Risk Analysis

The Capital Asset Pricing Model

Two-Stock Portfolios

- Two stocks can be combined to form a riskless portfolio if $\rho = -1.0$.
- Risk is not reduced at all if the two stocks have $\rho = +1.0$.
- In general, stocks have $\rho \approx 0.35$, so risk is lowered but not eliminated.
- Investors typically hold many stocks.
- What happens when $\rho = 0$?

Adding Stocks to a Portfolio

- What would happen to the risk of an average 1-stock portfolio as more randomly selected stocks were added?
- $\sigma_p$ would decrease because the added stocks would not be perfectly correlated, but the expected portfolio return would remain relatively constant.
σ₁ stock ≈ 35%
σ_{Many stocks} ≈ 20%

<table>
<thead>
<tr>
<th>Returns (%)</th>
<th>-75</th>
<th>-60</th>
<th>-45</th>
<th>-30</th>
<th>-15</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 stock</td>
<td></td>
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<td></td>
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<tr>
<td>2 stocks</td>
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<tr>
<td>Many stocks</td>
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</tbody>
</table>

Risk vs. Number of Stock in Portfolio

Company Specific (Diversifiable) Risk
Stand-Alone Risk, σₚ
Market Risk

Stand-alone risk = Market risk + Diversifiable risk

- Market risk is that part of a security’s stand-alone risk that cannot be eliminated by diversification.
- Firm-specific, or diversifiable, risk is that part of a security’s stand-alone risk that can be eliminated by diversification.
Conclusions

- As more stocks are added, each new stock has a smaller risk-reducing impact on the portfolio.
- $\sigma_p$ falls very slowly after about 40 stocks are included. The lower limit for $\sigma_p$ is about 20% = $\sigma_M$.
- By forming well-diversified portfolios, investors can eliminate about half the risk of owning a single stock.

Can an investor holding one stock earn a return commensurate with its risk?

- No. Rational investors will minimize risk by holding portfolios.
- They bear only market risk, so prices and returns reflect this lower risk.
- The one-stock investor bears higher (stand-alone) risk, so the return is less than that required by the risk.

How is market risk measured for individual securities?

- Market risk, which is relevant for stocks held in well-diversified portfolios, is defined as the contribution of a security to the overall riskiness of the portfolio.
- It is measured by a stock's beta coefficient. For stock $i$, its beta is:
  
  $$b_i = \frac{\rho_{i,M} \sigma_i}{\sigma_M}$$
How are betas calculated?

- In addition to measuring a stock’s contribution of risk to a portfolio, beta also measures the stock’s volatility relative to the market.

Use the historical stock returns to calculate the beta for PQU.

<table>
<thead>
<tr>
<th>Year</th>
<th>Market</th>
<th>PQU</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>25.7%</td>
<td>40.0%</td>
</tr>
<tr>
<td>2</td>
<td>8.0%</td>
<td>-15.0%</td>
</tr>
<tr>
<td>3</td>
<td>-11.0%</td>
<td>-15.0%</td>
</tr>
<tr>
<td>4</td>
<td>15.0%</td>
<td>35.0%</td>
</tr>
<tr>
<td>5</td>
<td>32.5%</td>
<td>10.0%</td>
</tr>
<tr>
<td>6</td>
<td>13.7%</td>
<td>30.0%</td>
</tr>
<tr>
<td>7</td>
<td>40.0%</td>
<td>42.0%</td>
</tr>
<tr>
<td>8</td>
<td>10.0%</td>
<td>-10.0%</td>
</tr>
<tr>
<td>9</td>
<td>-10.8%</td>
<td>-25.0%</td>
</tr>
<tr>
<td>10</td>
<td>-13.1%</td>
<td>25.0%</td>
</tr>
</tbody>
</table>

Calculating Beta for PQU

\[ r_{PQU} = 0.8308 \times r_M + 0.0256 \]

\[ R^2 = 0.3546 \]
What is beta for PQU?

- The regression line, and hence beta, can be found using a calculator with a regression function or a spreadsheet program. In this example, b = 0.83.

Calculating Beta in Practice

- Many analysts use the S&P 500 to find the market return.
- Analysts typically use four or five years’ of monthly returns to establish the regression line.
- Some analysts use 52 weeks of weekly returns.

How is beta interpreted?

- If b = 1.0, stock has average risk.
- If b > 1.0, stock is riskier than average.
- If b < 1.0, stock is less risky than average.
- Most stocks have betas in the range of 0.5 to 1.5.
- Can a stock have a negative beta?
### Finding Beta Estimates on the Web

- Go to Thomson ONE—Business School Edition using the information on the card that comes with your book.
- Enter the ticker symbol for a "Stock Quote", such as IBM or Dell, then click GO.

### Other Web Sites for Beta

- Go to http://finance.yahoo.com
- Enter the ticker symbol for a “Stock Quote”, such as IBM or Dell, then click GO.
- When the quote comes up, select Key Statistics from panel on left.

### Expected Return versus Market Risk: Which investment is best?

<table>
<thead>
<tr>
<th>Security</th>
<th>Expected Return (%)</th>
<th>Risk, b</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alta</td>
<td>17.4</td>
<td>1.29</td>
</tr>
<tr>
<td>Market</td>
<td>15.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Am. Foam</td>
<td>13.8</td>
<td>0.68</td>
</tr>
<tr>
<td>T-bills</td>
<td>8.0</td>
<td>0.00</td>
</tr>
<tr>
<td>Repo Men</td>
<td>1.7</td>
<td>-0.86</td>
</tr>
</tbody>
</table>
Use the SML to calculate each alternative’s required return.

- The Security Market Line (SML) is part of the Capital Asset Pricing Model (CAPM).
- SML: \( r_i = r_{RF} + (\text{RPM})b_i \).
- Assume \( r_{RF} = 8\%; r_M = r_M = 15\% \).
- \( \text{RPM} = (r_M - r_{RF}) = 15\% - 8\% = 7\% \).

Required Rates of Return

- \( r_{Alta} = 8.0\% + (7\%)(1.29) = 17\% \).
- \( r_M = 8.0\% + (7\%)(1.00) = 15.0\% \).
- \( r_{Am. F.} = 8.0\% + (7\%)(0.68) = 12.8\% \).
- \( r_{T-bill} = 8.0\% + (7\%)(0.00) = 8.0\% \).
- \( r_{Repo} = 8.0\% + (7\%)(-0.86) = 2.0\% \).

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</tr>
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SML: \( r_i = r_{RF} + (R_{PM}) b_i \)

\( r_i = 8\% + (7\%) b_i \)

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Calculate beta for a portfolio with 50% Alta and 50% Repo

\[
b_p = \text{Weighted average} \\
= 0.5(b_{Alta}) + 0.5(b_{Repo}) \\
= 0.5(1.29) + 0.5(-0.86) \\
= 0.22.
\]

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Required Return on the Alta/Repo Portfolio?

\[
r_p = \text{Weighted average } r \\
= 0.5(17\%) + 0.5(2\%) = 9.5\%.
\]

Or use SML:

\[
r_p = r_{RF} + (R_{PM}) b_p \\
= 8.0\% + 7\%(0.22) = 9.5\%.
\]
Has the CAPM been completely confirmed or refuted?

- No. The statistical tests have problems that make empirical verification or rejection virtually impossible.
- Investors’ required returns are based on future risk, but betas are calculated with historical data.
- Investors may be concerned about both stand-alone and market risk.