Chapter 12 - Risk Return & The Security Market Line

Expected & Unexpected Returns

\[
\text{Total Return} = \text{Expected Return} + \text{Unexpected Return}
\]

\[
R = E(R) + U
\]

so \( U = R - E(R) \)

---

Announcements & News

Announcement = Expected Port + Surprise

relates to \( E(R) \)

\[ U \]

"News" is what's unexpected in an announcement. Stocks react to news rather than to announcements.

Good news means there was a pleasant surprise and bad news means there was an unpleasant surprise.
Systematic Risk - Risk that influences a large number of assets. Also called market risk, or non-diversifiable risk.

Unsystematic Risk - Risk that influences a single company or a small number of companies. Also called unique risk or asset specific risk, or diversifiable risk.

Unsystematic risk is essentially eliminated by diversification, so a portfolio with many assets has almost no unsystematic risk.

Systematic Risk Principle - The reward for bearing risk depends only on the systematic risk of the investment.

Beta Coefficient - \( \beta \) - A measure of the systematic risk of an asset relative to the risk of the market

\[ \beta > 1 \Rightarrow \text{greater systematic risk than market} \]
\( \beta < 1 \Rightarrow \text{less " " "} \)

\( \beta = 1 \Rightarrow \text{equal " " "} \)

**Portfolio Beta (\( \beta_p \))**

\[
\beta_p = \sum_{i=1}^{N} x_i \beta_i
\]

The beta of a portfolio is the weighted average of the betas of the stocks in the portfolio.

**Example 12.4**

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<table>
<thead>
<tr>
<th>Security</th>
<th>$ Invested</th>
<th>( x_i )</th>
<th>( E(R_i) )</th>
<th>( \beta_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1000</td>
<td>0.1</td>
<td>8%</td>
<td>0.8</td>
</tr>
<tr>
<td>B</td>
<td>2000</td>
<td>0.2</td>
<td>12%</td>
<td>0.95</td>
</tr>
<tr>
<td>C</td>
<td>3000</td>
<td>0.3</td>
<td>15%</td>
<td>1.10</td>
</tr>
<tr>
<td>D</td>
<td>4000</td>
<td>0.4</td>
<td>18%</td>
<td>1.40</td>
</tr>
<tr>
<td></td>
<td>10,000</td>
<td>1.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\begin{align*}
E(R_p) &= 0.1(8\%) + 0.2(12\%) + 0.3(15\%) + 0.4(18\%) \\
&= 0.8\% + 2.4\% + 4.5\% + 7.2\% \\
&= 14.9\%
\end{align*}
\]
\[ \beta_p = 0.1(0.8) + 0.2(0.95) + 0.3(1.0) \\
+ 0.4(1.4) \\
= 0.08 + 0.19 + 0.33 + 0.56 \\
= 1.16 \]

Consider the following investment opportunity:

<table>
<thead>
<tr>
<th>Asset</th>
<th>( E(R_i) )</th>
<th>( \beta_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.20</td>
<td>1.6</td>
</tr>
<tr>
<td>B</td>
<td>0.16</td>
<td>1.2</td>
</tr>
<tr>
<td>R_f</td>
<td>0.08</td>
<td>0</td>
</tr>
</tbody>
</table>

\( R_f \) = risk-free asset (i.e., T-Bill)
- its systematic risk = 0 as it's risk-free.

Now consider the 2 asset portfolios that can be created from A and R_f.

Recall: 
\[ E(R_p) = \pi_A E(R_A) + (1-\pi_A) R_f \]
\[ \beta_p = \pi_A \beta_A + (1-\pi_A) 0 \]
\[ = \pi_A \beta_A \]

<table>
<thead>
<tr>
<th>( \pi_A )</th>
<th>1-( \pi_A )</th>
<th>( E(R_p) )</th>
<th>( \beta_p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.20</td>
<td>1.6</td>
</tr>
<tr>
<td>0.5</td>
<td>0.5</td>
<td>0.14</td>
<td>0.8</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0.08</td>
<td>0</td>
</tr>
</tbody>
</table>
Can also use for portfolios of Stock B and Rf

<table>
<thead>
<tr>
<th>( \alpha_B )</th>
<th>( 1-\alpha_B )</th>
<th>( E(R_D) )</th>
<th>( BP )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0.16</td>
<td>1.2</td>
</tr>
<tr>
<td>0.5</td>
<td>0.5</td>
<td>0.12</td>
<td>0.6</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>0.08</td>
<td>0</td>
</tr>
</tbody>
</table>

By our definition of an efficient portfolio (i.e., the highest possible return for a given level of risk) we observe that portfolios of B combined with the Rf are not efficient. To make asset B desirable, its price must fall so that its return goes up until it is a desirable investment.

Reward to Risk Ratio.
- The slope of these 2 asset portfolio lines shows the reward for taking on more risk, i.e., the extra return one gets as one accepts additional risk.
For all assets to be desirable they have to have the same reward to risk ratio i.e. Slope

\[ \text{slope} = \frac{E(R_a) - R_f}{\beta_a} \]

This has to be true for portfolios with asset B (i.e. after price adjustment), and all other assets, including the market portfolio.

\[ \text{slope of mkt portfolio} = \frac{E(R_m) - R_f}{\beta_m} = E(R_m) - R_f \]

\[ E(R_m) = \text{Expected return of mkt} \]

\[ \beta_m = 1 \]

Setting the two slopes equal

\[ \frac{E(R_a) - R_f}{\beta_a} = E(R_m) - R_f \]

Multiply both sides by \( \beta_a \)

\[ E(R_a) - R_f = \beta_a [E(R_m) - R_f] \]

Then add \( R_f \) to each side

\[ E(R_a) = R_f + \beta_a [E(R_m) - R_f] \]

This is called the CAPM
CAPM: Capital Asset Pricing Model

Note: $E(R_m) - R_f$ is often called the market risk premium, or equity risk premium.

The Security Market Line (SML) is the graph of the CAPM

$E(R_i)$ is a function of $E(R_m)$, $R_f$, and $\beta_i$.

This says $E(R_i)$ is a function of $E(R_m)$ (i.e., depends on) its beta.

$E(R_i)$ on asset $i$ depends on:

1. The risk free rate, which is the reward for delaying consumption i.e. the reward for waiting to get your money back.
2. A risk premium, that depends on the market risk premium, but is adjusted by the risk of your stock (via its beta).
How to compute Beta:
- Plot the time series of returns on the security of interest versus the returns on the market.

<table>
<thead>
<tr>
<th>Period</th>
<th>Ri</th>
<th>Rm</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 04</td>
<td>8%</td>
<td>14%</td>
</tr>
<tr>
<td>Apr 04</td>
<td>-3%</td>
<td>-7%</td>
</tr>
<tr>
<td>Mar 04</td>
<td>2%</td>
<td>-1%</td>
</tr>
<tr>
<td>Feb 04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(Regression)
Best Fit Line

\[
\text{Slope of line} = \text{Beta}
\]

So, Beta shows how your stock return reacts to changes in the market return.

Low Beta means that your stock is not very sensitive to changes in the market, such as utility stocks, food items, & consumer goods.

High Beta stocks are very sensitive to changes in the market, such as airline stocks.
Mathematically, Beta is

$$\beta_i = \text{Corr}(R_i, R_m) \times \frac{\sigma_i}{\sigma_m}$$

so it's related to the correlation a stock has with the market.

Why do Beta's differ? (i.e. from different sources)

1. Time period used to compute Beta (e.g. 2yr vs 5yr)
2. Periodicity of the data used (Daily, Weekly, Other Monthly Data, Quarterly)
3. Adjustments - Some sources "adjust" their Beta due to "regression to the mean."

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you have 1/3 in A, 1/3 in B, 1/3 in R and your $\beta_p = 1$. Stock A has $\beta_A = 1.4$. What is $\beta_B$?

$$\beta_p = \sum \beta_i$$

$$1 = \frac{1}{3} (1.4) + \frac{1}{3} (\beta_B) + \frac{1}{3} (0)$$
\[ 3 = 1.4 + \beta B \]
\[ 3 - 1.4 = \beta B \]
\[ = 1.6 \]

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Page 424 #8 - Apply CAPM

\[ \beta_i = 0.7 \]
\[ E(R_m) = 0.15 \]
\[ R_f = 0.065 \]

\[
E(R_i) = R_f + \beta_i \left[ E(R_m) - R_f \right]
\]
\[
= 0.065 + 0.7 \left[ 0.15 - 0.065 \right]
\]
\[
= 0.065 + 0.7 \left[ 0.085 \right]
\]
\[
= 0.065 + 0.0595
\]
\[
= 0.1245 = 12.45\%
\]