

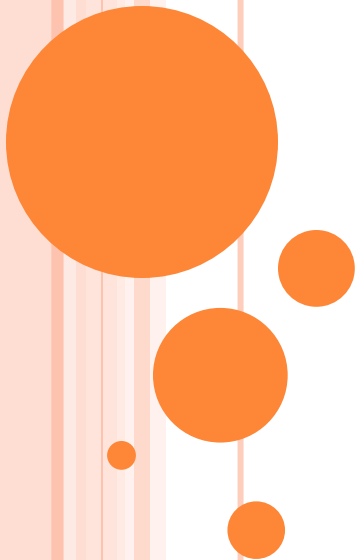
# INTRODUCTION TO MINERAL ECONOMICS

## COST FROM AN ECONOMIC PERSPECTIVE

By

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# CONTENTS

- Costs;
- Cost in economic perspective;
- Cost of production;
- Incremental (marginal) cost analysis;
- Incremental costs analysis with non-linear cost variation;
- Service producing investments-analysis of “cost” problem
- Analysis of mutually exclusive income producing projects;
- Maximization of profit, income and revenue;

# COST

- What is cost?
- Cost is the value that must be given up to acquire a good or service;



# COST IN ECONOMIC PERSPECTIVE

- In economics, the cost of anything is the highest valued opportunity necessarily forsaken;
- Project costs generally vary with the level of production activity of the project;



## CONT ...

- If cost is to influence choice, it must be based on anticipations.
- After the reality, someone else might;
  - 1. Enjoy some of the benefits; and
  - 2. Endure some of the pain;



## CONT ...

- Therefore, the choice is based on;
- 1. The anticipated value (in your mind) of this enjoyment; or
- 2. The pain (cost) in the mind of the decision maker (you.)

## CONT ...

- Failure to appreciate the purpose of the economic concept of cost may mean that efforts are misdirected.
- e.g, the most common difficulty is confusion between the concept of "cost" and the undesirable attributes of some event.
- A new mine includes lots of undesirable attributes:

## CONT ...

- 1. The regulatory approval process;
- 2. The wear and tear on local roads caused by the increased traffic; and
- 3. The potential for construction difficulties;
- These are undesirable attributes of the mine, but they are not costs;
- In an evaluation of any proposal, revenues (good consequences) are weighed against the expenses (bad consequences).



## CONT ...

- The value of a given plan is the sum of all of its elements i.e., good and bad.
- A typical mining study assesses all of these good and bad attributes;
- It then determines a risk-adjusted, time-valued sum of revenues, operating expenses, taxes, etc to arrive at the net present value (NPV).

## CONT ...

- Therefore, cost is the NPV of the next most attractive alternative plan that is forsaken in favour of the plan at hand;
- The NPV of this alternative plan is itself derived by weighing up the same good and bad attributes of that plan;
- This economic concept of cost also has important implications for decisions regarding capital and other long-term commitments;

## CONT ...

- Capital decisions are long-term decisions, but when the decision is made the choice is not necessarily an irreversible path into the future.
- The decision to perform the action may be partly revocable;

## CONT ...

- Thus, it is only the irrevocable part that constitutes value or likely loss of value in the event of unanticipated obstacles to plan fulfilment.



## TYPES OF COSTS

- Every business needs to know what the costs to produce its products are if it is to make sensible business decisions;
- Some of the more important cost include;
- 1. **Fixed costs** (costs that does not vary with the level of output);
- 2. **Sunk costs** (costs that have already been incurred and cannot be recovered e.g. exploration costs)
- 3. **Recoverable costs** (depreciated asset cost that you can recover);

## CONT ...

- 4. **Opportunity costs** (are costs that result from not taking up the alternate use of a good, service or asset);
- 5. **Variable costs** (costs that change with the level of output);
- 6. **Operating costs** (Operating costs are the recurring expenses which are related to the operation of a business);
- 7. **Externalities** (costs or benefits arising from an economic activity that affect somebody other than the people engaged in the economic activity);

# COST OF PRODUCTION

- The cost of a unit of product is made up;
  - Fixed costs;
  - Variable costs;

# FIXED COST

- These are also referred to as overhead costs.
- They remain constant regardless of the level of production activity.
- Examples of fixed costs are;
  - Rent on a plant and equipment
  - Taxes
  - Insurance
  - Management and staff salaries
  - Heat and light
  - License fees
  - property taxes



## CONT ...

- They also tend to be proportional to time.
- They are also independent of the number of units produced;
- These are simply not responsive to production levels.

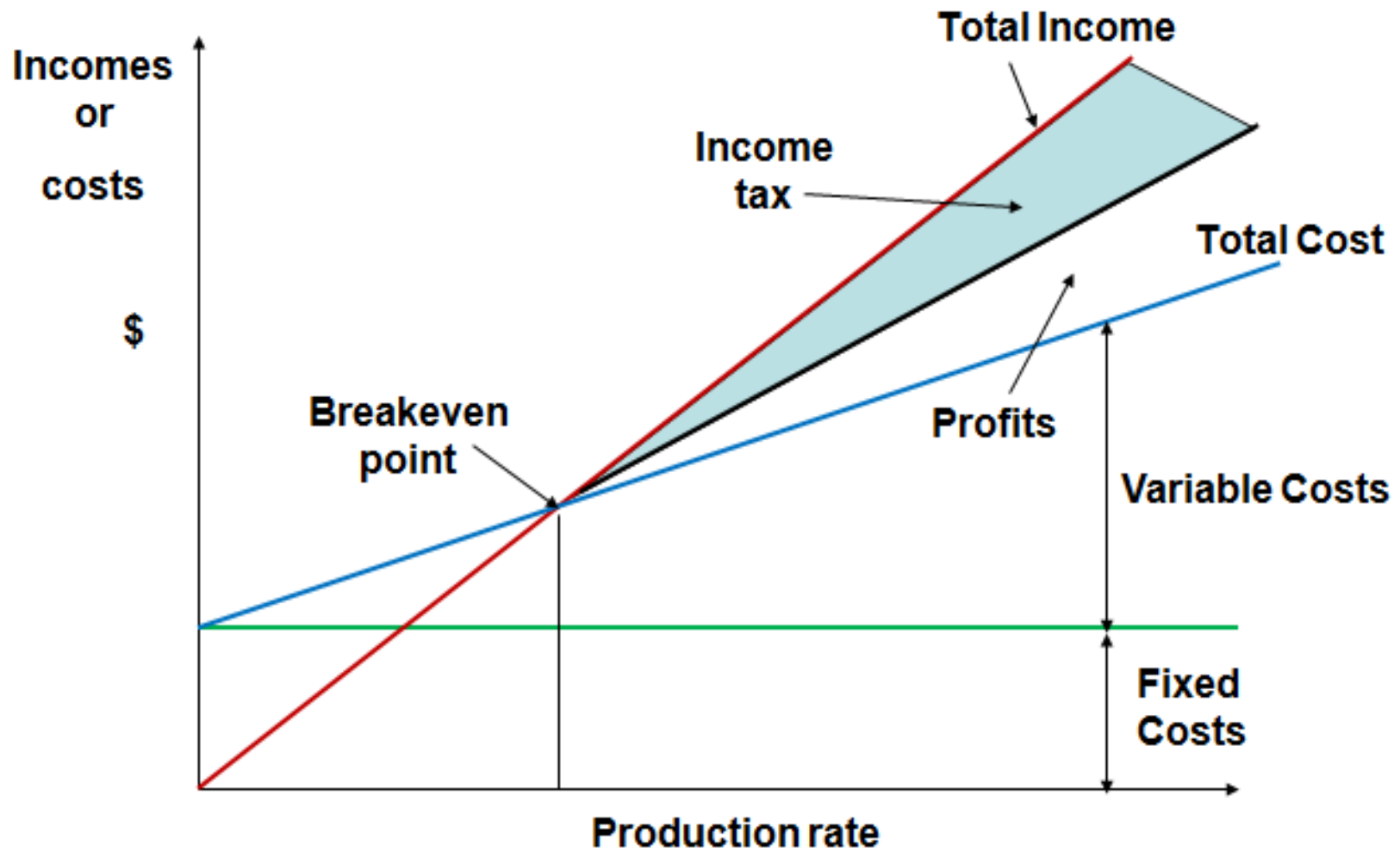
# VARIABLE COST

- Variable costs are costs that can be varied flexibly as conditions change.
- They normally vary with level of production (e.g. labour, material etc);
- Labour is a much more flexible resource than capital investment.
- People can change from one task to another flexibly;
- Variable costs grow with higher levels of production;

# EXAMPLE OF VARIABLE COST

- Raw materials and resources
- Direct labour
- Packaging
- Maintenance
- Freight

# CONT ...



## BREAK-EVEN ANALYSIS

- It refers to calculations to determine how much product a company must sell in order to break even on that product;
- It is an effective analysis to measure the impact of different marketing decisions;
- It focuses on the product to determine the potential outcomes of marketing tactics;

# COMPONENTS OF BREAK EVEN ANALYSIS

- The three components of break even analysis are;
  - Volume
  - Cost
  - Profit

# VOLUME

- This is the level of production by a company;
- This can be expressed as the number of units (i.e. quantity) produced and sold;

# COSTS

- Two types of costs are;
  - Variable cost
  - Fixed costs
- Total variable costs are a function of the volume and the variable cost per unit.
  - Total Variable costs =  $V \cdot VC$

Where

$VC$  = Variable cost per unit

$V$  = Volume (number of units)



## CONT ...

- Total cost of an operation is computed by summing total fixed cost and total variable cost as follows;
  - Total cost = Total Fixed Cost + Total variable cost
  - $TC = FC + V.VC$
- Total costs are the sum of all costs.
- This is what it costs to operate at some particular rate of output.
- Therefore, total cost describes the total economic cost of production and is made up of variable and fixed costs.

# PROFIT

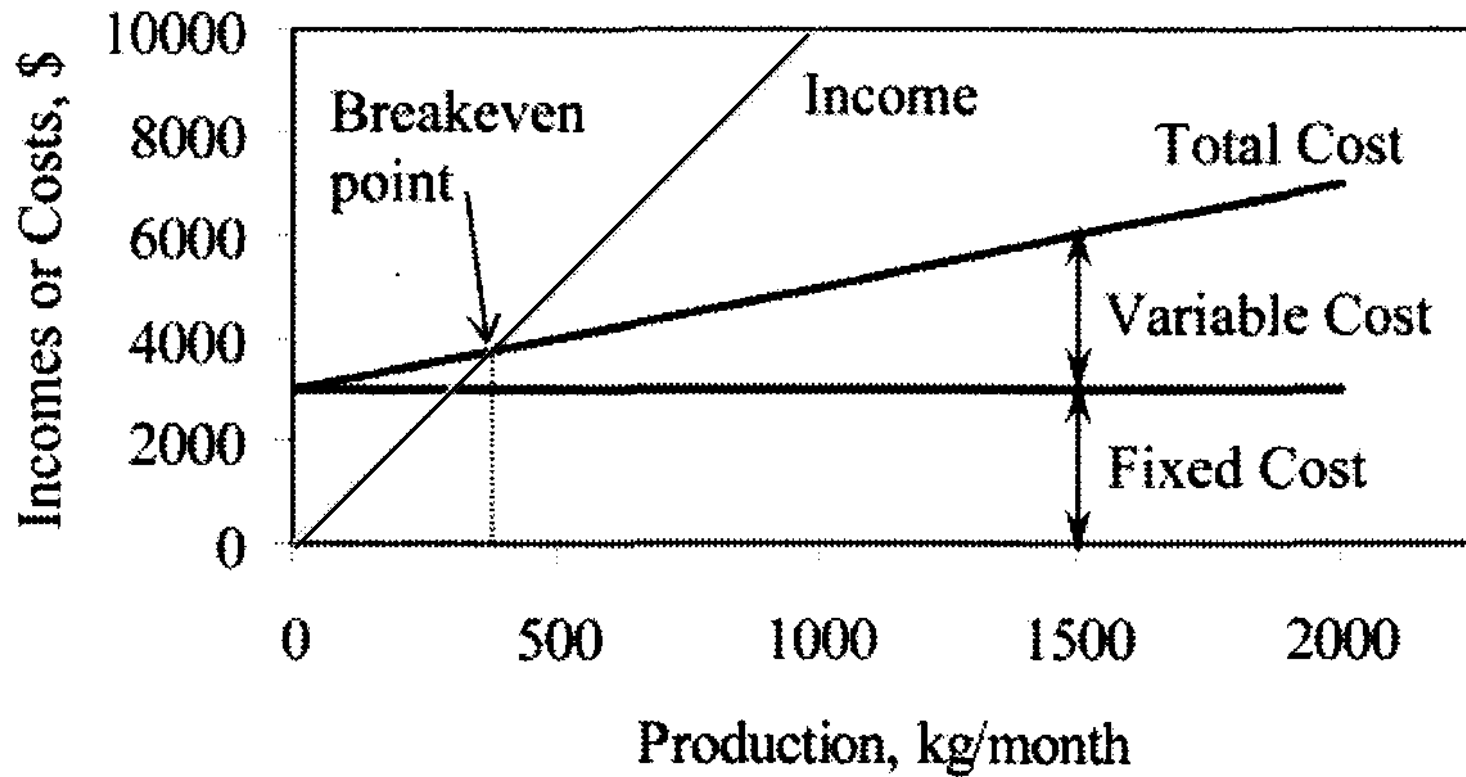
- Profit is the difference between total revenue and total cost.
- Total revenue is the volume multiplied by the price per unit.
  - Total Revenue =  $V.P$
  - Where
    - $P$  = Price per unit

## CONT ...

- The formula for a break even analysis is:
- Revenue @ break even point (\$) = Total Fixed Costs + Total Variable Costs.
- Total Variable Costs (\$) = Variable cost / unit x units sold.
- Unit contribution (\$) = Price per unit - Total cost per unit.

# EXAMPLE

- The total cost of producing 1000kg of a chemical product per month is \$5000. The total cost of producing 1500kg of the chemical per month is \$6000. Assuming that variable costs vary directly with production rate (**i.e. assuming they vary linearly with production rate**), determine the following.
  - The variable cost per unit
  - Total fixed cost
  - The fixed cost per unit for the first 1000 units / month
  - The total cost per unit for the first 1000 units / month
  - If the chemical product is sold for \$10 per kg, what production rate is required for costs to break even with income?
  - What is the profit or loss to produce and sell 200kg/month of chemical? 1000kg/month?



CONT ...

- (a) Variable cost per kg,  $C_v$  is the slope of the total cost curve. Therefore,

$$C_v = (6000 - 5000) / (1500 - 1000) \\ = \underline{\$2.00 \text{ per kg.}}$$

- $C_v$  is also the variable, marginal or incremental cost/unit.

## CONT ...

- (b) The total fixed cost can be calculated either graphically or mathematically. From Fig. 1, the total cost curve intersects the zero production rate axis where the fixed cost  $FC = \$3000$ . Mathematically, the equation for the straight line that represents the total curve is as follows;
- From equation of straight line  $y = mx + c$ ,
  - $\text{Cost} = C_v \times (\text{production rate}) + FC$

## CONT ...

- $\$5000 = C_v(1000) + FC$  or
  - $\$6000 = C_v(1500) + FC$
  - Since  $C_v$  is \$2.00 per unit
  - **FC = \$3000**
- 
- (c) Fixed cost for first 1000 units/month is calculated as follows;  
FC/No. of units  
 $3000/1000 = \textbf{\$3 per kg.}$



## CONT ...

- (d) Total cost for first 1000 units/month is calculated as follows;  
Total Cost for first 1000 units / No. of units  
 $5000/1000 = \underline{\$5 \text{ per kg.}}$   
or  $TC = FC + C_v$   
 $= 3 + 2 = \underline{\$5 \text{ per kg}}$
- (e) Breakeven point can be found graphically as being equal to \$375.  
Mathematically, it is the intersection of the total cost equation and the total income equation.

## CONT ...

- If we let **X** represent the production rate per month, breakeven production is calculated as follows;

$$\text{Total cost} = (\$2/\text{kg}) \times (\mathbf{X} \text{ kg/month}) + 3000$$

$$\text{Income} = (\$10/\text{kg}) \times (\mathbf{X} \text{ kg/month})$$

At breakeven,

$$\text{Total Cost} = \text{Total Income}$$

$$2X + 3000 = 10X$$

$$\underline{\mathbf{X = 375 \text{ kg/month}}}$$

Thus production below 375kg/month results in a loss and above yields a profit.

## CONT ...

- (f) A production of 200kg/month will result in a loss.

Income – Total Cost

$$=(\$10/\text{kg} \times 200\text{kg}) - (\$2/\text{kg} \times 200 + 3000)$$

$$=-\$1400 \text{ or a } \$1400 \text{ loss.}$$

- (g) A production of 1000 kg/month will give a profit.

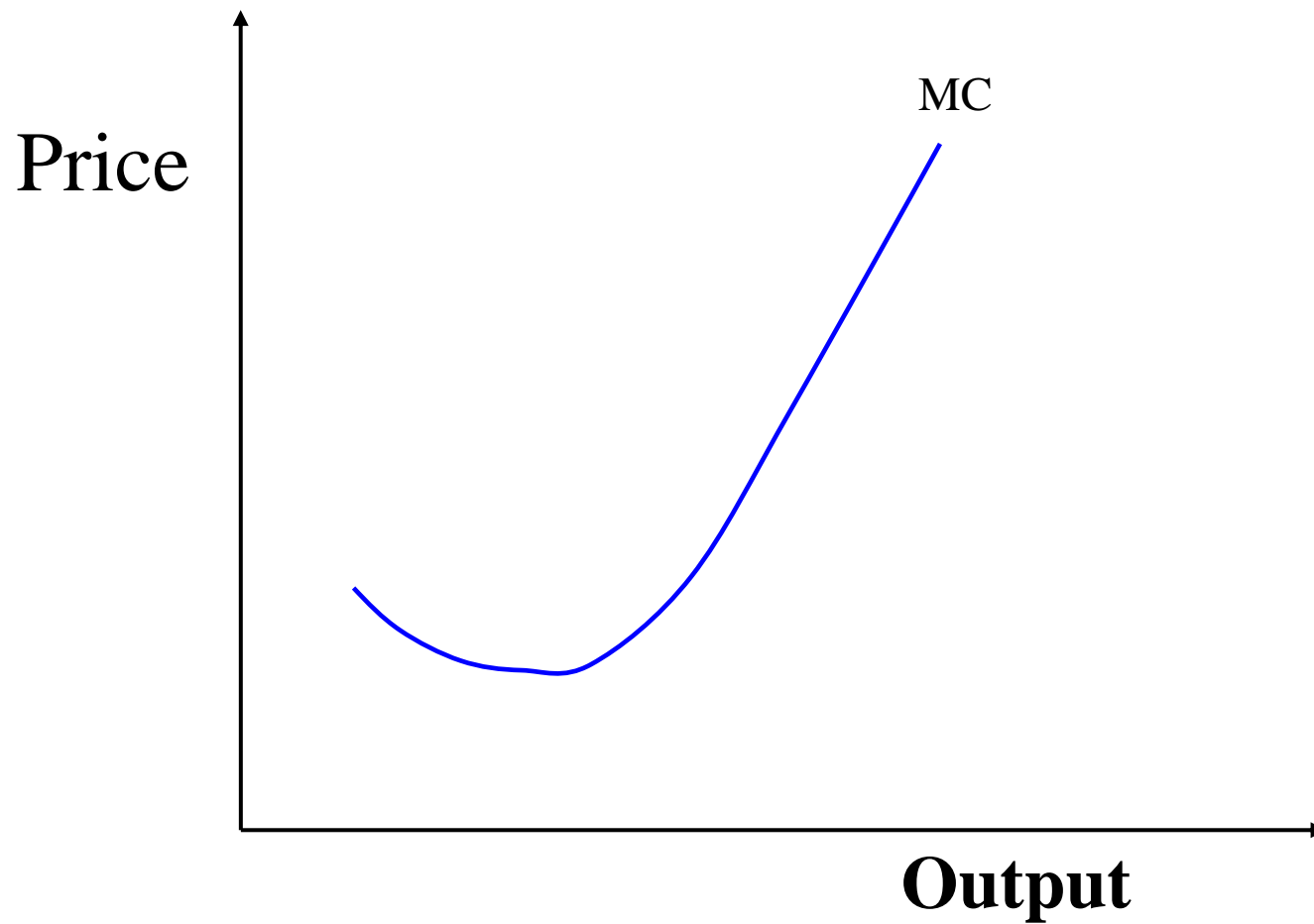
$$=(\$10/\text{kg} \times 1000\text{kg}) - (\$2/\text{kg} \times 1000\text{kg} + 3000)$$

$$=+\$5000 \text{ /month profit}$$

## INCREMENTAL (MARGINAL COSTS- MC) ANALYSIS

- Marginal cost is the change in total cost that arises when the quantity produced changes by one unit.
- They indicate by how much the total costs changes because of modification in the production level by one unit.
- MC function is expressed as the derivative of the total cost (TC) function with respect to level of production ( $Q$ ).

$$MC = \frac{\partial TC}{\partial Q}$$



## CONT ...

- When there are only fixed costs, marginal cost will be zero (**why?**)
- Any increase of production does not change costs.
- If there are only proportionally-growing variable costs, marginal costs will be equal to variable costs.

## INCREMENTAL COSTS ANALYSIS WITH NON-LINEAR COST VARIATION

- In this analysis, the variable cost does not increase linearly with production rate.
- Therefore, different production levels will not result in the same incremental cost.
- Since the variable cost is not linear, the total cost for different production rates will also be different.

## EXAMPLE

- The cost per period at different levels of output for a mine are given in the following table. The sales price of the product is \$20 per tonne. The mine is operating at 100% of rated capacity when a purchase order from a company is received for an extra 1000 tonnes per period at a reduced sales price of \$14/tonne.



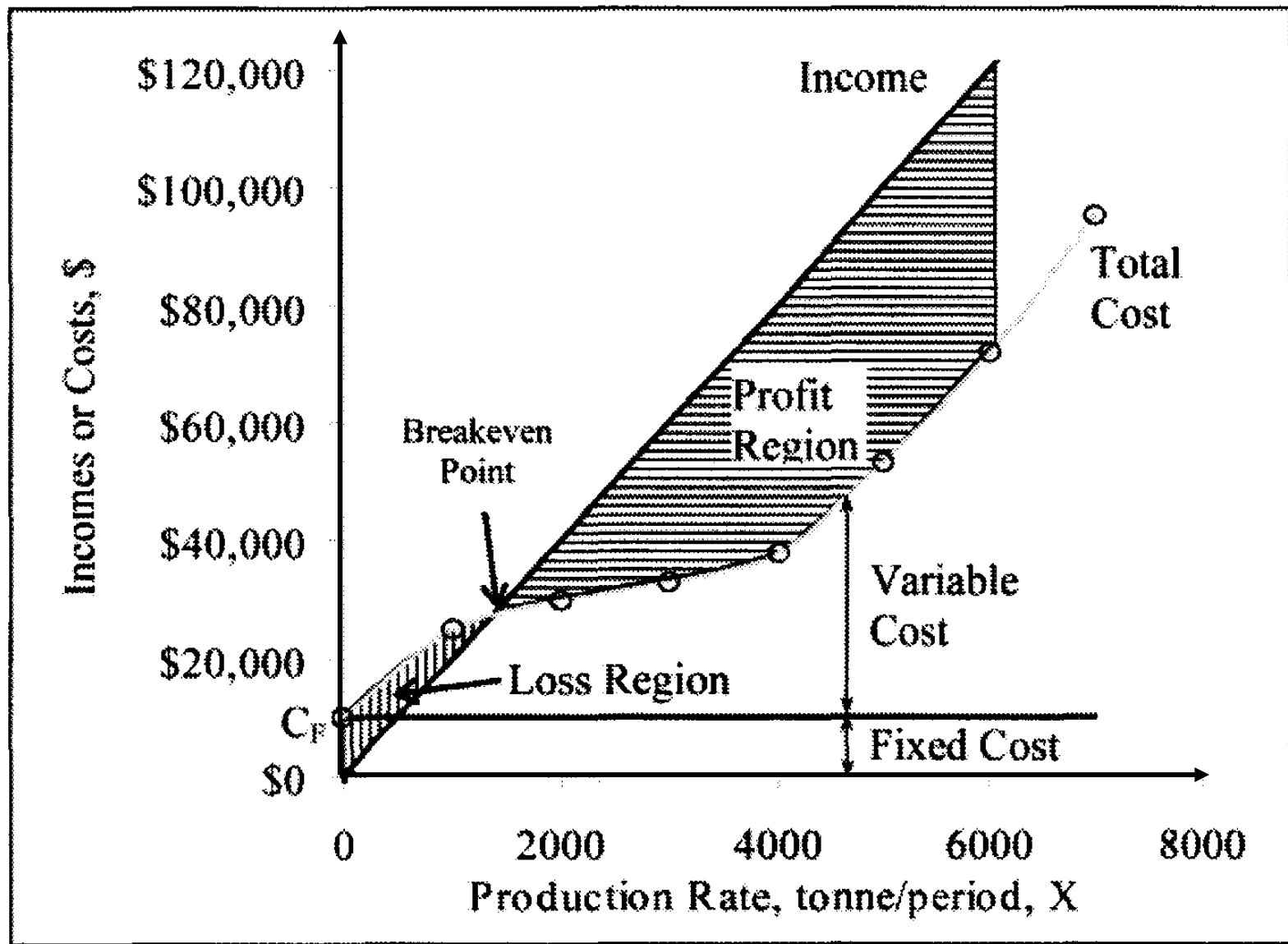
<b>Rated Capacity</b>	<b>Tonnage</b>	<b>Fixed Cost</b>	<b>Variable Cost</b>	<b>Total Cost</b>	<b>Total \$/t</b>	<b>Incremental Cost \$/t</b>
0	0	\$10000	0	\$10000	\$∞	
25%	1000	\$10000	\$15000	\$25000	\$25	\$15
50%	2000	\$10000	\$20000	\$30000	\$15	\$5
75%	3000	\$10000	\$23000	\$33000	\$11	\$3
<b>100%</b>	<b>4000</b>	<b>\$10000</b>	<b>\$28000</b>	<b>\$38000</b>	<b>\$9.5</b>	<b>\$5</b>
125%	5000	\$10000	\$43000	\$53000	\$10.6	\$15
150%	6000	\$10000	\$62000	\$72000	\$12	\$19
175%	7000	\$10000	\$85000	\$95000	\$13.57	\$23

## CONT ...

- (a) Should the sales manager accept the order if the decision is based on whether accepting the order will increase the period profit?
- (b) Where is the breakeven point at the regular \$20 per tonne price? Graph the breakeven chart.

## SOLUTION

- (a) Evaluating the \$/t data shows that the cost of producing 5000 tonnes is \$10.60 per tonne. This is less than the proposed selling price of \$14.00 per tonne.
- The incremental unit costs given in the last column of the table show that it would actually cost \$15.00 per tonne for the 1,000 tonnes needed to increase production from the 100% capacity to 125% capacity level. Selling the units for \$14.00 per tonne would leave the company with a \$1 per tonne loss for each 1,000 increment of tonnes. Obviously, total profitability for the company will be greater at the end of the period if the company rejects the order.
- (b) See graph



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- (b) From the graph, the breakeven point can be estimated as

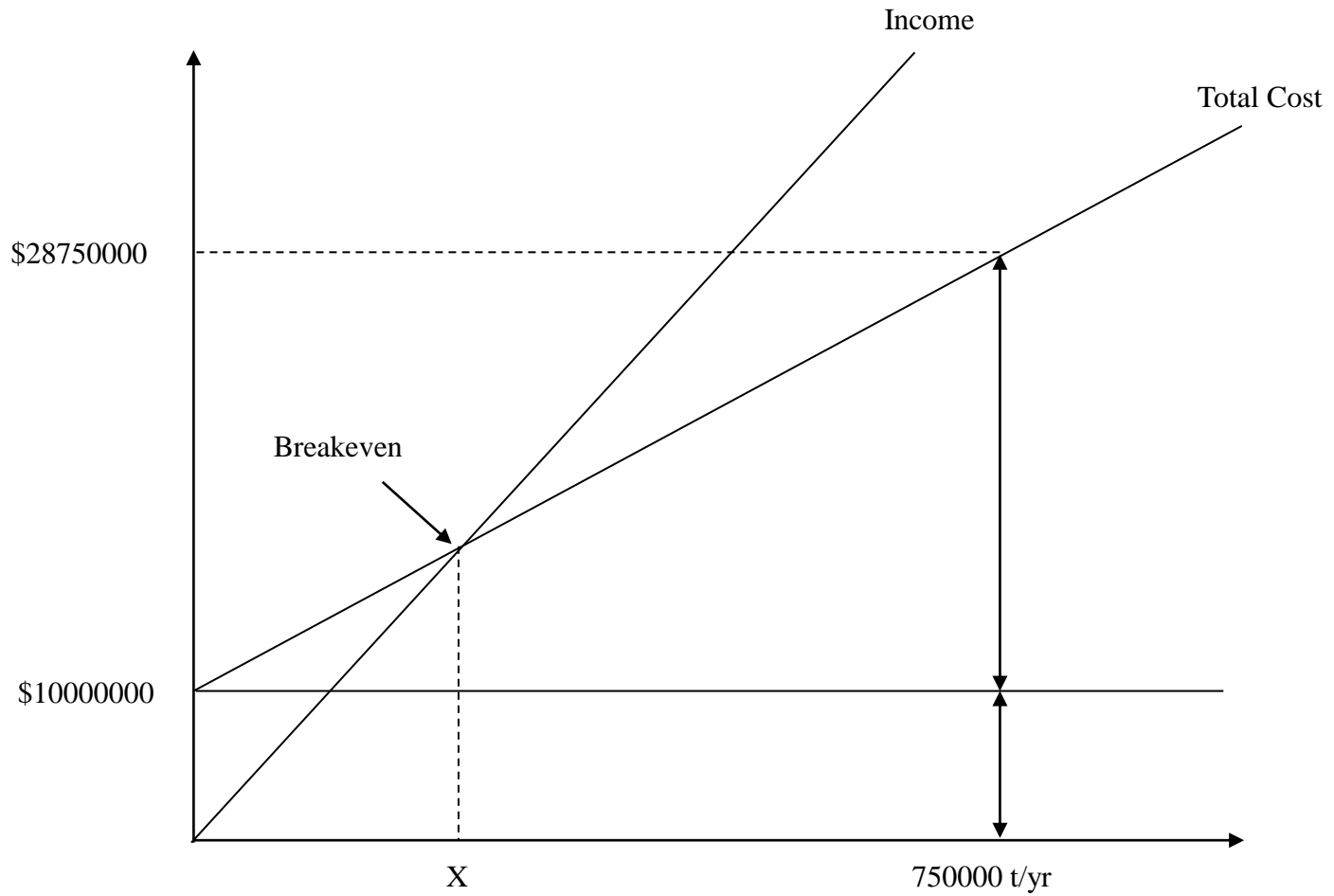
Production rate = 1333 tonnes / period

Total Cost = Income = \$26,666

## EXAMPLE

- A mining operation has the capacity to produce 1000000 tonnes per year. The present production rate is 75% of capacity, where the mine's annual income is \$3,750,000. Annual fixed costs are \$1,000,000 and variable production costs are constant at \$2.50 per tonne.
- (a) What is the profit or loss at present capacity.
- (b) At what volume of sales does the operation break even.

# SOLUTION



## CONT ...

- (a) Income – Total Costs  
= 3750000 – 2875000  
= **\$875000 (Profit)**
- (b) Income from 1 tonne is:  
= 3750000/750000  
= \$5/tonne

At breakeven,  
Income = Total Costs



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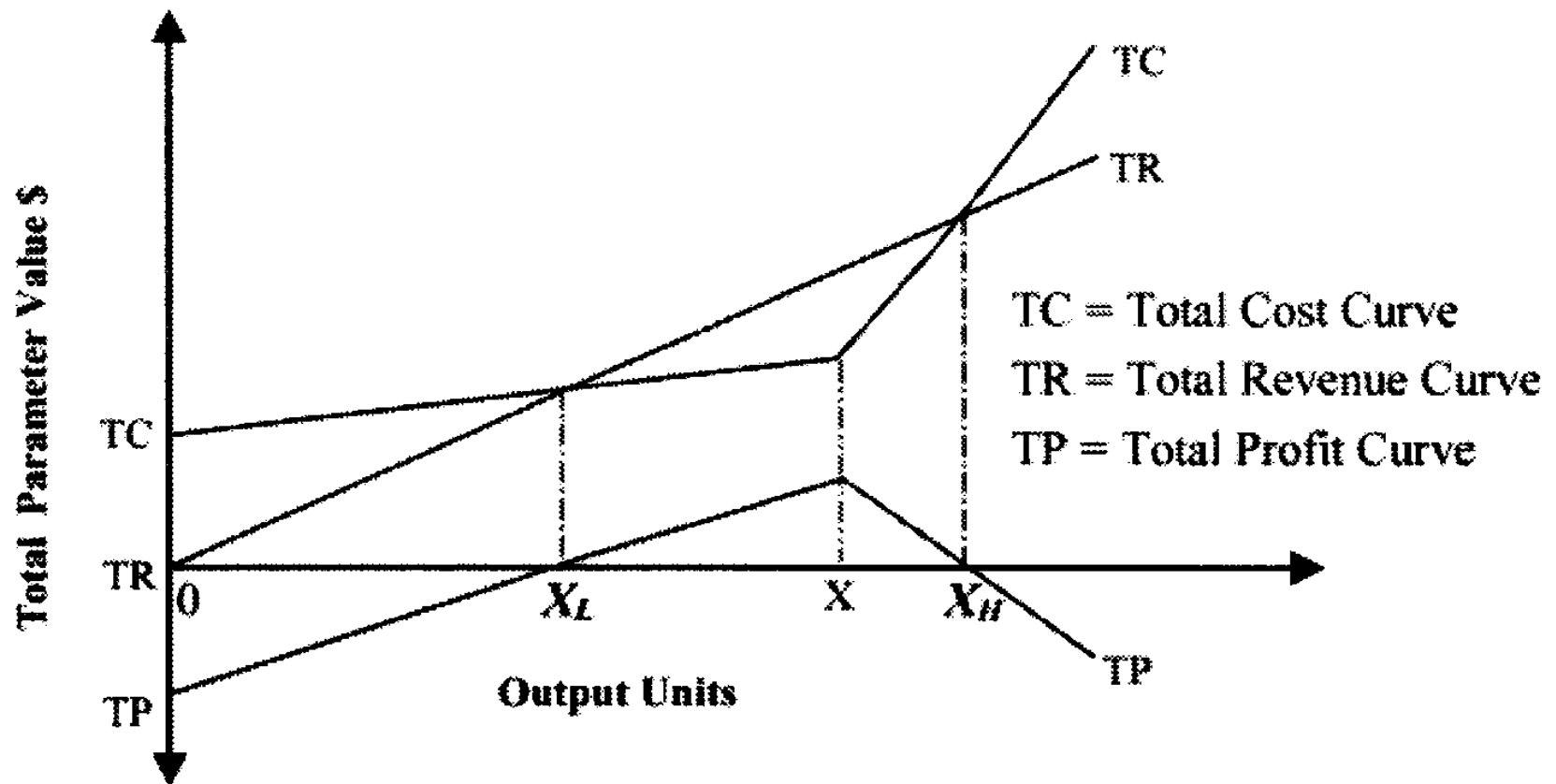
- $5X = 2.5X + 1000000$

- $5X - 2.5X = 1000000$

**$X = 400000$  tonnes to breakeven**

# MAXIMIZATION OF PROFIT, INCOME AND REVENUE

- Profit is the difference between total revenue and total cost.
- $\text{Total Profit} = \text{Total Revenue} - \text{Total Cost}$
- Maximum profits occurs at the point of output which produces the greatest difference between total revenue and total costs.



- The economic (optimum) point operation occurs at  $X$ .

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