

Corporate Finance

Risk and Return

Chapter 11

Dr Erkan Yalcin

Expected Returns

- These are based on the probabilities of possible outcomes
 - Expected means average if the process is repeated many times.
- The expected return does not even have to be a possible return.

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

- where p_i is the probability of state i occurring and R_i is the expected return on an asset in state i .

Expected Returns Cont'd

Example

STATE OF ECONOMY	PROBABILITY OF STATE OF ECONOMY	SECURITY RETURNS IF STATE OCCURS	
		EMU SHARES	KIWI SHARES
Recession	0.5	-20%	30%
Boom	0.5	70%	10%
	1.0		

Figure 1: States of the Economy and Share Returns

The expected return of each share:

$$E(R_k) = 0.50 \times 0.30 + 0.50 \times 0.10 = 0.20$$

$$E(R_E) = 0.50 \times -0.20 + 0.50 \times 0.70 = 0.25$$

Risk premium for Kiwi share if risk free rate (R_f) is 8%

$$\rho = E(R_k) - R_f = 20\% - 8\% = 12\%$$

Variance and Standard Deviation

- These measure the volatility of returns.
- They employ unequal probabilities for the entire range of possibilities.
- They are weighted average of squared deviations.
- Standard deviation is the square root of variance.

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

Example

Refer to the data in Table 1 and the expected return calculated in slide 3. Thus the variance of each share:

$$\sigma_k^2 = 0.5(0.3 - 0.2)^2 + 0.5(0.1 - 0.2)^2 = 0.01$$

$$\sigma_E^2 = 0.5(-0.2 - 0.25)^2 + 0.5(0.7 - 0.25)^2 = 0.2025$$

The standard deviation of each share:

$$\sigma_k = \sqrt{0.01} = 10\% \text{ and } \sigma_E = \sqrt{0.2025} = 45\%$$

Portfolio Expected Returns

- A portfolio is a collection of assets.
- The risk–return trade-off for a portfolio is measured by the portfolio expected return and standard deviation, as with individual assets.
- The expected return of a portfolio is the weighted average of the expected returns for each asset in the portfolio,
 - where weight w_j is the percentage of portfolio invested in each asset.

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

Portfolio Expected Returns Cont'd

Example

Refer to the data in Table 1 and assume equally weighted portfolio of shares:
 $w_K = 50\%$ and $w_E = 50\%$. Then portfolio expected return:

$$E(R_{Recession}) = 0.5(0.5 \times -0.2 + 0.5 \times 0.3) = 2.5\%$$

$$E(R_{Boom}) = 0.5(0.5 \times 0.7 + 0.5 \times 0.1) = 20\%$$

$$E(R_P) = 2.5\% + 20\% = 22.5\%$$

Portfolio Risk: Variance and 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:

$$R_{P,i} = w_1 R_{1,i} + w_2 R_{2,i} + \dots + w_m R_{m,i}$$

- 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: Variance and Standard Deviation Cont'd

Example

Refer to the data in Table 1 and calculate variance and standard deviation on an equally weighted portfolio of shares in Emu and Kiwi.

(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%	$(0.05 - 0.225)^2 = 0.030625$	0.0153125
				$\sigma_p^2 = 0.030625$

Therefore, the standard deviation is: $\sigma_p = \sqrt{0.030625} = 17.5\%$

Figure 2: Portfolio Risk

	1	2	3	4	2 × 4
1	Recession	0.50	0.05	$(0.05 - 0.225)^2 = 0.030625$	0.0153125
	Boom	0.50	0.40	$(0.40 - 0.225)^2 = 0.030625$	0.0153125
					$\sigma_p^2 = 0.030625$
					$\sigma_p = \sqrt{0.030625} = 0.175$

¹1: State of the Economy; 2: Probability of State of Economy; 3: Portfolio Return if State Occurs; and 4: Squared Deviation from Expected Return.

Expected versus Unexpected Returns

- Total return (R) is the Expected Return $E(R)$ plus Unexpected Return (U).
- Realised returns are generally not equal to expected returns.
- There is the expected component and the unexpected component.
 - At any point in time, the unexpected return can be either positive or negative.
 - Over time, the average of the unexpected component is zero.

Announcements and News

- Announcement contains both an expected component and a surprise component.
- It is the surprise component that affects a share's price and therefore its return.
- This is very obvious when we watch how share prices move when an unexpected announcement is made or earnings differ from what is anticipated.
- We assume markets are at least reasonably efficient in the semi-strong form sense.

Systematic Risk

- Factors that affect a large number of assets.
- This is the same as non-diversifiable risk and market risk (changes in GDP, inflation and interest rates).
- Systematic Risk Principle
 - There is a reward for bearing risk not unnecessarily.
 - The expected return on a risky asset depends solely on that asset's systematic risk, since unsystematic risk can be diversified away.

Unsystematic Risk

- Risk factors that affect a limited number of assets.
- Risk that can be eliminated by combining assets into portfolios.
- This is the same as diversifiable risk, idiosyncratic risk, asset-specific risk (labour strikes, part shortages).
- If we hold assets in the same industry, then we are exposing ourselves to risk that we could diversify away.

Systematic and Idiosyncratic Components of Return

- Total Return

$$R = \text{Expected Return} + \text{Unexpected Return} = E(R) + U$$

- Unexpected return (U)

$$U = \text{Systematic Portion} + \text{Unsystematic Portion} = m + \varepsilon$$

- Total Return

$$\begin{aligned} R &= \text{Expected Return} + \text{Systematic Portion} + \text{Unsystematic Portion} \\ &= E(R) + m + \varepsilon \end{aligned}$$

Diversification

- Portfolio diversification is investment in several different asset classes or sectors.
- Diversification is not just holding a lot of assets.
 - For example, if you own 50 internet company shares, you are not diversified. However, if you own 50 shares that span 20 different industries, you are diversified.
- The principle of diversification:
 - Diversification can substantially reduce the variability of returns without an equivalent reduction in expected returns.
 - This reduction in risk arises because worse than expected returns from one asset are offset by better than expected returns from another.
 - However, there is a minimum level of risk that cannot be diversified away, and that is the systematic portion.

Diversification Cont'd

(1) NUMBER OF SHARES IN PORTFOLIO	(2) AVERAGE STANDARD DEVIATION IN ANNUAL PORTFOLIO RETURNS	(3) RATIO OF PORTFOLIO STANDARD DEVIATION TO STANDARD DEVIATION OF A SINGLE SHARE
1	11.49%	1.00
5	7.91%	0.69
10	6.61%	0.58
15	6.08%	0.53
20	5.71%	0.50
25	5.60%	0.49
30	5.50%	0.48
35	5.50%	0.48
40	5.26%	0.46
45	5.12%	0.45

Source: This data is from an unpublished study conducted by S. Thompson, M. Christensen and J. McIvor in 1993.

Figure 3: Standard Deviations of Annual Portfolio Returns

Diversification Cont'd

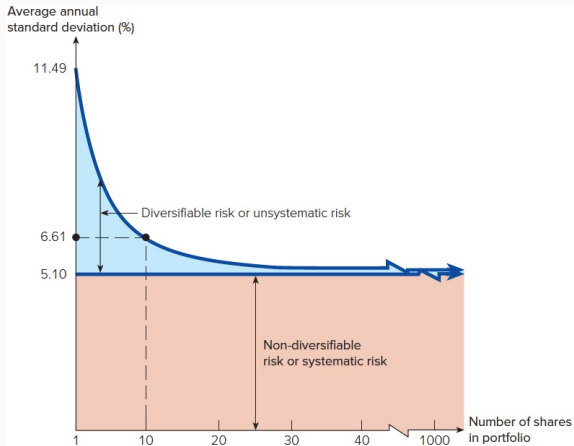


Figure 4: Portfolio Diversification

Diversification and Systematic 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.
- Measuring systematic risk:
 - We use the beta (β) coefficient to measure systematic risk.
 - $\beta = 1$ implies the asset has the same systematic risk as the overall market.
 - $\beta < 1$ implies the asset has less systematic risk than the overall market.
 - $\beta > 1$ implies the asset has more systematic risk than the overall market.

Diversification and Systematic Risk Cont'd

COMPANY (ASX CODE)	BETA COEFFICIENT (β_i)
ANZ Banking Group Ltd (ANZ.AX)	1.28
BHP Billiton Ltd (BHP.AX)	1.24
Cochlear Ltd (COH.AX)	1.10
CSL Ltd (CSL.AX)	0.87
Domino's Pizza Enterprises Ltd (DMP.AX)	1.35
Energy Resources of Australia Ltd (ERA.AX)	1.25
JB Hi-Fi Ltd (JBH.AX)	0.39
Pharmaxis Ltd (PXS.AX)	0.75
Ramsay Health Care Ltd (RHC.AX)	0.86
Seven West Media Ltd (SWM.AX)	1.33
Telstra Corporation Ltd (TLS.AX)	0.62
Webjet Ltd (WEB.AX)	1.27
Wesfarmers Ltd (WES.AX)	0.95

Source: Compiled based on individual company data from Thomson Reuters, www.reuters.com, accessed February 2019.

Figure 5: Beta Coefficients for Selected Companies

Diversification and Systematic Risk Cont'd

Example (Total Risk versus Beta)

Consider the following information on two securities:

	Standard Deviation	Beta
OZ Mining Group	18.56%	1.63
Australis Airlines	2.36%	2.15

Which security has greater risk? Which has greater systematic risk? Which has the greater idiosyncratic risk? Which asset will have a higher risk premium?

Australis Airlines has less total risk (as measured by standard deviation), but it has more systematic risk (as measured by beta). Since total risk is the sum of systematic and unsystematic risk, OZ Mining Group must have much greater unsystematic risk than Australis Airlines. Finally, from the systematic risk principle, Australis Airlines will have a higher risk premium and a greater expected return, despite the fact that it has much less total risk.

Portfolio Beta

$$\beta_P = \sum_{j=1}^m w_j \beta_j$$

- β_P is the weighted average of the betas of the assets in the portfolio.
- Weights (w_j) is the percentage of portfolio invested in asset.

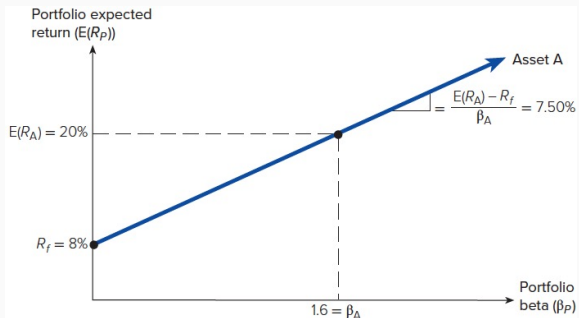
Example (Total Risk versus Beta)

Suppose we had the following investments:

SECURITY	AMOUNT INVESTED	EXPECTED RETURN	BETA
Share A	\$1000	8%	0.80
Share B	2000	12%	0.95
Share C	3000	15%	1.10
Share D	4000	18%	1.40

Portfolio Beta Cont'd

Example (Portfolio Expected Return and Beta)



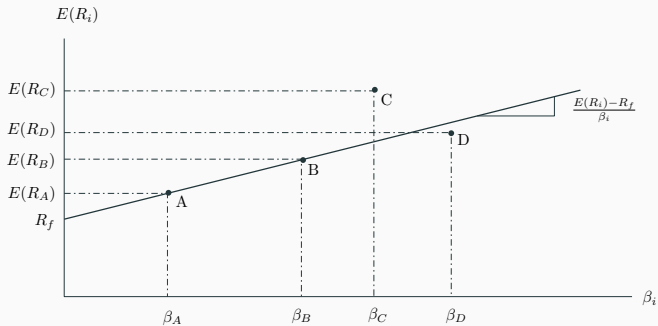
Reward-to-Risk Ratio

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

- Reward-to-risk ratio is the 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.
 - 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.

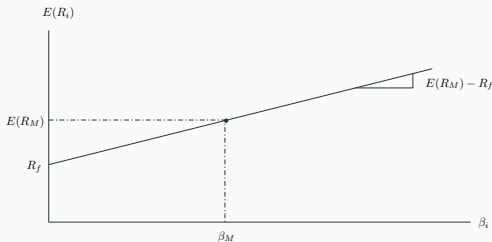
$$\frac{E(R_A) - R_f}{\beta_A} = \frac{E(R_M) - R_f}{\beta_M}$$

Expected Returns and Systematic Risk



Security Market Line (SML)

- SML is the representation of market equilibrium.
- The slope of the SML is the reward-to-risk ratio.
- Slope ($E(R_M) - R_f$) is the market risk premium, since β of the market is always 1.0



Capital Asset Pricing Model (CAPM)

- CAPM defines the relationship between risk and return:

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

- If we know an asset's systematic risk, we can use the CAPM to determine its expected return.
- This is true whether we are talking about financial assets or physical assets.
- Factors affecting expected return :
 - Pure time value of money: measured by the risk-free rate.
 - Reward for bearing systematic risk: measured by the market risk premium.
 - Amount of systematic risk: measured by beta.