Class

Capital budgeting

Methods (techniques):
PBP, DPBP, IRR, NPV, PI.
Initial cash outlay (ICO), Free Cash Flow (FCF).
Capital rationing.

RWJ: Ch. 6, 7, (8 optional)

What is Capital Budgeting (CB)?

The process of identifying, analyzing, and selecting investment projects whose *cash flows* are expected to extend beyond *one year*.

CB is NOT the same as Budgeting (=preparing annual financial plans and proforma statements for a business company)

The Capital Budgeting Process

- Generate investment proposals consistent with the firm's strategic objectives.
- Estimate after-tax cash flows for the investment projects.
- Evaluate project cash flows.
- NB: CF, FCF – no unified methodology

The Capital Budgeting Process

- Select projects based on a value-maximizing acceptance criterion.
- Reevaluate implemented investment projects continually and perform post-audits for completed projects.

Investment Project Proposals

1. New products or product modifications
2. Replacement of existing equipment or buildings
3. Real estate: hotels, etc
4. R&D
5. Exploration
6. Other (e.g., safety- or pollution-related)

Estimating After-Tax Incremental Cash Flows

Basic characteristics of relevant project flows

- Cash (not accounting income) flows
- Excluding financing costs
- After-tax flows
- Incremental flows

Estimating After-Tax Incremental Cash Flows

Principles that must be adhered to in the estimation

Ignore sunk costs

Include project-driven changes in working capital

Include effects of inflation

Calculating the Incremental Cash Flows

- Initial cash outflow - the initial net cash investment.
- Interim incremental net cash flows - those net cash flows occurring after the initial cash investment but not including the final period's cash flow.
- Terminal-year incremental net cash flows - the final period's net cash flow.

Free Cash Flows (CIIA program methodology)

FCF =

EBIT*
- Tax rate (%)
= NOPLAT
+ Depreciation
-/+ ΔNWC (+/- ΔAR +/- ΔInventory -/+ ΔAP)
-/+ Investments (Fixed Assets)
= FCF

**NB: financing costs (=interest expense) shall NOT be taken into consideration*

Initial Cash Outflow, ICO

a) *Cost of "new" assets*
b) + Capitalized expenditures
c) + (-) Increased (decreased) NWC
d) - Net proceeds from sale of "old" asset(s) if replacement
e) + (-) Taxes (savings) due to the sale of "old" asset(s) if replacement
f) = Initial cash *outflow*

Terminal-Year Incremental Cash Flows

a) Calculate the incremental net cash flow for the terminal period

b) + (-) Salvage value (disposal/reclamation costs) of any sold or disposed assets

c) - (+) Taxes (tax savings) due to asset sale or disposal of "new" assets

d) + (-) Decreased (increased) level of "net" working capital

e) = Terminal year incremental net cash flow

Project Evaluation: Alternative Methods

Payback Period (PBP)

Discounted PBP (DPBP)

Internal Rate of Return (IRR)

Net Present Value (NPV) – most popular ($)

Profitability Index (PI)

Other methods: ARR, MIRR, EAC…

Proposed Project Data

Julie is evaluating a new project for her firm, *Basket Wonders (BW)*. She has determined that the after-tax cash flows for the project will be $10,000; $12,000; $15,000; $10,000; and $7,000, respectively, for each of the Years 1 through 5.

The ICO is $40,000.

Payback Period (PBP)

0	1	2	3	4	5
-40 K	10 K	12 K	15 K	10 K	7 K

PBP is the period of time required for the cumulative expected cash flows from an investment project to equal the initial cash outflow.

Also called: *"breakeven time"*

Payback Solution (#1)

0	1	2	3 (a)	4	5
-40 K(-b)	10 K	12 K	15 K	*10 K*(d)	7 K
	10 K	22 K	*37 K*(c)	47 K	54 K

Cumulative Inflows

PBP = a + (b - c) / d = 3 + (40 - 37) / 10 = 3 + (3 / 10) = 3.30 Years

Payback Solution (#2)

0	1	2	3	4	5
-40 K	10 K	12 K	15 K	10 K	7 K
-40 K	-30 K	-18 K	-3 K	7 K	14 K

Cumulative Cash Flows

PBP $= 3 + (3K) / 10K = 3.30$ Years

Note: Take absolute value of last negative cumulative cash flow value.

PBP Acceptance Criterion

The management of *Basket Wonders* has set a maximum PBP of 3.5 years for projects of this type.

Should this project be accepted?

Yes! The firm will receive back the initial cash outlay in less than 3.5 years.

[3.3 Years < 3.5 Year MAX]

The PBP Method Strengths and Weaknesses

Strengths:

- Easy to use and understand
- Can be used as a measure of liquidity
- Easier to forecast short-term than long-term flows

Weaknesses:

- Does not account for TVM
- Does not consider cash flows *after* the PBP
- Cutoff period is often subjective/disputable
- Does not show absolute $$

Internal Rate of Return (IRR)

IRR is the discount rate that equates the PV of the future net CF with the initial cash outflow.

(NB: Compare with YTM in bonds!)

$$ICO = \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \ldots + \frac{CF_n}{(1+IRR)^n}$$

IRR Solution

$$\$40{,}000 = \frac{\$10{,}000}{(1+IRR)^1} + \frac{\$12{,}000}{(1+IRR)^2} + \frac{\$15{,}000}{(1+IRR)^3} + \frac{\$10{,}000}{(1+IRR)^4} + \frac{\$7{,}000}{(1+IRR)^5}$$

Need to find the interest rate (=*IRR*) that causes the 5 discounted cash flows to equal ICO of $40,000.

IRR Solution (Try 10%)

$\$40,000 = \$10,000(PVIF_{10\%,1}) + \$12,000(PVIF_{10\%,2}) + \$15,000(PVIF_{10\%,3}) + \$10,000(PVIF_{10\%,4}) + \$7,000(PVIF_{10\%,5})$

$\$40,000 = \$10,000(.909) + \$12,000(.826) + \$15,000(.751) + \$10,000(.683) + \$7,000(.621)$

$\$40,000 = \$9,090 + \$9,912 + \$11,265 + \$6,830 + \$4,347 = \$41,444$

[*Rate i~~s~~ too low*]

IRR Solution (Try 15%)

$\$40,000 = \$10,000(PVIF_{15\%,1}) + \$12,000(PVIF_{15\%,2}) + \$15,000(PVIF_{15\%,3}) + \$10,000(PVIF_{15\%,4}) + \$7,000(PVIF_{15\%,5})$

$\$40,000 = \$10,000(.870) + \$12,000(.756) + \$15,000(.658) + \$10,000(.572) + \$7,000(.497)$

$\$40,000 = \$8,700 + \$9,072 + \$9,870 + \$5,720 + \$3,479 = \$36,841$ [*Rate is too high*]

IRR Solution (Interpolate)

	0.10	$41,444		
0.05	IRR	$40,000	X	$1,444
				$4,603
	0.15	$36,841		

$$\frac{X}{0.05} = \frac{\$1,444}{\$4,603}$$

IRR Solution (Interpolate)

.10 $41,444

.05 IRR X $40,000 $4,603 $1,444

.15 $36,841

$$\frac{X}{.05} = \frac{\$1,444}{\$4,603}$$

IRR Solution (Interpolate)

0.10 $41,444

0.05 IRR $40,000 $4,603

0.15 $36,841

X

$1,444

$$X = \frac{(\$1,444)(0.05)}{\$4,603}$$

X = 0.0157

IRR = 0.10 + 0.0157 = 0.1157 or 11.57%

IRR Acceptance Criterion

The management of *Basket Wonders* has determined that the hurdle rate is 13% for projects of this type.

Should this project be accepted?

No! The firm will "receive" 11.57% for each dollar "required" for this project at a cost of 13%. [IRR < RRR, "Hurdle Rate"]

IRR Strengths and Weaknesses

Strengths:

- Accounts for TVM
- Considers all the cash flows
- Less subjectivity

Weaknesses:

- Assumes that all cash flows reinvested at the IRR
- Difficulties with project rankings
- Difficulties with multiple IRRs
- Does not show absolute $$

Net Present Value (NPV)

NPV is the present value of an investment project's net DCFs minus the project's initial cash outflow.

$$NPV = \frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + \ldots + \frac{CF_n}{(1+k)^n} - ICO$$

NPV Solution

Basket Wonders has determined that the appropriate discount rate (k) for this project is 13%.

$$NPV = \frac{\$10,000}{(1.13)^1} + \frac{\$12,000}{(1.13)^2} + \frac{\$15,000}{(1.13)^3} + \frac{\$10,000}{(1.13)^4} + \frac{\$7,000}{(1.13)^5} - \$40,000$$

NPV Solution

NPV = $10,000(PVIF$_{13\%,1}$) + $12,000(PVIF$_{13\%,2}$) + $15,000(PVIF$_{13\%,3}$) + $10,000(PVIF$_{13\%,4}$) + $ 7,000(PVIF$_{13\%,5}$) - $40,000

NPV = $10,000(.885) + $12,000(.783) + $15,000(.693) + $10,000(.613) + $ 7,000(.543) - $40,000

NPV = $8,850 + $9,396 + $10,395 + $6,130 + $3,801 - $40,000

= - $1,428

NPV Acceptance Criterion

The management of *Basket Wonders* has determined that the required rate is 13% for projects of this type.

Should this project be accepted?

No! The NPV is negative. This means that the project is reducing shareholder wealth.

Reject if *NPV* < *0.*

NPV Strengths and Weaknesses

Strengths:

(Cash flows assumed to be reinvested at the hurdle rate.)

Accounts for TVM.

Considers all cash flows.

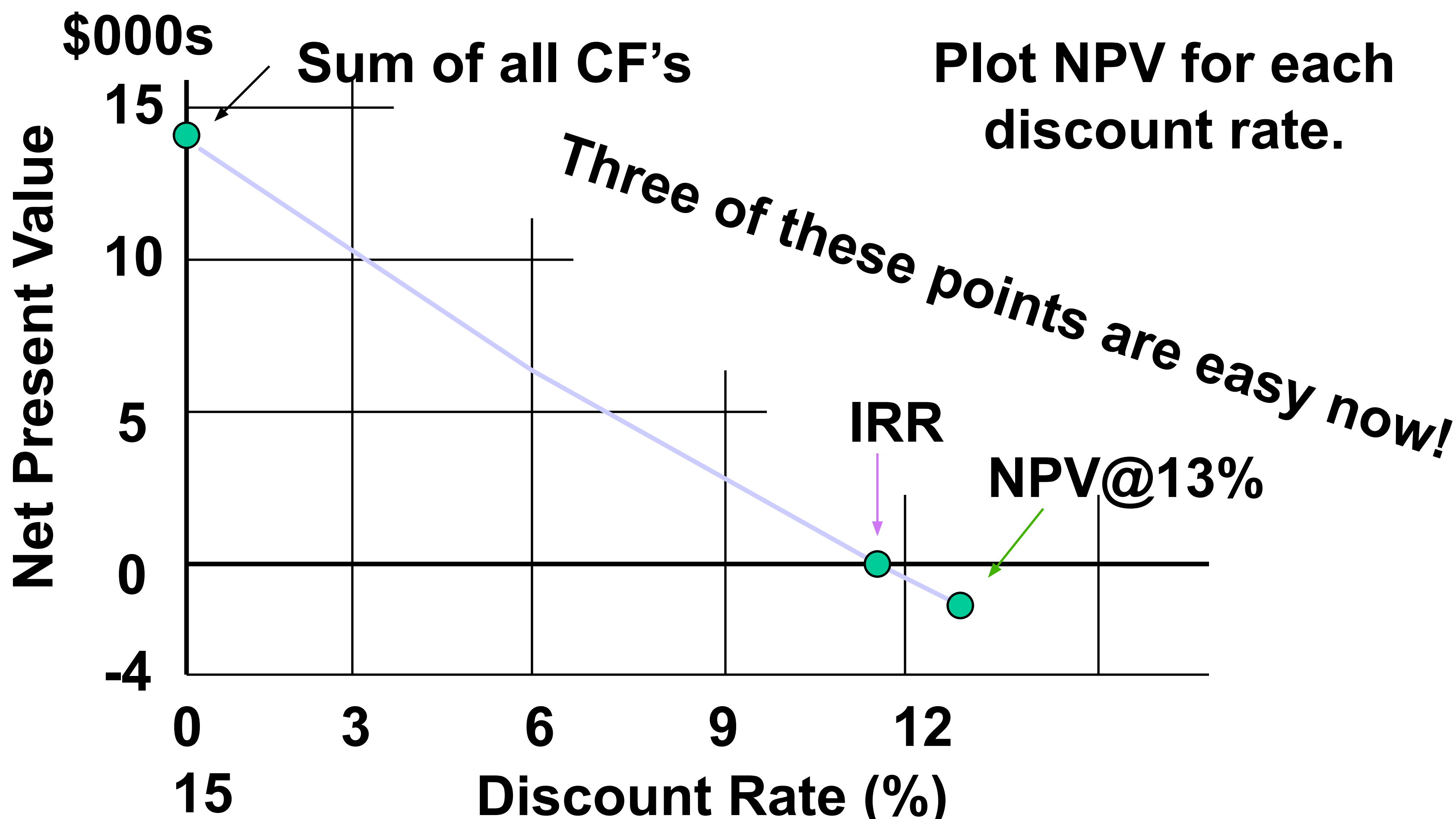
Shows absolute $ value in PRESENT $.

Weaknesses:

Problems with projects' sizes

"Correct" RRR (?)

Net Present Value Profile



Profitability Index (PI)

PI is the ratio of the present value of a project's future net cash flows to the project's initial cash outflow.

$$PI = \left[\frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + \ldots + \frac{CF_n}{(1+k)^n} \right] \div ICO$$

<< OR >>

$$PI = 1 + [\ NPV / |ICO|\ ]$$

PI Acceptance Criterion

PI = \$38,572 / \$40,000

= 0.9643

Should this project be accepted?

No! The PI is less than 1.00.

This means that the project is not profitable.

Reject if *PI < 1.00* times.

PI Strengths and Weaknesses

Strengths:

Same as NPV

Allows for comparison of different scale and lifetime projects

The correct solution in *capital rationing*

Weaknesses:

Provides only relative profitability (in times)

Potential ranking problems

Evaluation Summary

Basket Wonders Independent Project

Method	Project	Comparison	Decision
PBP	3.3	3.5	Accept
IRR	11.57%	13%	Reject
NPV	-$1,424	$0	Reject
PI	.96	1.00	Reject

Other Project Relationships

- ***Dependent*** **- A project whose acceptance depends on the acceptance of one or more other projects.**
- *Mutually Exclusive* - A project whose acceptance precludes the acceptance of one or more alternative projects.

Potential Problems Under Mutual Exclusivity

Ranking of project proposals *may* create contradictory results.

A. Scale of Investment
B. Cash-flow Pattern
C. Project Life

A. Scale Differences

Compare a small (S) and a large (L) project.

	NET CASH FLOWS	
END OF YEAR	Project S	Project L
0	-$100	-$100,000
1	0	0
2	$400	$156,250

A. Scale Differences

Calculate the PBP, IRR, NPV@10%, and PI@10%.

Which project is preferred? Why?

Project	IRR	NPV	PI
S	100%	$ 231	3.31
L	25%	$29,132	1.29

B. Cash Flow Pattern

Let us compare a *decreasing* cash-flow (D) project and an *increasing* cash-flow (I) project.

	END OF YEAR	NET CASH FLOWS Project D	Project I
	0	-$1,200	-$1,200
	1	1,000	
100	2	500	
600	3	100	
1,080			

Cash Flow Pattern

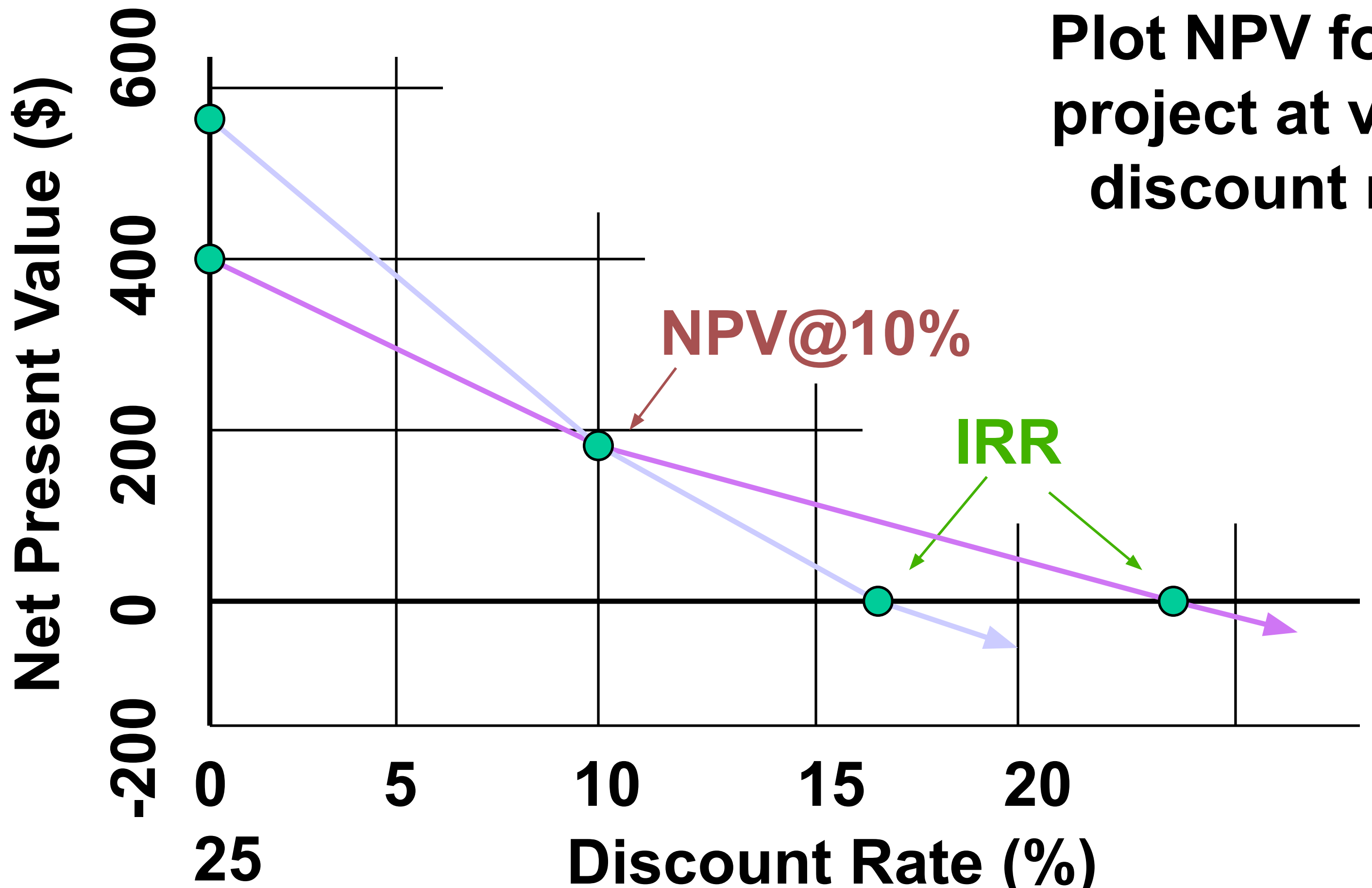
Calculate the IRR, NPV@10%, and PI@10%.

Which project is preferred?

Project	IRR	NPV	PI
D	23%	$197	1.16
I	17%	$198	1.17

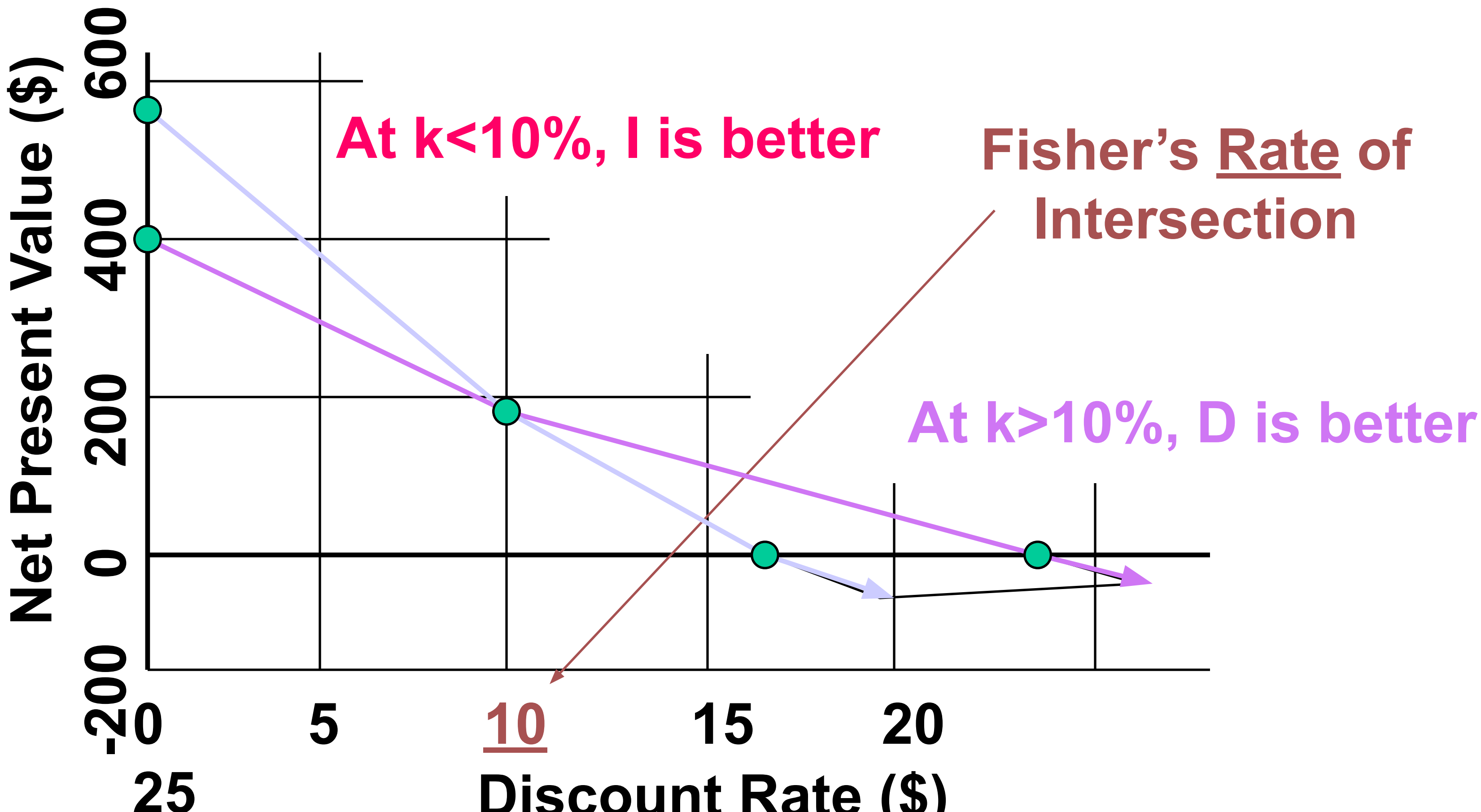
?

Examine NPV Profiles



Plot NPV for each project at various discount rates.

Fisher's Rate of Intersection



C. Project Life Differences

Let us compare a *long* life (X) project and a *short* life (Y) project.

END OF YEAR	NET CASH FLOWS Project X	NET CASH FLOWS Project Y
0	-$1,000	-$1,000
1	0	2,000
2	0	0
3	3,375	0

Project Life Differences

Calculate the PBP, IRR, NPV@10%, and PI@10%.

Which project is preferred? Why?

Project	IRR	NPV	PI
X	50%	$1,536	2.54
Y	100%	$ 818	1.82

?

Another Way to Look at Things

1. Adjust cash flows to a common terminal year if project "Y" will *NOT* be replaced.

Compound Project Y, Year 1 @10% for 2 years.

Year	0	1	2	3
CF	-$1,000	$0	$0	$2,420

Results: IRR* = 34.26%   NPV = $818

**Lower IRR* from adjusted cash-flow stream. X is still better.

Replacing Projects with Identical Projects

2. Use *Replacement Chain Approach* (Appendix B) when project “Y” will be replaced.

0	1	2	3
-$1,000	$2,000		
	-1,000	$2,000	
		-1,000	$2,000
-$1,000	$1,000	$1,000	

$2,000

Results: IRR* = 100% **NPV* = $2,238.17**

***Higher NPV, but the same IRR*. Y is better.**

Capital Rationing

Capital Rationing occurs when a constraint (or budget ceiling) is placed on the total size of capital expenditures during a particular period.

Example: Julie Miller must determine what investment opportunities to undertake for *Basket Wonders (BW)*. She is limited to a maximum expenditure of $32,500 *only* for this capital budgeting period.

Available Projects for BW

Project	ICO,$	IRR,%	NPV,$	PI
A	$ 500	18	50	1.10
B	5,000	25	6,500	2.30
C	5,000	37	5,500	2.10
D	7,500	20	5,000	1.67
E	12,500	26	500	1.04
F	15,000	28	21,000	2.40
G	17,500	19	7,500	1.43
H	25,000	15	6,000	1.24

Choosing by IRRs for BW

Project	ICO	IRR	NPV	PI
C	$5,000	37%	$5,500	2.10
F	15,000	28	21,000	2.40
E	12,500	26	500	1.04
B	5,000	25	6,500	2.30

Projects C, F, and E have the three *largest IRRs*.

The resulting *increase* in shareholder wealth is $27,000 with a $32,500 outlay.

Choosing by NPVs for BW

Project	ICO	IRR	NPV	PI
F	$15,000	28%	$21,000	2.40
G	17,500	19	7,500	1.43
B	5,000	25	6,500	2.30

Projects F and G have the two *largest NPVs*.

The resulting *increase* in shareholder wealth is $28,500 with a $32,500 outlay.

Choosing by PIs for BW

Project	ICO	IRR	NPV	PI
F	$15,000	28%	$21,000	2.40
B	5,000	25	6,500	2.30
C	5,000	37	5,500	2.10
D	7,500	20	5,000	1.67
G	17,500	19	7,500	1.43

Projects F, B, C, and D have the four *largest PIs*.

The resulting *increase* in shareholder wealth is $38,000 with a $32,500 outlay.

Summary of Comparison

Method	Projects Accepted	Value Added
PI	F, B, C, and D	$38,000
NPV	F and G	$28,500
IRR	C, F, and E	$27,000

PI generates the *greatest increase* in *shareholder wealth* when a limited capital budget exists for a *single period*.

Post-Completion Audit:
Usus Magister Est Optimus

Post-completion Audit

A formal comparison of the actual costs and benefits of a project with original estimates.

Identify any project weaknesses

Develop a possible set of corrective actions

Provide appropriate feedback

Result: Making better future decisions!

Multiple IRR Problem

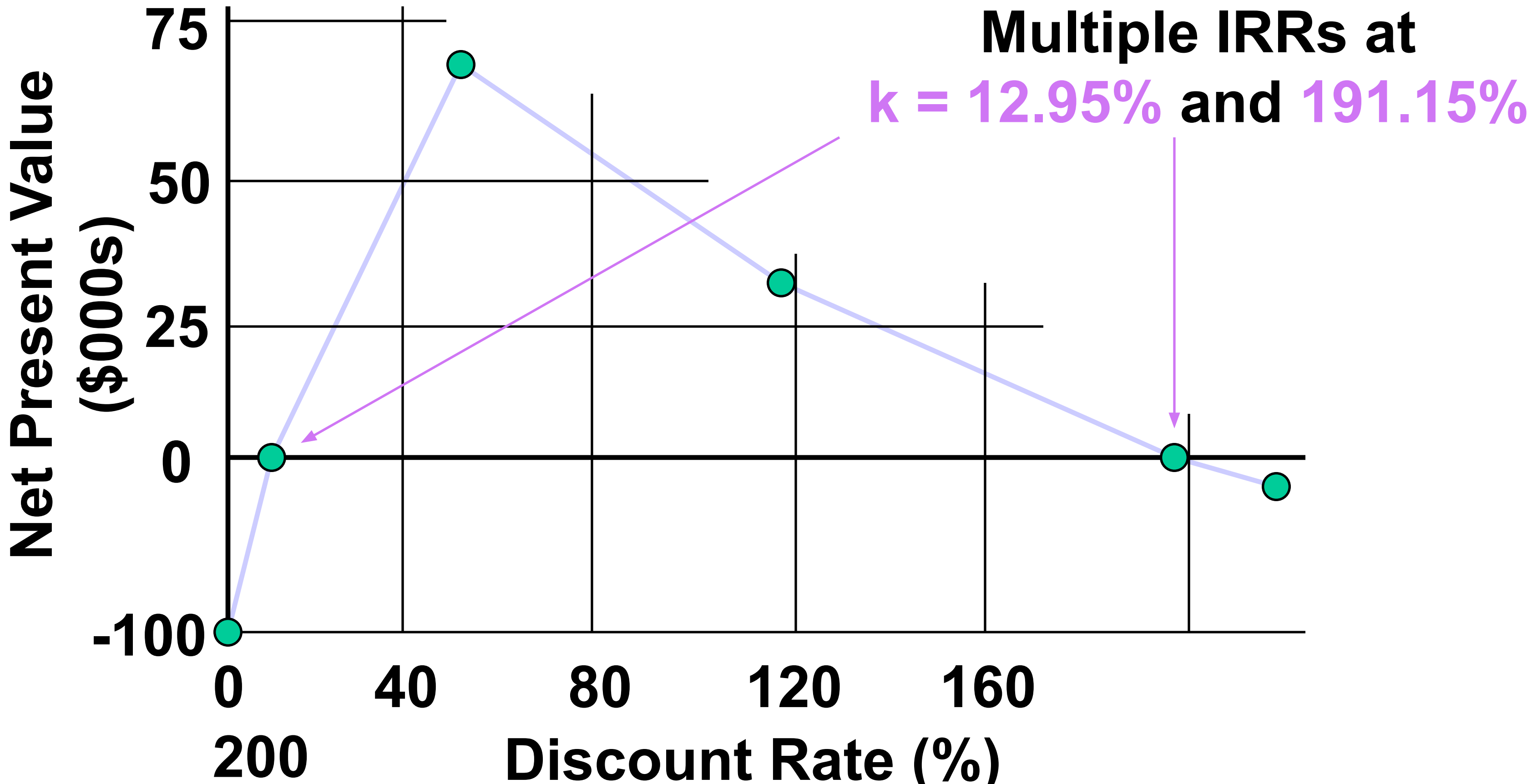
Let us assume the following cash flow pattern for a project for Years 0 to 4:

-$100 +$100 +$900 -$1,000

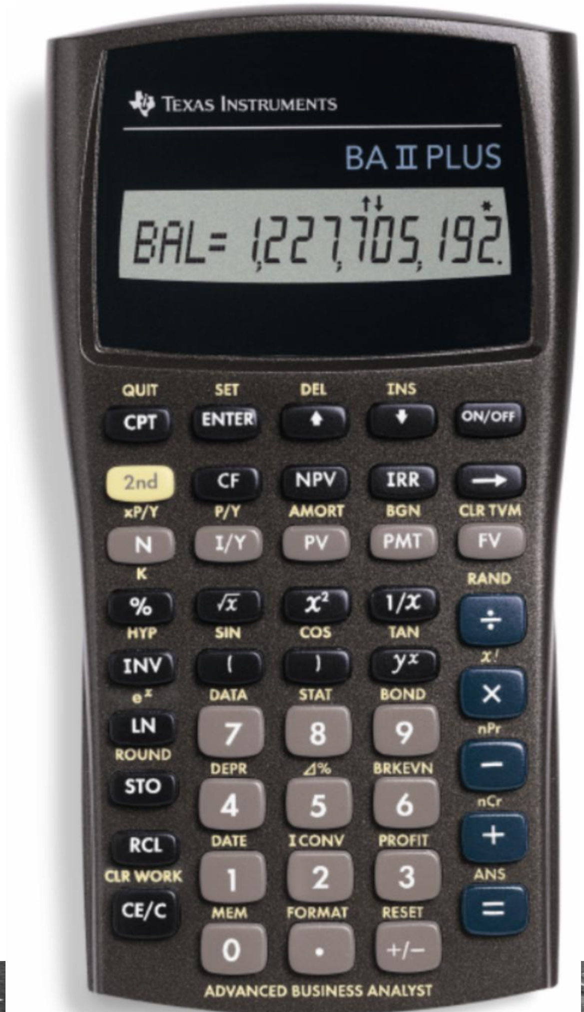
How many *potential* IRRs could this project have?

Two!! There are as many potential IRRs as there are sign changes.

NPV Profile -- Multiple IRRs



NPV Profile – Multiple IRRs



<u>Hint</u>: Your calculator will only find ONE IRR – even if there are multiple IRRs. It will give you the lowest IRR. In this case, 12.95%.