Lecture 2:
Discount factors and cost of capital

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MN3101 Corporate Finance and Control

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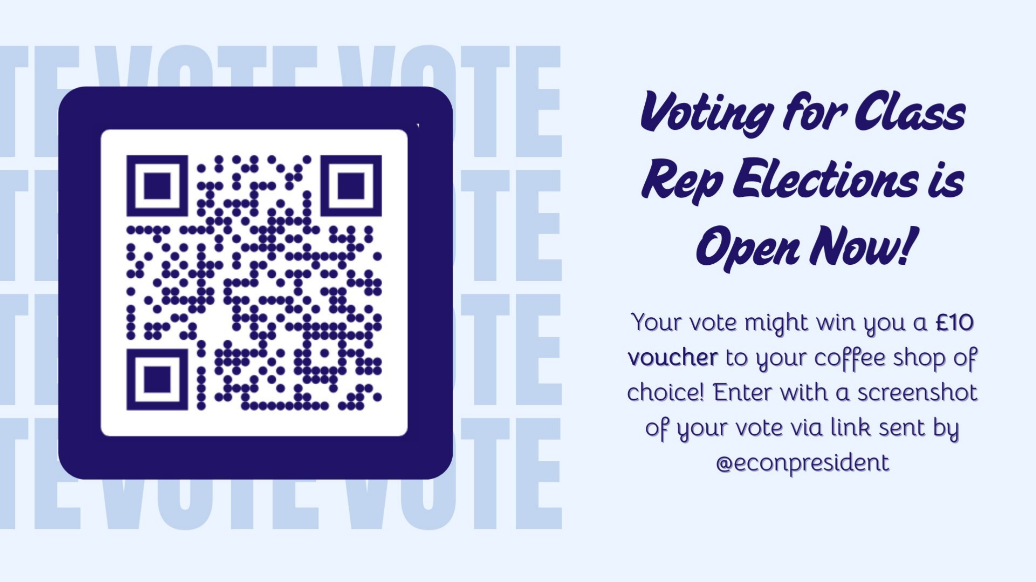
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Content of today's lecture

- Introduction to Risk and Return
  - Cost of Capital and Rate of Return
  - Expected Returns and Risk
  - Portfolio Theory and Diversification
  - Efficient Frontier and Portfolio Optimization
  - Limits of Diversification
- CML, SML and the CAPM
  - Risk-Free Asset and Portfolio Combinations
  - Capital Market Line and Tangent Portfolio
  - Security Market Line and CAPM
  - Beta and Cost of Capital Applications
  - CAPM Evaluation and Practical Applications

Reading

1. Brealey, R. A., Myers, S. C., Allen, F., & Edmans, A. (2022). Principles of Corporate Finance (14th ed.). McGraw-Hill Education. ISBN: 978-1265074159. Chapters 7, 8, 9.
2. Lundblad, C. (2007) The Risk Return Tradeoff in the Long Run: 1836–2003. *Journal of Financial Economics* 85, 123–150. `https://doi.org/10.1016/j.jfineco.2006.06.003`
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4. Fama, E.F., French, K.R. (2004) The Capital Asset Pricing Model: Theory and Evidence. *Journal of Economic Perspectives* 18, 25-46. https://doi.org/10.1257/0895330042162430
5. Graham, J.R., Harvey, C.R. (2001) The Theory and Practice of Corporate Finance: Evidence from the Field. *Journal of Financial Economics* 60, 187-243. https://doi.org/10.1016/S0304-405X(01)00044-7

Introduction to Risk and Return

Cost of Capital

- Corporate cost of capital is the return required by investors, which depends on the risk of the project
- Another way to look at this: the estimated risk of a project [real assets] will determine how much investors would pay for a firm's securities [financial assets]
- So one way to estimate the cost of capital is to estimate the expected return on securities of companies with similarly risky projects as those of your companies

- Return is a concept used to express the financial performance of an investment
- Monetary return = (Amount received − Amount invested)
- Percentage return (Rate of return) = $\frac{\text{Monetary return}}{\text{Amount invested}}$

Example 1

An investor pays £100 for a financial asset and receives £110 after a certain period.
Monetary return: (110 − 100) = £10
Percentage return: $\frac{(110 - 100)}{100} = 10\%$

Comparing Return for Different Holding Periods

- In order to compare the returns on investments with different holding periods, we need to convert the rates of return for different holding periods into a common period.
- Typically, all investment returns are expressed as an AER.
- A rate of return of r for a holding period of n years can be converted to an AER using Eq.(1).

$$AER = (1 + r)^{\frac{1}{n}} - 1 \quad (1)$$

Example 2

An investor compares returns of three investment opportunities. Which investment produces the highest rate of return?

Asset	Price(£)	Holding period	Expected receipt(£)
A	97	6 months	100
B	95	1 year	100
C	25	20 years	100

Asset	Rate of return	Annualized rate	
A	3.09%	6.28%	$= (1 + 0.0309)^{\frac{1}{0.5}} - 1$
B	5.26%	5.26%	$= (1 + 0.0526)^{1} - 1$
C	300.00%	7.18%	$= (1 + 3)^{\frac{1}{20}} - 1$

Expected Rates of Returns

- The price of a financial asset tomorrow is uncertain, but beliefs about the market tomorrow could be quantified
- How?
  - Historical rates of returns: the average of the realized returns for each period (year, quarter, month) during a particular historical time span
  - Scenario and probability analysis: the expected (or mean) return is calculated as the weighted sum of the possible returns, where the weights correspond to the probabilities

Expected Returns: Historical Data

$$\bar{r} = \frac{(r_1 + r_2 + \quad + r_T)}{T} = \frac{1}{T}\sum_{t=1}^{T} r_t \; (2)$$

- $\bar{r}$ = expected return of a security
- r_t = the realized return of a security in period t (month, quarter, year...)
- T = the total number of periods during a historical time span

Example 3 Calculate the expected monthly return on Barrick Gold's stock using price data below.

Date	Price ($)	Return(%)
01/05/2015	11.79	−8.5
01/04/2015	12.89	18.8
02/03/2015	10.85	−15.8
02/02/2015	12.89	2.3
02/01/2015	12.6	18.9
01/12/2014	10.6	

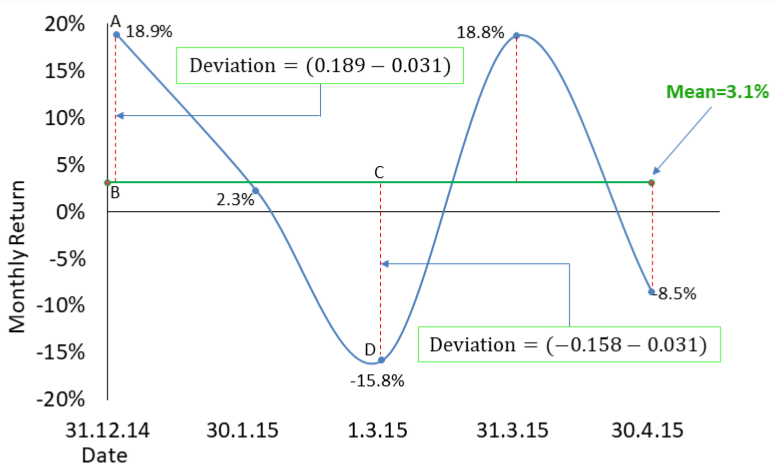
$$\bar{r}_{ABX} = \frac{(-0.085 + 0.188 - 0.158 + 0.023 + 0.189)}{5} = 3.1\%$$

Source: Data from https://uk.finance.yahoo.com

Risk

- Rates of returns (cost of capital) depend on the riskiness of a project, but how can risk be measured?
- Risk is the likelihood of deviations from the expected return
- One way to quantify risk is to estimate the variation of returns against the expected returns
- Variance is estimated by averaging squared deviations from the estimate of the expected return
- In practice, risk is measured by the standard deviation

Graphical Presentation: Barrick Gold



Source: Author's own calculation using stock data from https://uk.finance.yahoo.com

$$\text{Variance} = \sigma^2 = \frac{1}{(T-1)}\sum_{t=1}^{T}(r_t - \bar{r})^2 \ (4a)$$

$$\text{Standard Deviation} = \sigma = \sqrt{\sigma^2} \ (4b)$$

Back to Example 3:

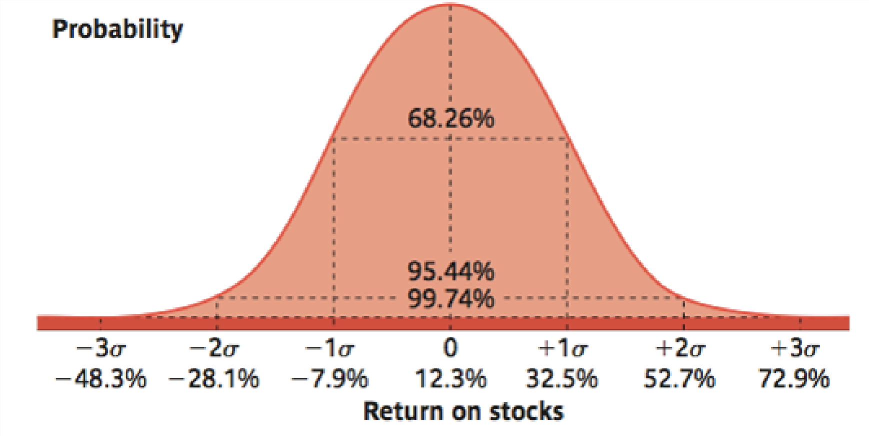
$$\bar{r} = 3.1\%$$

Date	Return (%)	Variance
01/05/2015	−8.5	$(-0.085 - 0.031)^2$=0.01356
01/04/2015	18.8	$(0.188 - 0.031)^2$=0.02456
02/03/2015	−15.8	$(-0.158 - 0.031)^2$=0.03590
02/02/2015	2.3	$(0.023 - 0.031)^2$=0.00007
02/01/2015	18.9	$(0.189 - 0.031)^2$=0.02483

$$\sigma^2 = 0.02473, \sigma = 15.7\%$$

Probability Distribution

- Probabilities are assigned to different expected outcomes in order to estimate the mean and variance
- If all possible events are listed and a probability is assigned to each event, the listing is called probability distribution
- Probability distribution of returns can be approximated by a bell-shaped curve known as normal distribution



$\bar{r} = 12.3\%$ and $\sigma = 20.2\%$

Source: Hillier, Ross, Westerfield, Jaffe & Jordan (2016) Corporate Finance 3rd ed. (Figure 9.7, page 242).

Diversification

- Diversification can substantially reduce risk (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
- So it is less risky to hold a portfolio of investments rather than relying on a single investment

- Portfolio theory was first developed by Harry Markowitz in 1952
- Markowitz gave us the tools for identifying portfolios which give the highest return for a particular level of risk (depending on personal risk aversion of investors)

Harry M. Markowitz
1927 – 2023
Nobel Prize in Economic Sciences, 1990

Portfolio Returns

- The expected return of a portfolio is the weighted sum of the expected returns of the individual assets in the portfolio

$$\bar{r}_p = w_1\bar{r}_1 + w_2\bar{r}_2 + \quad + w_N\bar{r}_N = \sum_{i=1}^{N} w_i\bar{r}_i \ (6)$$

- $\bar{r}_p$ = expected return of a portfolio
- w_i = the proportion of value invested in security i
- $w_1 + w_2 + \quad + w_n = 1$ (weights can be negative)
- $\bar{r}_i$ = expected return of security i
- N = the total number of securities in the portfolio

Portfolio Returns: Example 4

Suppose you want to purchase stocks of Wal-Mart (WMT) and Honeywell (HON) listed on NYSE. You have estimated the monthly rates of returns on these two stocks as shown below.

Date	Wal-Mart	Honeywell
04/01/2016	0.00261	−0.00966
01/12/2015	0.05053	−0.00366
02/11/2015	0.02795	0.01234
01/10/2015	−0.11721	0.09072
01/09/2015	0.0017	−0.04614

Source: Data from https://uk.finance.yahoo.com

You intend to invest 10% of your money in WMT and 90% in HON. Calculate the expected return of a portfolio of these two stocks.

Example 4: Solution

$$\bar{r}_{WMT} = \frac{1}{T}\sum_{t=1}^{T} r_t = -0.688\%$$

$$\bar{r}_{HON} = 0.872\%$$

$$\bar{r}_{(WMT+HON)} = w_{WMT} \times \bar{r}_{WMT} + w_{HON} \times \bar{r}_{HON} =$$

$$= 0.1 \times (-0.00688) + 0.9 \times 0.00872 = 0.716\%$$

Portfolio Risk: Formula

- Portfolio risk is reflected by the covariance: the extent to which returns on two assets ’move together’
- The standard deviation for a portfolio of N assets:

$$\sigma_p = \sqrt{\sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \sigma_{ij}} \quad (7)$$

- σ_{ij} = covariance between returns on assets *i* and *j*

Covariance and Correlation

- Covariance:

$$\sigma_{ij} = \sum_{s=1}^{S}[(r_{s,i} - \bar{r}_i)(r_{s,j} - \bar{r}_j)]p_s \quad (8)$$

$$\sigma_{ij} = \frac{1}{(T-1)} \sum_{t=1}^{T}(r_{t,i} - \bar{r}_i)(r_{t,j} - \bar{r}_j) \quad (9)$$

- Correlation coefficient:

$$\rho_{ij} = \frac{\sigma_{ij}}{(\sigma_i \times \sigma_j)} \quad (10)$$

- Correlation coefficient is always between –100% and +100%

Back to Example 4:

Calculate the variance and standard deviation of your portfolio.
The variance of a two-asset portfolio = the square-weighted sum of the variances plus twice the cross-weighted covariance (Eq.7):

$$\sigma^2_{p(2)} = w_1 w_1 \sigma_{11} + w_1 w_2 \sigma_{12} + w_2 w_1 \sigma_{21} + w_2 w_2 \sigma_{22} \quad (1)$$

$$= w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \sigma_{12} = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \sigma_1 \sigma_2 \rho_{12} \quad (2)$$

We need to calculate:

(1) σ^2_{WMT} and σ^2_{HON} (Eq.4a)

(2) $\sigma_{(WMT,HON)}$ (Eq.9)

Back to Example 4:

$\sigma^2_{WMT} = 0.00421$ and $\sigma^2_{HON} = 0.00256$

$$\sigma_{(WMT,HON)} = \frac{[0.00261 - (-0.00688)] \times [(-0.00966) - 0.00872]}{(5-1)}$$

$$+ \frac{[0.05053 - (-0.00688)] \times [(-0.00366) - 0.00872]}{(5-1)}$$

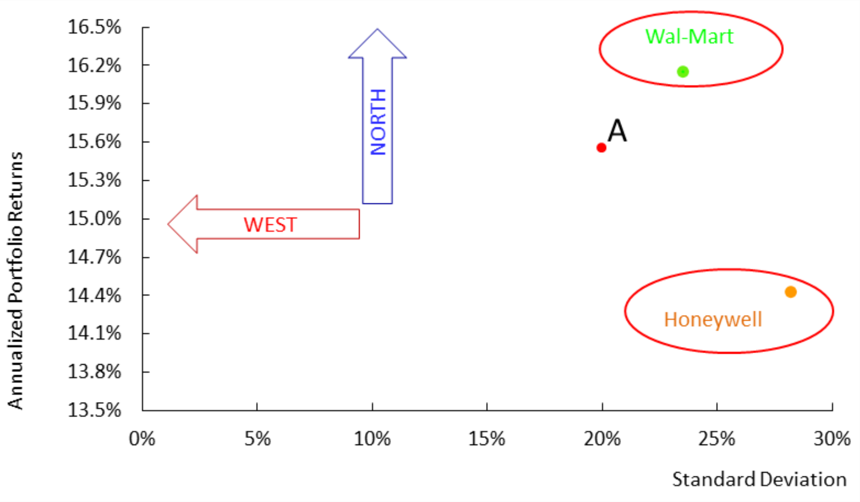
$$+ \frac{[0.02795 - (-0.00688)] \times [0.01234 - 0.00872]}{(5-1)}$$

$$+ \frac{[(-0.11721) - (-0.00688)] \times [0.09072 - 0.00872]}{(5-1)}$$

$$+ \frac{[0.00170 - (-0.00688)] \times [(-0.04614) - 0.00872]}{(5-1)} = -0.00257$$

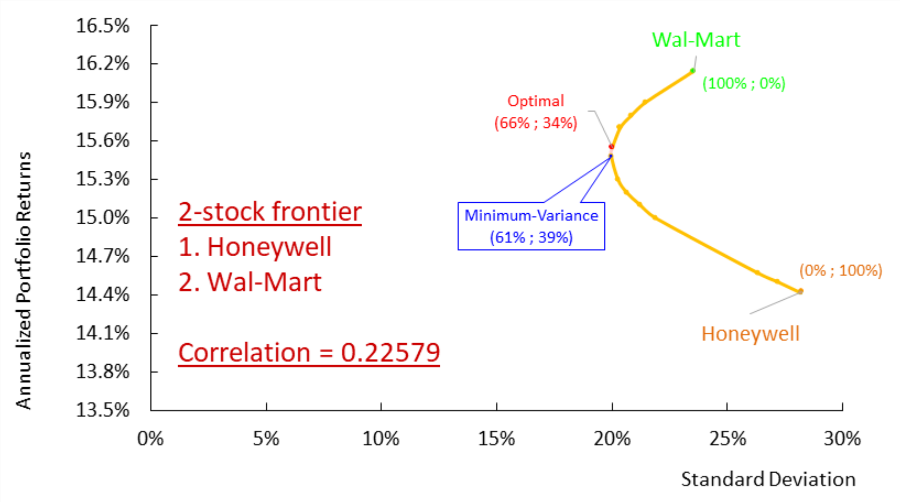
$\sigma^2_{(WMT+HON)} = 0.00165$ and $\sigma_{(WMT+HON)} = 0.04065 = 4.07\%$(monthly)

The Opportunity Set: Individual Stocks



Source: Author's own calculation using monthly stock price from 2/1985-1/2016, available at https://uk.finance.yahoo.com

The Opportunity Set: Portfolios



Source: Author's own calculation using monthly stock price from 2/1985-1/2016, available at https://uk.finance.yahoo.com

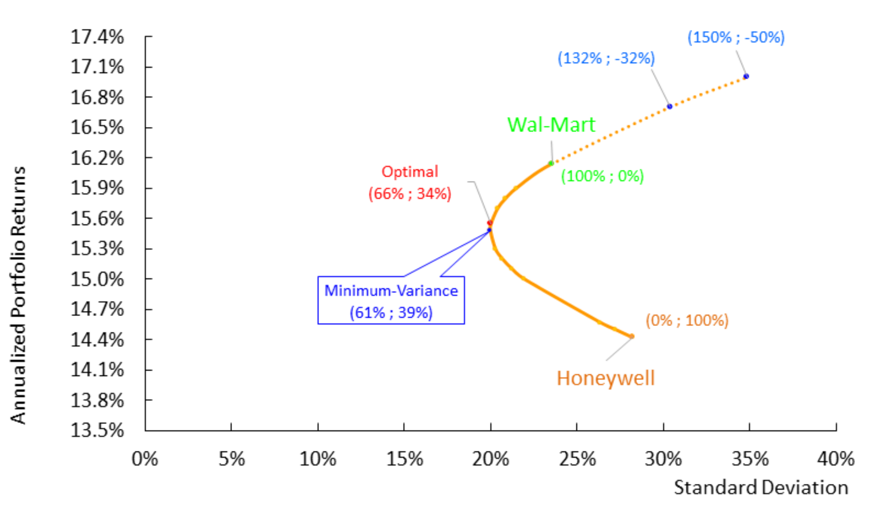
The Opportunity Set: Interpretations

- The curved line connecting different portfolios when the weights are changed represents an opportunity set or feasible set of portfolios for an investor
- An investor cannot achieve any point above (below) the curve because s/he cannot increase (reduce) the returns on the individual securities, reduce (increase) the standard deviations of the securities, or reduce (increase) the correlations between securities
- The minimum-variance portfolio is the one with the lowest risk while the optimal portfolio is the one that has the highest return per unit of risk

The Efficient Frontier

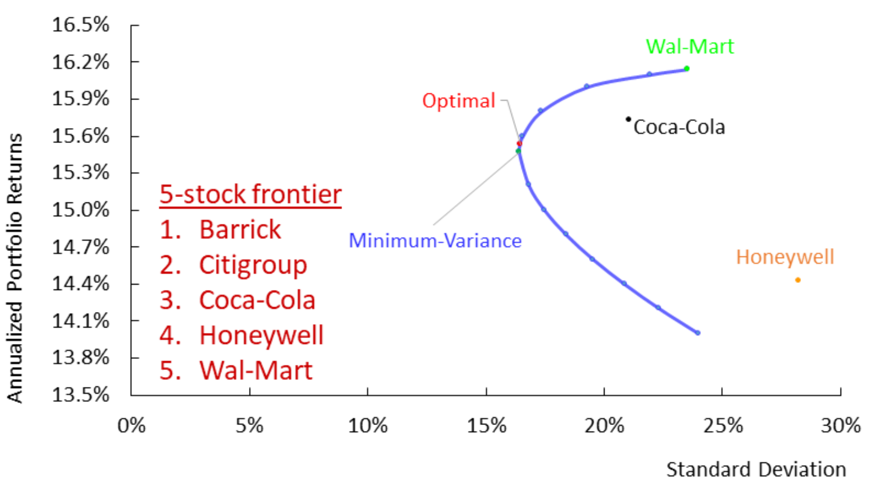
- The section of the opportunity set above the minimum variance portfolio is the efficient frontier
- The efficient portfolios are those which lie on the efficient frontier and offer the highest return for a given level of risk: there is no way to reduce the risk of the efficient portfolio without a decrease in its expected return
- The optimal portfolio is the one that has the highest return per unit of risk

The Opportunity Set: Short Sale



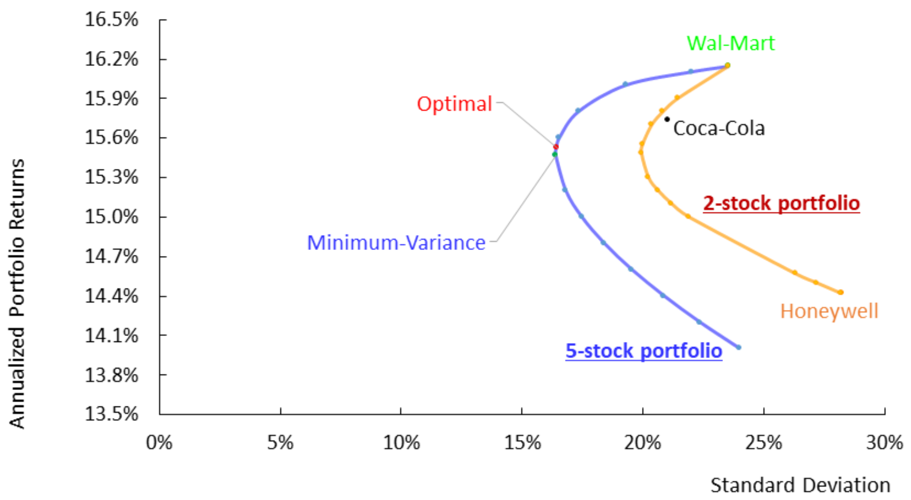
Source: Author's own calculation using monthly stock price from 2/1985-1/2016, available at https://uk.finance.yahoo.com

The Opportunity Set: Adding More Stocks



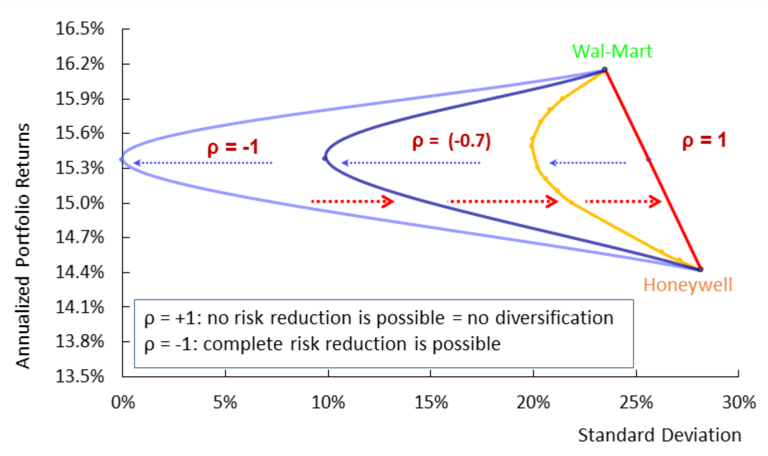
Source: Author's own calculation using monthly stock price from 2/1985-1/2016, available at https://uk.finance.yahoo.com

Two-Stock vs. Five-Stock Portfolio



Source: Author's own calculation using monthly stock price from 2/1985-1/2016, available at https://uk.finance.yahoo.com

The Effect of Correlation

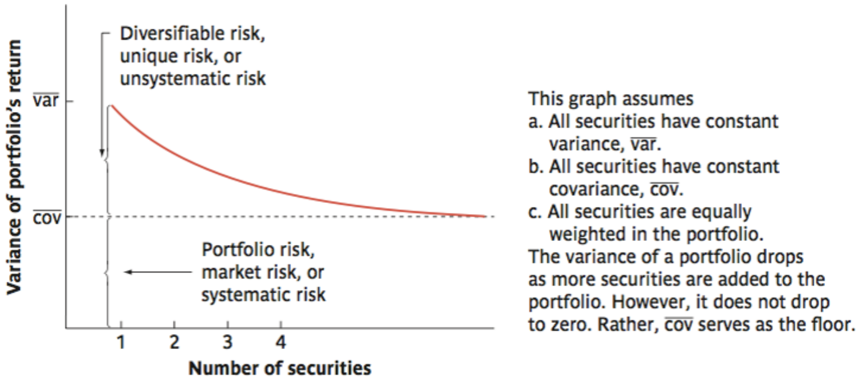


Source: Author's own calculation using monthly stock price from 2/1985-1/2016, available at https://uk.finance.yahoo.com

The Limit of Diversification

- There are risk factors that affect a large number of stocks in a similar way
- These risk factors could not be reduced through diversification even when holding a portfolio which includes all stocks in the market
- Such factors as changes in GDP, inflation, interest rate...
- They are known as non-diversifiable or market risk or systematic risks
- Total risk = firm-specific risk + market risk

Graphical Presentation



Source: Hillier, Ross, Westerfield, Jaffe and Jordan (2021) *Corporate Finance* 3rd ed. (Figure 10.7, page 272)

CML, SML and the CAPM

Topics Covered

- One Risk-Free Asset and a Risky Portfolio
- CML & SML
- CAPM
- Risk in a Context of Fully Diversified Portfolio
- Cost of Equity
- Criticisms of CAPM and Its Use in Practice

Portfolio of a Risky Portfolio & a Riskless Asset

- An investor could combine a risky portfolio (assets in this portfolio are all risky) with an investment in a risk-free security
- Back to the 5-security portfolio: ABX, WMT, HON, C and KO
- What is the return and risk of the portfolio of a five-risky-asset portfolio and a risk-free security?
- What does the opportunity set look like?
- Is the efficient frontier better?

The Return and Risk

Let

- w_1 = the amount of money invested in the risk-free asset
- w_2 = the amount of money invested in the risky portfolio
- r_f = the return on the risk-free asset = constant
- r_2 = the return on the risky portfolio
- σ_2 = the standard deviation of the risky portfolio

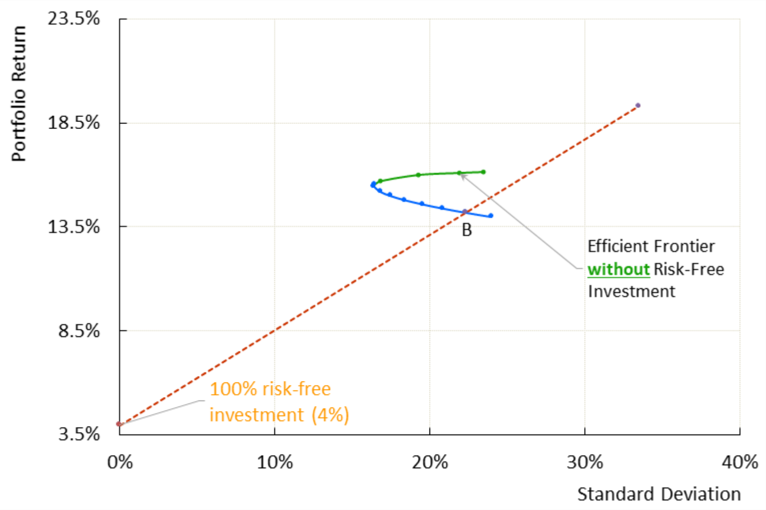
The expected return and standard deviation of the portfolio including the risky portfolio and risk-free asset:

- $\bar{r}_p = w_1 r_f + w_2 \bar{r}_2$
- $\sigma_p^2 = w_1^2 \sigma_f^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \sigma_{f,2}$
- $\sigma_f^2 = 0$ and $\sigma_{f,2} = 0$
- $\sigma_p = w_2 \sigma_2$

Characteristics of the Portfolio

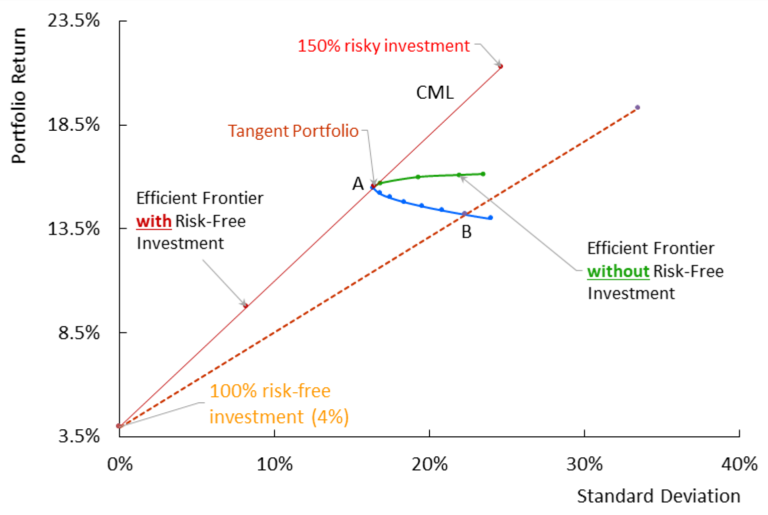
- The standard deviation is only a fraction of the risky portfolio, based on the amount we invest in it
- As we increase the amount invested in the risky portfolio, we increase both risk and return proportionally
- This combination is a straight line connecting the risky point and the risk-free one

The Risk-Return Combinations



Source: Author's own calculation using monthly stock price from https://uk.finance.yahoo.com (2/1985-1/2016)

The Tangent Portfolio (1)



Source: Author's own calculation using monthly stock price from https://uk.finance.yahoo.com(2/1985-1/2016)

The Tangent Portfolio (2)

- The straight line that is tangential to the efficient frontier of risky investments provides the best risk and return trade-off available to an investor
- The portfolio that generates this line is known as the tangent portfolio

Identify the Tangent Portfolio

- What is the slope of the straight line?
- $\bar{r}_p = r_f + a \times \sigma_p$
- $\bar{r}_p = w_1 r_f + w_2 \bar{r}_2$
- $\sigma_p = w_2 \sigma_2$
- $a = \frac{(\bar{r}_p - r_f)}{\sigma_p} = \frac{(1-w_2)r_f + w_2\bar{r}_2 - r_f}{w_2\sigma_2} = \frac{(\bar{r}_2 - r_f)}{\sigma_2} =$ Sharpe ratio
- The optimal portfolio to combine with the risk-free asset will be the one with the highest Sharpe ratio, as it will lead to the steepest possible line
- The steepest line is referred to as the Capital Market Line or Capital Allocation Line if the risky portfolio includes all investable securities in the market

The Capital Market Line (CML)

- The CML is an expression of risk and return for a fully diversified portfolio
- $\bar{r}_p = r_f + a \times \sigma_p$
- a: market price of risk (in the tangency portfolio the price is highest = max Sharpe ratio)
- σ_p: is the number of percentage points of risk taken on by a particular efficient portfolio which contains a risk-free and a risky portfolio
- This risk can no longer be diversified (even holding the entire market securities) = market risk

The Security Market Line (SML)

- The SML shows the relationship between return and risk of an individual security as measured by its sensitivity to market risk
- CML and SML are closely related
- CML: $\bar{r}_p = r_f + a \times \sigma_p$
- SML: $\bar{r}_i = r_f + a \times \sigma_i \times \rho_{im}$
- ρ_{im}: the correlation between return on security i and return on the market portfolio
- When $\rho_{im} = 1$, there is no risk reduction effect because total risk would be all non-diversifiable
- CML is a special case of SML (when $\rho_{im} = 1$)

The SML and the CAPM

- Remember $a = \frac{(\bar{r}_m - r_f)}{\sigma_m}$
- $\rho_{im} = \frac{\sigma_{im}}{\sigma_i \times \sigma_m}$
- SML: $\bar{r}_i = r_f + \frac{(\bar{r}_m - r_f)}{\sigma_m} \times \sigma_i \times \frac{\sigma_{im}}{(\sigma_i \times \sigma_m)}$
- SML: $\bar{r}_i = r_f + (\bar{r}_m - r_f) \times \frac{\sigma_{im}}{\sigma_m^2}$
- SML expression gives the return that an investor should expect from investment in security i given its level of market (systematic) risk

The CAPM

- This relationship between market risk and return is known as the Capital Asset Pricing Model (CAPM)

$$\bar{r}_i = r_f + \beta(\bar{r}_m - r_f) \quad (1)$$

- $\beta = \frac{\sigma_{im}}{\sigma_m^2} = \rho_{im} \times \frac{\sigma_i}{\sigma_m}$
- β measures the covariance between the returns on a particular stock with the returns on the market as a whole

The Basic Features of β

- $\beta = 1$: a 1% change in the market return generally leads to a 1% change in the return on a specific security
- $0 < \beta < 1$: a 1% change in the market return generally leads to a less than 1% change in the return on a specific security
- $\beta > 1$: a 1% change in the market return generally leads to a greater return than 1% change in the return on a specific security

Assumptions underlying CAPM

1. Investors buy and sell securities at competitive market prices without incurring taxes or transaction costs
2. All investors have the same information and are able to estimate returns and standard deviations
3. Investors are rational and risk-averse
4. Investors can borrow and lend at the risk-free rate as well as short-sell securities
5. All assets are traded and it is possible to buy a fraction of a unit of an asset

Risk in a Context of Fully Diversified Portfolio

- The only issue of concern to investors that are fully diversified is the market risk, not firm unique risk
- So the market only gives a premium for those taking market risk because firm-specific risk becomes very small in a fully diversified market portfolio
- A high return (or cost of capital) should be expected from a high-beta security

Calculating β

- The common approach is to use a broad index of securities as a proxy for the macroeconomic factor (market risk/non-diversifiable)
- Practically, β can be estimated using the following regression equation:

$$\Delta r_i = \alpha_i + \beta_i \Delta r_m + \epsilon_i \ (2)$$

- $\Delta r_i = (\bar{r}_i - r_f)$
- $\Delta r_m = (\bar{r}_m - r_f)$

Estimates of β for Individual Securities

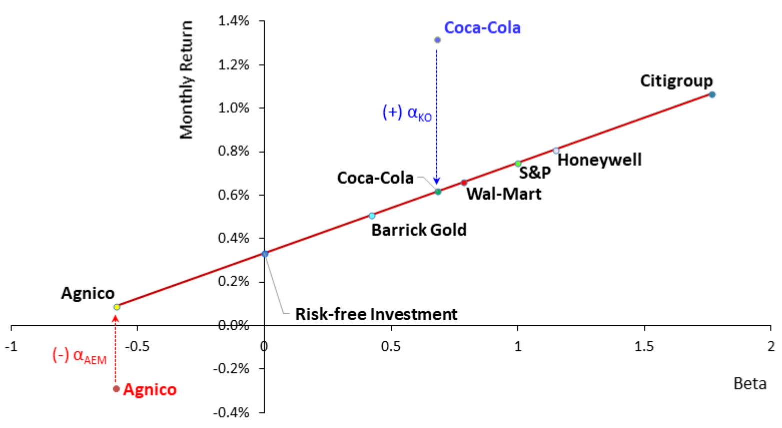
Stock	Symbol	β
Agnico Eagle Mines	AEM	−0.59
Barrick Gold	ABX	0.42
Citigroup	C	1.76
Coca-Cola	KO	0.68
Honeywell	HON	1.15
Wal-Mart	WMT	0.78
Risk-free investment		0
S&P 500		1

Source:
Monthly stock price data from https://uk.finance.yahoo.com (2/1985 – 1/2016)
Risk-free rate is one-month deposit rate from http://www.federalreserve.gov/releases/h15/data.htm
β of AEM based on 61 months from 1/2011 to 1/2016

Alpha

- ϵ_i in Eq.(2) is the error term which can be considered a random variable with expected value of zero
- Under the CAPM assumptions, the market portfolio is fully efficient (tangency), thus, if we plot individual securities according to their expected return and beta, they should fall along the SML: these securities have an alpha of zero
- α_i is the expected excess return of security i when the market excess return is zero (non-market premium)

The SML: Graphical Presentation



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β of AEM based on 61 months from 1/2011 to 1/2016

SML and CML: the Differences

CML

- Showing risk and return for a fully diversified portfolio (containing many risky assets and a risk-free asset)
- Risk is measured by standard deviation
- Each point on the line represents an entire portfolio (only)

SML

- Showing risk and return of a security or a portfolio including the tangency portfolio
- Risk is measured by beta
- Each point on the line represents either a security or a portfolio

The CAPM and Cost of Capital

- Under the CAPM, investors will hold a tangent portfolio (firm-specific risk is fully diversified)
- The appropriate risk premium for an investment depends on its market risk measured by β in Eq.(1)
- Therefore, the cost of capital of an investment is equal to the expected return of the best available portfolio in the market with the same sensitivity to systematic risk
- The best portfolio is the tangent portfolio or the portfolio that has the highest Sharpe ratio of any portfolio in the economy
- β determines the cost of capital of an investment

Example 1

Green Energy PLC is seeking to raise capital from a large group of investors to expand its operations. Suppose the S&P 500 is the efficient portfolio of risky securities. The S&P 500 portfolio has a volatility of 16% and an expected return of 12%.

The investment is expected to have a volatility of 35% and a 60% correlation with the S&P 500. If the risk-free interest rate is 3%, what is the appropriate cost of capital for Green Energy's expansion?

Example 1: Solution

First we calculate the beta:

$$\beta_{GE}^{S\&P} = \frac{\sigma_{GE} \times \rho_{GE,S\&P}}{\sigma_{S\&P}} = \frac{0.35 \times 0.6}{0.16} = 1.31$$

Then we use the CAPM to calculate the required return from investors:

$$r_{GE} = r_f + \beta_{GE}^{S\&P} \times (r_{S\&P} - r_f) = 0.03 + 1.31 \times (0.12 - 0.03) = 14.8\%$$

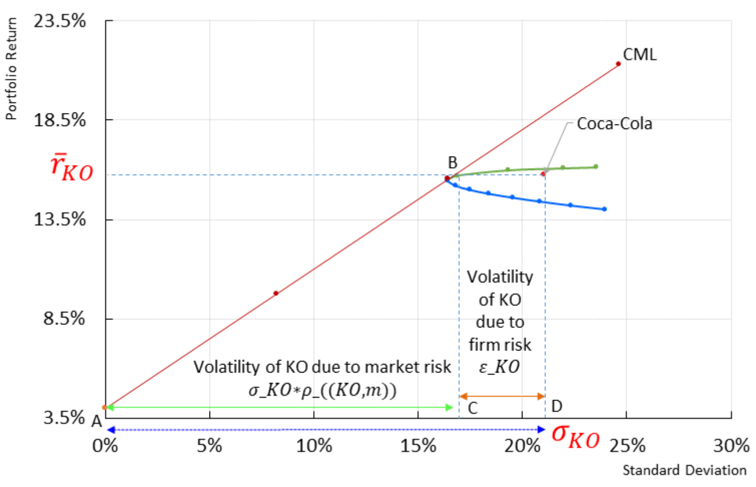
Because investors will require a return of 14.8%, this return is the appropriate cost of capital for the expansion.

Market Risk of Individual Securities

- Total risk (measured by standard deviation) of a security includes two parts, (1) market risk and (2) firm-specific risk.
  - $\sigma_{r_i}^2 = \beta_i^2 \sigma_m^2 + \sigma_i^2$
  - Under the CAPM, firm-specific risk is close to zero ($\epsilon_i = 0$)
  - Variance due to the market: $\beta_i^2 \sigma_m^2$
  - Standard deviation: $\beta_i \sigma_m$
- The β, return and risk of individual securities can also apply to portfolios

$$\beta_p = \sum_{i=1}^{n} \beta_i w_i \quad (3)$$

Total vs. Market Risk: Graphical Presentation



Source: Author's own calculation using monthly stock price from https://uk.finance.yahoo.com (2/1985-1/2016)

Criticisms of the CAPM

- The CAPM is empirically untestable because the underlying market portfolio is unobservable (Roll, 1977, JFE)
- Historical data (ex-ante vs. ex-post)
- Estimation of β
- One-period return (parameters to be estimated)
- Assumptions underlying the model

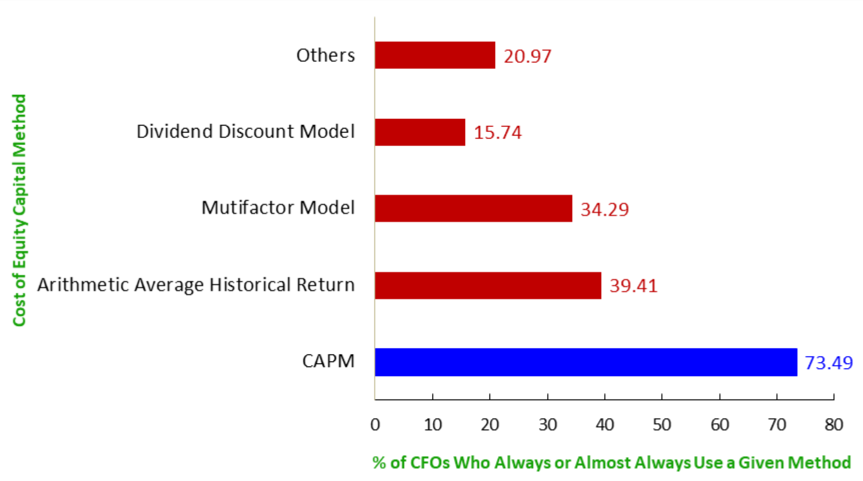
Empirical Evidence

- Earlier empirical work (Fama and MacBeth, 1973) showed that betas did influence return
- More recent empirical studies suggested that the relation between betas and returns are not reliable (Fama and French, 2006)
- *"The CAPM, like Markowitz's (1952, 1959) portfolio model on which it is built, is nevertheless a theoretical tour de force. We continue to teach the CAPM as an introduction to the fundamental concepts of portfolio theory and asset pricing, to be built on by more complicated models like Merton's (1973) ICAPM. But we also warn students that despite its seductive simplicity, the CAPM's empirical problems probably invalidate its use in applications."* (Fama and French, 2004, p.44)

CAPM in Practice

- The CAPM may not be perfect
- The imperfections of the CAPM may not be critical in the context of corporate budgeting and corporate finance, where errors in estimating project cash flows are likely to be far more important than small discrepancies in the cost of capital
- The CAPM remains the predominant model used in practice to determine the cost of equity
  - the logic of the decomposition to systematic and firm-specific risk is compelling
  - evidence against the CAPM may be the result of mismeasuring betas because they can change over time
- The CAPM is an accepted norm in the U.S. and many other developed countries
- Financial websites such as Yahoo! Finance, Bloomberg and FT.com frequently provide estimates of the beta of listed firms

Methods Used by Firms



Source: Graham and Harvey (2001)

Thank You!

Thank you for listening.

For issues or questions come to my office hours.

Or send me an email at **ce50@st-andrews.ac.uk**