Introduction to Mineral Economics

INVESTMENT DECISIONS ANALYSIS

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Introduction

- No mining company commits to a major investment without a thorough analysis to support the decision;
- Furthermore, companies do not rely on only one measure of value to arrive at this decision;
- Once the technical work is finalized, the computational effort to generate a full suite of economic indicators is relatively minor.

Cont …

- This section demonstrates how the DCF tools are applied for investment decisions;
- Along with financial analysis using DCF models, there are at least two other evaluation tools applied by investment strategists examining major mining projects;
- **1. Payback method**
- This examines the cumulative flow of cash into and out of the project;
- The payback method focuses on the time it takes until the initial outflows are recovered;

Cont …

- **2. Sensitivity analysis**
- This tool aims to provide information about the sensitivity of the project to changes in important data;
- It asks "what-if' questions, e.g.:
- What would happen to the return on investment if the selling price changed?
- Sensitivity analyses are usually prepared from a base case DCF model;

Cont …

- With changes to the input data it translates into changes in;
- 1. Net Present Value (NPV);
- 2. Internal Rate of Return (IRR);
- 3. Discounted average cost; or
- 4. Payback Period.

Cont …

- All of these tools are forward-looking indicators to aid decision making;
- At the same time, published projections are also prepared by using accounting rules;
- This is because these rules will be used to compare planned and actual performance once the project starts;
- These accounting rules sometimes present actual performance in ways that are contrary to expectations;

DCF ANALYSIS

- DCF analysis is a method of valuing a project, company, or asset using the concepts of the time value of money;
- This is a technique that is used to evaluate the attractiveness of investments;
- DCF can be an important factor when evaluating or comparing investments, proposed actions, or purchases;

Cont …

- Other things being equal, the action or investment with the larger DCF is the better decision;
- Generally all mining investments generate cash flows over their lives;
- The cash flows generated by the project are discounted back to the present;
- This is done at a specified discounted rate or required rate of return;

Cont …

- The present values of the annual cash flows are then summed up to determine the value of an investment;
- This result is called the Net Present Value (NPV);
- The discounted methods are more reliable due to the fact that they account for the time value of money;

Cont…

- The most important DCF methods include the following:
- 1. Net Present Value (NPV);
- 2. Profitability index (Benefit-Cost Ratio);
- 3. Present value ratio;
- 2. Internal Rate of Return (IRR);

Net Present Value (NPV)

- This is the method of measuring investment proposal;
- It is a measure of the value of the project;
- NPV represents an amount of money at the present time (t = 0);
- This money is equivalent to some future cash flows discounted at a specified interest rate.
- This technique recognizes the time vale of money;

Cont …

- It provides for calculation of an amount at the present time;
- Why do we perform present value calculations?
- To determine the present worth of an income producing property;
- If the future annual cash flows can be estimated, then by selecting an appropriate interest rate, the present value of the property can be calculated;

Cont …

- This value should provide a reasonable estimate of the price at which the property could be sold or bought.
- In general case of investment proposal evaluation, one is interested in determining the difference between cash outflows and cash inflows associated with the proposal on a present value basis;
- This calculation procedure is referred to as the Net Present Value (NPV) method.

CONT …

- NPV is thus, the difference between the sum of the present value of all cash inflows and the sum of the present value of all cash outflows;

- **NPV = Σ PV of cash benefits – Σ PV of cash costs**

- If the NPV of the proposal is a positive value (NPV > 0) then the project should be accepted;

Cont …

- A positive NPV indicates that the investment proposal will provide for the recovery of invested capital.
- Similarly proposals yielding a negative NPV at the required discount rate should be rejected.
- If the projects under consideration are mutually exclusive (i.e. they cannot occur at the same time) the one with the highest NPV should be chosen.

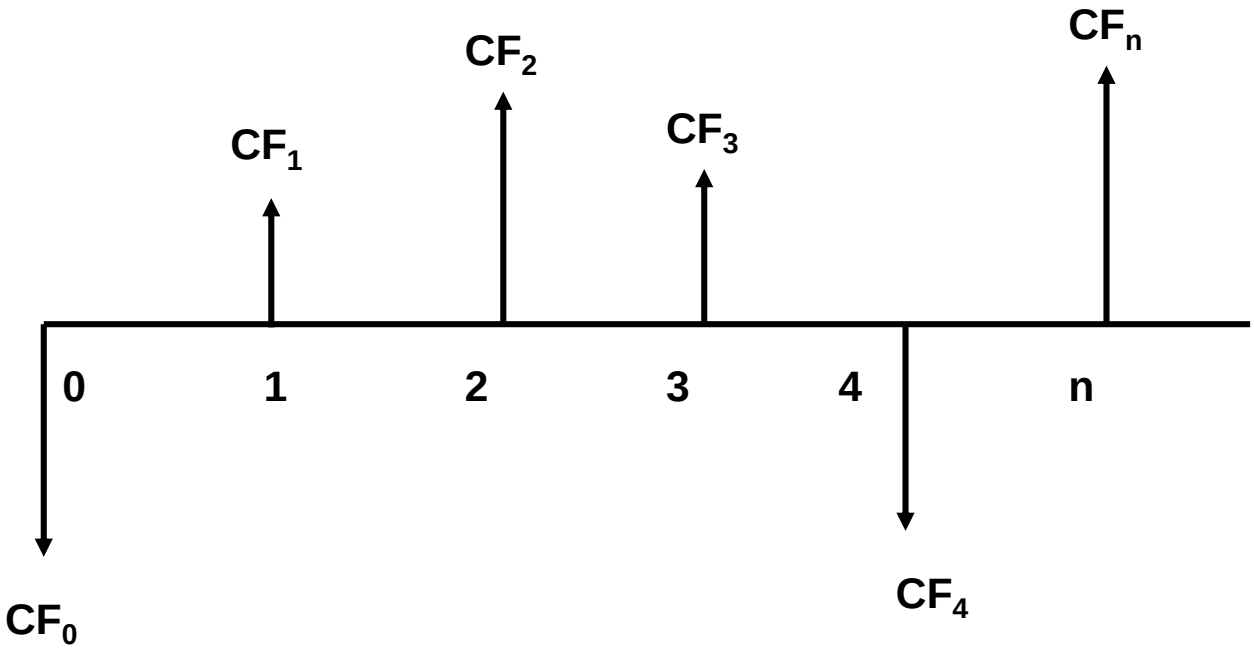
Criterion

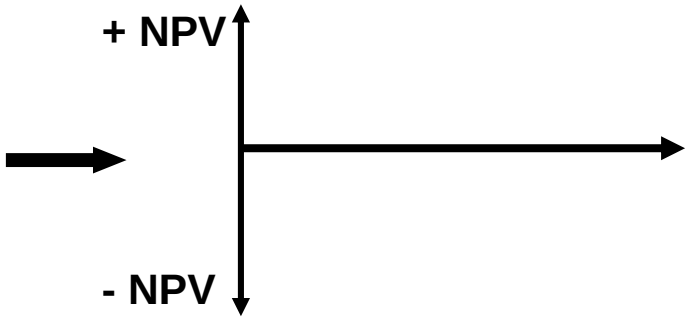
- **NPV > 0** Means good investment (accept project);

- **NPV = 0** Means costs are equal to Benefits (break even) - Decision should be based on other criteria, e.g. strategic positioning or other factors not explicitly included in the calculation;

- **NPV < 0** Investment opportunity not good (reject project);

Calculating NPV





Cont …

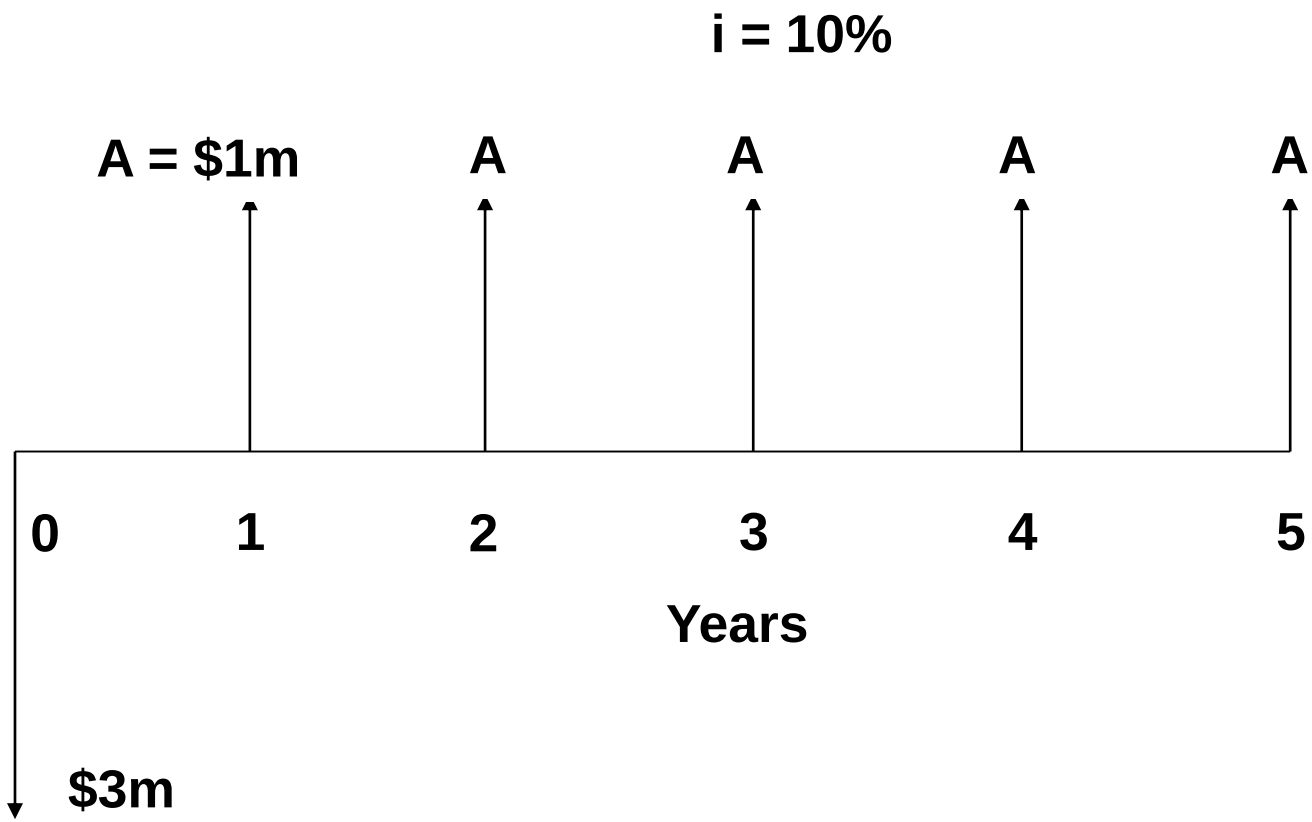
- NPV = Σ PV of cash benefits – Σ PV of cash costs.

$$NPV = \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + \ldots\ldots + \frac{CF_{n-1}}{(1+i)^{n-1}} + \frac{CF_n}{(1+i)^n} - \frac{CF_0}{(1+i)^0} - \frac{CF_4}{(1+i)^4}$$

$$NPV = \sum_{i=1}^{n} \frac{CF_n}{(1+i)^n} - \sum_{i=0}^{p} \frac{CF_p}{(1+i)^p}$$

Example 1

- An investment of $3 million is expected to generate cash flows of $1 million per year for 5 years. The cost of capital is 10%. What is the NPV of this investment?


i = 10%
A = $1m
A
A
A
A
0
1
2
3
4
5
Years
$3m

$$NPV = \frac{CF_1}{(1+i)^1} + \frac{CF_2}{(1+i)^2} + ... + \frac{CF_{n-1}}{(1+i)^{n-1}} + \frac{CF_n}{(1+i)^n} - \frac{CF_0}{(1+i)^0}$$

$$NPV = \frac{\$1m}{(1+0.1)^1} + \frac{\$1m}{(1+0.1)^2} + \frac{\$1m}{(1+0.1)^3} + \frac{\$1m}{(1+0.1)^4} + \frac{\$1m}{(1+0.1)^5} - \frac{\$3m}{(1+0.1)^0}$$

NPV = $790,900

Using tables

- NPV = CF $(P/A_{i,n})$ – 3mil
- NPV = 1mil . $(P/A_{10,5})$ – 3mil
- NPV = 1mil . 3.7908 – 3mil
- NPV = 3.7908 – 3
- NPV = $0.7908mil

Example 2

- You are a mining financial analyst for a Mining Company in Queensland and you have been asked to evaluate two mining projects. The projects cost $500mil each and the cost of capital for each of the project is 10%. The project's expected net cash flows are as follows:

Year	Expected Net Cash Flows in $Mill	
	Project 1	Project 2
0	-500	-500
1	325	175
2	150	175
3	150	175
4	50	175

- Calculate for each of the project Net Present Value (NPV);
- Which project should be accepted if they are mutually exclusive?

Solution

- **Project 1**

$$NPV = \frac{325}{(1+0.1)^1} + \frac{150}{(1+0.1)^2} + \frac{150}{(1+0.1)^3} + \frac{50}{(1+0.1)^4} - \frac{500}{(1+0.1)^0}$$

- $NPV_1 = 295.45 + 123.97+112.70+34.15 - 500$
- **$\underline{NPV_1 = \$66.27}$**

- **Project 2**
- $NPV_2 = A.(P/A_{10,4}) - 500$
- $NPV_2 = 175 \times 3.1699 - 500 = \underline{\$54.73}$
- Project 1 should be accepted because it has high NPV than project 2;

Profitability Index

- This is a variant of the NPV method;
- It assists with the selection of investment opportunities where the NPV criterion has limitations due to;
- 1. Different investment requirements;
- 2. Limitations on funds available for investments;

Cont …

- It is sometimes called Benefit-Cost Ratio or Present Value Index;
- It is calculated by dividing the present value of cash inflows by the present value of cash outflows;
- The decision criteria is to accept project with a Profitability Index (PI) greater than one;

$$PI = \frac{\text{PV of cash inflows}}{\text{PV of cash outflows}}$$

$$PI = \frac{\sum_{i=1}^{n} \frac{CF_n}{(1+i)^n}}{\sum_{i=0}^{p} \frac{CF_n}{(1+i)^n}}$$

- P = Investment period within n
- PI = Obtained by dividing the PV of cash inflow by the absolute value of the discounted negative cash flows.

Example 1

- An investment of $3 million is expected to generate cash flows of $1 million per year for 5 years. The cost of capital is 10%. What is the PI?

Solution

$$PI = \frac{\sum_{i=1}^{n} \frac{CF_n}{(1+i)^n}}{\sum_{i=0}^{p} \frac{CF_n}{(1+i)^n}}$$

$$PI = \frac{(1mil.(P/A_{10,5}))}{3m} = \frac{3.7909m}{3m} = 1.264$$

- So what does this value mean?
- This value means that for every dollar invested, you get $1.264;
- It measures the wealth created per dollar of initial outlay;

Example 2

- Given the following data for the two projects;

Year	Expected Net Cash Flows in $Mill	
	Project 1	Project 2
0	-500	-500
1	325	175
2	150	175
3	150	175
4	50	175

a) Calculate for, each project, the profitability index;

b) Which project should be accepted if they are mutually exclusive?

$$PI = \frac{\sum_{i=1}^{n} \frac{CF_n}{(1+i)^n}}{\sum_{i=0}^{p} \frac{CF_n}{(1+i)^n}}$$

- Project 1

$$\sum \text{PV Cash in} = \frac{325}{(1+0.1)^1} + \frac{150}{(1+0.1)^2} + \frac{150}{(1+0.1)^3} + \frac{50}{(1+0.1)^4} = \$566.27$$

$$\sum \text{PV Cash out} = \frac{500}{(1+0.1)^0} = \$500$$

$$PI = \frac{\sum \text{PV Cash in}}{\sum \text{PV Cash out}} = \frac{566.27}{500} = 1.1325$$

- Project 2

$$\sum \text{PV Cash in} = A.(P/A_{10,4})$$

$$\sum \text{PV Cash in} = 175 \text{ x } 3.1699 = \$554.73$$

$$\sum \text{PV Cash out} = \$500$$

$$PI = \frac{\sum \text{PV Cash in}}{\sum \text{PV Cash out}} = \frac{554.73}{500} = 1.1095$$

- Project 1 should be accepted because it has higher PI than Project 2

Present Value Ratio (PVR)

- Present Value Ratio is the ratio of NPV to Present Worth Cost (PWC);
- The PVR is calculated by dividing the NPV of a project by the Present Value of the Capital expenditure outflows;
- It is discounted at the same rate as used for NPV calculations;
- PVR measures the NPV of the project per unit investment;

CONT …

- PVR is determined as follows;

$$PVR = \frac{NPV}{\sum PV \text{ of } CE}$$

$$PVR = \frac{\sum PV \text{ of } PCF - \sum PV \text{ of } CE}{\sum PV \text{ of } CE}$$

- PCF = Project Cash Flows excluding Capital Expenditure;
- CE = Capital Expenditure;

Cont …

- Relationship between Present Value Ratio and Profitability index is indicated below;

- PVR = PI – 1

Example 1

- An investment of $3 million is expected to generate cash flows of $1 million per year for 5 years. The cost of capital is 10%. What is the PI?

$$PVR = \frac{NPV}{\sum PV \text{ of } CE}$$

$$PVR = \frac{3.7908 - 3}{3} = 0.264$$

Example 2

- Given the following two projects, calculate for each of the project, Present Value Ratio;
- Which project should be accepted if they are mutually exclusive?

Year	Expected Net Cash Flows in $Mill	
	Project 1	Project 2
0	-500	-500
1	325	175
2	150	175
3	150	175
4	50	175

$$PVR = \frac{NPV}{\sum PV \text{ of } CE}$$

- Project 1
- NPV1 = $66.27
- PV of cost = $500

$$PVR = \frac{66.27}{500} = 0.1325$$

- Project 2
- NPV2 = $54.73
- PV of cost = $500

$$PVR = \frac{54.73}{500} = 0.1095$$

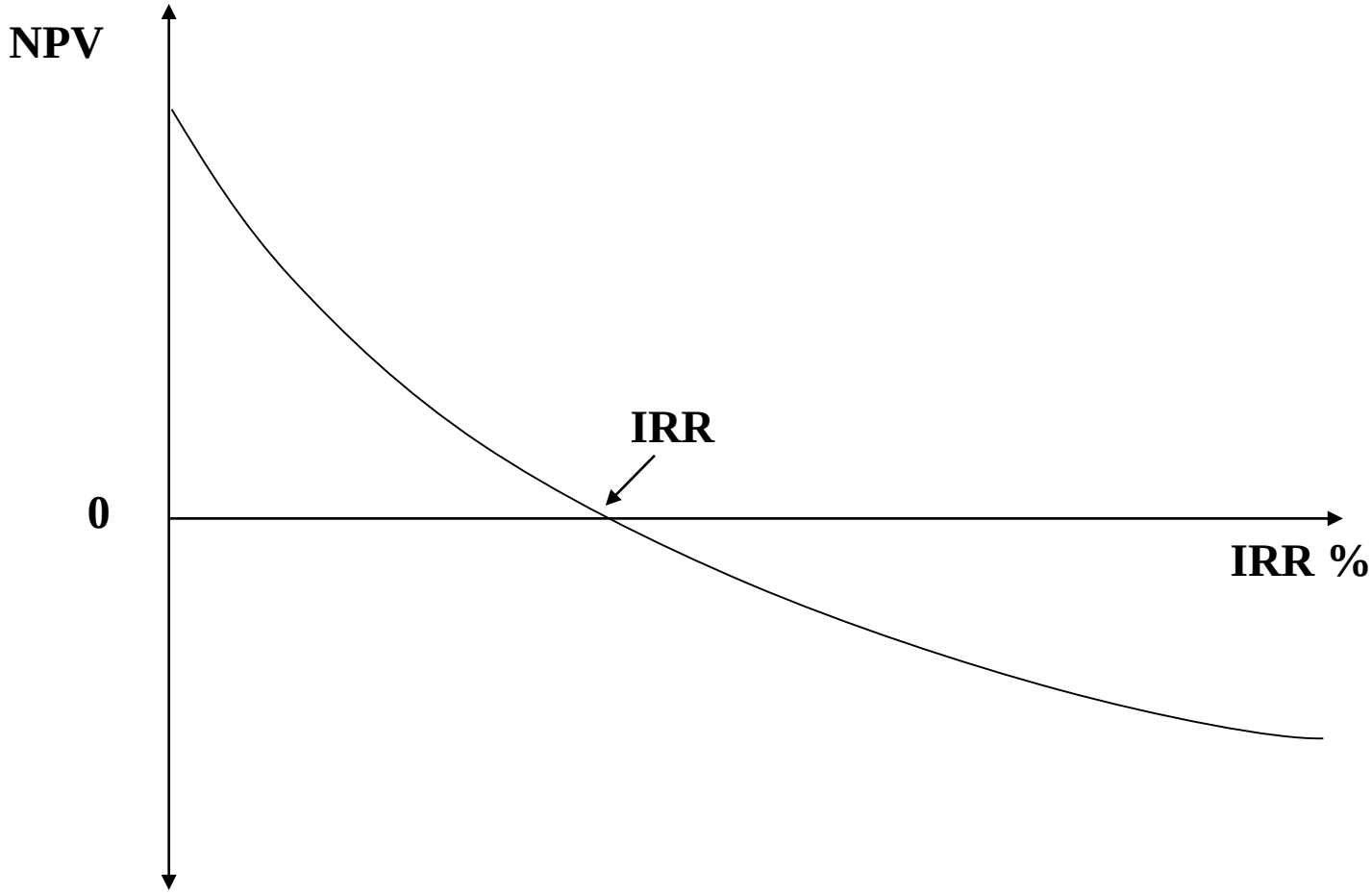
- Project 1 should be accepted because it has higher PVR than Project 2

Internal Rate of Return (IRR)

- The IRR is another discounted cash flow indicator;
- This is the annualized compounded rate of return which can be earned on the invested capital;
- This is the yield on the investment;
- In order for an investment to be attractive, it must generate sufficient positive cash flows to repay the investment expenditures;

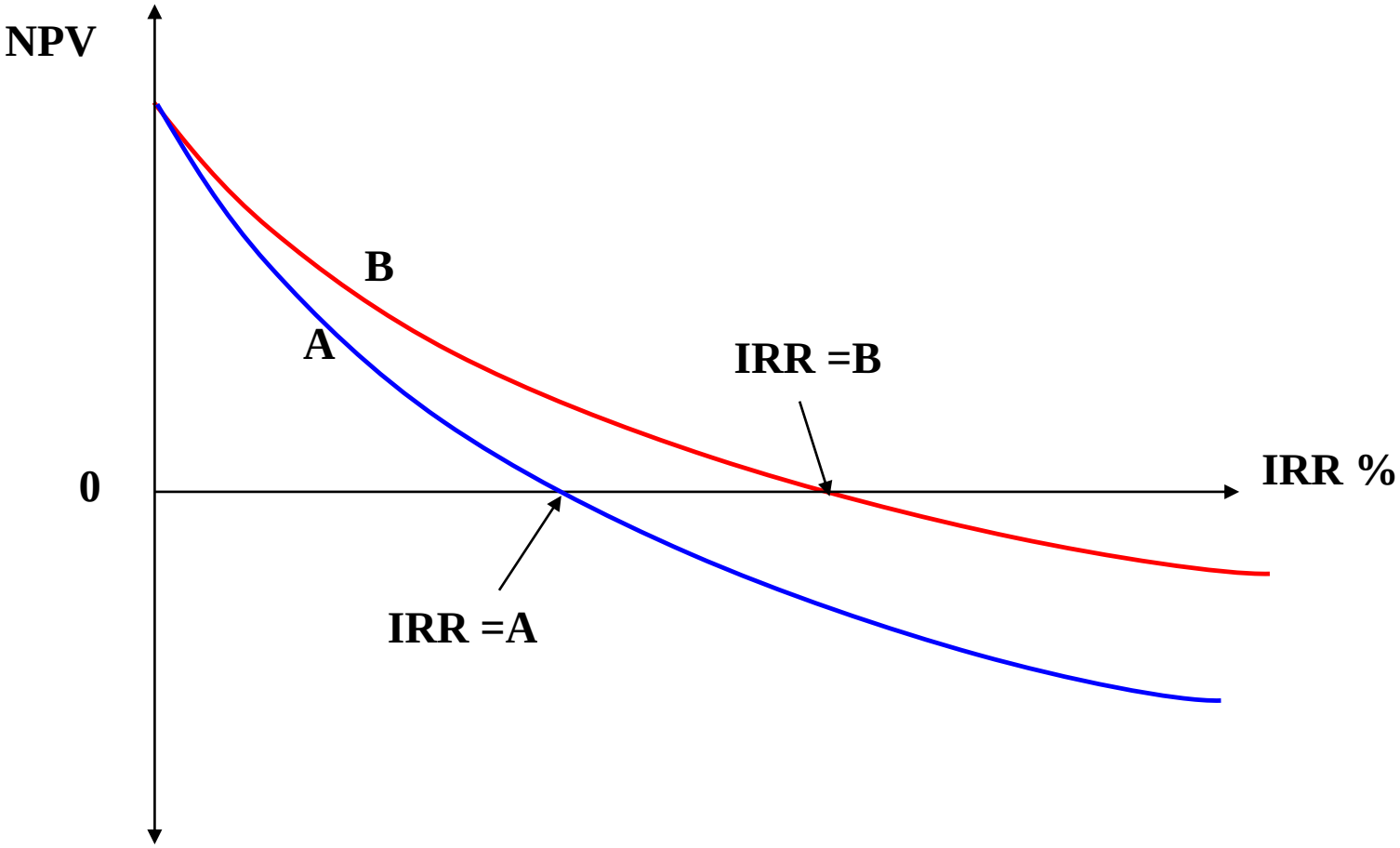
Cont …

- It is also supposed to provide a return for the use of the money;
- The IRR is defined as that discounted rate that sets the NPV exactly to zero;


NPV
IRR
0
IRR %

Cont …

- IRR should also satisfy the following expression;
- **Σ** PV cash inflows – **Σ**PV cash outflows = 0
- NPV = 0
- Calculation of IRR is a tedious iterative process by hand;
- However, computer software and most hand calculators will calculate IRR;
- The higher the IRR the more attractive the project;


NPV
B
A
IRR =B
0
IRR %
IRR =A

Cont …

- In decision making role, the projects generating IRRs greater than the company's target IRR are accepted;
- Projects generating IRRs lower than the target rate are rejected;
- Therefore, IRR can be used to rank several prospective projects a firm is considering;

Criterion

- IRR > Cost of capital (i), accept
- IRR = Cost of capital (i), Break even
- IRR < Cost of capital (i), Reject the investment

Calculating IRR

$$NPV = \frac{CF_1}{(1+R)^1} + \frac{CF_2}{(1+R)^2} + \frac{CF_3}{(1+R)^3} + ... + \frac{CF_n}{(1+R)^n} - \frac{CF_0}{(1+R)^0} = 0$$

- The IRR is found by trial and error method;
- One must solve the NPV equation using different discount rates getting progressively closer to the real IRR each time;

Cont …

- A rough approximation to the IRR can be determined by dividing the total investment expenditures by the average annual cash flows, and dividing the result into 0.7.
- Mathematically,
- 0.7 ÷ ((investment expenditures) / (average cash flow)) = Estimate IRR

Example

- An investment of \$3 million is expected to generate cash flows of \$1 million per year for 5 years. What is the expected IRR.

- NPV = $\sum$PV cash in – $\sum$PV cash out
- $\sum$ PV cash in = A x $(P/A_{R,5})$
- $\sum$ PV cash out = 3 mil
- NPV = 1 mil x $(P/A_{R,5})$ – 3 mil = 0
- $(P/A_{R,5})$ = 3

Cont …

- From tables, for n = 5
- For R = 19% : $(P/A_{R,5}) = 3.058$
- For R = 20% : $(P/A_{R,5}) = 2.991$
- By interpolation
- **R = 19.9%**

Advantages

- Considers all cash flows
- Considers time value of money

- **Disadvantages**
- Does not show dollar improvement in value of firm if project is accepted.
- IRR can be affected by the scale (size) of the project.

Example 1

- For a capital investment of $5m, a small mine returns an annual profit of $1.5m for a life of five years. A 12% return on investment is desired. Calculate;

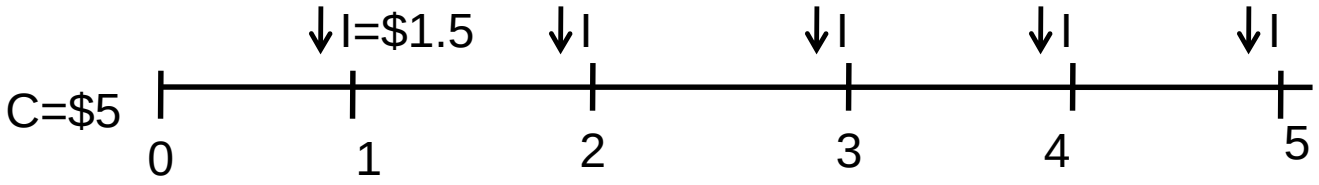
  (a) Present worth (NPV)

  (b) Future worth

  (c) Annual worth

  (d) IRR of the investment

SOLUTION



- Present worth (NPV) = ΣPV cash in – ΣPV cash out
  = $1.5(P/A_{12,5}) - 5$
  = 1.5 (3. 608) – 5
  = +$0.407m

- Future Value (F) = $P(1+r)^n$
  = $0.407\ (1+0.12)^5$
  = $0.715m

CONT …

$$\text{Annual worth (A)} = F\left[\frac{i}{[(1+i)^n - 1]}\right]$$

$$= 0.715\left[\frac{0.12}{[(1+0.12)^5 - 1]}\right] = +\$0.12 \text{ per year}$$

$$NPV = \frac{CF_1}{(1+R)^1} + \frac{CF_2}{(1+R)^2} + \frac{CF_3}{(1+R)^3} + ... + \frac{CF_n}{(1+R)^n} - \frac{CF_0}{(1+R)^0} = 0$$

$$= I.(P/A_{R,n}) - CF_0 = 0$$

CONT …

$$= 1.5 \text{ x } (P/A_{R,5}) - 5 = 0$$

$$= 1.5 \text{ x } (P/A_{R,5}) = 5$$

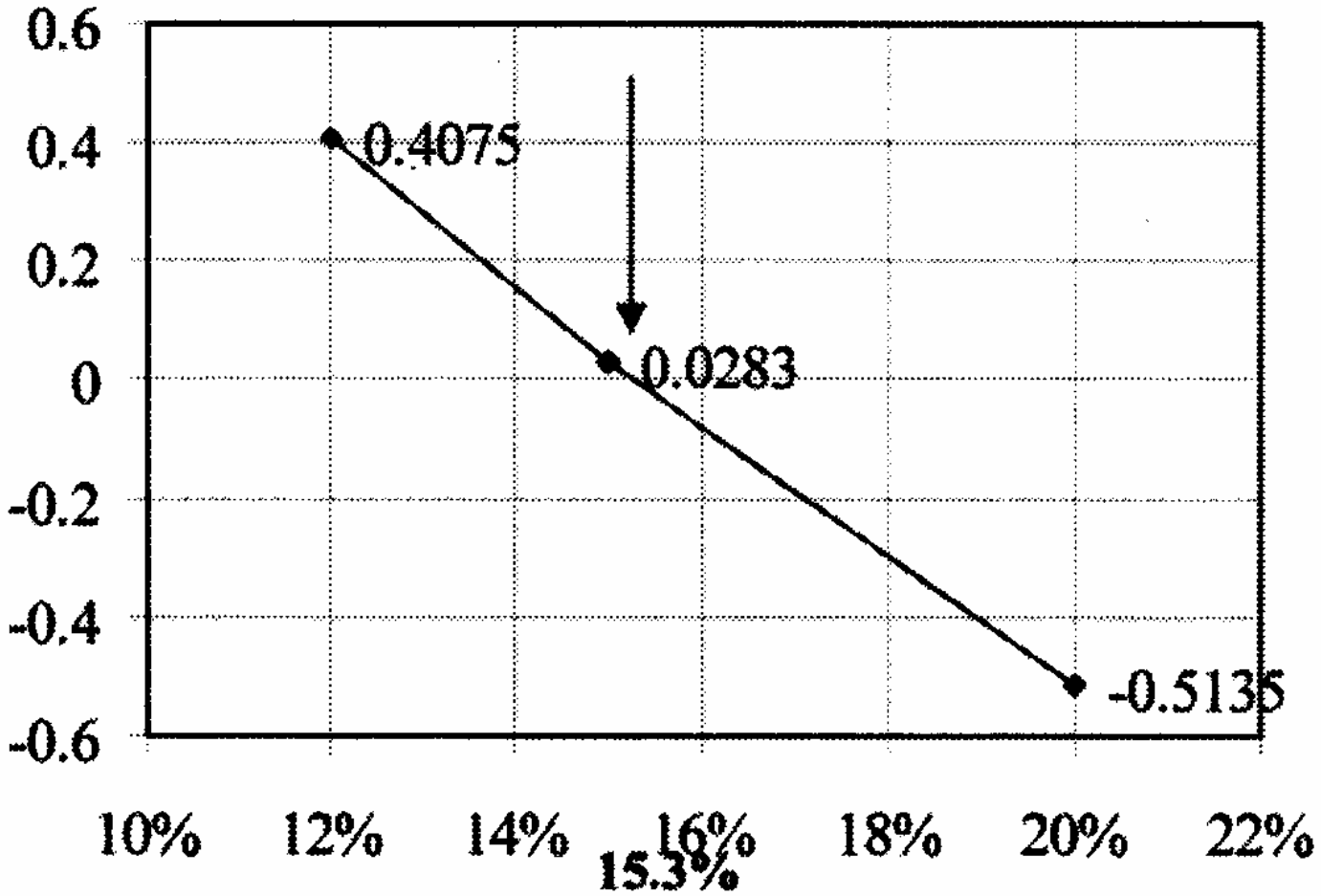
By trial and error

(a) R = 15% NPV is 0.0283

(b) R = 20% NPV is -0.5135

By interpolation

R = 15.3%



From graph, R = 15.3%

EXAMPLE 2

- A gold mining company invested $4 million in an Open Pit project. This investment is expected to generate cash flows of $1.2 million per year for 6 years. If the cost of capital is 10%, determine;
- 1. The expected IRR;
- 2. Comment on the financial viability of this investment.

Solution

- NPV = A.$(P/A_{R,6})$ – 4 = 0
- 1.2.$(P/A_{R,6})$ = 4
- $(P/A_{R,6})$ = 3.333

- From tables
- 20% = 3.3255
- 18% = 3.4976
- From interpolation IRR ≈ **19.9%**
- Project should be accepted since IRR is greater than the cost of capital.

Exercise

- You are a mining financial analyst for a Mining Company in Queensland and you have been asked to evaluate two mining projects. The projects cost $500mil each and the cost of capital for each of the project is 10%. The project's expected net cash flows are as follows:

Year	Expected Net Cash Flows in $Mill	
	Project 1	Project 2
0	-500	-500
1	325	175
2	150	175
3	150	175
4	50	175

- Calculate for each of the project IRR;
- Which project should be accepted if they are mutually exclusive?

Rate of return analysis for service producing investments

- Usually profitability measure for the selection of economic service producing investment will give an infinite IRR;
- This is because of the negative cash flows (costs) and no positive cash flows to offset these costs;
- Also one limitation of IRR is that it cannot be calculated when cash flows are either all positive or all negative;

Cont …

- This limitation can be avoided by performing **incremental IRR analysis** for selecting among service producing investment alternatives;
- This is done by subtracting the cost of one alternative from the cost of the other alternative;
- The difference between the two costs is the savings (positive and negative) one alternative generates over the other;

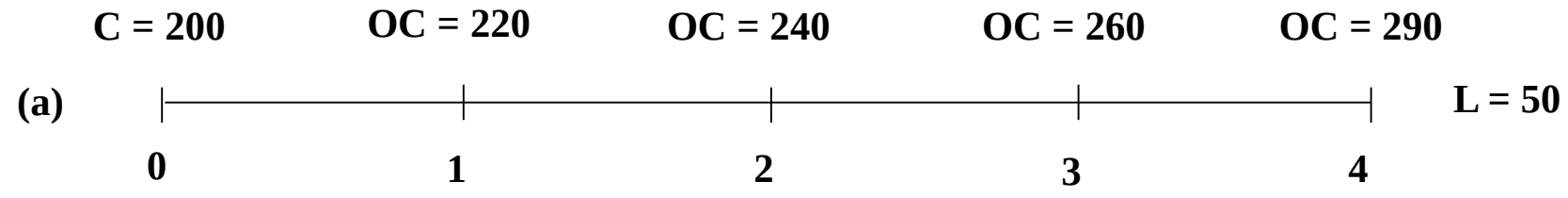
Cont …

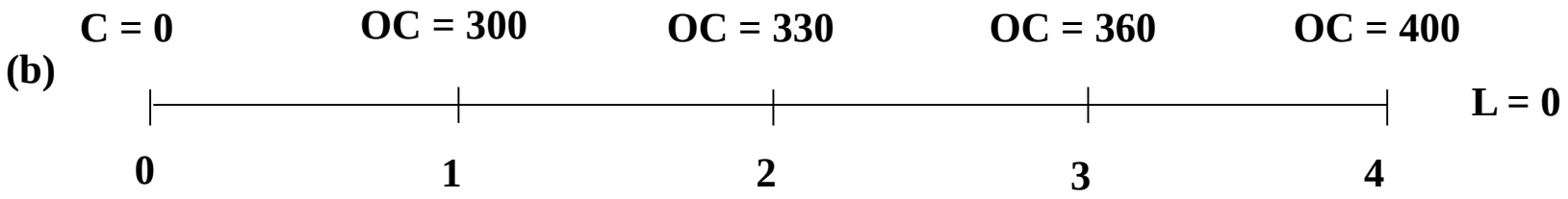
- The IRR analysis are then performed on these incremental costs;
- If the incremental IRR is greater than the minimum acceptable IRR select the high initial cost alternative and vice versa;
- If there are more than two alternatives, the survivor of the two is then compared with the next alternative;
- This is repeated until the entire available alternatives are exhausted;

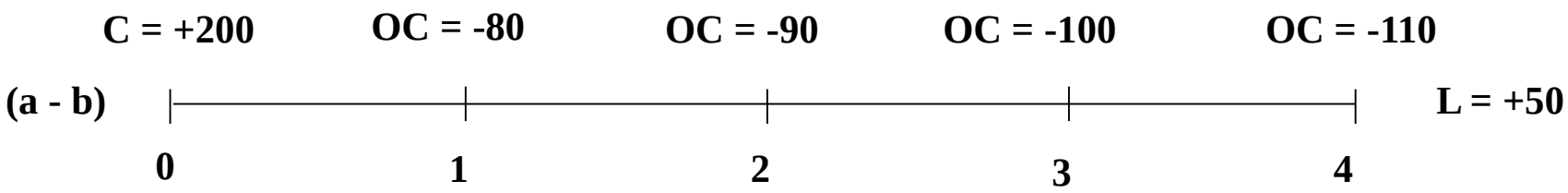
Example

- A mine is considering the installation of automated equipment in its processing plant to reduce labour costs from:
- $300,000 to $220,000 in year 1, from
- $330,000 to $240,000 in year 2, from
- $360,000 to $260,000 in year 3, and from $400,000 to $290,000 in year 4.
- The equipment will cost $200,000 now with an expected salvage value of $50,000 in four years. The minimum rate of return is 20%. Use IRR and NPV analysis to determine if the equipment should be installed.

CONT …


C = 200
OC = 220
OC = 240
OC = 260
OC = 290
(a)
L = 50
0
1
2
3
4


C = 0
OC = 300
OC = 330
OC = 360
OC = 400
(b)
L = 0
0
1
2
3
4


C = +200
OC = -80
OC = -90
OC = -100
OC = -110
(a - b)
L = +50
0
1
2
3
4

Solution

- ROR analysis (negative costs are the same as positive savings)

- $200-80(P/F_{i,1})-90(P/F_{i,2})-100(P/F_{i,3})-110(P/F_{i,4}) = 50(P/F_{i,4})$;

- $200=80(P/F_{i,1})+90(P/F_{i,2})+100(P/F_{i,3})+160(P/F_{i,4})$;

Cont …

- By trial and error

  For i = 30% right side of equation = $216

  For i = 40% right side of equation = $181

- By interpolation

  i = 30% + 10% [(216-200)/(216-181)]

  i = 34.6% > 20% so accept

Cont …

- NPV Analysis
- $NPV = 200-80(P/F_{20,1})-90(P/F_{20,2})-100(P/F_{20,3})-160(P/F_{20,4})$;

- = **+64.2>0 so accept**

Growth rate of return (GROR) – Revenue reinvestment questions

- The GROR assumes all positive cash flows are re-invested to the terminal year of the project;
- The problem with the IRR calculation is that the formula assumes that you are re-investing the annual cash flow at the **same rate** as calculated by the IRR;
- As a result, when you have a property that generates significant cash flow, the calculated IRR will **exaggerate** the likely financial return of the property.

Cont …

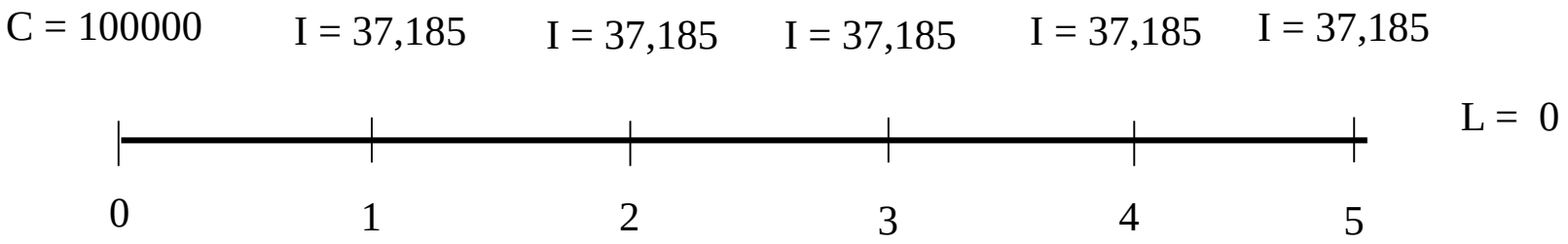
- The GROR allows you to enter a different rate that is applied to the property's annual cash flow;
- The GROR assumes that all cash flows are reinvested at the firm's cost of capital;
- GROR is therefore, the compound interest rate at which invested dollars grow.

Example

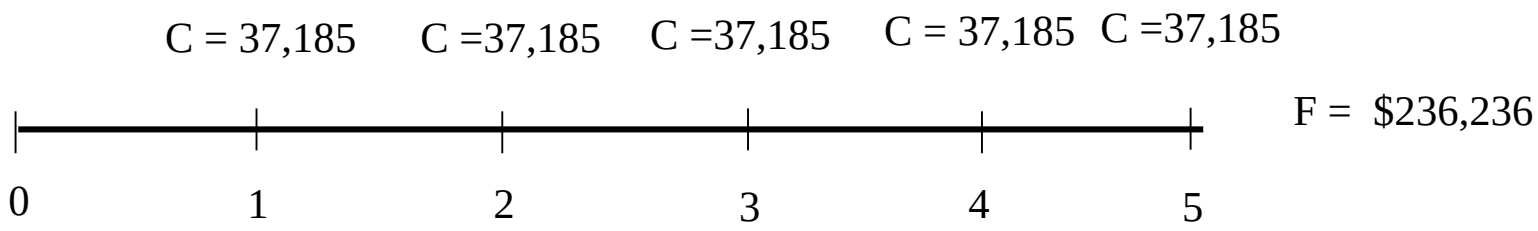
- Consider an investment of $100,000 at year 0 to generate five uniform and equal revenues of $37,185 at each of years 1 through 5 with zero salvage value at year 5. Assume that the investor minimum ROR is 12% over the five year project life. Calculate the project ROR and the investment GROR.

SOLUTION

Initial Project



Revenue reinvest



Future terminal value $F = 37,185\ (F/A_{12,5})$

$= \$236,236$

Cont …

Project ROR;

$= 37,185\ (P/A_{i,5}) - 100,000 = 0$

i = ROR = 25% (trial and error)

Growth ROR

$=236,236\ (P/F_{i,5}) - 100,000 = 0$

i = GROR = 18.76% (trial and error)

Evaluation of non-mutually exclusive investments

- In non-mutually exclusive investments, two or more projects can occur at the same time;
- Selection is based on the combination of projects that will maximise the net value of future worth profit;
- Normally, alternatives are ranked in order that you would want to select them using net value or GROR;

EXAMPLE

- Consider the following four investment alternatives which all have a five year life and zero salvage value. Assume that minimum ROR is 20%.

Alternative	Capital, $	OC saving /yr, $
1	10000	6000
2	25000	10000
3	35000	15000
4	50000	17000

Cont …

- (a) If $50000 is available and alternatives are mutually exclusive, which alternative is best;
- (b) If $35000 is available and alternatives are non-mutually exclusive, what should be chosen;

Solution

- (a) Mutually exclusive alternatives, NPV is used.
- $NPV_1 = 6000\ (P/A_{20,5}) - 10000 = +\$7946$
- $NPV_2 = 10000\ (P/A_{20,5}) - 25000 = +\$4910$
- $NPV_3 = 15000\ (P/A_{20,5}) - 35000 = +\$9865$
- $NPV_4 = 17000\ (P/A_{20,5}) - 50000 = +\$847$

- Alternative 3 should be selected since it has the largest NPV

Cont …

- Non-mutually exclusive alternative;
- Alternatives are;
  - Alternative 3;
  - Alternative 1 plus 2;

- NPV_3 = **$9865**
- NPV_{1+2} = $7946 + $4910 = **$12856**
- Select alternative 1 plus 2

Example of DCF comparison

Gold project: Case A discounted cash flow (Summary)

	Year					
	0	1	2	3	4	5
Production, *oz*		30,000	50,000	50,000	50,000	45,000
Operating revenue at $500/oz, *thousand $*		15,000	25,000	25,000	25,000	22,500
Operating expenses, *thousand $*		10,598	17,762	19,339	21,073	20,882
Operating profit, thousand $		4,402	7,238	5,661	3,927	1,618
Capital expenditure, *thousand $*	15,000					
Salvage value, *thousand $*						3,005
Income tax payable (at 35% tax rate), *thousand $*		97	1,486	1,223	824	167
Net cash flow, *thousand $*	(15,000)	4,305	5,751	4,439	3,103	4,455
Discounted cash flow (at 15% return on investment), *thousand $*	(15,000)	3,744	4,349	2,919	1,774	2,215
Net present value, $	**0**					

Example of DCF comparison

Gold project: Case B discounted cash flow

	Year					
	0	1	2	3	4	5
Production, *oz*		30,000	50,000	50,000	50,000	45,000
Operating revenue at $500/oz, *thousand $*		15,000	25,000	25,000	25,000	22,500
Operating expenses, *thousand $*		9,109	14,737	15,693	16,720	16,241
Operating profit, thousand $		*5,891*	*10,263*	*9,307*	*8,280*	*6,259*
Capital expenditure, *thousand $*	25,000					
Tax depreciation this year at 27.5% declining balance, *thousand $*		6,875	4,984	3,614	2,620	1,899
End-of-year written-down value for tax purposes, *thousand $*		18,125	13,141	9,527	6,907	5,008
Salvage value, *thousand $*						5,008
Taxable profit for this year, *thousand $*		(984)	5,279	5,694	5,661	4,359
Assessed profit for tax payable, *thousand $*		0	4,294	5,694	5,661	4,359
Income tax payable (at 35% tax rate), *thousand $*		0	1,503	1,993	1,981	1,526
After-tax profit, *thousand $*		(984)	3,775	3,701	3,679	2,834
Net cash flow, *thousand $*	(25,000)	5,891	8,760	7,315	6,299	9,741
Discount factor (at 15% return on investment)	*1.0000*	*0.8696*	*0.7561*	*0.6575*	*0.5718*	*0.4972*
Discounted cash flow, *thousand $*	(25,000)	5,122	6,624	4,809	3,602	4,843
Net present value, $	**0**					

Cont …

- The NPV is shown as zero in both cases because the tabulation was set up to derive the IRR.
- In both cases the IRR is 15%.
- A slightly different calculation is necessary to derive the NPV.
- The true (expected) NPV is the cash flow discounted at the cost of capital;
- If the cost of capital is assumed to be 8%, the Table below shows the NPV for both cases calculated at this discount rate;

Cont …

DCF comparison for cases A and B

Characteristic	Case A	Case B	Difference in Results
Production	Same for both cases		—
Operating cost as % of revenues	*78.2*	*63.6*	—
Initial capital cost, $	15,000,000	25,000,000	10,000,000
Internal rate of return, %	*15*	*15*	*15*
Net present value at 8% discount rate, $	2,753,000	5,031,000	2,278,000

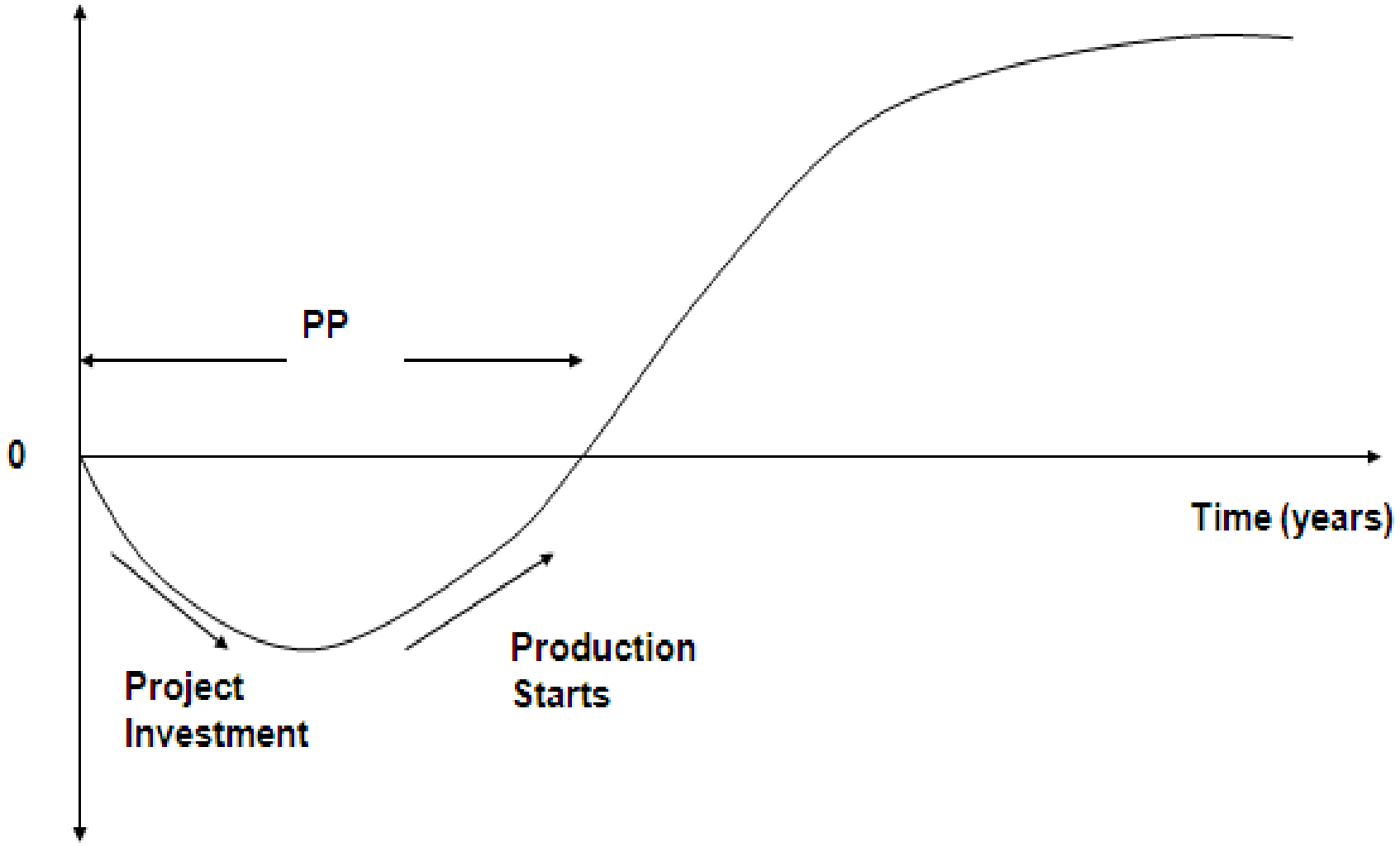
Cont …

- With respect to IRR, there is no difference between the projects;
- From NPV perspective, Case B has the highest value - but since the two projects have different capital requirements;
- They cannot be compared on the basis of NPV alone;
- To make a choice, the difference in capital requirements must first be reconciled;

Non-DCF analysis

Payback Period (PP)

- Also known as payout period;
- It is one of the most commonly evaluation criteria used by mining companies;
- This method answers the question "How long will it take to fully recover the initial investment in a project";
- This is the number of years required for cash income from a project to return the initial cash investment in the project;


PP
0
Time (years)
Project
Investment
Production
Starts

Cont …

- The PP remain unchanged no matter how long the project continues after the payback;
- It is also not affected by the cost of money;
- For investment purposes, project with PP less than the company limit should be funded;
- However, those with PP above limit should be rejected;
- For comparisons, projects should be ranked from shortest PP to the longest;

Advantages of PP

- It is very easy to calculate, but it can lead to wrong decision;
- It puts more emphasis to quick return of the invested funds so that they may be put to use in other places or in meeting other needs;
- It is easy to apply and simple to understand.

Disadvantages of PP

- It fails to give any consideration to cash flows beyond the PP;
- It does not consider time value of money;
- It fails to take into account differences in the timing of the cash flows within the PP;
- PP criteria commonly used (2 – 4 years) may result in the rejection of opportunities which offer a return in excess of the cost of capital;
- Thus can lead to under investment.

Cont …

- The “acceptable” time period is arbitrary.
- The above weaknesses disqualifies the PP as the general method of choosing among investment alternatives.

Calculating PP

$$PP = \frac{\text{Cost of project / investment}}{\text{Annual Cash Flows}}$$

- **Example;**
- If a project costs $500,000 and is expected to return $100,000 annually, the payback period will be $500,000 / $100,000, or five years;

Procedure to determine PP

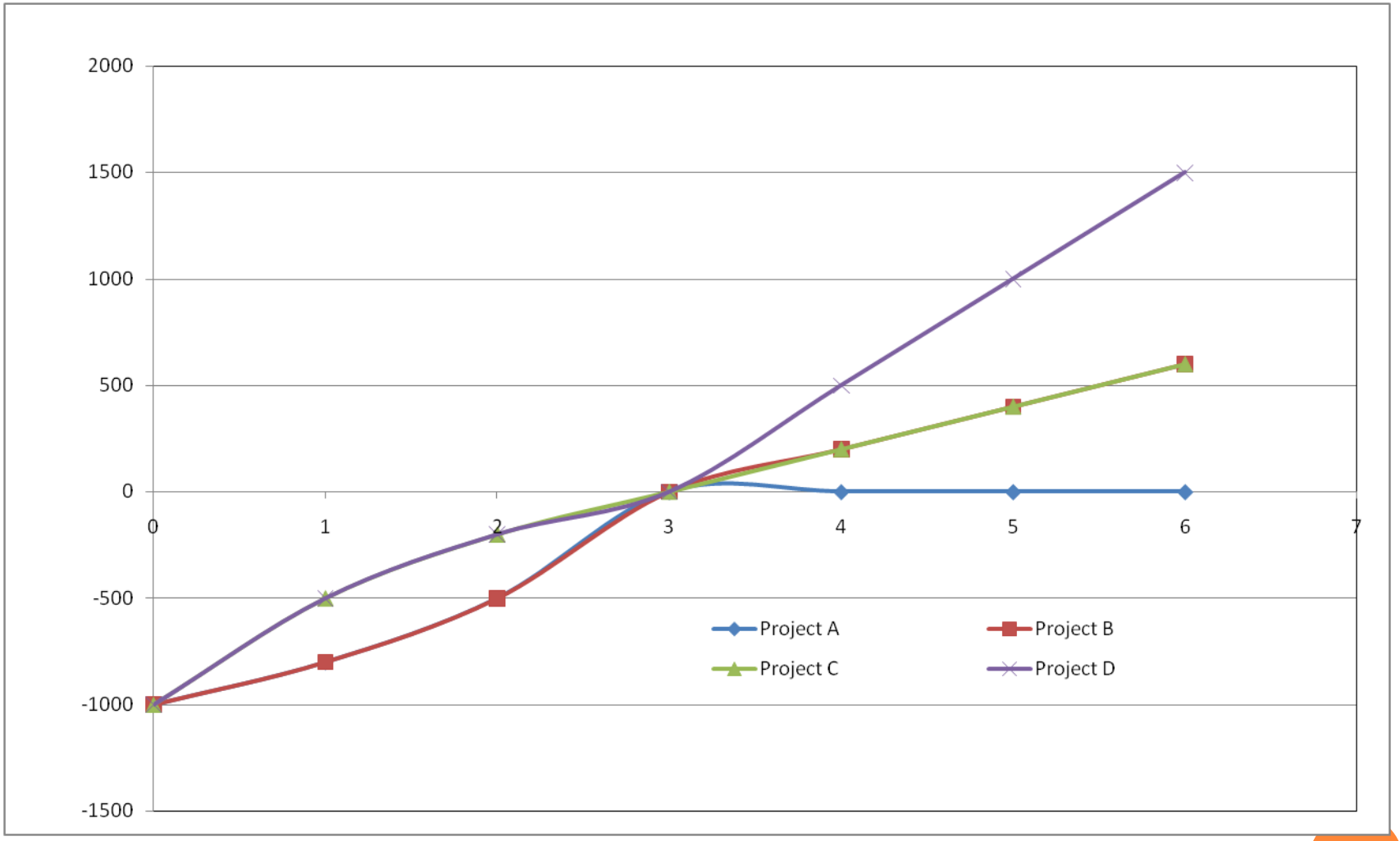
1. Lay out your years and cash flows;
2. Accumulate the cash flows;
3. Identify where the accumulation goes from negative to positive;

Example

Year	A	B	C	D
0	-1000	-1000	-1000	-1000
1	200	200	500	500
2	300	300	300	300
3	500	500	200	200
4	0	200	200	500
5	0	200	200	500
6	0	200	200	500
Total	**0**	**600**	**600**	**1500**

Cont …

Year	A	B	C	D
0	-1000	-1000	-1000	-1000
1	-800	-800	-500	-500
2	-500	-500	-200	-200
3	0	0	0	0
4	0	200	200	500
5	0	400	400	1000
6	0	600	600	1500
Total	**0**	**600**	**600**	**1500**


2000
1500
1000
500
0
-500
-1000
-1500
0
1
2
3
4
5
6
7
Project A
Project B
Project C
Project D

Cont …

- In all cases, the PP is 3 years;

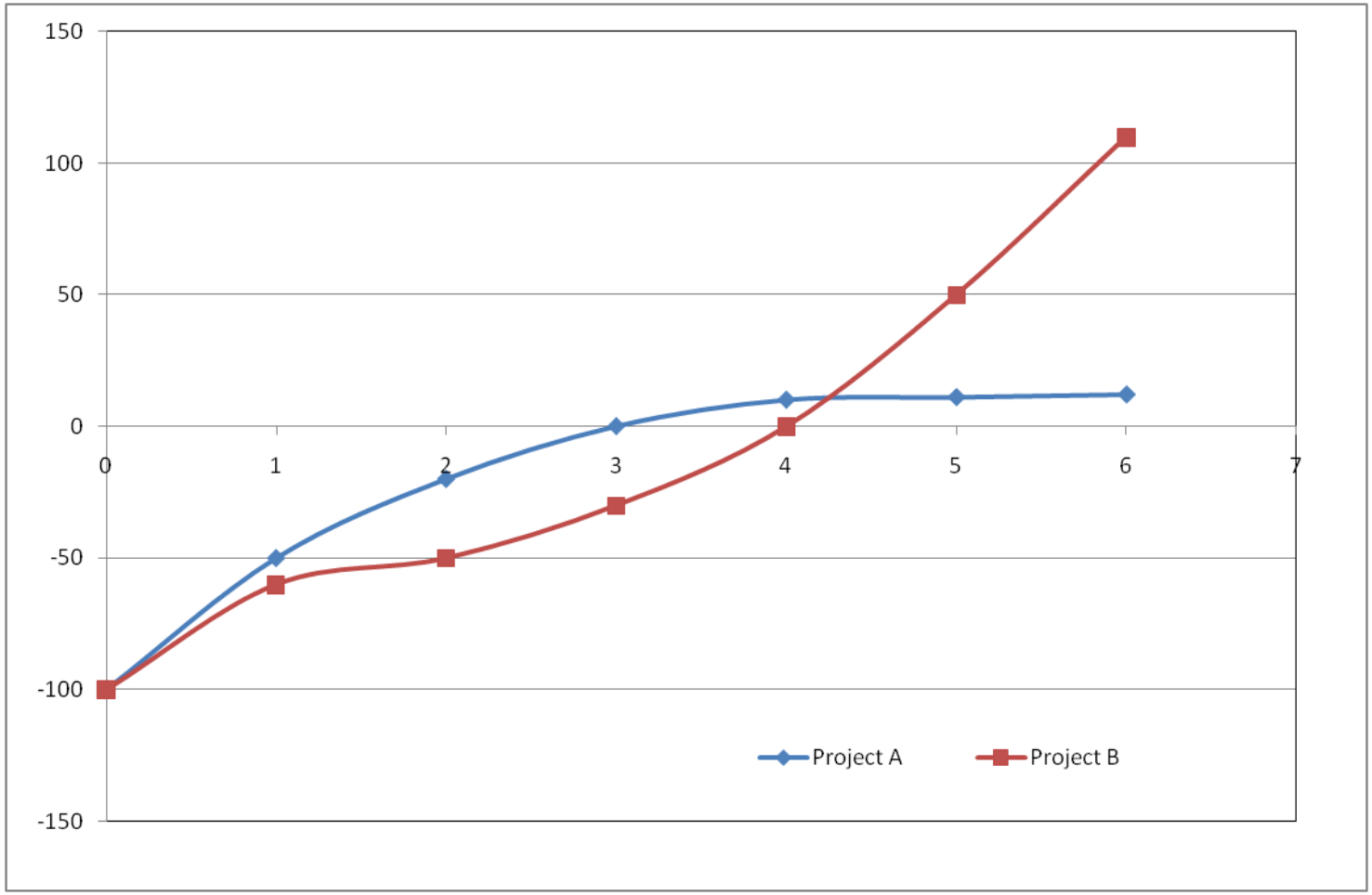
- **Example**
- Assume the firm is considering two projects i.e. **A** and **B**. Each project requires an investment of $100 millions. The cost of capital is 10%. Below is the summary of expected net cash flows in millions.

Year	Project A	Project B
0	-100	-100
1	50	40
2	30	10
3	20	20
4	10	30
5	1	50
6	1	60

- Calculate the payback period for both projects?

- Accumulate the cash flows for each year.

Year	Project A	Project B
0	-100	-100
1	-50	-60
2	-20	-50
3	0	-30
4	10	0
5	11	50
6	12	100


150
100
50
0
-50
-100
-150
0
1
2
3
4
5
6
7
Project A
Project B

Cont …

- PP for Project A = 3 years
- PP for Project B = 4 years

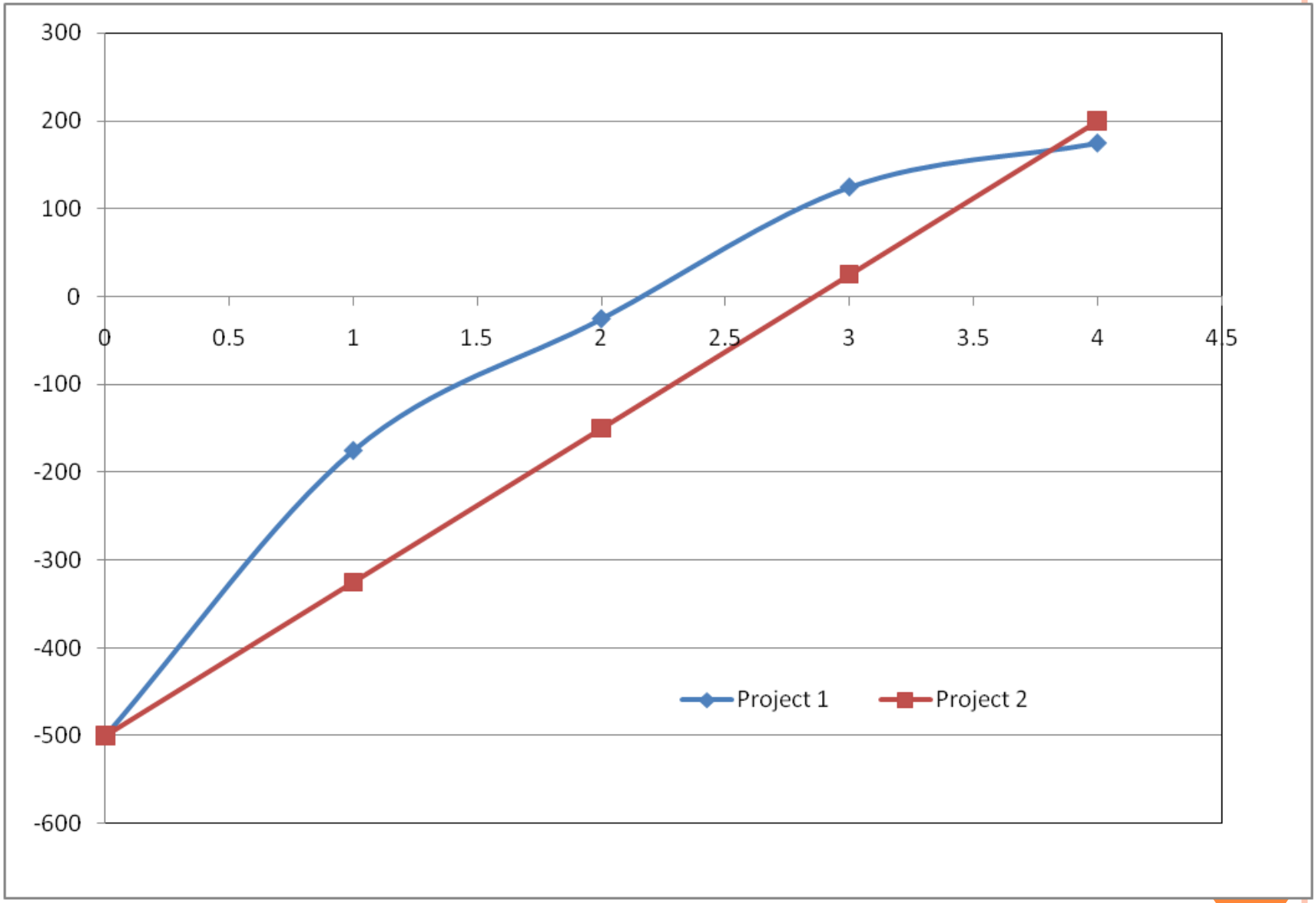
Example

- You are a mining financial analyst for a Mining Company in Queensland and you have been asked to evaluate two mining projects. The projects cost $500mil each and the cost of capital for each of the project is 12%. The project's expected net cash flows are as follows:

Year	Expected Net Cash Flows in $Mill	
	Project 1	Project 2
0	-500	-500
1	325	175
2	150	175
3	150	175
4	50	175

- Calculate the payback period for each of the project;
- Which project should be accepted if they are mutually exclusive?

Year	Expected Net Cash Flows in $Mill	
	Project 1	Project 2
0	-500	-500
1	-175	-325
2	-25	-150
3	125	25
4	175	200


300
200
100
0
-100
-200
-300
-400
-500
-600
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Project 1
Project 2

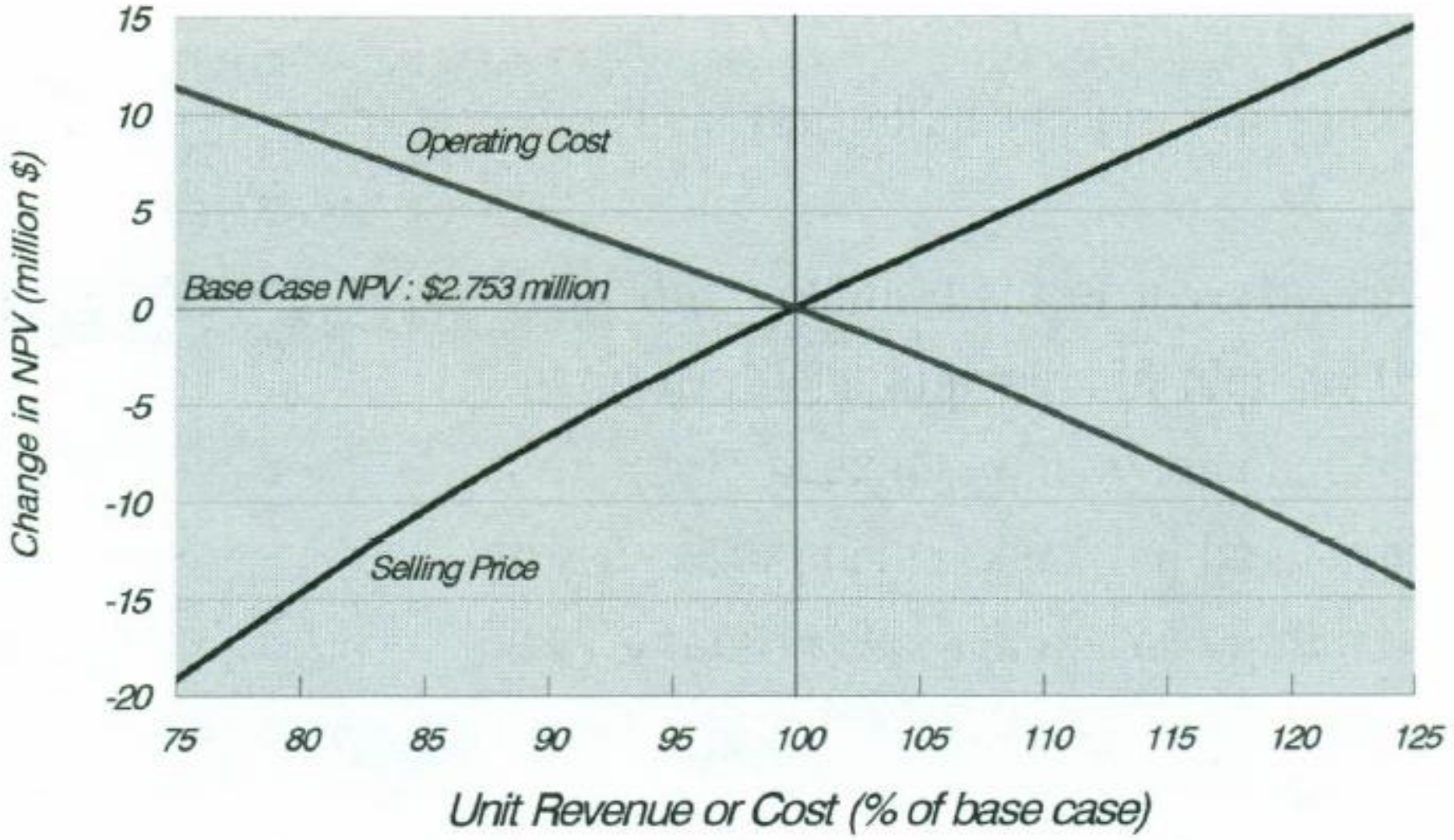
Sensitivity analysis

- Before a commitment is made for a major investment, decision makers must address the "what if' questions;
- e.g. if the selling price declines by $X, what will happen to the return on investment?
- These types of questions are usually addressed with a sensitivity analysis;

Cont …

- It looks at varying one or more of the input variables to determine how much the return on investment changes;
- The figure below shows a simple sensitivity analysis;

SENSITIVITY ANALYSIS: NPV



Cont …

- In the figure, if the operating costs turn out to be 10% greater than planned and nothing else changes, then the NPV will decline by approximately $5.2 million.
- If the selling price turns out to be 10% greater than planned and nothing else changes, then the NPV will increase by approximately $5.7 million.
- Similar diagrams can be prepared showing the change in return on investment.

Cont …

- Two difficulties are evident:
- What are these difficulties?
- 1. The analysis on its own does not provide any guidance for the likelihood of these events happening;
- In this case, is a 10% increase in costs equally as likely to occur as an increase in revenues?
- Projects may be very sensitive to certain assumptions, but if there is little likelihood of the assumption turning out to be wrong, then this is irrelevant.

Cont …

- 2. Sensitivity analyses invoke that all other things remain unchanged.
- This is the biggest difficulty, since mines are changing all of the time in response to changes in the external environment;
- If the price of fuel oil rises, the mine will preferentially use more electrically powered equipment.
- If the selling price rises, lower-grade ores will be incorporated into the mine plan, which may then be changed dramatically.

Cont …

- All other things do not remain unchanged;
- For these reasons, the simple sensitivity study is only of limited use;
- Nevertheless, sensitivity analysis does provide a useful starting point for two extensions of its application:
- 1. Probabilistic analysis; and
- 2. Relative sensitivity analysis;

Cont …

- The probabilistic analysis addresses the probability question;
- If the probability of some change (in an input characteristic) can be obtained or can be estimated, then this analysis allows a probability distribution of the NPV or IRR to be drawn;
- Probabilistic sensitivity analysis has found only limited application in the mining industry to date;

Cont …

- Sensitivity analysis can be used to highlight the relative differences between project alternatives.
- In this context the sensitivity of the project to changes in inputs becomes the decision criterion;

END

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