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CHAPTER 9

The Costs of Production

How a firm's costs behave as it produces more, and why the answer shapes the size and number of firms in an industry.

What this chapter covers



9.2–9.3 The measures

- Types of cost
- Accounting vs. economic profit
- Average & marginal cost



9.4–9.6 The shapes

- Short run vs. long run
- Economies of scale & scope
- The experience curve



9.7–9.8 Evidence

- Case: airlines & full planes
- Empirical: falling solar cost

THE BIG IDEA

A flight to London costs nearly the same with 100 or 200 passengers; a solar panel that cost \$100 per watt now costs under a dollar. Both are facts about cost, the subject of this chapter.

9.1

Introduction

- Three everyday facts about cost
- Building on production (Chapter 8)
- Why cost shapes industry structure

Three facts about cost



Airlines

A flight to London costs about the same with 100 or 200 passengers, fuel, crew, and aircraft are nearly fixed.



Solar

A panel that cost over \$100 per watt in the 1970s costs well under a dollar today.



Opportunity

A student who turns down a \$60,000 job to start a business gives up that salary, though no check changes hands.

THE QUESTION

Building on the production of Chapter 8, we ask how a firm's costs behave as it produces more.

9.2

Types of Cost

- Fixed, variable, and total cost
- Explicit vs. implicit costs
- Accounting vs. economic profit
- Sunk costs

9.2 TYPES OF COST

Fixed, variable, and total cost

■ Fixed costs

Do not vary with output, the rent on a factory, the cost of an aircraft. They must be paid even if the firm produces nothing.

■ Variable costs

Rise with output: the materials, fuel, and labor used to make each unit.

TOTAL COST

Total cost is simply the sum of fixed cost and variable cost.

9.2 TYPES OF COST

Explicit vs. implicit costs

■ Explicit costs

Out-of-pocket payments, wages, rent, supplies. The costs an accountant records.

■ Implicit costs

The opportunity costs of resources the firm already owns: the salary the owner gives up by running the business, or the interest she forgoes by investing her own savings.

9.2 TYPES OF COST

Accounting vs. economic profit

■ Economic cost = explicit + implicit

Adding implicit to explicit costs gives economic cost; revenue minus economic cost gives economic profit, a stricter, more meaningful measure than accounting profit, which ignores implicit costs.

THE KEY DISTINCTION

A business can show an accounting profit yet earn zero economic profit, meaning it merely covers what its resources could have earned elsewhere.

9.2 TYPES OF COST

One cost to ignore: the sunk cost

■ Sunk cost

Already spent and impossible to recover. The money spent on a failed advertising campaign is gone whatever the firm does next.

THE DECISION RULE

A rational manager bases the next decision only on costs that still lie ahead. We return to the temptation to “throw good money after bad” as a behavioral bias later in the book.

9.2.1 ECONOMIC PROFIT: A WORKED EXAMPLE

Maria opens a café

Item	Amount
Revenue	\$200,000
Explicit costs (rent, coffee, wages)	\$130,000
Accounting profit	\$70,000
Implicit: salary given up	\$50,000
Implicit: interest forgone	\$5,000
Economic profit	\$15,000

Maria quits a \$50,000 job and invests \$100,000 of savings.

THE ARITHMETIC

Accounting profit = \$200,000 – \$130,000 = \$70,000.

Economic profit subtracts \$55,000 of opportunity cost: \$70,000 – \$55,000 = \$15,000. Positive, the café is worth more to Maria than her next-best alternative.

9.2.1 ECONOMIC PROFIT: A WORKED EXAMPLE

Self-check

SELF-CHECK

An owner earns \$90,000 in revenue, pays \$60,000 in explicit costs, and gave up a \$40,000 salary. Find accounting and economic profit.

Accounting profit = $\$90,000 - \$60,000 = \$30,000$. Economic profit also subtracts the \$40,000 implicit cost: $\$30,000 - \$40,000 = -\$10,000$. The negative figure tells her she would have done better at her old job.

9.3

Average and Marginal Cost

- The full cost table
- The U-shaped average total cost
- Why marginal cost crosses average at its minimum

9.3 AVERAGE AND MARGINAL COST

Two derived measures

■ Average total cost

Total cost divided by output, the cost per unit.

■ Marginal cost

The extra cost of producing one more unit.

Table 9.1 builds them from a firm with \$100 of fixed cost.

9.3 AVERAGE AND MARGINAL COST

Table 9.1: building the cost measures

Output	Fixed cost	Variable cost	Total cost	Average total cost	Marginal cost
0	100	0	100		
1	100	50	150	150	50
2	100	90	190	95	40
3	100	120	220	73	30
4	100	160	260	65	40
5	100	220	320	64	60
6	100	300	400	67	80

Table 9.1 Building average and marginal cost from fixed and variable cost.

Why average total cost is U-shaped



Falling at low output

The \$100 fixed cost is spread over more units, the same force that lets an airline lower its cost per passenger by filling seats.



Rising at high output

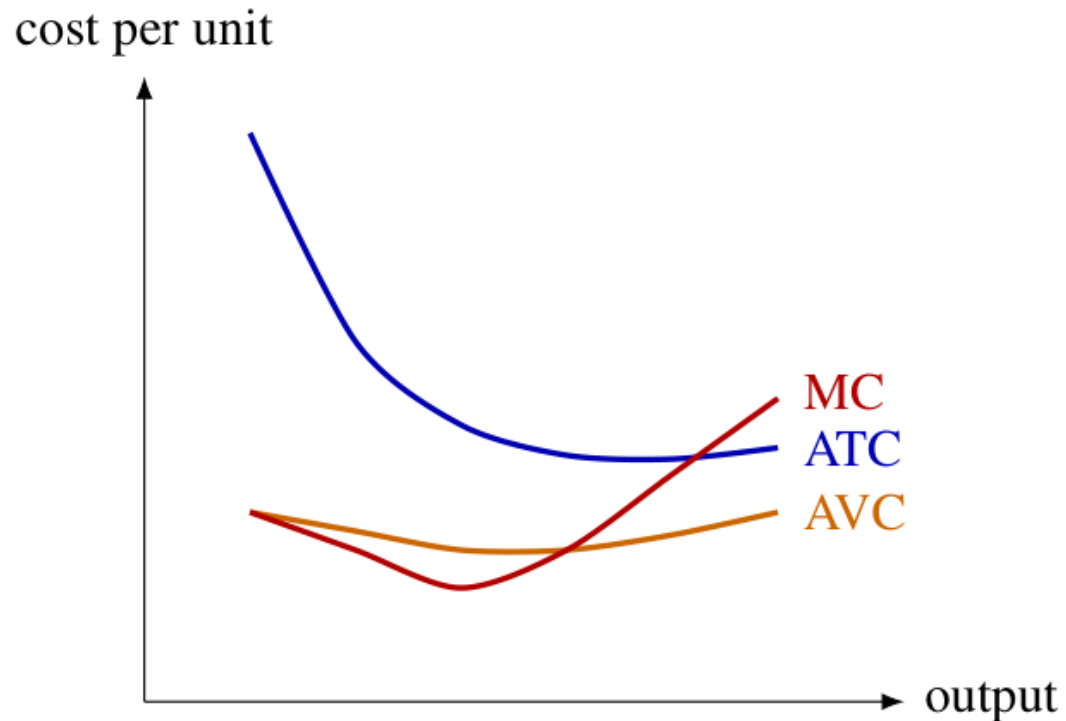
Diminishing marginal product (Chapter 8) makes each extra unit more expensive to produce.

MARGINAL COST TOO

Marginal cost, after an initial fall, rises for the same reason, diminishing returns. In Table 9.1 it bottoms near an output of 3, then climbs.

9.3 AVERAGE AND MARGINAL COST

Marginal cost cuts the average curves at their lowest points



- Marginal cost crosses average total cost at its minimum, near output 5, where ATC bottoms at \$64.
- When the next unit costs less than the average, it pulls the average down; when more, it pushes it up.
- So the curves can only cross where the average is flat, at its lowest point.

Figure 9.1 Marginal cost cuts both average variable and average total cost at their minimums.

9.3.1 HOW THE COST CURVES FIT TOGETHER

The curves are tied by simple arithmetic



Average fixed cost

Always falls as output rises, the same fixed cost spread over more units. This is “spreading the overhead.”



Average variable cost

U-shaped: falls at first, then rises as diminishing returns set in.



Average total cost

The sum of the two, also U-shaped. The gap above AVC narrows as AFC keeps falling.

THE MARGINAL COST THREAD

Running through all of them, marginal cost cuts both average curves at their lowest points, it can only equal an average where that average is momentarily flat.

9.4

The Short Run and the Long Run

- Short run: fixed costs are fixed
- Long run: all costs variable
- The long-run average cost curve as a lower boundary

Choosing the size of the plant



Short run

Fixed costs are truly fixed, the firm cannot change the size of its factory.



Long run

The firm can choose the size of its factory, so all costs become variable.

■ Long-run average cost

Traces the lowest cost per unit achievable at each output when the firm is free to build the best-sized plant. It forms a lower boundary beneath the short-run curves.

9.5

Economies and Diseconomies of Scale

- The shape of long-run average cost
- Minimum efficient scale
- Where the forces come from

9.5 ECONOMIES OF SCALE

What the shape of long-run cost tells us



Economies of scale

Long-run average cost FALLS as output rises, bigger is cheaper per unit (specialization, large machines, spread fixed costs).



Constant returns

Long-run average cost is FLAT, size does not change cost per unit.



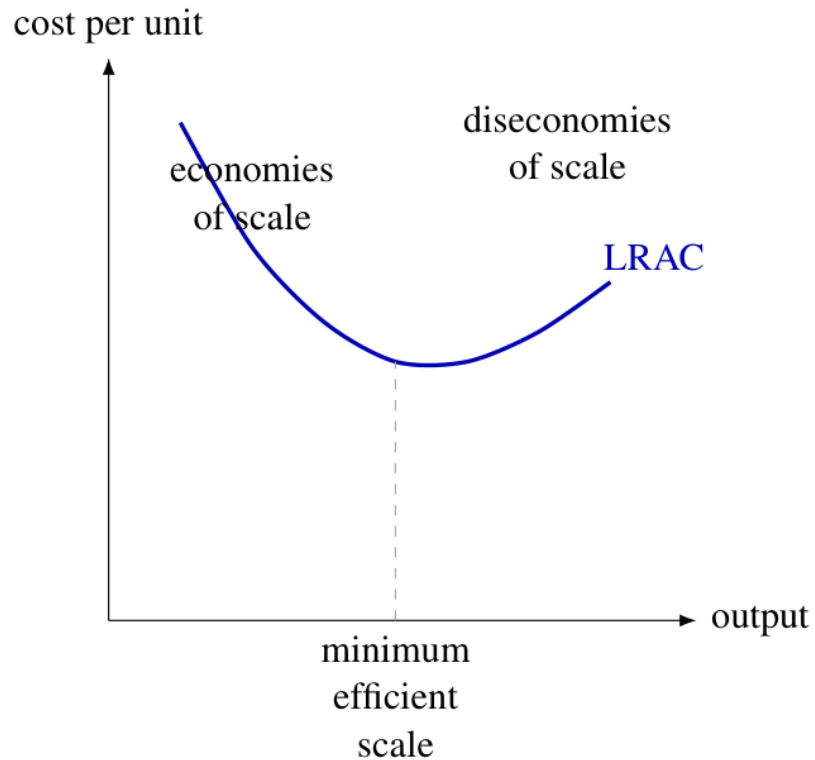
Diseconomies of scale

Long-run average cost RISES, usually from the growing difficulty of managing a very large organization.

Figure 9.2 shows a typical long-run average cost curve.

9.5 ECONOMIES OF SCALE

The long-run average cost curve



■ Minimum efficient scale

The output at which average cost first reaches its minimum. Its size relative to the whole market helps determine how many firms an industry can support.

Figure 9.2 Long-run average cost: economies of scale, a minimum efficient scale, then diseconomies.

Minimum efficient scale shapes the industry



Small MES → many firms

Where minimum efficient scale is small, restaurants, hair salons, many firms coexist.



Large MES → few firms

Where it is enormous relative to demand, aircraft, semiconductors, only a few firms can operate efficiently.

A point we develop in the market-structure chapters ahead.

9.5.1 WHERE SCALE ECONOMIES COME FROM

The forces behind the U-shape

■ Economies of scale (downward slope)

Specialization (each worker and machine focuses on one task); large, indivisible equipment (a blast furnace or assembly line); and spreading fixed costs like research, design, and advertising over many units.

■ Diseconomies of scale (upward slope)

The growing difficulty of managing a very large organization: communication slows, coordination falters, and layers of management multiply.

9.6

Economies of Scope and the Experience Curve

- Producing several products together
- The learning curve
- Scale vs. cumulative experience

Two related ideas

■ Economies of scope

It is cheaper to produce several products together than separately, a dairy that makes both milk and cheese, or a company that sells search and email from the same data centers.

■ Economies of experience (the learning curve)

Cost per unit falls as a firm accumulates total production experience over time, learning to produce more efficiently.

Scale vs. the learning curve



Economies of scale

Depend on the RATE of output, how much the firm produces per period.



The learning curve

Depends on CUMULATIVE output to date, total experience accumulated over time.

WHERE IT MATTERS MOST

The learning curve is most dramatic in high-technology manufacturing, as Section 9.8 shows for solar power.

9.7

Case Study: Why Airlines Chase Full Planes

The economies-of-scale logic of Section 9.5, operating flight by flight.

9.7 CASE STUDY

Air travel is a textbook study in fixed costs

- Once a flight is scheduled, most of its cost, the aircraft, the fuel, the pilots and cabin crew, the landing fees, is fixed regardless of how many board.
- The marginal cost of one more passenger on a flight departing anyway is very small: a bit of fuel for the added weight, a meal, and the cost of processing the ticket.

THE LOAD FACTOR

Because cost per passenger is total flight cost divided by passengers, filling more seats spreads the large fixed cost over more travelers, exactly the economies-of-scale logic of Section 9.5, flight by flight.

9.7 CASE STUDY

The obsession with the load factor

~83%

U.S. passenger load factor in 2023 (Bureau of Transportation Statistics)

≈ 0

extra cost of a seat flown full vs. empty

WHY IT MATTERS

Airlines use elaborate pricing, frequent-flyer programs, and last-minute discounts to fill seats that would otherwise fly empty. A seat flown empty earns nothing but costs almost as much as a seat flown full, and that simple fact drives much of how airlines behave.

9.8

Empirical Evidence: The Falling Cost of Solar Power

The learning curve of Section 9.6 at its clearest.

9.8 EMPIRICAL EVIDENCE

A learning curve in action

- The cost of a solar photovoltaic module, the price of generating a watt of capacity, has fallen sharply over half a century.
- From more than \$100 per watt in the mid-1970s to well under a dollar per watt today.

\$100+

per watt in the mid-1970s

< \$1

per watt today

THE MECHANISM

Cost falling with accumulated experience, not with the current rate of output. A textbook learning curve.

Swanson's law

SWANSON'S LAW

Each time the cumulative quantity of solar modules ever produced doubles, their cost per watt falls by roughly 20 percent.

- It has held for decades as manufacturers refined their materials, processes, and scale.
- The same fixed percentage decline per doubling of cumulative output, Wright's law, was first documented in aircraft manufacturing in the 1930s.
- Solar is its most consequential modern example, turning a once-exotic technology into one of the cheapest sources of electricity ever built.

Key takeaways

1

Types of cost

Fixed + variable = total; explicit + implicit = economic cost.

2

Economic profit

Subtracts implicit (opportunity) costs, a stricter measure than accounting profit.

3

Cost curves

Average total cost is U-shaped; marginal cost crosses it at its minimum.

4

Short vs. long run

In the long run all costs are variable; long-run average cost is a lower boundary.

5

Scale, scope, learning

Economies of scale set the minimum efficient scale; scope and the learning curve cut cost further.

6

Evidence

Airlines chase full planes; solar follows Swanson's law, falling 20% per doubling.