21: Theory of Cost
Recap from last Session

- Production cost
- Types of Cost: Accounting/Economic Analysis
- Cost – Output Relationship
- Short run cost Analysis
Session Outline

- The Long-Run Cost-Output Relations
- Break-Even Analysis: Linear Cost and Revenue Functions.
- Break-Even Analysis: Non-Linear Cost and Revenue Function
• Long-run is a period for which all inputs change or become variable.

• Long-run cost-output relations imply the relationship between the changing scale of a firm and the firm’s total output, whereas in the short-run, this relationship is essentially one between the total output and the variable costs such as, labour and raw materials.
The long-run cost curve (LTC) is composed of a series of short-run cost curves.

Assumes that the firm has only one plant, with the corresponding short-run cost curve given by STC1. Suppose the firm decides to add two more plants with associated two more short-run cost curves given by STC2 and STC3.
The long-run total cost curve (LTC) is then drawn through the minimum of the short-run cost curves, STC1, STC2, and STC3.

The Long-Run Average Cost Curve (LAC) is derived by combining the short-run average cost curves (SACs).
Long Run Total Cost Curve
Long Run Average Cost Curve
SR and LR Average Costs

The long-run average cost curve shows the minimum average cost at each output level when all inputs are variable, that is, when the firm can have any plant size it wants.

There is a relationship between the LRAC curve and the firm's set of short-run average cost curves.
SR and LR Average Costs

Economists use the term “plant size” to talk about having a particular amount of fixed inputs. Choosing a different amount of plant and equipment (plant size) amounts to choosing an amount of fixed costs.

Economists want you to think of fixed costs as being associated with plant and equipment. Bigger plants have larger fixed costs.
SR and LR Average Costs

If each plant size is associated with a different amount of fixed costs, then each plant size for a firm will give us a different set of short-run cost curves.

Choosing a different plant size (a long-run decision) then means moving from one short-run cost curve to another.
Economists usually assume that plant size is infinitely divisible (variable)

Each small U-shaped curve is a SAC curve.

The LRAC curve.

Average costs for a typical firm.
Long-Run Costs (LTC)

Long-run total cost \((LTC)\) for a given level of output:

\[
LTC = wL^* + rK^*
\]

Where \(w\) & \(r\) are prices of labor & capital, respectively, & \((L^*, K^*)\) is the input combination on the expansion path that minimizes the total cost of producing that output.
Long-Run Costs (LAC)

Long-run average cost (LAC) measures the cost per unit of output when production can be adjusted so that the optimal amount of each input is employed.

\[ LAC = \frac{LTC}{Q} \]

- LAC is U-shaped
- Falling LAC indicates economies of scale
- Rising LAC indicates diseconomies of scale
ECONOMIES OF SCALE: When output increases, long-run average costs declines.

LRAC shows economies of scale here.
DISECONOMIES OF SCALE: When output increases, long-run average costs increase.

LRAC shows diseconomies of scale here.
Long-run cost-output relations is similar to the short-run cost-output relations.

With subsequent increases in output, LTC first increases at a decreasing rate, and then at an increasing rate.

As a result, LAC initially decreases until the optimum utilization of the second plant capacity, and then it begins to increase.
These cost-output relations follow the ‘laws of returns to scale.’

When the scale of the firm expands, unit production cost initially decreases, but ultimately increases.

The decrease in unit cost is attributed to the internal and external economies and the eventual increase in cost, to the internal and external diseconomies.
Long-Run Costs (LMC)

- Long-run marginal cost \((LMC)\) measures the rate of change in long-run total cost as output changes along expansion path.

\[
LMC = \frac{\Delta LTC}{\Delta Q}
\]
Managerial Economics

Long-Run Average & Marginal Cost Curves
Long-Run Costs (LMC)

- $LMC$ is U-shaped
- $LMC$ lies below $LAC$ when $LAC$ is falling
- $LMC$ lies above $LAC$ when $LAC$ is rising
- $LMC = LAC$ at the minimum value of $LAC$
Various Shapes of LAC

Panel A - Early diseconomies
Panel B - Extended economies
Panel C - Extended constant LAC
Relations Between Short-Run & Long-Run Costs

- $LMC$ intersects $LAC$ when the latter is at its minimum point
- At each output where a particular $ATC$ is tangent to $LAC$, the relevant $SMC = LMC$
- For all $ATC$ curves, point of tangency with $LAC$ is at an output less (greater) than the output of minimum $ATC$ if the tangency is at an output less (greater) than that associated with minimum $LAC$
The LAC curve is also known in economics as the ‘Envelope Curve’ or ‘Planning Curve’ as it serves as a guide to the entrepreneur in plans to expand production.
Long-Run Average Cost as the Planning Horizon

The graph illustrates the relationship between output and average cost for different planning horizons. The curves represent the long-run average cost (LAC) and the short-run average cost (ATC) for different levels of capital (K). The LAC curve shows the minimum average cost for each level of output, while the ATC curves indicate the cost for a specific level of capital. The graph helps in understanding how long-run average cost evolves as the planning horizon changes.
Optimum Plant Size and Long-Run Cost Curves.
The short-run cost curves are extremely helpful in the
determination of the optimum utilization of a given plant, or
in the determination of the least-cost-output level.

Long run cost curves, on the other hand, can be used to show
how a firm can decide on the optimum size of the firm.
Optimum Plant Size and Long-Run Cost Curves.
The optimum size of the firm is one which ensures the most efficient utilization of the resources.

The optimum size of a firm is one in which the long-run average cost (LAC) is minimised.
Break-Even Analysis: Linear Cost and Revenue Functions. The basic objective of any business firm is to maximize profit.

The maximum profit does not necessarily coincide with the minimum cost, according to the traditional theory of the firm.
Break-Even Analysis: Linear Cost and Revenue Functions. Profit is Maximum at a specific level of output which is difficult to know beforehand.

Even though it is known, it cannot be achieved at the outset of production.

In real life, firms begin their activity even at a loss, in anticipation of profit in the future.
Break-Even Analysis: Linear Cost and Revenue Functions.

Nevertheless, firms plan their production activities much better if the level of production for which total cost and total revenue break even is known.

This implies the profitable and non-profitable range of production.
Break-Even Analysis: Linear Cost and Revenue Functions

Breakeven analysis, or profit contribution analysis is an important analytical technique used in studying the relationship between total cost, total revenue and total profits and losses over the whole range of stipulated output.
The cost function implies a total fixed cost (TFC) of N100. Its variable cost varies at a constant rate of N10 per unit in response to increases in output.

The revenue function implies that the market price for the firm’s product is N15 per unit of sale.
Break-Even Analysis: Linear Cost and Revenue Functions.

The break-even analysis is a technique of previewing profit prospects and a tool of profit planning.

It integrates cost and revenue estimates to ascertain the profits and losses associated with different levels of output.
In order to exemplify the break-even analysis under linear cost and revenue conditions, let us assume linear cost function and a linear revenue function as follows:

Cost function: \( C = 100 + 10Q \)
Revenue function: \( R = 150Q \).
At the break-even point,
Total Revenue (R) = Total Cost (C), so that in this example,
15Q = 100 + 10Q
5Q = 100
Q = 20
It follows that the break-even level of output is 20 units.
Graphical representation of Breakeven Analysis
Algebra of Breakeven Analysis
Limitation of Breakeven Analysis

- Breakeven analysis is applicable only if the cost and revenue functions are linear.
- In case of linear cost and revenue function, TC and TR are straight lines and they intersect only at one point dividing the whole range of output into two parts- Profitable and non-profitable.
Limitation of Breakeven Analysis

- Implication for this that the whole output beyond the break even level is profitable.
- In the real life this is not the fact as the conditions are difference due to changing price and cost.
- In reality cost and revenue functions may non linear.
Break-Even Analysis: Non-Linear Cost and Revenue Function

Non linearity arise because of AVC and price vary with variation in the output.

As a result, TC may increase at a increasing rate and TR may increase at a decreasing rate.

Some stages of output TC exceeds TR.
Break-Even Analysis: Non-Linear Cost and Revenue Function

There might be two breakeven points, limits the profitable ranges of output and determine lower and upper limit of output.

Need to pre test and verify the validity of linearity of cost and revenue functions
Break-Even Analysis: Non-Linear Cost and Revenue Function
The total fixed cost (TFC) line shows the fixed cost at OF, and the vertical distance between TC and TFC measures the total variable cost (TVC).

The curve, TR, shows the total sales or total revenue at different output levels and at different prices.

The vertical distance between the TR and TC measures the profit or loss for various levels of output.
Break-Even Analysis: Non-Linear Cost and Revenue Function

[Graph showing the relationship between Total Cost (TC) and Total Revenue (TR) with output per time unit. The graph highlights the break-even points B₁ and B₂.]
TR and TC curves intersect each other at two points, P1 and P2., where TR = TC.

These represent the lower and upper break-even points. For the whole range of output between OQ1 (corresponding to the break-even point, P1) and OQ2 (corresponding to the break-even point, P2), TR > TC.
This implies that a firm producing more than OQ1 and less than OQ2 will be making profits.

The profitable range of output lies between OQ1 and OQ2 units of output. Producing less or more than these limits will give rise to losses.
Summary

Business managers must plan for the long-run administration of costs, revenues, and profits. This is so because in the long run, firms will be in a position to expand the scale of production by increasing all inputs.
Summary

In the long-run, with increases in output, the total cost of production first increases at a decreasing rate, and then at an increasing rate. As a result, the long-run average cost initially decreases until the optimum utilization of the new plant capacity, and then it begins to increase. These cost-output relations follow the ‘laws of returns to scale.’
Summary
Firms are assumed to plan their production activities much better if the level of production for which total cost and total revenue break even is known. This implies the profitable and non-profitable range of production.
Summary

The break-even analysis or profit contribution analysis is an important analytical technique used in studying the relationship between total cost, total revenue, and total profits and losses over the whole range of stipulated output. The break-even analysis is a technique of previewing profit prospects and a tool of profit planning.
Session References

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