

Definition 1

The rate of return is the interest rate earned on the unpaid balance of an amortized loan.

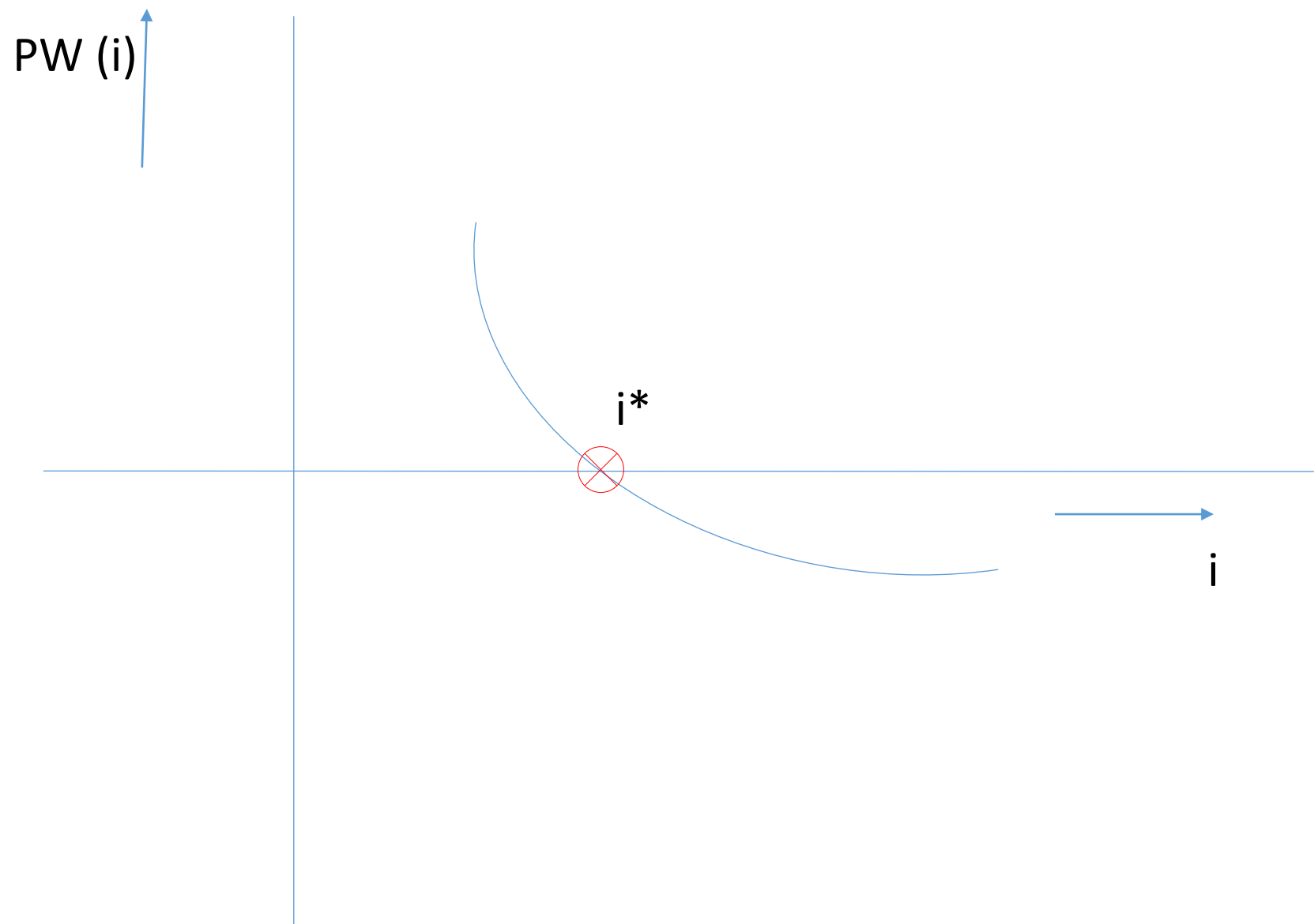
Definition 2

The rate of return is the break-even interest rate i^ that equates the present worth of a project's cash outflows to the present worth of its cash inflows, or*

$$\begin{aligned}PW(i^*) &= PW_{\text{Cash inflows}} - PW_{\text{Cash outflows}} \\ &= 0.\end{aligned}$$

Definition 3

The internal rate of return is the interest rate charged on the unrecovered project balance of the investment such that, when the project terminates, the unrecovered project balance will be zero.



DECISION CRITERIA

If $IRR > MARR$, accept the project.

If $IRR = MARR$, remain indifferent.

If $IRR < MARR$, reject the project.

Using Rate of Return as the decision criteria to evaluate
mutually exclusive projects
(Incremental Rate of Return)

Incremental Rate of Return method- STEPS

1. Check each alternative' s ROR /IRR to satisfy MARR (For e.g., if IRR is 15%, then $15% > 10%$, where $MARR = 10%$)
 2. Arrange them in the increasing order of their investment
 3. Find the difference amount by subtracting lower investment option from higher one
 4. Write NPW equation for the difference amount.
 5. Find ROR/IRR (ALTERNATELY IF THE NPW IS POSITIVE FOR GIVEN MARR, SELECT THE HIGHER INVESTMENT OPTION)
 6. Compare with MARR
 7. *If $IRR \geq MARR$, accept the one with higher investment, else accept the other one
- * With more than two options, the above steps are carried out for first two options, the accepted option will be compared with the third option and so on

TWO MUTUALLY EXCLUSIVE ALTERNATIVES

<i>n</i>	B1	B2
0	−\$3,000	−\$12,000
1	1,350	4,200
2	1,800	6,225
3	<u>1,500</u>	<u>6,330</u>
IRR	25%	17.43%

At MARR 10%, select best alternative

<i>n</i>	BI	B2	B2 – BI
0	−\$3,000	−\$12,000	−\$9,000
1	1,350	4,200	2,850
2	1,800	6,225	4,425
3	<u>1,500</u>	<u>6,330</u>	4,830
IRR	25%	17.43%	

Consider the following three sets of mutually exclusive alternatives:

<i>n</i>	D1	D2	D3
0	−\$2,000	−\$1,000	−\$3,000
1	1,500	800	1,500
2	1,000	500	2,000
3	800	500	1,000
IRR	34.37%	40.76%	24.81%

Which project would you select on the basis of the rate of return on incremental investment, assuming that $MARR = 15\%$?

SOLUTION

Given: Preceding cash flows and $\text{MARR} = 15\%$.

Find: IRR on incremental investment and which alternative is preferable.

Step 1: Examine the IRR of each alternative. At this point, we can eliminate any alternative that fails to meet the MARR. In this example, all three alternatives exceed the MARR.

Step 2: Compare D1 and D2 in pairs.⁹ Because D2 has a lower initial cost, compute the rate of return on the increment ($D1 - D2$), which represents an increment of investment.

n	$D1 - D2$
0	−\$1,000
1	700
2	500
3	300

The incremental cash flow represents a simple investment. To find the incremental rate of return, we write

$$-\$1,000 + \$700(P/F, i, 1) + \$500(P/F, i, 2) + \$300(P/F, i, 3) = 0.$$

Solving for i^*_{D1-D2} yields 27.61%, which exceeds the MARR; therefore, D1 is preferred over D2. Now you eliminate D2 from further consideration.

Step 3: Compare D1 and D3. Once again, D1 has a lower initial cost. Examine the increment (D3 – D1):

n	D3 – D1
0	–\$1,000
1	0
2	1,000
3	200

(D3 – D1) has an unsatisfactory 8.8% rate of return; therefore, D1 is preferred over D3. Accordingly, we conclude that D1 is the best alternative.

<i>n</i>	<i>C1</i>	<i>C2</i>
0	−\$9,000	−\$9,000
1	480	5,800
2	3,700	3,250
3	6,550	2,000
4	<u>3,780</u>	<u>1,561</u>
IRR	18%	20%

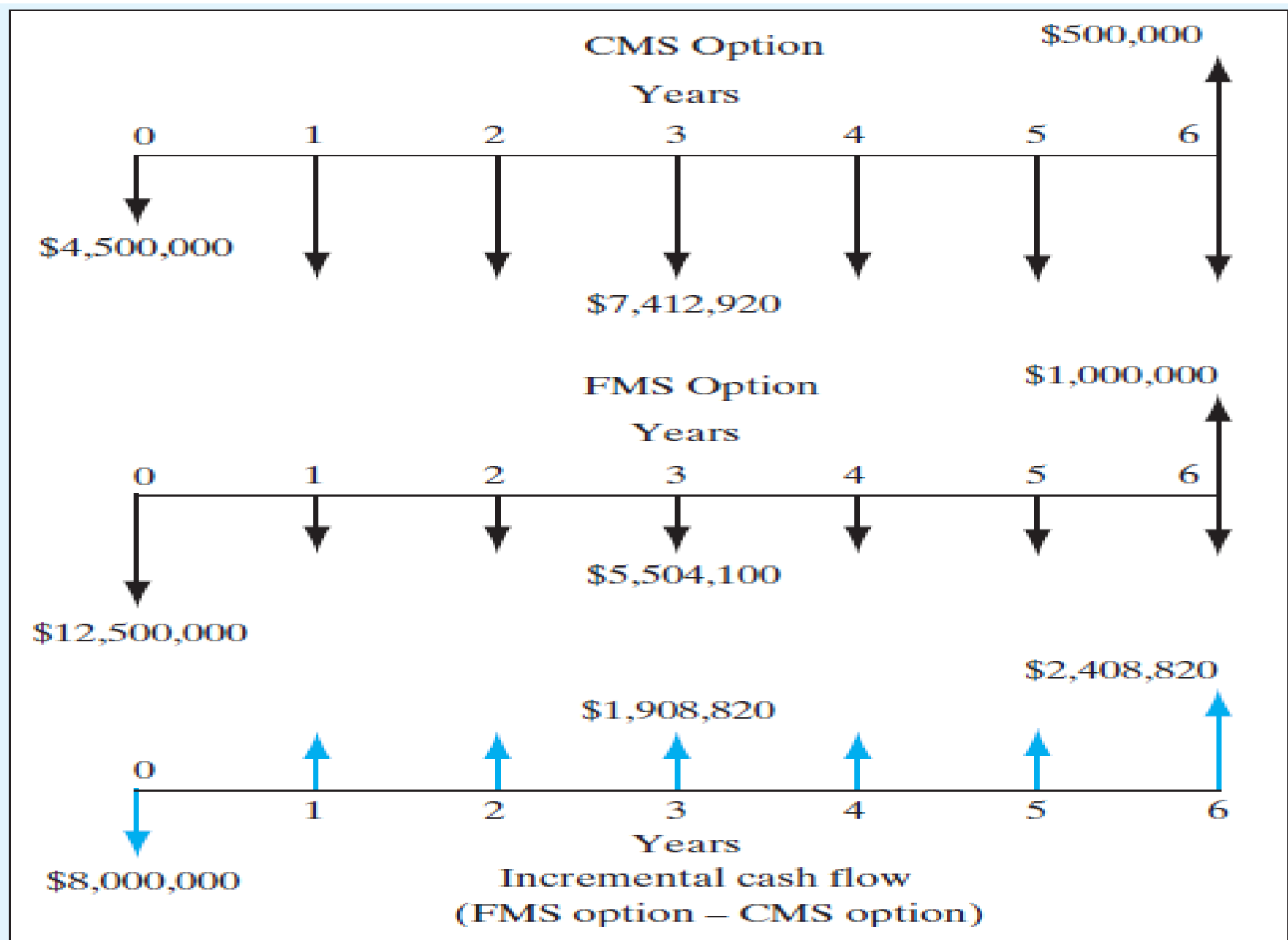
At MARR=12%, which alternative is better?

n	$C1 - C2$
0	\$ 0
1	-5,320
2	450
3	4,550
4	2,219

Example of Cost-only projects

If CMS and FMS are two mutually exclusive options, which one will you choose on the basis of incremental analysis of Rate of Return? Assume the firm's MARR as 15%. Analysis period is 6 years.

Items	CMS Option	FMS Option
Annual O&M costs:		
Annual labor cost	\$1,169,600	\$707,200
Annual material cost	832,320	598,400
Annual overhead cost	3,150,000	1,950,000
Annual tooling cost	470,000	300,000
Annual inventory cost	141,000	31,500
Annual income taxes	<u>1,650,000</u>	<u>1,917,000</u>
Total annual costs	\$7,412,920	\$5,504,100
Investment	\$4,500,000	\$12,500,000
Net salvage value	\$500,000	\$1,000,000



Consider two investments A and B with the following sequences of cash flows:

<i>n</i>	Net Cash Flow	
	Project A	Project B
0	−\$120,000	−\$100,000
1	20,000	15,000
2	20,000	15,000
3	120,000	130,000

- (a) Compute the IRR for each investment.
- (b) At $MARR = 15\%$, determine the acceptability of each project.
- (c) If A and B are mutually exclusive projects, which project would you select, based on the rate of return on incremental investment?

A plant engineer is considering two types of solar water heating system:

	Model A	Model B
Initial cost	\$7,000	\$10,000
Annual savings	\$700	\$1,000
Annual maintenance	\$100	\$50
Expected life	20 years	20 years
Salvage value	\$400	\$500

The firm's MARR is 12%. On the basis of the IRR criterion, which system is the better choice?

- 7.40 Fulton National Hospital is reviewing ways of cutting the cost of stocking medical supplies. Two new stockless systems are being considered, to lower the hospital's holding and handling costs. The hospital's industrial engineer has compiled the relevant financial data for each system as follows (dollar values are in millions):

	Current Practice	Just-in-Time System	Stockless Supply System
Start-up cost	\$0	\$2.5	\$5
Annual stock holding cost	\$3	\$1.4	\$0.2
Annual operating cost	\$2	\$1.5	\$1.2
System life	8 years	8 years	8 years

The system life of eight years represents the period that the contract with the medical suppliers is in force. If the hospital's MARR is 10%, which system is more economical?

A1-A0=83.34%;
A2-A1=58.49%;A2 is the choice

Baby Doll Shop manufactures wooden parts for dollhouses. The worker is paid \$8.10 an hour and, using a handsaw, can produce a year’s required production (1,600 parts) in just eight 40-hour weeks. That is, the worker averages five parts per hour when working by hand. The shop is considering purchasing of a power band saw with associated fixtures, to improve the productivity of this operation. Three models of power saw could be purchased: Model A (the economy version), model B (the high-powered version), and model C (the deluxe high-end version). The major operating difference between these models is their speed of operation. The investment costs, including the required fixtures and other operating characteristics, are summarized as follows

Category	By Hand	Model A	Model B	Model C
Production rate (parts/hour)	5	10	15	20
Labor hours required (hours/year)	320	160	107	80
Annual labor cost (@ \$8.10/hour)	2,592	1,296	867	648
Annual power cost (\$)		400	420	480
Initial investment (\$)		4,000	6,000	7,000
Salvage value (\$)		400	600	700
Service life (years)		20	20	20

Which model is most economical,
based on the rate-of-return principle?
Assume MARR 10%