

UNIT 3

Production, Cost, and the Perfect Competition Model

What lies behind the supply curve: the production function, costs, profit maximization, and perfect competition

22-25%

EXAM WEIGHTING

11-13

CLASS PERIODS

7

TOPICS IN UNIT

What This Unit Covers

TOPICS IN THIS UNIT

3.1 The Production Function

3.2 Short-Run Production Costs

3.3 Long-Run Production Costs

3.4 Types of Profit

3.5 Profit Maximization

3.6 Short-Run & Long-Run Decisions to Produce, Enter, or Exit

3.7 Perfect Competition

BIG IDEAS

- CBA — Costs, Benefits & Marginal Analysis: How do firms use marginal analysis?
- PRD — Production Choices and Behavior: What drives producers' decisions?

WHY IT MATTERS

Firms' production and cost constraints shape their optimal decisions in the short run and long run. Even with the common goal of profit maximization, market structure constrains prices, output, and efficiency — and the perfect competition model is the efficiency benchmark.

22-25%

of the AP Exam multiple-choice and free-response score

TOPIC 3.1

The Production Function

Enduring Understanding PRD-1 — Firms' production and cost constraints shape optimal decisions in the short run and long run.

LEARNING OBJECTIVES: PRD-1.A — Key terms of production and cost; how production and cost are related.

The Production Function

The production function describes the relationship between inputs and output.

- TOTAL PRODUCT (TP) is the total output produced by a given quantity of inputs.
- MARGINAL PRODUCT (MP) is the additional output from one more unit of an input.
- AVERAGE PRODUCT (AP) is total product divided by the quantity of the input.
- As input use changes, MP and AP change — and therefore total product changes.

KEY TAKEAWAY

Total, marginal, and average product all describe the input-to-output relationship. MP is the change in TP from one more input.

Diminishing Marginal Returns

The Law of Diminishing Marginal Returns

In the SHORT RUN, as a firm adds more of one variable input while holding other inputs fixed, the marginal product of that input eventually falls.

Why It Happens

With a fixed amount of capital, each additional worker has less capital to work with, so each one adds less extra output than the worker before.

Why It Matters

Diminishing marginal returns is a SHORT-RUN phenomenon (at least one input fixed). It is the reason marginal cost eventually rises — the link to the cost curves.

TOPIC 3.2

Short-Run Production Costs

Turning the production function into the cost curves that drive firm decisions.

LEARNING OBJECTIVES: PRD-1.A — Fixed and variable costs; the family of short-run cost curves.

Short-Run Cost Curves

In the short run, costs split into fixed and variable components, generating a family of cost curves.

- MARGINAL COST (MC) is U-shaped — it falls, then rises because of diminishing marginal returns.
- AVERAGE TOTAL COST (ATC) and AVERAGE VARIABLE COST (AVC) are U-shaped.
- AVERAGE FIXED COST (AFC) declines continuously as output is spread over more units.
- MC intersects both ATC and AVC at their MINIMUM points.

KEY TAKEAWAY

MC cuts ATC and AVC at their minimums. The gap between ATC and AVC is average fixed cost, which shrinks as output rises.

Short-Run Cost Formulas

TOTAL COST

$$TC = TFC + TVC$$

Total cost is total fixed cost plus total variable cost. Total fixed cost is constant at ALL output levels — including zero output.

AVERAGE COSTS

$$ATC = TC/Q \quad AVC = TVC/Q \quad AFC = TFC/Q$$

Each average cost is the corresponding total cost divided by quantity. Note that $ATC = AVC + AFC$.

MARGINAL COST

$$MC = \text{change in } TC / \text{change in } Q$$

The additional cost of producing one more unit. Diminishing marginal returns make the MC curve upward-sloping.

COST CURVE SHIFTS

shift if input prices or productivity change

A change in input costs or productivity shifts the cost curves up or down.

TOPIC 3.3

Long-Run Production Costs

In the long run every input — and therefore every cost — becomes variable.

LEARNING OBJECTIVES: PRD-1.A — Long-run costs, returns to scale, and economies of scale.

Long-Run Average Total Cost

In the long run, firms can adjust ALL inputs, so all costs become variable.

- ECONOMIES OF SCALE — long-run average cost FALLS as output rises (increasing returns to scale).
- CONSTANT RETURNS TO SCALE — long-run average cost is flat at its minimum (efficient scale).
- DISECONOMIES OF SCALE — long-run average cost RISES as output rises (decreasing returns to scale).
- The MINIMUM EFFICIENT SCALE (MES) is the smallest output at which long-run average cost is minimized.

KEY TAKEAWAY

The long-run ATC curve shows economies of scale, then constant returns, then diseconomies. The MES is where it first reaches its minimum.

TOPIC 3.4

Types of Profit

Enduring Understanding CBA-2 — Rational agents compare marginal benefits and marginal costs.

LEARNING OBJECTIVES: CBA-2.C — Define the types of profit; explain how firms respond to profit opportunities.

Accounting Profit vs. Economic Profit

The difference is whether IMPLICIT costs are counted. Firms respond to economic profit, not accounting profit.

ACCOUNTING PROFIT

- = **Total revenue - explicit costs**
- Counts only EXPLICIT (out-of-pocket) costs.
- The number that appears on financial statements.
- Ignores implicit costs, so it overstates true economic gain.

ECONOMIC PROFIT

- = **Total revenue - explicit costs - implicit costs**
- Counts BOTH explicit and implicit costs.
- Implicit costs include the cost of financial capital, compensation for risk, and the entrepreneur's own time.
- This is the profit measure firms actually respond to.

Normal Profit and the Zero-Profit Condition

Normal Profit

A firm earns NORMAL profit when its economic profit is exactly zero — total revenue covers all costs, explicit AND implicit, including a fair return to the owner.

Zero Economic Profit Is Not 'Bad'

Zero economic profit means the firm is doing exactly as well as its next-best alternative. The owners are fully compensated; there is no reason to leave the industry.

Why Firms Respond to Economic Profit

Positive economic profit attracts entry; negative economic profit (economic loss) drives exit. Normal profit means no incentive to enter or leave.

TOPIC 3.5

Profit Maximization

The single rule that governs every firm's output decision.

LEARNING OBJECTIVES: CBA-2.D — Define the profit-maximizing rule and the profit-maximizing level of production.

The Profit-Maximizing Rule: $MR = MC$

Firms are assumed to choose the output level that maximizes profit by comparing marginal revenue and marginal cost.

Marginal Revenue (MR)

The additional revenue from selling one more unit of output. Compare it, unit by unit, with marginal cost.

The Rule: Produce Where $MR = MC$

If $MR > MC$, the next unit adds more revenue than cost — produce it. If $MR < MC$, the next unit costs more than it earns — do not produce it. Profit is maximized where $MR = MC$.

It Is Marginal Analysis Again

$MR = MC$ is the firm's version of the $MB = MC$ rule from Unit 1 — the same logic of weighing the additional benefit against the additional cost.

Calculating a Firm's Profit

TOTAL PROFIT

$$\text{Profit} = \text{Total Revenue} - \text{Total Cost}$$

Total revenue = price x quantity. Total cost includes both explicit and implicit costs for economic profit.

PROFIT PER UNIT

$$\text{Profit per unit} = \text{Price} - \text{ATC}$$

At the profit-maximizing quantity, multiply (Price - ATC) by quantity to get total profit. If price is below ATC, this yields a loss.

TOPIC 3.6

Short-Run and Long-Run Decisions to Produce, Enter, or Exit

Enduring Understanding PRD-2 — Firms' decisions are based on profitability.

LEARNING OBJECTIVES: PRD-2.A — Short-run decisions to produce; long-run decisions to enter or exit.

The Short-Run Decision: Operate or Shut Down

Operate or Shut Down

In the short run a firm decides whether to produce a positive output or shut down (produce zero) — it cannot avoid its fixed costs either way.

The Shutdown Rule

Compare total revenue to total variable cost — equivalently, compare price to average variable cost (AVC). If price is below minimum AVC, the firm shuts down.

Why Fixed Costs Don't Decide It

Fixed costs must be paid whether or not the firm operates. So the firm operates as long as revenue covers its VARIABLE costs — even at a loss.

The Shutdown Decision on a Graph

The shutdown point is the minimum of the average variable cost curve.

- If price is ABOVE minimum AVC, the firm produces — it covers all variable costs and part of fixed costs.
- If price equals minimum AVC, the firm is indifferent — this is the shutdown point.
- If price is BELOW minimum AVC, the firm SHUTS DOWN — operating would lose more than the fixed costs alone.
- The portion of the MC curve above AVC is the firm's short-run supply curve.

KEY TAKEAWAY

Shut down if price falls below minimum AVC. The MC curve above AVC is the firm's short-run supply curve.

The Long-Run Decision: Enter or Exit

Long Run: All Costs Variable

In the long run, the factors that were fixed in the short run become variable. A firm can fully leave a market or fully enter one.

Enter When Profits Beckon

Absent barriers to entry, firms ENTER a market when there are economic profit-making opportunities — positive economic profit attracts new firms.

Exit When Losses Loom

Firms EXIT a market when they anticipate continued economic losses. In the long run there is no reason to stay in a market that cannot cover all costs.

TOPIC 3.7

Perfect Competition

Enduring Understanding PRD-3 — Market structure constrains prices, output, and efficiency.

LEARNING OBJECTIVES: PRD-3.A — Characteristics of perfectly competitive markets, equilibrium, firm decisions, and efficiency.

Perfect Competition: The Market and the Firm

In perfect competition, the market sets the price and each firm takes it as given.

- Perfectly competitive firms face NO barriers to entry and have NO market power.
- The market's supply and demand set the price; each firm is a PRICE TAKER.
- Each firm can sell all its output at that constant market price, so price = marginal revenue = demand for the firm.
- The firm maximizes profit by producing where MARGINAL COST = MARGINAL REVENUE (= price).

KEY TAKEAWAY

The market sets the price; the firm is a price taker facing a horizontal demand curve where $P = MR = D$. It produces where $MC = MR$.

Short-Run Profit in Perfect Competition

In the short run, a perfectly competitive firm can earn economic profit when price exceeds average total cost.

- The firm produces where $MC = P (= MR)$, the profit-maximizing quantity Q^* .
- If price is ABOVE ATC at Q^* , the firm earns ECONOMIC PROFIT.
- Profit per unit = price - ATC; total profit = (price - ATC) \times Q^* .
- If price equals ATC at Q^* , economic profit is zero — the firm breaks even.

KEY TAKEAWAY

Short-run profit: produce where $MC = P$; if P is above ATC, total economic profit equals $(P - ATC) \times Q^*$.

Short-Run Loss in Perfect Competition

A perfectly competitive firm takes a loss when price is below average total cost.

- The firm still produces where $MC = P$ — that is the loss-MINIMIZING quantity.
- If price is BELOW ATC but ABOVE AVC, the firm produces at a loss in the short run.
- Loss per unit = $ATC - \text{price}$; total loss = $(ATC - \text{price}) \times Q^*$.
- If price falls below AVC, the firm shuts down instead.

KEY TAKEAWAY

Short-run loss: the firm still produces where $MC = P$ as long as price is above AVC; it shuts down only if price falls below AVC.

Long-Run Equilibrium and Efficiency

Entry and Exit Eliminate Profit

Short-run profit attracts entry, which lowers price; short-run loss causes exit, which raises price. Free entry and exit drive economic profit to ZERO in the long run.

Long-Run Equilibrium Conditions

In long-run equilibrium, $P = MR = MC = \text{minimum ATC}$. Every firm produces at efficient scale and earns zero economic profit (normal profit).

Allocatively AND Productively Efficient

ALLOCATIVE efficiency: $P = MC$, so the right quantity is produced. PRODUCTIVE efficiency: production occurs at minimum ATC. Perfect competition achieves both.

Common Pitfalls & Exam Tips

MC cuts the averages at their minimum

Marginal cost intersects both ATC and AVC at their lowest points. Draw it accurately.

Economic, not accounting, profit

Economic profit subtracts implicit costs too. Normal profit means zero ECONOMIC profit — the firm is doing fine.

Always produce where $MR = MC$

This rule sets quantity for profit AND for loss minimization. Find Q^* first, then check profit or loss.

Shutdown vs. loss

Price vs. ATC tells profit or loss. Price vs. AVC tells produce or shut down. Shut down only if P is below AVC.

Price taker: $P = MR = D$

A perfectly competitive firm faces a horizontal demand curve. Price equals marginal revenue.

Long run: zero economic profit

Entry and exit drive economic profit to zero; the firm produces at minimum ATC — both efficiencies hold.

Unit 3 — Key Takeaways

1

The production function links inputs to output; diminishing marginal returns make marginal cost eventually rise.

2

Short-run costs split into fixed and variable; MC cuts ATC and AVC at their minimum points.

3

In the long run all costs are variable; the LRATC curve shows economies, constant returns, then diseconomies of scale.

4

Economic profit subtracts implicit costs; normal profit means zero economic profit — firms respond to economic profit.

5

Every firm maximizes profit (or minimizes loss) by producing where $MR = MC$; shut down if price falls below AVC .

6

Perfectly competitive firms are price takers; long-run equilibrium has zero profit and is allocatively & productively efficient.