333-201 Business Finance

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Lecture 14:
Capital Budgeting / Project Evaluation 1

Capital Budgeting I

- Outline the capital budgeting process
- Define, use and interpret the net present value
- Define, use and interpret the internal rate of return
- Examine the problems associated with the internal rate of return method

Required Readings: Lectures 14 -17

Lecture 14 PBEHP, Ch. 5 (sections 5.1 5.4.2)

Lecture 15 PBEHP, Ch. 5 (sections 5.4.3 5.5.2)

Lecture 16 PBEHP, Ch. 6 (sections 6.1 6.3)

Lecture 17 PBEHP, Ch. 14 (sections 14.1 14.2, 14.4 14.5)

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The Capital Budgeting Process

- Generation of investment proposals
- Evaluation and selection of these proposals
- Approval and control of capital expenditures
- Post-completion audit of investment projects
- Focus here is on the evaluation and selection of investment proposals

Methods of Project Evaluation

- The major methods used by managers to evaluate projects are:
  - Net present value
  - Internal rate of return
  - Accounting rate of return
  - Payback period

- The net present value and internal rate of return methods are analyzed in this lecture and the other methods analyzed in the next lecture

Types of Projects

- The two broad categories of projects that a firm typically analyzes are

- Independent projects
  - These are projects that can be evaluated on their own and independently of each other

- Mutually exclusive projects
  - These are projects where the acceptance of one project rules out the acceptance of other (competing) projects

- Which types of projects are easier to evaluate and why?

What Do Managers Do?

Method Used Always or Almost Always	*Percentage*
Internal rate of return	75.6%
Net present value	74.9%
Payback period	56.7%
Accounting rate of return	20.3%
Profitability index	11.9%

Source: Graham and Harvey, 2001, The Theory and Practice of Corporate Finance: Evidence From the Field, Journal of Financial Economics. Based on survey of 392US-based CFOs. The aggregate percentage exceeds 100 percent because most respondents used more than one method of project evaluation. Profitability index = Present value of net cash flows/Initial outlay.

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The Net Present Value Method

The net present value (NPV) method involves.

- Computing the difference between the present value of the net cash flows from an investment and the initial investment outlay

- All cash flows are discounted at the required rate of return which reflects the project's risk

Project's net cash flows

- Identify the size and timing of incremental cash flows as a result of the project

- Net cash flows after corporate taxes need to be evaluated

- Incremental cash flows are the cash flows earned by the firm if the project is undertaken minus cash flows earned by the firm if the project is not undertaken

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The Net Present Value Method

The net present value is computed as

$$NPV = \frac{C_1}{(1+k)} + \frac{C_2}{(1+k)^2} + \ldots + \frac{C_N}{(1+k)^N} - I_0$$

$$NPV = \sum_{t-1}^{N} \frac{C_t}{(1+k)^t} - I_0$$

I_0 = Initial investment
C_t = Net after-tax cash flow at the end of year t
k = Project's required rate of return or opportunity cost of capital
N = Economic life of the project in years

Decision: Accept project if NPV 0, reject if NPV < 0

Note: Point of indifference when NPV = 0

The Net Present Value Method

Example: The net after-tax cash flows from a four-year project that costs $1 million are as follows. Evaluate the project using the net present value method assuming that the project's required rate of return is 12% p.a. How does your decision change if the initial investment were $1,300,000 and not $1,000,000?

End of Year	Net Cash Flows
0	-$1,000,000
1	$400,000
2	$460,000
3	$400,000
4	$340,000

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The Net Present Value Method

The project's net present value is:

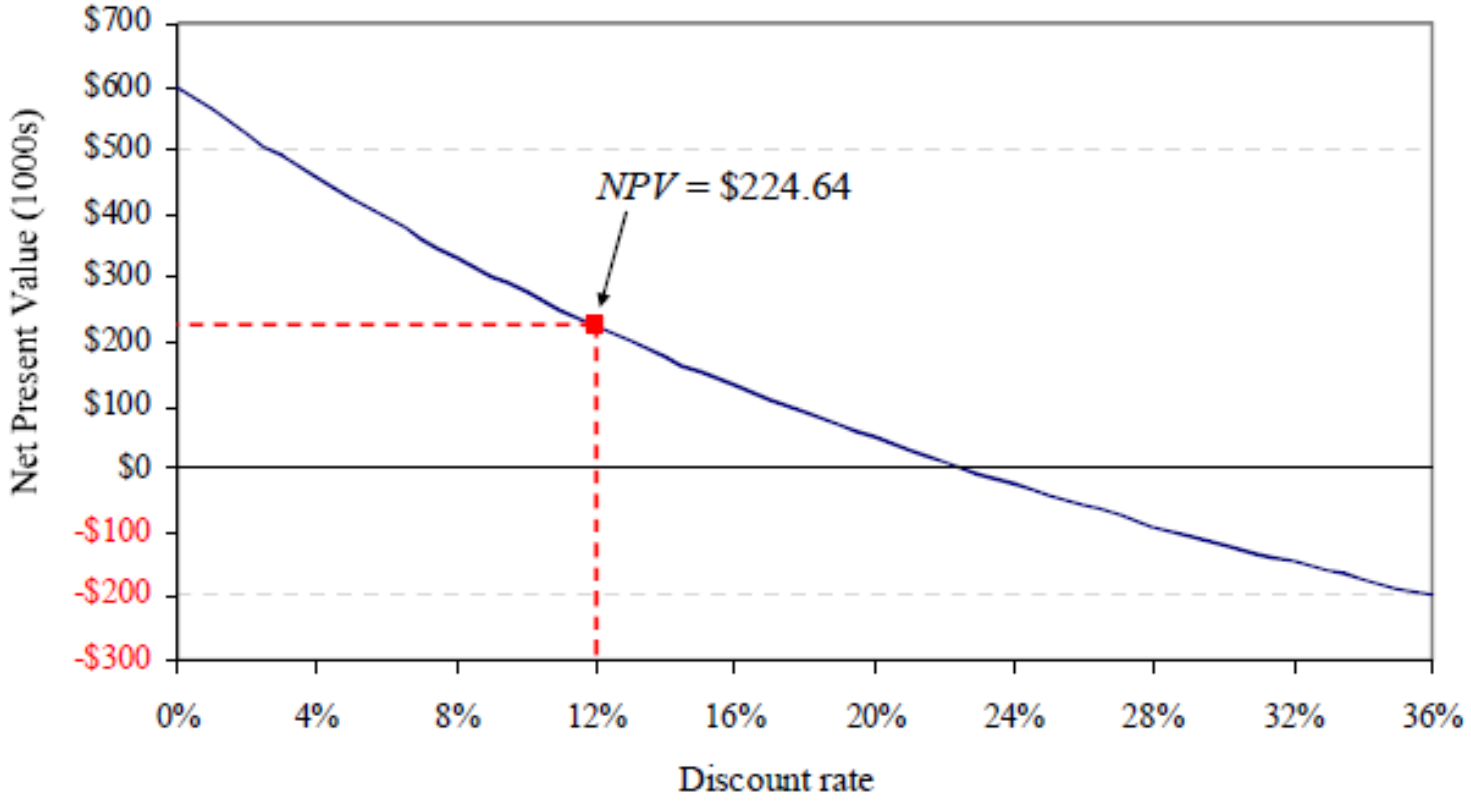
$$NPV = \frac{400}{1.12} + \frac{460}{1.12^2} + \frac{400}{1.12^3} + \frac{340}{1.12^4} - 1000 = \$224.64$$

Since the NPV is positive the project should be accepted.
If the initial investment was $1,300,000 the revised NPV is:

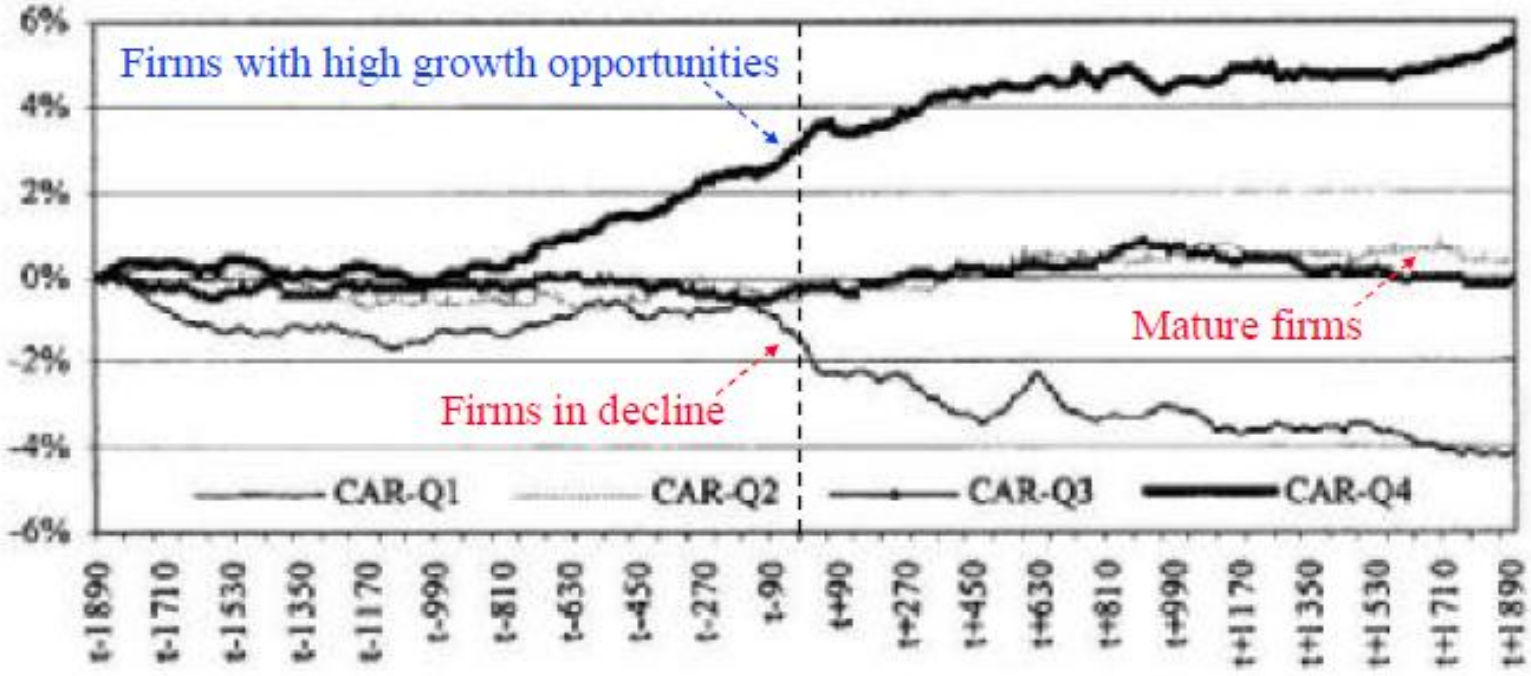
$$NPV = \frac{400}{1.12} + \frac{460}{1.12^2} + \frac{400}{1.12^3} + \frac{340}{1.12^4} - 1300 = -\$75.36$$

What interpretation can be associated with the net present value?

The Net Present Value Profile



Market's Interpretation of NPV



Source: Brailsford and Yeoh, 2004, Agency Problems and Capital Expenditure Announcements, Journal of Business. Market.s reaction at 15 minute intervals over days -5 to +5. CAR-Q1 represents firms in decline while CAR-Q4 represents firms with high growth opportunities.

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Internal Rate of Return

The internal rate of return (IRR or r) is the rate of return that is earned by the project over its economic life

Reinvestment rate assumed in the context of the IRR?

Set NPV equal to 0 and compute the internal rate of return (r)

$$NPV \equiv 0 = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_N}{(1+r)^N} - I_0$$

$$NPV \equiv 0 = \sum_{t=1}^{N} \frac{C_t}{(1+r)^t} - I_0$$

Decision: Accept project if r k, reject if r < k

Note: Point of indifference when r = k

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Internal Rate of Return

The internal rate of return for .simple. projects is relatively easy to compute

Example: Consider a project which involves an initial investment of $100,000 and yields a net cash flow of $150,000 at the end of year 4. What is the IRR of this project?

Compute the IRR by setting the NPV to zero and solving for the IRR in…

$$NPV \equiv 0 = \frac{150000}{(1+r)^4} - 100000$$

$$r = \left(\frac{150000}{100000}\right)^{1/4} - 1 = 10.7\%$$

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Internal Rate of Return

Example: The net cash flows from a four-year project that costs $1,000,000 are as follows. Evaluate the project using the internal rate of return method and assuming that the project's required rate of return is 12% p.a.

End of Year	Net Cash Flows
0	-$1,000,000
1	$400,000
2	$460,000
3	$400,000
4	$340,000

Internal Rate of Return

Recall: The net present value is of the project was.

$$NPV = \frac{400}{1.12} + \frac{460}{1.12^2} + \frac{400}{1.12^3} + \frac{340}{1.12^4} - 1000 = \$224.64$$

Internal rate of return is obtained by solving for r in…

$$NPV \equiv 0 = \frac{400}{(1+r)} + \frac{460}{(1+r)^2} + \frac{400}{(1+r)^3} + \frac{340}{(1+r)^4} - 1000$$

At r = 22%, NPV = $10.68
At r = 23%, NPV = -$7.25
At r = 22.5%, NPV = $1.65
Actual r = 22.6% > k = 12%

Both rules give the *same decision for individual projects*

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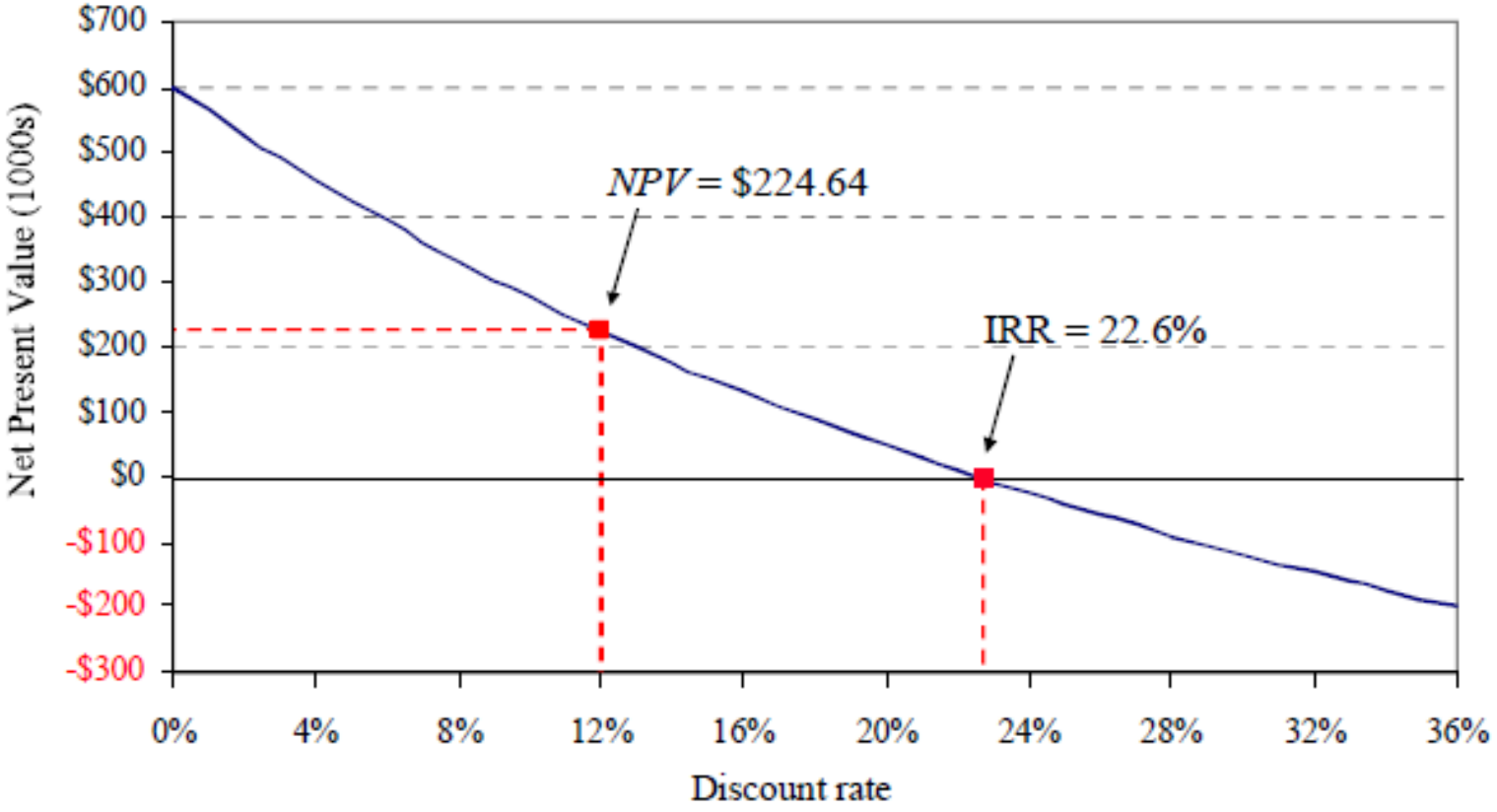
Internal Rate of Return



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Problems with the IRR Method

A project's IRR is invariant to the scale (or size) of the project

Example: In the previous example, consider another four-year project which has the following initial cost and net cash flows. Which project would the firm prefer if it used the IRR method to evaluate the projects and if the required rate of return was 12% p.a.?

End of Year	Project A	Project B
0	-$1,000,000	-$500,000
1	$400,000	$200,000
2	$460,000	$230,000
3	$400,000	$200,000
4	$340,000	$170,000

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Problems with the IRR Method

Note that project B's cash inflows and outflows are one-half of project A's cash flows

- This implies that the IRRs of the projects are equal at 22.6%

Should the firm be indifferent between the two projects?

End of Year	Project A	Project B
0	-$1,000,000	-$500,000
1	$400,000	$200,000
2	$460,000	$230,000
3	$400,000	$200,000
4	$340,000	$170,000
IRR	22.6%	22.6%
NPV	$224,640	$112,320

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Multiple Internal Rates of Return

- In certain circumstances it is possible for a project to have multiple internal rates of return
  - That is, there is more than one discount rate for which the NPV of a project is equal to zero

- A necessary condition for multiple IRRs is that there is more than one sign change in the future expected net cash flows
  - Note that this is not a sufficient condition!

Sign of Cash Flows	Number of Sign Changes	*Maximum* Number of *IRR*s
– + + +	1 sign change	1
+ – – –	1 sign change	1
– + – + –	4 sign changes	4
– + + + –	2 sign changes	2

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Multiple Internal Rates of Return

Example: Consider a project with the following cash flows and evaluate the project using the internal rate of return method

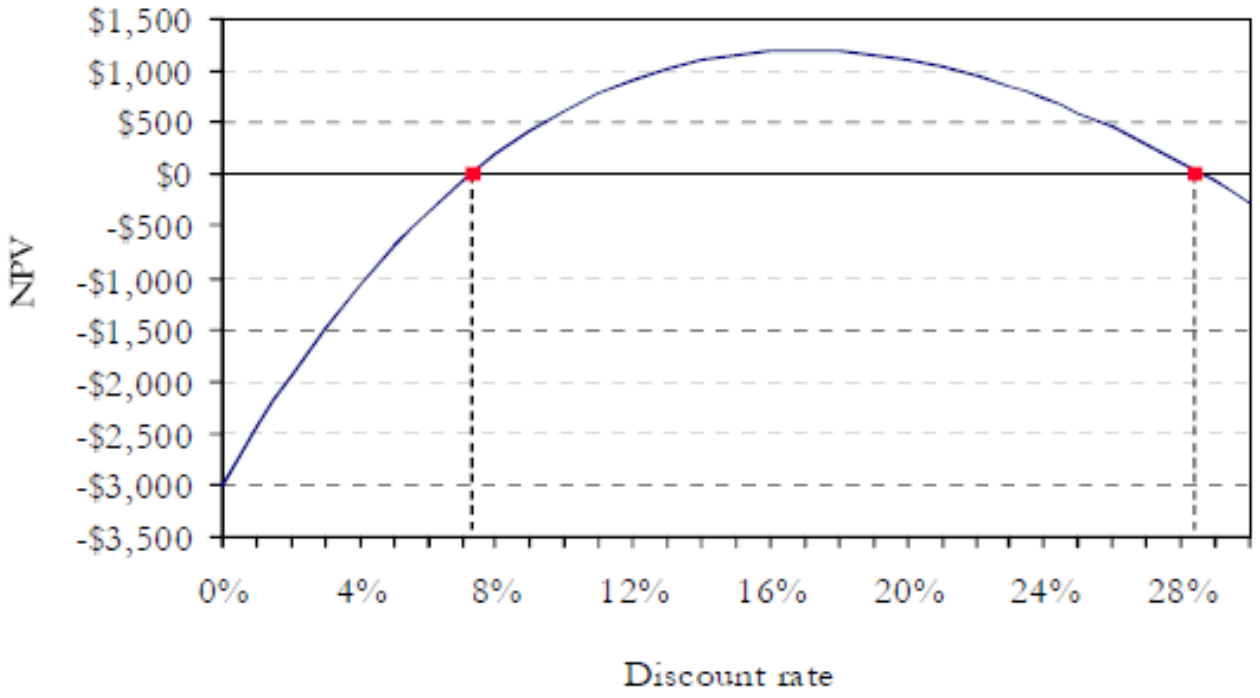
	Year 0	Year 1	Year 2
Net Cash Flow	-$145,000	$342,000	-$200,000

$$NPV \equiv 0 = -145000 + \frac{342000}{(1+r)} - \frac{200000}{(1+r)^2}$$

- There are two IRRs (see next slide) - 7.2% and 28.6%
- Based only on the internal rates of return is the project acceptable if its required rate of return is 16% (that is, it lies between 7.2% and 28.6%)?

Multiple Internal Rates of Return

$$NPV \equiv 0 = -145000 + \frac{342000}{(1+r)} - \frac{200000}{(1+r)^2}$$



Is the project acceptable if its required rate of return is 16% (that is, it lies between 7.2% and 28.6%)?

Multiple Internal Rates of Return

Example (continued): Now consider a project with the following pattern of cash flows. Evaluate the project using the internal rate of return method

	Year 0	Year 1	Year 2
Net Cash Flow	$145,000	-$342,000	$200,000

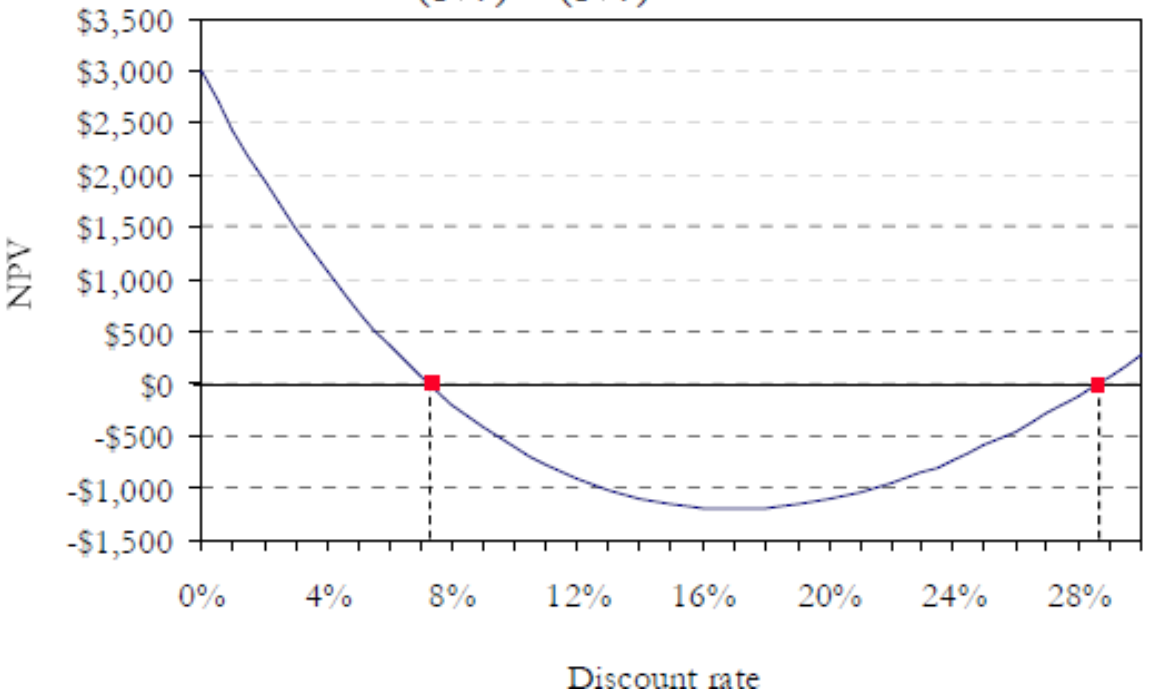
$$NPV \equiv 0 = 145000 - \frac{342000}{(1+r)} + \frac{200000}{(1+r)^2}$$

- The two IRRs are the same as before...
  - 7.2% and 28.6%

Decision now?

Multiple Internal Rates of Return

$$NPV \equiv 0 = 145000 - \frac{342000}{(1+r)} + \frac{200000}{(1+r)^2}$$



Decision now if the project's required rate of return is 16% (that is, lies between 7.2% and 28.6%)?

No Internal Rate of Return

- In rare cases a project may not have an internal rate of return!

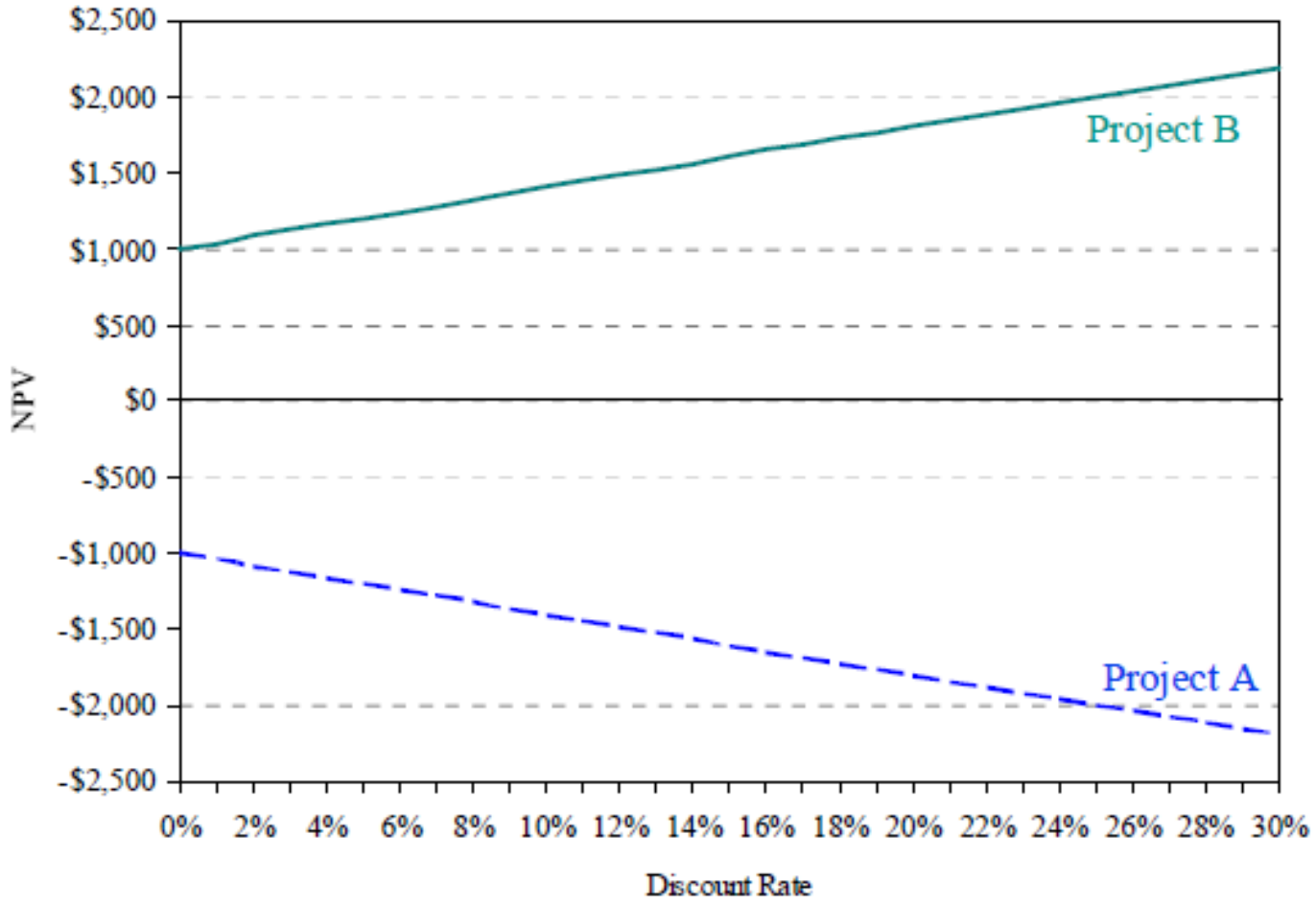
- The NPV of the project remains positive or negative no matter what discount rate is applied to the cash flows

- Example: Can the following projects be evaluates using the internal rate of return method?

	Year 0	Year 1	Year 2
Project A	-$10,000	$14,000	-$5,000
Project B	$10,000	-$14,000	$5,000

Note: Even though there are two sign changes, this is not sufficient for multiple IRRs to exist

No Internal Rate of Return



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Key Concepts

- The NPV method is recommended for investment evaluation
- NPV is consistent with maximization of shareholder wealth
- NPV is also simple to use and gives rise to fewer problems than the IRR method
- The IRR method has severe drawbacks including multiple IRRs as well as undefined IRRs
- The NPV method is generally preferable to the IRR method due to the weaknesses in the latter, including multiple IRRs and undefined IRRs

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Key Relationships/Formula Sheet

- Net present value

$$NPV = \frac{C_1}{(1+k)} + \frac{C_2}{(1+k)^2} + \ldots + \frac{C_N}{(1+k)^N} - I_0$$

$$NPV = \sum_{t=1}^{N} \frac{C_t}{(1+k)^t} - I_0$$

- Internal rate of return

$$NPV \equiv 0 = \frac{C_1}{(1+r)} + \frac{C_2}{(1+r)^2} + \ldots + \frac{C_N}{(1+r)^N} - I_0$$