Chapter 7

The Cost of Production
Topics to be Discussed

- Measuring Cost: Which Costs Matter?
- Cost in the Short Run
- Cost in the Long Run
- Long-Run Versus Short-Run Cost Curves
- Production with Two Outputs: Economies of Scope
Measuring Cost: Which Costs Matter?

- Accountants tend to take a retrospective view of firms' costs, whereas economists tend to take a forward-looking view.

- **Accounting Cost**
  - Actual expenses plus depreciation charges for capital equipment.

- **Economic Cost**
  - Cost to a firm of utilizing economic resources in production, including opportunity cost.
Measuring Cost: Which Costs Matter?

- Economic costs distinguish between costs the firm can control and those it cannot
  - Concept of opportunity cost plays an important role
- Opportunity cost
  - Cost associated with opportunities that are foregone when a firm’s resources are not put to their highest-value use
Measuring Cost: Which Costs Matter?

- Although opportunity costs are hidden and should be taken into account, sunk costs should not.

- **Sunk Cost**
  - Expenditure that has been made and cannot be recovered
  - Should not influence a firm’s future economic decisions
Sunk Cost

- Firm buys a piece of equipment that cannot be converted to another use
- Expenditure on the equipment is a sunk cost
  - Has no alternative use so cost cannot be recovered – opportunity cost is zero
  - Decision to buy the equipment might have been good or bad, but now does not matter
Measuring Cost: Which Costs Matter?

- Total cost can be divided into:
  1. Fixed Cost
     - Does not vary with the level of output
  2. Variable Cost
     - Cost that varies as output varies

\[ TC = FC + VC \]
Fixed and Variable Costs

- Which costs are variable and which are fixed depends on the time horizon
- Short time horizon – most costs are fixed
- Long time horizon – many costs become variable
- Fixed cost and sunk cost are often confused
Measuring Costs

- Marginal Cost (MC):
  - The cost of expanding output by one unit
  - Fixed costs have no impact on marginal cost, so it can be written as:

\[ MC = \frac{\Delta VC}{\Delta q} = \frac{\Delta TC}{\Delta q} \]
Measuring Costs

- **Average Total Cost (ATC)**
  - Cost per unit of output
  - Also equals average fixed cost (AFC) plus average variable cost (AVC)

\[
\text{ATC} = \frac{TC}{q} = \frac{TFC}{q} + \frac{TVC}{q}
\]

\[
\text{ATC} = \frac{TC}{q} = AFC + AVC
\]
### A Firm’s Short Run Costs

<table>
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<tr>
<th>Rate of Output (Units per Year)</th>
<th>Fixed Cost (Dollars per Year)</th>
<th>Variable Cost (Dollars per Year)</th>
<th>Total Cost (Dollars per Year)</th>
<th>Marginal Cost (Dollars per Unit)</th>
<th>Average Fixed Cost (Dollars per Unit)</th>
<th>Average Variable Cost (Dollars per Unit)</th>
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Determinants of Short Run Costs

- Assume the wage rate ($w$) is fixed relative to the number of workers hired.
- Variable costs is the per unit cost of extra labor times the amount of extra labor: $wL$

\[
\text{MC} = \frac{\Delta VC}{\Delta q} = \frac{w\Delta L}{\Delta q}
\]
Determinants of Short Run Costs – An Example

- Remembering that

\[
MP_L = \frac{\Delta q}{\Delta L}
\]

\[
MC = \frac{\Delta VC}{\Delta q} = \frac{w\Delta L}{\Delta q} = \frac{w}{MP_L}
\]
Production in the Short Run

![Graph showing production function and average product curve]
Cost Curves

- **MC** (Marginal Cost)
- **ATC** (Average Total Cost)
- **AVC** (Average Variable Cost)
- **AFC** (Average Fixed Cost)

Cost ($/unit) vs. Output (units/yr)
Cost Curves

- When MC is below AVC, AVC is falling
- When MC is above AVC, AVC is rising
- When MC is below ATC, ATC is falling
- When MC is above ATC, ATC is rising
- Therefore, MC crosses AVC and ATC at the minimums
  - The Average – Marginal relationship
Cost Curves for a Firm

- The line drawn from the origin to the variable cost curve:
  - Its slope equals AVC
  - The slope of a point on VC or TC equals MC
  - Therefore, MC = AVC at 7 units of output (point A)
Cost in the Long Run

- Delta needs to compare its revenues and costs on an annual basis.
- If the firm had not purchased the plane, it would have earned interest on the $150 million.
- Forgone interest is an opportunity cost that must be considered.
  - Price of labor: wage rate (w)
  - The price of capital (r) = depreciation rate + interest rate
Cost in the Long Run

The Isocost Line

- A line showing all combinations of L & K that can be purchased for the same cost
- Total cost of production is sum of firm’s labor cost, wL, and its capital cost, rK:
  \[ C = wL + rK \]
- For each different level of cost, the equation shows another isocost line
Cost in the Long Run

- Rewriting C as an equation for a straight line:
  - $K = \frac{C}{r} - \left(\frac{w}{r}\right)L$
  - Slope of the isocost: $\frac{\Delta K}{\Delta L} = -\left(\frac{w}{r}\right)$
    - $-(w/r)$ is the ratio of the wage rate to rental cost of capital.
    - This shows the rate at which capital can be substituted for labor with no change in cost.
Producing a Given Output at Minimum Cost

Q₁ is an isoquant for output Q₁. There are three isocost lines, of which 2 are possible choices in which to produce Q₁.

Isocost C₂ shows quantity Q₁ can be produced with combination K₂,L₂ or K₃,L₃. However, both of these are higher cost combinations than K₁,L₁.
Input Substitution When an Input Price Change

If the price of labor rises, the isocost curve becomes steeper due to the change in the slope \( -(w/L) \).

The new combination of \( K \) and \( L \) is used to produce \( Q_1 \). Combination \( B \) is used in place of combination \( A \).
Cost Minimization in the Long Run
(Profit Maximization in the LR)

\[ \text{MRTS} = -\frac{\Delta K}{\Delta L} = -\frac{\text{MP}_L}{\text{MP}_K} \]

Slope of isocost line \( = \frac{\Delta K}{\Delta L} = -\frac{w}{r} \)

\[ \frac{\text{MP}_L}{\text{MP}_K} = \frac{w}{r} \quad \text{when firm minimizes cost} \]

OR \[ \frac{\text{MP}_L}{w} = \frac{\text{MP}_K}{r} \]
A Firm’s Expansion Path

The expansion path illustrates the least-cost combinations of labor and capital that can be used to produce each level of output in the long-run.
Long Run Versus Short Run Cost Curves

- In the short run, some costs are fixed
- In the long run, firm can change anything including plant size
  - Can produce at a lower average cost in long run than in short run
  - Capital and labor are both flexible
- We can show this by holding capital fixed in the short run and flexible in long run
The Inflexibility of Short Run Production

Capital is fixed at K1. To produce q1, min cost at K1,L1. If increase output to Q2, min cost is K1 and L3 in short run.

In LR, can change capital and min costs falls to K2 and L2.
Long Run Versus Short Run Cost Curves

- Long-Run Average Cost (LAC)
  - Most important determinant of the shape of the LR AC and MC curves is relationship between scale of the firm’s operation and inputs required to minimize cost
Long Run Versus Short Run Cost Curves

1. Constant Returns to Scale
   - If input is doubled, output will double
   - AC cost is constant at all levels of output

2. Increasing Returns to Scale
   - If input is doubled, output will more than double
   - LAC decreases at all levels of output

3. Decreasing Returns to Scale
   - If input is doubled, output will less than double
   - LAC increases at all levels of output
Long Run Versus Short Run Cost Curves

- Long-run marginal cost leads long-run average cost:
  - If $\text{LMC} < \text{LAC}$, $\text{LAC}$ will fall
  - If $\text{LMC} > \text{LAC}$, $\text{LAC}$ will rise
  - Therefore, $\text{LMC} = \text{LAC}$ at the minimum of $\text{LAC}$

- In special case where $\text{LAC}$ is constant, $\text{LAC}$ and $\text{LMC}$ are equal
Long Run Average and Marginal Cost

![Graph showing Long Run Average Cost (LAC) and Marginal Cost (LMC) curves. The LAC curve is a downward sloping U shape, while the LMC curve intersects the LAC curve at point A, indicating the minimum average cost.](image-url)
Long Run Costs

- Economies of scale reflects input proportions that change as the firm changes its level of production

- Economies of Scale
  - Increase in output is greater than the increase in inputs

- Diseconomies of Scale
  - Increase in output is less than the increase in inputs
Economies of scale are measured in terms of cost-output elasticity, $E_C$

$E_C = \frac{\Delta C}{C} \div \frac{\Delta Q}{Q} = \frac{MC}{AC}$

$E_C$ is the percentage change in the cost of production resulting from a 1-percent increase in output.
Long Run Costs

- $E_C$ is equal to 1, $MC = AC$
  - Costs increase proportionately with output
  - Neither economies nor diseconomies of scale

- $E_C < 1$ when $MC < AC$
  - Economies of scale
  - Both $MC$ and $AC$ are declining

- $E_C > 1$ when $MC > AC$
  - Diseconomies of scale
  - Both $MC$ and $AC$ are rising
Long Run Cost with Economies and Diseconomies of Scale
Production with Two Outputs – Economies of Scope

- Many firms produce more than one product and those products are closely linked
- Examples:
  - Chicken farm--poultry and eggs
  - Automobile company--cars and trucks
  - University--teaching and research
Production with Two Outputs – Economies of Scope

- Advantages
  1. Both use capital and labor
  2. The firms share management resources
  3. Both use the same labor skills and types of machinery
Production with Two Outputs – Economies of Scope

- The degree of economies of scope (SC) can be measured by percentage of cost saved producing two or more products jointly:

\[ SC = \frac{C(q_1) + C(q_2) - C(q_1,q_2)}{C(q_1,q_2)} \]

- \( C(q_1) \) is the cost of producing \( q_1 \)
- \( C(q_2) \) is the cost of producing \( q_2 \)
- \( C(q_1,q_2) \) is the joint cost of producing both products
Production with Two Outputs – Economies of Scope

- With economies of scope, the joint cost is less than the sum of the individual costs.
- Interpretation:
  - If SC > 0 → Economies of scope
  - If SC < 0 → Diseconomies of scope
  - The greater the value of SC, the greater the economies of scope.
Production with Two Outputs – Economies of Scope

- There is no direct relationship between economies of scope and economies of scale
  - May experience economies of scope and diseconomies of scale
  - May have economies of scale and not have economies of scope