Chapter 11
Risk, Return, and Capital Budgeting

Topics Covered
- Measuring Market Risk
- Portfolio Betas
- Risk and Return
- CAPM and Expected Return
- Security Market Line
- Capital Budgeting and Project Risk

Chapter 11 Objectives
- To be able to measure and interpret the market risk, or beta of a security.
- To relate the market risk of a security to the rate of return that investors demand and apply this rate to stock valuation.
- To calculate the opportunity cost of capital for a project.
Some risk can be diversified away and some cannot.

- **Market risk** (systematic risk) is nondiversifiable. This type of risk cannot be diversified away. Macroeconomic factors that affect all companies.
- **Unique risk** (unsystematic risk) is diversifiable. This type of risk can be reduced through diversification. Specific (microeconomic) factors that affect individual firms or industries.

As you add stocks to your portfolio, unique risk is reduced.

Note:

- The market compensates investors for accepting risk - but only for market risk. Unique risk can and should be diversified away.
- So - we need to be able to measure market risk. We use **beta** as a measure of market risk.
The Concept of Beta

- **Beta** ($\beta$) measures how the return of an individual asset (or even a portfolio) varies with the market portfolio (a stock index like the S&P 500).
- $\beta = 1.0$ : same risk as the market (average stock)
- $\beta < 1.0$ : less risky than the market (defensive stock)
- $\beta > 1.0$ : more risky than the market (aggressive stock)
- Beta is the slope of the regression line ($y = a + \beta x$) between a stock’s return ($y$) and the market return ($x$) over time, $\beta$ from simple linear regression.
- $\beta_i = \frac{\text{Covariance}_{i,m}}{\text{Mkt. Var.}} = \frac{\rho_{im}\sigma_i}{\sigma_m^2}$

Measuring Market Risk

**Example** - Turbo Charged Seafood has the following % returns on its stock, relative to the listed changes in the % return on the market portfolio. The beta of Turbo Charged Seafood can be derived from this information.

![Shark]

<table>
<thead>
<tr>
<th>Month</th>
<th>Market Return %</th>
<th>Turbo Return %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>+ 1</td>
<td>+ 0.8</td>
</tr>
<tr>
<td>2</td>
<td>+ 1</td>
<td>+ 1.8</td>
</tr>
<tr>
<td>3</td>
<td>+ 1</td>
<td>- 0.2</td>
</tr>
<tr>
<td>4</td>
<td>- 1</td>
<td>- 1.8</td>
</tr>
<tr>
<td>5</td>
<td>- 1</td>
<td>+ 0.2</td>
</tr>
<tr>
<td>6</td>
<td>- 1</td>
<td>- 0.8</td>
</tr>
</tbody>
</table>

Measuring Market Risk

**Example** - continued
Measuring Market Risk

Example - continued

- When the market was up 1%, Turbo average % change was +0.8%.
- When the market was down 1%, Turbo average % change was -0.8%.
- The average change of 1.6 % (-0.8 to 0.8) divided by the 2% (-1.0 to 1.0) change in the market produces a beta of 0.8.

$$B = \frac{1.6}{2} = 0.8$$

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Portfolio Beta

- The $\beta$ for a portfolio of stocks is the weighted average of the individual stock $\beta$s.
- $\beta_p = \sum w_i \beta_i$

**Example:** What is the portfolio beta for a portfolio consisting of 40% Dell with $b = 2.14$, 30% General Electric with $b = 1.18$, and 30% PepsiCo. with $b = 0.67$.
- $B_p = .4(2.17) + .3(1.18) + .3(0.67) = 1.423$
Relating Market Risk and Expected Return: the CAPM

- Here’s the word story: a stock’s expected rate of return = risk-free rate + the (stock’s) risk premium.
- The main assumption is investors hold well diversified portfolios = only concerned with market risk.
- A stock’s risk premium = measure of market risk X market risk premium.

CAPM Equation

- market risk premium = \( r_m - r_f \)
- risk premium = \( \beta (r_m - r_f) \)
- \( r = r_f + \beta (r_m - r_f) \)

Example: What is Yahoo’s expected return if its \( \beta \) = 1.75, the current 3-mo. T-bill rate is 1%, and the historical market risk premium of 8% is demanded?

Yahoo \( k = 1\% + 1.75(8\%) = 15\% \)

The Security Market Line (SML)

- A graphical representation of the CAPM equation.
- Gives expected returns for investments with different betas.
- Y axis = expected return, X axis = beta
- Intercept = risk-free rate = 3-month T-bill rate (B = 0)
- Slope of SML = market risk premium
- For the following SML graph, let’s use the current 3-month T-bill rate of 1% and assume investors expect a market risk premium equal to the historical market risk premium of 8%.
- Graph \( r = 1\% + B(8\%) \)
- Expected market return (B=1) = 1+1(8%) = 9%
Application of CAPM to Stock Valuation

- Can use CAPM to calculate a stock’s expected return for valuation purposes.
- Also, our previous expected return formulas should equal CAPM expected return.
- Expected Dividend Yield + Expected Capital Gains Yield = CAPM expected return
- \((\text{Div}_1 + \frac{P_1 - P_0}{P_0})\) or \(\text{Div}_1/P_0 + g = \text{CAPM}\)

CAPM and Stock Valuation: Pepsi

- Pepsi’s B = 0.67, assume \(r_f = 1\%\), \(r_m = 9\%\). Pepsi’s stock price today is $48 and it’s expected dividend is $0.68. What price do investors expect Pepsi’s stock to sell for a year from now?
- From CAPM: \(r = 1\% + 0.67(9\%-1\%) = 6.36\%\)
- \(6.36\% = \text{Exp. Dividend Yld.} + \text{Exp. Capital Gains Yld.}\)
- \(P_0 = \$48, \text{Div}_1 = \$0.68; \text{Div}_1/P_0 = \$0.68/\$48 = 1.42\%\)
- \(1.42\% + \text{Exp. Capital Gain Yld} = 6.36\%\)
- \(\text{Exp Capital Gain Yld} = 4.94\% = (P_1-P_0)/P_0 \text{ or } g\)
- \(\text{Exp. } P_1 = P_0(1+g) = \$48(1.0494) = \$50.37\)
What about this Pepsi?

• Pepsi’s $B = 0.67$, assume $r_i = 1\%$, $r_m = 9\%$. Pepsi’s stock price today is $48$ and it’s expected dividend is $0.68$. Analysts now expect a constant growth rate of 5.25% for Pepsi? Would you want to buy Pepsi today for $48$?

• Pepsi’s CAPM return = $1\% + 0.67(9\%-1\%)$ = 6.36\%

• Div$/P_0 + g = \frac{0.68}{48} + .0525 = 6.67\%$

Pepsi: Analyst Expected Return vs. CAPM

• Investors would want to buy Pepsi and will drive up the price until its expected return = CAPM return of 6.36%.

• New Price = Div$/\text{CAPM} r – g = \frac{0.68}{0.0636 - .0525} = 61.26$

Capital Budgeting & Project Risk

• The project cost of capital depends on the use to which the capital is being put. Therefore, it depends on the risk of the project and not the risk of the company.

• For now, we can assume a firm uses only equity financing. (We’ll relax this assumption in Chapter 12.)

• Given this assumption, we can use the market risk of the project and the CAPM to find the opportunity cost of capital.
Capital Budgeting & Project Risk

Example. Based on the CAPM with $r_f = 3\%\text{ and market risk premium of }9\%$, MAD-Doctor Inc. (insert maniacal laughter here) has a cost of capital of $3\% + 2.1(9\%) = 21.9\%$. A breakdown of the company’s investment projects is listed below. When evaluating a new tissue re-animation investment, which cost of capital should be used?

1/3 Lightning Power Generation $B=1.6$
1/3 Surgical Equipment $B=2.0$
1/3 Tissue Re-animation $B=2.7$

AVG. $B$ of assets = 2.1

Re-animation $r = 3\% + 2.7(9\%) = 27.3\%$

27.3\% reflects the opportunity cost of capital on an investment given the unique risk of the project.