

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

-/+ Δ NWC (+/- Δ AR +/- Δ Inventory +/- Δ AP)

-/+ 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)

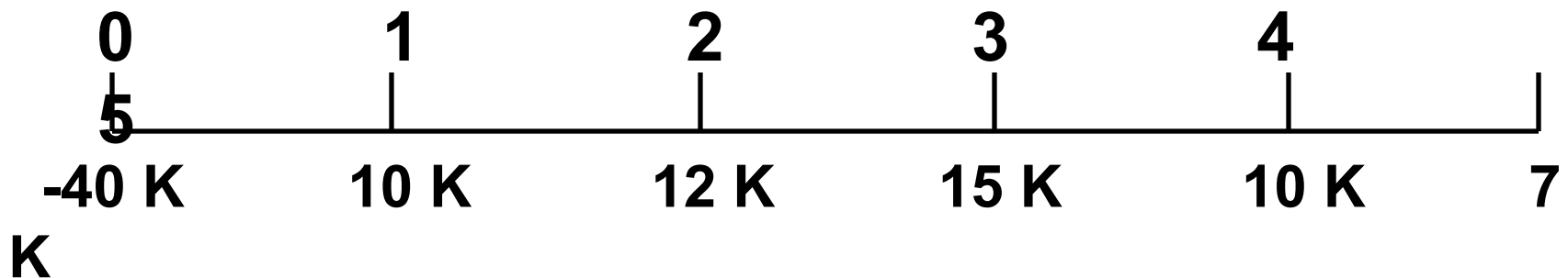
Other methods: ARR, MIRR, EAC...

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)



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

$$\begin{aligned}
 \text{PBP} &= a + (b - c) / d && = 3 + \\
 &= 3 + (40 - 37) / 10 && = 3 + (3 / 10) \\
 &= 3.30 \text{ Years}
 \end{aligned}$$

Payback Solution (#2)

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

Cumulative
Cash Flows

$$\text{PBP} = 3 + (3\text{K}) / 10\text{K} = 3.30 \text{ Years}$$

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!)

$$\text{ICO} = \frac{\text{CF}_1}{(1+\text{IRR})^1} + \frac{\text{CF}_2}{(1+\text{IRR})^2} + \dots + \frac{\text{CF}_n}{(1+\text{IRR})^n}$$

IRR Solution

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

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

IRR Solution (Try 10%)

$$\begin{aligned} \$40,000 = & \$10,000(\text{PVIF}_{10\%,1}) + \$12,000(\text{PVIF}_{10\%,2}) + \\ & \$15,000(\text{PVIF}_{10\%,3}) + \$10,000(\text{PVIF}_{10\%,4}) + \\ & 7,000(\text{PVIF}_{10\%,5}) \end{aligned}$$

$$\begin{aligned} \$40,000 = & \$10,000(.909) + \$12,000(.826) + \\ & \$15,000(.751) + \$10,000(.683) + \\ & 7,000(.621) \end{aligned}$$

$$\begin{aligned} \$40,000 = & \$9,090 + \$9,912 + \$11,265 + \\ & \$6,830 + \$4,347 \qquad \qquad \qquad = \$41,444 \end{aligned}$$

[Rate is / too low]

IRR Solution (Try 15%)

$$\begin{aligned} \$40,000 = & \$10,000(\text{PVIF}_{15\%,1}) + \$12,000(\text{PVIF}_{15\%,2}) + \\ & \$15,000(\text{PVIF}_{15\%,3}) + \$10,000(\text{PVIF}_{15\%,4}) + \\ & 7,000(\text{PVIF}_{15\%,5}) \end{aligned}$$

$$\begin{aligned} \$40,000 = & \$10,000(.870) + \$12,000(.756) + \\ & \$15,000(.658) + \$10,000(.572) + \\ & 7,000(.497) \end{aligned}$$

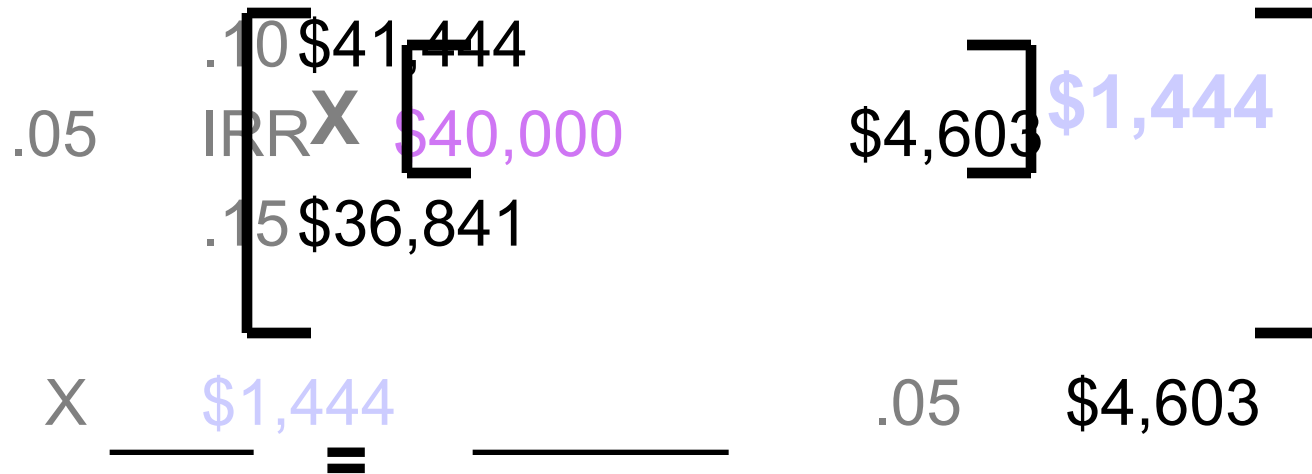
$$\begin{aligned} \$40,000 = & \$8,700 + \$9,072 + \$9,870 + \\ & \$5,720 + \$3,479 = \$36,841 \end{aligned}$$

is too high

IRR Solution (Interpolate)

	0	10	\$41,444		
0.05		X	IRR	\$40,000	\$4,603
	0	15	\$36,841		
X			\$1,444		
			=		
				0.05	\$4,603

IRR Solution (Interpolate)



IRR Solution (Interpolate)

	0	10	\$41,444		
0.05		IRR	\$40,000	\$4,603	\$1,444
	0	15	\$36,841		

$$\frac{(\$1,444)(0.05)}{\quad}$$

$$X =$$

$$X = 0.0157$$

$$\text{IRR} = 0.10 + 0.0157 = 0.1157 \text{ or } 11.57\%$$

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.

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

NPV Solution

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

$$\text{NPV} = \frac{\$10,000}{(1.13)^0} + \frac{\$12,000}{(1.13)^2} + \frac{\$15,000}{(1.13)^3} + \frac{\$10,000}{(1.13)^4} + \frac{\$7,000}{(1.13)^5} - \$40,000$$

NPV Solution

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

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

$$\text{NPV} = \$8,850 + \$9,396 + \$10,395 + \\ \$6,130 + \$3,801 - \$40,000 \\ = -\$1,428$$

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.

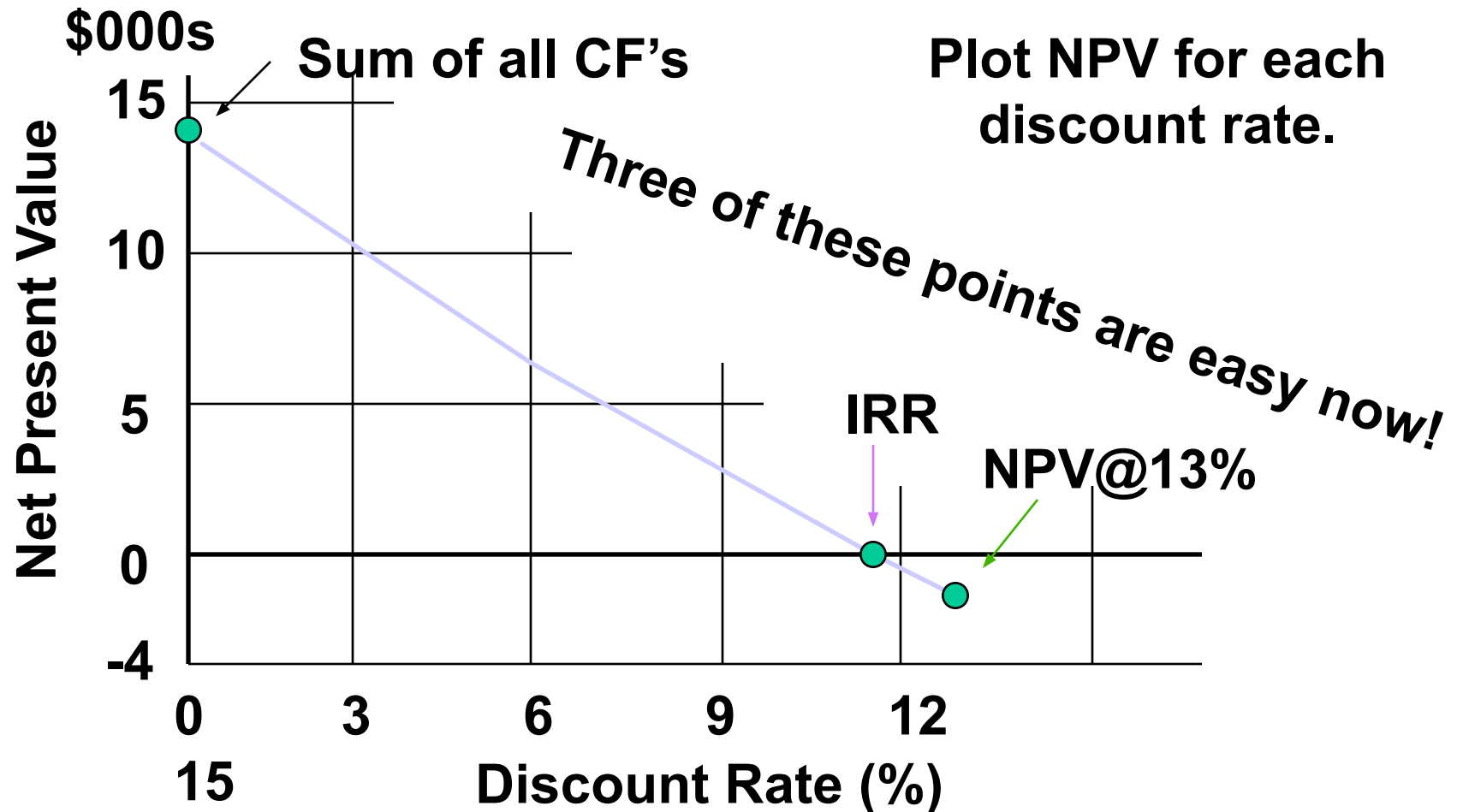
Considers all cash flows.

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.

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

<< OR >>

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

PI Acceptance Criterion

$$\begin{aligned} \text{PI} &= \$38,572 / \$40,000 \\ &= 0.9643 \end{aligned}$$

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.

END OF YEAR	NET CASH FLOWS	
	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?

<u>Project</u>	<u>IRR</u>	<u>NPV</u>	<u>PI</u>
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.

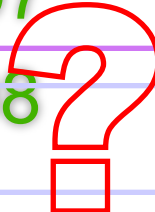
END OF YEAR	NET CASH FLOWS	
	Project D	Project I
0	-\$1,200	-\$1,200
1	1,000	
100 2	500	
600 3	100	
1,080		

Cash Flow Pattern

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

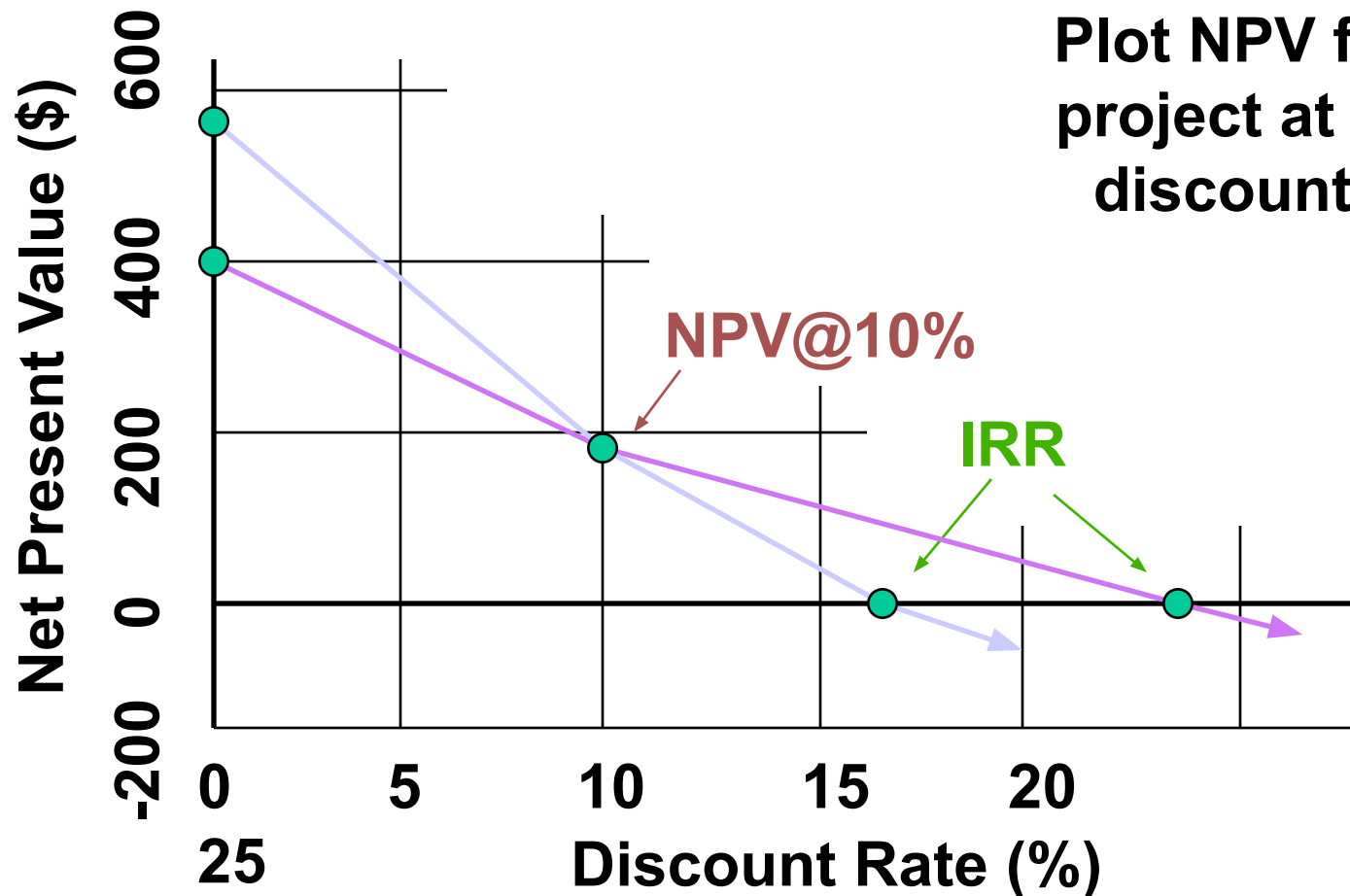
Which project is preferred?

<u>Project</u>	<u>IRR</u>	<u>NPV</u>	<u>PI</u>
D	23%	\$197	1.16
I	17%	\$198	1.17

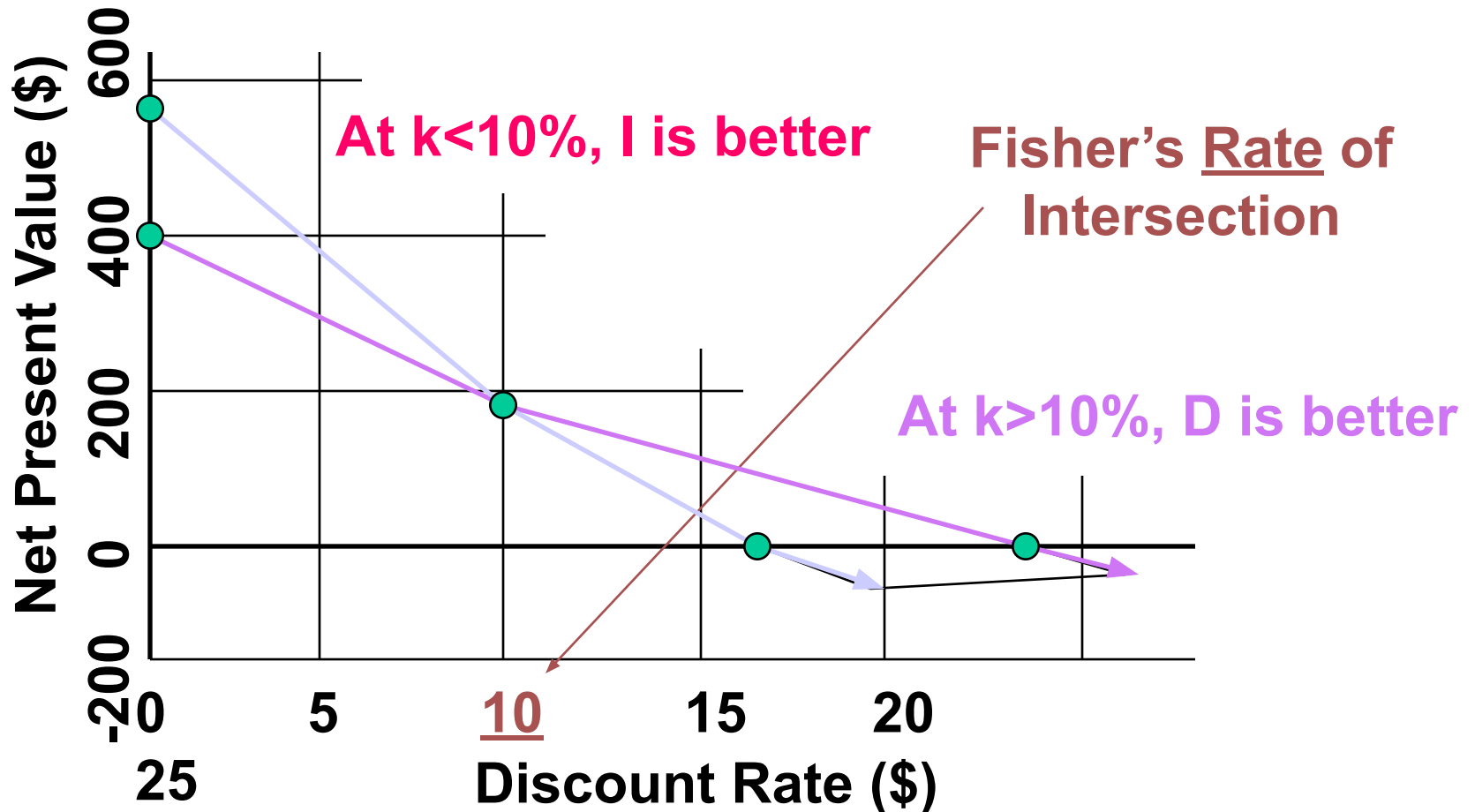


Examine NPV Profiles

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	Project Y
0	-\$1,000	-\$1,000
1	0	
2,000	0	
0	3,375	
0		

Project Life Differences

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

Which project is preferred? Why?

<u>Project</u>	<u>IRR</u>	<u>NPV</u>	<u>PI</u>
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.

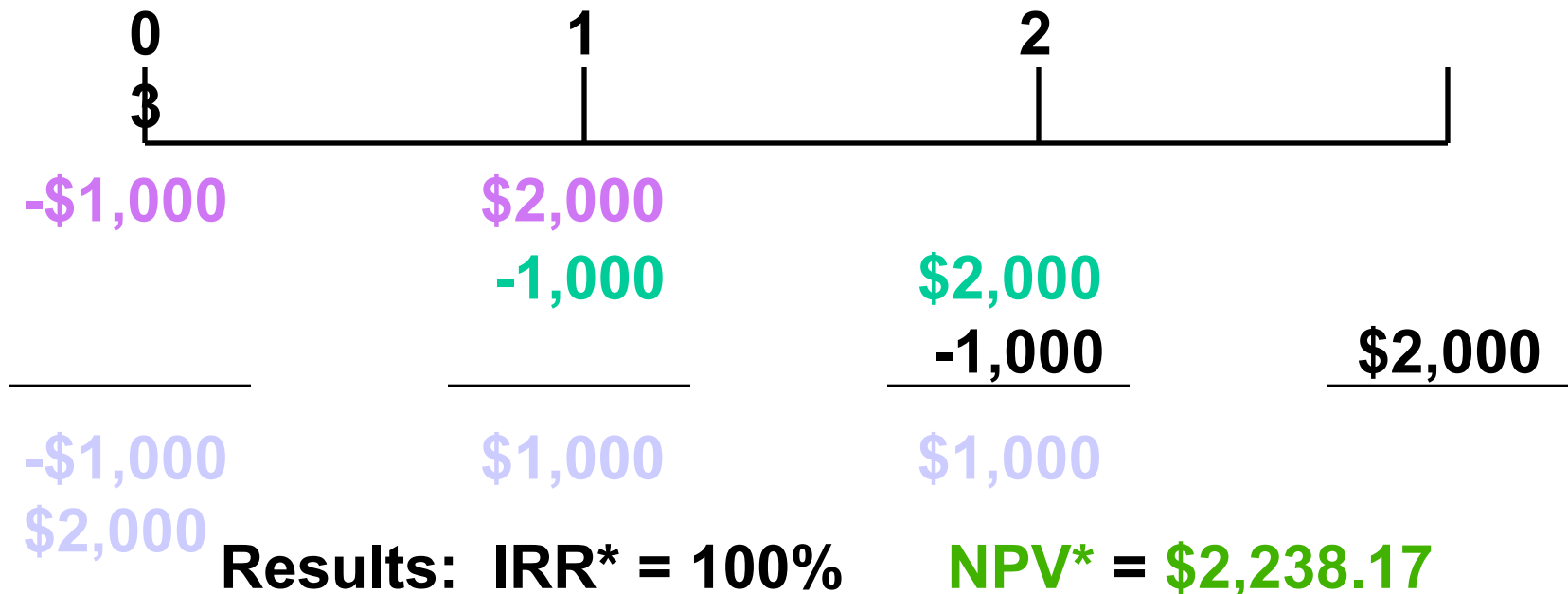
Year	0	1	2	3
CF	-\$1,000	\$0	\$0	\$2,420

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.



***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

<u>Project</u>	<u>ICO,\$</u>	<u>IRR,%</u>	<u>NPV,\$</u>	<u>PI</u>
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	21,000	2.40
F	15,000	28	7,500	1.43
G	17,500	19	25,000	15
H	25,000	15		

Choosing by IRRs for BW

<u>Project</u>	<u>ICO</u>	<u>IRR</u>	<u>NPV</u>	<u>PI</u>
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

<u>Project</u>	<u>ICO</u>	<u>IRR</u>	<u>NPV</u>	<u>PI</u>
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
25	6,500	2.30	C	5,000
2.10	D	7,500	20	5,000
17,500	19	7,500	1.43	G

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

<u>Method</u>	<u>Projects Accepted</u>	<u>Value Added</u>
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

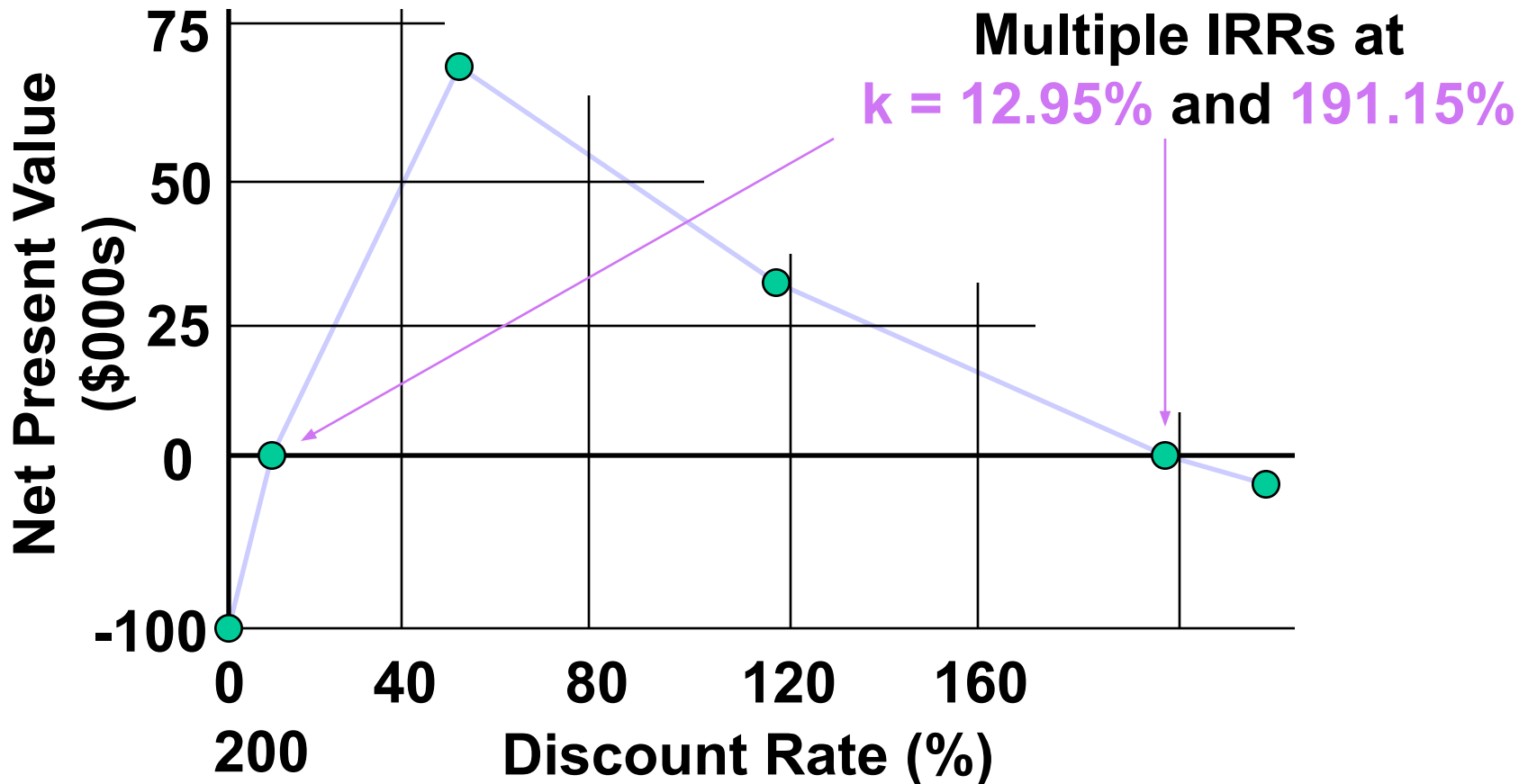
Let us assume the following cash flow pattern for a project for Years 0 to 4:

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

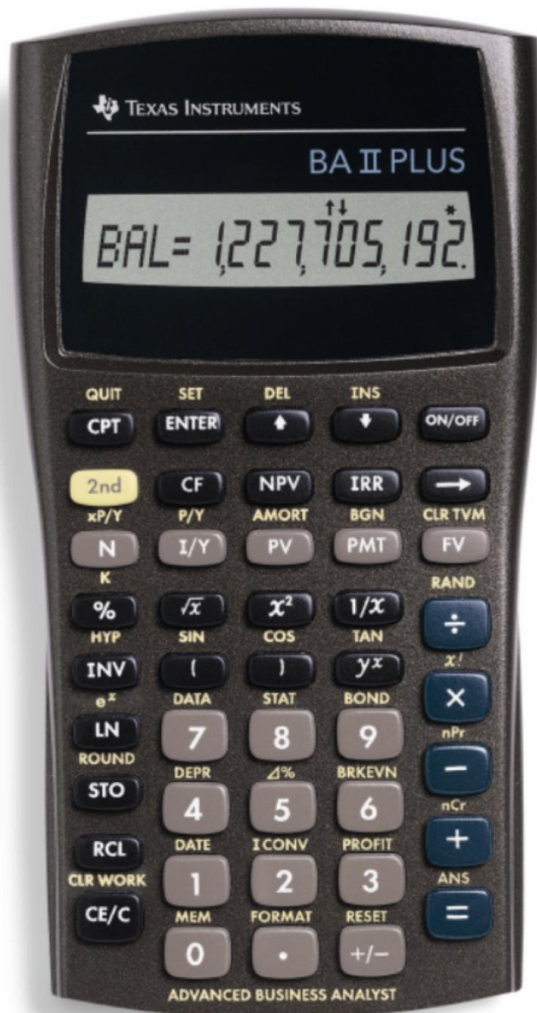
How many *potential* IRRs could this project have?

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

NPV Profile – Multiple IRRs



NPV Profile – Multiple IRRs



Hint: 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%.