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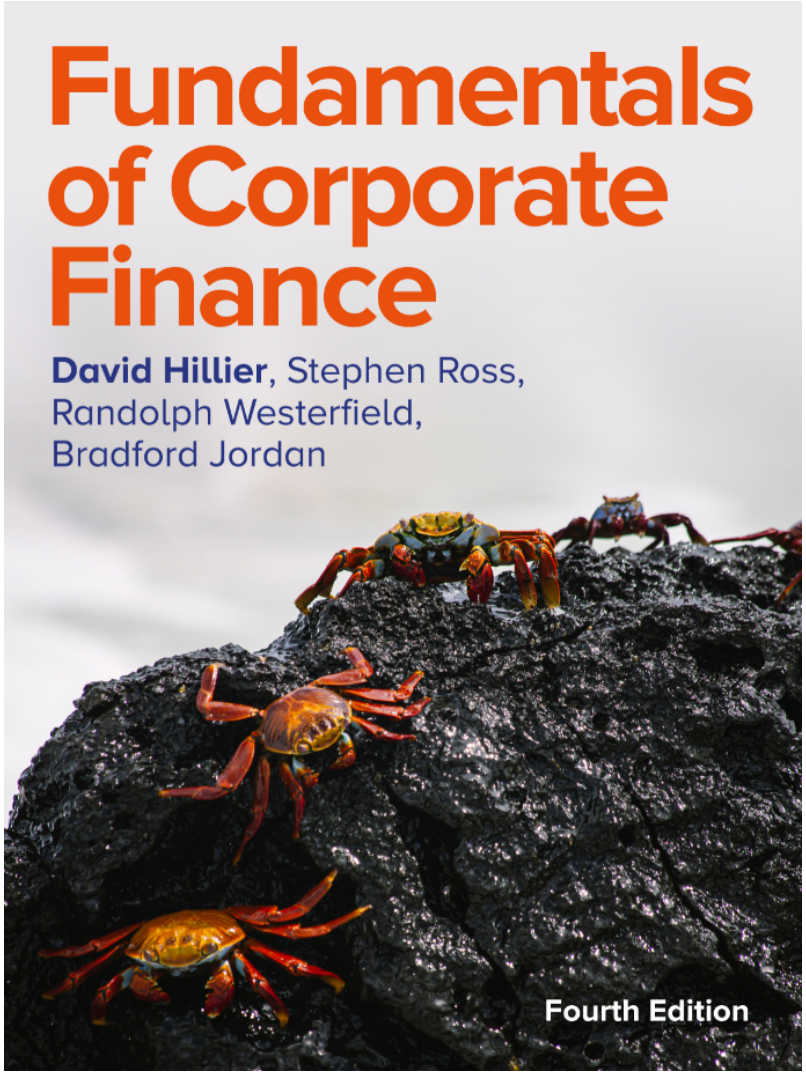
Chapter 12

Return, Risk and the Security Market Line

Hillier, Fundamentals of Corporate Finance 4e



Chapter Overview

- Expected Returns and Variances
- Portfolios
- Announcements, Surprises and Expected Returns
- Risk: Systematic and Unsystematic
- Diversification and Portfolio Risk
- Systematic Risk and Beta
- The Security Market Line
- The SML and the Cost of Capital: A Preview

Expected Returns and Variances

What is an Expected Return

Expected Return

The return on a risky asset expected in the future

Expected Returns and Variances Example

Two equities:

Equity L is expected to have a return of **25 per cent** in the coming year.

Equity U is expected to have a return of **20 per cent** for the same period.

The return on Equity L, although it is *expected* to be 25 per cent, could actually turn out to be higher or lower.

What happens if the economy booms? We think Equity L will have a 70 per cent return. If the economy enters a recession, we think the return will be 20 per cent. In this case, we say that there are two *states of the economy.*

We think a boom and a recession are equally likely to happen, a 50-50 chance of each.

TABLE 12.1

States of the economy and equity returns

State of economy	Probability of state of economy	Rate of return if state occurs (%)	
		Equity L	Equity U
Recession	0.50	−20	30
Boom	0.50	70	10
	1.00		

Expected Returns and Variances Example

If you hold Equity U for a number of years, you'll earn 30 per cent about half the time and 10 per cent the other half. In this case, we say that your **expected return** on Equity U, $E(R_U)$, is 20 per cent:

$$E(R_U) = 0.50 \times 30\% + 0.50 \times 10\% = 20\%$$

In other words, you should expect to earn 20 per cent from this equity, on average.

What is the expected return on L?

TABLE 12.2

Calculation of expected return

		Equity L		Equity U	
(1) State of economy	(2) Probability of state of economy	(3) Rate of return if state occurs	(4) Product (2) × (3)	(5) Rate of return if state occurs	(6) Product (2) × (5)
Boom	0.50	−0.20	−0.10	0.30	0.15
Recession	0.50	0.70	0.35	0.10	0.05
	1.00	$E(R_L) = 0.25 = 25\%$		$E(R_U) = 0.20 = 20\%$	

Risk Premium Example

Suppose risk-free investments are currently offering 8 per cent. We will say that the *risk-free rate*, which we label as R_f, is 8 per cent.

Given this, what is the projected risk premium on Equity U?

Risk premium = Expected return – Risk-free rate

$= E(R_U) - R_f$

$= 20\% - 8\%$

$= 12\%$

Similarly, the risk premium on Equity L is 25% – 8% = 17%.

How to Calculate Variance

Calculating the Variance

1. Determine the squared deviations from the expected return.
2. Multiply each possible squared deviation by its probability.
3. Add these up, and the result is the variance. The standard deviation, as always, is the square root of the variance.

TABLE 12.4

Calculation of variance

(1) State of economy	(2) Probability of state of economy	(3) Return deviation from expected return	(4) Squared return deviation from expected return	(5) Product (2) × (4)
Equity L				
Recession	0.50	$-0.20 - 0.25 = -0.45$	$-0.45^2 = 0.2025$	0.10125
Boom	0.50	$0.70 - 0.25 = 0.45$	$0.45^2 = 0.2025$	0.10125
				$\sigma_L^2 = 0.20250$
Equity U				
Recession	0.50	$0.30 - 0.20 = 0.10$	$0.10^2 = 0.01$	0.005
Boom	0.50	$-0.10 - 0.20 = -0.45$	$-0.10^2 = 0.01$	0.005
				$\sigma_U^2 = 0.010$

Portfolios

Definitions

Terms

Portfolio

A group of assets such as equities and bonds held by an investor.

Portfolio Weight

The percentage of a portfolio's total value that is in a particular asset.

Portfolios Example

Let's return to Equities L and U.

You put half your money in each – portfolio weights are obviously 0.50 and 0.50.

What is the pattern of returns on this portfolio?

The expected return?

TABLE 12.5

Expected return on an equally weighted portfolio of Equity L and Equity U

(1) State of economy	(2) Probability of state of economy	(3) Portfolio return if state occurs	(4) Product (2) × (3)
Recession	0.50	$0.50 \times -20\% + 0.50 \times 30\% = 5\%$	0.025
Boom	0.50	$0.50 \times 70\% + 0.50 \times 10\% = 40\%$	0.200
			$E(R_P) = 22.5\%$

What is the standard deviation of return on this portfolio?

TABLE 12.6

Variance on an equally weighted portfolio of Equity L and Equity U

(1) State of economy	(2) Probability of state of economy	(3) Portfolio return if state occurs (%)	(4) Squared deviation from expected return	(5) Product (2) × (4)
Recession	0.50	5	$(0.05 - 0.225)^2 = 0.030625$	0.0153125
Boom	0.50	40	$(0.40 - 0.225)^2 = 0.030625$	0.0153125
				$\sigma_P^2 = 0.030625$
			$\sigma_P = \sqrt{0.030625} = 17.5\%$	

Announcements, Surprises and Expected Returns

Expected and Unexpected Returns

Total return = Expected return + Unexpected return

$$R = \mathrm{E}(R) + U$$

Where:

R = actual total return in the year

$\mathrm{E}(R)$ = expected part of the return

U = unexpected part of the return

Announcements and News

An **announcement** can be broken into two parts:
1. The anticipated, or expected, part
2. The surprise, or innovation

Announcement = Expected Part + Surprise

The expected part of any announcement is the part of the information that the market uses to form the expectation, E(R), of the return on the equity.

The surprise is the news that influences the unanticipated return on the equity, U.

Risk: Systematic and Unsystematic

Definitions

Terms

Systematic Risk

A risk that influences a large number of assets. Also, market risk.

Unsystematic Risk

A risk that affects at most a small number of assets. Also, unique or asset-specific risk.

Systematic and Unsystematic Risk

Actual return breaks down into its expected and surprise components:

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

Now recognize that the total surprise component, U, has a systematic and an unsystematic component, so:

R = E(R) + Systematic portion + Unsystematic portion

Use the Greek letter epsilon, **ε**, to stand for the unsystematic portion and the letter **m** to stand for the systematic part of the surprise. The formula for the total return is:

$$R = E(R) + U = E(R) + m + \varepsilon$$

The unsystematic portion, **ε**, is more or less unique to the company. For this reason, it is unrelated to the unsystematic portion of return on most other assets.

Diversification and Portfolio Risk

TABLE 12.7

Standard deviations of annual portfolio returns

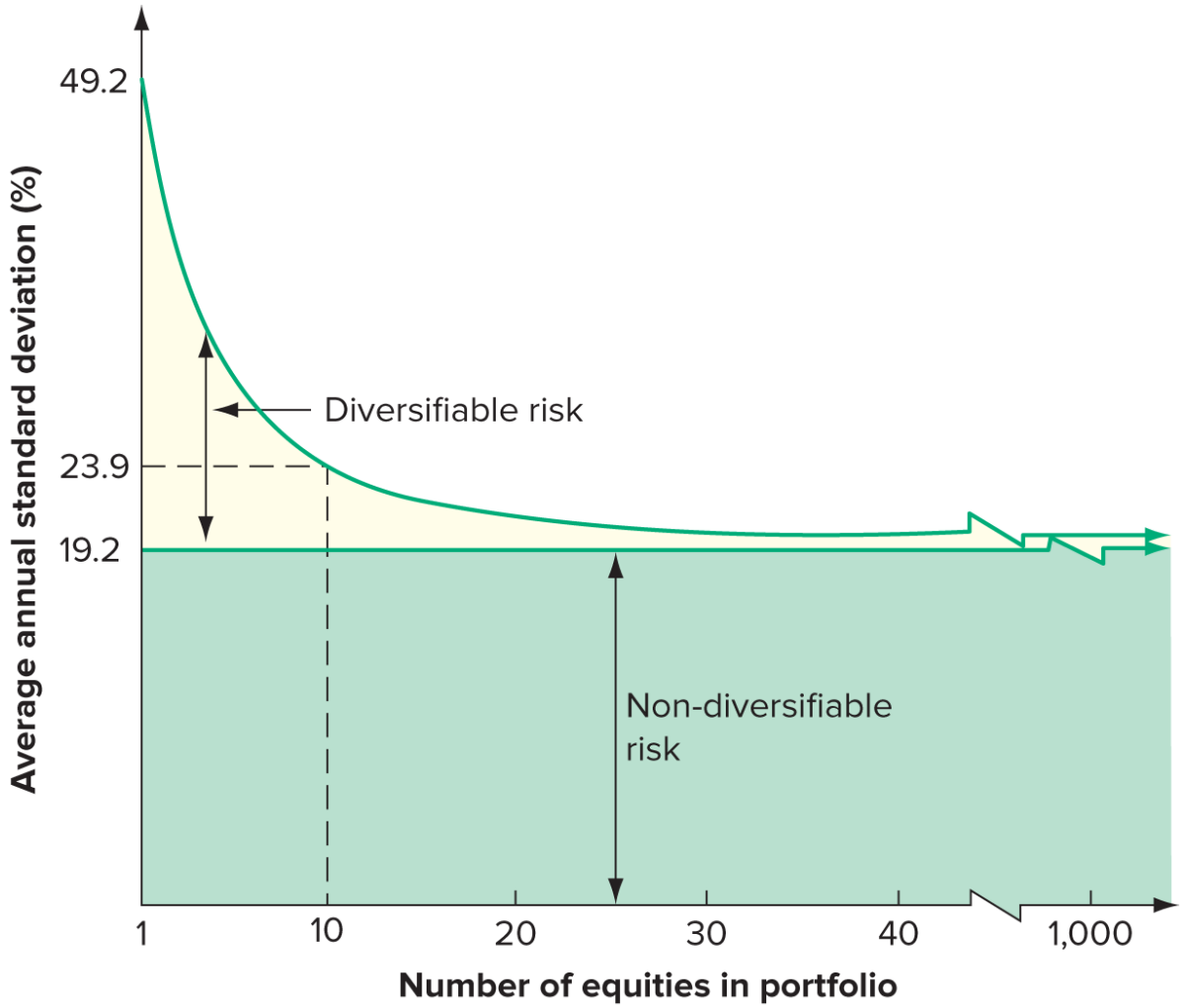
(1) Number of equities in portfolio	(2) Average standard deviation of annual portfolio returns (%)	(3) Ratio of portfolio standard deviation to standard deviation of a single equity
1	49.24	1.00
2	37.36	0.76
4	29.69	0.60
6	26.64	0.54
8	24.98	0.51
10	23.93	0.49
20	21.68	0.44
30	20.87	0.42
40	20.46	0.42
50	20.20	0.41
100	19.69	0.40
200	19.42	0.39
300	19.34	0.39
400	19.29	0.39
500	19.27	0.39
1,000	19.21	0.39

Source: Table 1 in M. Statman (1987). How many stocks make a diversified portfolio? Journal of Financial and Quantitative Analysis, 22(3), 353-364. Derived from E.J. Elton and M.J. Gruber (1977). Risk reduction and portfolio size: An analytic solution. Journal of Business, 50, October, 415-437.

The Principal of Diversification

Spreading an investment across a number of assets will eliminate some, but not all, of the risk

Diversifiable and Non-Diversifiable Risk



Diversification and Unsystematic Risk

Unsystematic risk is eliminated by diversification, so a portfolio with many assets has almost no unsystematic risk

Systematic and Unsystematic Risk

Systematic risk is also called ***non-diversifiable risk*** or ***market risk***.

Unsystematic risk is also called ***diversifiable risk***, ***unique risk*** or ***asset-specific risk***.

For a well-diversified portfolio, the unsystematic risk is negligible.

For such a portfolio, essentially all of the risk is systematic.

Diversification an Systematic Risk

The total risk of an investment, as measured by the standard deviation of its return, can be written as:

Total risk = Systematic risk + Unsystematic risk

Systematic Risk and Beta

Definitions

Terms

The Systematic Risk Principle

The expected return on a risky asset depends only on that asset's systematic risk.

The Beta Coefficient

The amount of systematic risk present in a particular risky asset relative to that in an average risky asset.

TABLE 12.8

Beta coefficients for selected companies

Equity	Beta
Adidas	0.68
L'Oréal	0.54
SAP	0.94
Siemens	1.20
Daimler	1.55
Telefonica	1.06
Renault	1.70
Volkswagen	1.54

Source: The Financial Times Limited (2020). All rights reserved.

Portfolio Betas

$$\beta_P = w_x \beta_x + w_y \beta_y$$

where w = portfolio weight

The Security Market Line

The Security Market Line Example

Consider a portfolio made up of:

- **Asset A**, and
- A **risk-free** asset.

We can calculate some different possible portfolio expected returns and betas by varying the percentages invested in these two assets.

The Security Market Line Example

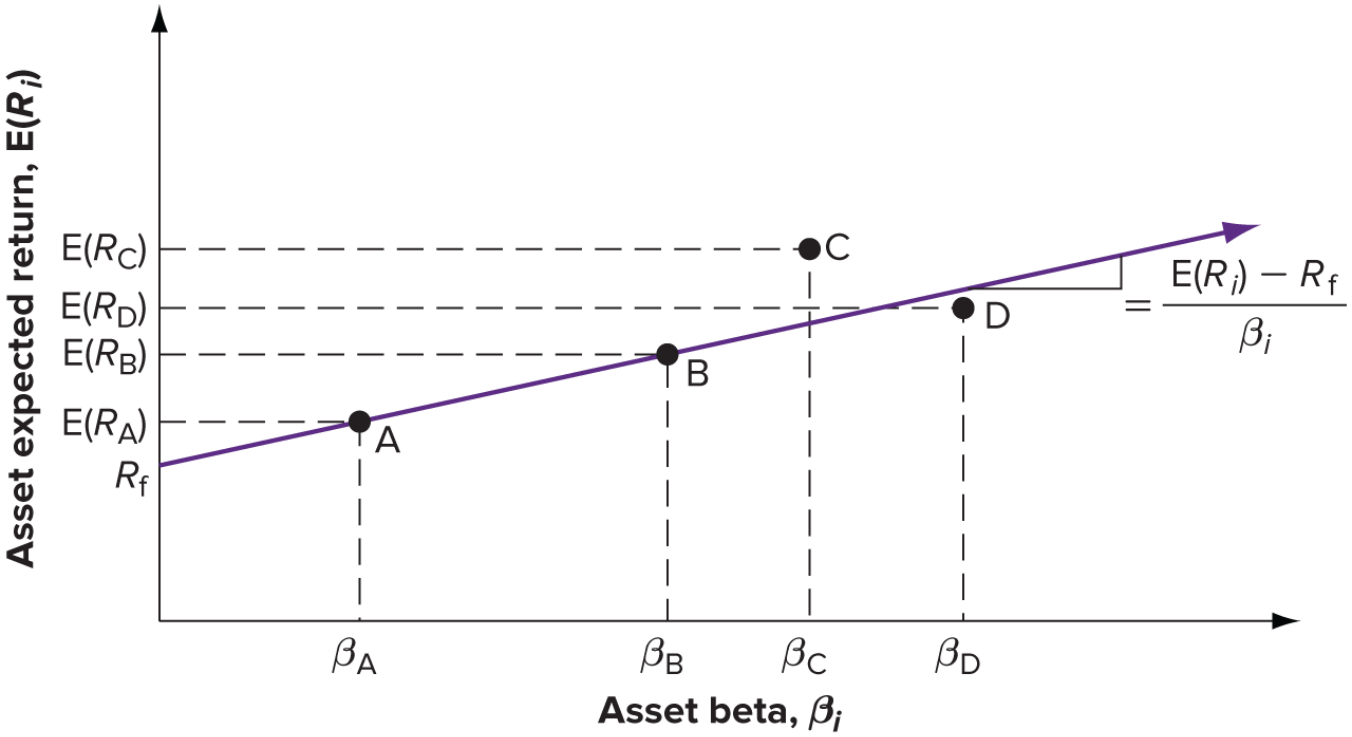
Percentage of portfolio in Asset A (%)	Portfolio expected return (%)	Portfolio beta
0	8	0.0
25	11	0.4
50	14	0.8
75	17	1.2
100	20	1.6
125	23	2.0
150	26	2.4

Reward to Risk Ratio

In equilibrium, the reward-to-risk ratio must be the same for all the assets in the market

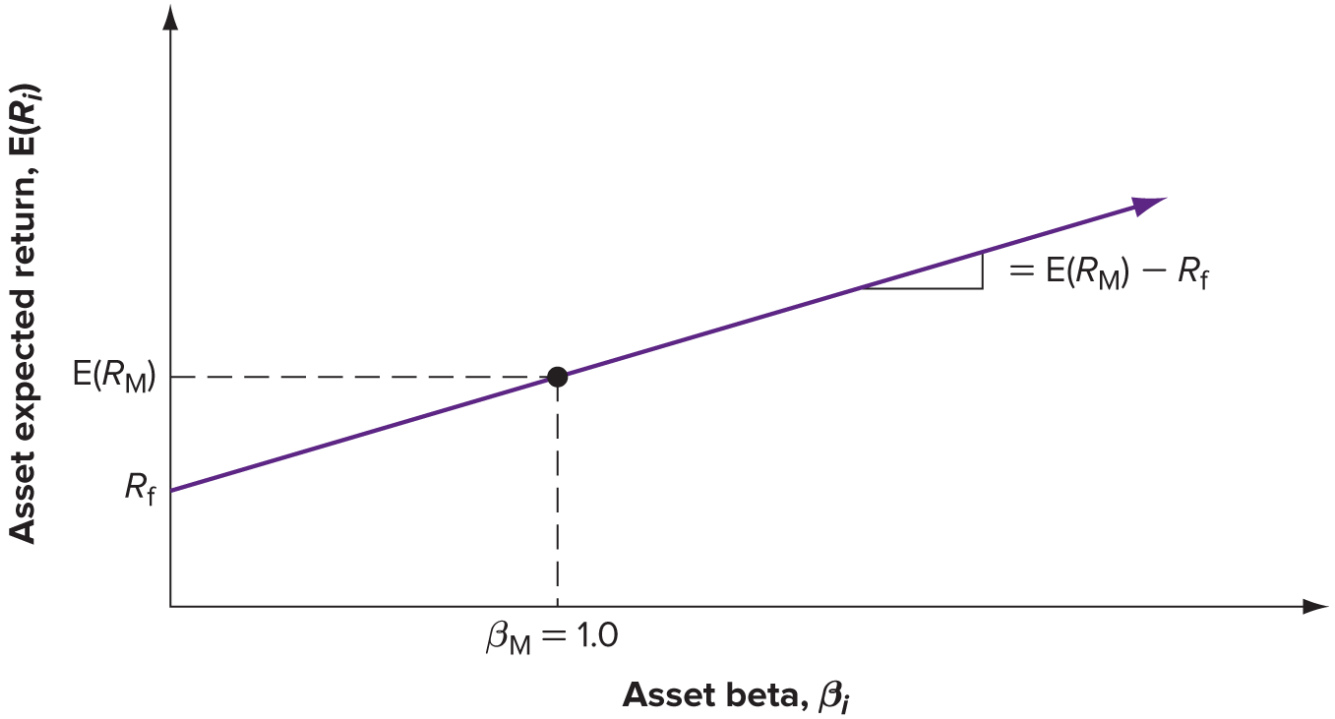
$$\frac{E(R_A) - R_f}{\beta_A} = \frac{E(R_B) - R_f}{\beta_B}$$

The Security Market Line: Graphical Presentation



The fundamental relationship between beta and expected return is that all assets must have the same reward-to-risk ratio, $[E(R_i) - R_f]/\beta_i$. This means that they would all plot on the same straight line. Assets A and B are examples of this behaviour. Asset C's expected return is too high; asset D's is too low.

The Security Market Line: Graphical Presentation



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

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

which is the capital asset pricing model (CAPM).

The Capital Asset Pricing Model

The Security Market Line

- A positively sloped straight line displaying the relationship between expected return and beta.

Market Risk Premium

- The slope of the SML – the difference between the expected return on a market portfolio and the risk-free rate.

Capital Asset Pricing Model (CAPM)

- The equation of the SML showing the relationship between expected return and beta

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

Capital Asset Pricing Model Assumptions

CAPM – The expected return for a particular asset depends on three things

The pure time value of money: As measured by the risk-free rate, R_f, this is the reward for merely waiting for your money, without taking any risk.

The reward for bearing systematic risk: As measured by the market risk premium, $E(R_M) - R_f$, this component is the reward the market offers for bearing an average amount of systematic risk in addition to waiting.

The amount of systematic risk: As measured by β_i, this is the amount of systematic risk present in a particular asset or portfolio, relative to that in an average asset.

The SML and The Cost of Capital

Cost of Capital

The minimum required return on a new investment

Concept Quiz

How do we calculate the expected return on a security and the variance of this expected return?

What is the principle of diversification? Why is some risk diversifiable and some risk not?

What is the fundamental relationship between risk and return in a well-functioning market?