CHAPTER 11
Capital Budgeting Decision Methods

- Payback
- Net present value (NPV)
- Internal rate of return (IRR)
- Modified internal rate of return (MIRR)

What is capital budgeting?

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

Capital Budgeting Steps:

1. Generate ideas.
2. Estimate the CFs (inflows and outflows).
3. Assess the riskiness of the CFs.
4. Determine the project cost of capital.
5. Find NPV, IRR, and/or MIRR.
6. Accept if NPV > 0.

What is the difference between independent and mutually exclusive projects?

- Projects are independent if the cash flows of one are not affected by the acceptance of the other
- Projects are mutually exclusive if acceptance of one "precludes" acceptance of the other

What is the difference between normal and non-normal projects?

- Projects are normal if they have outflows or costs in the first year(s) followed by a series of inflows
- Projects are non-normal if one or more outflows occur after the inflows have begun

Cash flow data we will use for example:

Year	CF
0	-$150
1	15
2	90
3	120

What is the payback period?

- The expected number of years required to recover a project's cost, i.e. how long will it take to get our money back?

What is the rationale for the payback period?

It is a type of "breakeven" analysis. It tells us when the project will break even in a cash flow sense.

Payback for Project

	0	1	2	3
CF_t	-150	15	90	120
Cumulative CF =	-150	-135	-45	75

Payback = 2 + 45/120 = 2.375 years

Strengths of Payback:

1. Indication of a project's
   risk and liquidity.
2. Easy to calculate and understand.

Weaknesses:

1. Ignores time value of money.
2. Ignores CF's occurring after
   payback.

Should we look at payback?

- Some firms do calculate payback and give it some weight in capital budgeting decisions.
- It's not the primary criterion; rather it is used as one measure of a project's liquidity and riskiness.

Discounted payback period

- Uses discounted cash flows rather than raw CFs.

0 10% 1 2 2.7 3

	0	1	2	3
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

Disc Payback = 2 + 41.32 / 60.11 = 2.7 years

Net Present Value (NPV)

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

OR:

$$NPV = \sum_{t=1}^{n} \frac{CF_t}{(1+k)^t} - CF_0$$

NPV in words:

- NPV = PV of future CFs discounted at the firm's cost of capital MINUS the initial outlay

- NPV = the change in shareholder wealth if the project is accepted

What is the project's NPV?

0	1	2	3
-150	15	90	120

13.64
74.38
<u>90.16</u>
28.18 = NPV

Calculator Solution

Uneven cash flow problem:

-150	CF_0
15	CF_1
90	CF_2
120	CF_3
10	I

NPV = \$28.18 = NPV

Rationale for NPV method?

- NPV = PV inflows - PV costs
  = Net gain in wealth
- Accept project if NPV $\geq$ 0
- Choose between mutually exclusive projects on the basis of higher positive NPV. Adds most to value.

Internal Rate of Return (IRR)

IRR is the discount rate which forces the NPV to equal zero:

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

Internal Rate of Return (IRR)

IRR is the discount rate which forces the present value of future CFs to equal the initial outlay:

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

What is the project's IRR?

Enter in cash flows:

-150	CF_0
15	CF_1
90	CF_2
120	CF_3

IRR = 18.126%

Internal rate of return rationale:

If IRR = k,

the project cash flows just meet the investors' required return.

If IRR > k

return is beyond what shareholders expected.

IRR acceptance criteria:

- If projects are <u>independent,</u>
  - accept all projects with IRR $\geq$ k
  - reject all projects with IRR < k

NPV and IRR always lead to the same accept/reject decision for any independent project.

IRR > k and NPV > 0	IRR < k and NPV < 0
ACCEPT	REJECT

NPV and IRR can rank "acceptable" projects differently which can lead to conflicting choices for mutually exclusive projects.

Timing differences:
A project with faster payback provides more CF in early years for reinvestment.

Size (scale) differences:
Smaller project frees up funds at t = 0 for investment. The higher the opportunity cost, the more valuable these funds are.

Problems with IRR:

- Lack of unique solution: Projects with non-normal CFs can have more than one IRR.

- Reinvestment rate: IRR assumes that future CFs can be reinvested at the same rate of return for the current project.

NPV

- Always has a unique solution.
- Assumes reinvestment at the opportunity cost (firm's cost of capital).

Reinvestment rate assumptions

- Reinvestment at the opportunity cost, k, is more realistic, since it only implies that the firm exists. Any higher reinvestment rate implies that the future projects meet that return.
- NPV should be used to choose between mutually exclusive projects.

BUT, Managers like rates - they can visualize IRR better than NPV. Can we give them a better IRR?

YES. The Modified Internal Rate of Return (MIRR) is the discount rate which causes the PV of a project's terminal value (TV) to equal the PV of its costs.

Modified Internal Rate of Return (MIRR)

The MIRR is always unique.

Also, the TV is found by compounding inflows at the opportunity cost of capital, so the MIRR assumes cash inflows are reinvested at the firm's cost of capital (as in NPV).

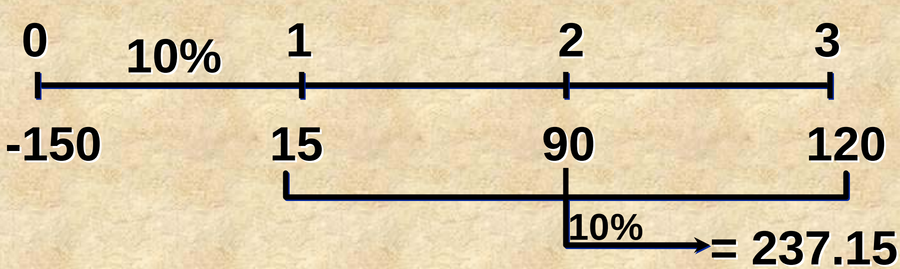
MIRR Formula

$$\sum_{t=0}^{n} \frac{COF_t}{(1+k)^t} = \frac{\sum_{t=0}^{n} CIF_t (1+k)^{n-t}}{(1+MIRR)^n}$$

COF = cash outflows

CIF = cash inflows

MIRR for project (k = 10%)



PV of outflows

TV of inflows

$$\$150 = \frac{\$237.15}{(1+MIRR)^3}$$

MIRR = 16.5%

MIRR Calculation Steps:

- Step 1: Calculate the present value of all negative CFs (using the cost of capital as the interest rate).
- Step 2: Calculate the future value of all positive CFs as of the end of the project (using the cost of capital as the interest rate). First, get PV and use it to calculate FV.
- Step 3: Find the interest rate (MIRR) that equates the future value from 2 with the present value from 1.

EXAMPLE: Your firm's cost of capital is 10% and it is considering a project with the following CFs. What is the project's MIRR?

Separate negative and positive CFs

Year	CFs	Step1	Step2
0	-100,000	-100,000	0
1	20,000	0	20,000
2	40,000	0	40,000
3	-35,000	-35,000	0
4	80,000	0	80,000
5	70,000	0	70,000
6	-10,000	-10,000	0

Step 1: PV(-)

CF_0 = -100000

CF_1 = 0

CF_2 = 0

CF_3 = -35000

CF_4 = 0

CF_5 = 0

CF_6 = -10000

I = 10

NPV = -131,940.76

Step 2a: PV(+)

CF_0 = 0

CF_1 = 20000

CF_2 = 40000

CF_3 = 0

CF_4 = 80000

CF_5 = 70000

CF_6 = 0

I = 10

NPV = 149,345.24

Step 2b: FV(+)

N = number of years in project

I = cost of capital

PV = present value of positive cash flows

N	I	PV	SOLVE *FV*
6	10	149345.24	264574.20

Step 3: MIRR

N = number of years in project

PV = present value of negative cash flows

FV = future value of positive cash flows

N	SOLVE *I*	PV	FV
6	12.295 MIRR	-131940.76	264574.20

Is MIRR better than NPV?

NO. MIRR does not always lead to the same decision as NPV for mutually exclusive projects. Small projects often have a higher MIRR, but a lower NPV than larger projects.

NPV remains the conceptually best decision rule.