Lecture 1:
Discounting, compounding and investment appraisal

Dr Christian Engels
ce50@st-andrews.ac.uk

EC3318 Financial Economics: Corporate Finance
MN3101 Corporate Finance and Control

University of St Andrews Business School
16 September 2025

Tagging of calculators required for Class Test and Final Exam

For this module: calculators are permitted in in-person class tests/exams, but only if they are **University-tagged** and on the **approved list**. Untagged calculators will be removed by invigilators.

We will tag calculators after the Week 2 lecture – please bring your calculator.

What you need to do

1. Check your model is approved (see list).
2. Bring your calculator and student ID to Week 2 Lecture for tagging. If already tagged by another School, no re-tagging needed.
3. Keep the tag on your calculator for all assessments.

Key rules

- Only the models on the list are allowed.
- **No exceptions.**

Approved calculator models

- Sharp `EL-531`
- Casio `FX-85GTCW`
- **Helect-2**
- **Renus 2-line**
- Casio `fx-83GTX`
- Casio `fx-83GT CW`
- Casio `fx-85GTX`
- Casio `fx-85GT CW`

GitHub sign-up & Education verification (for next week's labs)

All students must have a GitHub account and start verification for the **GitHub Education as a student** before next week's computational labs.

What you need to do

1. Create a GitHub account at https://github.com.
2. Choose a professional username (see right).
3. Sign up using your `@st-andrews.ac.uk` email.
4. Apply for the **GitHub Education as a student** (https://github.com/settings/education/benefits).
5. **Record your login details:** GitHub username, password, etc.
6. Bring your working login to the lab (you should be able to sign in on a lab machine).

Username format (examples)

- `firstname-lastname`
- `firstname-lastname-yy`
- `firstinitial-lastname`

Key rules / tips

- Use only your `@st-andrews.ac.uk` address to register/verify.
- Keep usernames professional; avoid nicknames and numbers where possible.

Self-certification of absence

Attendance is a basic assessment requirement. Unavoidable absences must be explained using the University's **Self-Certificate of Absence** via MySaint (My details and development).

What counts as an absence

- Missing an **exam** or any **compulsory** class/activity listed in the module.
- Failing to submit a **compulsory assignment** on time (even with an extension).
- Being unable to study for **>5 consecutive days** or **>15 non-consecutive days**.

How to self-certify

- Submit the self-certificate in **MySaint** within **3 days** of the first day of absence.
- Further information: https://www.st-andrews.ac.uk/students/rules/selfcertification/

Content of today's lecture

Part 1: Discounting and Compounding

- Reading
- Interest Rate
- Simple vs. Compound Interest
- The Timeline
- Rules of Time Travel
- APR vs. AER
- Inflation and the Time Value of Money
- Perpetuities and Annuities
- Common Mistakes

Part 2: Investment Appraisal

- Reading
- Net Present Value
- The IRR Rule
- IRR Rule Limitations
- The Payback Period Rule
- The Average Accounting Return
- The Profitability Index
- Capital Budgeting in Practice

Part 1: Discounting and Compounding

Required reading

1. Hillier, D., Ross, S., Westerfield, R., Jaffe, J. & Jordan, B. (2021) Corporate Finance. 4th ed. London: McGraw-Hill Education. ISBN-13: 9781526848086. Chapter 4.
2. Brealey, R. A., Myers, S. C., Allen, F., & Edmans, A. (2022). Principles of Corporate Finance (14th ed.). McGraw-Hill Education. ISBN: 978-1265074159. Chapter 5.
3. Ruback, R.S. (2011) Downsides and DCF: Valuing Biased Cash Flow Forecasts. *Journal of Applied Corporate Finance* 23, 8-17. https://doi.org/10.1111/j.1745-6622.2011.00322.x

The Misleading Number?

A $91-million contract signed in 1998 between the New York Mets and catcher Mike Piazza

But how much did Mike really get?

Bonus: $7.5 million

1999	$4m
2002	$3.5m

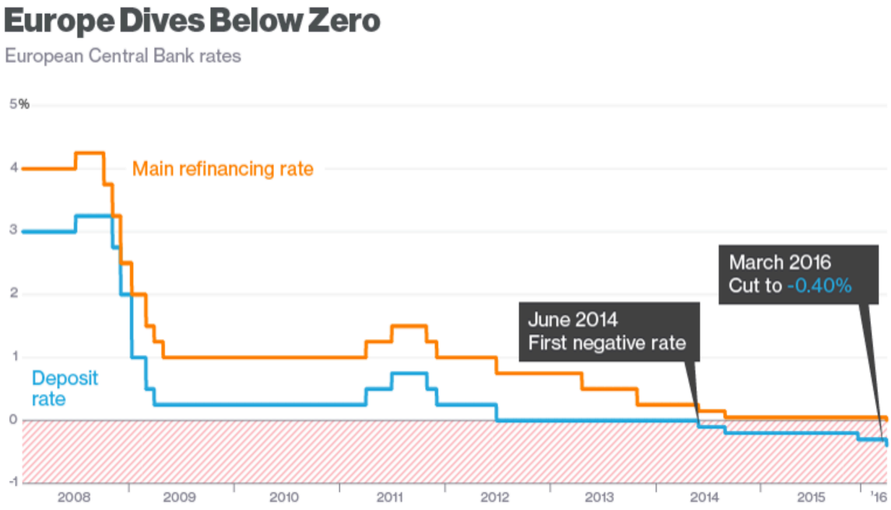
Salary: $83.5 million

1999	$6m
2000	$11m
2001	$12.5m
2002	$9.5m
2003	$14.5m
2004	$15m
2005	$15m

Interest Rate

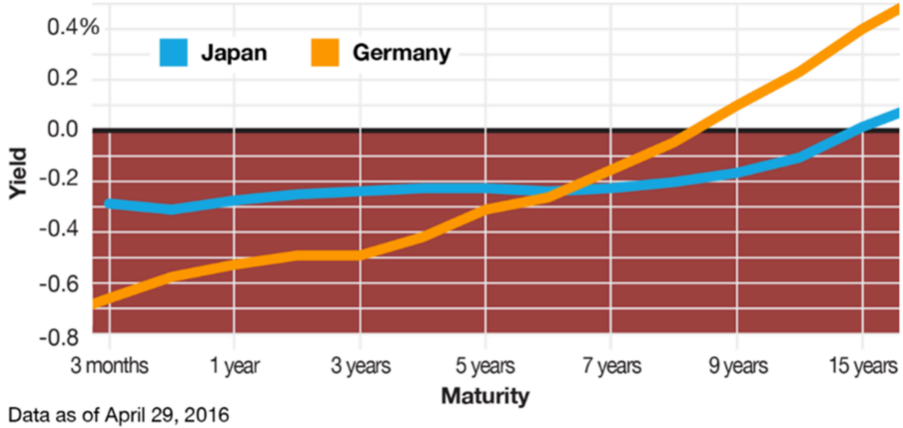
- With the passage of time, money grows
- The growth rate for money is interest
- Cash flows at different points in time have different values = the time value of money
- Interest rate reflects the value of cash flows
- Cost of money for borrowers = required return for lenders

Negative Interest Rate



Source: ECB/Bloomberg

Pay to Save



Source: Bloomberg

Simple vs. Compound Interest

What is the value of £100 two years from today if the interest is 5% per year?

- **Simple:** interest on the original principal only
- **Compound:** interest on (interest + principal)

Period	Simple	Compound
Year 1	$100 \times 0.05 = £5$	$100 \times 0.05 = £5$
Year 2	$100 \times 0.05 = £5$	$(5 + 100) \times 0.05 = £5.25$
Interest	£10	£10.25

Future vs. Present: Valuing a Single Cash Flow

$$FV = PV \times (1 + r)^n \qquad (1)$$

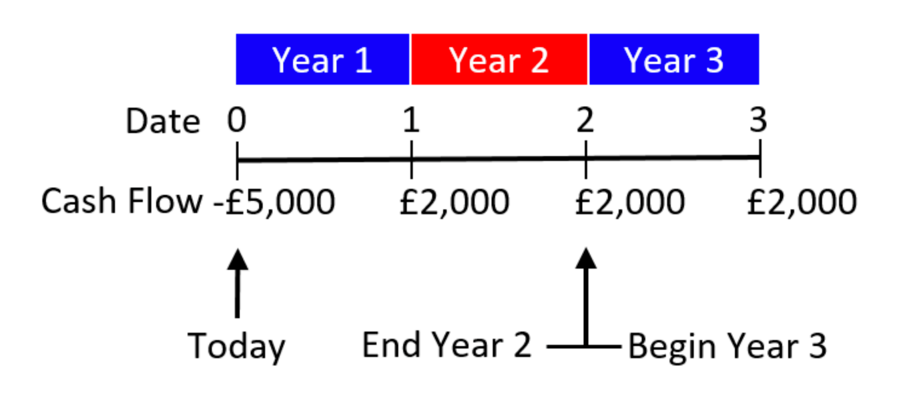
$$PV = \frac{FV}{(1 + r)^n} \qquad (2)$$

- r = interest rate for one period = 5%
- PV = today's value of a cash flow = present value = £100
- FV = value of a cash flow n period(s) from today = £110.25
- n = number of periods = 2 years

The Timeline

- A linear representation of the timing of the expected cash flows
- A stream of cash flows = a series of cash flows lasting several periods
- Assume that you have agreed to lend a friend £5,000 today and your friend has agreed to repay this loan in three instalments of £2,000 at the end of each of the next three years, construct a timeline.

Constructing a Timeline



You may feel it is not worth spending the time to construct the timeline.

Elements of a Timeline

- Date (Time) 0 represents the present
- Date 1 is one period from now and represents the end of Period 1 (year, quarter, month. . .)
- Date 2 is two periods from now and represents the end of Period 2. . .
- The space between Date 0 and Date 1 represents the time period between these two dates
- Date 1 signifies both the end of Period 1 and the beginning of Period 2

Rules of Time Travel

- Values can only be compared and combined if cash flows occur at the same point in time in the same unit
  - £100 + $100 = ?
  - €1 today + €1 tomorrow = ?
- Moving cash flows forward = compounding (Eq.1)
- Moving cash flows back in time = discounting (Eq.2)

Valuing a Stream of Cash Flows

Most investments have multiple cash flows: applying the rules of time travel

$$PV = \sum_{n=0}^{N} PV(CF_n) = \sum_{n=0}^{N} \frac{CF_n}{(1+r)^n} \qquad (3)$$

The present value is the amount you need to invest today to generate the cash flow stream $CF_1, CF_2, \ldots, CF_n$ in the future; that is, receiving these cash flows is equivalent to having their present value in the bank today

Example 1

You have just graduated and need money to buy a new car. Your rich Uncle Richard will lend you the money so long as you agree to pay him back within five years, and you offer to pay him a rate of interest that he would otherwise get by putting his money in a savings account.

Based on your expected earnings and living expenses, you think you will be able to pay him £3,200 in one year; £3,500 in two years; £4,100 in three years; £5,500 in four years and £7,000 in five years.

If your uncle would otherwise earn 3% per year on his savings, how much can you borrow from him today? Verify your answer by calculating the future value of this stream of cash flows.

Solution

He would lend you an amount that is equivalent to the future payments in present value terms

$$PV = \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \frac{CF_3}{(1+r)^3} + \frac{CF_4}{(1+r)^4} + \frac{CF_5}{(1+r)^5}$$

$$= \frac{3200}{1.03} + \frac{3500}{(1.03)^2} + \frac{4100}{(1.03)^3} + \frac{5500}{1.03^4} + \frac{7000}{1.03^5} = 21,082.9$$

This amount is less than the sum of your promised payments (£23,300) because of the time value of money

Verification

If your uncle, instead of lending you the money, deposited £21,082.90 in the bank today earning 3% interest, in five years he would have:

$$FV_5 = 21,082.9 \times (1.03)^5 = 24,440.86$$

Now suppose he gives you the money and then deposits your payments to him in a bank account each year, five years from now he will have:

$$\sum_{n=1}^{5} FV(CF_n) = CF_1 \times 1.03^{(5-1)} + CF_2 \times 1.03^{(5-2)} + CF_3 \times 1.03^{(5-3)}$$

$$+CF_4 \times 1.03^{(5-4)} + CF_5 \times 1.03^{(5-5)} = 24,440.86$$

APR vs. AER

- **APR (Annual Percentage Rate)** = simple interest for one year, without the effect of compounding
- The APR is smaller than the actual amount of interest that is earned or to be paid
- APR cannot be used as a discount rate (r)
- Use APR per period or AER (Annual Effective Rate)
- AER increases as the compounding period increases because of the effect of "interest-on-interest"

Convert APR to AER

- n = number of years
- If compounding occurs once a year for n years:

$$FV_n = PV \times (1 + AER)^n$$

- If compounding occurs m times a year for n years:

$$FV_{(n,m)} = PV \times \left(1 + \frac{APR}{m}\right)^{n \times m}$$

- Converting an APR to an AER by setting $FV_n = FV_{(n,m)}$:

$$(1 + AER) = \left(1 + \frac{APR}{m}\right)^m \qquad (4)$$

AERs for a 10% APR

Compounding Interval	AER
Annually ($m = 1$)	10%
Semi-annually ($m = 2$)	10.25%
Quarterly ($m = 4$)	10.381%
Monthly ($m = 12$)	10.471%
Weekly ($m = 52$)	10.506%
Daily ($m = 365$)	10.516%
Continuously ($m = \infty$)	10.517%

Inflation and the Time Value of Money

- An overall general rise in prices is known as inflation
- Nominal cash flows refer to the amount of money of the day while real cash flows reflect the purchasing power
- Interest rates quoted are nominal, not real rates
- Current dollar cash flows must be discounted by the nominal rate; real cash flows are discounted by the real interest rate
- The two methods should always give the same answer:

$$(1 + \text{real rate}) = \frac{(1 + \text{nominal})}{(1 + \text{inflation})} \tag{5}$$

Valuing Real Cash Payments

Interest rate = 3%; inflation = 2%. How much do you need to invest now to produce $100 after one year?

$$PV = \frac{100}{1.03} = \$97.09$$

Using real cash payment and real interest rate:

- Real cash: $\frac{100}{1.02} = \$98.04$ (future value)
- Real interest rate: $\frac{(1+0.03)}{(1+0.02)} - 1 = 0.0098$
- Present value: $\frac{98.04}{(1+0.0098)} = \$97.09$

Perpetuities

- A perpetuity is a stream of equal cash flows that occur at regular intervals and last forever (!)
- Example: British consols
- Note that the first cash flow does not occur immediately - it arrives at the end of the first period
- The PV of a perpetuity with payment: $CF_1 = CF_2 = ... = CF_N = C$

$$PV = \frac{C}{r} \qquad (6)$$

Growing Perpetuities

A growing perpetuity is a stream of cash flows that occur at regular intervals and grow at a constant rate forever (!)

$$PV = \frac{C}{(r-g)} \qquad (7)$$

If $g \geq r$:

- An infinite present value: meaning that no matter how much money you start with, it is impossible to reproduce those cash flows
- A promise to pay an amount that forever grows faster than the interest rate is unlikely to be kept (or believed)

Annuities

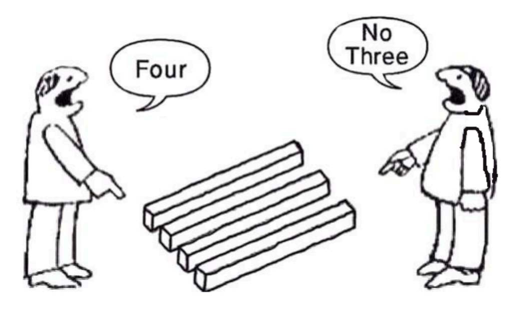
- An annuity is a stream of N equal cash flows that occur at regular intervals and end after a fixed number of payments
- Examples: car loans, mortgages, bonds, . . .

$$PV = \frac{C}{r} \times \left[1 - \frac{1}{(1+r)^N}\right] \tag{8}$$

$$FV = \frac{C}{r} \times \left[(1+r)^N - 1\right] \tag{9}$$

Common Mistakes

- Delayed perpetuities
- Delayed annuities



An alumnus of University of St Andrews wants to endow £5,000 per year forever for an annual graduation party for students in the School of Management. If the university earns 12% per year on its investments, and if the first party is held two years from today, how much will the alumnus need to donate?

Solution

$$\frac{C}{r} = \frac{5000}{0.12} = 41,666.7 = PV_1$$

$$PV_0 = \frac{PV_1}{(1+r)^n} = \frac{41666.7}{(1+0.12)^1} = 37,202.40$$

Seven years from today, Roberta Balotelli is expected to receive the first cash flow of a five-year annuity of €1,000 per year. If the interest rate is 3%, what is the present value of her annuity?

Solution

$$\frac{C}{r} \times \left[1 - \frac{1}{(1+r)^n}\right] = \frac{1000}{0.03} \times \left[1 - \frac{1}{(1+0.03)^5}\right] = 4,579.71 = PV_6$$

$$PV_0 = \frac{PV_6}{(1+r)^n} = \frac{4579.71}{(1+0.03)^6} = 3,835.43$$

Part 2: Investment Appraisal

Required and further reading

- Hillier, D., Ross, S., Westerfield, R., Jaffe, J. & Jordan, B. (2021) Corporate Finance. 4th ed. London: McGraw-Hill Education. ISBN-13: 9781526848086. Chapter 6.
- Brealey, R. A., Myers, S. C., Allen, F., & Edmans, A. (2022). Principles of Corporate Finance (14th ed.). McGraw-Hill Education. ISBN: 978-1265074159. Chapter 6.
- 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
- Andor, G., Mohanty, S.K., and Toth, T. (2015) Capital Budgeting Practices: A Survey of Central and Eastern European Firms. *Emerging Markets Review* 23, 148-172. https://doi.org/10.1016/j.ememar.2015.04.002 (Further reading)

Net Present Value

The difference between the sum of the present values of a project's cash inflows and that of cash outflows

$$NPV = \sum_{i=0}^{I} PV(CF_i) - \sum_{o=0}^{O} PV(CF_o) \qquad (1)$$

- CF_i: a stream of cash inflows
- CF_o: a stream of cash outflows

The NPV Rule - Example 1

Barrick Gold is considering investing in a new gold mine in South Africa. Gold in South Africa is buried very deep, so the mine will require an initial investment of $150 million. If this money is spent immediately, the mine is expected to produce revenues of $30 million per year for 20 years, with the first cash flow coming one year from today. It will cost $10 million per year to operate the mine, with the first cash outflow also occurring in one year's time. After 20 years, the gold will be depleted. The mine must then be stabilized on an ongoing basis, which will cost $5 million per year forever with the first cash outflow starting after 21 years.

Assuming that the cost of capital for Barrick Gold is 15%, calculate the NPV of this project.

Two-Step Solution

Step 1: Calculating total net cash inflows:

$$\sum_{i=1}^{20} PV(CF_i) = \frac{C}{r} \times \left[1 - \frac{1}{(1+r)^n}\right]$$

$$= \frac{(30-10)}{0.15} \times \left[1 - \frac{1}{(1+0.15)^{20}}\right] = 133.33 \times 0.9389 = \$125.19 \text{ mil}$$

Step 2: Calculating total cash outflows:

1. Calculating the perpetuity

$$\sum_{i=1}^{20} PV(CF_i) = 150 + \frac{C/r}{(1+0.15)^{20}}$$

$$= 150 + \frac{33.33}{1.15^{20}} = 150 + 2.04 = \$152.04 \text{ mil}$$

2. Adding the initial cash outflow to the perpetuity

$$NPV = 125.19 - 152.04 = -\$26.85 \text{ mil}$$

Estimating Discount Rates

Next lecture will do this in detail

Approach 1: Use the CAPM

- Observe the risk-free rate from the market (e.g., the return on a coupon government bond).
- Observe beta(s) of companies operating in a similar business scope.
- Estimate the cost of capital using CAPM.

Approach 2: Single risk-adjusted rate from a maturity-matched coupon bond

- Use the return on a coupon government bond with the same time horizon as the project (for a 10-year project, use a 10-year bond's rate).
- Add a risk premium to the risk-free rate.

Approach 3: Term-structure approach using zero-coupon bonds and forward rates

- Collect returns on zero-coupon government bonds of different maturities and estimate the forward interest rates after each period.
- Add risk premium(s) to these risk-free rates to estimate the (risk-adjusted) reinvestment/discount rates.

Economic Rents and NPV

- Profits that more than cover the opportunity cost of capital are known as economic rents
- Think about competitive advantage

The IRR Rule

- Companies should invest in any project offering a rate of return that is higher than the opportunity cost of capital
- The internal rate of return is the discount rate at which NPV equals zero

The IRR Rule - Example 2

Suppose that you are in the real estate business. You are considering the construction of an office block to let. You have been approached by a potential tenant who is prepared to rent your office block for 5 years at a fixed annual rent of £35,000. The construction would cost you £750,000 and the office block would be ready to let one year from now if work starts immediately. You predict that 6 years from now you will be able to sell the office block for £1,125,500. Assume the rent is paid annually at the beginning of each year and your opportunity cost of capital is 9%. Is the construction a worthwhile investment?

Cash Flows of the Project

The cash flows:

Year	0	1	2	3	4	5	6
CFs	-£750,000	£35,000	£35,000	£35,000	£35,000	£35,000	£1,125,500

$$NPV = -750000 + \frac{35000}{(1+IRR)^1} + \frac{35000}{(1+IRR)^2} + \frac{35000}{(1+IRR)^3} + \frac{35000}{(1+IRR)^4} + \frac{35000}{(1+IRR)^5} + \frac{1125500}{(1+IRR)^6} = 0$$

There is no simple general method for solving this equation

Finding the IRR

Trial and error:

- Try IRR = 0%: NPV = 550,500
- Try IRR = 20%: NPV = -268,401
- IRR must lie somewhere between 0% and 20%
- Try IRR = 15%: -146,090
- Try IRR = 13%: -86,298
- Try IRR = 12%: -53,620
- Try IRR = 11%: -18,905
- Try IRR = 10.5%: -739
- Try IRR = 10%: 17,993
- Keep trying ...

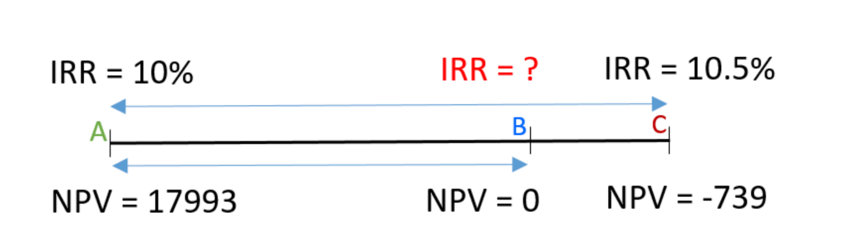
Use interpolation to find the rate

Excel:

- Goal Seek (Data / What-if Analysis / Goal Seek)
- IRR (Formulas / Insert Function / Financial / IRR)

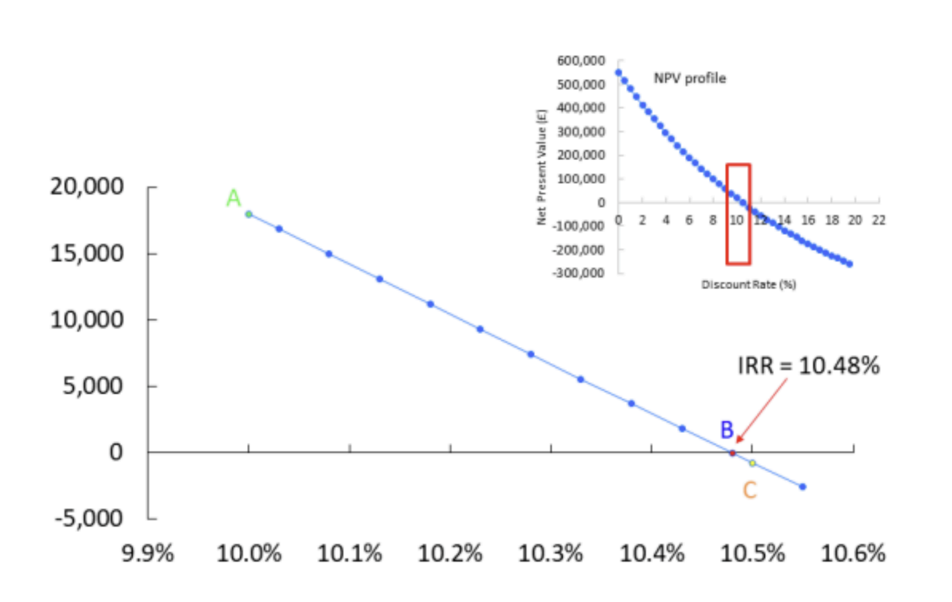
Interpolation

Within a narrow range of discount rates, the relationship between the discount rate and NPV is a linear approximation:



$$IRR = \frac{17993}{(17993 + 739)} \times (10.5 - 10) + 10 = 10.48\%$$

IRR > 9%



NPV profile
Net Present Value (£)
600,000
500,000
400,000
300,000
200,000
100,000
0
-100,000
-200,000
-300,000
0 2 4 6 8 10 12 14 16 18 20 22
Discount Rate (%)
20,000
15,000
10,000
5,000
0
-5,000
A
B
C
IRR = 10.48%
9.9% 10.0% 10.1% 10.2% 10.3% 10.4% 10.5% 10.6%

The IRR Rule Limitations

- Firms usually have to choose only one from a number of mutually exclusive projects (MEPs)
- This is the one with the highest NPV, but what about the IRR rule?
- Would it make sense to choose the project with the highest IRR?

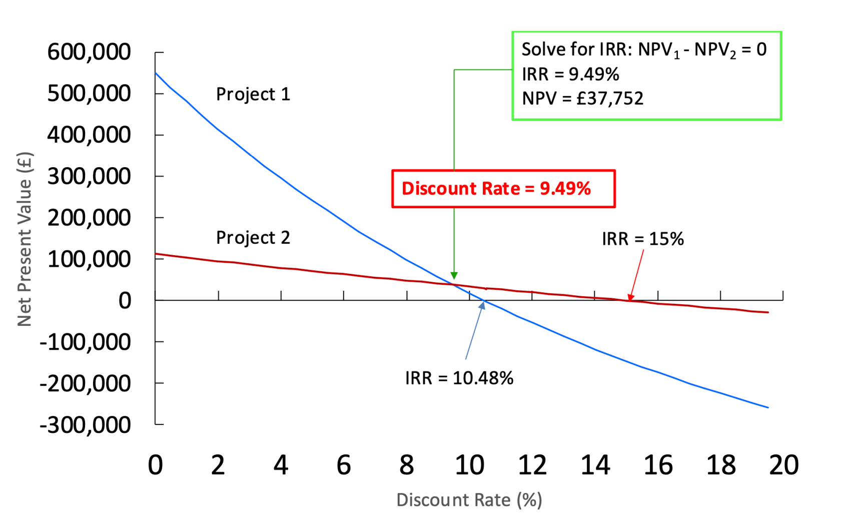
Example 3

Suppose that you are considering an alternative proposal to Example 2; instead of constructing the office block to let and then selling it after 6 years, you plan to sell it after completing the construction (the construction costs £750,000 and will be completed one year from now). You forecast that you can sell it for £862,500. Which proposal should you choose?

NPVs and IRRs of the two proposals:

	IRR	NPV at 9%
Project 1 (to let):	10.48%	+£57,237
Project 2 (to sell):	15%	+£41,284

Which Project?



The Scale Problem (1.2) - MEPs

- The IRR measures the average return of the investment while the NPV measures return in monetary values
- Suppose you can manage to construct 2 office blocks:
  - The NPV of Project 1 will double (£114,474 = £57,237 x 2)
  - But the IRR of Project 1 remains the same (10.48%)
- The IRR of Project 2 is higher (15%), but Project 1 makes more money

The Timing Problem (1.3) - MEPs

- IRR can be altered by changing the timing of the cash flows, even when that change in timing does not affect the NPV
- Therefore, it is possible to alter the ranking of projects' IRR without changing their ranking in terms of NPV

NPV is Unchanged - Example 4

Michael wants to start a laundry service for which he would need to invest £20,000 to buy the washers and dryers. The business is expected to generate £8,000 a year forever. However, he is evaluating two options for the maintenance of his machines.

Option 1: If he pays for his own maintenance, the cash flows from the business would decline by 20% per year forever.

Option 2: Alternatively, Michael can sign a maintenance contract on these machines under which he would pay a fixed amount of £5,000 at the end of each year forever.

Michael has an opportunity cost of capital of 12% and the first cash inflow occurs one year from now if Michael starts his business immediately.

Compare the NPV and IRR of the two options.

NPV versus IRR

$$NPV_1 = \frac{C}{(r-g)} = \frac{8000}{(0.12+0.2)} - 20000 = 5000$$

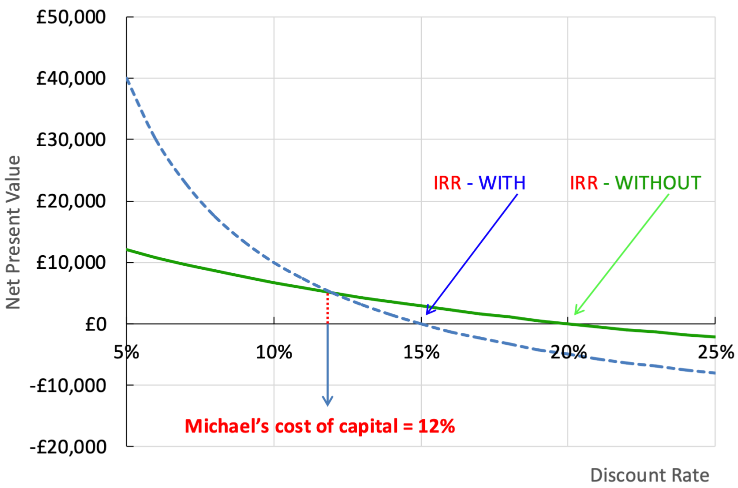
$$NPV_2 = \frac{C}{r} = \frac{(8000-5000)}{0.12} - 20000 = 5000$$

$$IRR_1 = 20\%$$

$$IRR_2 = 15\%$$

Michael is indifferent with a 12% cost of capital

IRR with and without Maintenance Contract



The Incremental IRR

- The incremental IRR investment rule applies the IRR rule to the difference between the cash flows of the two mutually exclusive alternatives (the increment to the cash flows of one investment over the other)
- But the incremental IRR rule shares several problems with the regular IRR rule
- In addition, the incremental IRR assumes that the riskiness of the two projects is the same

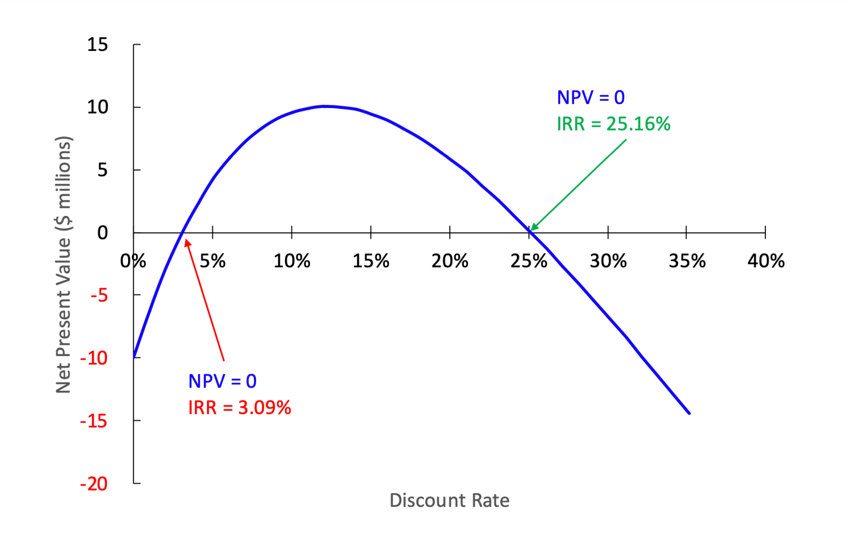
Multiple IRRs (2) - Example 5

King Coal Corporation is considering a project to strip-mine coal. The project requires an investment of \$210 million and is expected to produce a cash inflow (at the end of each year) of \$125 million in the first two years, building up to \$175 million each year in years 3 and 4. However, the company is obliged in year 5 to reclaim the land at a cost of \$400 million. The opportunity cost of capital of King Coal is 20%.

Find the IRR of this project.

At 20%: NPV = \$5.89 million

Two IRRs



15
10
5
0
-5
-10
-15
-20
Net Present Value ($ millions)
0%
5%
10%
15%
20%
25%
30%
35%
40%
Discount Rate
NPV = 0
IRR = 25.16%
NPV = 0
IRR = 3.09%

The Modified IRRs

- In general, there can be as many IRRs as the number of times the project's cash flows change sign over time
- In the case of King Coal, sign changes twice: (–) to (+) and (+) back to (–)
- Companies get around this problem by calculating the modified IRR (MIRR), which can then be compared with the cost of capital (in order to reduce the change in sign to once)

The MIRR: King Coal

First, let's try replacing the last two cash flows with a single year 4 cash flow that has the same present value:

$(+175)\ (\text{year } 4) - \frac{400}{(1+0.2)} = -158.33$

This figure is still negative; therefore, we need to step back a further year and combine the last three cash flows into a single year-3 cash flow:

$(+175)(year3) + \frac{175}{(1+0.2)} - \frac{400}{(1+0.02)^2} = +43.06$

$-210 + \frac{125}{(1+MIRR)} + \frac{125}{(1+MIRR)^2} + \frac{43.06}{(1+MIRR)^3} = 0$

MIRR = 22.05% > 20%: accept the project

Delayed Investments (3) - Example 6

John Star, the founder of SuperTech, the most successful company in the last 20 years, has just retired as CEO. A major publisher has offered him a €1 million "how I did it" book deal. That is, the publisher will pay him €1 million upfront if Star agrees to write a book about his experiences. He estimates that it will take him three years to write the book. The time that he spends writing will cause him to forgo alternative sources of income amounting to €500,000 per year. Considering the risk of his alternative income sources and available investment opportunities, Star estimates his opportunity cost of capital to be 10%.

Calculate the IRR of this project.

The IRR Rule versus the IRR

- IRR = 23.38% > 10%
- But NPV = - €243,426
- It is as if Star was borrowing money
- IRR should be lower than the opportunity cost of capital for this project to be accepted
- The IRR rule fails but the IRR itself still provides useful information in conjunction with the NPV rule

Non-existent IRR (4) - Example 7

Luckily for John Star, he has other opportunities available to him. An agent has approached him and guaranteed €1 million in each of the next three years if he will agree to give four lectures per month over that period. Star estimates that preparing and delivering the lectures would take the same amount of time as writing the book – that is, the cost would be €500,000 per year. What is the IRR of this opportunity?

$$\frac{(1-0.5)}{(1+IRR)}+\frac{(1-0.5)}{(1+IRR)^2}+\frac{(1-0.5)}{(1+IRR)^3}=0$$

NPV = €1,243,426 (but NPV can also be always negative!)

The Payback Period Rule

- The payback period is the length of time required for an investment to generate cash flows sufficient to recover its initial cost
- Simple payback versus discounted payback
- Based on the payback rule, an investment is acceptable if its payback period is less than a pre-specified number of years

The Payback Rule: Example 8

Initial investment ¥300 million

The opportunity cost of capital 5%

	SPB Period		DPB Period	
Year	CFs	Accumulated	Discounted CFs	Accumulated
1	100	100	95	95
2	150	250	136	231
3	150		130	

$$SPB = 2 + \frac{(300 - 250)}{150} = 2.33 \qquad DPB = 2 + \frac{(300 - 231)}{130} = 2.53$$

The Average Accounting Return

The average accounting return (ARR) is the average earnings after taxes and depreciation from a project, divided by the average book value of the investment during its life

$$AAR = \frac{\text{Average Net Income (ANI)}}{\text{Average Book Value of Investment (ABVI)}}$$

A project is acceptable if its AAR exceeds the target AAR

The AAR: Example 9

Suppose we are deciding whether or not to open a store in a new shopping mall. The required investment in improvements is £500,000. The store would have a five-year life because everything reverts to the mall owners after that time. The required investment would be 100-percent depreciated using straight line depreciation. The tax rate is 25%. The target return on new investments is 15%.

Should the project be accepted?

Projected Yearly Revenue and Costs for AAR

Unit: thousands (£)

	Year 1	Year 2	Year 3	Year 4	Year 5
Sales	350	360	355	320	310
Expenses	200	170	150	150	150
Earnings before depreciation	150	190	205	170	160
Depreciation	100	100	100	100	100
Earnings before taxes	50	90	105	70	60
Taxes	13	23	26	18	15
Net income	38	68	79	53	45

The ARR of this Project

$$ANI = \frac{(38 + 68 + 79 + 53 + 45)}{5} = 56$$

$$ABVI = \frac{(500 + 400 + 300 + 200 + 100 + 0)}{6} = 250\ (*)$$

$$AAR = \frac{56}{250} = 22.5\% > 15\%$$

(*) As long as we use straight-line depreciation, the ABVI will always be one half of the initial investment: $\frac{500}{2} = 250$.

The Profitability Index

$$\text{Profitability Index (PI)} = \frac{NPV}{\text{Initial Investment}}$$

- If a project has an initial investment of \$10 million and has a NPV of \$1 million, the PI would be 10%
- The PI is also known as the benefit-cost ratio and measures the value created per dollar invested
- When capital is scarce, it may make sense to allocate it to those projects with the highest PIs
- The PI is very similar to NPV but faces the (same) scale problem as the IRR rule in ranking mutually exclusive projects

The Use of Capital Budgeting Techniques

Source: Graham and Harvey (2001)

Technique	Always or Almost Always Used	Average Score (4 = always to 0 = never)		
		Overall	Large Firms	Small Firms
IRR	76%	3.09	3.41	2.87
NPV	75%	3.08	3.42	2.83
Simple Payback	57%	2.53	2.25	2.72
Discounted Payback	29%	1.56	1.55	1.58
AAR	20%	1.34	1.25	1.41
Profitability Index	12%	0.83	0.75	0.88

The Role of Mathematical Techniques

- Mathematical technique is merely ONE element of successful project appraisal
- Projects require people to implement them and their enthusiasm and commitment will be of CENTRAL importance:
    - Be aware of corporate social context
- Discussion of and consensus on major project proposals may matter more than selecting the mathematically correct option:
    - Gain general acceptance first (quantification later)

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**