Interrelationship between Sharpe Index Model and Portfolio – Markowitz Model in the Context of Correlation Coefficient and Market Variance

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Abstract:

Problem: There are different types of market that do exist which are Monopsony, Duopsony and Oligopsony. If one buyer exists, then it is called as Monopsony. If two buyers are present, then it is called Duopsony. If more than two buyers exist then it is called as Oligopsony. In the same way there are different markets which are classified based on the number of sellers. If number of seller is one then it is called as Monopoly. If the number of sellers is two, then such situation is called as Duopoly. A situation where the number of sellers is more than two is called as Oligopoly. In the context of Duopoly, there are many companies which are present in the market. When analysis of these companies is done it is generally observed that the theories used are Portfolio Markowitz Model. In this model, details of assets with respect to their $\beta$ values, $\sigma$ values and correlation coefficient are collected and the final analyses with respect to proportions are made. These proportions help in dividing the available funds in the market. Similarly there is one more theory called, Sharpe Index Model which deals with stocks when the investment is huge i.e. for more than two shares. If the Sharpe Index Model is considered for two stocks than it gives important results This paper deals with identifying effects on parameters Correlation Coefficient and Market Variance which arises when the Sharpe Index Model and Portfolio Markowitz Model are equated under Duopoly Market where the numbers of stocks are two only. Design/Methodology/Approach: Applied Research Design, Convenienace Sampling, Theoretical Approach Findings: The value of correlation coefficient is $r_{12} = \frac{\beta_1\beta_2}{\sigma_1\sigma_2}$ Conclusion: Further application of theories of complex numbers in identifying standard deviation and variance with respect to market can be new scope of research. Keywords: Sharpe Index Model, Portfolio Markowitz Model, Correlation Coefficient

Introduction: Return and risk decides the direction of portfolio movement. This statement holds well under the purview of Portfolio Markowitz model. If there are two stocks, the risk and return are calculated by using Portfolio Markowitz model. Another theory which is most commonly used is Sharpe Index Model. Sharpe Index Model is used with respect to Market return. Specific coefficients of Market return with respect to Specific stock are calculated. When these two theories are put at equilibrium with respect to two stocks, different formula originates with respect to coefficient of correlation.
Literature Review:

1. Portfolio is an important parameter for any investor. Under the Portfolio, Investor constructs a collection of different stocks. These stocks in turn provide security to the investors. The investors generally construct portfolio so that they can get more return on less risk. The utility of portfolio construction lies with the theme that it can be used to know whether an investor is risk bearer, risk tolerant or risk recessive. These kind of portfolio investors help the brokerages to deal with insolvable times where brokerages know who is ready to take risk at crash of the market. [oliynyk, viktor & Kozmenko, Olga. (2019)]

2. Portfolio Construction is an important process. This process consists of different stages. At early stage, the need of investment is taken into consideration. Need and objectives of the investment are made clear. These need and objectives define the purpose and way of investment. Purpose of investment is the key factor in analyzing how and when the returns will come back. If the purpose is for short term, then the strategies would differ from the long term purpose.] Portfolio construction for different people are different. This construction differs from different factors point of view. In general short term investment and long term investments are taken into consideration and the process is initiated. [Krishnamoorthy N, Mahabub Basha. (2002)].

3. Under the process of portfolio construction, after deciding the need and objectives of the investment, different avenues are listed along with their risk and return parameters. Then out of these avenues, some are selected. Selection is based on the choices and situations in which the investor is trying to build the portfolio. Selection is truly based on priority towards the future aspects, present situation and past experience. Based on this selection, allocation of the fund is done [Block Frank E (1969).]

4. After allocation of the funds, the total fund is distributed amongst the avenues for certain period of time. This time duration depends on short goals or long term goals. Generally two things come up in this particular regard one is the tactics and another one is the strategy. In tactics short term investment is taken seriously mainly intraday trade etc. Under Strategy, long term investments are carried out. Retirement plans, availability of funds and cash at ease during old ages etc [Kabir Md. Enamul (2017)].

5. For different proportion of investment, different theories are used. Investor always has many options with respect to selecting the stocks. These kind of selections would bring different outcomes. The choice of what kind of stocks and especially how many stocks to be purchased depends with the investor. If the investor selects more than one stock wherein the investor is selecting only two stocks to invest, Portfolio Markowitz theory is used. [Nukula, Vasishta Bhargava, Prasada Rao, S.S. (2021)].

6. Risk is one of the investment parameter whose presence is inevitable. Any kind of investment, always deals with someway of the risk factor. Sometimes it can be as high as possible or as low as possible. When it comes to Risk, there are two types of risks associated with the market. These are Systematic Risk and Unsystematic Risk. Under the systematic risk is the market risk associated broadly on the factors that run the market. Forces which run the market have a direct influence on the Systematic Risk. [Shukla Ajay, Kukreja Kegha (2014)].

7. Unsystematic Risk are the risks which are unique to the company. These risks are the risks which arise due to the internal factors prevalent within the organization. Company decisions, working culture, administrative styles etc determine Unsystematic Risk. Unsystematic Risk is also called as Unique Risk. [Cox, Larry. A, Griepentrog Gary. L. (1988)].

8. Measurement of Risk: There are different techniques to measure the risk factor. In these lines, Mathematical Statistics is used. Under Mathematical Statistics, application of Probability techniques are done in order to analyze the statistical data. [Jokhadze Valeriane, Schmidt Wolfgang M. (2020)]

9. [Virat V. Acharya and others (2017)] Formula for evaluating Systematic Risk: It is also known as on Diversifiable risk wherein the risk calculated with the help of the following formula:

\[
E_r = R_f + \beta(R_m - R_f)
\]
where

- \( E_r \) = Expected return of the security
- \( R_f \) = Risk free rate
- \( R_m \) = Return of the market portfolio
- \( \beta \) = Systematic Risk

10. There are many noted ratios which add to the understanding of the Portfolio. These ratios help in analyzing the portfolio to such an extent that it helps in knowing the factors which have affected the portfolio. Amongst these ratios, they are Sharpe’s Ratio, Treynor’s Ratio and Jensen’s Alpha [Cogneau, Philippe & Hubner, Georges. (2009)]

11. [Schmid, Friedrich & Schmidt, Rafael (2009) ] Sharpe’s Ratio: it is a ratio which gives an important update regarding to what extent return on investment has been there on the risk free rate of return with respect to the standard deviation of an investment distribution. The formula used for the analysis of this particular ratio is

\[
\text{Sharpe’s Ratio} = \frac{R_p - R_f}{\sigma_p}
\]

where \( R_p \) = Expected Portfolio Return
- \( R_f \) = Risk free rate of return
- \( \sigma_p \) = Standard Deviation of Portfolio

12. [Hubner, Georges, The Generalized Treynor Ratio: A Note (2003)] Treynor’s Ratio: It is the ratio which gives relevant information on the return on risk free rate of return with respect to the beta coefficient of the portfolio. The formula used for the analysis of this particular ratio is:

\[
\text{Treynor’s Ratio} = \frac{R_p - R_f}{\beta}
\]

where \( R_p \) = Expected Portfolio Return
- \( R_f \) = Risk free rate of return
- \( \beta \) = Beta of the portfolio

13. [Happy Catherine, Robiyanto Robiyanto (2020)] Jensen’s Alpha: It is a parameter which tells to what extent is the performance of the portfolio for a particular risk involved. Jensen’s Alpha can be calculated by the following formula:

\[
\text{Jensen’s Alpha} = R_p - [R_f + \beta_p (R_m - R_f)]
\]

where
- \( R_p \) = Expected Portfolio Return
- \( R_f \) = Risk Free Rate
- \( \beta_p \) = Beta of the portfolio
- \( R_m \) = Expected Market Return

14. Sharpe Index Model: It is one of the most important models used for the analysis under portfolio investments. In this model variance of the portfolio is calculated with the help of expected market variance, amount of portion of stock to be used in investment, Beta coefficient of the stock and residual variance. [Nagendra, Marishetty (2012)]

15. [Dr. Aloysius Edward J. and Prof. Jagadish K.K (2020)] Formula of Sharpe Index Model: According to Sharpe Index Model:

\[
\sigma_p^2 = \left( \sum X_i \beta_i \right)^2 \sigma_{m}^2 + \sum X_i^2 e_i^2 \text{ for } i=1 \text{ and } i=N
\]

where
- \( \sigma_p^2 \) = Variance of Portfolio
- \( \sigma_m^2 \) = Expected Market Variance of Index
- \( e_i^2 \) = Residual Variance
- \( X_i \) = Portion of Stock in the portfolio
- \( \beta_i \) = Beta Coefficient of i\text{th} Stock
16. Future aspects of Sharpe Index Model: Sharpe Index Model acts as a bridge from traditional approach to modern approach. Utility of Sharpe Index model can be seen in building such portfolios where Residual Variance is almost nil. [Ujwala Chitre, Dr Yogesh Puri (2021)]

17. There are many other Portfolio Evaluating Models have been listed in order to evaluate the Optimal Portfolio for a given set of funds and proportion. [Lekovic, Milijan. (2021)]

18. Capital Asset Pricing Model: It is a model which helps in estimating risk and expected return’s relationship. Basically there are assumptions, which are being formulated in order to build the Capital Asset Pricing Model. One is that the investors are risk averse, with freedom of borrowing and lending at a risk free rate of interest. The condition of market is perfect where entry and exit is applicable. [Rossi, Matteo. (2016)]

19. There are many such parameters which are often associated with Capital Asset Pricing Model such as Expectations of investor with respect to the market, direct or indirect tax that has to be filled, costs incurred during the transactions. To take care of this, a statement is made where apart from assumptions, homogeneous expectations, taxes, transaction costs are nullified. Investors are more interested in maximizing returns in a given period of time. [Rossi, Matteo. (2016.).]

20. [Valeed A Ansari (2000)] The formula used under the CAPM model:

\[ E(R_i) = R_f + [E(R_m) - R_f/\sigma_m^2] \sigma_{im} \]

where

- \( E(R_i) \) = Expected return on security \( i \)
- \( R_f \) = Risk Free Return
- \( E(R_m) \) = Expected return on Market Portfolio
- \( \sigma_m^2 \) = Variance of return on market portfolio
- \( \sigma_{im} \) = Covariance of returns between security \( i \) and security \( m \)

21. When it comes to Capital Asset Pricing Model, there are two lines which are very important. One is SML and another one is CML. Security Market Line is a graphical line which represents relationship between expected return and covariance of \( I \) and \( M \) security. [James R. Garven (1988)]

22. [Chinh Duc Pham, Le Tan Phuoc (2020)] One of the striking factors which contribute to the CAPM theory is the utility of \( \beta \) measure. \( \beta \) is measured by using

\[ \beta = \frac{\sigma_{im}}{\sigma_m^2} \]

The measure of \( \beta \) gives the estimate of slope of the regression line

23. The major drawback of CAPM is that some security can get high returns from the market after adjusting with the returns of the market index. It also adds other that the risk factor is not measured wholly. [Pankaj Chaudhary (2016)]

24. In order to overcome the drawbacks of CAPM, APT was framed. [Gregory Connor, Robert A. Korajczyk (1986)]

25. [M. Ali Khan, Yeneng Sun (1997)] Arbitrage Pricing Theory is a theory developed by Stephen Ross where number of factors is included with respect to different returns. The formula of Arbitrage Pricing Theory is:

\[ R_i = a_0 + a_1 b_{i1} + a_2 b_{i2} + a_3 b_{i3} + \ldots + a_j b_{ij} \]

Where \( R_i = \) average Expected return
- \( a_1 \) = sensitivity of return to \( b_{i1} \)
- \( b_{i1} \) = beta Coefficient relevant to a factor.

26. The drawback of APT is that it uses different factors together which is difficult to gather data. All the factors which are taken for analysis are many times difficult to get the required data. On such cases analysis becomes difficult. Apart from getting the data, another challenge is calculation. Taking all factors into consideration and then calculating becomes tedious work. Due to this many times this theory is not used. [Gur Huberman (1982)]
27. [Mangram, Myles. (2013)] The formula used for the calculation of Portfolio Standard Deviation under Portfolio Markowitz model is 
\[ \sigma_p = \sqrt{X_1^2\sigma_1^2 + X_2^2\sigma_2^2 + 2X_1X_2\sigma_1\sigma_2r_{12}} \]
where 
\( \sigma_p \) = Portfolio Standard Deviation 
\( X_1 = \) Percentage of Portfolio value in the Stock X
\( X_2 = \) Percentage of Portfolio value in the Stock X
\( \sigma_1 = \) Standard Deviation of Stock X
\( \sigma_2 = \) Standard Deviation of Stock X 
\( r_{12} = \) Correlation Coefficient between X

28. Future Aspects of Portfolio Markowitz Model: [Kambholiya, Krishna. (2020)]

29. Correlation Coefficient is very important when the Portfolio Markowitz model is used. Correlation Coefficient is the parameter which tells whether there is any relationship between two variables or not. [Richard Taylor (1990)]

30. [Jie Wu, Na li, Yan Zhao, Julie Wang (2022)] Correlation Coefficient is the parameter which justifies dependent variable and independent variable. X is generally taken as independent variable and Y is taken as dependent variable.

Formula for Correlation Coefficient is: 
\[ r_{12} = \frac{n\sum XY - \sum X \sum Y}{\sqrt{n\sum X^2 - (\sum X)^2}[n\sum Y^2 - (\sum Y)^2]} \]

Another Formula for Correlation Coefficient is 
\[ r_{12} = \frac{Covariance \ of \ X_{12}}{\sigma_1 \sigma_2} \]

31. Covariance is a parameter which determines the associated variance between two parameters X and Y. Covariance determines the associated difference between two variables which are running under regression relationship with each other. [Garcia Asuero, Agustin & Sayago, Ana & Gonzalez, Gustavo, (2006)]

32. Variance of 1st stock and 2nd stock has to be calculated. Variance will lead to measurement of standard deviation of the both the stocks. Calculating variance of both the stocks help in making the understanding much better as compared to other parameters. [Richard G. Brereton (2018)]

33. Standard Deviation of 1st stock and 2nd stock are very important part of Portfolio Markowitz model. Standard Deviation with respect to all stocks helps in analyzing the variance of the entire portfolio. [Lee, Dong & In, Junyong & lee, Sangseok (2015)]

Objectives:
1. To Study the Sharpe Index Model
2. To Study the Portfolio Markowitz Model
3. To Study the interrelationship between Sharpe Index Model and Portfolio Markowitz Model
4. To Study Correlation Coefficient Formula by Equating Sharpe Index Model and Portfolio Markowitz Model
5. To study Market Variance under different values of Correlation Coefficient by equating Sharpe Index Model and Portfolio Markowitz Model.

Theoretical Framework:
According to Sharpe Index Model: 
\[ \sigma_p^2 = (\sum X_i \beta_i)^2 \sigma_m^2 + (\sum X_i \varepsilon_i)^2 \] for i=1 and i=N
where 
\( \sigma_p^2 = \) Variance of Portfolio 
\( \sigma_m^2 = \) Expected Market Variance of Index 
\( \varepsilon_i^2 = \) Residual Variance 
\( X_i = \) Portion of Stock in the portfolio 
\( \beta_i = \) Beta Coefficient of ith Stock 

Above formula’s form gets changed when limit is taken from i=1 to i=2
\[ \sigma^2 = (X_1 \beta_1 + X_2 \beta_2)^2 \sigma^2_m + (X_1^2 \varepsilon_1^2 + X_2^2 \varepsilon_2^2) \]

According to Portfolio Markowitz Model:
\[ \sigma_p^2 = \sqrt{(X_1^2 \sigma_1^2 + X_2^2 \sigma_2^2 + 2X_1X_2 \sigma_1 \sigma_2 \rho_{12})} \]

where
\[ \sigma_p = \text{Portfolio Standard Deviation} \]
\[ X_1 = \text{Percentage of Portfolio value in the Stock X} \]
\[ X_2 = \text{Percentage of Portfolio value in the Stock X} \]
\[ \sigma_1 = \text{Standard Deviation of Stock X} \]
\[ \sigma_2 = \text{Standard Deviation of Stock X} \]
\[ \rho_{12} = \text{Correlation Coefficient between X_1 and X_2} \]
\[ \sigma_{p2}^2 = (X_1^2 \sigma_1^2 + X_2^2 \sigma_2^2 + 2X_1X_2 \sigma_1 \sigma_2 \rho_{12}) \]

Comparing Left hand Side with Right Hand Side
\[ \beta_1^2 \sigma_1^2 + \varepsilon_1^2 = \sigma_1^2 \]
\[ \beta_2^2 \sigma_2^2 + \varepsilon_2^2 = \sigma_2^2 \]
\[ \beta_1 \beta_2 \sigma_{m2} = \sigma_{12} \]
\[ \sigma_1^2 = \sqrt{\beta_1^2 \sigma_1^2 + \varepsilon_1^2} \]
\[ \sigma_2^2 = \sqrt{\beta_2^2 \sigma_2^2 + \varepsilon_2^2} \]
\[ \rho_{12} = \beta_1 \beta_2 \sigma_{m2} / \sigma_1 \sigma_2 \]

Substituting (3) in (4)
\[ \text{Covariance} = \beta_1 \beta_2 \sigma_{m2} \]
\[ \beta_1^2 \sigma_1^2 + \varepsilon_1^2 = \sigma_1^2 \]
\[ \sigma_{m2} = (\sigma_1^2 - \varepsilon_1^2) / \beta_1^2 \]
\[ \beta_2^2 \sigma_2^2 + \varepsilon_2^2 = \sigma_2^2 \]
\[ \sigma_{m2} = (\sigma_2^2 - \varepsilon_2^2) / \beta_2^2 \]

from (5) and (6)
\[ (\sigma_1^2 - \varepsilon_1^2) / \beta_1^2 = (\sigma_2^2 - \varepsilon_2^2) / \beta_2^2 \]
\[ (\sigma_1^2 - \varepsilon_1^2) \beta_2^2 / (\sigma_2^2 - \varepsilon_2^2) \beta_1^2 = 1 \]
Table 1: Statistical Parameters

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Standard Deviation</th>
<th>Variance of each Stock</th>
<th>Correlation Coefficient</th>
<th>Covariance</th>
<th>Variance of the Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$\sigma_1 = \sqrt{\beta_1^2 \sigma_m^2 + e_1^2}$</td>
<td>$\sigma_1^2 = \beta_1^2 \sigma_m^2 + e_1^2$</td>
<td>$r_{12} = \beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2$</td>
<td>Cov = $\beta_1 \beta_2 \sigma_m^2$</td>
<td>$\sigma_m^2 = (\sigma_1^2 - e_1^2) / \beta_1^2$</td>
</tr>
<tr>
<td>2</td>
<td>$\sigma_2 = \sqrt{\beta_2^2 \sigma_m^2 + e_2^2}$</td>
<td>$\sigma_2^2 = \beta_2^2 \sigma_m^2 + e_2^2$</td>
<td></td>
<td></td>
<td>$\sigma_m^2 = (\sigma_2^2 - e_2^2) / \beta_2^2$</td>
</tr>
</tbody>
</table>

Special Cases:

1. When $r_{12} = 1$
   
   $\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = 1$
   
   $\sigma_m^2 = \sigma_1 \sigma_2 / \beta_1 \beta_2$
   
   $\sigma_m = \sqrt{\sigma_1 \sigma_2 / \beta_1 \beta_2}$
   
   From (7) and (8)
   
   $\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = (\sigma_1^2 - e_1^2) / (\sigma_2^2 - e_2^2) \beta_1^2$
   
   $\sigma_m^2 = \sigma_1 \sigma_2 (\sigma_1^2 - e_1^2) / (\sigma_2^2 - e_2^2) \beta_1^2$

2. When $r_{12} = -1$
   
   $\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = -1$
   
   $\sigma_m = \sqrt{-\sigma_1 \sigma_2 / \beta_1 \beta_2}$
   
   From (7) and (10)
   
   $\sigma_m^2 = -\sigma_1 \sigma_2 (\sigma_1^2 - e_1^2) / (\sigma_2^2 - e_2^2) \beta_1^2$

3. When $r_{12} = 0$
   
   $\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = 0$

Table 2: Conditions of Correlation Coefficient

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Conditions of Correlation Coefficient</th>
<th>Formula for $\sigma_m^2$</th>
<th>Formula for $\sigma_m^2$</th>
<th>Formula for $\sigma_m$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$r_{12} = 1$</td>
<td>$\sigma_m^2 = \sigma_1 \sigma_2 (\sigma_1^2 - e_1^2) / (\sigma_2^2 - e_2^2) \beta_1^3$</td>
<td>$\sigma_m^2 = \sigma_1 \sigma_2 / \beta_1 \beta_2$</td>
<td>$\sigma_m = \sqrt{\sigma_1 \sigma_2 / \beta_1 \beta_2}$</td>
</tr>
<tr>
<td>2</td>
<td>$r_{12} = -1$</td>
<td>$\sigma_m^2 = -\sigma_1 \sigma_2 (\sigma_1^2 - e_1^2) / (\sigma_2^2 - e_2^2) \beta_1^3$</td>
<td>$\sigma_m^2 = -\sigma_1 \sigma_2 / \beta_1 \beta_2$</td>
<td>$\sigma_m = \sqrt{-\sigma_1 \sigma_2 / \beta_1 \beta_2}$</td>
</tr>
<tr>
<td>3</td>
<td>$r_{12} = 0$</td>
<td>$\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = 0$</td>
<td>$\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = 0$</td>
<td>$\beta_1 \beta_2 \sigma_m^2 / \sigma_1 \sigma_2 = 0$</td>
</tr>
</tbody>
</table>

Research Methodology:

Research Design: Applied Research: Firstly the theoretical background is developed with the help of

Type of Data: Secondary Data: The available data has been recorded from the relevant source. The closing
price of the company stock has been taken for analysis.

Source: www.nse.com
Sampling Design: Convenience Sampling
Sampling Size: 414;
Sample Size: 
**Cochran’s Formula:** \( \frac{Z^2}{4e^2} \)
Cochran’s Formula: \(1.96*1.96*4(0.05)^2\)
Sample Size = 384.15
Interpretation: Past one month data has been taken for the analysis. The timeline for data collection was from 17th May to 16th June 2023. Totally the data was collected for 23 days. 384 divided by 23 gives the value up to 16.69 rounding till 17. As the paper deals with two sellers in the market, so to bring even numbers for analysis 18 companies where taken up. This makes a total of 414 (23 X18). Total of 414 samples have been taken for collection and analysis.

**Data Collection:** There are 18 different data sets which have been collected. Based on the data, all the parameters are calculated.

**Table 3: Stock Price of Different Companies-I**

<table>
<thead>
<tr>
<th>17th May - 16th June</th>
<th>Asian Paints Ltd (Rs)</th>
<th>Berger Paints Ltd (Rs)</th>
<th>Airtel</th>
<th>Bsnl</th>
<th>Dr Reddy</th>
<th>Apollo</th>
<th>SBI</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>3092.45</td>
<td>620.1</td>
<td>792.45</td>
<td>191.25</td>
<td>4481.50</td>
<td>4482.15</td>
<td>586.30</td>
<td>15.90</td>
</tr>
<tr>
<td>18</td>
<td>3109.05</td>
<td>622.75</td>
<td>799.35</td>
<td>192.20</td>
<td>4423.10</td>
<td>4442.00</td>
<td>574.20</td>
<td>15.70</td>
</tr>
<tr>
<td>19</td>
<td>3084.45</td>
<td>625.25</td>
<td>805.75</td>
<td>189.20</td>
<td>4391.95</td>
<td>4447.15</td>
<td>575.15</td>
<td>15.65</td>
</tr>
<tr>
<td>22</td>
<td>3084.9</td>
<td>626.2</td>
<td>801.85</td>
<td>188.50</td>
<td>4457.65</td>
<td>4605.30</td>
<td>577.15</td>
<td>15.65</td>
</tr>
<tr>
<td>23</td>
<td>3120.6</td>
<td>630.2</td>
<td>799.95</td>
<td>201.00</td>
<td>4460.55</td>
<td>4550.40</td>
<td>581.60</td>
<td>15.55</td>
</tr>
<tr>
<td>24</td>
<td>3101.5</td>
<td>634.5</td>
<td>801.40</td>
<td>198.00</td>
<td>4519.25</td>
<td>4536.45</td>
<td>582.70</td>
<td>15.60</td>
</tr>
<tr>
<td>25</td>
<td>3123.55</td>
<td>641.6</td>
<td>822.70</td>
<td>193</td>
<td>4503.95</td>
<td>4568.15</td>
<td>581.25</td>
<td>15.50</td>
</tr>
<tr>
<td>26</td>
<td>3128.4</td>
<td>647.1</td>
<td>817.95</td>
<td>189.90</td>
<td>4530.95</td>
<td>4609.90</td>
<td>586.00</td>
<td>15.60</td>
</tr>
<tr>
<td>29</td>
<td>3137.4</td>
<td>640.95</td>
<td>821.25</td>
<td>192.00</td>
<td>4556.25</td>
<td>4640.45</td>
<td>595.00</td>
<td>15.90</td>
</tr>
<tr>
<td>30</td>
<td>3144.4</td>
<td>648.85</td>
<td>818.45</td>
<td>190.15</td>
<td>4518.90</td>
<td>4599.15</td>
<td>592.80</td>
<td>15.90</td>
</tr>
<tr>
<td>31</td>
<td>3192.95</td>
<td>650.45</td>
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### Table 4: Stock Price of Different Companies -II

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Table 5: Stock Price of Different Companies -III

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<th>Patanjali</th>
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Data Analysis
Case 1: Asian paints and Berger Paints

\[
\begin{align*}
\beta_1 &= 0.202298, \beta_1^2 = 0.040924 \\
\sigma_1 &= 69.40584, \sigma_1^2 = 4817.17 \\
\beta_2 &= 3.945048, \beta_2^2 = 15.56341 \\
\sigma_2 &= 15.71684, \sigma_2^2 = 247.0192
\end{align*}
\]

Covariance of Asian Paints and Berger Paints = 974.5027

\[
\beta_1 \beta_2 \sigma_m^2 = 974.5027 \text{ from table}
\]

\[
0.202298 \times 3.945048 \times 1221.05493378 / 69.40584 \times 15.71684
\]

\[
\sigma_m^2 = 1221.05493378
\]

Correlation Coefficient between Asian Paints and Berger Paints Ltd \((r_{12}) = 0.933956905\)

From the generated formula

\[
\begin{align*}
r_{12} &= \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \\
r_{12} &= \frac{0.202298 \times 3.945048 \times 1221.05493378 / 69.40584 \times 15.71684}{\sqrt{69.40584 \times 15.71684}} \\
r_{12} &= 0.893350
\end{align*}
\]

Case 2: Airtel and BSNL

\[
\begin{align*}
\beta_1 &= 0.065846, \beta_1^2 = 0.004336 \\
\sigma_1 &= 16.059, \sigma_1^2 = 257.8916 \\
\beta_2 &= 0.775354, \beta_2^2 = 0.601174 \\
\sigma_2 &= 4.679851, \sigma_2^2 = 21.90101
\end{align*}
\]

Covariance of Airtel and Bsnl = 16.98103

\[
\beta_1 \beta_2 \sigma_m^2 = 16.98103 \text{ from table}
\]

\[
0.065846 \times 0.775354 \times 16.98103 / 16.059 \times 4.679851
\]

\[
\sigma_m^2 = 16.98103
\]

Correlation Coefficient between Airtel and Bsnl \((r_{12}) = 0.236221\)

From the generated formula

\[
\begin{align*}
r_{12} &= \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \\
r_{12} &= \frac{0.065846 \times 0.775354 \times 16.98103 / 16.059 \times 4.679851}{\sqrt{16.059 \times 4.679851}} \\
r_{12} &= 0.236221
\end{align*}
\]
\( r_{12} = 0.065846 \times 0.775354 \times 332.609462085 / 16.059 \times 4.679851 \)
\( r_{12} = 0.22595060327 \)

**Case 3: Dr Reddy and Apollo**

\[ \beta_1 = 1.75886, \beta_1^2 = 3.09359 \]
\[ \sigma_1 = 123.7834, \sigma_1^2 = 15322.34 \]
\[ \beta_2 = 0.463729, \beta_2^2 = 0.215045 \]
\[ \sigma_2 = 241.0716, \sigma_2^2 = 58115.5 \]

Covariance of Dr Reddy and Apollo = 26949.85

\[ \beta_1 \beta_2 \sigma_m^2 \text{ = Covariance from table} \]
\[ 1.75886 \times 0.463729 \times \sigma_m^2 = 26949.85 \]
\[ 0.81563438894 \times \sigma_m^2 = 26949.85 \]
\[ \sigma_m^2 = 26949.85 / 0.81563438894 \]
\[ \sigma_m^2 = 33041.5813328 \]

Correlation Coefficient between Dr Reddy and Apollo (\( r_{12} \)) = 0.944176

*From the generated formula*

\[ r_{12} = \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \]
\[ r_{12} = 1.75886 \times 0.463729 \times 33041.5813328 / 123.7834 \times 241.0716 \]
\[ r_{12} = 0.90312506260 \]

**Case 4: SBI and Yes Bank**

\[ \beta_1 = -0.00157784, \beta_1^2 = 0.00 \]
\[ \sigma_1 = 7.014593765, \sigma_1^2 = 49.20452569 \]
\[ \beta_2 = -0.59275, \beta_2^2 = 0.35135 \]
\[ \sigma_2 = 0.361909, \sigma_2^2 = 0.130978 \]

Covariance of SBI and Yes Bank = -0.077637051

\[ \beta_1 \beta_2 \sigma_m^2 \text{ = Covariance from table} \]
\[ -0.00157784 \times -0.59275 \times \sigma_m^2 = -0.077637051 \]
\[ 0.00093526466 \times \sigma_m^2 = -0.077637051 \]
\[ \sigma_m^2 = -0.077637051 / 0.00093526466 \]
\[ \sigma_m^2 = -83.01078221 \]

Correlation Coefficient between SBI and Yes Bank (\( r_{12} \)) = -0.031972165

*From the generated formula*

\[ r_{12} = \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \]
\[ r_{12} = -0.00157784 \times -0.59275 \times -83.01078221 / 7.014593765 \times 0.361909 \]
\[ r_{12} = -0.07763705099 / 2.53864461489 \]
\[ r_{12} = 0.3058208720 \]

**Case 5: Hindustan Copper and Hind Zinc**

\[ \beta_1 = -0.32726, \beta_1^2 = 0.1071 \]
\[ \sigma_1 = 5.242451, \sigma_1^2 = 27.48329 \]
\[ \beta_2 = -1.06104, \beta_2^2 = 1.125808 \]
\[ \sigma_2 = 2.911494, \sigma_2^2 = 8.476798 \]

Covariance of Hindustan Copper and Hind Zinc = -8.99423
\[ \beta_1 \beta_2 \sigma^2_m = -8.99423 \text{ from table} \]
\[ -0.32726 \times 1.06104 \times \sigma^2_m = -8.99423 \]
\[ 0.3472359504 \times \sigma^2_m = -8.99423 \]
\[ \sigma^2_m = -8.99423/0.3472359504 \]
\[ \sigma^2_m = -25.9023582945 \]

Correlation Coefficient between Hindustan Copper and Hind Zinc \((r_{12}) = -0.61605\)

\[ r_{12} = \frac{\beta_1 \beta_2 \sigma^2_m}{\sigma_1 \sigma_2} \]

**Case 6: IOCL and BPCL**

\[ \beta_1 = 2.129625, \beta_1^2 = 4.535302 \]
\[ \sigma_1 = 1.89682, \sigma_1^2 = 3.597925 \]
\[ \beta_2 = 0.204134, \beta_2^2 = 0.041671 \]
\[ \sigma_2 = 6.126609, \sigma_2^2 = 37.53534 \]

Covariance of IOCL and BPCL = 7.662231

\[ \beta_1 \beta_2 \sigma^2_m = 7.662231 \text{ from table} \]
\[ 2.129625 \times 0.204134 \times \sigma^2_m = 7.662231 \]
\[ 0.43472886975 \times \sigma^2_m = 7.662231 \]
\[ \sigma^2_m = 7.662231/0.43472886975 \]
\[ \sigma^2_m = 17.6253097807 \]

Correlation Coefficient between IOCL and BPCL \((r_{12}) = 0.689309\)

\[ r_{12} = \frac{\beta_1 \beta_2 \sigma^2_m}{\sigma_1 \sigma_2} \]

**Case 7: Tata Motors and Suzuki Motors**

\[ \beta_1 = 8.374941, \beta_1^2 = 70.13964 \]
\[ \sigma_1 = 21.82247, \sigma_1^2 = 476.22 \]
\[ \beta_2 = 0.095707, \beta_2^2 = 0.009161 \]
\[ \sigma_2 = 204.1378, \sigma_2^2 = 41672.24 \]

Covariance of Tata Motors and Suzuki Motors = 3988.314

\[ \beta_1 \beta_2 \sigma^2_m = 3988.314 \text{ from table} \]
\[ 8.374941 \times 0.095707 \times \sigma^2_m = 3988.314 \]
\[ 0.80154047828 \times \sigma^2_m = 3988.314 \]
\[ \sigma^2_m = 3988.314/0.80154047828 \]
\[ \sigma^2_m = 4975.8110886 \]

Correlation Coefficient between Tata Motors and Suzuki Motors \((r_{12}) = 0.935982\)

\[ r_{12} = \frac{\beta_1 \beta_2 \sigma^2_m}{\sigma_1 \sigma_2} \]
\[ r_{12} = 8.374941 \times 0.095707 \times 4975.81108886/21.82247 \times 204.1378 \]
\[ r_{12} = 0.89528644224 \]

**Case 8: Britannia and HUL**
\[ \beta_1 = 0.105811, \beta_1^2 = 0.011196 \]
\[ \sigma_1 = 176.4954, \sigma_1^2 = 31150.63 \]
\[ \beta_2 = 2.854271, \beta_2^2 = 8.146865 \]
\[ \sigma_2 = 33.98224, \sigma_2^2 = 1154.793 \]
Covariance of Britannia and HUL = 3296.092
\[ \beta_1 \beta_2 \sigma_m^2 = 3296.092 \text{ from table} \]
\[ 0.105811 \times 2.854271 \times \sigma_m^2 = 3296.092 \]
\[ 0.30201326878 \times \sigma_m^2 = 3296.092 \]
\[ \sigma_m^2 = 3296.092/0.30201326878 \]
\[ \sigma_m^2 = 10913.7324108 \]
Correlation Coefficient between Britannia and HUL \( (r_{12}) \) = 0.574538

From the generated formula
\[ r_{12} = \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \]
\[ r_{12} = 0.105811 \times 2.854271 \times 10913.7324108 / 176.4954 \times 33.98224 \]
\[ r_{12} = 0.55052793816 \]

**Case 9: Dabur and Patanjali**
\[ \beta_1 = 2.508231, \beta_1^2 = 6.291224 \]
\[ \sigma_1 = 15.96806, \sigma_1^2 = 254.9789 \]
\[ \beta_2 = 0.274276, \beta_2^2 = 0.075227 \]
\[ \sigma_2 = 48.28833, \sigma_2^2 = 2331.763 \]
Covariance of Dabur and Patanjali = 639.5461
\[ \beta_1 \beta_2 \sigma_m^2 = 639.5461 \text{ from table} \]
\[ 2.508231 \times 0.274276 \times \sigma_m^2 = 639.5461 \]
\[ 0.68794756575 \times \sigma_m^2 = 639.5461 \]
\[ \sigma_m^2 = 639.5461/0.68794756575 \]
\[ \sigma_m^2 = 929.643670303 \]
Correlation Coefficient between AP Ltd and BP Ltd \( (r_{12}) \) = 0.867127

From the generated formula
\[ r_{12} = \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \]
\[ r_{12} = 2.508231 \times 0.274276 \times 929.643670303 / 15.96806 \times 48.28833 \]
\[ r_{12} = 639.5461/771.070950739 \]
\[ r_{12} = 0.8294257482 \]

**Table 6: T Test**

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<tr>
<th>Sl.No</th>
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<th>Correlation Coefficient Value from Generated Formula</th>
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</table>
Hypothesis $H_0$: There is no significant difference between two groups.

$H_1$: There is a significant difference between two groups.

**Paired T Test:** $0.104732183; \text{df=} n-1=9-1=8; T \text{ Table Value}= 2.306$

**P Test:** The Probability of Occurrence of an event can be analyzed using P Test.

$P (Z = 0.104732183) = 0.0398 + 0.5 = 0.5398$

**Mann Whitney U Test:** 1. Arrange the data in increasing order.

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Data</th>
<th>Increasing Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.93956905</td>
<td>-0.61605</td>
</tr>
<tr>
<td>2</td>
<td>0.236221</td>
<td>-0.589269</td>
</tr>
<tr>
<td>3</td>
<td>0.944176</td>
<td>-0.305821</td>
</tr>
<tr>
<td>4</td>
<td>-0.03197217</td>
<td>-0.031972</td>
</tr>
<tr>
<td>5</td>
<td>-0.61605</td>
<td>0.2259506</td>
</tr>
<tr>
<td>6</td>
<td>0.689309</td>
<td>0.236221</td>
</tr>
<tr>
<td>7</td>
<td>0.935982</td>
<td>0.5505279</td>
</tr>
<tr>
<td>8</td>
<td>0.574538</td>
<td>0.574538</td>
</tr>
<tr>
<td>9</td>
<td>0.867127</td>
<td>0.6593393</td>
</tr>
<tr>
<td>10</td>
<td>0.89335</td>
<td>0.689309</td>
</tr>
<tr>
<td>11</td>
<td>0.225950603</td>
<td>0.8294257</td>
</tr>
<tr>
<td>12</td>
<td>0.903125063</td>
<td>0.867127</td>
</tr>
<tr>
<td>13</td>
<td>-0.305820872</td>
<td>0.89335</td>
</tr>
<tr>
<td>14</td>
<td>-0.589269156</td>
<td>0.8952864</td>
</tr>
<tr>
<td>15</td>
<td>0.65933929</td>
<td>0.9031251</td>
</tr>
<tr>
<td>16</td>
<td>0.895286442</td>
<td>0.9339569</td>
</tr>
<tr>
<td>17</td>
<td>0.550527938</td>
<td>0.935982</td>
</tr>
<tr>
<td>18</td>
<td>0.829425748</td>
<td>0.944176</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Increasing Order</th>
<th>Ranks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-0.61605</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>-0.589269</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>-0.305821</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>-0.031972</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>0.2259506</td>
<td>5</td>
</tr>
<tr>
<td>6</td>
<td>0.236221</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>0.5505279</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>0.574538</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>0.6593393</td>
<td>9</td>
</tr>
</tbody>
</table>
Table 9: 3. Classifying according to the group and adding ranks

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Data: Group 1</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.933956905</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>0.236221</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>0.944176</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>-0.03197217</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>-0.61605</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>0.689309</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>0.935982</td>
<td>17</td>
</tr>
<tr>
<td>8</td>
<td>0.574538</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>0.867127</td>
<td>12</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td>92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Data: Group 1</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.89335</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>0.225950603</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>0.903125063</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>-0.305820872</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>-0.589269156</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>0.65933929</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>0.895286442</td>
<td>14</td>
</tr>
<tr>
<td>8</td>
<td>0.550527938</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>0.829425748</td>
<td>11</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td>79</td>
</tr>
</tbody>
</table>

4. Comparing with formula

\[ U_1 = \frac{n_1 n_2 + n_1(n_2+1)}{2} - R_1 \]
\[ U_1 = 9*9 + 9*10/2 - 92 \]
\[ U_1 = 34 \]
\[ U_2 = \frac{n_1 n_2 + n_1(n_2+1)}{2} - R_2 \]
\[ U_2 = 9*9 + 9*10/2 - 79 \]
\[ U_2 = 126-79 \]
\[ U_2 = 47; U_{tab} = 21 \]
Findings and Suggestions:
1. Both the Sharpe Index model and Portfolio Markowitz model have been studied with respect to two stocks.
2. By equating Sharpe Index model and Portfolio Markowitz Model for two stocks new formulas where generated for Statistical Parameters.
3. The formula which provides the values of correlation coefficient is \[ r_{12} = \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \]
4. With respect to Correlation Coefficient, new formula that got generated by equating Sharpe Index Model and Portfolio Markowitz Model was comparatively tested with the known formula of Correlation Coefficient by using statistical tests like T Test and Mann Whitney U Test.
5. T Test briefs that Null Hypothesis is accepted where there is no significant difference between the calculated values of correlation coefficient and Values of Correlation coefficient generated by the formula.
6. The possibility of the Occurrence of the T test is calculated using P test.
7. P test reveals that the possibility of Occurrence of the \[ r_{12} = \frac{\beta_1 \beta_2 \sigma_m^2}{\sigma_1 \sigma_2} \] is 0.5378 which is more than 50%.
8. Mann Whitney U Test gives the result that the calculated values of correlation coefficient and generated values of correlation coefficient are same.
9. The analysis also gives the formula for covariance where Covariance = \[ \beta_1 \beta_2 \sigma_m^2 \]
10. Market Variance Formula with respect to Stock 1: \[ \sigma_m^2 = \frac{(\sigma_1^2 - \xi_1^2)}{\beta_1^2} \]
11. Market Variance Formula with respect to stock 2: \[ \sigma_m^2 = \frac{(\sigma_2^2 - \xi_2^2)}{\beta_2^2} \]
12. Under special case for \( r_{12} = 1 \), Variance of market is \[ \sigma_m^2 = \sigma_1 \sigma_2 / \beta_1 \beta_2 \] and Standard Deviation is \( \sigma_m = \sqrt{\sigma_1 \sigma_2 / \beta_1 \beta_2} \)
13. Under special case for \( r_{12} = -1 \), Variance of market is \[ \sigma_m^2 = \sigma_1 \sigma_2 / \beta_1 \beta_2 \] and Standard Deviation is \( \sigma_m = \sqrt{-\sigma_1 \sigma_2 / \beta_1 \beta_2} \)
14. When \( r_{12}=-1 \), Standard Deviation tends to be \[ \sigma_m = \sqrt{-\sigma_1 \sigma_2 / \beta_1 \beta_2} \] This result tells that the Standard Deviation can be square root of a negative number. Such representation implies that the \( \sigma_m = \sqrt{-\sigma_1 \sigma_2 / \beta_1 \beta_2} \) is a complex number which resembles X= i where \( i = \sqrt{-1} \).
15. Further application of theories of complex numbers in identifying standard deviation and variance with respect to market can be new scope of research.

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