

Introduction to Financing

Prepared by Dr. Sara Ahmed

Lecture 6





مجموعة جامعة
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Risk and Return

Lecture 6

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Topic
06

OUTLINE

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Topic
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Key Concepts and Skills

- Know how to calculate expected returns
- Understand:
 - The impact of diversification
 - The systematic risk principle
 - The security market line and the risk-return trade-off

Expected Returns

- Expected returns are based on the probabilities of possible outcomes

$$E(R) = \sum_{i=1}^n p_i R_i$$

Where:

p_i = the probability of state “i” occurring

R_i = the expected return on an asset in state i

Example: Expected Returns

		E(R)	
		Stock A	Stock B
State (i)	p(i)	E(Ra)	E(Rb)
Recession	0.25	-20%	30%
Neutral	0.50	15%	15%
Boom	0.25	35%	-10%
E(R)	1.00	25%	20%

$$E(R) = \sum_{i=1}^n p_i R_i$$

Example: Expected Returns

		E(R)			
		Stock A		Stock B	
State (i)	p(i)	E(Ra)	p(i) x E(Ra)	E(Rb)	p(i) x E(Rb)
Recession	0.25	-20%	-5.0%	30%	7.5%
Neutral	0.50	15%	7.5%	15%	7.5%
Boom	0.25	35%	8.8%	-10%	-2.5%
E(R)	1.00		11.3%		12.5%

$$E(R) = \sum_{i=1}^n p_i R_i$$

Variance and Standard Deviation

- Variance and standard deviation measure the volatility of returns
- Variance = Weighted average of squared deviations
- Standard Deviation = Square root of variance

$$\sigma^2 = \sum_{i=1}^n p_i (R_i - E(R))^2$$

Variance & Standard Deviation

		Stock A		
State (i)	p(i)	E(R)	DEV ²	x p(i)
Recession	0.25	-20%	10%	0.0244141
Neutral	0.50	15%	2%	0.0112500
Boom	0.25	35%	6%	0.0141016
1.00				
Expected Return		11.3%		
Variance				0.0497656
Standard Deviation				22.3%

		Stock B		
State (i)	p(i)	E(R)	DEV ²	x p(i)
Recession	0.25	30%	3%	0.0076563
Neutral	0.50	15%	2%	0.0112500
Boom	0.25	-10%	5%	0.0126563
1.00				
Expected Return		12.5%		
Variance				0.0316
Standard Deviation				17.8%

Portfolios

- Portfolio = collection of assets
- An asset's risk and return impact how the stock affects the risk and return of the portfolio
- The risk-return trade-off for a portfolio is measured by the portfolio expected return and standard deviation, just as with individual assets

Portfolio Expected Returns

- The expected return of a portfolio is the weighted average of the expected returns for each asset in the portfolio
- Weights (w_j) = % of portfolio invested in each asset

$$E(R_P) = \sum_{j=1}^m w_j E(R_j)$$

Example: Portfolio Weights

Asset	Dollars Invested	% of Pf w(j)	E(R_j)	w(j) x E(R_j)
A	\$15,000	30%	12.5%	3.735%
B	\$8,600	17%	9.5%	1.627%
C	\$11,000	22%	10.0%	2.191%
D	\$9,800	20%	7.5%	1.464%
E	\$5,800	12%	8.5%	0.982%
	\$50,200	100%		10.000%

Expected Portfolio Return

Alternative Method

	A	B	C	D	E	F	G	H
1			Stock V	Stock W	Stock X	Stock Y	Stock Z	Portfolio
2		w(j)	30%	17%	22%	20%	12%	100%
3	State (i)	p(i)	Expected Return					
4	Recession	0.25	-20.0%	18.0%	5.0%	-8.0%	4.0%	-3%
5	Neutral	0.50	17.5%	15.0%	10.0%	11.0%	9.0%	13%
6	Boom	0.25	35.0%	-10.0%	15.0%	16.0%	12.0%	17%
7	E(R)	1.00	12.5%	9.5%	10.0%	7.5%	8.5%	10%

Steps:

1. Calculate expected portfolio return in each state: $\Rightarrow E(R_{P,i}) = \sum_{j=1}^5 w_j E(R_j)$
2. Apply the probabilities of each state to the expected return of the portfolio in that state
3. Sum the result of step 2

$$\left. \begin{array}{l} \text{Step 2} \\ \text{Step 3} \end{array} \right\} E(R_p) = \sum_{i=1}^3 p_i E(R_{P,i})$$

Portfolio Risk

Variance & Standard Deviation

- Portfolio standard deviation is **NOT** a weighted average of the standard deviation of the component securities' risk
 - If it were, there would be no benefit to diversification.

Portfolio Variance

- Compute portfolio return for each state:

$$R_{P,i} = w_1R_{1,i} + w_2R_{2,i} + \dots + w_mR_{m,i}$$

- Compute the overall expected portfolio return using the same formula as for an individual asset
- Compute the portfolio variance and standard deviation using the same formulas as for an individual asset

Portfolio Risk

		Portfolio			
State (i)	p(i)	E(R)	Dev	Dev^2	x p(i)
Recession	0.25	-3%	-13%	0.01663	0.00416
Neutral	0.50	13%	3%	0.00101	0.00050
Boom	0.25	17%	7%	0.00428	0.00107
E(R)	1.00	10%		VAR(Pf)	0.00573259
				Std(Pf)	7.6%

1. Calculate Expected Portfolio Return in each state of the economy and overall ([Slide 11-12](#))
2. Compute deviation (DEV) of expected portfolio return in each state from total expected portfolio return
3. Square deviations (DEV^2) found in step 2
4. Multiply squared deviations from Step 3 times the probability of each state occurring (x p(i)).
5. The sum of the results from Step 4 = Portfolio Variance

Announcements, News and Efficient markets

- Announcements and news contain both expected and surprise components
- The surprise component affects stock prices
- Efficient markets result from investors trading on unexpected news
 - The easier it is to trade on surprises, the more efficient markets should be
- Efficient markets involve random price changes because we cannot predict surprises

Returns

- Total Return = Expected return + unexpected return

$$R = E(R) + U$$

- Unexpected return (U) = Systematic portion (m) + Unsystematic portion (ε)
- Total Return = Expected return $E(R)$ + Systematic portion m
+ Unsystematic portion ε
 $= E(R) + m + \varepsilon$

Systematic Risk

- Factors that affect a large number of assets
- “Non-diversifiable risk”
- “Market risk”
- Examples: changes in GDP, inflation, interest rates, etc.

Unsystematic Risk

- = Diversifiable risk
- Risk factors that affect a limited number of assets
- Risk that can be eliminated by combining assets into portfolios
- “Unique risk”
- “Asset-specific risk”
- Examples: labor strikes, part shortages, etc.

The Principle of Diversification

- Diversification can substantially reduce risk without an equivalent reduction in expected returns
 - Reduces the variability of returns
 - Caused by the offset of worse-than-expected returns from one asset by better-than-expected returns from another
- Minimum level of risk that cannot be diversified away = *systematic portion*

Standard Deviations of Annual Portfolio Returns

Table 11.7

(1) Number of Stocks in Portfolio	(2) Average Standard Deviation of Annual Portfolio Returns	(3) Ratio of Portfolio Standard Deviation to Standard Deviation of a Single Stock
1	49.24%	1.00
2	37.36	.76
4	29.69	.60
6	26.64	.54
8	24.98	.51
10	23.93	.49
20	21.68	.44
30	20.87	.42
40	20.46	.42
50	20.20	.41
100	19.69	.40
200	19.42	.39
300	19.34	.39
400	19.29	.39
500	19.27	.39
1,000	19.21	.39

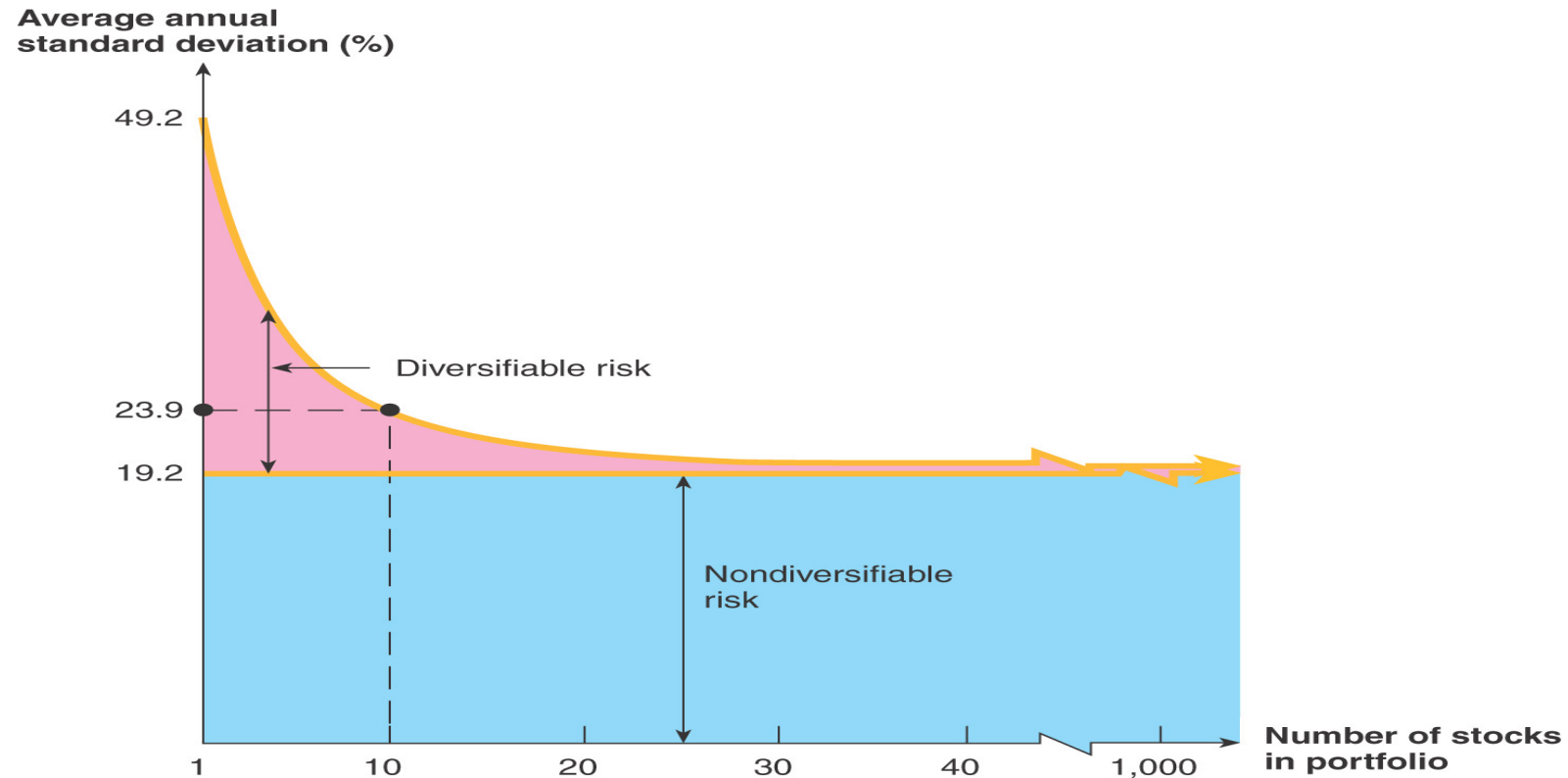
These figures are from Table 1 in Meir Statman, How Many Stocks Make a Diversified Portfolio? *Journal of Financial and Quantitative Analysis* 22 (September 1987), pp. 353—64. They were derived from E. J. Elton and M. J. Gruber, Risk Reduction and Portfolio Size: An Analytic Solution, *Journal of Business* 50 (October 1977), pp. 415—37.

Portfolio Conclusions

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

Portfolio Diversification

Figure 11.1



Total Risk = Stand-alone Risk

Total risk = Systematic risk + Unsystematic risk

- The standard deviation of returns is a measure of total risk
- For well-diversified portfolios, unsystematic risk is very small
 - ➔ Total risk for a diversified portfolio is essentially equivalent to the systematic risk

Systematic Risk Principle

- There is a reward for bearing risk
- There is no reward for bearing risk unnecessarily
- The expected return (market required return) on an asset depends only on that asset's systematic or market risk.

Market Risk for Individual Securities

- The contribution of a security to the overall riskiness of a portfolio
- Relevant for stocks held in well-diversified portfolios
- Measured by a stock's beta coefficient
- For stock i, beta is:

$$\beta_i = (\rho_{i,M} \sigma_i) / \sigma_M = \sigma_{iM} / \sigma_M^2$$

- Measures the stock's volatility relative to the market

The Beta Coefficient

$$\beta_i = (\rho_{i,M} \sigma_i) / \sigma_M = \sigma_{iM} / \sigma_M^2$$

[Slides describing covariance and correlation](#)

Where:

$\rho_{i,M}$ = Correlation coefficient of this asset's returns with the market

σ_i = Standard deviation of the asset's returns

σ_M = Standard deviation of the market's returns

σ_M^2 = Variance of the market's returns

σ_{iM} = Covariance of the asset's returns and the market

Interpretation of beta

- If $\beta = 1.0$, stock has average risk
- If $\beta > 1.0$, stock is riskier than average
- If $\beta < 1.0$, stock is less risky than average
- Most stocks have betas in the range of 0.5 to 1.5
- Beta of the market = 1.0
- Beta of a T-Bill = 0

Beta Coefficients for Selected Companies

Table 11.8

Company	Beta Coefficient (β_i)	TABLE 11.8
Home Depot	0.46	Beta coefficients for selected companies
Kellogg Co.	0.57	
Southwest Airlines	0.85	
American Eagle Outfitters	0.96	
Google	1.28	
Abercrombie & Fitch	1.33	
General Electric	1.39	
eBay	1.43	
Citigroup	2.42	

Source: finance.yahoo.com, 2009.

Example: Work the Web

- Many sites provide betas for companies
- Yahoo! Finance provides beta, plus a lot of other information under its profile link
- Click on the Web surfer to go to Yahoo! Finance
 - Enter a ticker symbol and get a basic quote
 - Click on key statistics
 - Beta is reported under stock price history

Quick Quiz:

Total vs. Systematic Risk

- Consider the following information:

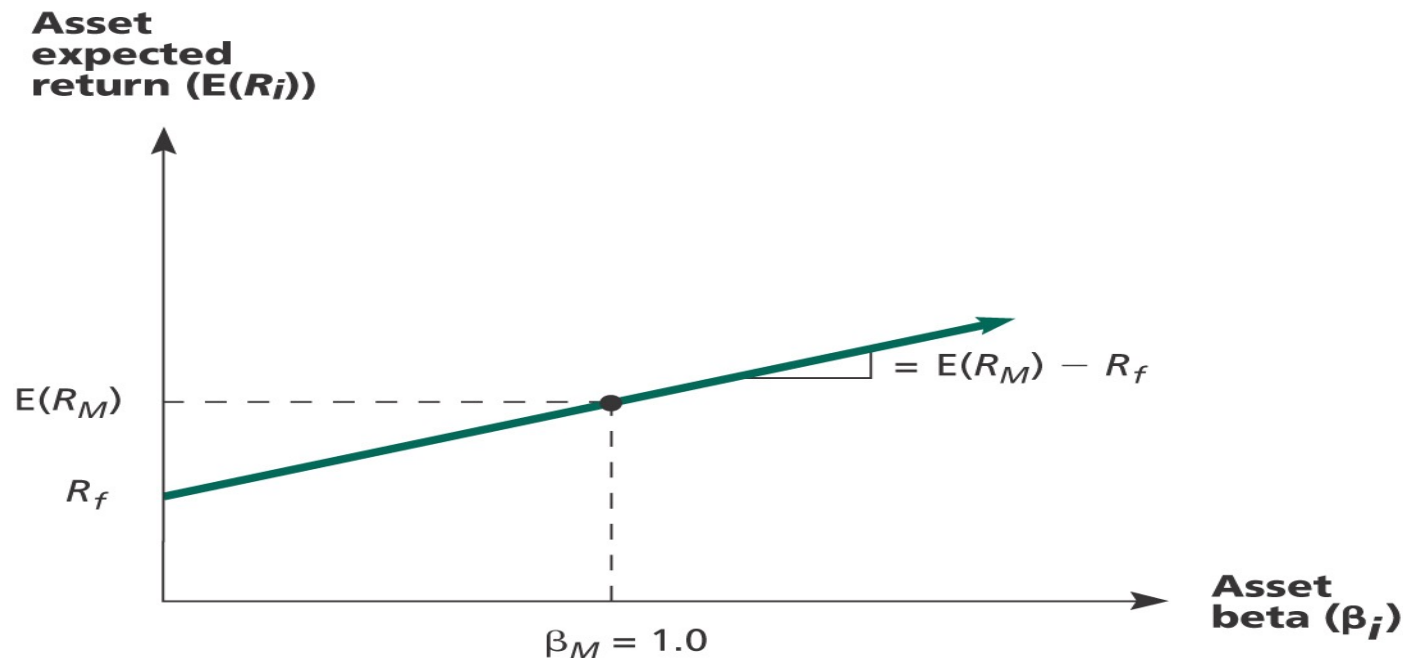
	Standard Deviation	Beta
Security C	20%	1.25
Security K	30%	0.95

- Which security has more total risk?
- Which security has more systematic risk?
- Which security should have the higher expected return?

Beta and the Risk Premium

- Risk premium = $E(R) - R_f$
- The higher the beta, the greater the risk premium should be
- Can we define the relationship between the risk premium and beta so that we can estimate the expected return?
 - YES!

SML and Equilibrium



The slope of the security market line is equal to the market risk premium; i.e., the reward for bearing an average amount of systematic risk. The equation describing the SML can be written:

$$E(R_i) = R_f + \beta_i \times [E(R_M) - R_f]$$

which is the capital asset pricing model (CAPM).

Figure 11.4

Reward-to-Risk Ratio

- Reward-to-Risk Ratio:

$$\frac{E(R_i) - R_f}{\beta_i}$$

- = Slope of line on graph
- In equilibrium, ratio should be the same for all assets
- When $E(R)$ is plotted against β for all assets, the result should be a straight line

Market Equilibrium

- In equilibrium, all assets and portfolios must have the same reward-to-risk ratio
- Each ratio must equal the reward-to-risk ratio for the market

$$\frac{E(R_A) - R_f}{\beta_A} = \frac{E(R_M - R_f)}{\beta_M}$$

Security Market Line

- The security market line (SML) is the representation of market equilibrium
- The slope of the SML = reward-to-risk ratio:

$$(E(R_M) - R_f) / \beta_M$$

- Slope = $E(R_M) - R_f$ = market risk premium
 - Since β of the market is always 1.0

The SML and Required Return

- The Security Market Line (SML) is part of the Capital Asset Pricing Model (CAPM)

$$\begin{aligned} E(R_i) &= R_f + [E(R_M) - R_f] \beta_i \\ E(R_i) &= R_f + RP_M \beta_i \end{aligned}$$

R_f = Risk-free rate (T-Bill or T-Bond)

R_M = Market return $\approx$ S&P 500

RP_M = Market risk premium = $E(R_M) - R_f$

$E(R_i)$ = "Required Return"

Capital Asset Pricing Model

- The capital asset pricing model (CAPM) defines the relationship between risk and return

$$E(R_A) = R_f + (E(R_M) - R_f)\beta_A$$

- If an asset's systematic risk (β) is known, CAPM can be used to determine its expected return

SML example

Expected vs Required Return

Stock	E(R)	Beta	Req R
A	14%	1.3	13.4%
B	10%	0.8	11.1%

Undervalued
Overvalued

Assume: Market Return = 12.0%
Risk-free Rate = 7.5%

$$E(R_i) = R_f + [E(R_M) - R_f] \beta_i$$

Factors Affecting Required Return

$$E(R_i) = R_f + [E(R_M) - R_f] \beta_i$$

- R_f measures the pure time value of money
- $RP_M = (E(R_M) - R_f)$ measures the reward for bearing systematic risk
- β_i measures the amount of systematic risk

Portfolio Beta

β_p = Weighted average of the Betas of the assets in the portfolio

Weights (w_i) = % of portfolio invested in asset i

$$\beta_p = \sum_{i=1}^n w_i \beta_i$$

Quick Quiz

1. How do you compute the expected return and standard deviation:
 - For an individual asset? (For a portfolio?)
 - What is the difference between systematic and unsystematic risk?
 - What type of risk is relevant for determining the expected return?

Quick Quiz

4. Consider an asset with a beta of 1.2, a risk-free rate of 5%, and a market return of 13%.
- What is the reward-to-risk ratio in equilibrium?

$$\frac{E(R_A) - R_f}{\beta_A} = \frac{E(R_M - R_f)}{\beta_M} = \frac{13\% - 5\%}{1.0}$$

$$0.08 \times 1.2 = E(R_A) - R_f = .096 = .05 = E(R_A)$$

$$E(R_A) = 14.6\%$$

- What is the expected return on the asset?
 - $E(R) = 5\% + (13\% - 5\%) \times 1.2 = 14.6\%$



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Thank You

