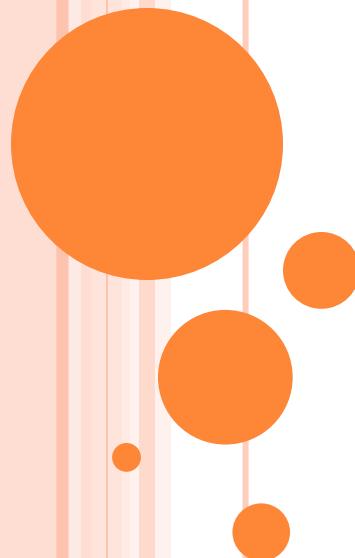


INTRODUCTION TO MINERAL ECONOMICS

COST FROM AN ECONOMIC PERSPECTIVE



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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

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- 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.

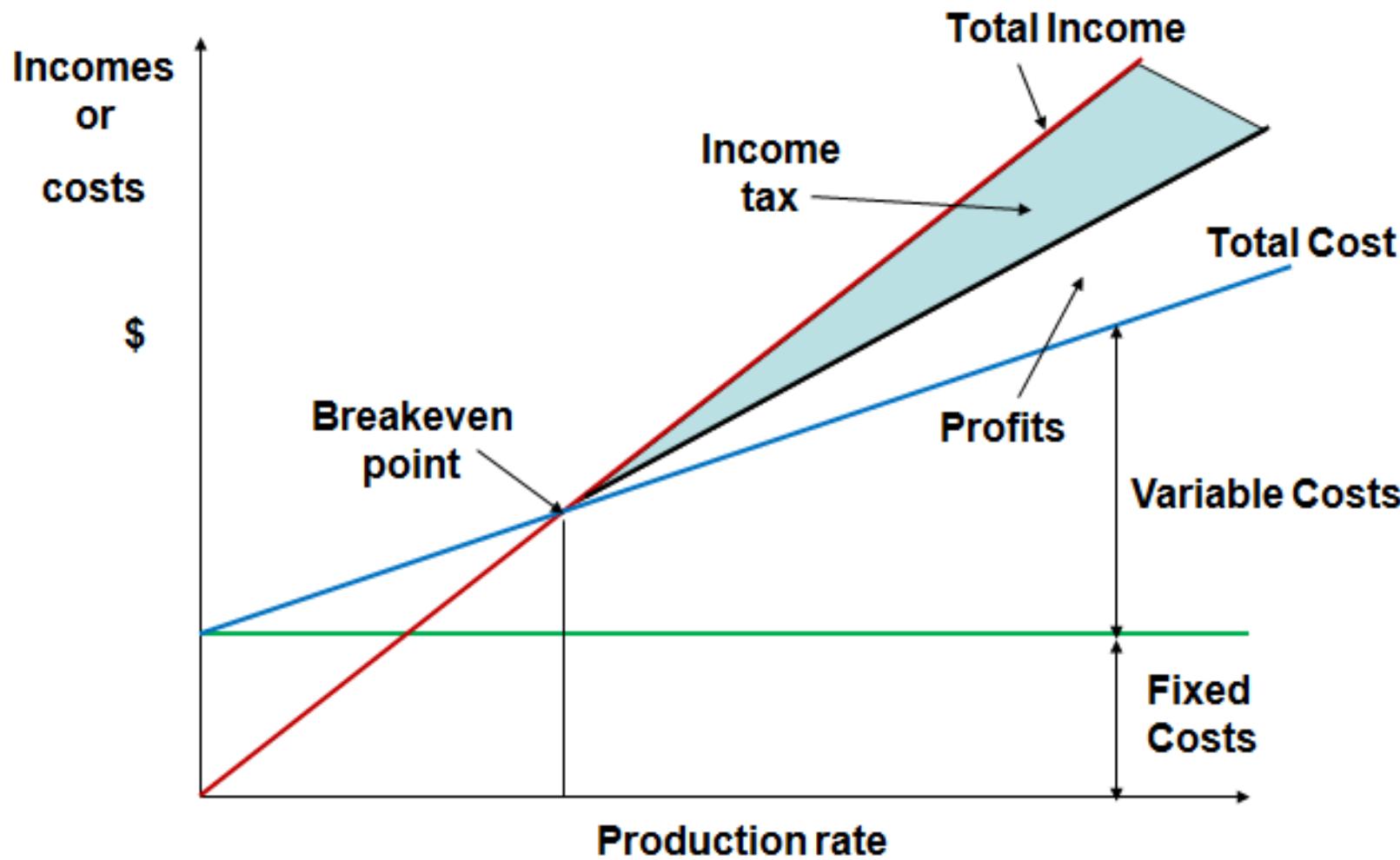
VARIABLE COST

- 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. 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

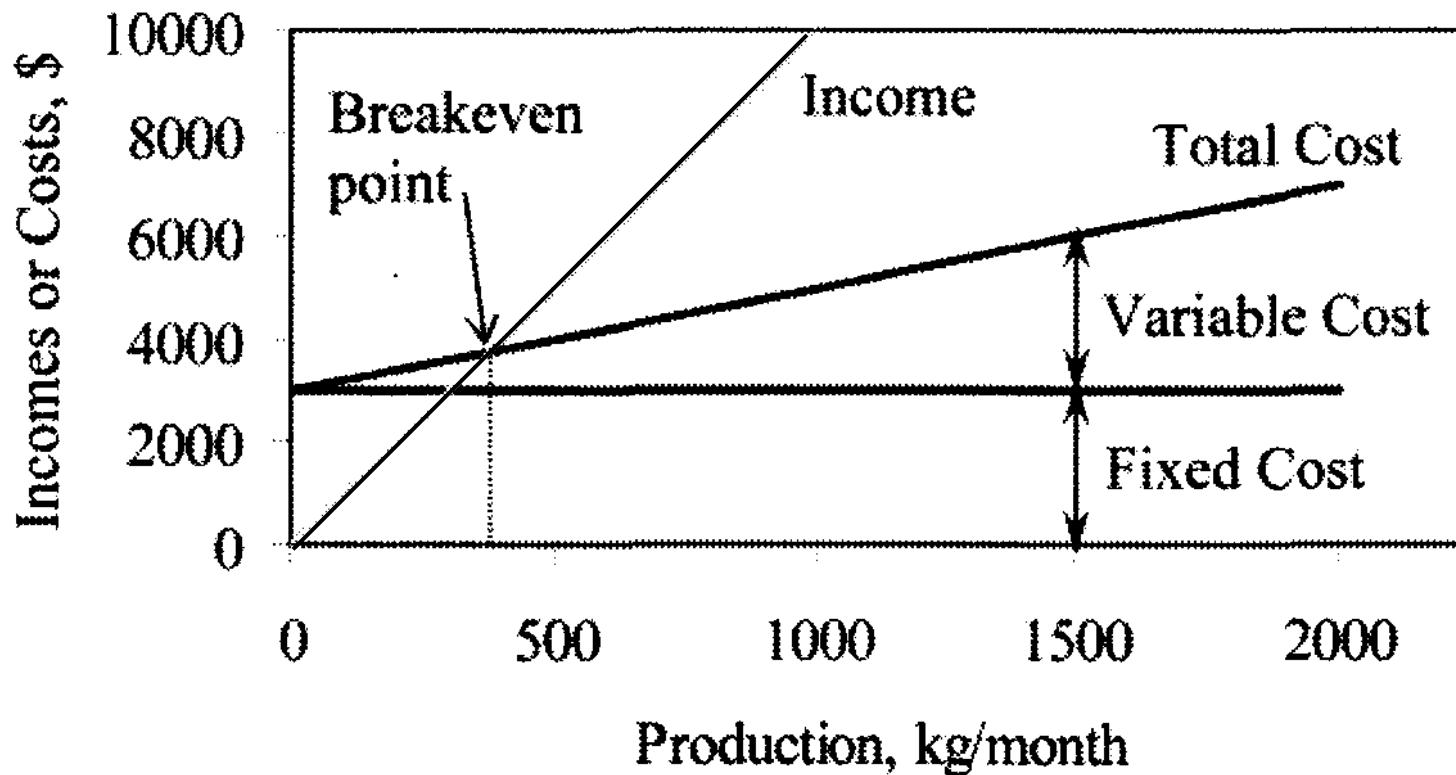
- Profit is the difference between total revenue and total cost.
- Total revenue is the volume multiplied by the price per unit.
 - Total Revenue = V.P
 - Where
 - P = Price per unit

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, Cv is the slope of the total cost curve. Therefore,

$$\begin{aligned} Cv &= (6000-5000)/(1500-1000) \\ &= \underline{\$2.00 \text{ per kg.}} \end{aligned}$$

- Cv 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 $y=mx+c$,
- Cost = $Cv \times (\text{production rate}) + FC$

CONT ...

- $\$5000 = Cv(1000) + FC$ or
- $\$6000 = Cv(1500) + FC$
- Since Cv is \$2.00 per unit
- **FC = \$3000**

- (c) Fixed cost for first 1000 units/month is calculated as follows;
 $FC/\text{No. of units}$
 $3000/1000 = \underline{\$3 \text{ per kg.}}$

CONT ...

- o (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 $TC = FC + Cv$

$$= 3 + 2 = \underline{\$5 \text{ per kg}}$$

- o (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;

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

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

At breakeven,

Total Cost = Total Income

$$2X+3000=10X$$

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

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

CONT ...

- o (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 or a \$1400 loss.

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

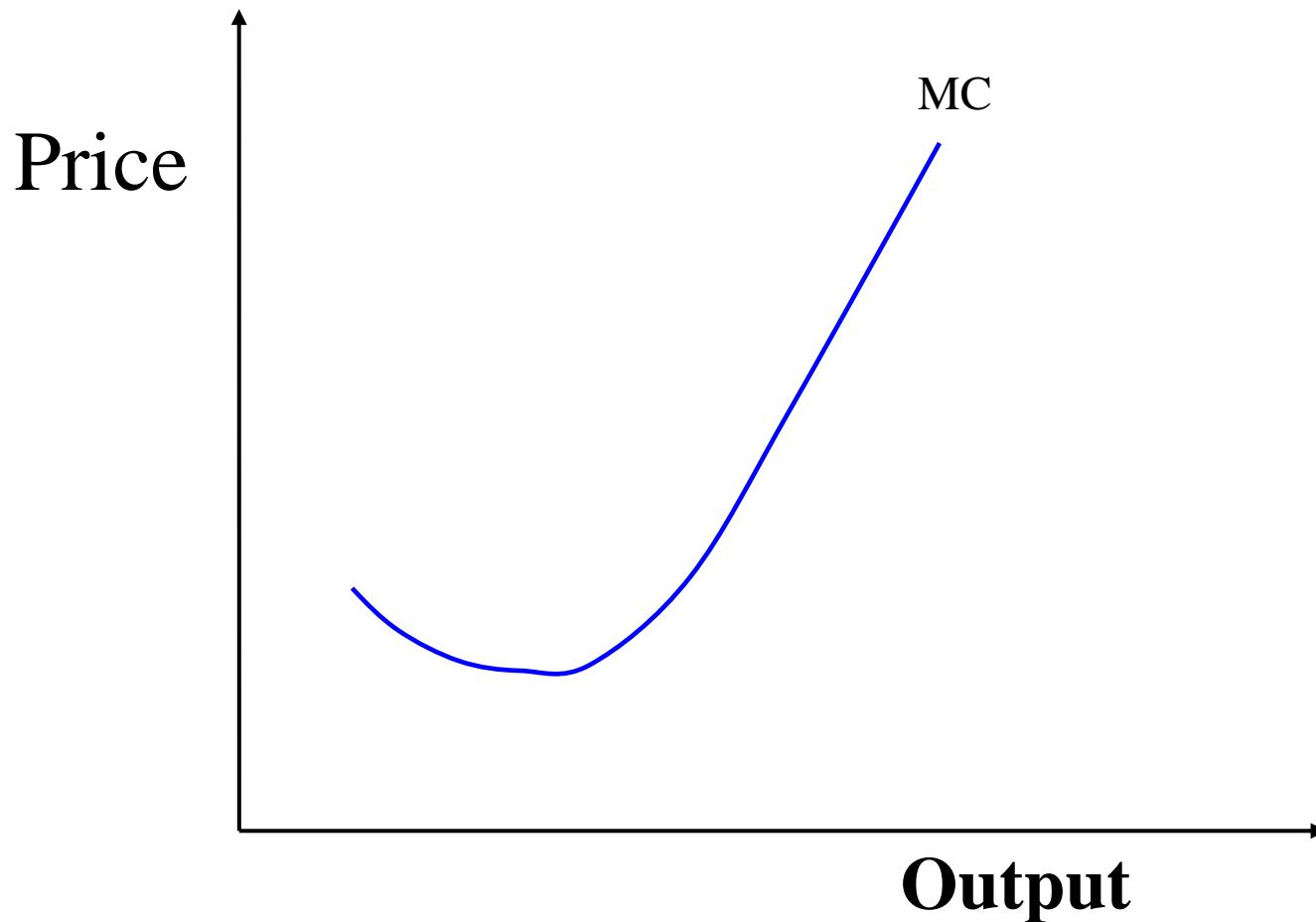
$$= (\$10/\text{kg} \times 1000\text{kg}) - (\$2/\text{kg} \times 1000\text{kg} + 3000)$$

+\$5000 /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.

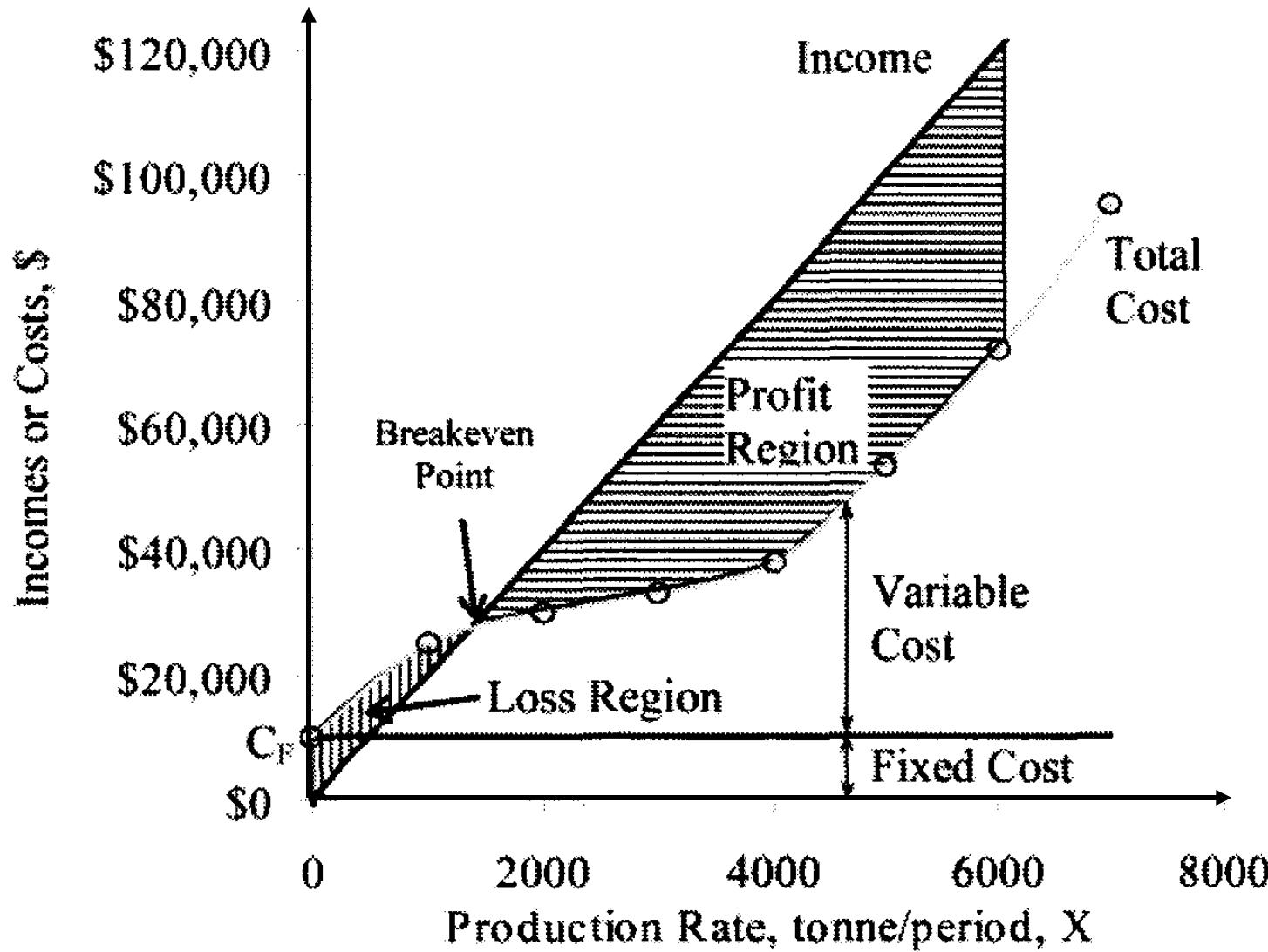
Rated Capacity	Tonnage	Fixed Cost	Variable Cost	Total Cost	Total \$/t	Incremental Cost \$/t
0	0	\$10000	0	\$10000	\$∞	
25%	1000	\$10000	\$15000	\$25000	\$25	\$15
50%	2000	\$10000	\$20000	\$30000	\$15	\$5
75%	3000	\$10000	\$23000	\$33000	\$11	\$3
100%	4000	\$10000	\$28000	\$38000	\$9.5	\$5
125%	5000	\$10000	\$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

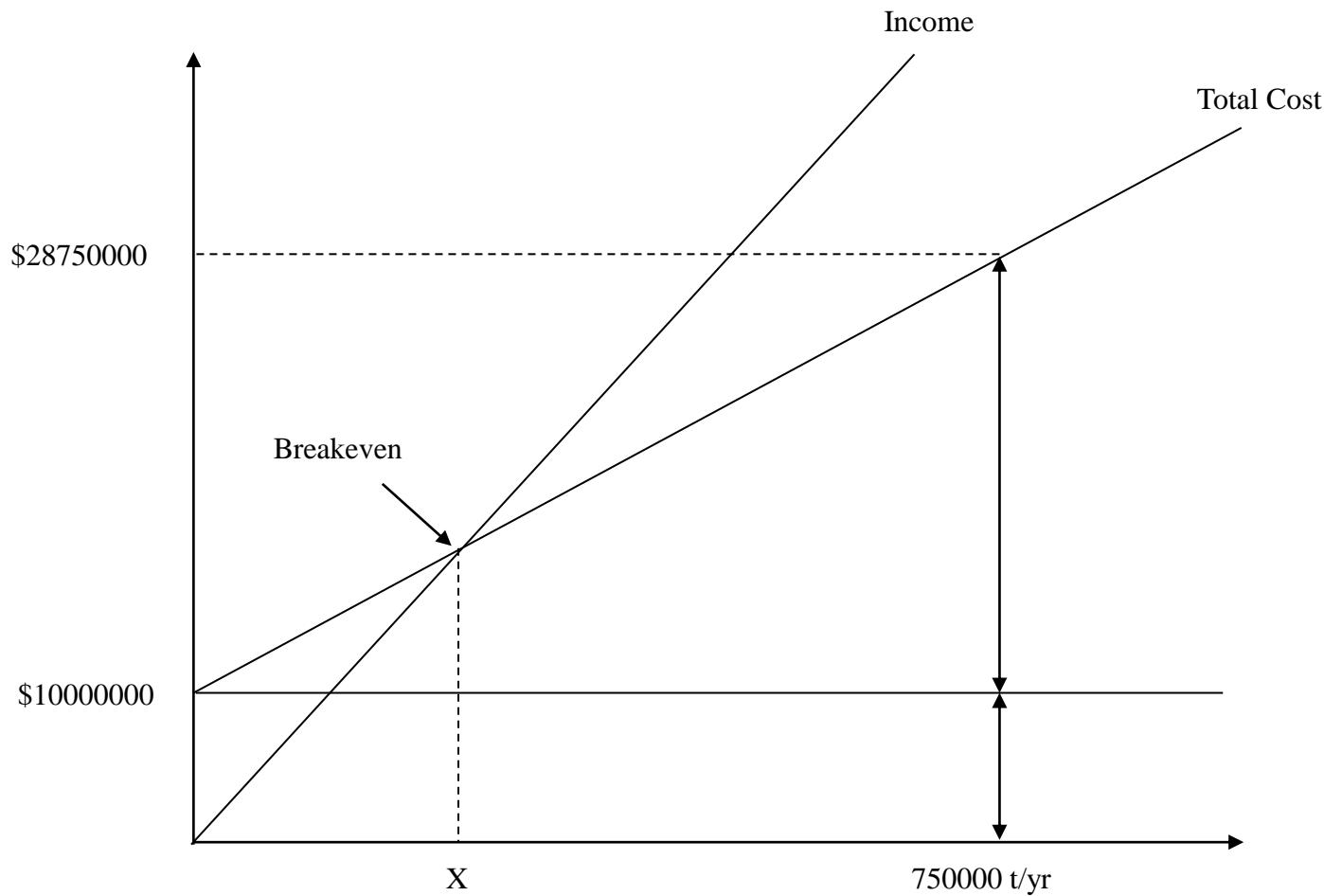
Production rate = 1333 tonnes / period

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 ...

- o (a)
$$\begin{aligned} \text{Income} - \text{Total Costs} \\ = 3750000 - 2875000 \\ = \$875000 \text{ (Profit)} \end{aligned}$$

- o (b)
$$\begin{aligned} \text{Income from 1 tonne is:} \\ = 3750000/750000 \\ = \$5/\text{tonne} \end{aligned}$$

At breakeven,
Income = Total Costs

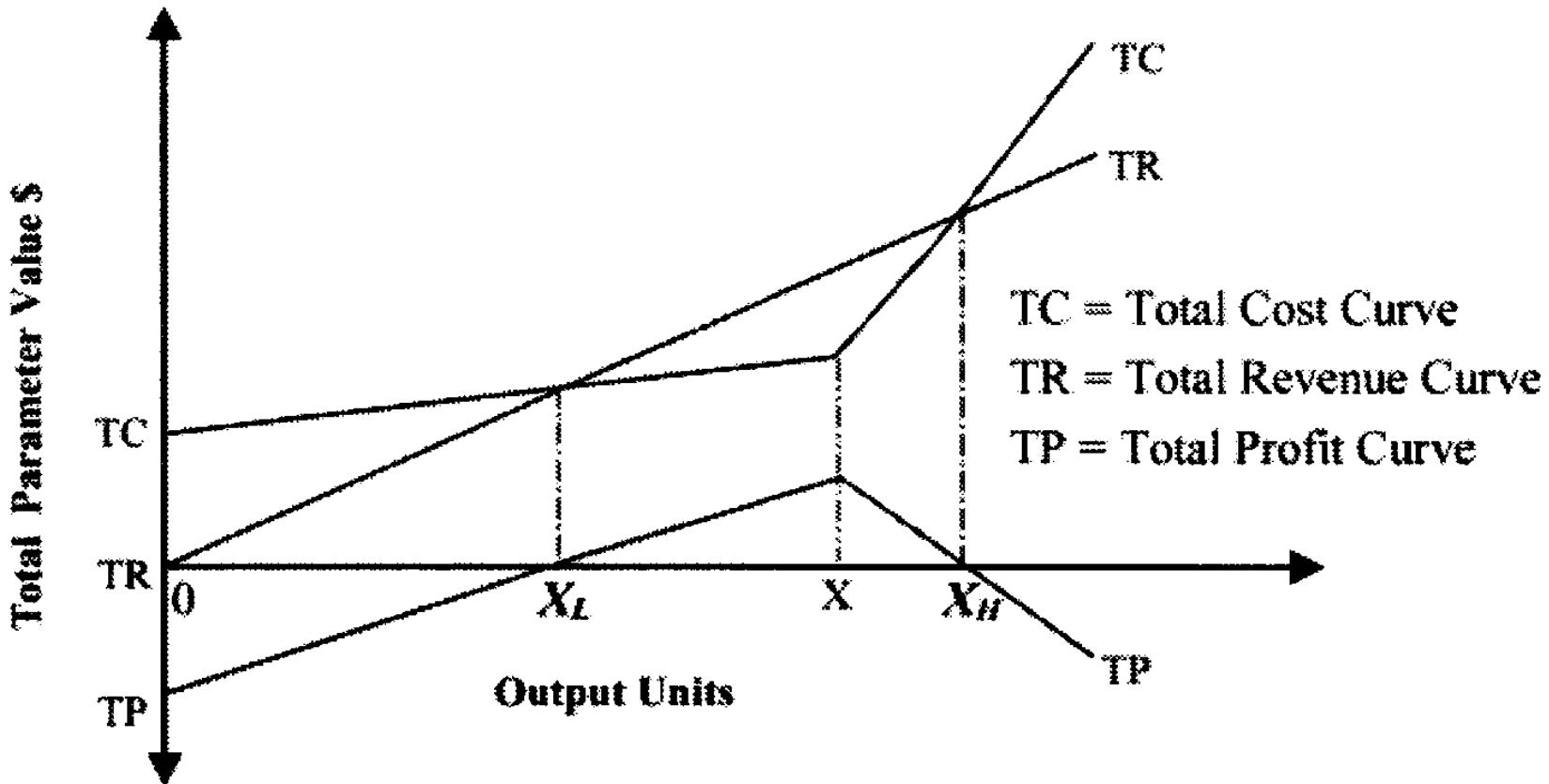
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- $5X = 2.5X + 1000000$
- $5X - 2.5X = 1000000$

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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