Note 1: Valuation Basics

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Agenda

Cash flows and value

- The value of an investment is determined by the future stream of cash flows that the investment generates

Time value of money

- You are asked to choose from the following:

  1. Receive ₹100 today
  2. Receive ₹100 one year from now

- Would you choose 1 or 2? Choose 1

Basic Principle

A rupee today is worth more than a rupee tomorrow because the rupee today can be invested to grow to an amount greater than one rupee tomorrow

Timelines

- To better understand the timing of cash flows, we will make extensive use of linear representations of the timing of cash flows called *timelines*
- Drawing a timeline of the cash flows will help you visualize the financial problem

Timelines

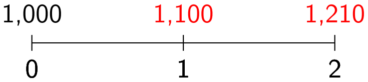
- Here is an example of a timeline with two cash flows, ₹1,000 at the end of Year 1 and ₹1,500 at the end of Year 2:

Cash Flow (CF) →	0	1,000	1,500
Period →	0	1	2
	↑ Today		

Time value of money

Important things to remember:

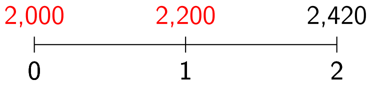
- You may compare, add or subtract values at the **same** point in time but not across time
- Move values forward in time by compounding cash flows
  - How much is ₹1,000 worth after two years if interest rate is 10% per year?



- Calculations:
  - After Year 1: $1000 \times 1 + 0.10 = 1{,}100$
  - After Year 2: $1100 \times 1 + 0.10 = 1{,}210$
  - Putting the two together, $1000 \times 1 + 0.10^2 = 1{,}210 \Leftarrow$ called the **Future Value (FV)**

Time value of money

- Move values backward in time by discounting cash flows
  - How much is ₹2,420 in two years' time worth today if interest rate is 10% per year?



- Calculations:
  - After Year 1: $\dfrac{2420}{1 + 0.10} = 2{,}200$
  - Today: $\dfrac{2200}{1 + 0.10} = 2{,}000$
  - Putting the two together, $\dfrac{2420}{1 + 0.10^2} = 2{,}000 \Leftarrow$ called the **Present Value (PV)**

Time value of money

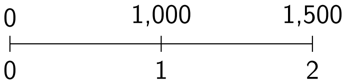
Formulas for lump-sum (single) cash flow:

$$
\begin{aligned}
PV &= \frac{FV_n}{1 + r^{\,n}} \\
FV_n &= PV \times 1 + r^{\,n}
\end{aligned}
$$

where r is the interest rate (also called the discount rate) and n is the number of periods you are compounding or discounting the cash flow

Stream of cash flows

What if we have the following stream of annual cash flows? How will we calculate its PV (today) if the discount rate is 15% per year?



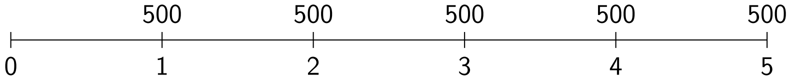
PV of stream of cash flows

Calculate the PV of each cash flow separately and add them up (**Value Additivity Principle**)

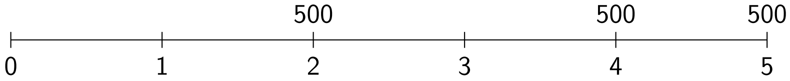
$$
\begin{aligned}
PV &= \frac{1000}{1 + 0.15^1} + \frac{1500}{1 + 0.15^2} \\
&= 869.57 + 1134.22 \\
&= 2,003.79
\end{aligned}
$$

What is an annuity?

- An annuity is a stream of N equal cash flows paid at regular intervals
- An example of an annuity:



- Not an annuity:



Ordinary annuity

Each cash flow occurs at the end of the period

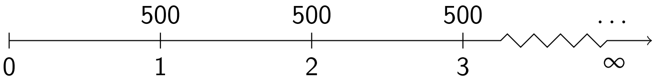
	500	500	500	500	500
0	1	2	3	4	5

PV of an ordinary annuity

$$
\begin{aligned}
PV(\text{Ordinary Annuity}) &= \frac{C}{1+r^1} + \frac{C}{1+r^2} + \cdots + \frac{C}{1+r^N} \\
&= \frac{C}{r}\left(1 - \frac{1}{1+r^N}\right]
\end{aligned}
$$

Constant perpetuity

- A constant perpetuity is a stream of equal cash flows paid at regular intervals and goes on forever
- An example of a constant perpetuity:

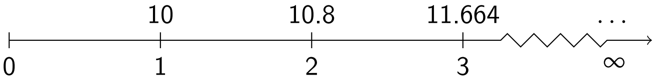


- $PV(\text{C in perpetuity}) = \dfrac{C}{r}$

Growing perpetuity

- A growing perpetuity is a series of cash flows that grows at a constant rate every period and goes on forever

- An example of a growing perpetuity with a constant growth rate of 8%:



- $PV(\text{Growing Perpetuity}) = \dfrac{C_1}{r - g}$

Wealthy alumnus example

- A wealthy alumnus wants to set up an endowment fund to finance a Chair position in the name of her favourite business analytics professor
- The endowment can earn 10% per year
- How much does she have to set aside today if
  1. she wants to finance a salary supplement of ₹1,500,000 each year for 20 years?
     - $PV(\text{Ordinary Annuity}) = \frac{C}{r}\left(1 - \frac{1}{1 + r^N}\right] = \frac{1500000}{0.10}\left(1 - \frac{1}{1 + 0.10^{20}}\right] =$ 12,770,345.58
  2. she wants to finance a salary supplement of ₹1,500,000 each year *forever*?
     - $PV(\text{C in perpetuity}) = \frac{C}{r} = \frac{1500000}{0.10} = 15{,}000{,}000$

Wealthy alumnus example

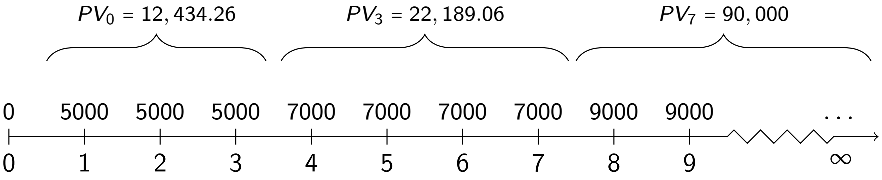
3. she wants to finance a salary supplement *forever* starting at ₹1,500,000 at the end of first year and growing at 5% each year?

- $PV(\text{Growing Perpetuity}) = \dfrac{C}{r-g} = \dfrac{1500000}{0.10-0.05} = 30{,}000{,}000$

Uneven cash flows: Example

- An investment promises the following series of payments:
  - At the end of each of the first three years, ₹5,000
  - At the end of each of the following four years, ₹7,000
  - And, ₹9,000 each year subsequently *forever*
- Your required rate of return is 10 percent
- How much should invest today?

Uneven cash flows: Example



$$PV_0 = 12434.26 + \frac{22189.06}{1 + 0.10^3} + \frac{90000}{1 + 0.10^7} = 75,289.46$$

- Remember, the PV formula gives the present value one period before the first payment of the ordinary annuity or perpetuity

Discount rate

- Let's focus on the denominator, namely, the discount rate
- There are a number of ways of understanding the discount rate
  - It is a market interest rate, that is, the rate of return on other investments with the same level of risk
  - It is the expected compensation for taking on risk of a project
- In a corporate setting, the discount rate is also known by others names: hurdle rate, cost of capital, weighted average cost of capital (WACC)
- The discount rate comprises of
  1. Inflation
  2. Real rate of return (change in purchasing power)
  3. Risk or uncertainty faced by investors from investing in a project

Decision to invest

- How does one decide whether to invest in a new project or not?
- Or which one of many projects should one accept?
- Clearly, we must look at the benefits and costs of the project(s)
- If costs outweigh benefits then we should not accept the project
- If benefits outweigh costs, then we should accept the project

Tools used in investment decisions

In this course, we will focus on the following common investment decision tools:

- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback Period (PBP)

Net present value

- It is the difference between the present value of all future inflows from a project minus the present value of all future outflows from the project

- NPV $=$ PV$\{$Inflows$\}$ – PV$\{$Outflows$\}$

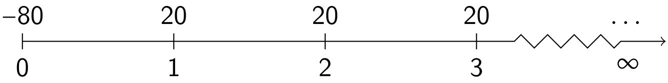
- It measures how much *additional* shareholder wealth a project adds

- Clearly, we must accept projects whose NPV > 0 and reject projects whose NPV < 0

Example

- Consider a project that requires ₹80 crores in investment at time 0 (today)
- This investment will generate a cash inflow of ₹20 crores a year forever
- The discount rate is 10%
- Should the company accept the project or not?

Example



- Inflows form a constant payment perpetuity

- NPV $=$ PV$\{$Inflows$\}$ − PV$\{$Outflows$\}$ $= \dfrac{20}{0.10} - 80 =$ ₹120 crores $\Rightarrow$ NPV > 0 and so accept the project!

Internal rate of return

- It is the discount rate that makes NPV equal zero
- Think of it as a *break-even* discount rate
- If we have a series of N annual cash flows, then IRR is the discount rate r that makes

$$CF_0 + \frac{CF_1}{1+r^1} + \frac{CF_2}{1+r^2} + \cdots + \frac{CF_N}{1+r^N} = 0$$

- This is a non-linear equation in r and so may be solved
  1. by trial-and-error or
  2. using IRR function in Excel

Example

- Going back to our example, it is the discount rate r that makes $\frac{20}{r} - 80 = 0$

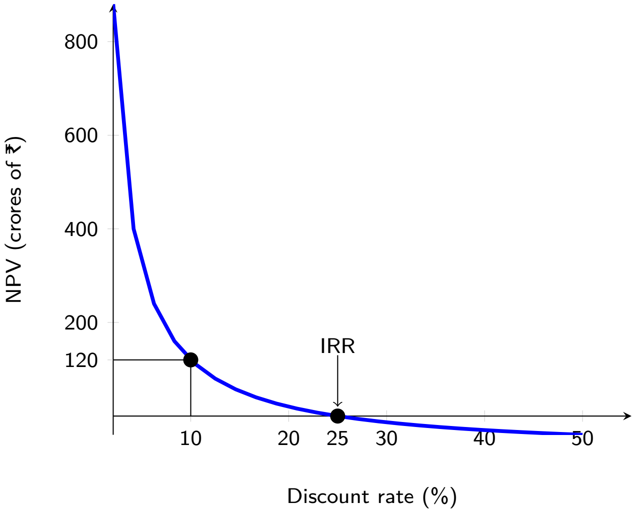
- Solving for r, we get $r = \frac{20}{80} = 25\%$

- IRR $= 25\%$

Decision rule for IRR

- What happens to the NPV if the discount rate is greater than 25%?
  - NPV will be negative
- What happens to the NPV if the discount rate is lesser than 25%?
  - NPV will be positive
- Decision rule for IRR: Accept the project if IRR $>$ the discount rate and reject the project if IRR $<$ the discount rate

Plot of NPV and discount rate



Payback period

- It measures how quickly one recovers the initial investment made in the project
- In our example, the initial investment of ₹80 crores results in annual cash flows of ₹20 crores forever

Year	Cash Flow (crores ₹)	Yet to be recovered (crores of ₹)
0	–80	–80
1	20	–60
2	20	–40
3	20	–20
4	20	0

- Payback period for this project is 4 years

Choosing from among several projects

- So far, we have looked at the decision rule for accepting or rejecting a single project
- A more likely scenario is a manager evaluates a number of (*mutually exclusive*) projects
- She needs to select one from among several projects
- Clearly, using one of the rules we have already seen will not work
- More than one project may have a positive NPV or an IRR greater than discount rate or an acceptable PBP

Decision rule

- Select project with the highest NPV
- We *cannot* say select the project with the highest IRR as the scale of the projects and/or the cash flow patterns may differ
- For example, doubling all cash flows will double NPV but will not affect IRR

Drawbacks of the PBP

- Ignores time value of money (no discounting of cash flows)
  - Fix: Discounted PBP, which requires one to discount all cash flows back to time zero and then determine the PBP
  - In our example, assuming a discount rate of 10%,

Year	Cash Flow (crores of ₹)	Discounted CF (crores of ₹)	Yet to be recovered (crores of ₹)
0	–80	–80	–80.00
1	20	18.18	–61.82
2	20	16.53	–45.29
3	20	15.03	–30.26
4	20	13.66	–16.60
5	20	12.42	–4.81
6	20	11.29	7.11

  - PBP $= 5 + \dfrac{4.81}{11.29} = 5.37$ years

Drawbacks of the PBP

- What is an acceptable payback period? Why? No economic rationale for the threshold and so can lead to arbitrary decisions

- Ignores cash flows beyond the end of the payback period

  - Example:

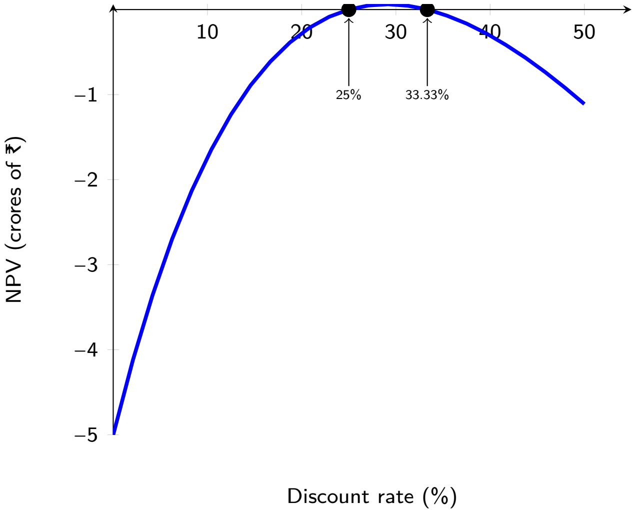
Year	Project A
0	-100
1	40
2	30
3	30
4	-40

  - PBP is 3 years for this project but then it has additional outflow in Year 4, which is ignored in the PBP calculations

Multiple IRRs

- Multiple IRRs
  - This usually happens when the direction of cash flows change more than once during the life of the project
  - For example, net outflow at time 0, followed by net inflows for a few periods and then net outflows for some periods after that
- Example: Say a strip-mining project requires an initial investment of ₹60 crores, which generates ₹155 crores in cash flows in the first year; the mine is depleted by the second year and so the company spends ₹100 crores to restore the terrain
- We have $\text{NPV} = -60 + \dfrac{155}{1+r} - \dfrac{100}{1+r^2} = 0$

Multiple IRRs



IRR assumes compounding

- IRR assumes all cash flows generated by a project are reinvested back into the project and the reinvested capital also earns the IRR
  - Basic idea of compounding
  - But this is not practical as investments can usually be made only at particular points in time over the life of the project

Contradictory decisions between NPV and IRR

- IRR greater than discount rate, though NPV is negative (contradictory decisions)
  - This usually happens when there is a net cash inflow at time 0 and the periodic cash flows are net cash outflows
- When comparing mutually exclusive projects, NPV and IRR may give contradictory decisions
  - Example on next few slides

Contradictory decisions between NPV and IRR

The CEO of an FMCG firm is considering investing in a sophisticated analytics platform that will help its Product Development group create superior customer value propositions. However, its Operations group suggests that upgrading its supply chain is a better investment. Given a constrained budget, how can the CEO decide between these alternatives?

Contradictory decisions between NPV and IRR

Analytics Platform	Supply Chain Reengineering
▪ Will yield incremental revenues of ₹15.6 lakhs and 19.3 lakhs, respectively, for each of the two years following implementation. Thereafter, profits will settle at ₹19.6 lakhs	▪ Will yield incremental revenues five years following the implementat nology
▪ Maintenance costs for this time period are estimated at ₹1.8 lakhs	▪ Annual license and maintenanc lakhs
▪ The platform involves upfront hardware costs of ₹3.06 lakhs, software costs of ₹6.12 lakhs and training costs of ₹1.16 lakhs	▪ Upfront implementation costs, in training and consulting, are ₹16 lak

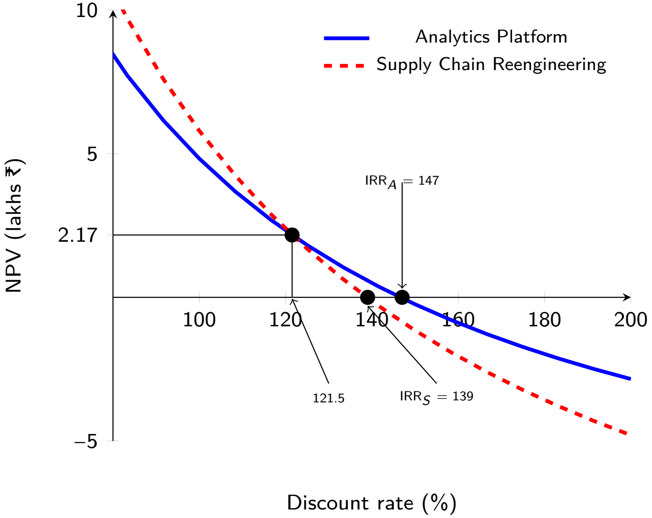
Assume that the discount rate is 15% for both investments

Contradictory decisions between NPV and IRR

Analytics Platform (lakhs ₹)						
	Yr0	Yr1	Yr2	Yr3	Yr4	Yr5
Revenue		15.60	19.30	19.60	19.60	19.60
Cost	10.34	1.80	1.80	1.80	1.80	1.80
Cash Flows	–10.34	13.80	17.50	17.80	17.80	17.80
PV (Cash Flows)	–10.34	12.00	13.23	11.70	10.18	8.85
NPV	**45.62**					
IRR	**147%**					

Supply Chain Reengineering (lakhs ₹)						
	Yr0	Yr1	Yr2	Yr3	Yr4	Yr5
Revenue		25.00	25.00	25.00	25.00	25.00
Cost	16.00	2.50	2.50	2.50	2.50	2.50
Cash Flows	–16.00	22.50	22.50	22.50	22.50	22.50
PV(Cash Flows)	–16.00	19.57	17.01	14.79	12.86	11.19
NPV	**59.42**					
IRR	**139%**					

Contradictory decisions between NPV and IRR



Contradictory decisions between NPV and IRR

- IRR for Analytics Platform is 147%, while IRR for Supply Chain Reengineering is 139%
- IRR based decision says invest in the Analytics Platform and reject the Supply Chain Reengineering
- Intersection point is 121.50%
- If discount rate for both projects is less than 121.50% (say 15%), then invest in Supply Chain Reengineering as it has the higher NPV

Other drawbacks of IRR

- Non-existent IRR
  - This usually happens if all cash flows are of only one sign (either all inflows or all outflows)

Drawbacks of NPV

- NPV (and IRR) are based on *forecast* of future cash flows, which could be very different from reality for various reasons
  - This leads to uncertain NPV and IRR values
  - Alleviate this problem by doing Scenario, Sensitivity and Simulation Analysis
- Decision to accept or reject a project is irreversible
  - There are flexibilities (called *real options*), which we will talk about tomorrow (Scenario Analysis)

Drawbacks of NPV

- NPV ignores the scale of the project
- Example:
  - Going back to our example of the Analytics Platform and the Supply Chain Reengineering options, the first had an NPV of ₹45.62 lakhs and the second an NPV of ₹59.42 lakhs
  - Which one to select?
  - NPV rule says to accept the second project because it has the higher NPV
  - However, it requires a much higher initial investment (₹10.34 lakhs for the first project vs ₹16 lakhs for the second project)

Profitability index

- Fix: Profitability Index (PI), which is defined as the NPV divided by its initial investment
- It measures how much bang for the buck you get
  - First project has a PI of $\frac{45.62}{10.34} = 4.41$
  - Second project has a PI of $\frac{59.42}{16.00} = 3.71$
  - Clearly, first project gives us greater bang for the buck and so we should accept it

Takeaways

- The financial case for a technology project is a key determinant of investment in that project
- NPV and IRR are often used to assess the financial value of a technology project
- However, there are limitations to the use of these valuation measures that must be kept in context while valuing technology projects