



Alternative Investment Criterion

Previously...

In Chapters 4 and 5 we studied NPV.

- Rule: accept if $NPV > 0$.

Positive characteristics of the NPV rule:

- Time value of money.
- Uses forecasted project cash flows
- Risk-adjusted discount rate.
- NPV is additive.

Alternative Investment Criteria:

- We will examine:
 - Payback and Discounted Payback
 - Profitability Index
 - Internal Rate of Return

The Payback Period Method

Payback Period: The time it takes to recover the initial investment.

Payback Period Rule: A particular cutoff date, say, 2 years, is selected. All investment projects that have payback periods of 2 years or less are accepted. The rest are rejected.

Example of Payback Period

Period	1	2	3	4	NPV(10%)	PB(yrs)
Proj. 1	-20	10	10	100	72.49	2
Proj. 2	-20	10	10	0	-2.64	2
Proj. 3	-20	0	20	0	-3.47	2

Which one to choose?

Any problems with Payback Period?

Discounted Payback period

Discount all cash flows.

Apply Payback period rule.

Period	1	2	3	4	NPV-10%	PB
Proj. 1	-20	10	10	100	72.49	2
	<i>-20</i>	<i>9.09</i>	<i>8.26</i>	<i>75.13</i>		<i>>2</i>
Proj. 2	-20	10	10		-2.64	2
		<i>9.09</i>	<i>8.26</i>			<i>>2</i>
Proj. 3	-20	0	20		-3.47	2
		<i>0</i>	<i>16.53</i>			<i>>2</i>
Proj. 4	-20	15	15		6.03	2(1.33)
		<i>13.64</i>	<i>12.40</i>			<i>2</i>

Example

	0	1	2	3	4
Proj. A	-\$2,300	\$600	\$750	\$800	\$1,000
Proj. B	-\$2,300	\$1,100	\$950	\$500	\$450

What is the NPV of the two projects?

What is the payback period for projects A and B?

What is the discounted payback period?

Profitability Index (PI) or Benefit/Cost Ratio

$$PI = \frac{\text{PV of Inflows}}{\text{PV of Outflows}}$$

PI Rule : Accept all projects with $PI > 1$

Popular in Non-Profit Management

Period	1	2	3	NPV(12%)	PI
Project 1	-20	70	10	50.5	3.52
Project 2	-10	15	40	35.2	4.52
Project 3	-10	-5	50	25.4	2.76

Connection with NPV

- Numerator is PV of inflows
- Denominator is PV of costs

- If fraction is greater than one, that means numerator is greater than denominator, so NPV is positive

- Problem: scale is not considered

Internal Rate Of Return (IRR)

The IRR is the discount rate that equates a project's NPV to Zero.

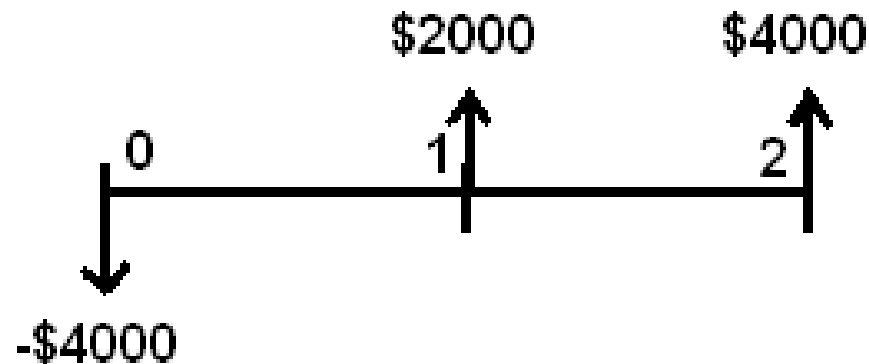
The IRR is defined exclusively in terms of an asset's cost and its cash flows.

IRR RULE :

Accept an investment/project if the opportunity cost of capital (discount rate) is less than the IRR.

Example:

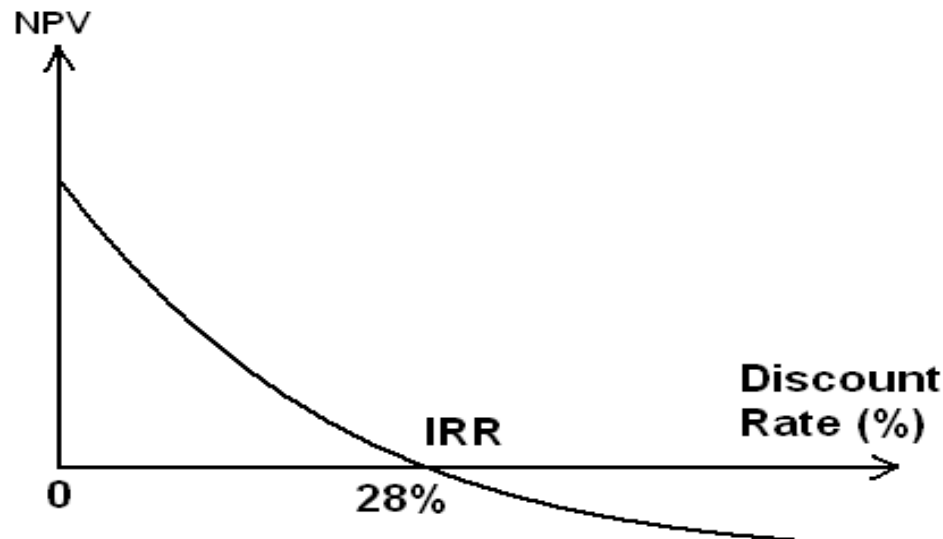
A project with an Initial Investment of \$4,000 and Cash flows at time 1,2 of \$2,000 and \$4,000 respectively.



$$0 = NPV = -4000 + \frac{2000}{(1 + IRR)} + \frac{4000}{(1 + IRR)^2}$$

$$IRR = 28\%$$

Graphically,



When the discount rate is less than IRR, NPV is positive, so we accept the project.

This graph assumes we have an initial cash *outflow* followed by cash *inflows* in the future.

Example II

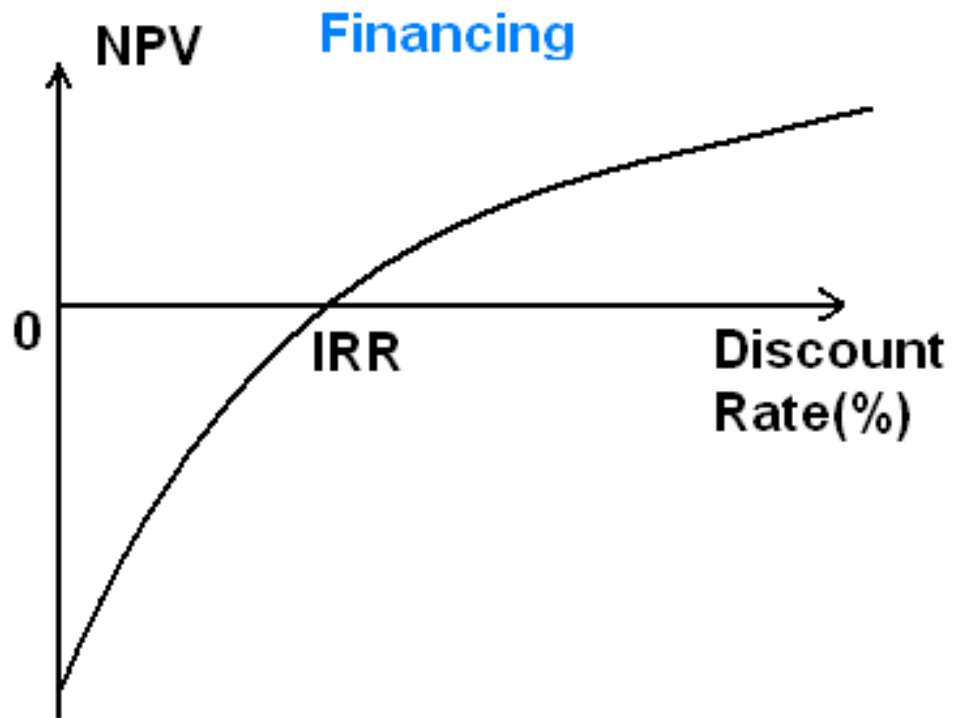
An investment costs \$125 and produces cash inflows of \$15 per year in perpetuity.

What is the IRR of this investment?

Problems with IRR

- Hard to calculate...
 - Since it may involve solving a polynomial, the best way is often trial and error.
- Investing vs. financing
 - Investing: $C_0 < 0$ and $C_1, C_2, \dots > 0$.
 - Accept the project if $r < \text{IRR}$.
 - Financing: $C_0 > 0$ and $C_1, C_2, \dots < 0$.
 - Accept the project if $r > \text{IRR}$.

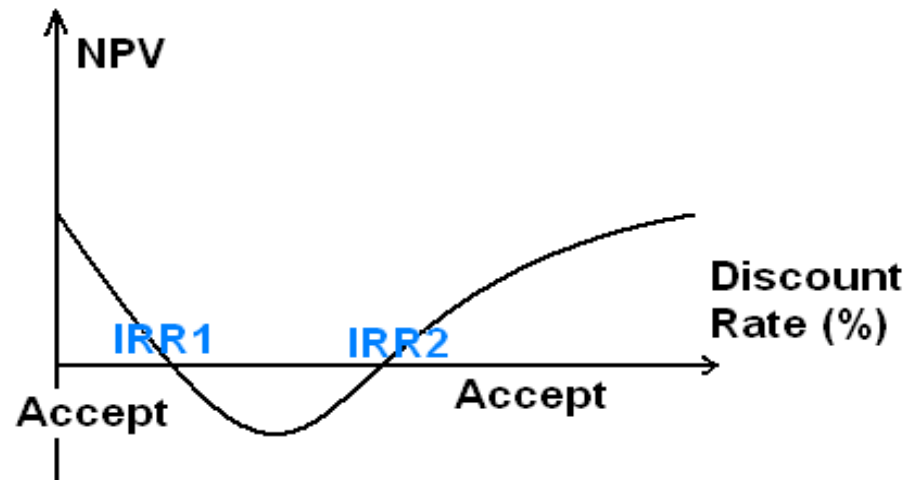
Financing graph



Problems (continued)

- Can have multiple IRRs.
 - If cash flows change signs more than once (for example, $C_0 = -100$, $C_1 = 50$, $C_2 = 60$, $C_3 = -30$, $C_4 = 45$, ...), then we will have more than one IRR!

In general, # of IRRs equals # of times the sign changes.



Example

Calculate the IRR for an investment with the following cash flows:

	0	1	2
Project	\$792	-\$1780	\$1000

Problems III

- The Scale Problem.

Small project with high IRR is preferred to large project with lower IRR... but the latter may have higher PV!

No way to compare mutually exclusive projects.

Incremental cash flows can be used.

Example of IRR (text, page 160)

	C_0	C_1	NPV (25%)	IRR
Small Budget	-10m	40m	22m	300%
Large Budget	-25m	65m	27m	160%

Incremental Cash flows from choosing large instead of small budget

C_0	C_1
$-25 - (-10) = -15$	$65 - 40 = 25$

Incremental IRR

$$0 = -15 + \frac{25}{1 + IRR}$$

Incremental IRR=66.67%

NPV of Incremental cash flow:

$$-15 + \frac{25}{1 + 25\%} = 5$$

66.67% > 25% (discount rate) and NPV is positive, so we accept the large budget.

Incremental Cash Flow Example

Dioxal Oil Company is in the process of cleaning up a minor oil spill. The firm could do the work with one cleanup team or two.

One team would cost \$25 per month for five months. Two teams would cost \$40 per month for three months. If two teams are used, the firm can start refining earlier and collect \$10 in earnings in months 4 and 5.

Should Dioxal use one or two teams to clean up the oil spill? Base your decision on IRR.