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Principles of Economics and Management I

Session 4 · Production, Costs and Market Structures

Introduction



Where We Came From

Sessions 2 and 3 built the buyer: preferences, the constrained optimum, market demand and its elasticity.

Today we build the other side. Supply comes out of **costs** and the objective of **maximizing profit**. 🏭

And then we ask what changes when the firm is large enough to face the whole demand curve by itself. 👑



Today's Map

1. 🏠 Where costs come from, and why MC rises
2. 🧱 Fixed, variable, average and marginal cost
3. 🎯 Profit maximization: $MR = MC$
4. 🏁 Perfect competition: $P = MC$, supply **is** marginal cost, and its elasticity
5. ❤️ Producer surplus and the shutdown condition
6. 👑 Monopoly, the markup, and the link back to elasticity

By the end we hold a supply curve. Session 5 puts it against demand. 🔧

Part 1 · Production and Costs



Where Costs Come From

Costs come from a **production function** and the prices of inputs.

$$q = f(L), \quad MP_L = f'(L)$$

Diminishing marginal returns: $f'' < 0$. Adding workers to a fixed plant raises output by less and less.

 Source: OpenStax *Micro* 3e, §7.2 “Production in the Short Run”, tabulated for a firm adding workers one at a time.

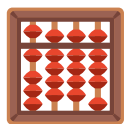
Which Is Exactly Why MC Rises

To make one more unit you need $1/MP_L$ extra workers, each costing the wage w . So

$$MC = \frac{w}{MP_L}$$

MP_L falls, therefore MC rises. The U shape of the cost curve is **diminishing returns, seen from the cost side**.

And it tells you what shifts MC : the **wage** and **productivity**. Hold that list; it is exactly what shifts supply in session 5. 



From a Production Function to a Cost Curve

Take $q = \sqrt{L}$, so $L = q^2$, with wage w and a fixed cost F .

$$TC(q) = F + w q^2, \quad MC(q) = 2wq, \quad AC(q) = \frac{F}{q} + wq$$

MC rises because $f'' < 0$; AC falls first (the fixed cost is spread over more units) and rises later (marginal cost drags it up).

The shapes are **consequences** of the production function, visible already in this example. 

Types of Cost

Fixed cost (FC): does not depend on quantity (rent, insurance).

Variable cost (VC): grows with output (materials, energy).

Total cost: $TC = FC + VC$. **Average cost:** $AC = TC/q$.

Average variable cost: $AVC = VC/q$.

+ Marginal Cost

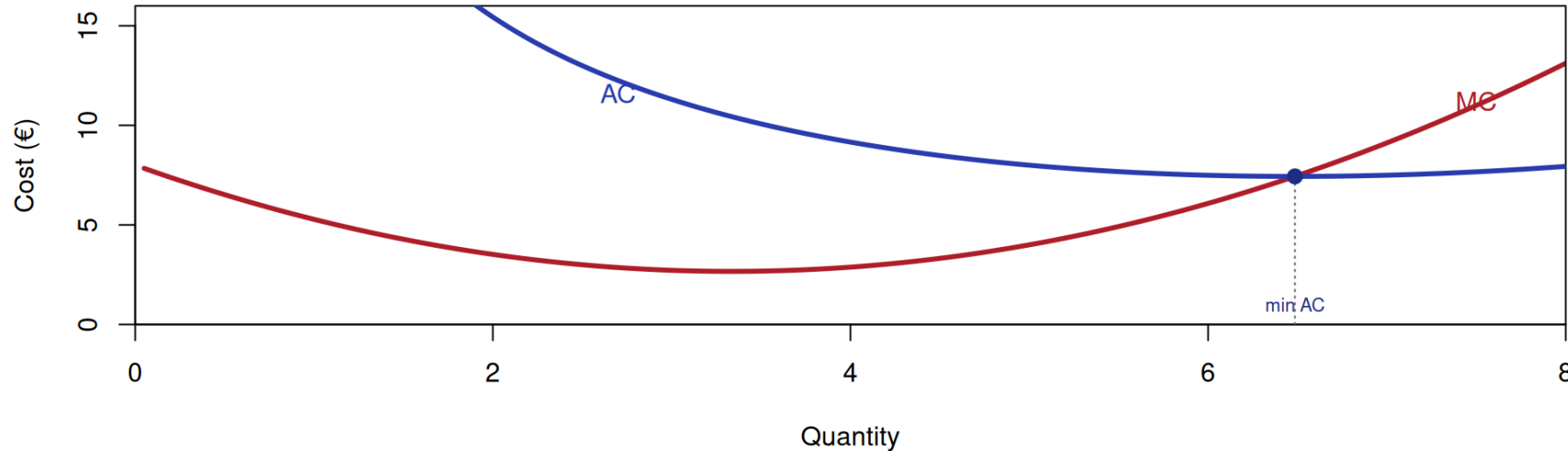
Marginal cost (MC): the cost of producing **one more** unit.

$$MC = \frac{dTC}{dq}.$$

Typically U shaped: it falls first (gains from specialization), then rises (diminishing returns).



The Cost Curves



Note: MC crosses AC at its **minimum**, and it has to.

$AC' = (MC - AC)/q$, so AC falls exactly while $MC < AC$ and rises once $MC > AC$. 

 Source: OpenStax *Micro* 3e, §7.3 “Costs in the Short Run”, “Fixed and Variable Costs” and “Where do marginal and average costs meet?”

The Golden Rule of Profit

The firm chooses q to maximize profit $\pi(q) = R(q) - TC(q)$.

First order condition: $\pi'(q) = 0$, that is

$$MR = MC.$$

Produce up to the point where **marginal revenue** equals **marginal cost**. No more, no less.

Check the second order condition too: $\pi'' = MR' - MC' < 0$, so MC must cut MR **from below**. Of the two solutions, only the **rising** one is a maximum. ⚠

? Multiple Choice 1

A firm's marginal cost curve is U shaped and it faces a given price. Profit is maximized where $P = MC$:

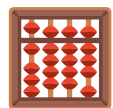
- A. At either of the two quantities where the curves cross.
 - B. At the lower of the two, where MC is falling.
 - C. Only if the firm is also minimizing average cost.
 - D. At the higher of the two, where MC is rising.
- ✓ **D.** The second order condition needs $MC' > MR' = 0$. On the falling branch, $P = MC$ is a profit **minimum**, and producing one more unit strictly improves things.

? Multiple Choice 2

Marginal cost is currently **below** average cost. Then average cost is:

- A. Falling.
- B. Rising.
- C. At its minimum.
- D. Constant.

✓ **A.** From $AC' = (MC - AC)/q$, the sign of AC' is the sign of $MC - AC$. It is the same arithmetic as a grade average: a mark below your average pulls it down.



Numerical Question

A firm has $q = \sqrt{L}$, a wage of $w = 2$ euros and a fixed cost of $F = 18$ euros.

- a) Write $TC(q)$, $MC(q)$ and $AC(q)$.
- b) At which quantity is average cost minimized?
- c) Check that MC equals AC there.
- d) What is the minimum average cost?

Solution

a) $L = q^2$, so $TC = 18 + 2q^2$, $MC = 4q$ and $AC = 18/q + 2q$.

b) $AC' = -18/q^2 + 2 = 0 \Rightarrow q^2 = 9$, so $q = 3$.

c) $MC(3) = 12$ and $AC(3) = 6 + 6 = 12$. They meet, exactly as $AC' = (MC - AC)/q$ requires. 

d) 12 euros per unit. Note this is the long run break-even price: below it the firm cannot cover its full cost at any quantity.

Part 2 · Competitive Supply

Perfect Competition

Many small firms, a homogeneous product. Each one is a **price taker**.

It faces the polar case from session 3: a **perfectly elastic** demand for its own output. Charge a cent more and it sells nothing.

If it is a price taker, selling one more unit always brings in P : hence $MR = P$, and the profit rule becomes $P = MC$. 

 Source: OpenStax *Micro* 3e, [§8.2](#) “How Perfectly Competitive Firms Make Output Decisions”, worked through for a raspberry farm, and “Marginal Cost and the Firm’s Supply Curve”.



The Seller's Side, Same Logic

Read $P = MC$ the way we read demand in session 3. A seller hands over the good and receives the price, so they sell when

$$p - c \geq 0$$

where c is the cost of producing **that** unit.

Reservation price of a seller: the lowest price at which they still sell. It equals their **marginal cost** c .

Sort those costs and you get the **supply curve**: whoever can produce below the price sells. 



A Warning About That Cost

c is the cost of producing **one more** unit.

Costs the firm pays whether or not it produces that unit (the rent on the factory, the licence, the loan already taken) are **not** in c .

So the supply curve is built out of **variable** cost only. We need this in about three slides.

+ From the Firm to Market Supply

Same aggregation as demand, in the other direction: at each price, ask every firm how much it wants to produce and **add the quantities**.

$$Q_s(p) = \sum_{j=1}^m q_j^*(p), \quad \text{where } p = MC_j(q_j^*)$$

Each firm's supply is its rising marginal cost, so market supply slopes **up**. Horizontal aggregation again. 



Elasticity of Supply

Now that we hold a supply curve, we can measure it the way we measured demand.

Price elasticity of supply: the percentage change in quantity supplied over the percentage change in price.

$$\varepsilon_s = \frac{dQ_s}{dP} \cdot \frac{P}{Q_s} > 0.$$

It is positive, because supply slopes up.

It depends above all on **time** 🕒. Overnight a firm can only run its existing plant harder, *MC* climbs steeply and quantity barely moves: **inelastic**. Over years it can build another plant, and the same price rise brings out much more: **elastic**.

Session 5 needs this number. Together with ε on the demand side, it decides who pays a tax.



Source: OpenStax *Micro* 3e, §5.1, "Price Elasticity of Supply".

Producer Surplus, Carefully

Producer surplus (PS): revenue minus the **variable** cost of what was produced. The area **below the price and above the supply curve**.

The supply curve is built from marginal costs, and marginal cost contains **only variable** cost. Fixed costs never entered it, so they are not in PS either.

$$PS = p q - VC(q), \quad \text{profit} = p q - VC(q) - FC = PS - FC$$



So PS Is Not Profit

A firm can have a perfectly healthy producer surplus and still **lose money**, once the fixed costs are paid.

That gap is exactly why a firm keeps operating at a loss in the short run: as long as $PS > 0$, shutting down would lose even more.

Two different questions: “is this trade worth doing?” (PS) and “was this business worth starting?” (profit).

Should It Produce at All?

$P = MC$ says **how much**. It does not say **whether**. For that, compare with average cost.

 **Short run:** fixed costs are sunk, so ignore them (session 1). Produce if $P \geq AVC$; shut down if not.

 **Long run:** everything is variable. Stay in the market only if $P \geq AC$; otherwise exit.

Between AVC and AC the firm makes a **loss and still operates**, because it covers its variable cost and contributes something toward the fixed one.

That gap is exactly the difference between **producer surplus** and **profit** from two slides ago. Now you know where it lives. 

 Source: OpenStax *Micro* 3e, [§8.2](#), "The Shutdown Point"; the exit decision is [§8.3](#) "Entry and Exit Decisions in the Long Run".



In the Long Run, Entry Eats the Profit

Suppose price sits above minimum average cost, so firms are making money.

Nothing stops new firms entering. Market supply expands, and the price falls.

It stops falling only where profit is zero, that is at $P = \min AC$.

Which is why long run competitive price equals minimum average cost.

“Zero profit” means capital earns exactly what it would earn elsewhere. The opportunity cost is already inside the cost.



✨ The Efficiency of Competition

Under perfect competition, $P = MC$: the price equals the cost of producing the last unit.

The buyer's value of the last unit equals its cost. No trade worth doing is left undone, and none that destroys value is done.

Everything in Part 3 is measured **against** this benchmark.

? Multiple Choice 3

In the short run a competitive firm finds $AVC < P < AC$. It should:

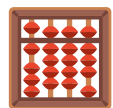
- A. Keep producing, even though it is making a loss.
- B. Shut down at once, since it is losing money.
- C. Raise its price until it covers AC.
- D. Produce where $P = AC$ instead.

✓ **A.** Fixed costs are **sunk** in the short run, so they should not enter the decision. Since the price covers variable cost, operating loses less than shutting down. Option C is not available: the firm is a price taker.

? Multiple Choice 4

Producer surplus is:

- A. Revenue minus total cost, including fixed cost.
 - B. Revenue minus the variable cost of what was produced.
 - C. The firm's accounting profit for the year.
 - D. The area above the demand curve and below the price.
-  **B.** The supply curve is made of marginal costs, which contain no fixed cost. Subtract fixed cost from PS and only then do you have profit.



Numerical Question

Total cost $TC = q^2 + 10$ (euros), in a competitive market at a price of 12 euros.

- a) Find the optimal quantity.
- b) Compute profit.
- c) Compute producer surplus, and reconcile it with (b).
- d) Below which price would the firm shut down in the short run?



Solution

a) $MC = 2q$, and $P = MC$ gives $12 = 2q$, so $q^* = 6$. MC is rising, so it really is the maximum.

b) $\pi = 12 \times 6 - (36 + 10) = 72 - 46 = 26$ euros.

c) $VC = q^2 = 36$, so PS = $72 - 36 = 36$ euros. And $PS - FC = 36 - 10 = 26$, the profit.



d) $AVC = q^2/q = q$, which is minimized as $q \rightarrow 0$. So $AVC \leq P$ holds for any positive price: this firm **never** shuts down in the short run. The fixed cost of 10 is sunk and irrelevant to that call.

Part 3 · Market Power

Monopoly

A single seller. The firm is **not** a price taker: it faces the **entire** demand curve.

To sell more, it has to **cut** the price on all units. That is why $MR < P$.

The profit rule ($MR = MC$) still holds, but now MR lies **below** the price.



Where Market Power Comes From

A monopoly needs a barrier that keeps rivals out.



Costs: a natural monopoly, where average cost falls over the whole relevant range, so one firm serves the market more cheaply than two.



Law: patents, licences, concessions. Deliberately granted, usually to pay for the invention.

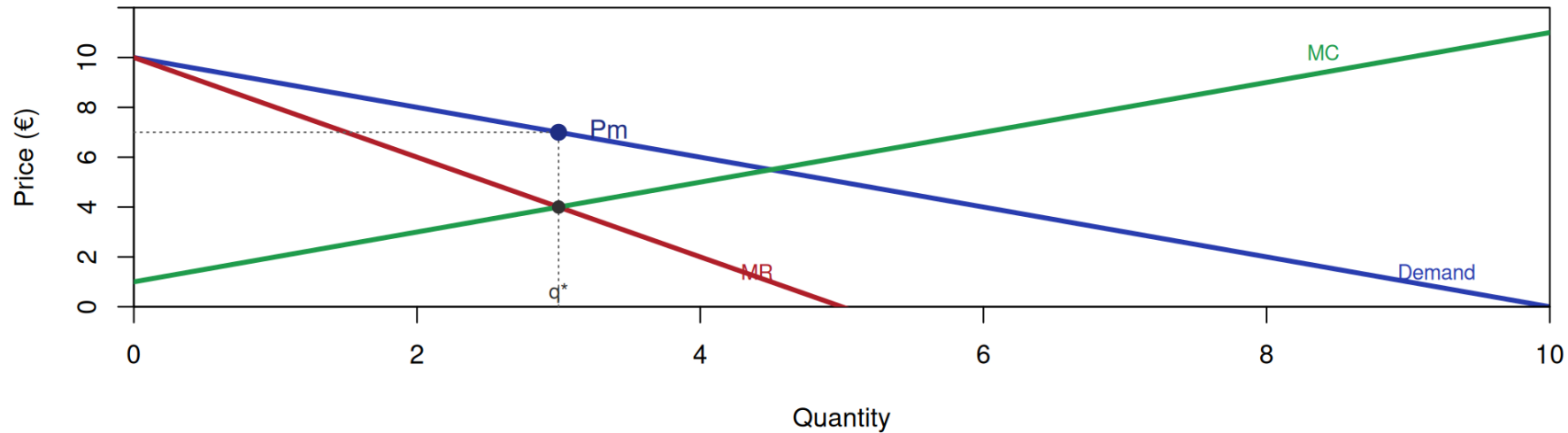


Control of an input, or a network that gets more valuable the more users it has.

 Source: OpenStax *Micro* 3e, [§9.1](#) “How Monopolies Form: Barriers to Entry”.



The Monopolist's Choice



It picks the q where $MR = MC$, and charges the price P_m **on the demand curve** (above MC).

Source: OpenStax *Micro* 3e, §9.2 “How a Profit-Maximizing Monopoly Chooses Output and Price”, built numerically around a drug called HealthPill.



The Inefficiency of Monopoly

The monopolist produces **less** and charges **more** than competition would.

$P_m > MC$: between the monopoly quantity and the competitive one, buyers value the good above what it costs to make, and those trades do **not** happen.

Deadweight loss: the surplus destroyed by producing below the efficient level.

The monopolist's profit is a **transfer** from buyers, not a loss. What is lost is the triangle of trades nobody gets.

 Source: OpenStax *Micro* 3e, §9.2, "The Inefficiency of Monopoly".



Markup and Elasticity

Recall the formula from session 3: $MR = P \left(1 + \frac{1}{\varepsilon}\right)$. With $MR = MC$:

$$\frac{P - MC}{P} = -\frac{1}{\varepsilon} = \frac{1}{|\varepsilon|}.$$

Lerner index: the margin over cost is **larger** the **more inelastic** demand is. Market power is the power to set price above cost. 💰

Sanity check: perfect competition is $|\varepsilon| \rightarrow \infty$, giving a margin of zero and $P = MC$. Competition is the limit case.

A Monopolist Never Prices in the Inelastic Region

From the same first order condition:

$MC \geq 0$ and $MC = MR = P \left(1 + \frac{1}{\varepsilon}\right)$, with $P > 0$. So $1 + 1/\varepsilon \geq 0$, which forces $|\varepsilon| \geq 1$.

So a profit-maximizing monopolist always sits on the **elastic** part of demand. Never the inelastic part.

The intuition from session 3: where demand is inelastic, raising the price raises **revenue** and cuts **output**, so it raises revenue and cuts cost at the same time. No firm leaves that on the table.





Financial Applications



Understanding **market power** is essential for valuing firms: high margins signal competitive advantage, and the Lerner index says where they come from.

Sector analysis (how concentrated the market is, how elastic demand is) feeds directly into asset valuation. 

A margin that no barrier explains will not survive competition.

? Multiple Choice 5

Under monopoly, at the optimum:

A. $P = MC$.

B. $MR > P$.

C. $P > MC$.

D. $P = MR$.



C. Since $MR < P$ and $MR = MC$ at the optimum, it follows that $P > MC$: there is a margin over cost.

? Multiple Choice 6

A profit-maximizing monopolist with $MC \geq 0$ always operates where demand is:

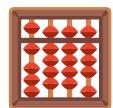
A. Inelastic, since that is where the margin is largest.

B. Unit elastic, since that maximizes revenue.

C. At whatever elasticity the market happens to have.

D. Elastic, since $MR = MC \geq 0$ requires $|\varepsilon| \geq 1$.

✓ **D.** From $MC = P(1 + 1/\varepsilon) \geq 0$. Option A confuses the Lerner index, which says a *less* elastic demand allows a bigger margin, with the claim that the firm ends up in the inelastic **region**. It never does.



Numerical Question

A monopoly with demand $P = 20 - Q$ and constant $MC = 4$ euros. Note $MR = 20 - 2Q$.

- a) Find the monopoly quantity and price.
- b) Compute the Lerner index and the elasticity at that point.
- c) What would a competitive industry with the same costs produce?
- d) Compute the deadweight loss.



Solution

- a) $20 - 2Q = 4 \Rightarrow Q_m = 8$, and $P_m = 20 - 8 = 12$ euros.
- b) Lerner = $(12 - 4)/12 = 2/3$, so $|\varepsilon| = 3/2 > 1$: elastic, as it must be.
- c) $P = MC$ gives $20 - Q = 4$, so $Q_c = 16$ at a price of 4 euros. The monopolist produces **half** as much.
- d) The lost triangle between Q_m and Q_c : $\frac{1}{2}(12 - 4)(16 - 8) = 32$ euros of surplus that simply disappears. 

Wrap-Up

What to Take From This Session

 Costs come from **technology**. Diminishing returns is why MC rises: $MC = w/MP_L$.

 MC cuts AC at its **minimum**: $AC' = (MC - AC)/q$ is an identity, true for any cost function.

The firm produces where $MR = MC$, on the **rising** branch. Under price taking that is $P = MC$, so **supply is marginal cost**.

 **PS is not profit**: it leaves out fixed cost, which is what makes the short run shutdown rule $P \geq AVC$ rather than $P \geq AC$.

 Market power is $P > MC$, and the Lerner index ties the margin to $1/|\varepsilon|$. Competition is the case $|\varepsilon| \rightarrow \infty$.

Next Session

Market Equilibrium and Taxes.

We now have both curves. Next they meet: what sets the price, why that outcome maximizes surplus, and what a tax does to it.



See you next week. 