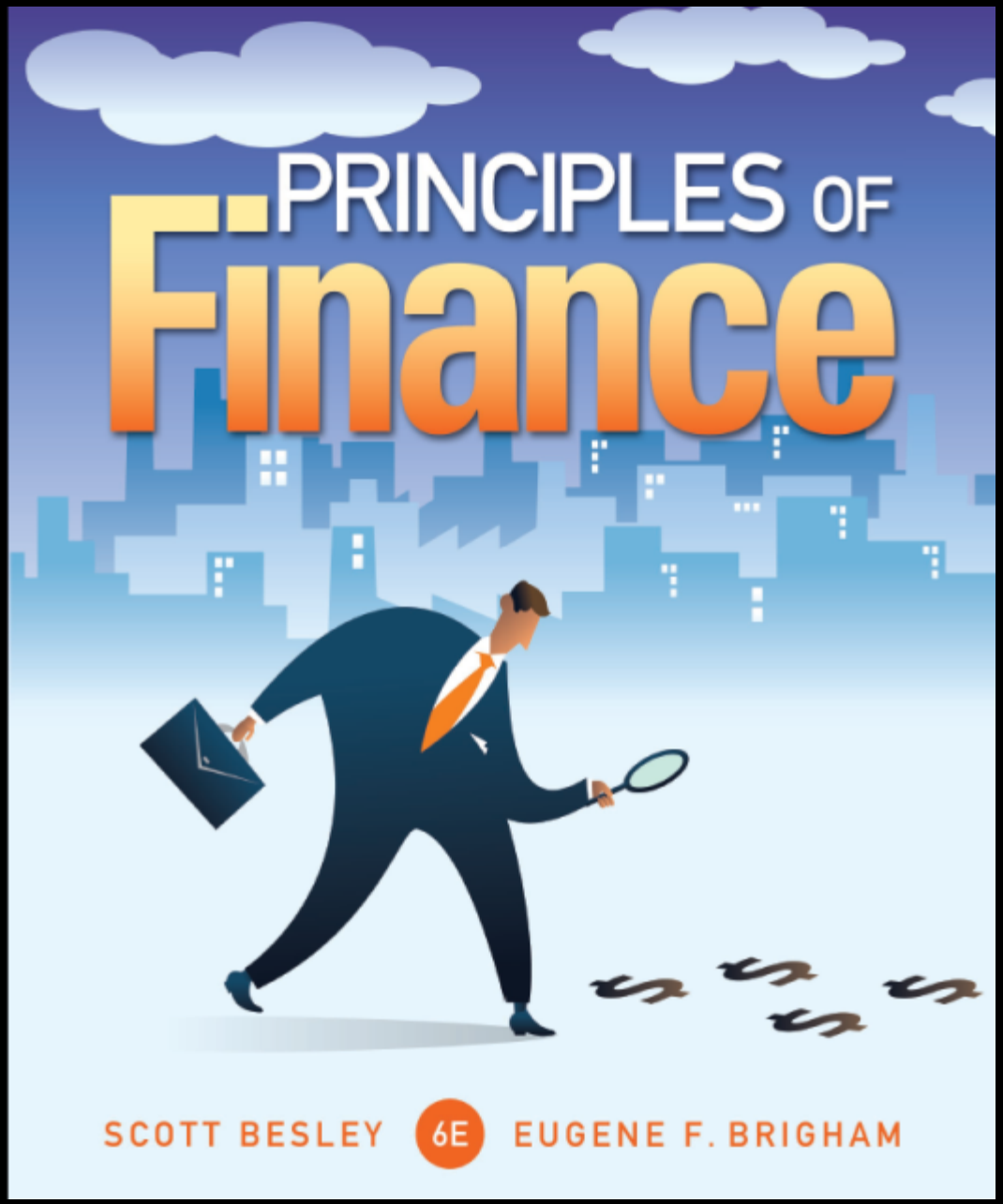


Chapter 11

Risks and Rates of Return

Besley & Brigham

Chapter 11 – Learning Objectives

- ✓ Explain what it means to take risk when investing.
- ✓ Compute the risk and return of an investment and explain how the risk and return of an investment are related.
- ✓ Identify relevant and irrelevant risk and explain how irrelevant risk can be reduced.
- ✓ Describe how to determine the appropriate reward—that is, risk premium—that investors should earn for purchasing a risky investment.
- ✓ Describe actions that investors take when the return they require to purchase an investment is different from the return they expect the investment to produce.
- ✓ Identify different types of risk and classify each as relevant or irrelevant with respect to determining an investment's required rate of return.

Defining and Measuring Risk

- Risk is the chance that an outcome other than the one expected will occur
- A one-word definition of risk is "variability" (of returns)
- A probability distribution is a list of all possible outcomes with a probability assigned to each
  - Probabilities must sum to 1.0 (100%)

Probability Distributions

- It either will rain, or it will not rain
  - Only two possible outcomes

Outcome	Probability
Rain	0.40 = 40%
No rain	0.60 = 60
	1.00 = 100%

Probability Distributions

State of the Economy	Probability of This State Occurring	Rate of Return on Stock if Economic State Occurs	
		Martin Products	U.S. Electric
Boom	0.2	110%	20%
Normal	0.5	22	16
Recession	0.3	-60	10
	1.0		

Expected Rate of Return

- ✓ The rate of return expected to be realized from an investment over a long period of time
- ✓ The mean value of the probability distribution of possible returns
- ✓ The weighted average of the outcomes, where the weights are the probabilities

Expected Rate of Return

$$\hat{r} = Pr_1 r_1 + Pr_2 r_2 + \ldots + Pr_n r_n$$

$$= \sum_{i=1}^{n} Pr_i r_i$$

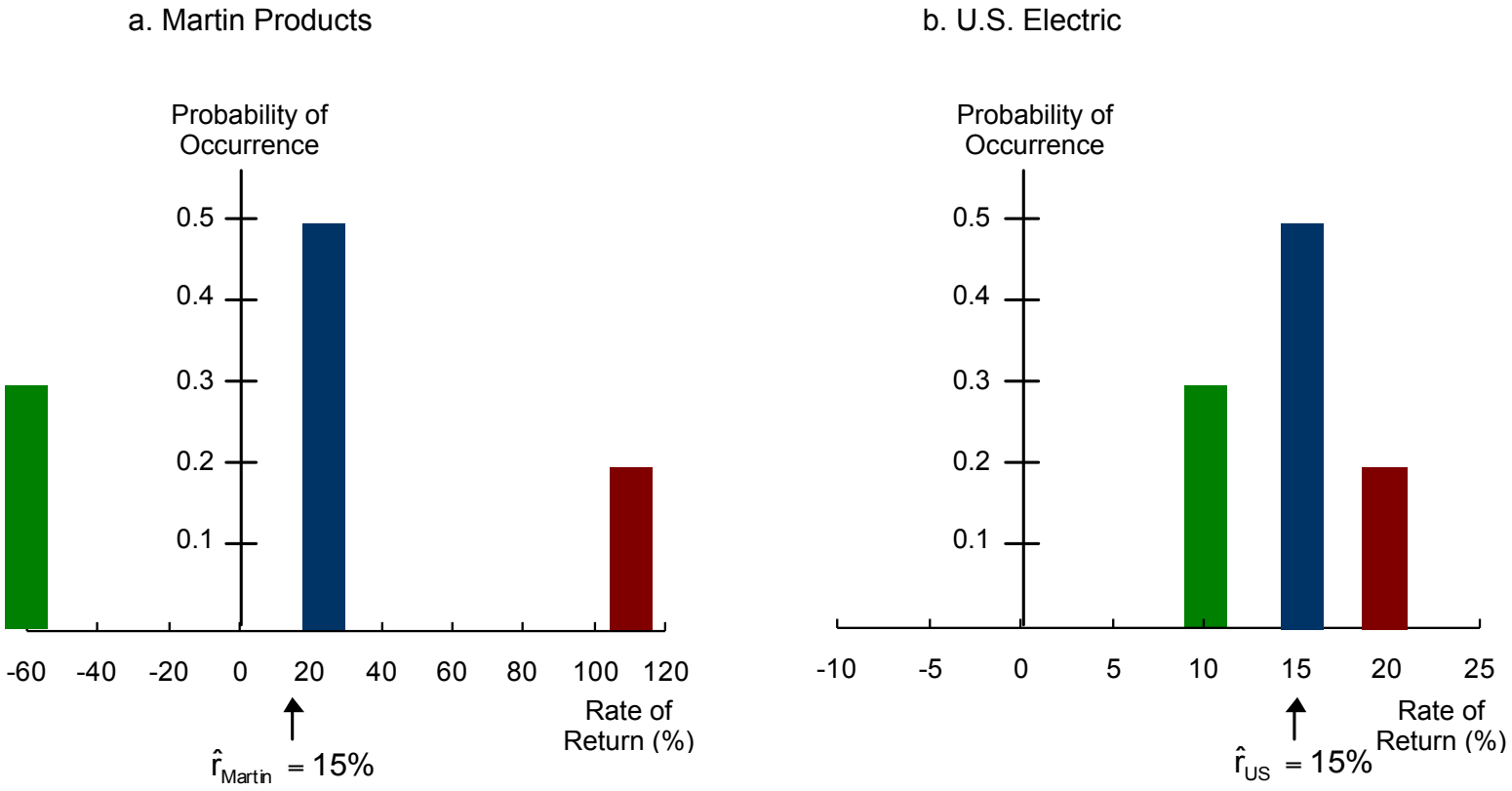
r_i = the ith possible outcome

Pr_i = probability that the ith outcome will occur

Discrete Probability Distributions

- ✓ The number of possible outcomes is limited, or finite

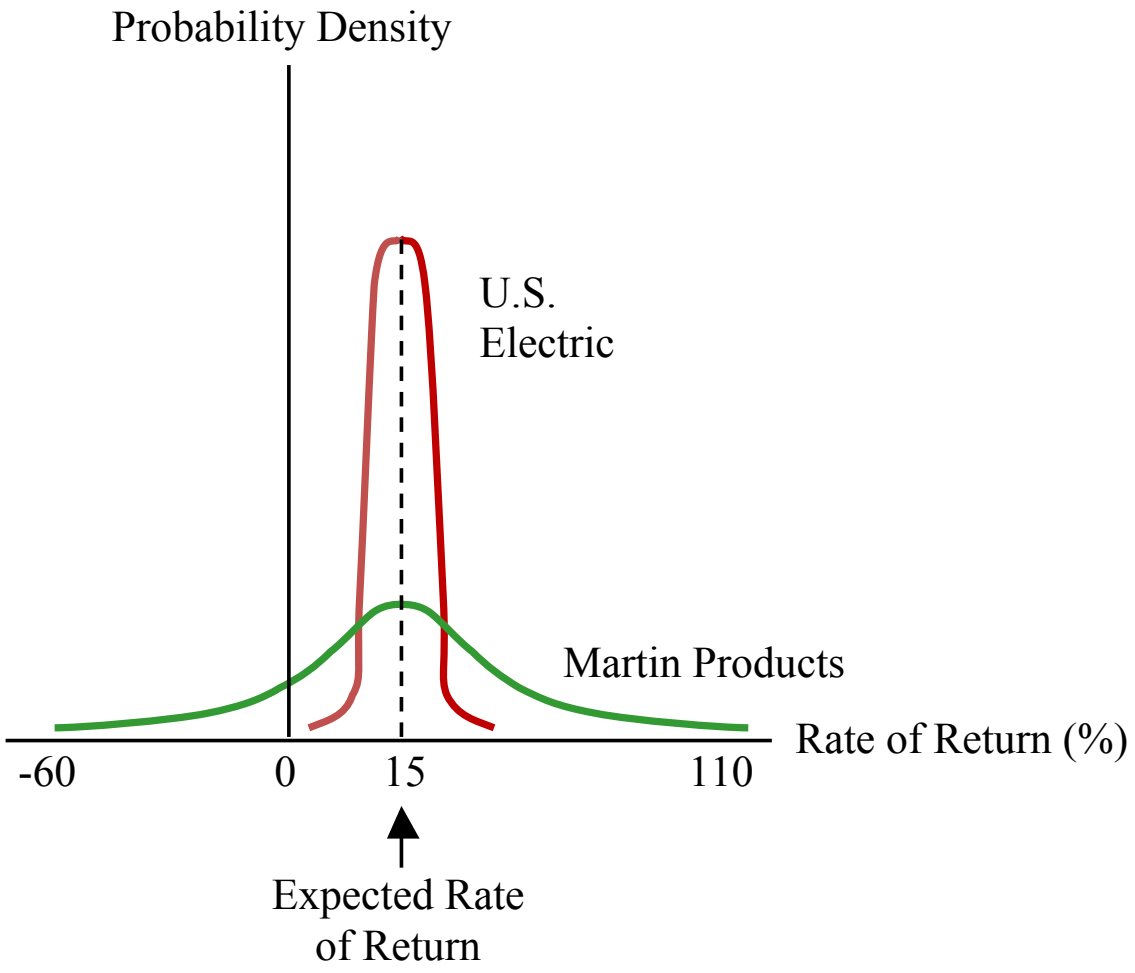
Discrete Probability Distributions



Continuous Probability Distributions

- ✓ The number of possible outcomes is unlimited, or infinite

Continuous Probability Distributions



Measuring (Stand-Alone) Risk: The Standard Deviation, σ

- ✓ Measures of the tightness, or variability, of a set of outcomes

Calculating Standard Deviation

1. Calculate the deviation from the expected return for each possible outcome

$$\text{Deviation}_i = r_i - \hat{r}$$

2. Square each deviation: $(r_i - \hat{r})^2$
3. Multiply the result by the probability of occurrence for its related outcome, and then sum the results, which is the variance of the probability distribution

$$\text{Variance} = \sigma^2 = \sum_{i=1}^{n} (r_i - \hat{r})^2 Pr_i$$

Calculating Standard Deviation

4. Take the square root of the variance to get the standard deviation

$$\text{Standard deviation} = \sigma = \sqrt{\sigma^2} = \sqrt{\sum_{i=1}^{n} (r_i - \hat{r})^2 Pr_i}$$

Measuring Risk: The Standard Deviation

- ✓ Calculating Martin Products' Standard Deviation

Payoff r_i (1)		Expected Return $\hat{r}$ (2)		Deviation $(r_j - \hat{r})$ (1) – (2) = (3)	$(r_j - \hat{r})^2$ = (4)	Prob-ability (5)	$(r_j - \hat{r})^2 Pr_j$ (4) x (5) = (6)
110%	-	15%	=	95	9,025	0.2	9,025 x 0.2 = 1,805.0
22	-	15	=	7	49	0.5	49 x 0.5 = 24.5
-60	-	15	=	-75	5,625	0.3	5,625 x 0.3 = 1,678.5

Standard deviation = $\sigma = \sqrt{\sigma} = \sqrt{3,517} =$ 59.3%

Historical Measures—Average Return

- ✓ The arithmetic average of past returns is computed as

$$\bar{r} = \frac{\ddot{r}_1 + \ddot{r}_2 + \cdots + \ddot{r}_n}{n}$$

Here, $\ddot{r}_1$ is the return that was earned in Period 1, and so forth.

Historical Measures—Estimated σ

- ✓ σ can be estimated using historical return using the following equation:

$$\text{Estimated } s = \sigma = \sqrt{\frac{(\ddot{r}_1 - \bar{r})^2 + (\ddot{r}_2 - \bar{r})^2 + \cdots + (\ddot{r}_n - \bar{r})^2}{n-1}}$$

Here, $\ddot{r}_1$ is the return that was earned in Period 1, and so forth, and $\bar{r}$ is the average of the historical returns.

Measuring Risk: Coefficient of Variation

- ✓ Standardized measure of risk per unit of return
- ✓ Calculated as the standard deviation divided by the expected return

$$\text{Coefficient of variation} = \text{CV} = \frac{\text{Risk}}{\text{Return}} = \frac{\sigma}{\hat{r}}$$

- ✓ Useful where investments differ in both risk and expected returns

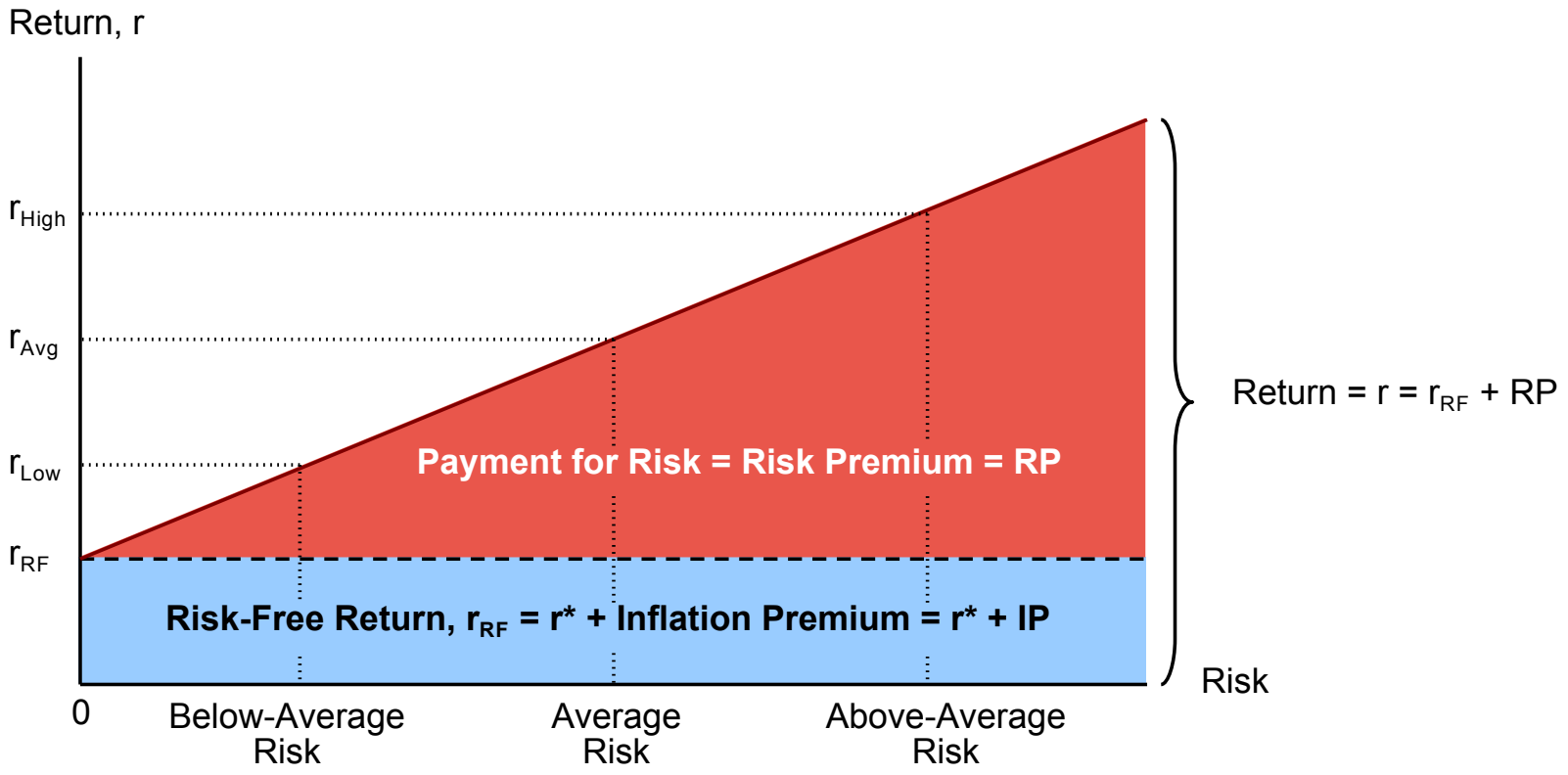
Risk Aversion

- Risk-averse investors require higher rates of return to invest in higher-risk securities

Risk Aversion and Required Returns

- Risk premium (RP)
  - The portion of the expected return that can be attributed to the additional risk of an investment
  - The difference between the expected rate of return on a given risky asset and that on a less risky asset

Risk/Return Relationship



Portfolio Risk and the Capital Asset Pricing Model (CAPM)

- ✓ Portfolio
  - ✓ A collection of investment securities
- ✓ CAPM
  - ✓ A model based on the proposition that any stock's required rate of return is equal to the risk-free rate of return plus a risk premium, where risk reflects diversification

Portfolio Returns

- Expected return on a portfolio $\hat{r}_p$

  - The weighted average expected return on the stocks held in the portfolio

$$\hat{r}_p = w_1\hat{r}_1 + w_2\hat{r}_2 + \ldots + w_N\hat{r}_N$$

$$= \sum_{j=1}^{N} w_j\hat{r}_j$$

Portfolio Risk

- ✓ Correlation coefficient ρ
  - ✓ A measure of the degree of relationship between two variables
  - ✓ Positively correlated investments have rates of return that generally move in the same direction
  - ✓ Negatively correlated investments have rates of return that generally move in opposite directions

Portfolio Risk

- Risk reduction
  - Combining stocks that are not perfectly positively correlated will reduce portfolio risk through diversification
  - The riskiness of a portfolio is reduced as the number of stocks in the portfolio increases
  - The smaller the positive correlation, the greater the reduction of risk from adding another investment

Firm-Specific Risk versus Market Risk

- The total risk of an investment can be divided into two components:
  - Firm-specific risk—unique to a firm or industry
  - Market risk—economic risk
- The following relationship exists:

  Total risk = Firm-specific risk + Market risk

Firm-Specific Risk versus Market Risk

- ✓ Firm-specific risk
  - ✓ That part of a security's risk associated with random outcomes generated by events, or behaviors, specific to the firm
  - ✓ It can be eliminated through proper diversification

Firm-Specific Risk versus Market Risk

- Market risk
  - That part of a security's risk that cannot be eliminated through diversification because it is associated with economic, or market factors that systematically affect all firms

The Concept of Beta

- Beta coefficient β
  - A measure of the extent to which the returns on a given stock move with the entire stock market
  - β = 0.5: stock is only half as volatile, or risky, as the average stock (market)
  - β = 1.0: stock has average risk
  - β = 2.0: stock is twice as risky as the average stock

Portfolio Beta Coefficients

- The beta of any set of securities is the weighted average of the individual securities' betas

$$\beta_p = w_1\beta_1 + w_2\beta_2 + \ldots + w_N\beta_N$$

$$= \sum_{j=1}^{N} w_j\beta_j$$

The Relationship between Risk and Rates of Return

r_j = Required rate of return on Stock j

r_{RF} = Risk-free rate of return

β_j = Stock j's beta coefficient

r_M = Required rate of return on a portfolio consisting of all stocks (i.e., the market)

$RP_M = (r_M - r_{RF})$ = Risk premium on the market, given an average amount of relevant risk

$RP_j = (r_M - r_{RF})\ \beta_j$ = Risk premium on Stock j that is appropriate for the amount of relevant risk

Market Risk Premium

- ✓ RP_M is the additional return over the risk-free rate needed to compensate investors for assuming an average amount of risk
- ✓ Assuming:
  - ✓ Treasury bonds yield = 5%
  - ✓ Average stock required return = 11%
  - ✓ Thus, the market risk premium is 6%:
- ✓ $RP_M = r_M - r_{RF} = 11\% - 5\% = 6\%$

Risk Premium for a Stock

- ✓ Risk premium for Stock j if $\beta = 0.5$

$$= RP_M \times \beta_j$$

$$= 6\% \times 0.5$$

$$= 3.0\%$$

The Required Rate of Return for a Stock

- Security Market Line (SML)
  - The line that shows the relationship between risk as measured by beta and the required rate of return for individual securities

The Required Rate of Return for Stock j

$$\text{SML:} \quad r_j = r_{RF} + (RP_M)\beta_j$$

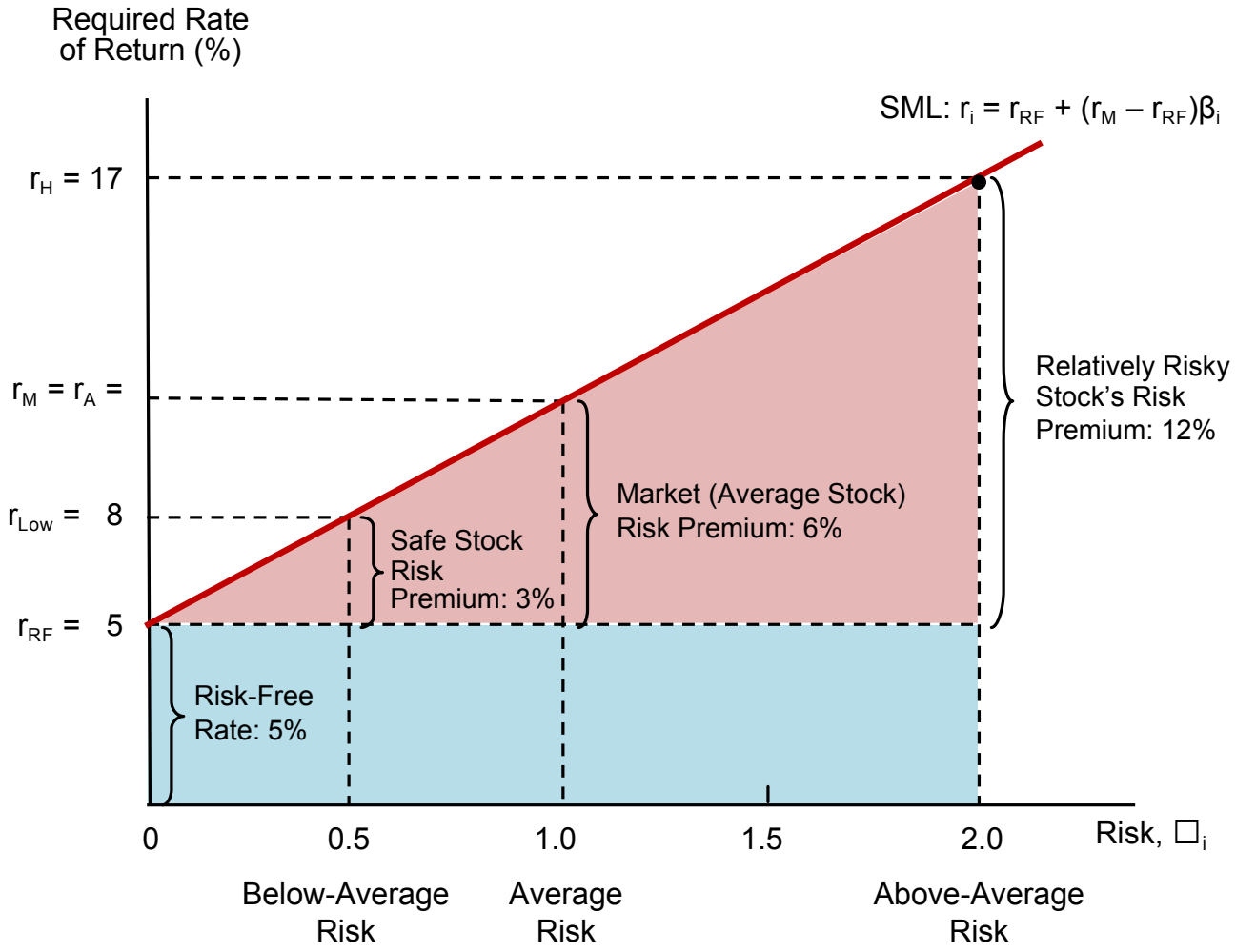
$$= r_{RF} + (r_M - r_{RF})\beta_j$$

$$= 5\% + (11\% - 5\%)(0.5)$$

$$= 5\% + 6\%(0.5)$$

$$= 8\%$$

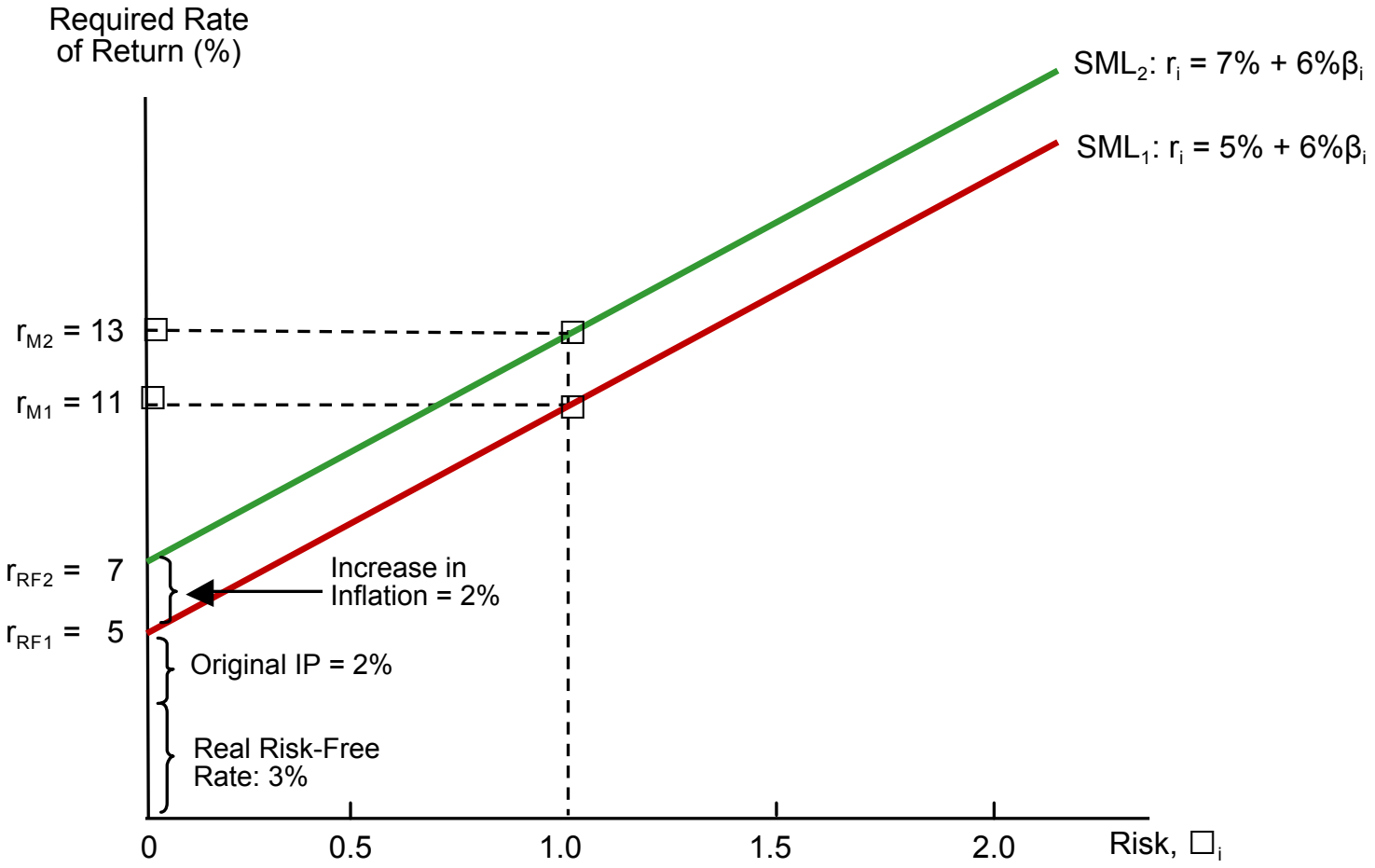
Security Market Line



The Impact of Inflation

- ✓ r_{RF} is the price of money to a riskless borrower
- ✓ The nominal rate consists of
  - ✓ A real (inflation-free) rate of return, r*
  - ✓ An inflation premium (IP)
- ✓ An increase in expected inflation would increase the risk-free rate, r_{RF}

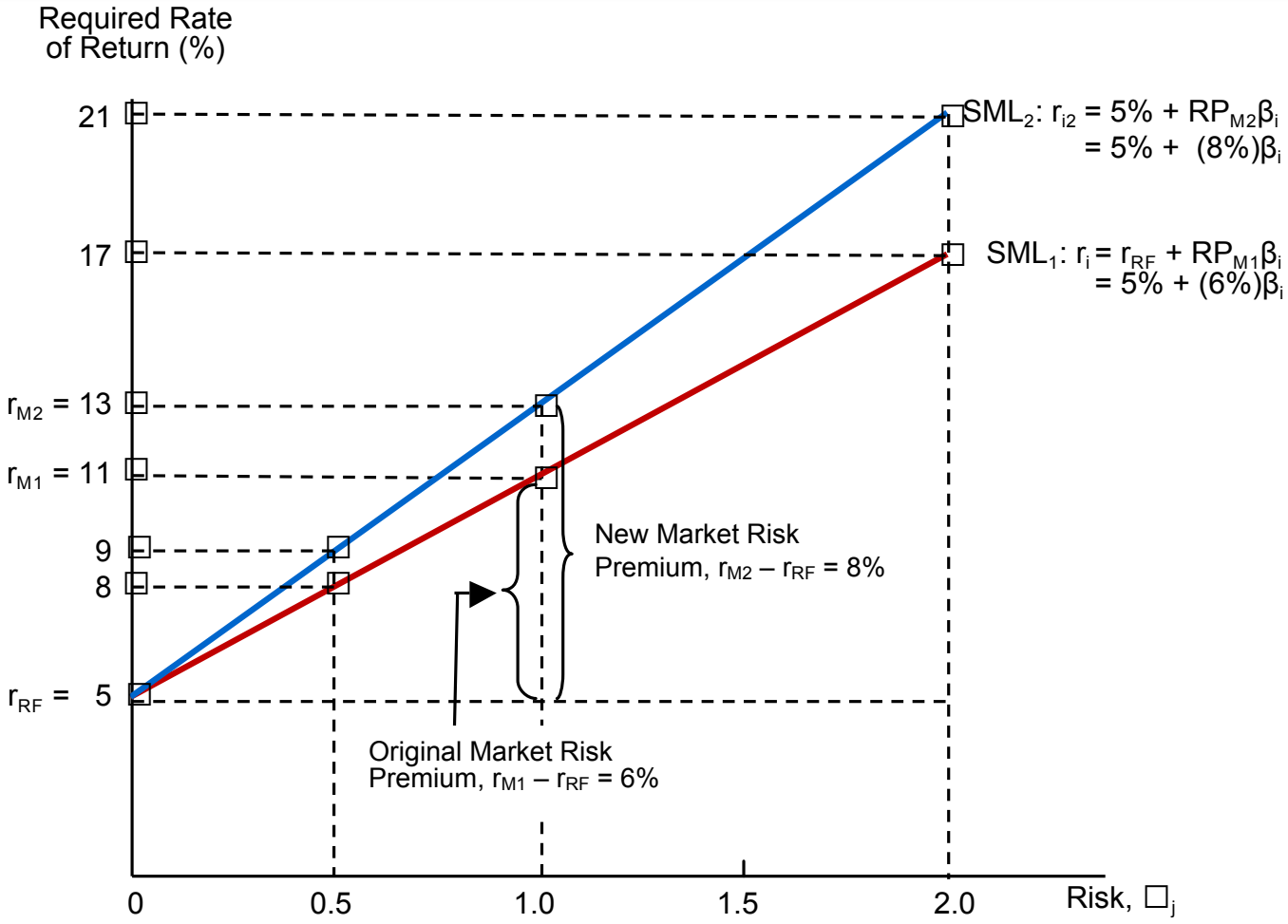
Shift in the SML Caused by a 2% Increase in Inflation



Changes in Risk Aversion

- The slope of the SML reflects the extent to which investors are averse to risk
- An increase in risk aversion increases the risk premium, which in turn increases the slope

Shift in the SML Caused by Increased Risk Aversion



Changes in a Stock's Beta Coefficient

- The β risk of a stock is affected by
  - Composition of its assets
  - Use of debt financing
  - Increased competition
  - Expiration of patents, copyrights, etc.
- Any change in the required return (from change in β or in expected inflation) affects the stock price

Word of Caution

- CAPM
  - Based on expected conditions
  - Only have historical data
  - As conditions change, future volatility may differ from past volatility
  - Estimates are subject to error

Stock Market Equilibrium

- The condition under which the expected return on a security, $\hat{r}_j$, is just equal to its required return, r_j. That is, $\hat{r}_j = r_j$
- Actual market price equals its intrinsic value as estimated by the marginal investor, leading to price stability

Changes in Equilibrium Stock Prices

- Stock prices are not constant due to changes in:
  - Risk-free rate, r_{RF}
  - Market risk premium, $r_M - r_{RF}$
  - Stock X's beta coefficient, β_X
  - Stock X's expected growth rate, g_X
  - Changes in expected dividends, $D_0(1+g)$

Physical Assets versus Securities

- ✓ Riskiness of a physical asset is only relevant in terms of its effect on the company's relevant risk

Different Types of Risk

- ✓ Systematic Risks
  - ✓ Interest rate risk
  - ✓ Inflation risk
  - ✓ Maturity risk
  - ✓ Liquidity risk
  - ✓ Exchange rate risk
  - ✓ Political risk

Different Types of Risk

- ✓ Unsystematic Risks
  - ✓ Business risk
  - ✓ Financial risk
  - ✓ Default risk
- ✓ Combined Risks
  - ✓ Total risk
  - ✓ Corporate risk

Chapter Principles
Key Risks and Rates of Return Concepts

- What does it mean to take risk when investing?
  - The chance of receiving a return other than the one expected
- How are the risk and return of an investment related?
  - Riskier investments must offer higher expected returns than less risky investments; otherwise, people will not purchase investments with higher risks.

Chapter Principles
Key Risks and Rates of Return Concepts

- What are relevant and irrelevant risk?
  - Relevant risk is nondiversifiable risk, because it cannot be eliminated, even in a perfectly diversified portfolio.
  - Irrelevant risk can be reduced through diversification.
- How is appropriate reward (risk premium) determined?
  - The effects of nondiversifiable risk can be determined by computing the beta coefficient (β) of an investment.
  - An investment's required rate of return can be computed as: $r_i = r_{RF} + (r_{RF} - r_M)\beta_i = r_{RF} + (RP_M)\beta_i$

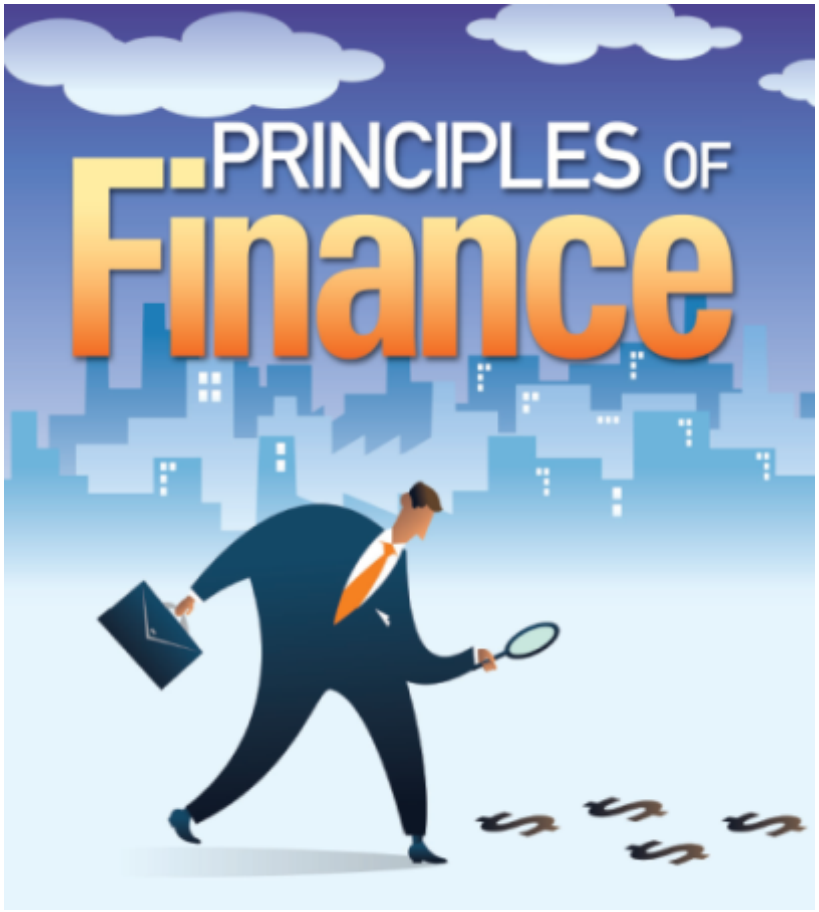
Chapter Principles
Key Risks and Rates of Return Concepts

- What actions do investors take when the return they require to purchase an investment is different form the return the investment is expected to produce?
  - When an investment's expected return is less than investors' required return, potential investors will not purchase it and those who own the investment will tend to sell it
  - These actions will lower the price of the investment, which will increase it expected rate of return

Chapter Principles
Key Risks and Rates of Return Concepts

- What are different types of relevant and irrelevant risks?
  - Relevant risks include those types that are related to economic factors, such as interest rate risk, inflation risk, and so forth
  - Risks that are not relevant because they can be diversified away include those types that are related to a specific firm or industry, such as business risk, default risk, and so forth.

End of Chapter 11



Risks and Rates of Return