Capital Budgeting

Chapter Outline

- Capital Budgeting
- The Payback Rule
- The Discounted Payback
- Net Present Value
- The Internal Rate of Return
- Profitability Index
- The Practice of Capital Budgeting

What is capital budgeting?

- Analysis of potential additions to fixed assets.
- Long-term decisions; involve large expenditures.
- Very important to firm's future.

Steps to capital budgeting

1. Estimate CFs (inflows & outflows).
2. Assess riskiness of CFs.
3. Determine the appropriate cost of capital.
4. Evaluate projects
5. Accept/Reject decision

Estimate Cash Flows

- **The cash flows that should be included in a capital budgeting analysis are those that will only occur if the project is accepted**
- These cash flows are called *incremental cash flows*

Asking the Right Question

- You should always ask yourself "Will this cash flow occur ONLY if we accept the project?"
  - If the answer is "yes", it should be included in the analysis because it is incremental
  - If the answer is "no", it should **not** be included in the analysis because it will occur anyway
  - If the answer is "part of it", then we should include the part that occurs because of the project

What is the difference between independent and mutually exclusive projects?

- Independent projects – if the cash flows of one are unaffected by the acceptance of the other.
- Mutually exclusive projects – if the cash flows of one can be adversely impacted by the acceptance of the other.

Payback period

- The number of years required to recover a project's initial cost back, or "How long does it take to get our money back?"
- Calculated by adding project's cash inflows to its cost until the cumulative cash flow for the project turns positive.
- Decision Criteria:
  - **Independent projects**: accept if the payback period is less than some preset limit
  - **Mutually exclusive projects**: Among those that are less than the preset limit, choose the minimum.

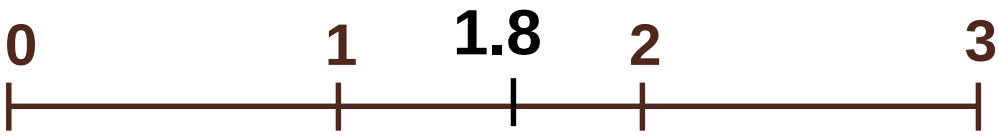
Calculating payback period

Project L

CF_t	-110	10	80	110	80
Cumulative	-110	-100	-20	0	60

$$\text{Payback}_L = 2 + \frac{20}{80} = 2.25 \text{ years}$$

Project S



CF_t	-110	70	100	50	20
Cumulative	-110	-40	0	10	30

$$\text{Payback}_S = 1 + \frac{40}{50} = 1.8 \text{ years}$$

Computing Payback For The Project

- Assume we will accept the project if it pays back within two years. ***Do we accept or reject the projects?***
- Now, suppose the discount rate is 20%, what are the NPV for project L and S, respectively? (NPV_L=0.2; NPV_S=-5.4)

Strengths and weaknesses of payback

- Strengths
  - Provides an indication of a project's risk and liquidity.
  - Easy to calculate and understand.
- Weaknesses
  - Ignores the time value of money.
  - Requires an arbitrary cutoff point
  - Ignores CFs occurring after the payback period.

Discounted Payback Period

- Compute the present value of each cash flow and then determine how long it takes to payback on a discounted basis
- Compare to a specified required period
- Decision Criteria:
  - **Independent projects**: accept if the payback period (discounted basis) is less than some preset limit
  - **Mutually exclusive projects**: Among those that are less than the preset limit, choose the minimum.

Discounted payback period

- Uses discounted cash flows rather than raw CFs. Assume we will accept the project if it pays back on a discounted basis in 2 years. ***Do we accept or reject the project?***

CF_t	-100	10	60	80
PV of CF_t	-100	9.09	49.59	60.11
Cumulative	-100	-90.91	-41.32	18.79

$$\text{Disc Payback}_L = 2 + 41.32 / 60.11 = 2.7 \text{ years}$$

Net Present Value (NPV)

- The difference between the market value of a project and its cost.
- Sum of the PVs of all cash inflows and outflows of a project:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+k)^t}$$

Net Present Value (NPV)

- How much value is created from undertaking an investment?
  - The first step is to estimate the expected future cash flows.
  - The second step is to estimate the required return for projects of this risk level.
  - The third step is to find the present value of the cash flows and subtract the initial investment.

NPV – Decision Rule

- A positive NPV means that the project is expected to add value to the firm and will therefore increase the wealth of the owners.
- Since our goal is to increase owner wealth, NPV is a direct measure of how well this project will meet our goal.
- Decision criteria:
  - **Independent projects**: accept iff NPV>0
  - **Mutually exclusive projects**: accept the project with the highest NPV among those with NPV>0

NPV Decision Rule: Example

- You are looking at a new project and you have estimated the following cash flows:
  - Year 0: CF = -165,000
  - Year 1: CF = 63,120; NI = 13,620
  - Year 2: CF = 70,800; NI = 3,300
  - Year 3: CF = 91,080; NI = 29,100
  - Average Book Value = 72,000
- Your required return for assets of this risk is 12%.

NPV Decision Rule (Con't)

- Using the calculator:
  - CF_0 = -165,000; C01 = 63,120; F01 = 1; C02 = 70,800; F02 = 1; C03 = 91,080; F03 = 1; NPV; I = 12; CPT NPV = 12,627.42
- ***Do we accept or reject the project?***

Internal Rate of Return (IRR)

- IRR is the discount rate that forces PV of inflows equal to cost, and the NPV = 0:

$$0 = \sum_{t=0}^{n} \frac{CF_t}{(1 + IRR)^t}$$

- Decision criteria:
  - **Independent projects**: accept a project if IRR > some fixed IRR*, the opportunity cost of capital
  - **Mutually exclusive projects**: accept the highest IRR among projects with IRR > IRR*
- If IRR > k, the project's rate of return is greater than its costs. There is some return left over to increase stockholders' returns.

Internal Rate of Return (Con't)

- This is the most important alternative to NPV
- It is often used in practice and is intuitively appealing
- It is based entirely on the estimated cash flows and is independent of interest rates found elsewhere

Reinvestment rate assumptions

- NPV method assumes CFs are reinvested at k, the opportunity cost of capital.
- IRR method assumes CFs are reinvested at IRR.
- Assuming CFs are reinvested at the opportunity cost of capital is more realistic, so NPV method is the best. NPV method should be used to choose between mutually exclusive projects.

IRR: Example 1

- You invest in a 2-year project with annual cash flow of $50 and a face amount of $1,000. You pay $990 for the bond. What is the IRR for the bond?

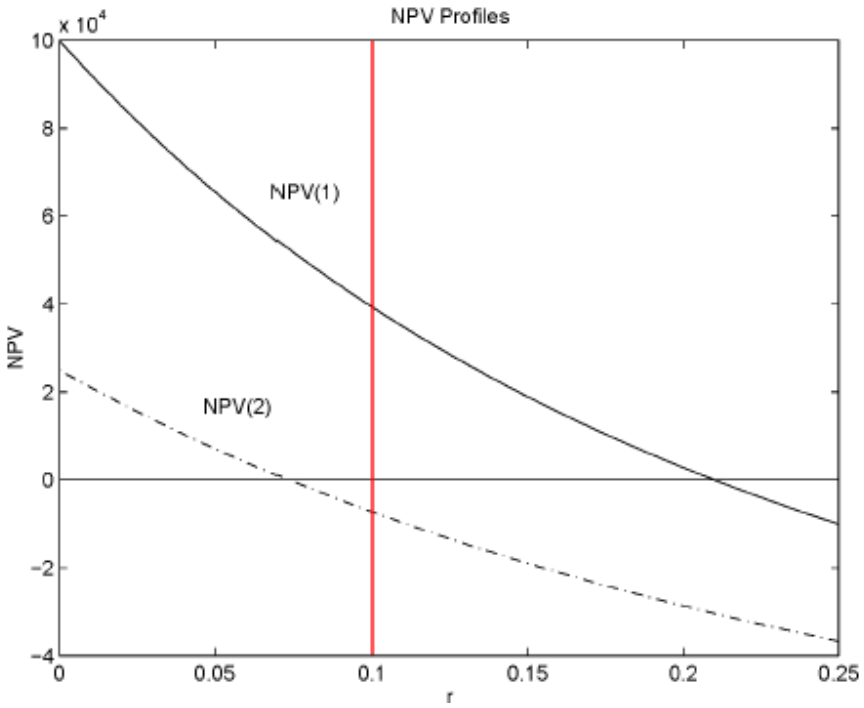
$$0 = -990 + \frac{50}{(1+r)} + \frac{1050}{(1+r)^2}$$

- Solving the quadratic equation, r=5.54%

IRR: Example 2

	C_0	C_1	C_2	C_3	C_4	C_5	C_6
Project 1	-100,000	20,000	40,000	30,000	10,000	40,000	60,000
Project 2	-100,000	10,000	10,000	80,000	5,000	10,000	10,000

IRR_1=21%, IRR_2=7% Suppose the cost of capital is IRR*=10%. Do the IRR and NPV decision rules agree?



- Used properly, no need to know the cost of capital when comparing projects
- Project 1: NPV>0 when cost of capital, r < 21%

When do NPV and IRR Agree?

- There is only one cash outflow at time 0 and all other cash flows are positive (conventional cash flows)
- Only one project is under consideration (not mutually-exclusive projects)
- The opportunity cost of capital is the same for all periods

Conflicts Between NPV and IRR

- NPV directly measures the increase in value to the firm
- Whenever there is a conflict between NPV and another decision rule, you should ***always*** use NPV
- IRR is unreliable

Example: IRR and Mutually Exclusive Projects

Period	Project A	Project B
0	-500	-400
1	325	325
2	325	200
IRR	19.43%	22.17%
NPV	64.05	60.74

The required return for both projects is 10%.

What are the IRR and NPV for both projects?

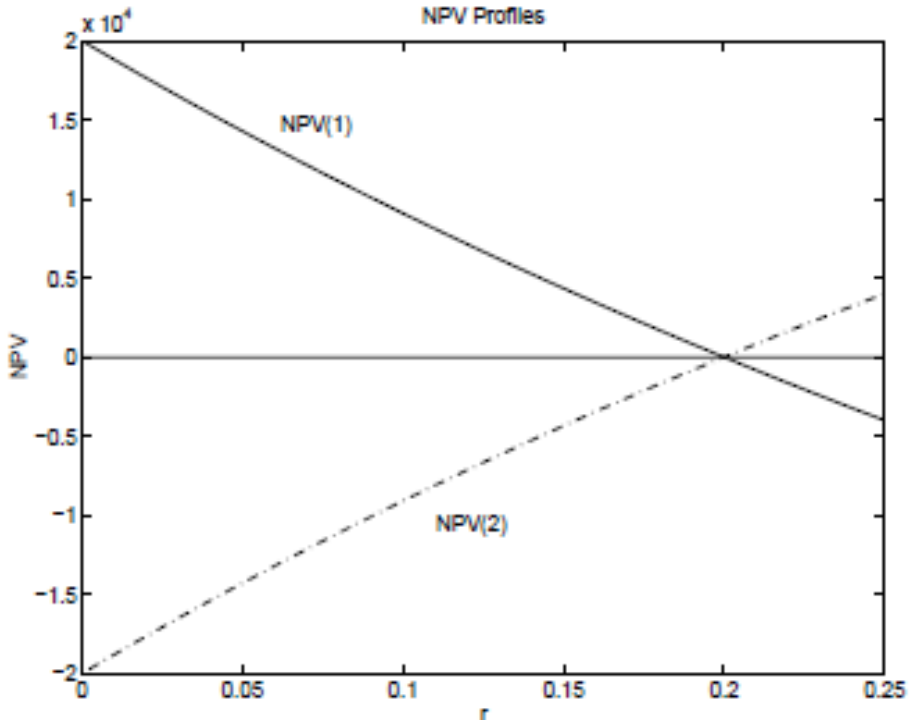
Which project should you accept and why?

Problems with IRR

- Projects of the loan type
- Multiple IRRs
- Project ranking for mutually exclusive projects
- Project with different time patterns of cash flows
- IRR ignores the term structure of interest rate

(1) Projects of the loan type

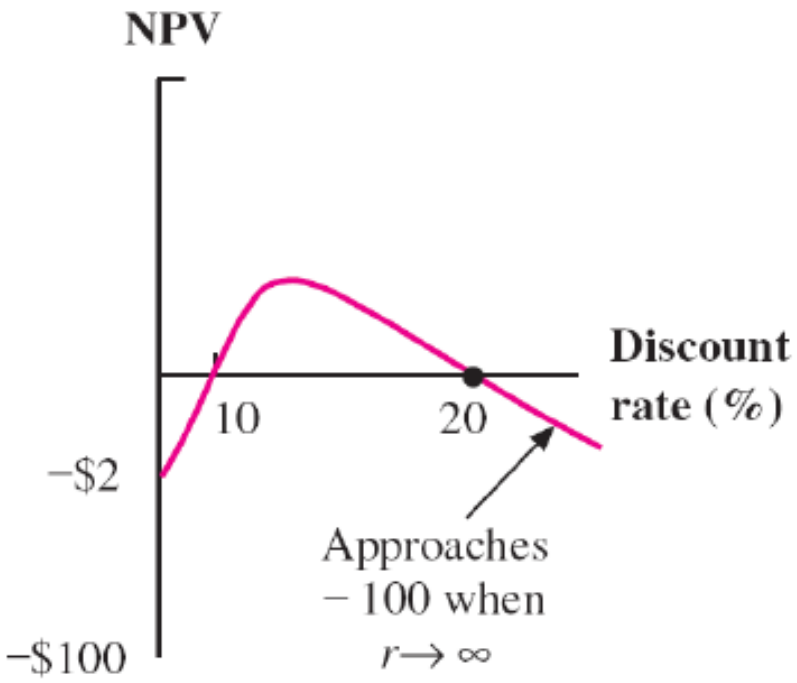
	C_0	C_1	NPV(r=10%)	IRR
Project 1	-100,000	120,000	9,091	20%
Project 2	100,000	-120,000	-9,091	20%



- NPV as a function of cost of capital

(2) Multiple IRRs

	C_0	C_1	C_2
Project 1	−100	230	−132



- The project has two IRRs: 10% and 20%. The IRR is indecisive.
- Multiple IRRs exist when the sequence of CFs change signs more than once.

(2) Multiple IRRs (Con't)

- The modified IRR method deals with the problem by combining CFs until only one change in sign remains.
- Using r=15%, the value of the last CF is -114.78 @ T=1 and the adjusted CF @ T=1 is 230 – 114.78 = 115.22
- By discounting and combining cash flows, we have only one change in sign: (-100,115.22)
- Applying the IRR rule gives IRR=15.22, which is larger than the cost of capital (15%). Accept the project.

(3) Project ranking for mutually exclusive projects

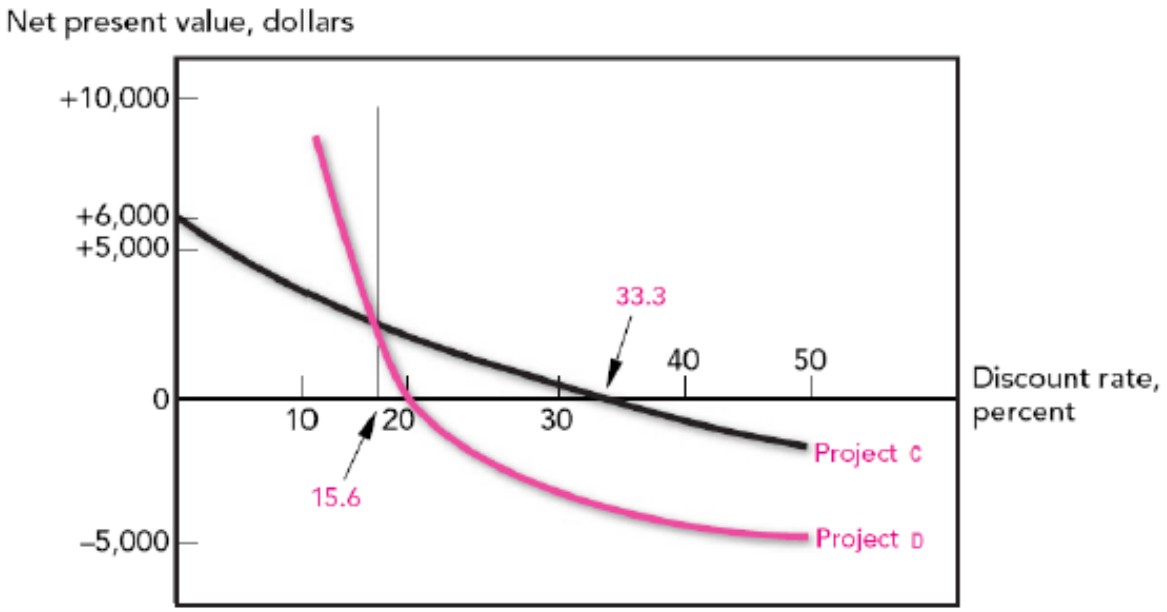
	C_0	C_1	IRR	NPV at 10%
Project A	−10,000	20,000	100%	8,181.82
Project B	−20,000	36,000	80%	12,727.27
B−A	−10,000	16,000	60%	4,545.45

- Accept A using IRR but B using NPV
- Solution to the scale problem is to use incremental CF.
  - Is taking B better than A? Require more outlay today ($10,000), but create more CF in 1 year ($16,000).
  - Accept B if IRR of incremental investment is larger than the cost of capital, or equivalently the incremental NPV is positive.

(4) Projects with Different CF Patterns

- Among mutually exclusive projects with the same scale, but different time patterns of CFs, IRR favors projects that deliver CFs faster.

	C_0	C_1	C_2	C_3	C_4	C_5	ETC	IRR	NPV at 10%
C	−9,000	6,000	5,000	4,000	0	0	· · ·	33%	3,592
D	−9,000	1,800	1,800	1,800	1,800	1,800	· · ·	20%	9,000



(4) Projects with Different CF Patterns

- As with the scale problem, we can also fix this timing problem by looking at the incremental cash flows.

	C_0	C_1	C_2	C_3	C_4	C_5	ETC	IRR	NPV(10%)
C	−9,000	6,000	5,000	4,000	0	0	· · ·	33%	3,592
D	−9,000	1,800	1,800	1,800	1,800	1,800	· · ·	20%	9,000
D−C	0	−4,200	−3,200	−2,200	1,800	1,800	. . .	15.6%	5,408

- This problem also exists when projects have the same horizon, but generate cash flows at different speeds.

	C_0	C_1	C_2	IRR	NPV at 10%
Project C	−100	115	10	23%	12.81
Project D	−100	10	130	19%	16.53
$D - C$	0	−105	120	14%	3.72

(5) IRR Ignores Term Structure of Interest Rates

- When we compute an IRR we get just one number. However, interest rates may not be constant over time.
- If the interest rate varies over different horizons then which hurdle rate should we compare our IRR to?
- Need to compute NPV: discount cash flows at different dates with the corresponding interest rates.

Quick Quiz

- Consider an investment that costs $100,000 and has a cash inflow of $25,000 every year for 5 years. The required return is 9%, and required payback is 4 years.
  - What is the payback period? (4 years)
  - What is the discounted payback period?
  - What is the NPV? (-2,758.72)
  - What is the IRR? (7.93%)
  - Should we accept the project?
- What decision rule should be the primary decision method?
- When is the IRR rule unreliable?

Profitability Index (PI)

- Profitability index is the ratio of the present value of future cash flows and the initial cost of a project: $\text{PI} = \frac{\text{PV}}{-C_0} = \frac{\text{PV}}{I_0}$
- Decision criteria:
  - **Independent project**: Accept all projects with PI > 1. Note: Identical to the NPV rule.
  - **Mutually exclusive project**: Among projects with PI > 1, accept the highest PI.
- Useful supplement to NPV in cases with resource constraints

Profitability Index (Con't)

- To invest in all NPV>0 projects, firm must be able to raise unlimited capital at cost of capital, r, by issuing securities.
- Sometimes, firms may be rationed with limited capital to invest. How do we maximize the NPV of the set of projects you choose?
- The PI helps to solve this problem. Rationed NPV is maximized by choosing:
  - Projects with the highest PI that is > 1.
  - Use up the capital budget

Example: PI and Capital rationing

- As an entrepreneur you have $1,000,000 in available venture capital. You cannot raise more capital. You can choose to take on any combination of the following projects:

Project	Cost	PV(Future CFs)	NPV	PI
A	200,000	300,000	100,000	1.50
B	500,000	620,000	120,000	1.24
C	400,000	700,000	300,000	1.75
D	200,000	275,000	75,000	1.38
E	100,000	130,000	30,000	1.30
F	100,000	140,000	40,000	1.40

- Which should you take? First, rank the projects by PI: C > A > F > D > E > B. Then, choose projects in this order till you use up the capital.

Example (Con't)

- In descending order of PI:

C	Costs	400,000
C+A	Costs	600,000
C+A+F	Costs	700,000
C+A+F+D	Costs	900,000
C+A+F+D+E	Costs	1,000,000

- So, you should take all projects, except B.
  - Total NPV is $545K
  - Give up B ($120K) – if you can raise more capital, you can add another $120K firm value
- Note: if the initial outlays of chosen projects fall short of the budget, you need to consider all feasible combinations of projects within the budget and to pick the combination with highest NPV.

Capital Budgeting in Practice

Technique	% Always or Almost Always
IRR	75.61
NPV	74.93
Payback Period	56.74
Discounted Payback Period	29.45
Profitability Index	11.87

The Theory and Practice of Corporate Finance: Evidence From the Field" in Journal of Financial Economics (2001), by John Graham & Campbell Harvey

- They conducted a survey of 392 CFOs.
- Included in the survey they asked: What technique do you use to evaluate investment projects?

Capital Budgeting in Practice (Con't)

- Graham & Harvey (2001) found that NPV and IRR are relatively more popular in firms that are:
  - Larger.
  - With high leverage.
  - Paying dividends.
  - Public companies.
  - Firms with foreign sales.
  - Firms whose the CEO has an MBA.
  - Firms in the Fortune 500.
- Overall, it seems that NPV is more popular among large, well established firms.

Capital Budgeting in Practice (Con't)

- Payback period is relatively more popular for:
  - Smaller firms
  - Firms whose management owns a large share of the firm
  - Private firms
  - Firms whose CEO is younger than 59
- Overall, payback period seems to be used by small and less established firms

Lesson Summary

- Independent vs. Mutually-exclusive Projects
- Payback Period
- Discounted Payback Period
- NPV
- Internal Rate of Return (IRR)
  - Issues with IRR
  - Useful to evaluate estimation error
- Profitability Index (PI)
  - Same as NPV for independent projects
  - Useful to maximize NPV from a set of projects with resource constraints

End of Lesson