Chapter 10

Introduction to Risk, Return, and the Opportunity Cost of Capital

Chapter 10 Topics

- Risk: The Big Picture
- Rates of Return
- Risk Premiums
- Expected Return
- Stand Alone Risk
- Portfolio Return and Risk
- Risk Diversification
- Unique & Market Risk

What is Risk? The big picture.

- **Risk** is an uncertain outcome or chance of an adverse outcome.
- Concerned with the riskiness of cash flows from financial assets.
- Stand Alone Risk: Single Asset
  - relevant risk measure is the standard deviation of expected cash flows or returns.
Risk: The Big Picture (cont.)
- Portfolio Context: A group of assets.
  - Unique (Diversifiable) Risk
  - Market Risk
- Small group of assets with Diversifiable Risk remaining:
  - Total risk (σ) correlation (-1≤ρ ≤+1) between asset returns which affects portfolio standard deviation

finishing the Big Picture on Risk
- Well-diversified Portfolio
  - Large Portfolio (10-15 assets) eliminates unique risk for the most part.
  - Interested in Market Risk which is the risk that cannot be diversified away.
  - The relevant risk measure is Beta which measures the riskiness of an individual asset in relation to the market portfolio.

Rates of Return (review)

<table>
<thead>
<tr>
<th>Percentage Return</th>
<th>Capital Gain + Dividend</th>
<th>Initial Share Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal vs. Real</td>
<td>1 + real ror = [\frac{1 + \text{nominal ror}}{1 + \text{inflation rate}}]</td>
<td></td>
</tr>
</tbody>
</table>
Market Indexes

**Dow Jones Industrial Average (The Dow)**
Value of a portfolio holding one share in each of 30 large industrial firms.

**Standard & Poor’s Composite Index (The S&P 500)**
Value of a portfolio holding shares in 500 firms. Holdings are proportional to the number of shares in the issues.

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Some Historical Risk & Return Perspective (1900-2001)

<table>
<thead>
<tr>
<th>Investment Portfolio</th>
<th>Average Annual Return</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasury Bills</td>
<td>4.1%</td>
<td>2.8%</td>
</tr>
<tr>
<td>Treasury Bonds</td>
<td>5.1%</td>
<td>8.2%</td>
</tr>
<tr>
<td>Common Stocks</td>
<td>11.8%</td>
<td>19.9%</td>
</tr>
</tbody>
</table>

Historical Risk Premium over T-bills:
- Treasury Bonds: 5.1% - 4.1% = 1.0%
- Common Stock (Market) Risk Premium: 11.8% - 4.1% = 7.7%

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Using Historical Evidence to Estimate Today’s Cost of Capital

- For a risk-free investment = today’s 3-month T-bill rate.
- For an average risk project that has the same risk as the stock market = today’s 3-month T-bill rate + historical market risk premium = expected return on the market.
- Today’s 3-month T-bill rate = 0.9%, historical market risk premium = 7.7%
- Expected Market Return = 0.9% + 7.7% = 8.6%
**Expected Return: Single Asset**

- Expected Rate of Return given a probability distribution of possible returns ($r_i$): $E(r)$
  
  $E(r) = \sum_{i=1}^{n} p_i r_i$

- Realized or Average Return on Historical Data:
  
  $r = \frac{1}{n} \sum_{i=1}^{n} r_i$

**Standard Deviation**

- Relevant Risk Measure for single asset

  Variance = $\sigma^2 = \sum p_i (r_i - E(r))^2$

- Standard Deviation = Square Root of Variance

**Example: Exp. Return and $\sigma$**

<table>
<thead>
<tr>
<th>State of Economy</th>
<th>Probability</th>
<th>MAD Inc.</th>
<th>Co. (CON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boom</td>
<td>0.25</td>
<td>80%</td>
<td>5%</td>
</tr>
<tr>
<td>Normal</td>
<td>0.60</td>
<td>25%</td>
<td>10%</td>
</tr>
<tr>
<td>Recession</td>
<td>0.15</td>
<td>-25%</td>
<td>15%</td>
</tr>
</tbody>
</table>

- MAD $E(r) = .25(80\%) + .60(25\%) + .15(-25\%) = 31.25\%$

- CON $E(r) = .25(5\%) + .60(10\%) + .15(15\%) = 9.5\%$
Example: Standard Deviation

\[ \sigma^2 = .25(80\%-31.25\%)^2 + .60(25\%-31.25\%)^2 + .15(-25\%-31.25\%)^2 = 1092.1875\% \]
\[ \sigma = (1092.1875\%)^{1/2} = 33.0\% \]

Contrary \( \sigma \):

\[ \sigma^2 = .25(5\%-9.5\%)^2 + .60(10\%-9.5\%)^2 + .15(15\%-9.5\%)^2 = 9.75\% \]
\[ \sigma = (9.75\%)^{1/2} = 3.1\% \]

Portfolio Risk and Return

\[ E(r_p) = \sum_{i} w_i E(r_i) = \text{weighted average of the expected return of each asset in the portfolio} \]

In our example, MAD \( E(r) = 31.25\% \) and CON \( E(r) = 9.5\% \)

What is the expected return of a portfolio consisting of 50% MAD and 50% CON?

Risk and Diversification

Portfolio rate of return = \((\text{fraction of portfolio in first asset}) \times \left( \text{rate of return on first asset} \right) + (\text{fraction of portfolio in second asset}) \times \left( \text{rate of return on second asset} \right)\)

\[ E(r_p) = \sum_{i} w_i E(r_i) = .5(31.25\%) + .5(9.5\%) = 20.375\% \]
Portfolio Risk

- Looking at a 2-asset portfolio for simplicity, the riskiness of a portfolio is determined by the relationship between the returns of each asset over different scenarios or over time.
- This relationship is measured by the correlation coefficient $\rho$: $-1 \leq \rho \leq +1$
- Lower $\rho$ = less portfolio risk compared to the weighted average of the standard deviations.

Example 50% MAD, 50% CON

Portfolio $\sigma$

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<tr>
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<th>MAD Inc.</th>
<th>Co. (CON)</th>
<th>Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boom</td>
<td>0.25</td>
<td>80%</td>
<td>5%</td>
<td>42.5%</td>
</tr>
<tr>
<td>Normal</td>
<td>0.60</td>
<td>25%</td>
<td>10%</td>
<td>17.5%</td>
</tr>
<tr>
<td>Recession</td>
<td>0.15</td>
<td>-25%</td>
<td>15%</td>
<td>-5.0%</td>
</tr>
</tbody>
</table>

- $\sigma^2 = .25(42.5\% - 20.375\%)^2 + .60(17.5\% - 20.375\%)^2 + .15(-5\% - 20.375\%)^2 = 223.9\%$
- $\sigma = (223.9\%)^{1/2} \approx 14.96\%$

Risk and Diversification

Diversification - Strategy designed to reduce risk by spreading the portfolio across many investments.
Unique Risk - Risk factors affecting only that firm. Also called “diversifiable risk.”
Market Risk - Economy-wide sources of risk that affect the overall stock market. Also called “systematic risk.”
As more and more assets are added to a portfolio, total risk measured by $\sigma$ decreases. However, we could put every conceivable asset in the world into our portfolio and still have risk remaining. This remaining risk is called Market Risk and is measured by Beta (Chapter 11).