

Chapter 9

Net Present Value and Other Investment Criteria

Chapter Organization

- 9.1 Net Present Value
- 9.2 The Payback Rule
- 9.3 The Average Accounting Return
- 9.4 The Internal Rate of Return
- 9.5 The Profitability Index
- 9.6 The Practice of Capital Budgeting
- 9.7 Summary and Conclusions

T9.2 NPV Illustrated

- Assume you have the following information on Project X:

Initial outlay -\$1,100

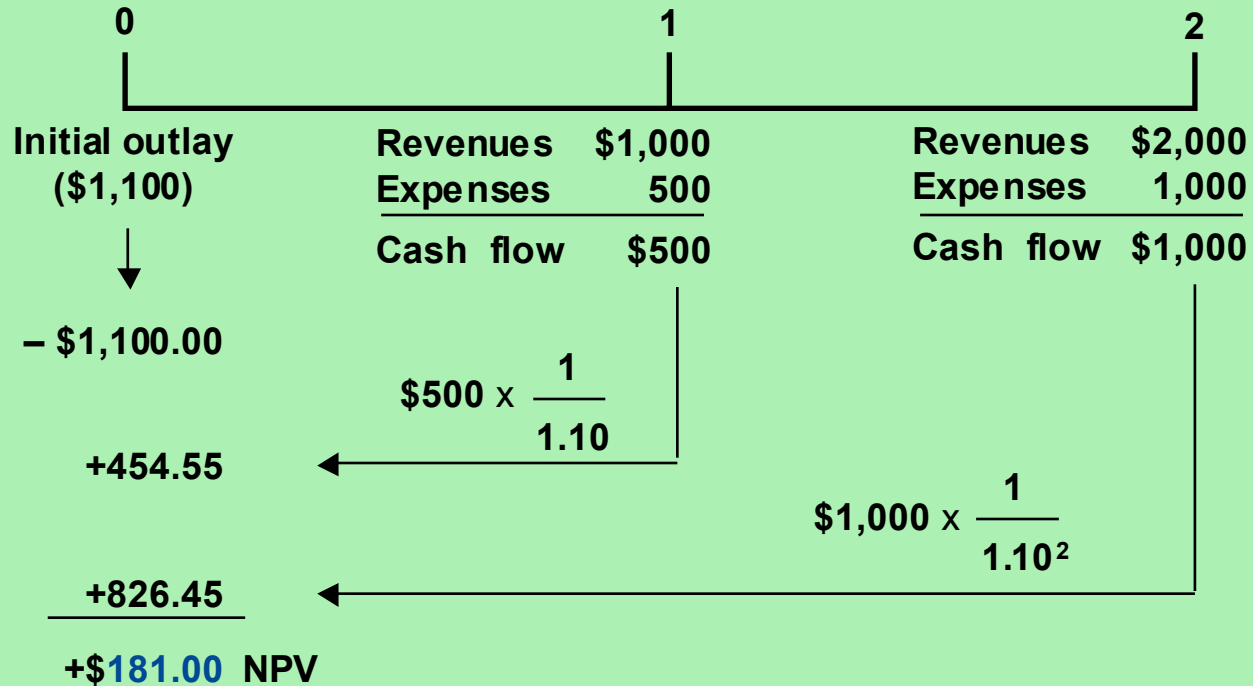
Required return = 10%

Annual cash revenues and expenses are as follows:

<u>Year</u>	<u>Revenues</u>	<u>Expenses</u>
1	\$1,000	\$500
2	2,000	1,000

- Draw a time line and compute the NPV of project X.

T9.2 NPV Illustrated (concluded)



T9.3 Underpinnings of the NPV Rule

- Why does the NPV rule work? And what does “work” mean?
Look at it this way:

A “firm” is created when securityholders supply the funds to acquire assets that will be used to produce and sell a good or a service;

The market value of the firm is based on the present value of the cash flows it is expected to generate;

Additional investments are “good” if the present value of the incremental expected cash flows exceeds their cost;

Thus, “good” projects are those which increase firm value - or, put another way, good projects are those projects that have positive NPVs!

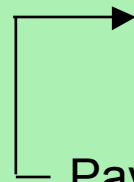
Moral of the story: Invest only in projects with positive NPVs.

T9.4 Payback Rule Illustrated

Initial outlay -\$1,000

<u>Year</u>	<u>Cash flow</u>
1	\$200
2	400
3	600

<u>Year</u>	<u>Accumulated Cash flow</u>
1	\$200
2	600
3	1,200



Payback period = 2 ²/₃ years

T9.5 Discounted Payback Illustrated

Initial outlay -\$1,000

R = 10%

Year	Cash flow	PV of Cash flow
1	\$ 200	\$ 182
2	400	331
3	700	526
4	300	205

Year	Accumulated <i>discounted</i> cash flow
1	\$ 182
2	513
3	1,039
4	1,244

→
Discounted payback period is just under 3 years

T9.6 Ordinary and Discounted Payback (Table 9.3)

Year	<i>Cash Flow</i>		<i>Accumulated Cash Flow</i>	
	Undiscounted	Discounted	Undiscounted	Discounted
1	\$100	\$89	\$100	\$89
2	100	79	200	168
3	100	70	300	238
4	100	62	400	300
5	100	55	500	355

T9.7 Average Accounting Return Illustrated

- Average net income:

	Year		
	1	2	3
Sales	\$440	\$240	\$160
Costs	<u>220</u>	<u>120</u>	<u>80</u>
Gross profit	220	120	80
Depreciation	<u>80</u>	<u>80</u>	<u>80</u>
Earnings before taxes	140	40	0
Taxes (25%)	<u>35</u>	<u>10</u>	<u>0</u>
Net income	<u>\$105</u>	<u>\$30</u>	<u>\$0</u>

$$\text{Average net income} = (\$105 + 30 + 0)/3 = \$45$$

T9.7 Average Accounting Return Illustrated (concluded)

- Average book value:

$$\text{Initial investment} = \$240$$

$$\text{Average investment} = (\$240 + 0)/2 = \$120$$

- Average accounting return (AAR):

$$\text{AAR} = \frac{\text{Average net income}}{\text{Average book value}} = \frac{\$45}{\$120} = 37.5\%$$

T9.8 Internal Rate of Return Illustrated

Initial outlay = -\$200

Year	Cash flow
1	\$ 50
2	100
3	150

- Find the IRR such that NPV = 0

$$0 = -200 + \frac{50}{(1+IRR)^1} + \frac{100}{(1+IRR)^2} + \frac{150}{(1+IRR)^3}$$

$$200 = \frac{50}{(1+IRR)^1} + \frac{100}{(1+IRR)^2} + \frac{150}{(1+IRR)^3}$$

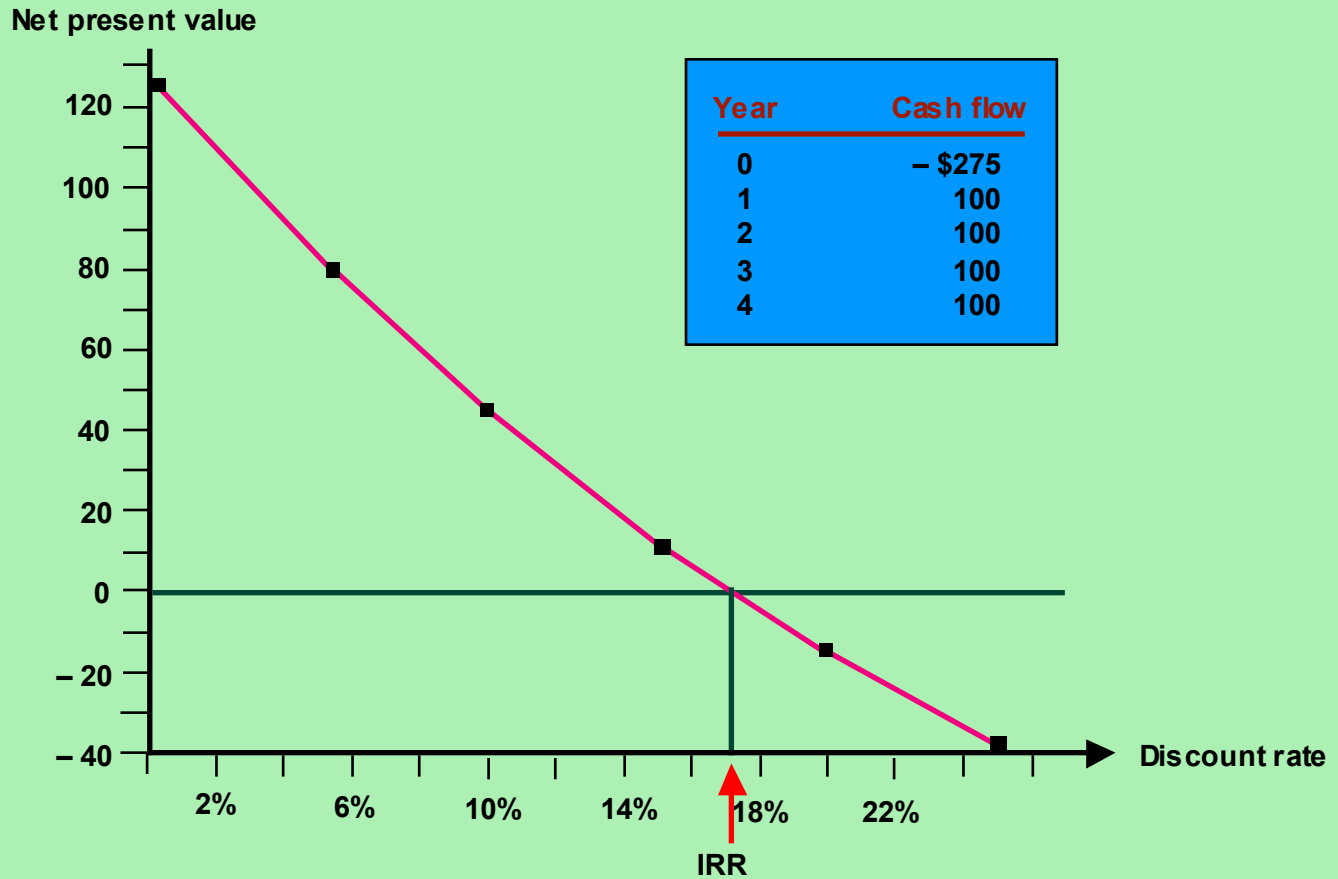
T9.8 Internal Rate of Return Illustrated (concluded)

- Trial and Error

Discount rates	NPV
0%	\$100
5%	68
10%	41
15%	18
→ 20%	-2

IRR is just under 20% -- about 19.44%

T9.9 Net Present Value Profile



T9.10 Multiple Rates of Return

- Assume you are considering a project for which the cash flows are as follows:

Year	Cash flows
0	-\$252
1	1,431
2	-3,035
3	2,850
4	-1,000

T9.10 Multiple Rates of Return (continued)

- What's the IRR? Find the rate at which the computed NPV = 0:

at 25.00%: NPV = _____

at 33.33%: NPV = _____

at 42.86%: NPV = _____

at 66.67%: NPV = _____

T9.10 Multiple Rates of Return (continued)

- What's the IRR? Find the rate at which the computed NPV = 0:

at 25.00%: NPV = 0

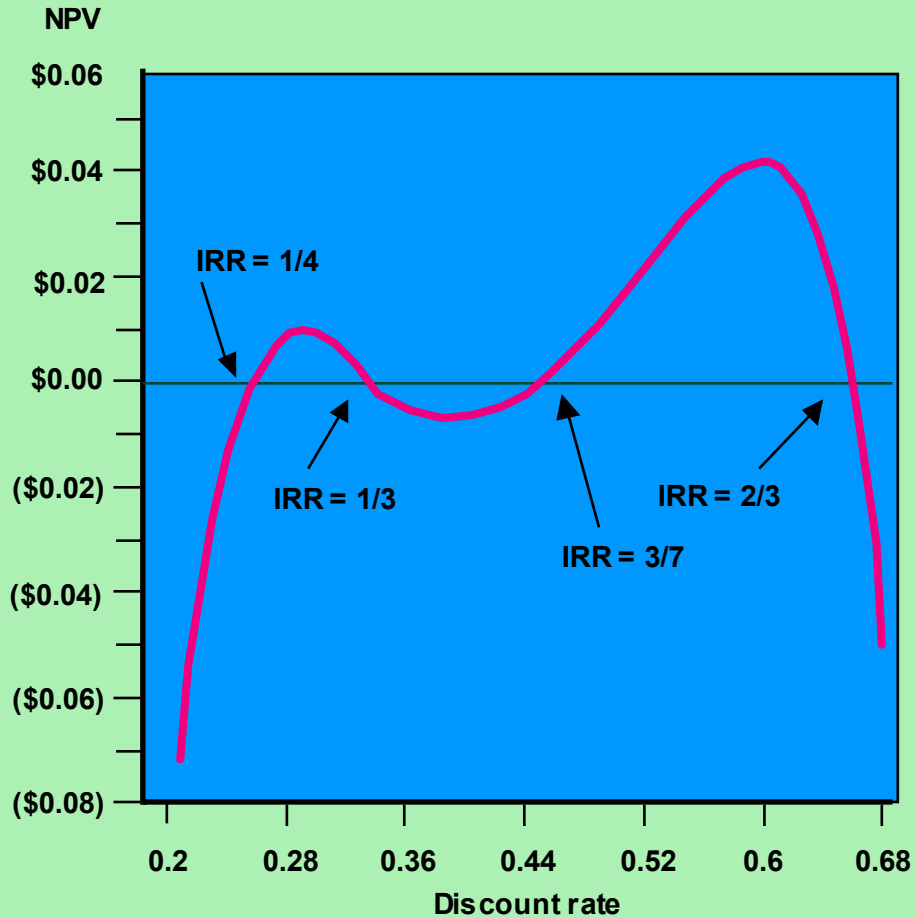
at 33.33%: NPV = 0

at 42.86%: NPV = 0

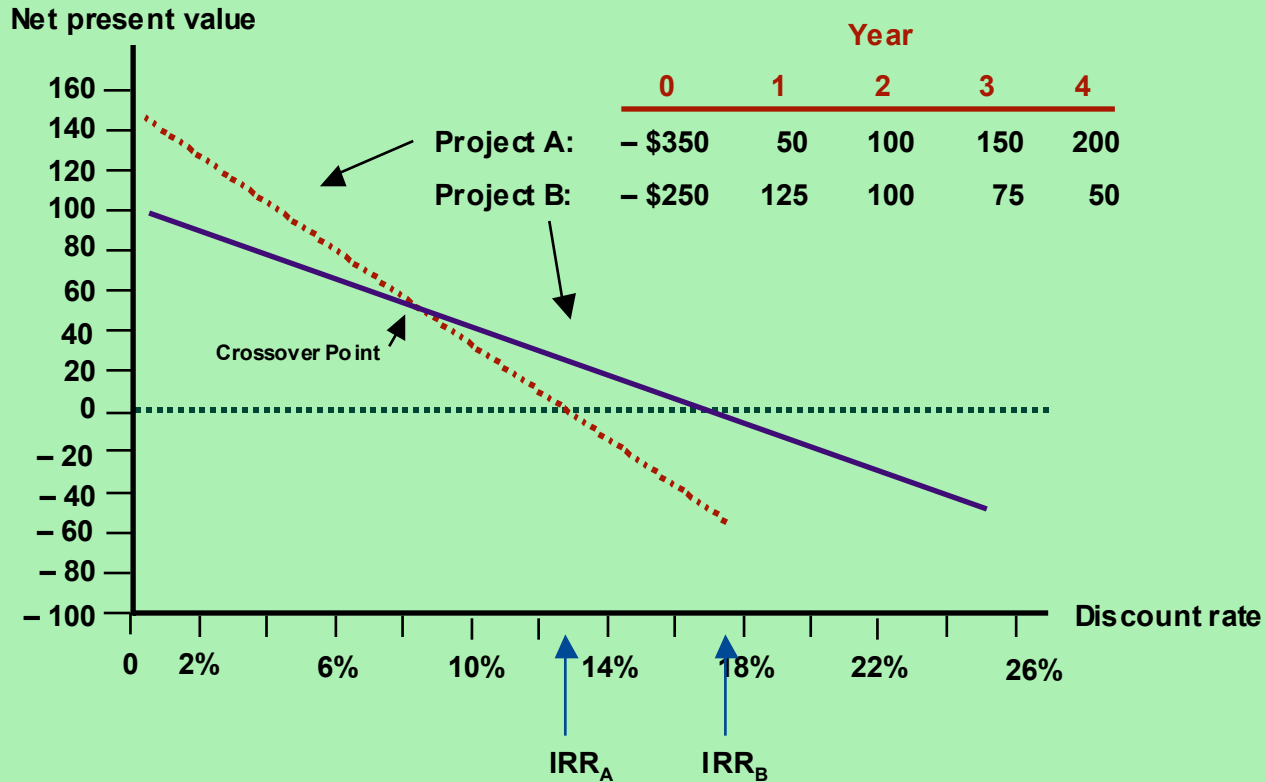
at 66.67%: NPV = 0

- Two questions:
 - ◆ 1. What's going on here?
 - ◆ 2. How many IRRs can there be?

T9.10 Multiple Rates of Return (concluded)



T9.11 IRR, NPV, and Mutually Exclusive Projects



T9.12 Profitability Index Illustrated

- Now let's go back to the initial example - we assumed the following information on Project X:

Initial outlay -\$1,100 Required return = 10%

Annual cash benefits:

<u>Year</u>	<u>Cash flows</u>
1	\$ 500
2	1,000

- What's the Profitability Index (PI)?

T9.12 Profitability Index Illustrated (concluded)

- Previously we found that the NPV of Project X is equal to:

$$(\$454.55 + 826.45) - 1,100 = \$1,281.00 - 1,100 = \$181.00.$$

- The PI = PV inflows/PV outlay = $\$1,281.00/1,100 = 1.1645$.
- This is a good project according to the PI rule. Can you explain why?

It's a good project because the present value of the inflows exceeds the outlay.

T9.13 Summary of Investment Criteria

■ I. Discounted cash flow criteria

A. *Net present value (NPV)*. The NPV of an investment is the difference between its market value and its cost. The **NPV rule** is to take a project if its NPV is positive. NPV has no serious flaws; it is the preferred decision criterion.

B. *Internal rate of return (IRR)*. The IRR is the discount rate that makes the estimated NPV of an investment equal to zero. The **IRR rule** is to take a project when its IRR exceeds the required return. When project cash flows are not conventional, there may be no IRR or there may be more than one.

C. *Profitability index (PI)*. The PI, also called the *benefit-cost ratio*, is the ratio of present value to cost. The **profitability index rule** is to take an investment if the index exceeds 1.0. The PI measures the present value per dollar invested.

T9.13 Summary of Investment Criteria (concluded)

■ II. Payback criteria

A. *Payback period*. The payback period is the length of time until the sum of an investment's cash flows equals its cost. The **payback period rule** is to take a project if its payback period is less than some prespecified cutoff.

B. *Discounted payback period*. The discounted payback period is the length of time until the sum of an investment's discounted cash flows equals its cost. The **discounted payback period rule** is to take an investment if the discounted payback is less than some prespecified cutoff.

■ III. Accounting criterion

A. *Average accounting return (AAR)*. The AAR is a measure of accounting profit relative to book value. The **AAR rule** is to take an investment if its AAR exceeds a benchmark.

T9.14 The Practice of Capital Budgeting

Table 9.5	NPV	IRR	Payback Period	Accounting ROR	Other
Replacement projects	34.6	46.6	48.9	13.5	12.9
Expansion - existing operations	41.4	61.6	50.0	16.5	7.5
Expansion - new operations	45.1	61.6	47.4	18.8	6.8
Foreign operations	29.3	41.4	30.8	9.0	8.3
Abandonment	29.3	19.6	15.0	11.3	21.8
General & Administrative	17.3	19.6	27.8	12.0	21.8
Social expenditures	10.5	8.3	6.8	5.3	40.6
Leases	42.9	36.1	14.3	7.5	13.5

T9.15 Chapter 9 Quick Quiz

1. Which of the capital budgeting techniques *do* account for both the time value of money and risk?
2. The change in firm value associated with investment in a project is measured by the project's _____ .
 - a. Payback period
 - b. Discounted payback period
 - c. Net present value
 - d. Internal rate of return
3. Why might one use several evaluation techniques to assess a given project?

T9.15 Chapter 9 Quick Quiz

1. Which of the capital budgeting techniques *do* account for both the time value of money and risk?

Discounted payback period, NPV, IRR, and PI

2. The change in firm value associated with investment in a project is measured by the project's *Net present value*.

3. Why might one use several evaluation techniques to assess a given project?

To measure different aspects of the project; e.g., the payback period measures liquidity, the NPV measures the change in firm value, and the IRR measures the rate of return on the initial outlay.

T9.16 Solution to Problem 9.3

- Offshore Drilling Products, Inc. imposes a payback cutoff of 3 years for its international investment projects. If the company has the following two projects available, should they accept either of them?

<u>Year</u>	<u>Cash Flows A</u>	<u>Cash Flows B</u>
0	-\$30,000	-\$45,000
1	15,000	5,000
2	10,000	10,000
3	10,000	20,000
4	5,000	250,000

T9.16 Solution to Problem 9.3 (concluded)

- Project A:

$$\begin{aligned}\text{Payback period} &= 1 + 1 + (\$30,000 - 25,000)/10,000 \\ &= 2.50 \text{ years}\end{aligned}$$

- Project B:

$$\begin{aligned}\text{Payback period} &= 1 + 1 + 1 + (\$45,000 - 35,000)/\$250,000 \\ &= 3.04 \text{ years}\end{aligned}$$

- Project A's payback period is 2.50 years and project B's payback period is 3.04 years. Since the maximum acceptable payback period is 3 years, the firm should accept project A and reject project B.

T9.17 Solution to Problem 9.7

- A firm evaluates all of its projects by applying the IRR rule. If the required return is 18 percent, should the firm accept the following project?

Year	Cash Flow
0	-\$30,000
1	25,000
2	0
3	15,000

T9.17 Solution of Problem 9.7 (concluded)

- To find the IRR, set the NPV equal to 0 and solve for the discount rate:

$$\text{NPV} = 0 = -\$30,000 + \$25,000/(1 + \text{IRR})^1 + \$0/(1 + \text{IRR})^2 + \$15,000/(1 + \text{IRR})^3$$

- At 18 percent, the computed NPV is _____.
- So the IRR must be (greater/less) than 18 percent. How did you know?

T9.17 Solution of Problem 9.7 (concluded)

- To find the IRR, set the NPV equal to 0 and solve for the discount rate:

$$\text{NPV} = 0 = -\$30,000 + \$25,000/(1 + \text{IRR})^1 + \$0/(1 + \text{IRR})^2 + \$15,000/(1 + \text{IRR})^3$$

- At 18 percent, the computed NPV is \$316.
- So the IRR must be greater than 18 percent. We know this because the computed NPV is positive.
- By trial-and-error, we find that the IRR is 18.78 percent.