Capital-Budgeting Techniques

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Capital Budgeting Concepts

❖ *Capital Budgeting involves evaluation of (and decision about) projects. Which projects should be accepted? Here, our goal is to accept a project which maximizes the shareholder wealth. Benefits are <u>worth</u> more than the cost.*

❖ *The Capital Budgeting is based on forecasting.*

❖ *Estimate future expected cash flows.*

❖ *Evaluate project based on the evaluation method.*

❖ *Classification of Projects*

  ❖ Mutually Exclusive - accept ONE project only
  ❖ Independent - accept ALL <u>profitable</u> projects.

Capital Budgeting Concepts

Cash Flows

❖ *Initial Cash Outlay - amount of capital spent to get project going.*

Capital Budgeting Concepts

Cash Flows

❖ *Initial Cash Outlay - amount of capital spent to get project going.*

❖ *If spend $10 million to build new plant then the Initial Outlay (IO) = $10 million*

$$CF_0 = \text{Cash Flow time } 0 = \text{-10 million}$$

Capital Budgeting Concepts

Cash Flows

❖ *Initial Cash Outlay - amount of capital spent to get project going.*

❖ *If spend $10 million to build new plant then the Initial Outlay (IO) = $10 million*

$$CF_0 = \text{Cash Flow time } 0 = -10 \text{ million}$$

❖*Annual Cash Inflows--after-tax CF*

　❖Cash inflows from the project

$$CF_n = \text{Sales - Costs}$$

We will determine these in Chapter 10

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

Capital Budgeting Methods

Payback Period

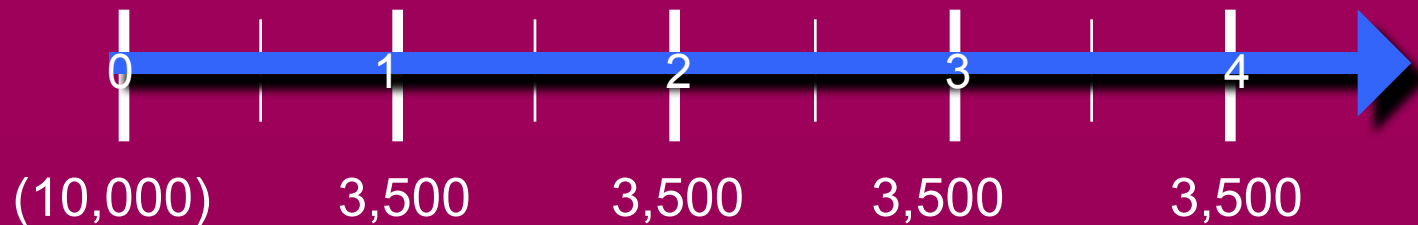❖ *Number of years needed to recover your initial outlay.*

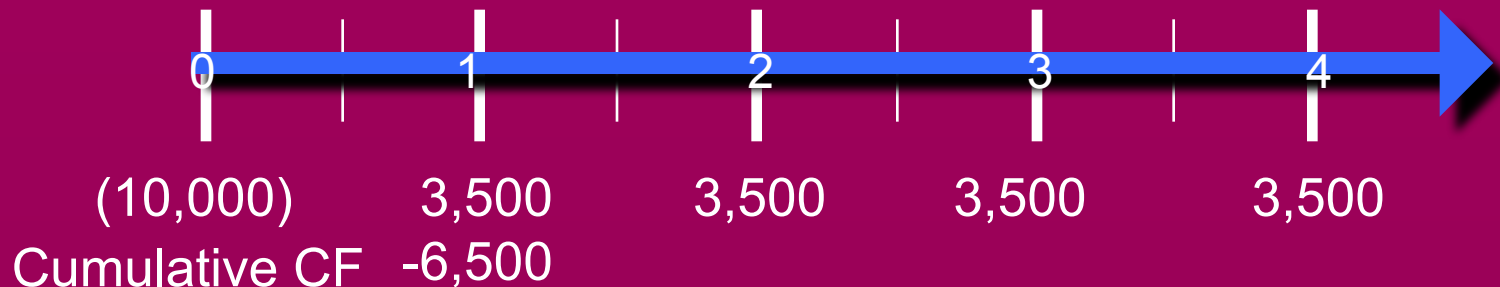|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

Time	PROJECT A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

```
0          1          2          3          4

(10,000)   3,500      3,500      3,500      3,500
```

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

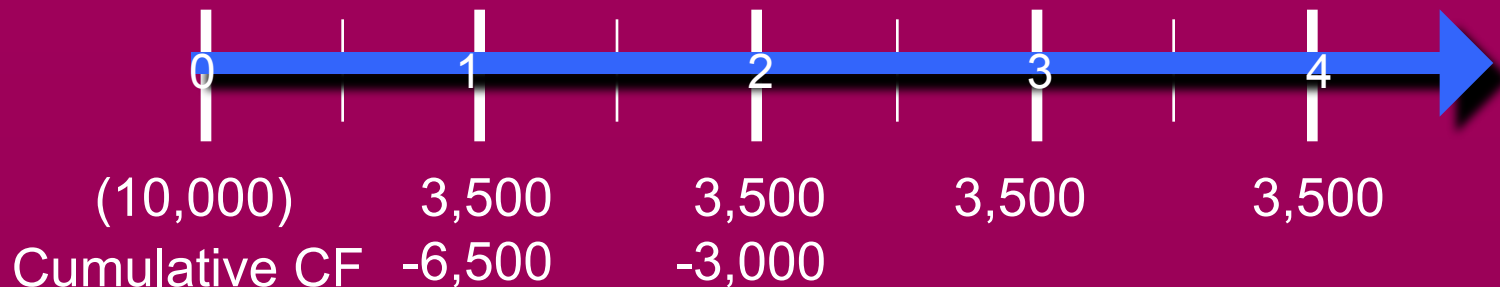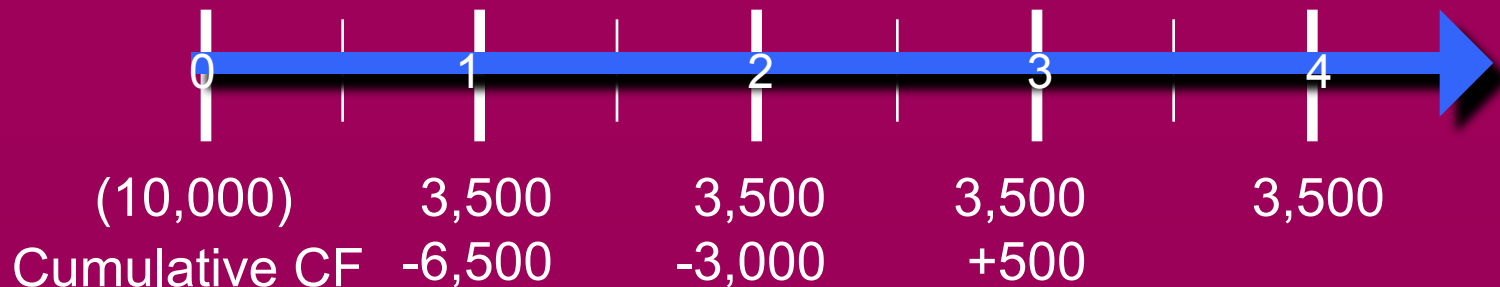|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

```
0 ─────── 1 ─────── 2 ─────── 3 ─────── 4 ──────►
```

0	1	2	3	4
(10,000)	3,500	3,500	3,500	3,500

Cumulative CF -6,500

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

```
0              1              2              3              4
(10,000)     3,500        3,500        3,500        3,500
Cumulative CF -6,500      -3,000
```

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

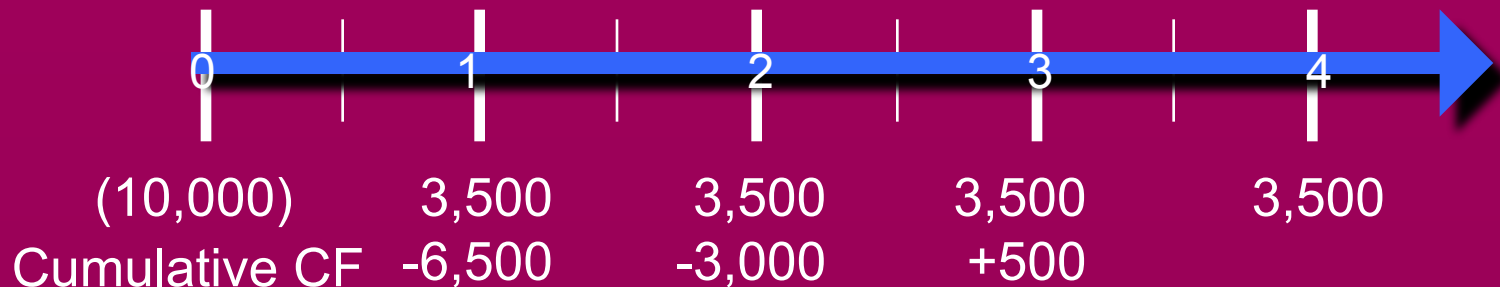|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0	1	2	3	4
(10,000)	3,500	3,500	3,500	3,500
Cumulative CF	-6,500	-3,000	+500	

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*
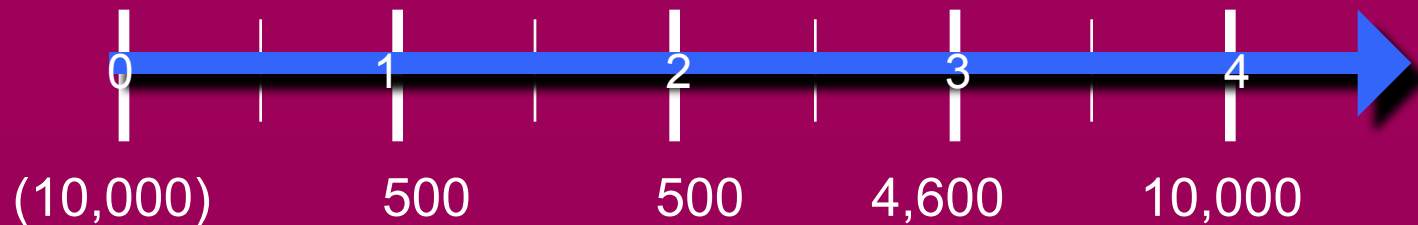
	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0	1	2	3	4
(10,000)	3,500	3,500	3,500	3,500
Cumulative CF	-6,500	-3,000	+500	

Payback 2.86 years

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

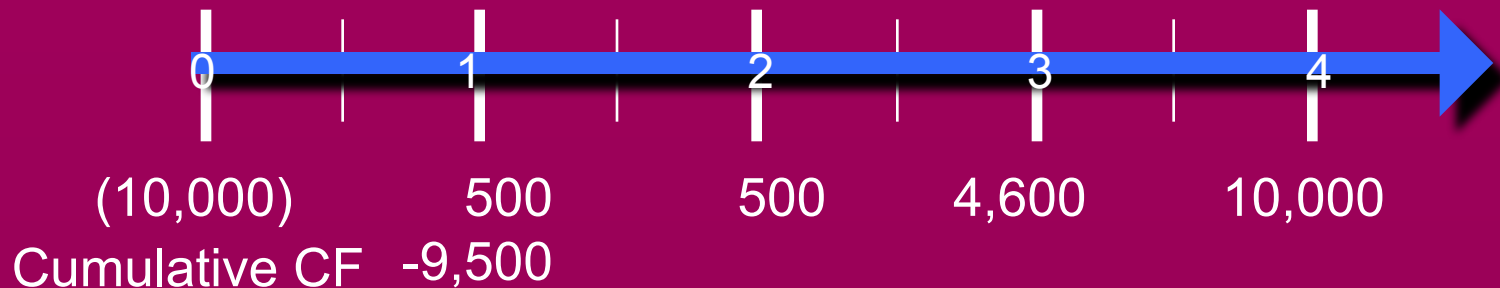|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

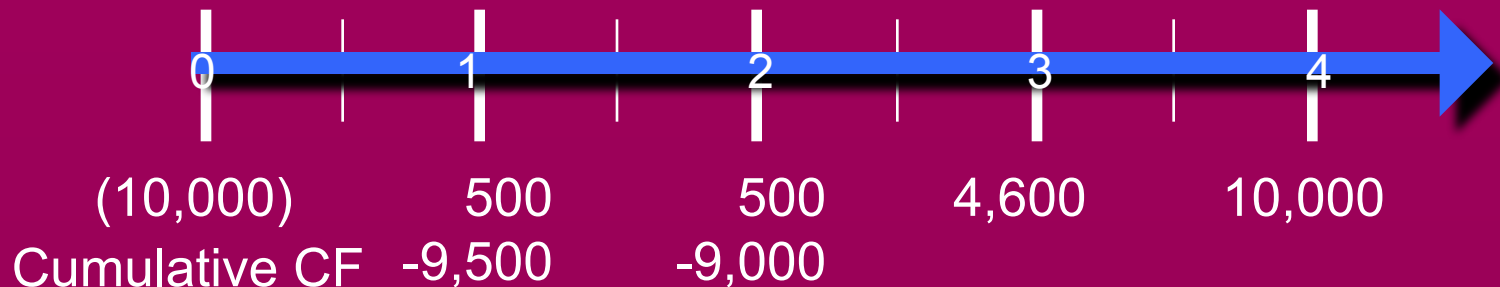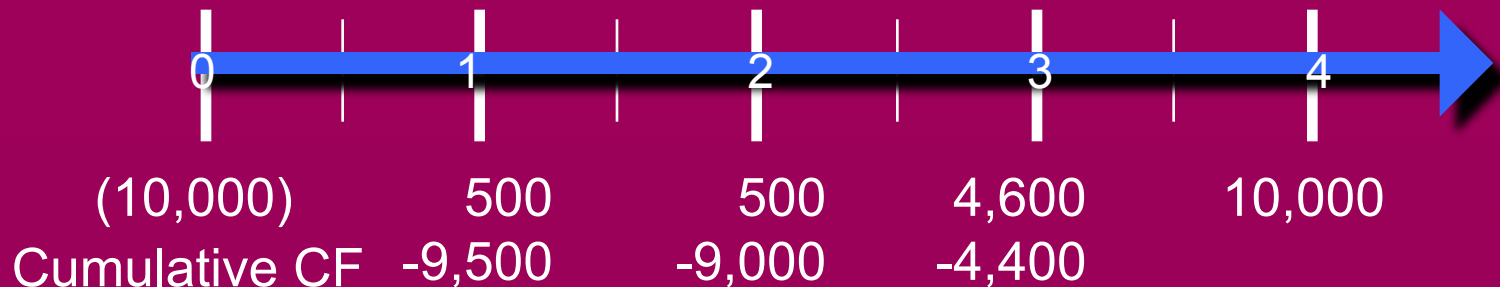|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0	1	2	3	4
(10,000)	500	500	4,600	10,000

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0   1   2   3   4

(10,000)   500   500   4,600   10,000

Cumulative CF   -9,500

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

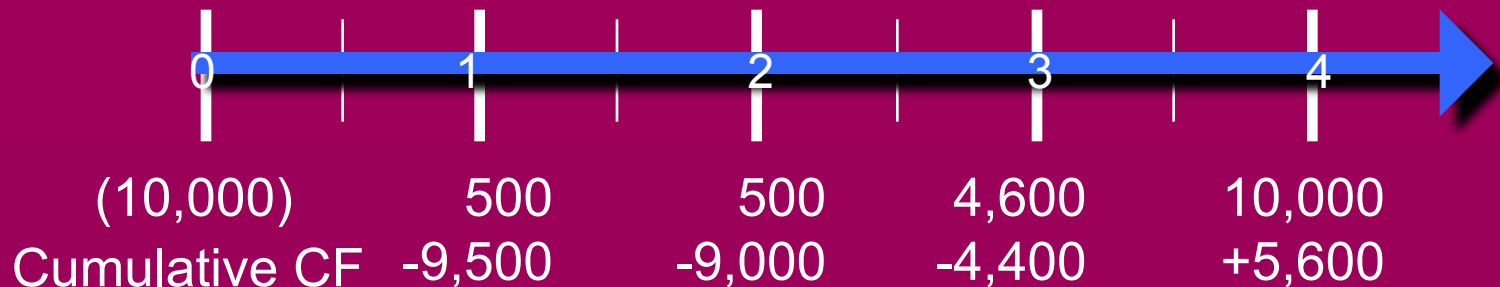|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0	1	2	3	4
(10,000)	500	500	4,600	10,000

Cumulative CF -9,500   -9,000

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

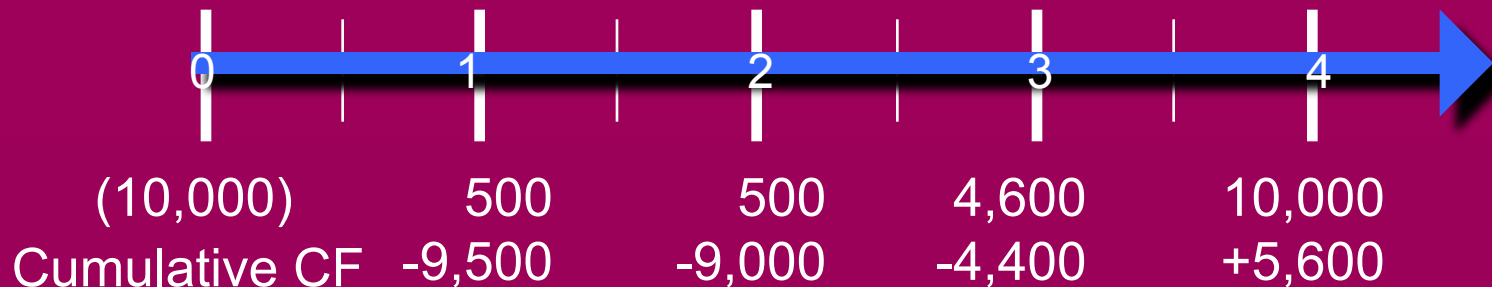|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

| 0 | 1 | 2 | 3 | 4 |

(10,000)	500	500	4,600	10,000
Cumulative CF	-9,500	-9,000	-4,400	

Capital Budgeting Methods

**Payback Period**

❖ *Number of years needed to recover your initial outlay.*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0	1	2	3	4
(10,000)	500	500	4,600	10,000
Cumulative CF	-9,500	-9,000	-4,400	+5,600

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

		P R O J E C T
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

0	1	2	3	4
(10,000)	500	500	4,600	10,000
Cumulative CF	-9,500	-9,000	-4,400	+5,600

Payback = 3.44 years

Capital Budgeting Methods

Payback Period

❖ *Number of years needed to recover your initial outlay.*

Time	PROJECT A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Evaluation:

Company sets maximum acceptable payback. If Max PB = 3 years, accept project A and reject project C

	0	1	2	3	4
	(10,000)	500	500	4,600	10,000
Cumulative CF		-9,500	-9,000	-4,400	+5,600
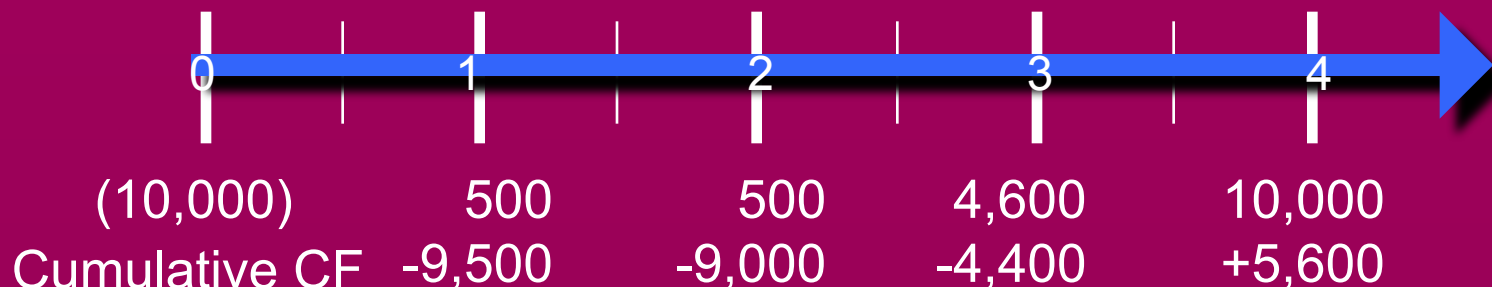
Payback 3.44 years

•Payback Method

The payback method is not a good method as it does not consider the time value of money.

Which project should you choose?

	CF0	CF1	CF2	CF3
A	-100,000	90,000	9,000	1,000
B	-100,000	1,000	9,000	90,000

•Payback Method

The Discounted payback method can correct this shortcoming of the payback method.

To find the discounted pay back

(1) Find the PV of each cash flow on the time line.

(2) Find the payback using the discounted CF and NOT the CF.

Example In Table 9-2

•Payback Method

Also, the payback method is not a good method as it does not consider the cash flows beyond the payback period.

Payback Method

Also, the payback method is not a good method as it does not consider the cash flows beyond the payback period.

Which project should you choose?

	CF0	CF1	CF2	Cf3	CF4
A	-100000	90000	10000	0	0
B	-100000	90000	9000	80000	1000000

Payback Method

Also, the payback method is not a good method as it does not consider the cash flows beyond the payback period.

Which project should you choose?

	CF0	CF1	CF2	Cf3	CF4
A	-100,000	90,000	10,000	0	0
B	-100,000	90,000	9,000	80,000	100,0000

These two shortcomings often result in an incorrect decisions.

Capital Budgeting Methods

Methods that consider time value of money and all cash flows

Net Present Value:
Present Value of all costs and benefits of a project.

Capital Budgeting Methods

Net Present Value

Present Value of all costs and benefits of a project.

Concept is similar to Intrinsic Value of a security but subtracts cost of the project.

NPV = PV of Inflows - Initial Outlay

Capital Budgeting Methods

Net Present Value

❖ *Present Value of all costs and benefits of a project.*

❖ *Concept is similar to Intrinsic Value of a security but subtracts of cost of project.*

NPV = PV of Inflows - Initial Outlay

$$NPV = \frac{CF_1}{(1+k)} + \frac{CF_2}{(1+k)^2} + \frac{CF_3}{(1+k)^3} + \cdots + \frac{CF_n}{(1+k)^n} - IO$$

Capital Budgeting Methods

Net Present Value

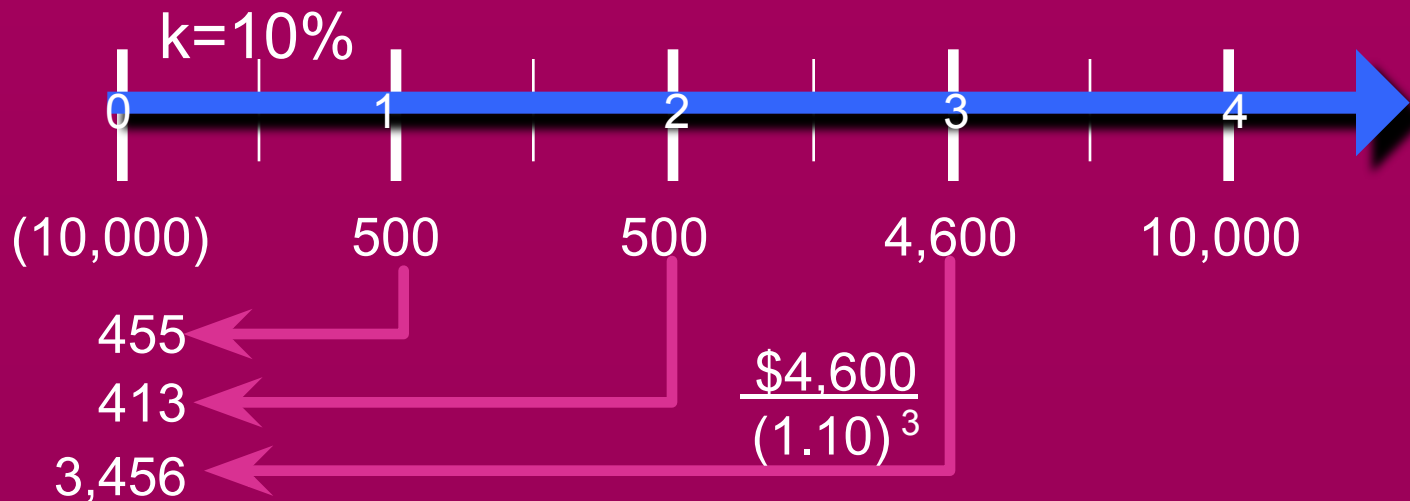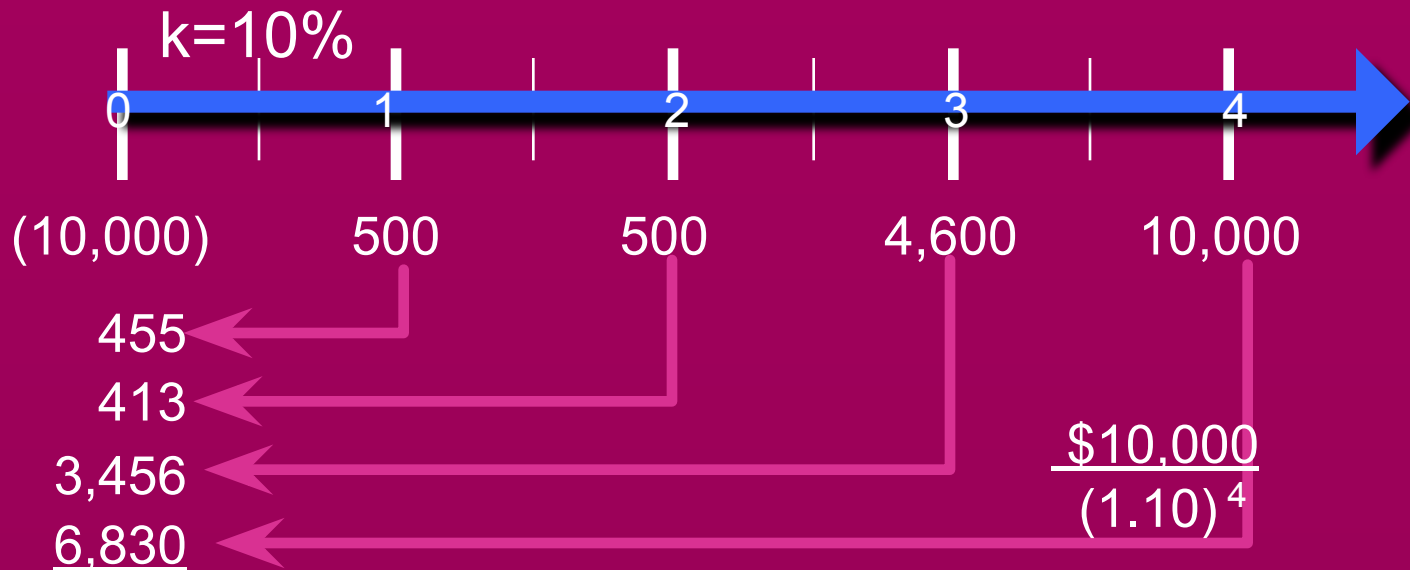|	P R O	J E C T
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

```
0          1          2          3          4
```

(10,000)   500   500   4,600   10,000

Capital Budgeting Methods

Net Present Value

Time	A	B		P R O J E C T
0	(10,000.)	(10,000.)		
1	3,500	500		
2	3,500	500		
3	3,500	4,600		
4	3,500	10,000		

k=10%

0   1   2   3   4

(10,000)   500   500   4,600   10,000

$$455 \leftarrow \frac{\$500}{(1.10)}$$

Capital Budgeting Methods

Net Present Value

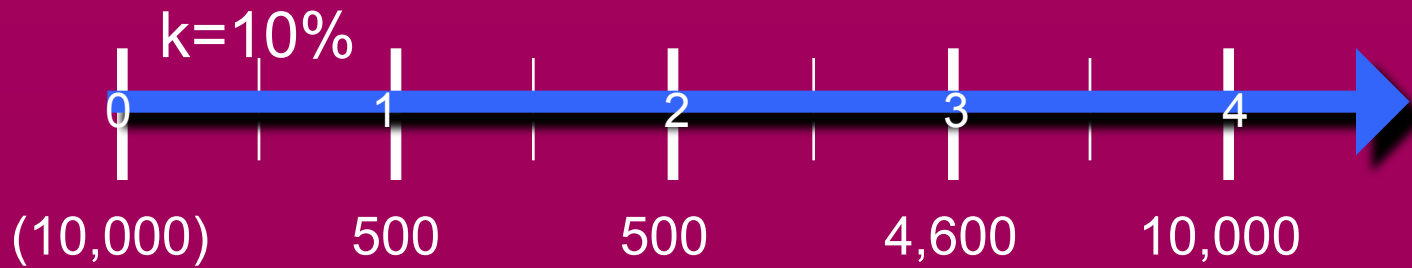|		P R O J E C T
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0	1	2	3	4
(10,000)	500	500	4,600	10,000

455

413

$$\frac{\$500}{(1.10)^2}$$

Capital Budgeting Methods

Net Present Value

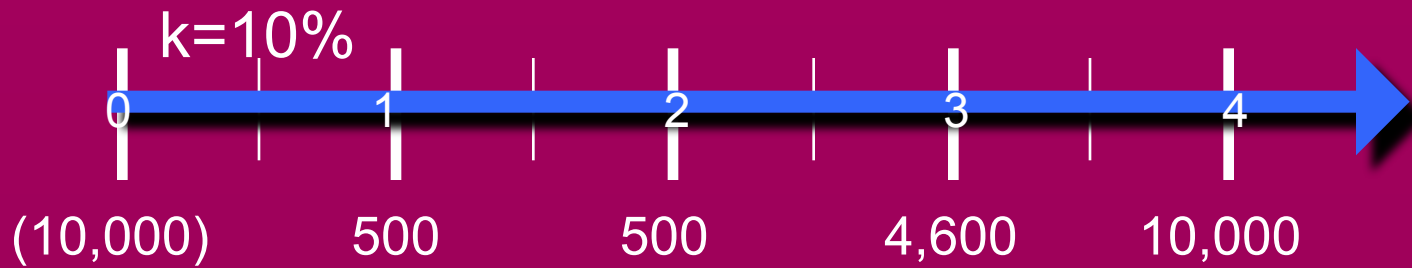| | | P R O J E C T | |
|---|---|---|
| Time | A | B |
| 0 | (10,000.) | (10,000.) |
| 1 | 3,500 | 500 |
| 2 | 3,500 | 500 |
| 3 | 3,500 | 4,600 |
| 4 | 3,500 | 10,000 |

k=10%

0	1	2	3	4
(10,000)	500	500	4,600	10,000

455

413

3,456

$$\frac{\$4,600}{(1.10)^3}$$

Capital Budgeting Methods

Net Present Value

Time	P R O J E C T	
	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0   1   2   3   4

(10,000)   500   500   4,600   10,000

455

413

3,456

6,830

$$\frac{\$10,000}{(1.10)^4}$$

Capital Budgeting Methods

Net Present Value

Time	A	B
P R O J E C T		
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0   1   2   3   4

(10,000)   500   500   4,600   10,000

455
413
3,456
6,830
$11,154

Capital Budgeting Methods

Net Present Value

P R O J E C T

Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0   1   2   3   4

(10,000)   500   500   4,600   10,000

455
413
3,456
6,830
$11,154

PV Benefits > PV Costs
$11,154 > $ 10,000

Capital Budgeting Methods

Net Present Value
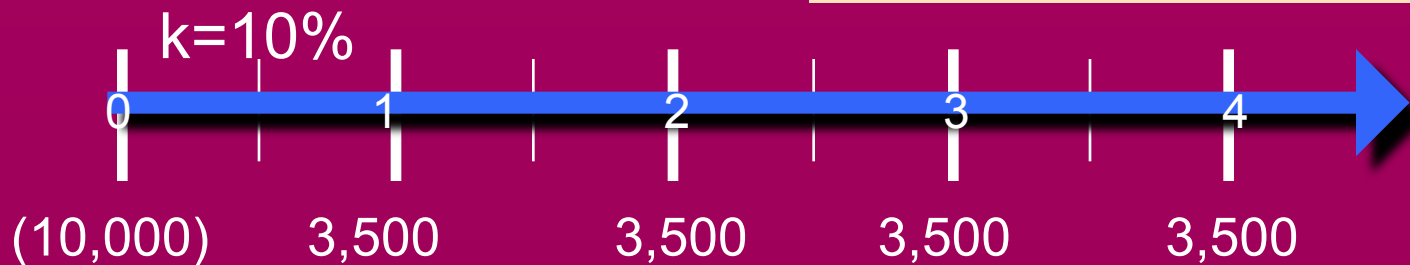
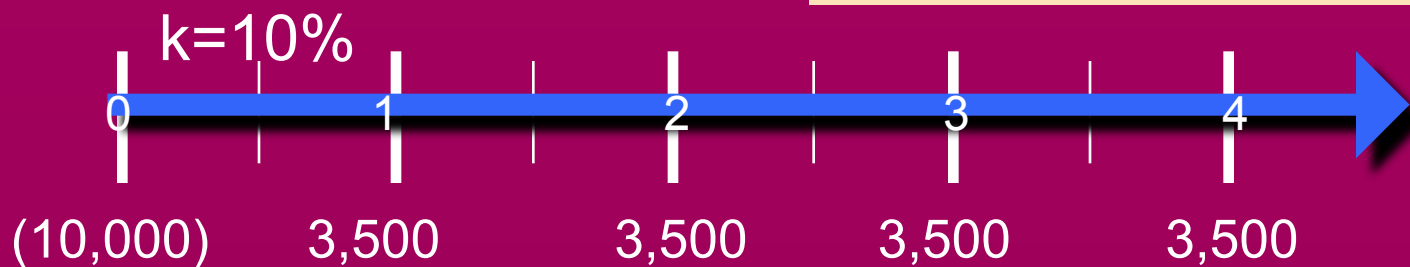|	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0	1	2	3	4
(10,000)	500	500	4,600	10,000
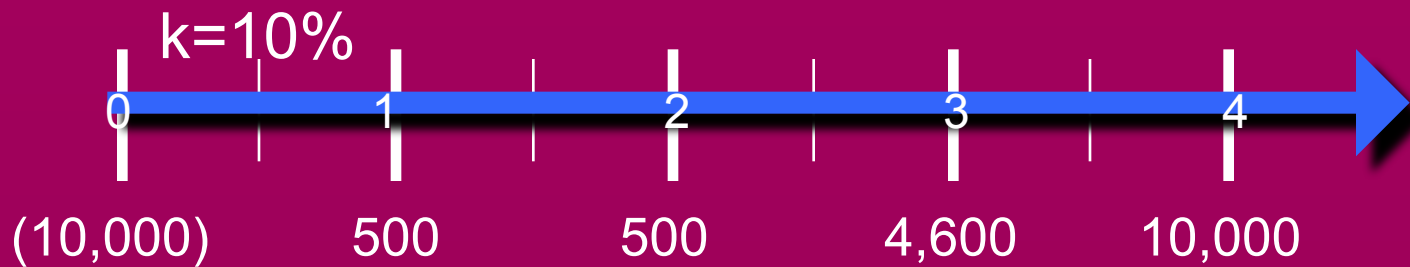
455
413
3,456
6,830
$11,154
$1,154 = NPV

PV Benefits > PV Costs
$11,154 > $ 10,000

→
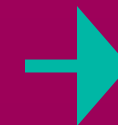
NPV > $0
$1,154 > $0

Capital Budgeting Methods

Net Present Value

| Time	A	B
	P R O J E C T	
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0   1   2   3   4

(10,000)   3,500   3,500   3,500   3,500

Capital Budgeting Methods

Net Present Value

Time	A	B	P R O J E C T
0	(10,000.)	(10,000.)	
1	3,500	500	
2	3,500	500	
3	3,500	4,600	
4	3,500	10,000	

k=10%

0   1   2   3   4

(10,000)   3,500   3,500   3,500   3,500
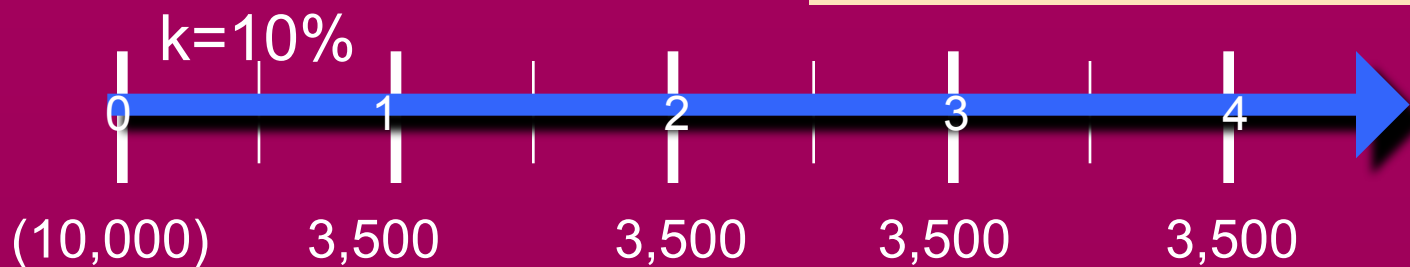
$$NPV = \frac{3{,}500}{(1+.1)} + \frac{3{,}500}{(1+.1)^2} + \frac{3{,}500}{(1+.1)^3} + \frac{3{,}500}{(1+.1)^4} - 10{,}000$$

Capital Budgeting Methods

Net Present Value

Time	P R O J E C T	
	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0   1   2   3   4

(10,000)   3,500   3,500   3,500   3,500

$$\text{NPV} = \frac{3,500}{(1+.1)} + \frac{3,500}{(1+.1)^2} + \frac{3,500}{(1+.1)^3} + \frac{3,500}{(1+.1)^4} - 10,000$$

PV of 3,500 Annuity for 4 years at 10%

Capital Budgeting Methods

Net Present Value

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

k=10%

0   1   2   3   4
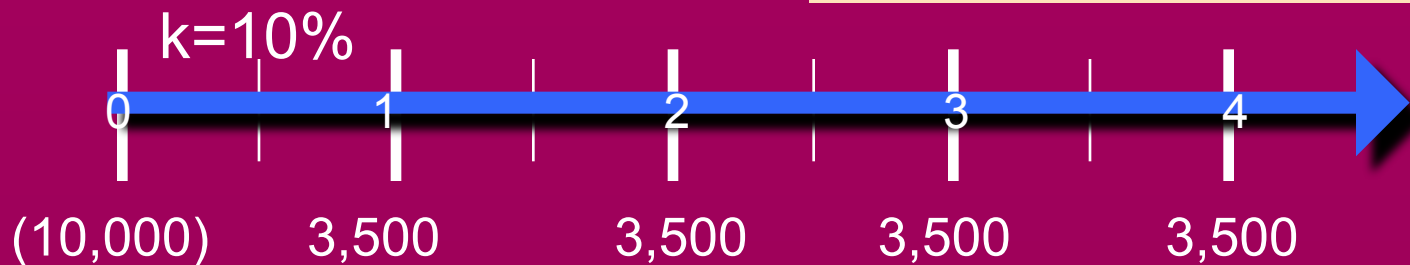
(10,000)   3,500   3,500   3,500   3,500

$$NPV = \frac{3{,}500}{(1+.1)} + \frac{3{,}500}{(1+.1)^2} + \frac{3{,}500}{(1+.1)^3} + \frac{3{,}500}{(1+.1)^4} - 10{,}000$$

$$= 3{,}500 \times PVIFA_{4,.10} - 10{,}000$$

$$= 11{,}095 - 10{,}000 = \$1{,}095$$

Capital Budgeting Methods

NPV Decision Rules

❖ *If projects are independent then accept all projects with NPV ≥ 0.*

ACCEPT A & B

Capital Budgeting Methods

NPV Decision Rules

❖ *If projects are independent then accept all projects with NPV ≥ 0.*   ACCEPT A & B

❖ *If projects are mutually exclusive, accept projects with higher NPV.*   ACCEPT B only

Net Present Value Profile

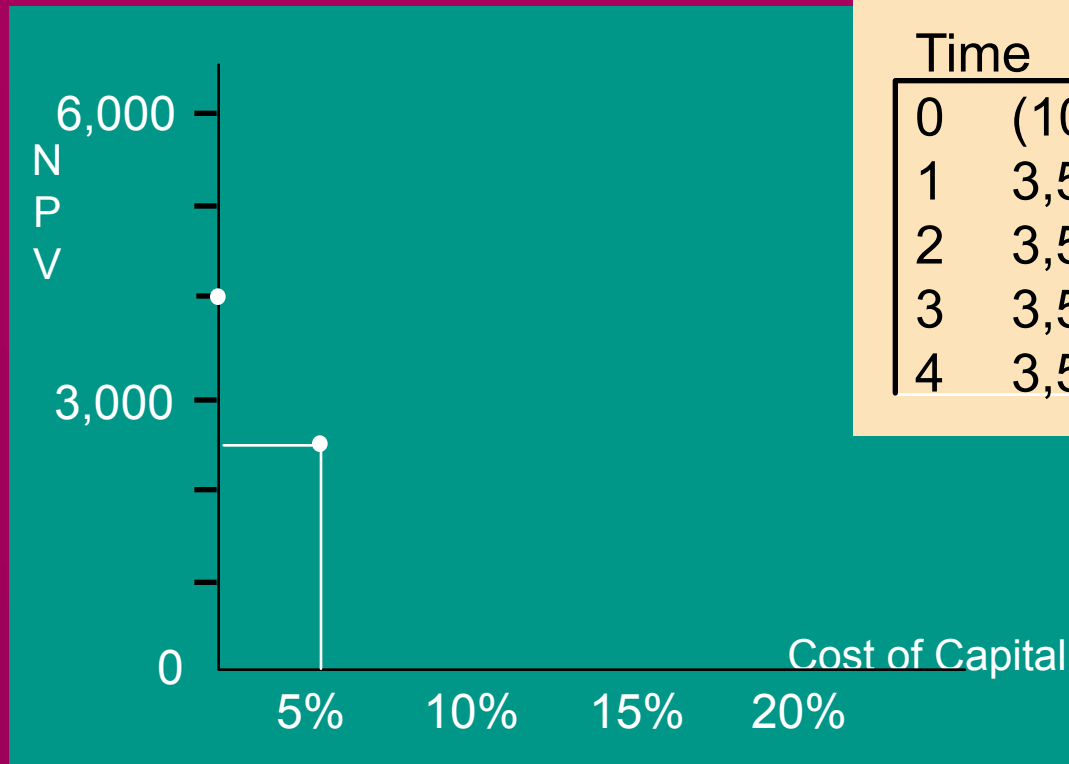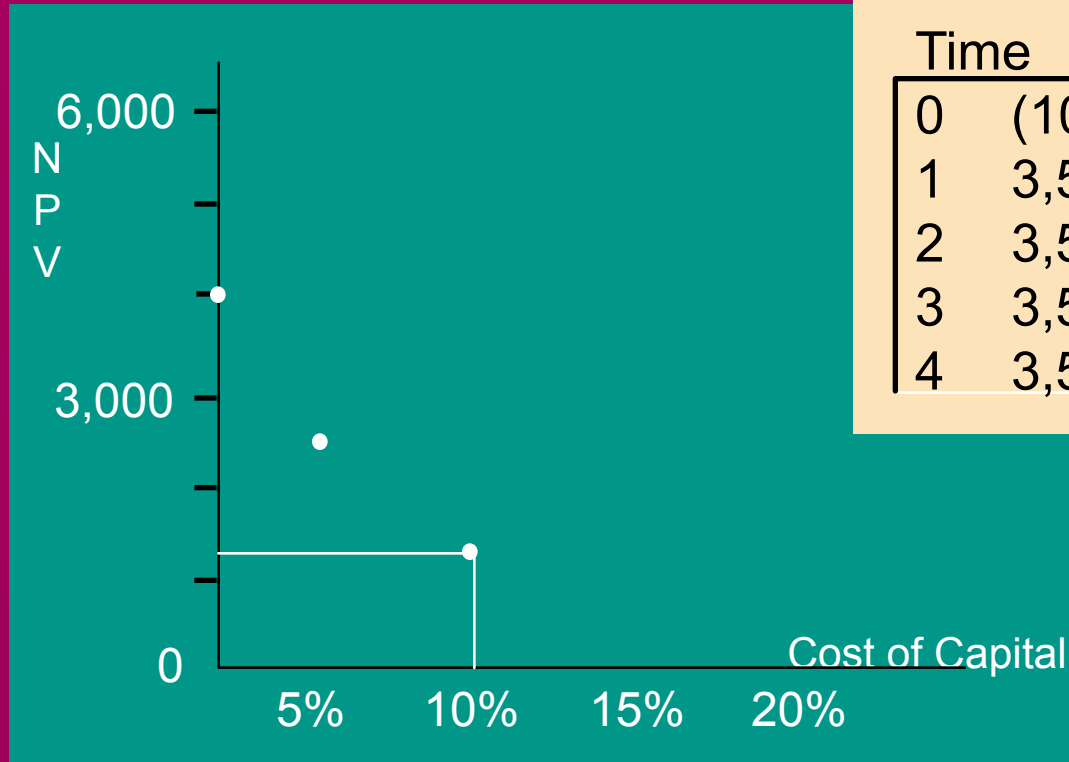❖ *Graphs the Net Present Value of the project with different required rates*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

(NPV chart: y-axis labeled N P V with values 0, 3,000, 6,000; x-axis labeled Cost of Capital with values 5%, 10%, 15%, 20%)
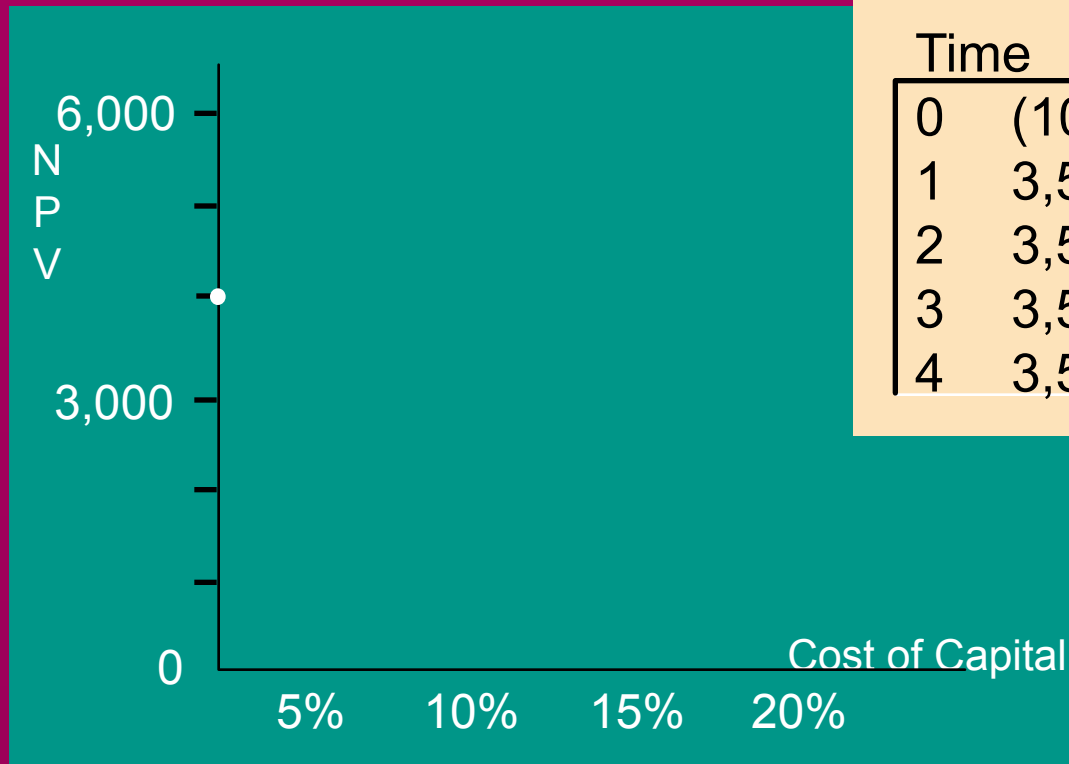
$$\text{NPV(0\%)} = \frac{3,500}{(1+0)} + \frac{3,500}{(1+0)^2} + \frac{3,500}{(1+0)^3} + \frac{3,500}{(1+0)^4} - 10,000$$

$$= \$4,000$$

Net Present Value Profile

❖ *Graphs the Net Present Value of the project with different required rates*

Time	P R O J E C T A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

N P V

6,000

3,000

0

5%   10%   15%   20%

Cost of Capital

$$NPV(5\%) = \frac{3,500}{(1+.05)} + \frac{3,500}{(1+.05)^2} + \frac{3,500}{(1+.05)^3} + \frac{3,500}{(1+.05)^4} - 10,000$$

$$= \$2,411$$

Net Present Value Profile

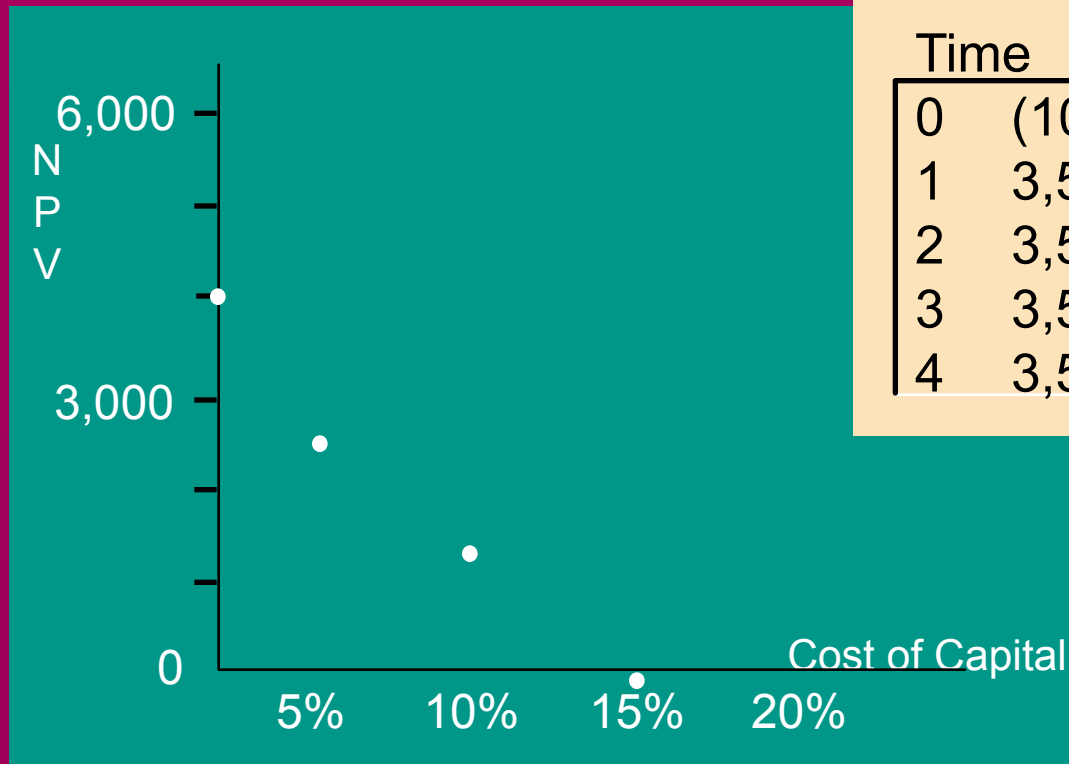❖ *Graphs the Net Present Value of the project with different required rates*

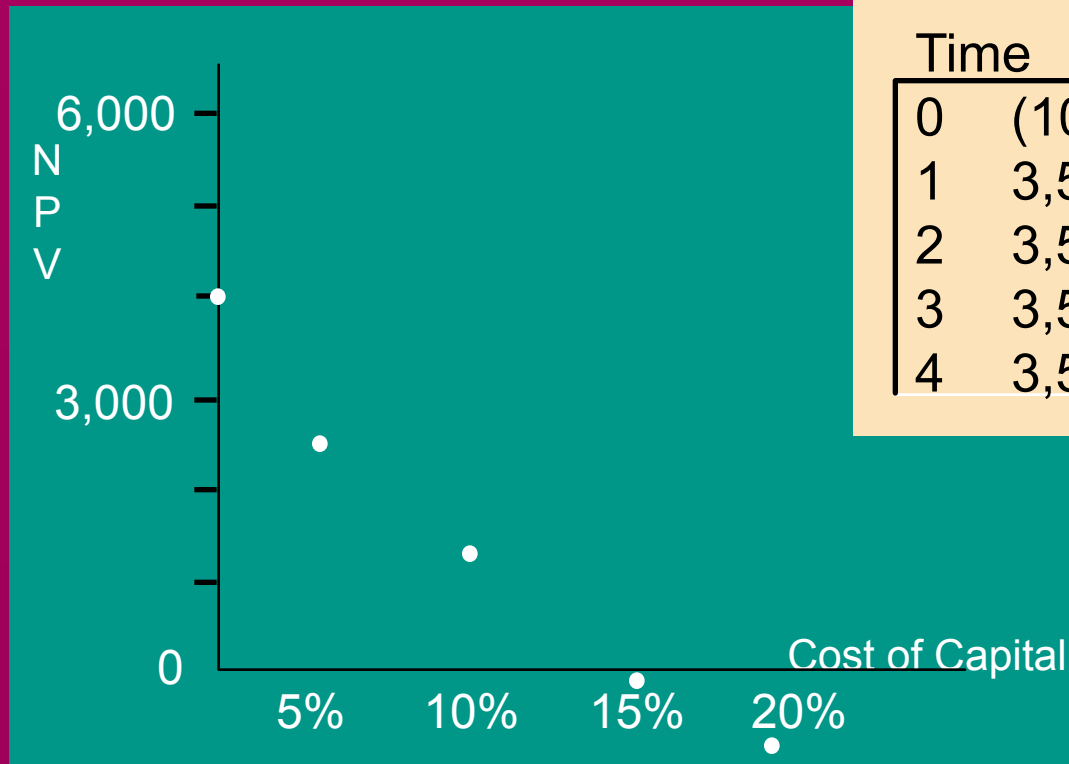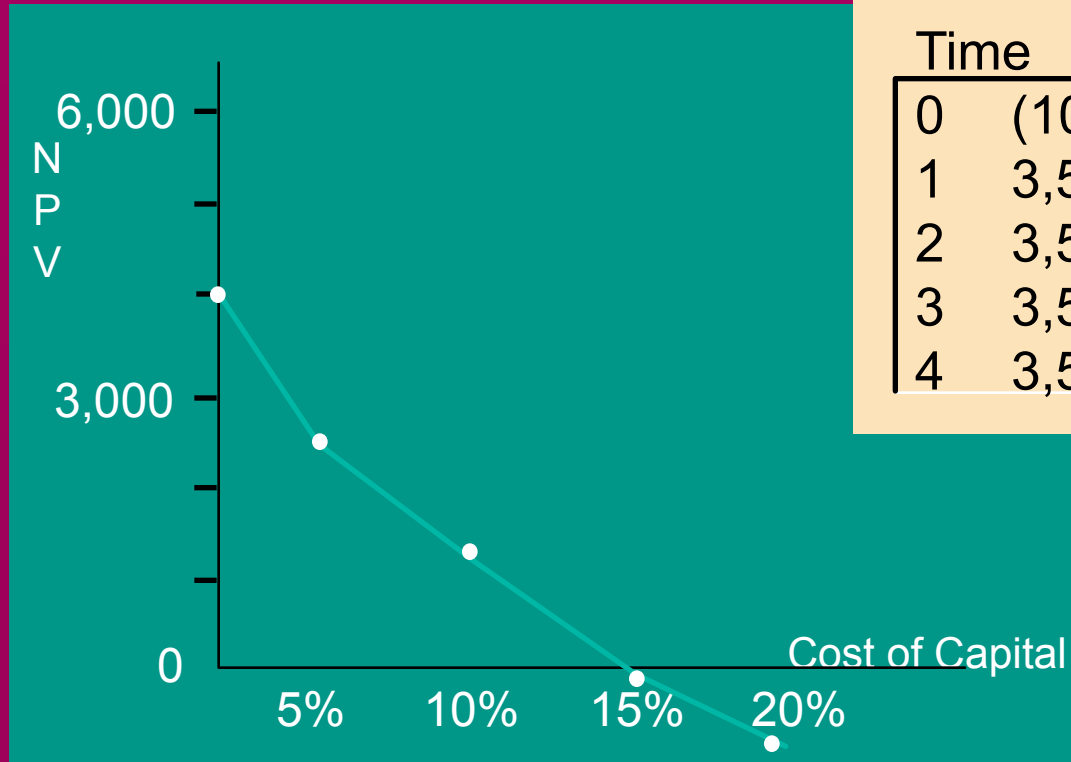| Time	P R O J E C T	
	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

N
P
V

6,000

3,000

0

5% 10% 15% 20%

Cost of Capital

$$\text{NPV(10\%)} = \frac{3{,}500}{(1+.10)} + \frac{3{,}500}{(1+.10)^2} + \frac{3{,}500}{(1+.10)^3} + \frac{3{,}500}{(1+.10)^4} - 10{,}000$$

$$= \$1{,}095$$

Net Present Value Profile

❖ *Graphs the Net Present Value of the project with different required rates*

Time	A	B
	P R O J E C T	
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

NPV
6,000 –
3,000
0

5% 10% 15% 20%

Cost of Capital

$$NPV(15\%) = \frac{3,500}{(1+.15)} + \frac{3,500}{(1+.15)^2} + \frac{3,500}{(1+.15)^3} + \frac{3,500}{(1+.15)^4} - 10,000$$

$$= -\$7.58$$

Net Present Value Profile

❖ *Graphs the Net Present Value of the project with different required rates*

Time	PROJECT A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

N P V

6,000

3,000

0

5%   10%   15%   20%

Cost of Capital

$$\text{NPV(20\%)} = \frac{3,500}{(1+.20)} + \frac{3,500}{(1+.20)^2} + \frac{3,500}{(1+.20)^3} + \frac{3,500}{(1+.20)^4} - 10,000$$

$$= -\$939$$

Net Present Value Profile

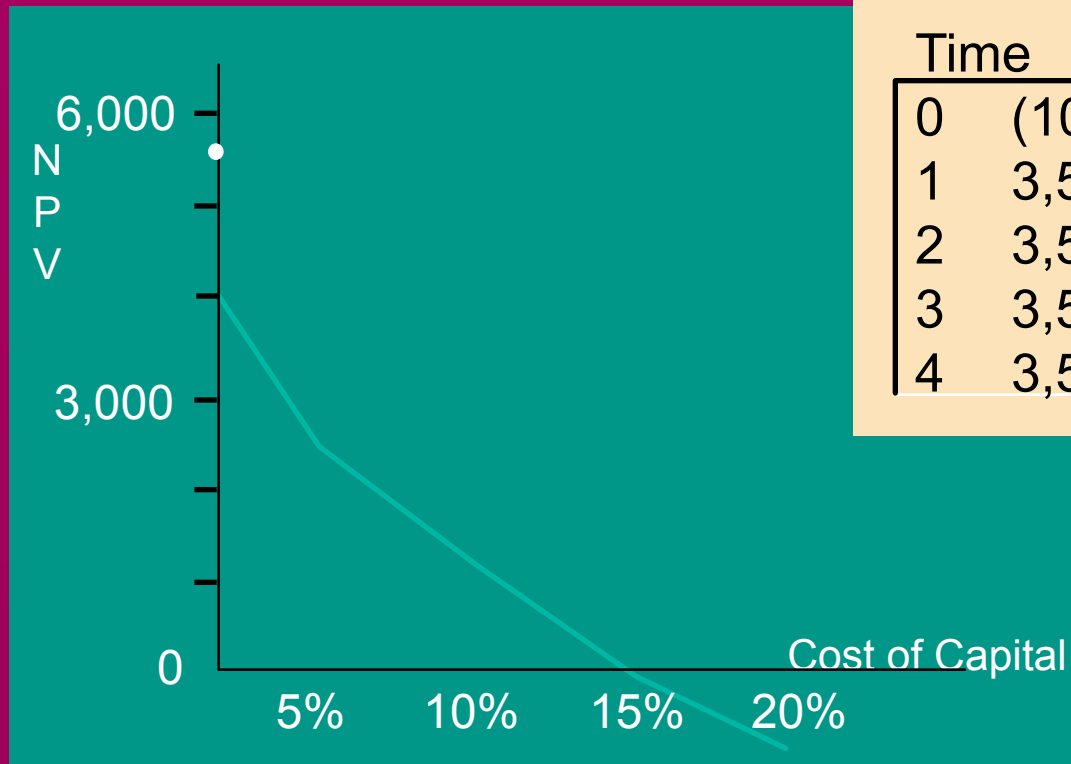❖ *Graphs the Net Present Value of the project with different required rates*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

NPV graph with axis labels 6,000 / 3,000 / 0 and Cost of Capital at 5%, 10%, 15%, 20%

Connect the Points

Net Present Value Profile

❖ *Graphs the Net Present Value of the project with different required rates*

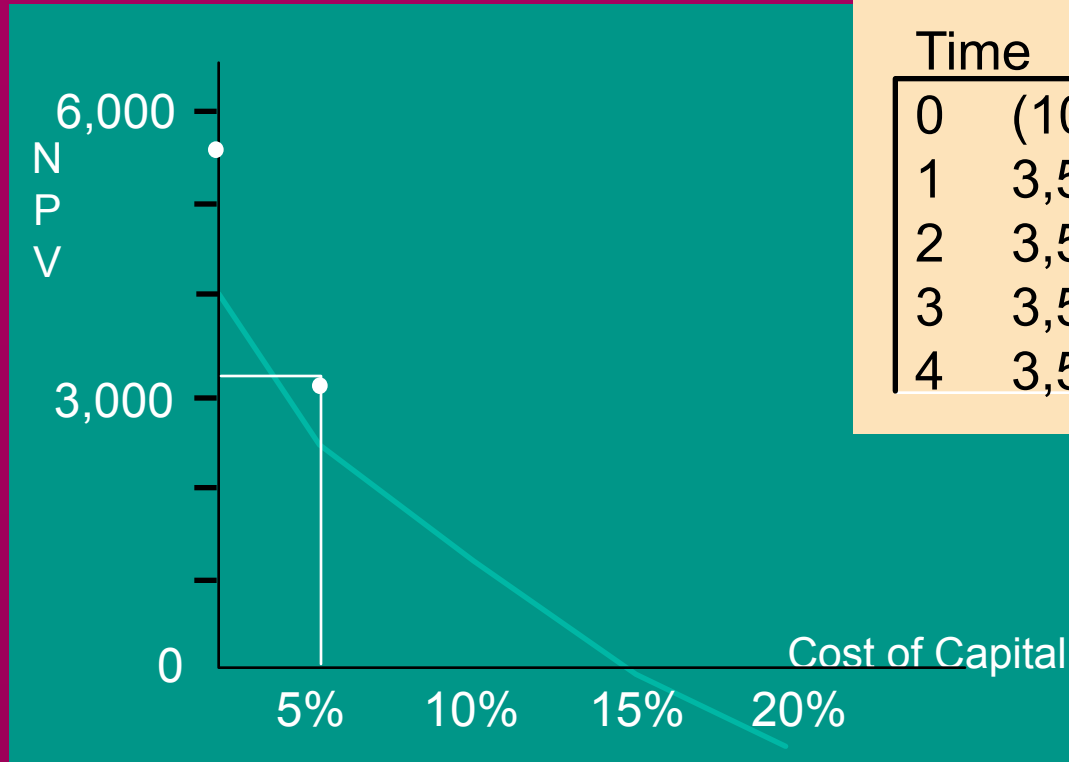|			P R O J E C T
Time	A	B	
0	(10,000.)	(10,000.)	
1	3,500	500	
2	3,500	500	
3	3,500	4,600	
4	3,500	10,000	

NPV
6,000 –
3,000 –
0
5%   10%   15%   20%
Cost of Capital

$$NPV(0\%) = \frac{500}{(1+0)} + \frac{500}{(1+0)^2} + \frac{4,600}{(1+0)^3} + \frac{10,000}{(1+0)^4} - 10,000$$

$$= \$5,600$$

Net Present Value Profile

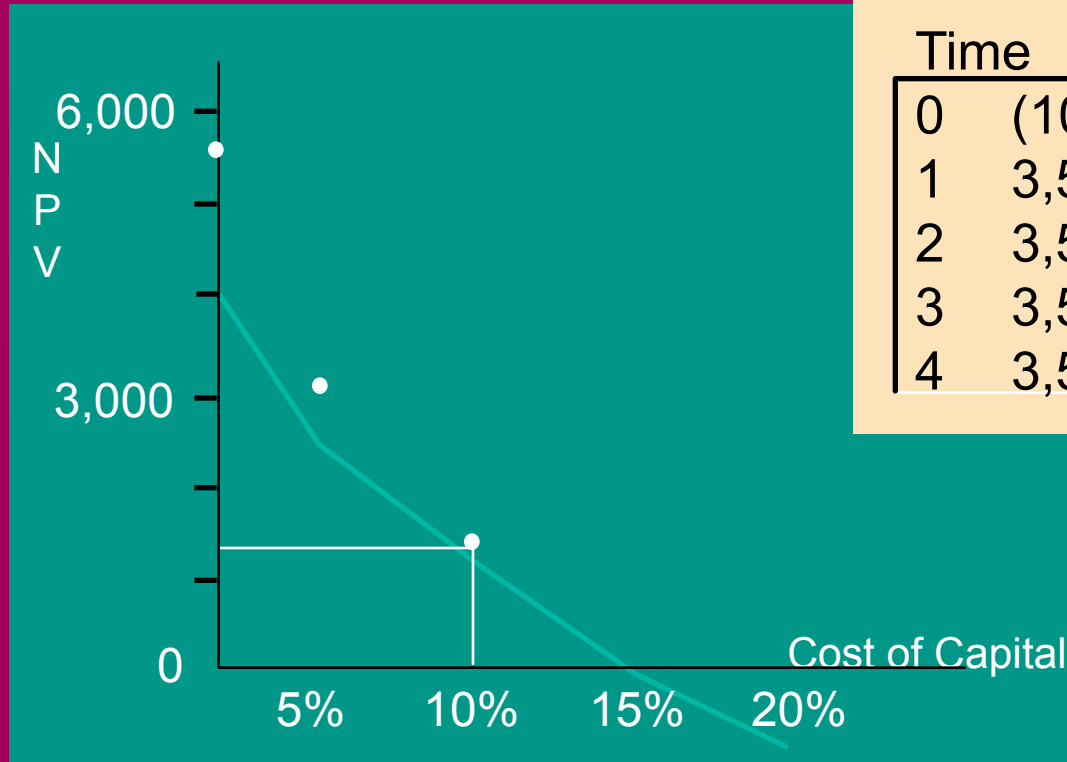❖ *Graphs the Net Present Value of the project with different required rates*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

$$NPV(5\%) = \frac{500}{(1+.05)} + \frac{500}{(1+.05)^2} + \frac{4,600}{(1+.05)^3} + \frac{10,000}{(1+.05)^4} - 10,000$$

$$= \$3,130$$

Net Present Value Profile

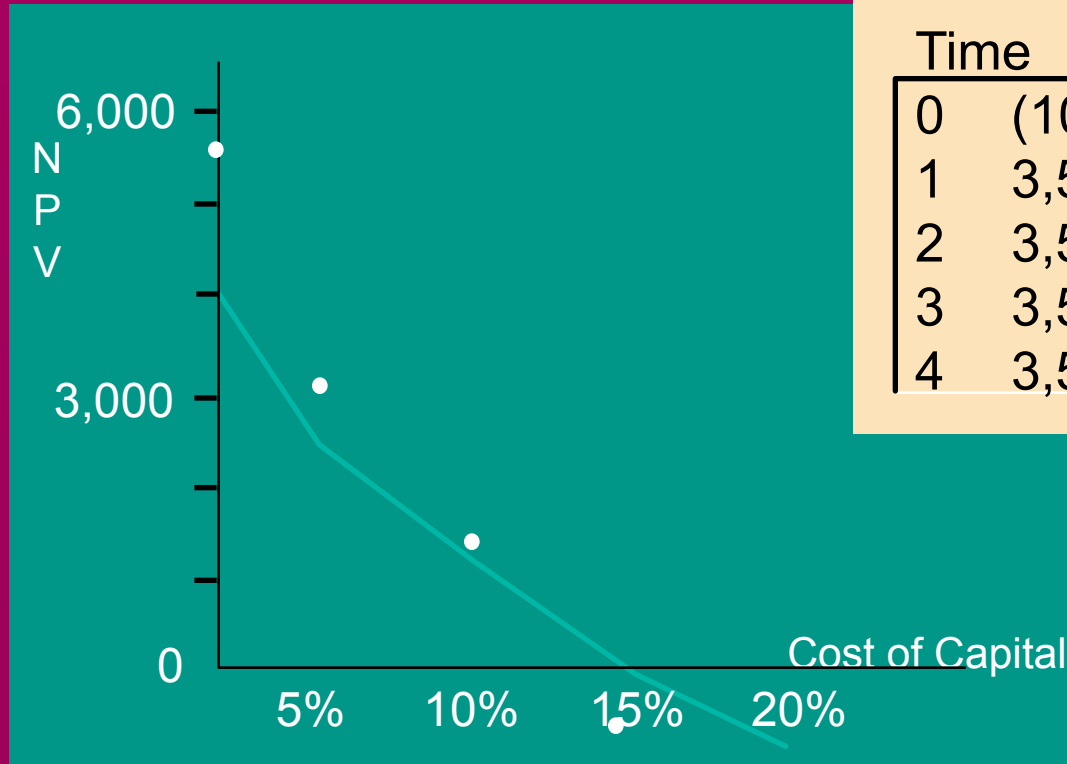❖ *Graphs the Net Present Value of the project with different required rates*

Time	PROJECT A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

NPV axis labels: 6,000; 3,000; 0

X-axis (Cost of Capital): 5%, 10%, 15%, 20%

$$NPV(10\%) = \frac{500}{(1+.10)} + \frac{500}{(1+.10)^2} + \frac{4,600}{(1+.10)^3} + \frac{10,000}{(1+.10)^4} - 10,000$$

$$= \$1.154$$

Net Present Value Profile

❖ *Graphs the Net Present Value of the project with different required rates*

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

N
P
V

6,000

3,000

0

5%   10%   15%   20%

Cost of Capital

$$NPV(15\%) = \frac{500}{(1+.15)} + \frac{500}{(1+.15)^2} + \frac{4,600}{(1+.15)^3} + \frac{10,000}{(1+.15)^4} - 10,000$$

$$= -\$445$$

Net Present Value Profile

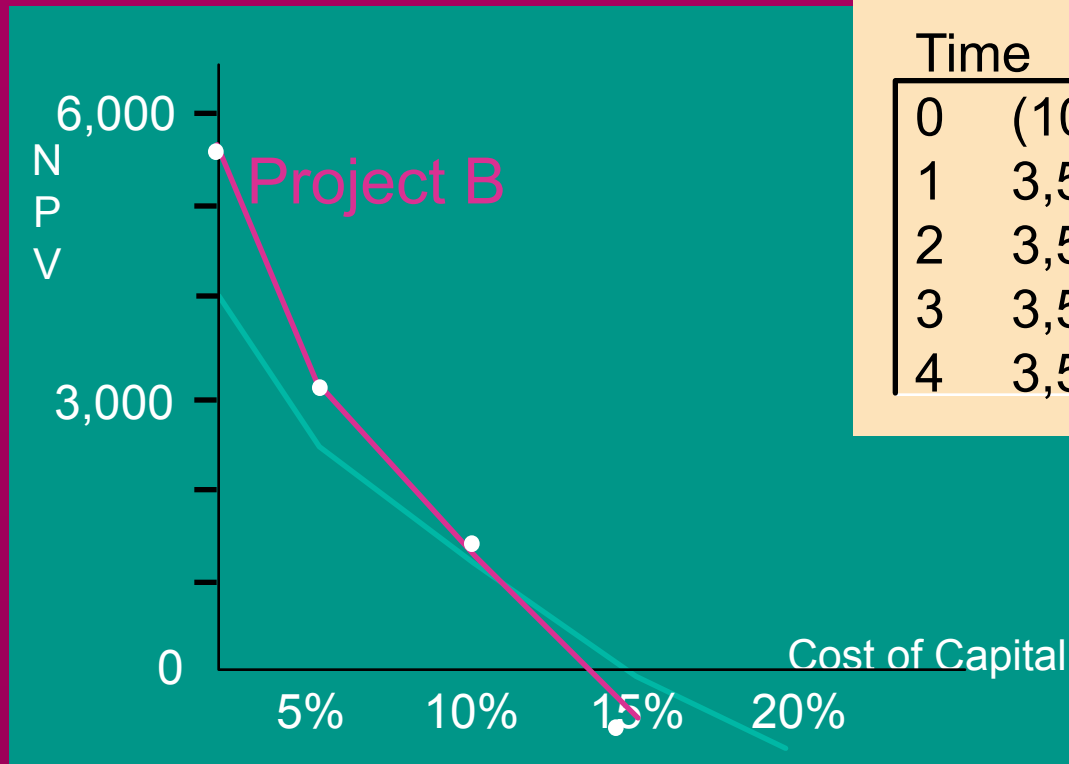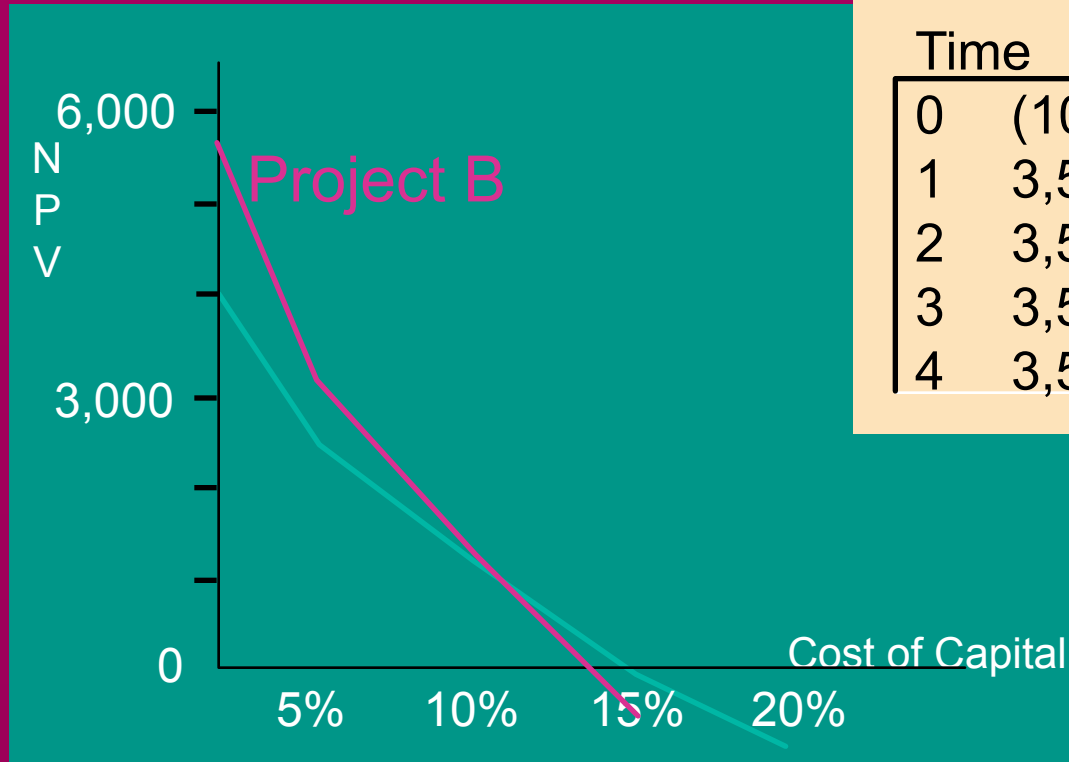❖ *Graphs the Net Present Value of the project with different required rates*

Time	P R O J E C T	
	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Project B

NPV

6,000

3,000

0

5%   10%   15%   20%

Cost of Capital

Connect the Points

Net Present Value Profile

❖ *Graphs the Net Present Value of the project with different required rates*

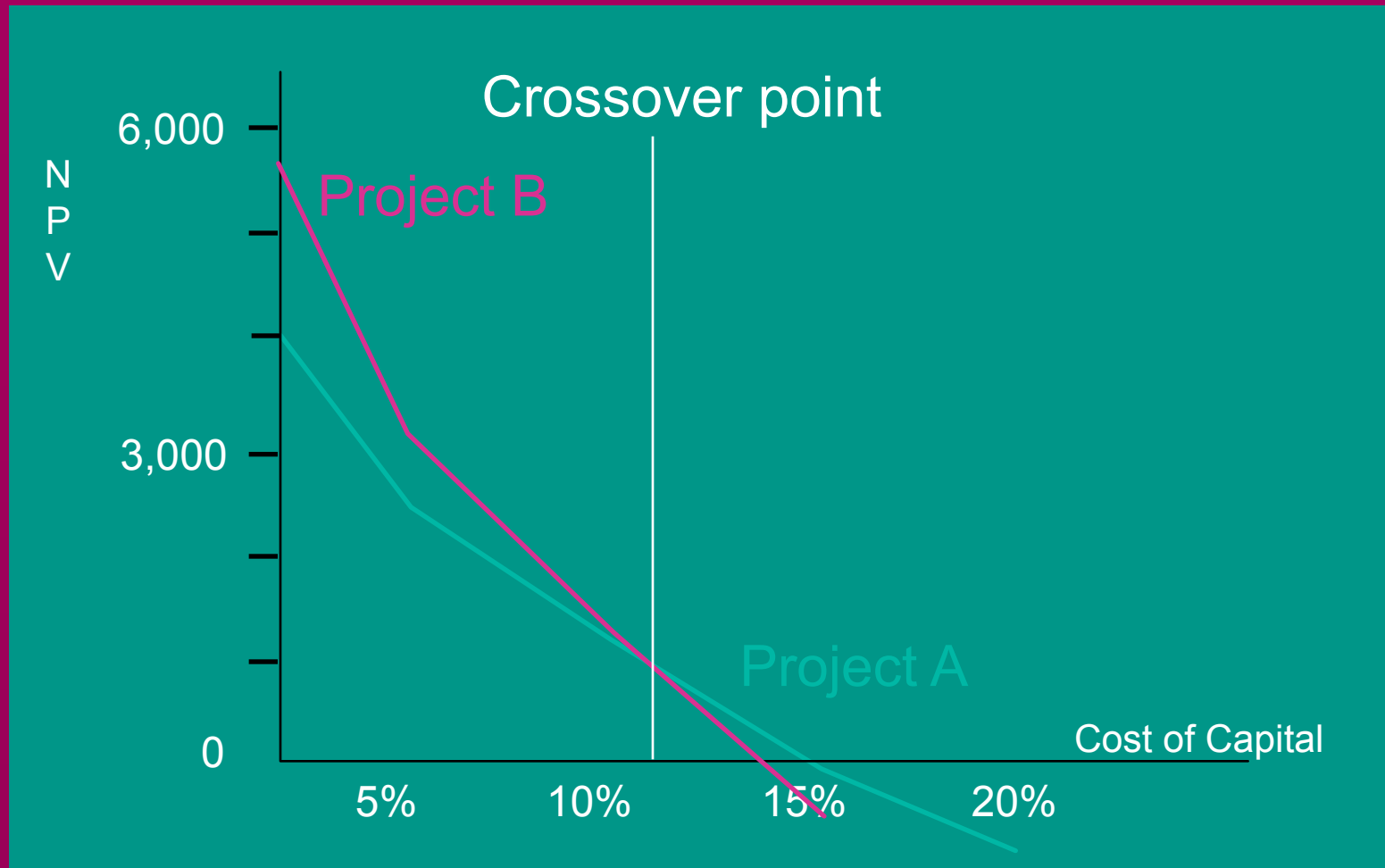| Time	A	B
	P R O J E C T	
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Net Present Value Profile

❖ *Compare NPV of the two projects for different required rates*

Crossover point

Project B

Project A

6,000

3,000

0

N P V

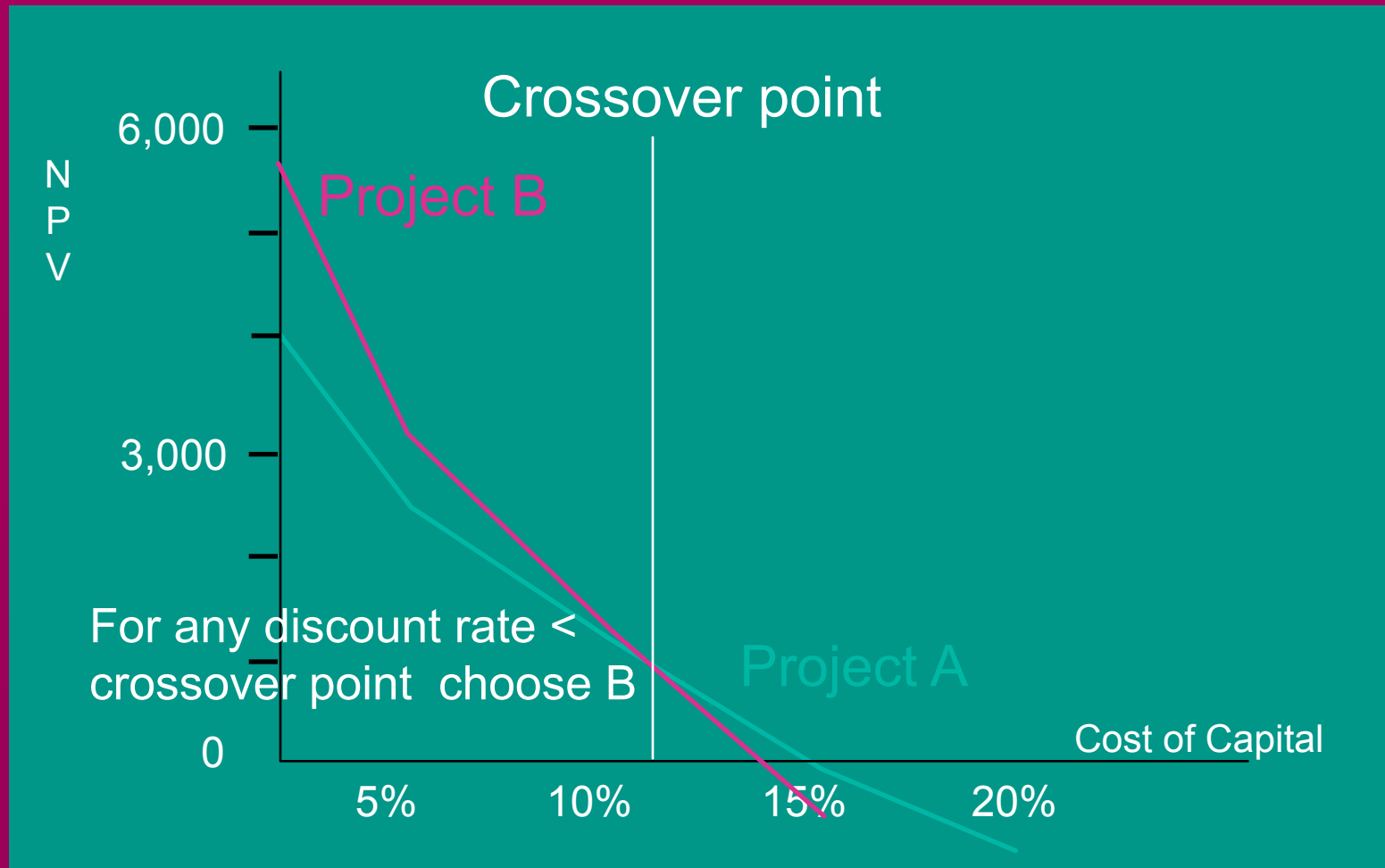5%   10%   15%   20%

Cost of Capital

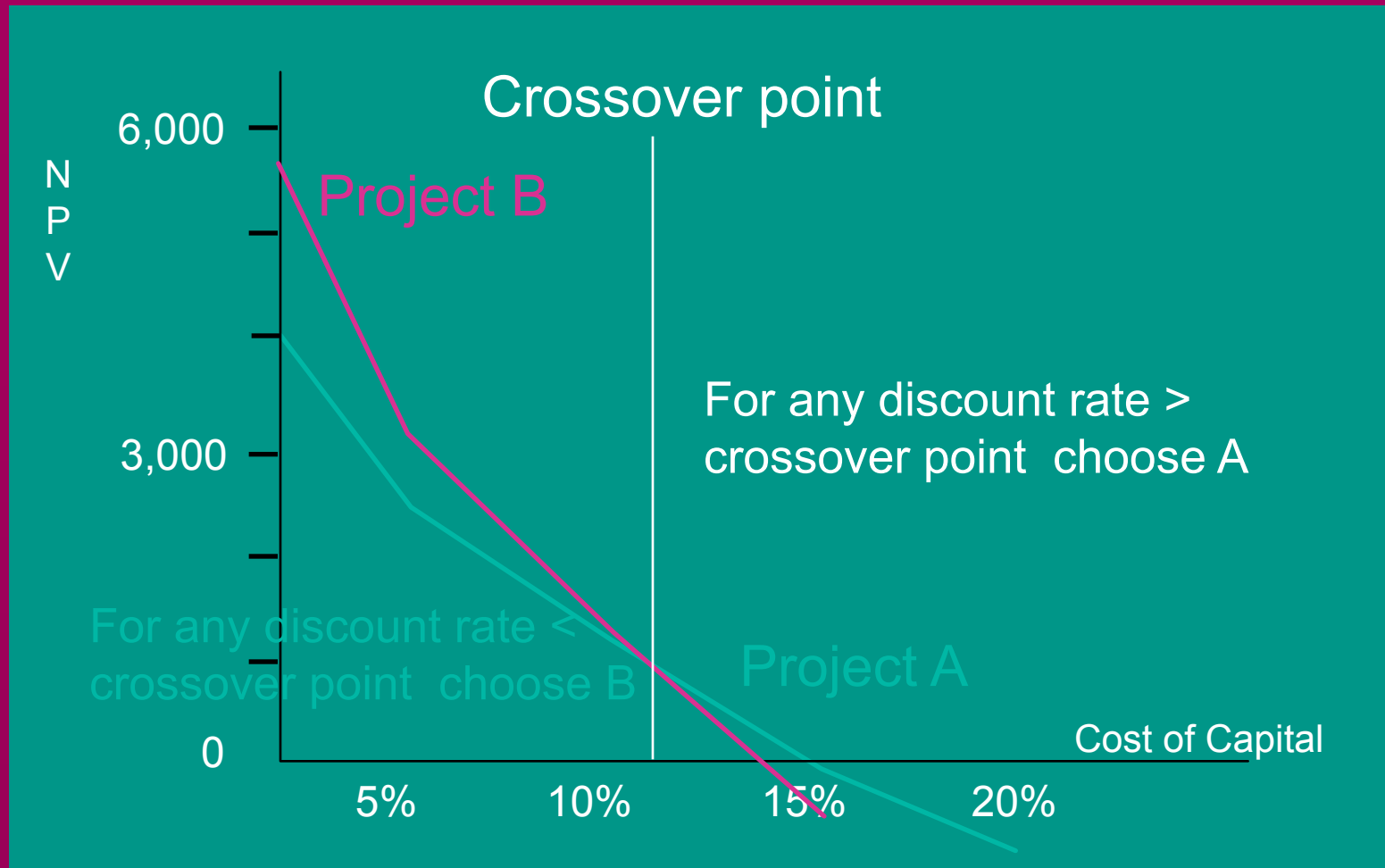# Net Present Value Profile

❖ *Compare NPV of the two projects for different required rates*

Net Present Value Profile

❖ *Compare NPV of the two projects for different required rates*

Crossover point

NPV

6,000 —

Project B

3,000 —

For any discount rate > crossover point choose A

For any discount rate < crossover point choose B

Project A

0 —

Cost of Capital

5%   10%   15%   20%

Capital Budgeting Methods

Internal Rate of Return

❖ *Measures the rate of return that will make the PV of future CF equal to the initial outlay.*

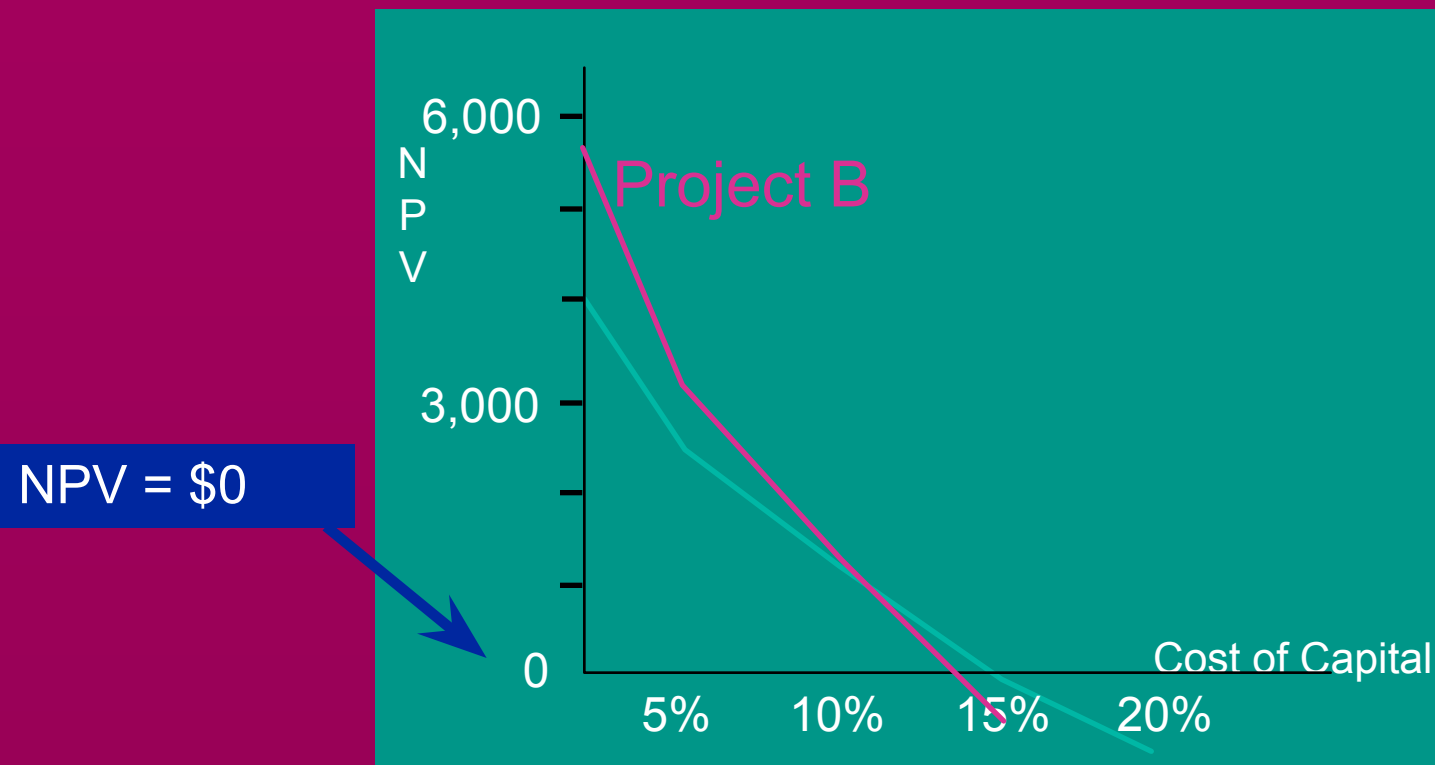Definition:
The IRR is that discount rate at which
NPV = 0

IRR is like the YTM. It is the same cocept but the term YTM is used only for bonds.

Capital Budgeting Methods

Internal Rate of Return

❖ *Measures the rate of return that will make the PV of future CF equal to the initial outlay.*

The IRR is the discount rate at which NPV = 0

NPV = $0

6,000

N
P
V

Project B

3,000

0

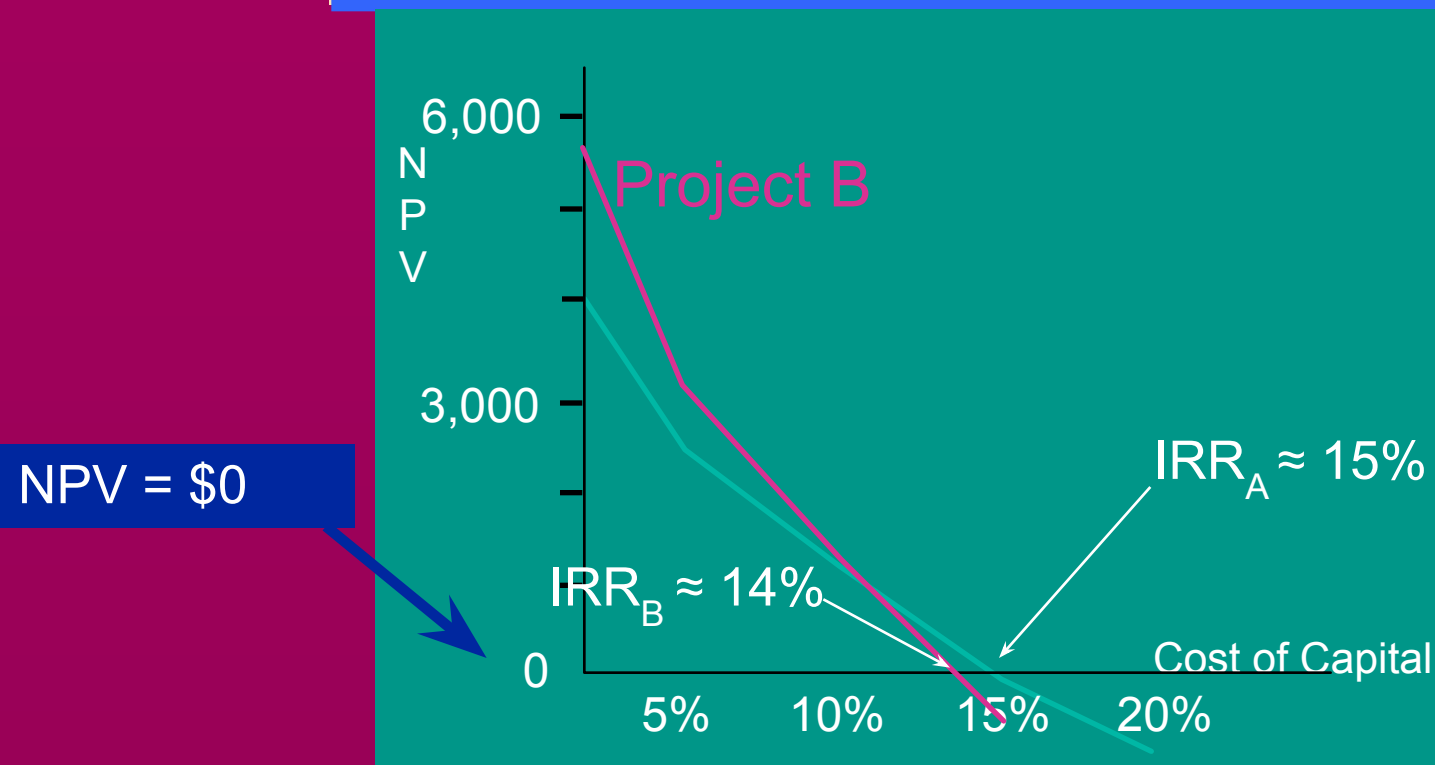5%   10%   15%   20%

Cost of Capital

Capital Budgeting Methods

Internal Rate of Return

❖ *Measures the rate of return that will make the PV of future CF equal to the initial outlay.*

Or, the IRR is the discount rate at which NPV = 0

NPV = $0

6,000

N
P
V

3,000

Project B

$IRR_A \approx 15\%$

$IRR_B \approx 14\%$

0

Cost of Capital

5%   10%   15%   20%

Capital Budgeting Methods

Internal Rate of Return

❖ *Determine the mathematical solution for IRR*

Capital Budgeting Methods

Internal Rate of Return

❖ *Determine the mathematical solution for IRR*

$$0 = NPV = \frac{CF_1}{(1+ IRR)} + \frac{CF_2}{(1+ IRR)^2} + \cdots + \frac{CF_n}{(1+ IRR)^n} - IO$$

Capital Budgeting Methods

Internal Rate of Return

❖ *Determine the mathematical solution for IRR*

$$0 = NPV = \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \cdots + \frac{CF_n}{(1+IRR)^n} - IO$$

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

Outflow = PV of Inflows

Capital Budgeting Methods

Internal Rate of Return

❖ *Determine the mathematical solution for IRR*

$$0 = NPV = \frac{CF_1}{(1+ IRR)} + \frac{CF_2}{(1+ IRR)^2} + \cdots + \frac{CF_n}{(1+ IRR)^n} - IO$$

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

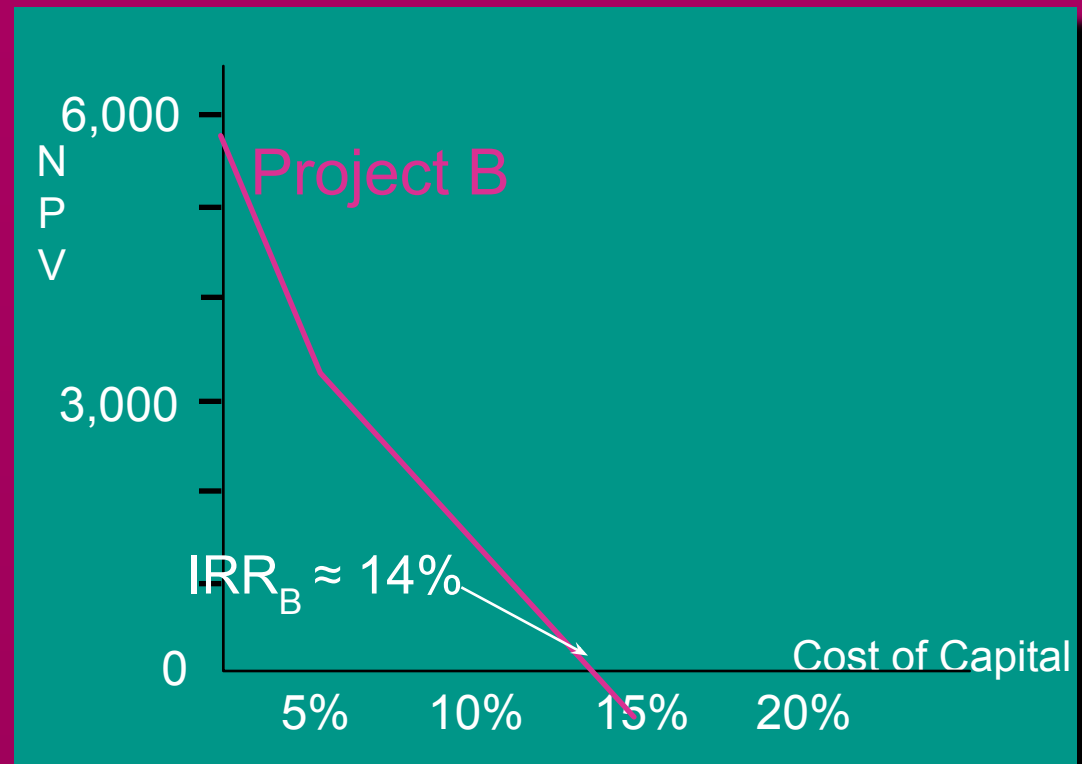$$+ \cdots +$$

Outflow = PV of Inflows

Solve for Discount Rates

Capital Budgeting Methods

**Internal Rate of Return
For Project B**

Cannot solve for IRR
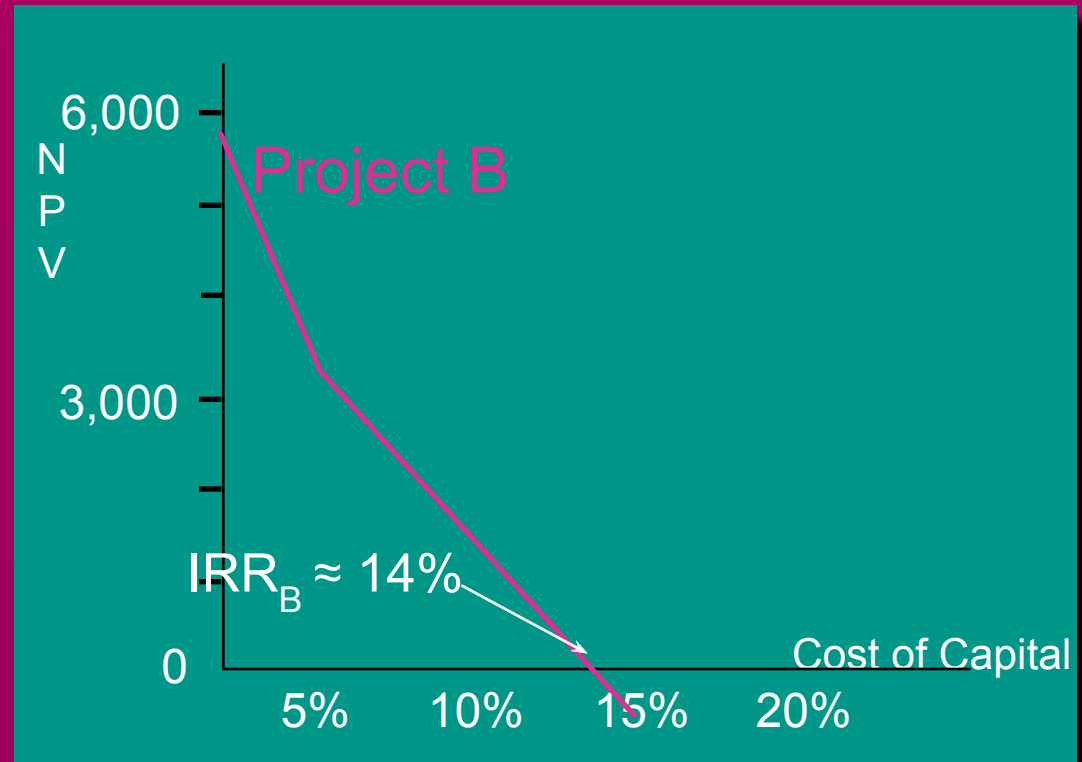directly, must use Trial &
Error

NPV vs Cost of Capital for Project B, showing IRR$_B$ ≈ 14%

$$10,000 = \frac{500}{(1+ \text{IRR})} + \frac{500}{(1+ \text{IRR})^2} + \frac{4,600}{(1+ \text{IRR})^3} + \frac{10,000}{(1+ \text{IRR})^4}$$

Capital Budgeting Methods

Internal Rate of Return For Project B

Cannot solve for IRR directly, must use Trial & Error

Project B

$IRR_B \approx 14\%$

Cost of Capital

$$10,000 = \frac{500}{(1+ IRR)} + \frac{500}{(1+ IRR)^2} + \frac{4,600}{(1+ IRR)^3} + \frac{10,000}{(1+ IRR)^4}$$

<u>TRY 14%</u>

$$10,000 \overset{?}{=} \frac{500}{(1+ .14)} + \frac{500}{(1+ .14)^2} + \frac{4,600}{(1+ .14)^3} + \frac{10,000}{(1+ .14)^4}$$

Capital Budgeting Methods

Internal Rate of Return For Project B

Cannot solve for IRR directly, must use Trial & Error

NPV

6,000

3,000

$IRR_B \approx 14\%$

0

5%   10%   15%   20%

Cost of Capital

Project B

$$10{,}000 = \frac{500}{(1+ \text{IRR})} + \frac{500}{(1+ \text{IRR})^2} + \frac{4{,}600}{(1+ \text{IRR})^3} + \frac{10{,}000}{(1+ \text{IRR})^4}$$
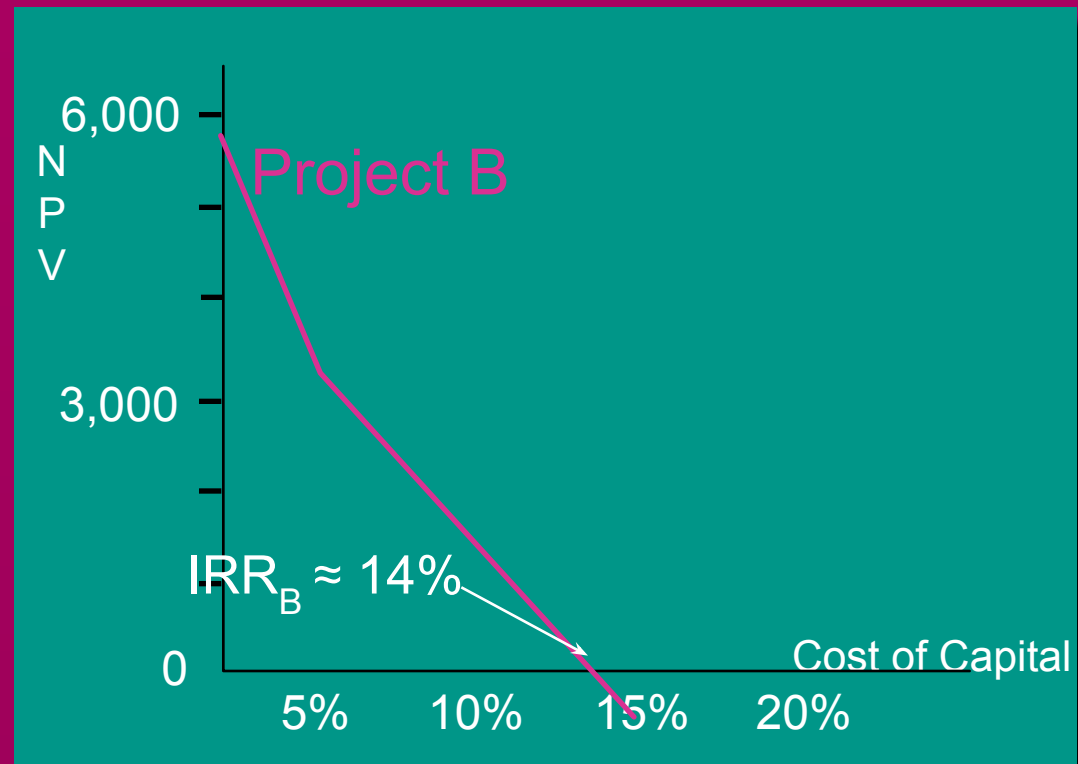
<u>TRY 14%</u>

$$10{,}000 \overset{?}{=} \frac{500}{(1+ .14)} + \frac{500}{(1+ .14)^2} + \frac{4{,}600}{(1+ .14)^3} + \frac{10{,}000}{(1+ .14)^4}$$

$$10{,}000 \overset{?}{=} 9{,}849$$

PV of Inflows too low, try lower rate

Capital Budgeting Methods

Internal Rate of Return For Project B

Cannot solve for IRR directly, must use Trial & Error

6,000

N
P
V

3,000

$IRR_B \approx 14\%$

Project B

0

Cost of Capital

5%   10%   15%   20%

$$10,000 = \frac{500}{(1+ IRR)} + \frac{500}{(1+ IRR)^2} + \frac{4,600}{(1+ IRR)^3} + \frac{10,000}{(1+ IRR)^4}$$

TRY 13%

$$10,000 \overset{?}{=} \frac{500}{(1+ .13)} + \frac{500}{(1+ .13)^2} + \frac{4,600}{(1+ .13)^3} + \frac{10,000}{(1+ .13)^4}$$

Capital Budgeting Methods

Internal Rate of Return For Project B

Cannot solve for IRR directly, must use Trial & Error

NPV

6,000

3,000

0

Project B

$IRR_B \approx 14\%$

Cost of Capital

5%   10%   15%   20%

$$10{,}000 = \frac{500}{(1+ IRR)} + \frac{500}{(1+ IRR)^2} + \frac{4{,}600}{(1+ IRR)^3} + \frac{10{,}000}{(1+ IRR)^4}$$

TRY 13%

$$10{,}000 \overset{?}{=} \frac{500}{(1+ .13)} + \frac{500}{(1+ .13)^2} + \frac{4{,}600}{(1+ .13)^3} + \frac{10{,}000}{(1+ .13)^4}$$
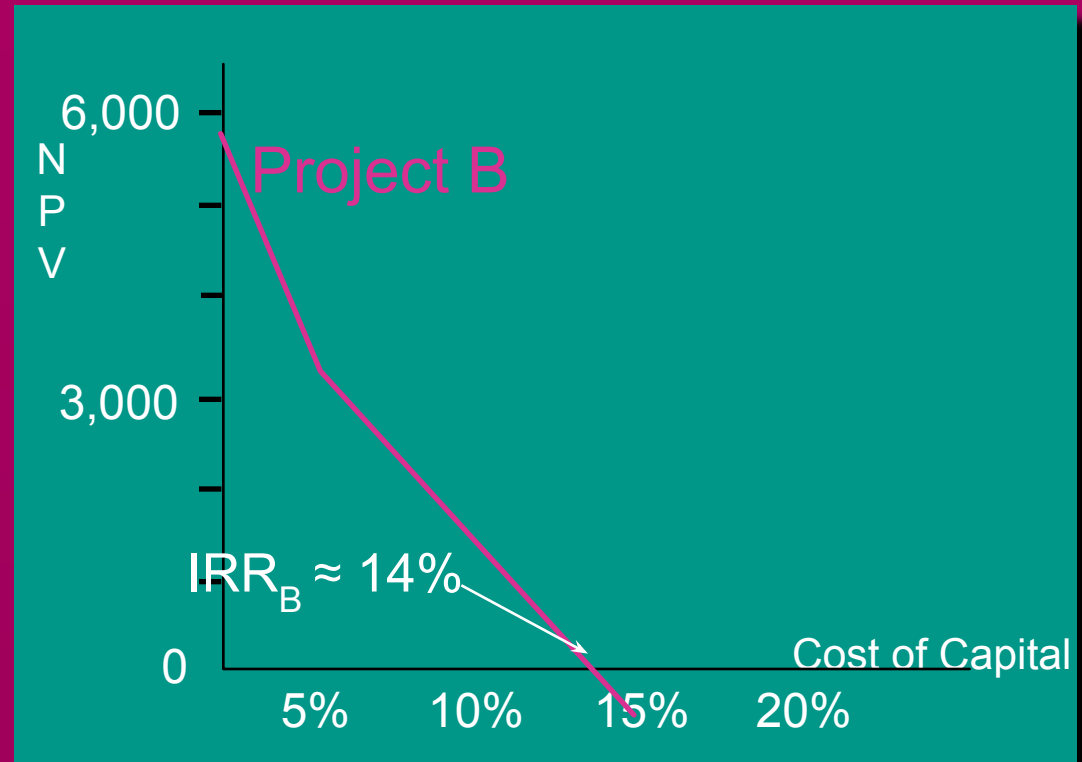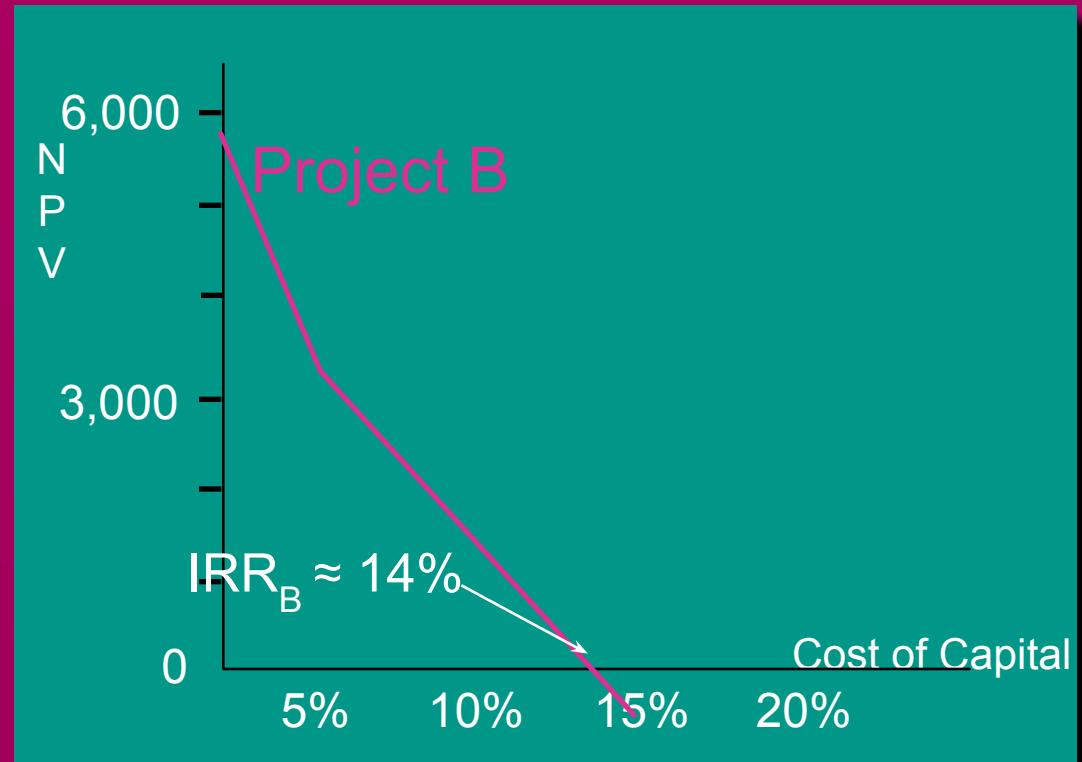
$$10{,}000 \overset{?}{=} 10{,}155$$

Capital Budgeting Methods

Internal Rate of Return For Project B

Cannot solve for IRR directly, must use Trial & Error

Project B

6,000

N
P
V

3,000

$IRR_B \approx 14\%$

0

Cost of Capital

5%   10%   15%   20%

$$10{,}000 = \frac{500}{(1+ IRR)} + \frac{500}{(1+ IRR)^2} + \frac{4{,}600}{(1+ IRR)^3} + \frac{10{,}000}{(1+ IRR)^4}$$
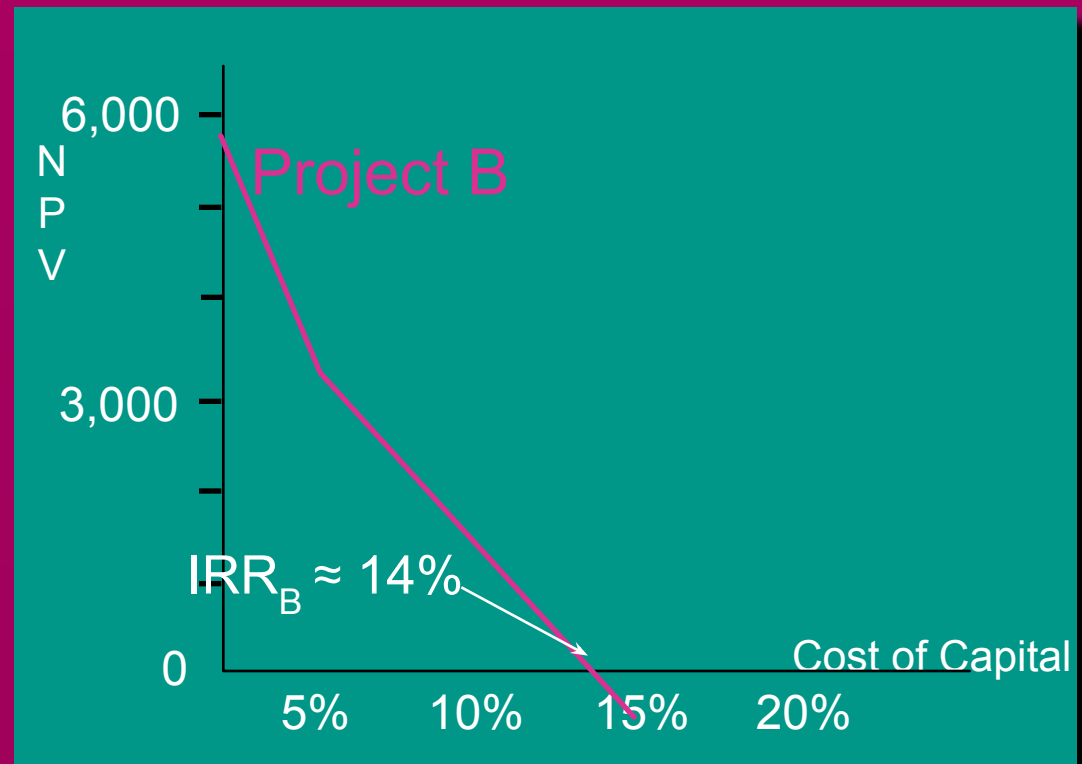
TRY 13%

$$10{,}000 \overset{?}{=} \frac{500}{(1+ .13)} + \frac{500}{(1+ .13)^2} + \frac{4{,}600}{(1+ .13)^3} + \frac{10{,}000}{(1+ .13)^4}$$

$$10{,}000 \overset{?}{=} 10{,}155 \qquad 13\% < IRR < 14\%$$

Capital Budgeting Methods

Decision Rule for Internal Rate of Return

Independent Projects

Accept Projects with
         IRR ≥ required rate

Mutually Exclusive Projects

Accept project with highest
         IRR ≥ required rate

Capital Budgeting Methods

Profitability Index

Very Similar to Net Present Value

$$PI = \frac{\text{PV of Inflows}}{\text{Initial Outlay}}$$

Capital Budgeting Methods

Profitability Index

Very Similar to Net Present Value

$$PI = \frac{PV \text{ of Inflows}}{Initial\ Outlay}$$

Instead of Subtracting the Initial Outlay from the PV of Inflows, the Profitability Index is the ratio of Initial Outlay to the PV of Inflows.

Capital Budgeting Methods

Profitability Index

Very Similar to Net Present Value

$$PI = \frac{\text{PV of Inflows}}{\text{Initial Outlay}}$$

Instead of Subtracting the Initial Outlay from the PV of Inflows, the Profitability Index is the ratio of Initial Outlay to the PV of Inflows.

$$PI = \frac{\frac{CF_1}{(1+k)} + \frac{CF_2}{(1+k)^2} + \frac{CF_3}{(1+k)^3} + \cdots + \frac{CF_n}{(1+k)^n}}{IO}$$

Capital Budgeting Methods

Profitability Index for Project B

$$PI = \frac{\dfrac{500}{(1+.1)} + \dfrac{500}{(1+.1)^2} + \dfrac{4,600}{(1+.1)^3} + \dfrac{10,000}{(1+.1)^4}}{10,000}$$

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Capital Budgeting Methods

Profitability Index for Project B

$$PI = \frac{\dfrac{500}{(1+.1)} + \dfrac{500}{(1+.1)^2} + \dfrac{4,600}{(1+.1)^3} + \dfrac{10,000}{(1+.1)^4}}{10,000}$$

$$PI = \frac{11,154}{10,000} = 1.1154$$

	P R O	J E C T
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Capital Budgeting Methods

Profitability Index for Project B

$$PI = \frac{\dfrac{500}{(1+.1)} + \dfrac{500}{(1+.1)^2} + \dfrac{4,600}{(1+.1)^3} + \dfrac{10,000}{(1+.1)^4}}{10,000}$$

$$PI = \frac{11,154}{10,000} = 1.1154$$

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Profitability Index for Project A

$$PI = \frac{3,500 \times PVIFA_{4, .10}}{10,000}$$

Capital Budgeting Methods

Profitability Index for Project B

$$PI = \frac{\dfrac{500}{(1+.1)} + \dfrac{500}{(1+.1)^2} + \dfrac{4,600}{(1+.1)^3} + \dfrac{10,000}{(1+.1)^4}}{10,000}$$

$$PI = \frac{11,154}{10,000} = 1.1154$$

	P R O J E C T	
Time	A	B
0	(10,000.)	(10,000.)
1	3,500	500
2	3,500	500
3	3,500	4,600
4	3,500	10,000

Profitability Index for Project A

$$PI = \frac{3,500\left(\dfrac{1}{.10} - \dfrac{1}{.10(1+.10)^4}\right)}{10,000}$$

$$PI = \frac{11,095}{10,000} = 1.1095$$

Capital Budgeting Methods

Profitability Index Decision Rules

❖ *Independent Projects*
   ❖ Accept Project if PI ≥ 1
❖ *Mutually Exclusive Projects*
   ❖ Accept Highest PI ≥ 1 Project

Comparison of Methods

	Project A	Project B	Choose
Payback	< 3 years	< 4 years	A
NPV	$1,095	$1,154	B
IRR	14.96%	13.50%	A
PI	1.1095	1.1154	B

Comparison of Methods

❖ *Time Value of Money*
   ❖ Payback - Does not adjust for timing differences (ignore Discounted Payback)
   ❖ NPV, IRR and PI take into account the time value of money

Comparison of Methods

❖ *Time Value of Money*
- ❖ Payback - Does not adjust for timing differences
- ❖ NPV, IRR and PI take into account the time value of money

❖ *Relevant Cash Flows?*
- ❖ NPV, IRR and PI use all Cash Flows
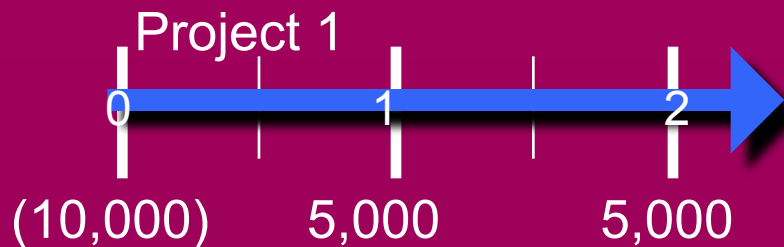- ❖ Payback method ignores Cash Flows that occur after the Payback Period.

Comparison of Methods

❖ *Time Value of Money*
  ❖ Payback - Does not adjust for timing differences
  ❖ NPV, IRR and PI take into account the time value of money

❖ *Relevant Cash Flows?*
  ❖ NPV, IRR and PI use all Cash Flows
  ❖ Payback method ignores Cash Flows that occur after the Payback Period.

Project 1

```
0              1              2  ➜
```
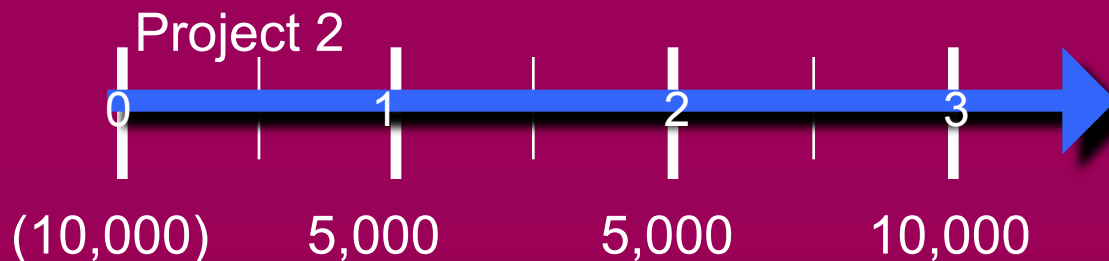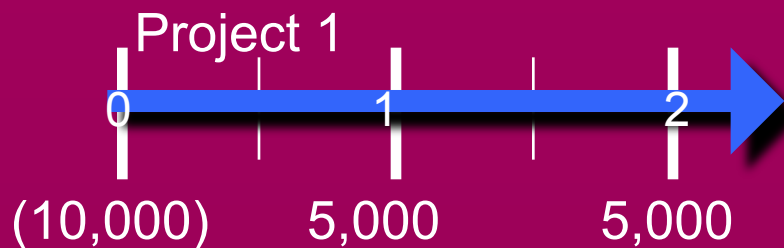
(10,000)   5,000   5,000

Comparison of Methods

❖ *Time Value of Money*
  ❖ Payback - Does not adjust for timing differences
  ❖ NPV, IRR and PI take into account the time value of money

❖ *Relevant Cash Flows?*
  ❖ NPV, IRR and PI use all Cash Flows
  ❖ Payback method ignores Cash Flows that occur after the Payback Period.

Project 1

```
0                 1                 2
|-----------------|-----------------|---->
(10,000)       5,000             5,000
```

Both Projects have Identical Payback

Project 2

```
0         1         2         3
|---------|---------|---------|---->
(10,000) 5,000   5,000    10,000
```

Comparison of Methods

NPV & PI indicated accept Project B while IRR indicated that Project A should be accepted. Why?

Sometimes there is a conflict between the decisions based on NPV and IRR methods.

The conflict arises if there is difference in the timing of CFs or sizes of the projects (or both).

The cause of the conflict is the underlying reinvestment rate assumption.

Reinvestment Rate Assumptions

❖ NPV assumes cash flows are reinvested at the required rate, k.

❖ IRR assumes cash flows are reinvested at IRR.

Reinvestment Rate of k more realistic as most projects earn approximately k (due to competition)

__*NPV*__ *is the Better Method for project evaluation*

IRR

Because of its unreasonable reinvestment rate assumption, IRR method can result in bad decisions.

Another problem with IRR is that if the sign of the cash flow changes more than once, there is a possibility of multiple IRR. See p 340.

The problem of unreasonable assumption can be addressed by using Modified IRR

MIRR

To find MIRR

1. Find the FV of all intermediate CFs using the cost of capital (the hurdle rate) as the interest rate.

2. Add all FV.

3. Find that discount rate which makes the PV of the FV equal to the PV of outflows.

Drop MIRR computations.

Thank you