LESSON 6:
MEASUREMENT & EVALUATION OF RISK

How does we Measure Risk?
Understanding the nature of the risk is not adequate unless the investor or analyst is capable of expressing it in some quantitative terms. Expressing the risk of a stock in quantitative terms makes it comparable with other stocks. Measurement cannot be assures of percent accuracy because risk is caused by numerous factors as discussed above. Measurement provides an approximate quantification of risk. The statistical tool often used to measure is the standard deviation.

Standard Deviation: It is a measure of the values of the variables around its mean or it is the square root of the sum of the squared deviations from the mean divided by the number of observances. The arithmetic mean of the returns may be same for two companies but the returns may vary widely. This can be illustrated with an example.

Now let us take two companies A and B to calculate the expected returns.

<table>
<thead>
<tr>
<th>COMPANY A</th>
<th>COMPANY B</th>
</tr>
</thead>
<tbody>
<tr>
<td>ri</td>
<td>Pi</td>
</tr>
<tr>
<td>6</td>
<td>0.10</td>
</tr>
<tr>
<td>7</td>
<td>0.25</td>
</tr>
<tr>
<td>8</td>
<td>0.50</td>
</tr>
<tr>
<td>9</td>
<td>0.25</td>
</tr>
<tr>
<td>10</td>
<td>0.10</td>
</tr>
</tbody>
</table>

\[ \bar{E}(r) = 8.00 \quad \bar{E}(r) = 8.00 \]

Company A Company B
Where:
ri is the rate of return
P is the probability
Lets calculate the expected mean for both the companies.
For Company A: \[ \bar{r}_i / n = (6+7+8+9+10) / 5 = 8 \]
For Company B: \[ \bar{r}_i / n = (4+6+8+10+12) / 5 = 8 \]
You can note that the expected means for both the companies are same i.e. 8.
However, the return varies from 6%-10% in Company A and 4%-12% for Company B. To find out the variation, the standard deviation technique is applied.

Measuring Portfolio Risk
Like in case of individual securities, the risk of a portfolio could be measured in terms of its variance or standard deviation. However, the variance or standard deviation of a portfolio is not simply the weighted average of variances or standard deviation of individual securities. The portfolio variance or standard deviation is affected by the association of movement of returns of two securities. Covariance of two securities measures their co-movement.

How do we Calculate Co-variance?
There are three steps involved in the calculation of covariance between two securities:
Determine the expected returns for securities Determine the deviation of possible returns from the expected return for each security. Determine the sum of the product of each deviation of returns of two securities and probability.
Let us consider the data of two securities X and Y.

<table>
<thead>
<tr>
<th>State of economy</th>
<th>Probability</th>
<th>Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>A</td>
<td>0.1</td>
<td>-8</td>
</tr>
<tr>
<td>B</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>0.4</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>0.2</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>0.1</td>
<td>-4</td>
</tr>
</tbody>
</table>

The expected return for security X:
\[ E(\text{Rx}) = (0.1\times-0.8)+(0.2\times10)+(0.4\times8)+(0.2\times5)+(0.1\times-0.4) \]
\[ = 5\% \]

The expected return for security Y:
\[ E(\text{Ry}) = (0.1\times14)+(0.2\times-4)+(0.4\times6)+(0.2\times15)+(0.1\times20) \]
\[ = 8\% \]

Covxy is the covariance of returns of securities X & Y, Rx and Ry are the returns of securities X & Y respectively
E (Rx) and E (Ry) are the expected returns of securities X & Y respectively
Pi is the probability of occurrence of the state of economy.
Thus the covariance between the securities X & Y is:
\[ \text{Cov}_{xy} = 0.1(-8-5)(14-8) + 0.2(-4-8)(-4-8) + 0.4(8-5)(-4-8) + 0.2(5-5)(15-8) + 0.1(-0.4-15)(-4-8) \]
\[ = -7.8-12.2+4-0.8-10.8 \]
\[ = -33 \]
You can note from the calculation of covariance of returns of securities X and Y that it is a measure of both the standard deviations of the securities and their associations. Thus, covariance can also be calculated as follows:
Covariance XY = Standard deviation X * Standard deviation Y * Correlation XY
Covxy = sx * sy * Corxy

Where x and y are standard deviation of returns for securities X and Y. Corxy is the correlation coefficient of securities X and Y. Correlation measures the linear relationship between two variables (in case of two securities).

Thus, from the above formula, we can obtain the following formula for calculating the correlation coefficient of securities X & Y:

\[ \text{Correlation XY} = \frac{\text{Covariance XY}}{\text{Standard deviation X} \times \text{Standard deviation Y}} \]

The variances and standard deviation of securities x and y are as follows:

\[
\begin{align*}
s_x^2 &= 0.1(-8-5)^2 + 0.2(10-5)^2 + 0.4(8-5)^2 + 0.2(5-5)^2 + 0.1(-4-5)^2 = 16.9 + 5 + 3.6 + 0 + 8.1 = 33.6 \\
x &= \sqrt{33.6} = 5.8\% \\
y^2 &= 0.1(14-8)^2 + 0.2(-4-8)^2 + 0.4(6-8)^2 + 0.2(15-8)^2 + 0.1(20-8)^2 = 3.6 + 28.8 + 1.6 + 9.8 + 14.4 = 58.2 \\
y &= \sqrt{58.2} = 7.63\%
\end{align*}
\]

The correlation coefficient of securities X and y is as follows:

\[ \text{Corxy} = \frac{-33}{5.8 \times 7.63} = 0.7456 \]

Securities X and Y are negatively correlated. If an investor invests in the combination of these securities, he or she can reduce the risk.

The Characteristic Regression Line (CRL)

The Characteristic Regression Line (CRL) is a simple linear regression model estimated for a particular stock against the market index return to measure its diversifiable and undiversifiable risks.

The model is: \( R_i = a_i + b_i R_m + e_i \)

\( i \) = Return of the ith stock
\( a_i \) = Intercept
\( b_i \) = Slope of the ith stock
\( R_m \) = Return of the market index
\( e_i \) = the error term

The security return = \( \text{Today's price - Yesterday's price} \times 100 \)

\( \text{Yesterday's price} \)

Today's market return = \( \text{Today's index - Yesterday's index} \times 100 \)

\( \text{Yesterday's index} \)

Like daily returns, weekly returns can be calculated by using this week's and last week's prices instead of today's and yesterday's prices in the above mentioned formula. Monthly can also be calculated. Let's consider the daily prices of the Bajaj Auto stock and the NSE index for the 5th Oct 2000 to 16th October 2000.

<table>
<thead>
<tr>
<th>Date</th>
<th>NSE index (X)</th>
<th>Bajaj Auto (Y)</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 5</td>
<td>904.95</td>
<td>597.8</td>
</tr>
<tr>
<td>October 6</td>
<td>845.75</td>
<td>570.8</td>
</tr>
<tr>
<td>October 7</td>
<td>874.25</td>
<td>582.95</td>
</tr>
<tr>
<td>October 8</td>
<td>847.95</td>
<td>559.85</td>
</tr>
<tr>
<td>October 9</td>
<td>849.10</td>
<td>554.60</td>
</tr>
<tr>
<td>October 12</td>
<td>835.80</td>
<td>545.10</td>
</tr>
<tr>
<td>October 13</td>
<td>816.75</td>
<td>519.15</td>
</tr>
<tr>
<td>October 14</td>
<td>843.55</td>
<td>560.70</td>
</tr>
<tr>
<td>October 15</td>
<td>835.55</td>
<td>560.95</td>
</tr>
</tbody>
</table>

What is Beta? What Does it Imply?

Beta is the slope of the characteristic regression line. Beta describes the relationship between the stock's return and the index returns. In the above example, beta indicates that 1% change in NSE index return would cause 1.19% change in the Bajaj auto stock return. Varying beta has the following implications:

- Beta = +1.0: 1% change in the market index return causes exactly 1% change in the stock return. It indicates that the stock moves in tandem with the market.
- Beta = +0.5: 1% change in the market index return causes exactly 0.5% change in the stock return. The stock is less volatile compared to the market.
- Beta = +2.0: 1% change in the market index return causes exactly 2% change in the stock return. The stock is more volatile. When there is a decline of 10% in the market return, the stock with a beta of 2 would give a negative return of 20%. The stocks with more than 1 beta value is considered to be risky.
- Negative beta value indicates that the stock return moves in the opposite direction to the market return. A stock with a negative beta of -1 would provide a return of 10%, if the market return declines by 10% and vice-versa.

Note: Stocks with negative beta resist the decline in the market return. But stocks with negative returns are very rare.

Alpha: The intercept of the characteristic regression line is alpha i.e. distance between the intersection and the horizontal axis. It indicates that the stock return is independent of the market return. A positive value of alpha is the healthy sign. Positive alpha values would yield profitable return.
Correlation
The correlation co-efficient measures the nature and extent of relationship between the stock market index return and the stock return in the particular period.

The square of the correlation coefficient is the co-efficient of determination. It gives the percentage of variation in the stock’s return explained by the variation in the market’s return.

\[ r^2 = (0.79)^2 = 0.62 \]

What does an r of 0.62 imply?
The interpretation is that 62% of variation in stock’s return is due to the variations in NSE index return.

Recap
- Risk is measured by the variability of return. It has two components, systematic and unsystematic risk
- Systematic risk affects the market as a whole. Tangible event like Pokaran blast and intangible event like investor’s psychology affect the entire stock market, which are known as market risk.
- Interest rate risk is the variation in return caused by the changes in the market interest rate.
- Purchasing power risk is caused by inflation. Inflation reduces the real rate of return earned from the securities.
- Unsystematic risk is unique to the particular industry or company. This is classified as business risk and financial risk.
- Business risk is caused by operating environment of the business. This may be caused by the internal factors like fluctuations in sales or personnel management or external factors like government policies, rules and regulations.
- Financial risk emerges from the debt component of the capital structure.
- A careful analysis of the past, planning and diversification of the investment can moderate the effects of the various risk factors.
- Statistically, standard deviation and beta estimation help to quantify the risk.

Notes