variance} = \frac{1}{n-1} (\sum d^2) = \frac{1}{5-1} (20608.5) = 5152.13$$

$$\text{Standard Deviation} = \sqrt{\text{Variance}} = \sqrt{5152.13} = 71.78$$

The standard deviation of the company is 71.78. This shows the company has highest risk factor.

Table-6: Sun Pharmaceutical Industries Ltd

Variance =  $1/n-1 (\sum d^2) = 1/5-1 (9006.56) = 2251.64$

Standard Deviation =  $\sqrt{\text{Variance}} = \sqrt{2251.64} = 47.45$

The standard deviation is 47.45 and variance is 2251.64. The risk is lower when compared to Dr. Reddy's laboratories.

Table-7: Hindustan Motors Ltd

Year	Return (R)	Avg. Return (R <sup>-</sup> )	D = (R-R <sup>-</sup> )	D <sup>2</sup>
2006	11.48	18.31	-6.83	46.65
2007	77.21	18.31	58.9	3469.21
2008	-78.66	18.31	-96.97	9403.18
2009	79.84	18.31	61.53	3785.94
2010	1.67	18.31	-16.64	276.89
<b>TOTAL</b>				<b>Σ d<sup>2</sup>=16981.87</b>

Year	Return (R)	Avg. Return (R <sup>-</sup> )	d = (R-R <sup>-</sup> )	D <sup>2</sup>
2006	45.68	16.98	28.7	823.69
2007	24.07	16.98	7.09	50.26
2008	-12.56	5.90	-18.46	340.77
2009	40.85	5.90	34.95	1221.50
2010	-68.49	5.90	-74.39	5533.87
<b>TOTAL</b>				<b>Σ d<sup>2</sup>=9006.56</b>

Table-8: Hero Honda Motors Ltd

Year	Return (R)	Avg. Return (R <sup>-</sup> )	d = (R-R <sup>-</sup> )	D <sup>2</sup>
2006	-11.35	24.91	-36.26	1314.79
2007	-8.20	24.91	-33.11	1096.27
2008	15.34	24.91	-9.57	91.58
2009	114.56	24.91	89.65	8037.12
2010	14.21	24.91	-10.7	114.19
<b>TOTAL</b>				<b>Σ d<sup>2</sup>=10653.95</b>

Variance =  $1/n-1 (\sum d^2) = 1/5-1 (10653.95) = 2663.49$

Standard Deviation =  $\sqrt{\text{Variance}} = \sqrt{2663.49} = 51.61$   
 The standard deviation is 51.61 and variance is 2663.49. The risk is lower when compared to Hindustan Motors Ltd.

**Calculation of Correlation between two Companies**

Covariance (COVab) =  $1/(n-1) (\sum dx.dy)$   
 Correlation of coefficient =  $\text{COVab} / s_x * s_y$

Table-9: Dr. Reddy's Laboratories Ltd & Sun Pharmaceutical Industries Ltd

$$COV_{ab} = 1/(5-1)(1298.08) = 324.52$$

$$\text{Correlation of coefficient} = 324.52/71.78 \times 47.45 = .01$$

The coefficient of correlation is .01. Indicating that, there is minimum correlation between the two.

Table-10 Hindustan Motors Ltd & Hero Honda Motors Ltd

YEAR	Dev. Of Hindustan Motors Ltd (dx)	Dev. Of Hero Honda Motors Ltd (dy)	Product of dev. (dx)(dy)
2006	-6.83	-36.26	247.66
2007	58.9	-33.11	-1950.18
2008	-96.97	-9.57	928.01
2009	61.53	89.65	5516.16
2010	-16.64	-10.7	178.05
<b>TOTAL</b>			$\sum dx. dy = 4919.7$

$$COV_{ab} = 1/(5-1)(4919.7) = 1229.93$$

$$\text{Correlation of coefficient} = 1229.93/65.16 \times 51.61 = 0.36$$

The correlation of Hindustan Motors Ltd & Hero Honda Motors Ltd is 0.36.

#### Calculation of Portfolio Weights

Deriving the minimum risk portfolio, the following formula is used:

$$W_A = \frac{(s_b)^2 - r_{ab}(s_a)(s_b)}{(s_a)^2 + (s_b)^2 - 2r_{ab}(s_a)(s_b)}$$

Where,

X<sub>a</sub> is the proportion of security A

X<sub>b</sub> is the proportion of security B

s<sub>a</sub> = standard deviation of security A

s<sub>b</sub> = standard deviation of security B

r<sub>ab</sub> = correlation co-efficient between A&B

#### Dr. Reddy's Laboratories Ltd & Sun Pharmaceutical Industries Ltd

$$X_a = \frac{(47.45)^2 - (0.01)(71.78)(47.45)}{(71.78)^2 + (47.45)^2 - 2(0.01)(71.78)(47.45)}$$

$$= 0.30$$

$$X_b = 1 - X_a$$

$$= 1 - 0.30$$

$$= 0.70$$

#### Calculation of Portfolio Weights

##### Hindustan Motors Ltd & Hero Honda Motors Ltd

Deriving the minimum risk portfolio, the following formula is used:

$$W_A = \frac{(s_b)^2 - r_{ab}(s_a)(s_b)}{(s_a)^2 + (s_b)^2 - 2r_{ab}(s_a)(s_b)}$$

Where,

X<sub>a</sub> is the proportion of security A

X<sub>b</sub> is the proportion of security B

s<sub>a</sub> = standard deviation of security A

s<sub>b</sub> = standard deviation of security B

r<sub>ab</sub> = correlation co-efficient between A&B

$$X_a = \frac{(51.61)^2 - (0.036)(65.16)(51.61)}{(65.16)^2 + (51.61)^2 - 2(0.036)(65.16)(51.61)}$$

$$= 0.32$$

$$X_b = 1 - X_a$$

$$= 1 - 0.32$$

$$= .68$$

### Calculation of Portfolio Return

$$R_p = W_1 R_1 + W_2 R_2 \text{ (for two securities)}$$

Where,

W1, W2 are the weights of the securities

R1, R2 are the Expected returns

### Dr. Reddy's Laboratories Ltd & Sun Pharmaceutical Industries Ltd

$$R_p = (0.30)(24.61) + (0.70)(5.9)$$

$$= 11.51$$

### Hindustan Motors Ltd & Hero Honda Motors Ltd

$$R_p = (0.32)(18.31) + (0.68)(24.91)$$

$$= 22.8$$

The combination of Hindustan Motors Ltd & Hero Honda Motors Ltd is more when compared to Dr. Reddy's Laboratories Ltd & Sun Pharmaceutical Industries Ltd. However decision cannot be taken only by returns the portfolio risk also should be analyzed.

### Portfolio Standard Deviation:

#### Calculation of Portfolio Risk

##### For two securities

$$s_p = \sqrt{s_a^2(X_a)^2 + s_b^2(X_b)^2 + 2r_{ab}s_a s_b X_a X_b}$$

Where,

$s_p$  = portfolio risk

$X_a$  = proportion of investment in security A

$X_b$  = proportion of investment in security B

$R_{12}$  = correlation co-efficient between security 1 & 2

$s_a$  = standard deviation of security 1

$s_b$  = standard deviation of security 2

The portfolio standard deviation of Dr. Reddy's Laboratories Ltd & Sun Pharmaceutical Industries Ltd is

$$\begin{aligned} s_p &= \sqrt{(71.78)^2(0.30)^2 + (47.45)^2(0.70)^2 + 2(0.01)(71.78)(47.45)(0.30)(0.70)} \\ &= \sqrt{2997.45} \\ &= 54.75 \end{aligned}$$

The combined risk is 54.75 and return of the portfolio is 11.51%.

Calculation of portfolio risk for Hindustan Motors Ltd & Hero Honda Motors Ltd

$$\begin{aligned} s_p &= \sqrt{(65.16)^2(0.32)^2 + (51.61)^2(0.68)^2 + 2(0.36)(65.16)(51.61)(0.32)(0.68)} \\ &= \sqrt{2193.28} \\ &= 46.83 \end{aligned}$$

The combined risk of Hindustan Motors Ltd & Hero Honda Motors Ltd is 46.83 and combined returns are 22.8. Therefore this is optimal portfolio as per Markowitz theory.

### Conclusion:

The study revealed that portfolio risk can be minimized and returns can be maximized by proper selection of portfolio. The Markowitz theory helps in selecting a portfolio with maximum returns and minimum risk. The theory helps in management of risk through proper selection of portfolio. The standard deviation of Dr. Reddy's is 71.78 and for Sun Pharmaceuticals is 47.45. The combined standard deviation is 54.75. The individual returns of Dr. Reddy's and Sun Pharmaceuticals are 24.61 and 5.9 respectively. The portfolio returns of the same are 11.51. This portfolio does not promise returns as per the risk involved therefore cannot be taken as ideal portfolio. The standard deviation of Hindustan Motors is 65.16 and for Hero Honda is 51.61. The combined standard deviation is 46.83. The individual returns of Hindustan Motors and Hero Honda are 18.31 and 24.91 respectively. The portfolio returns are 22.8. This is an ideal portfolio as it promises more returns and risk is less when compared with the portfolio of Dr. Reddy's and Sun Pharmaceuticals. The study therefore proves that Markowitz model helps in management of risk and selection of ideal portfolio.

### References

- Ansari Mohiuddin Zia, Portfolio Risk Management in Shipping real assets and shipping security assets, Erasmus University Rotterdam, 2006.
- Caster Carlos, "Portfolio Choice Under Local Industry and Country Factors" Swiss Society for financial markets 12<sup>th</sup> October 2010.
- Chow G., Jacquier E., Kritzman M., and K. Lowry (1999) "Optimal Portfolios in Good Times and Bad Times" *Financial Analysts Journal*, vol. 55, no.3, (March/June): 65-73.
- Donald E. Fischer, Ronald J. Jordan, SAPM, 1999, Sixth Edition, *Portfolio Analysis*, page no: 559-588.
- Dybvig, P., Farnsworth, H.K., Carpenter, J.N. "Portfolio performance and agency" Working Paper, Washington University in Saint Louis (2001)
- Kraft Holger, Continuous – Time delegated portfolio management with homogenous expectations: can an agency conflict be avoided, Swiss Society for financial markets, 2007.
- Louargand A. Marc, A survey of pension fund real estate portfolio risk management practices, Centre for real estate, Massachusetts Institute of technology, Cambridge, July 1992.

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Punithavathy Pandian, *Security Analysis & Portfolio Management*, 2007, Portfolio Markowitz Model, page no: 329-349.

Prasanna Chandra, *Investment Analysis & Portfolio Management*, 2006, Second edition, Portfolio Return & Risk, page no: 244-251.

Rustagi R. P., *Investment Management*, Sultan Chand & Sons, New Delhi, 2005

Zhou Guo Zhong, Chen Chao, *Portfolio returns, Market volatility and seasonality* Kluwar Academic Publishers, Netherlands, 2001.