

Competitive Market Equilibrium

Lecture 4

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Quick Review

Consumer Optimization

Consumers maximize utility subject to a budget constraint:

$$\max_{x,y} U(x, y) \quad \text{s.t.} \quad p_x x + p_y y = I$$

Solution: $x^*(p_x, p_y, I)$ and $y^*(p_x, p_y, I)$

Gives us individual **demand functions** for goods x and y .

Firm Optimization

Profit maximization for a price-taking firm:

$$\max_q \pi = p \cdot q - C(q)$$

First-order condition: $p = MC(q)$

Short-run supply curve: Portion of the MC curve above AVC

The firm produces where price equals marginal cost, as long as it covers variable costs.

Gives us the **supply function** for each firm: $q^*(p, r, w)$

From Individual to Market

So far: Individual consumer and firm decisions

Today: How do individual decisions aggregate into market outcomes?

- How are market demand and supply constructed?
- What determines equilibrium prices?
- What happens when conditions change?

Study above under the special case of perfectly competitive markets that are characterized by many buyers and sellers, homogeneous products, and free entry/exit in the long run.

Demand, Supply, and Equilibrium

Market Demand

Individual i has demand: $x_i(p_x, p_y, I_i)$

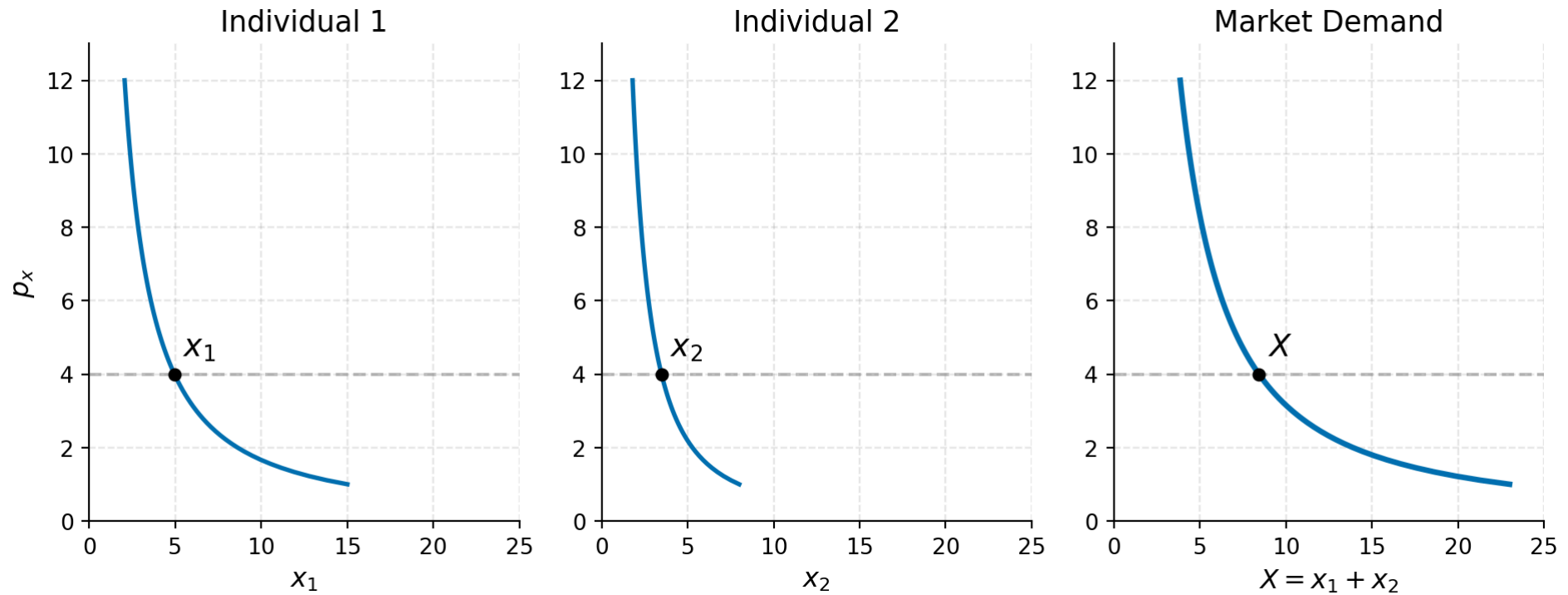
Market demand is the horizontal sum of individual demands:

$$Q^D(p_x, p_y, I_1, \dots, I_m) = \sum_{i=1}^m x_i(p_x, p_y, I_i)$$

If each individual's demand is downward sloping, so is market demand

Shifts in market demand: Changes in income, prices of related goods, preferences, or number of consumers shift the curve

Market Demand: Graphical Construction



At any price, market quantity is the sum of individual quantities demanded.

Market Demand Elasticity

$$e_{D,p} = \frac{\partial Q^D}{\partial p} \cdot \frac{p}{Q^D}$$

Classification:

- $|e_{D,p}| > 1$: Elastic demand
- $|e_{D,p}| = 1$: Unit elastic
- $|e_{D,p}| < 1$: Inelastic demand

Why it matters for equilibrium: The elasticity of demand determines how market prices respond to supply shocks

Timing of the Supply Response

How quickly can supply adjust?

Very short run: Quantity is fixed so only price adjusts (vertical supply curve).

Short run: Existing firms adjust output but no entry/exit.

Long run: Firms can enter or exit, all inputs are variable.

The distinction matters for policy analysis.

Short-Run Market Supply

Each firm j has short-run supply $q_j(p, r, w)$

Market supply is also a horizontal sum:

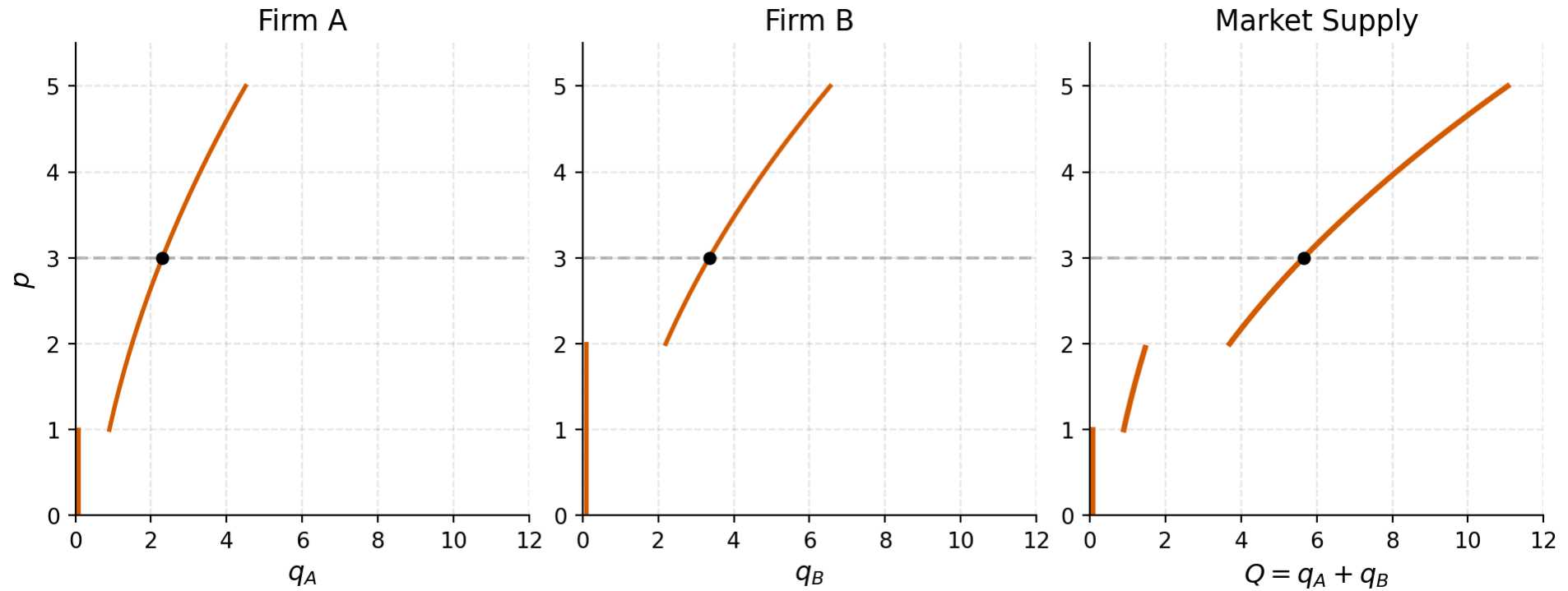
$$Q^S(p, r, w) = \sum_{j=1}^n q_j(p, r, w)$$

Since each firm's supply curve slopes upward (rising MC), market supply also slopes upward

Supply elasticity:

$$e_{S,p} = \frac{\partial Q^S}{\partial p} \cdot \frac{p}{Q^S} > 0$$

Market Supply: Graphical Construction



Market supply is the horizontal sum of individual firms' supply (MC) curves

Equilibrium

An **equilibrium price** p^* solves:

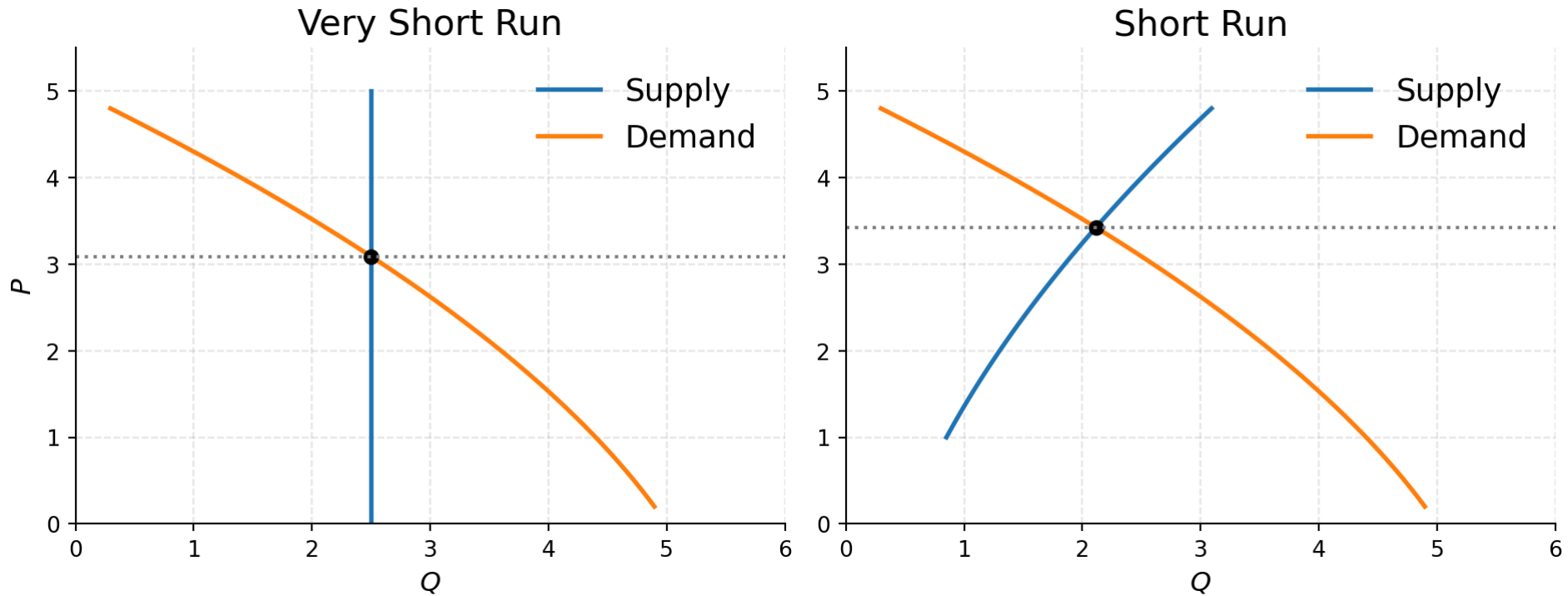
$$Q^D(p^*) = Q^S(p^*)$$

The equilibrium price serves two functions:

- **Signal to producers:** How much to produce
- **Rationing device:** Allocates goods among consumers

At p^* , neither demanders nor suppliers have an incentive to change behavior

Equilibrium Graphically



What happens to equilibrium price and quantity if there is an increase in demand?

Concert Tickets and Surge Pricing

Very short run in action:

- Concert venues have fixed capacity (vertical supply)
- A surge in demand → prices must rise to ration seats
- Explains why popular concerts sell out / prices spike on resale markets

Uber/Lyft surge pricing works similarly: in the very short run, the number of drivers is nearly fixed, so price surges ration available rides.

Question: Is this “fair”?

Comparative Statics

Shifts in Supply and Demand

Demand Curves Shift Because

Incomes change

Prices of substitutes/complements change

Preferences change

Supply Curves Shift Because

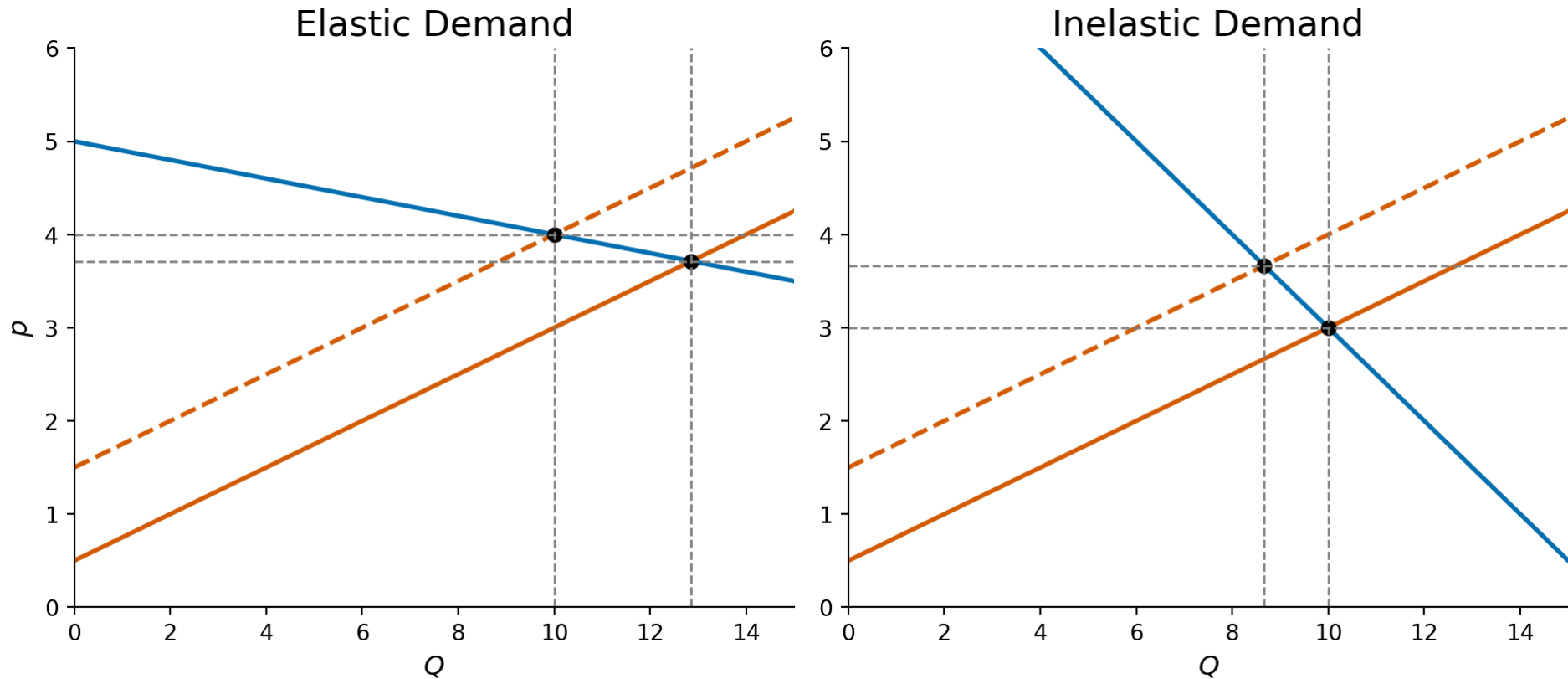
Input prices change

Technology changes

Number of producers changes

Key insight: The relative magnitudes of price and quantity changes depend on the shapes (elasticities) of the curves

Supply Shift: Role of Demand Elasticity



Elastic demand \rightarrow quantity adjusts more, price less. Inelastic demand \rightarrow price absorbs most of the shock.

A Comparative Statics Model

Demand: $Q^D = D(p, \alpha)$ where α shifts demand

Supply: $Q^S = S(p, \beta)$ where β shifts supply

Equilibrium: $D(p^*, \alpha) = S(p^*, \beta)$

Differentiate with respect to α :

$$D_p \cdot \frac{dp^*}{d\alpha} + D_\alpha = S_p \cdot \frac{dp^*}{d\alpha}$$

$$\frac{dp^*}{d\alpha} = \frac{D_\alpha}{S_p - D_p} > 0$$

Since $D_p < 0$, $S_p > 0$, and $D_\alpha > 0$ (demand increase), equilibrium price rises

In Elasticity Form

Using expression from last slide:

$$e_{p,\alpha} = \frac{dp^*}{d\alpha} \cdot \frac{\alpha}{p} = \frac{D_\alpha}{S_p - D_p} \cdot \frac{\alpha}{p} = \frac{D_\alpha}{S_p - D_p} \cdot \frac{\alpha/Q^*}{p/Q^*} = \frac{e_{D,\alpha}}{e_{S,p} - e_{D,p}}$$

Note that $\frac{dQ^*}{d\alpha} = S_p \cdot \frac{dp^*}{d\alpha}$, we can write:

$$e_{Q^*,\alpha} = \frac{dQ^*}{d\alpha} \cdot \frac{\alpha}{Q^*} = \frac{e_{S,p} e_{D,\alpha}}{e_{S,p} - e_{D,p}}$$

This is a useful framework as we can estimate elasticities from data and predict how shocks will affect prices and quantities.

Intuition?

Long-Run Equilibrium

Key Assumptions for the Long Run

Entry and exit are free: No barriers, no special costs

All inputs are variable: Firms can adjust capital, labor, everything

Firms are identical: Same cost functions, no special resources

Long-run equilibrium requires:

- $p = MC$ (profit maximization)
- $p = AC$ (zero economic profit)
- Each firm operates at the minimum of long-run AC (remember: $MC = AC$ at the minimum point)

Why Zero Profits?

If $p > AC$: Economic profits attract entry \rightarrow supply shifts right \rightarrow price falls

If $p < AC$: Losses cause exit \rightarrow supply shifts left \rightarrow price rises

Process continues until $p = \min AC$ and economic profits are exactly zero

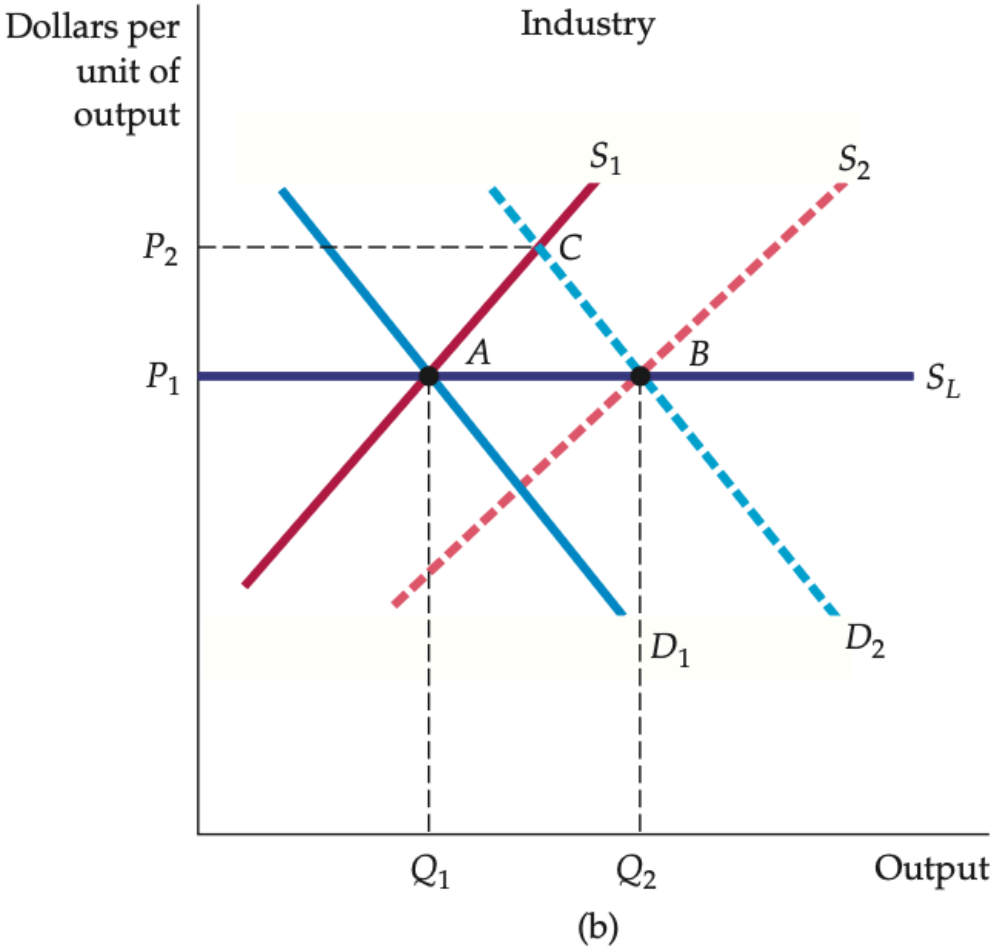
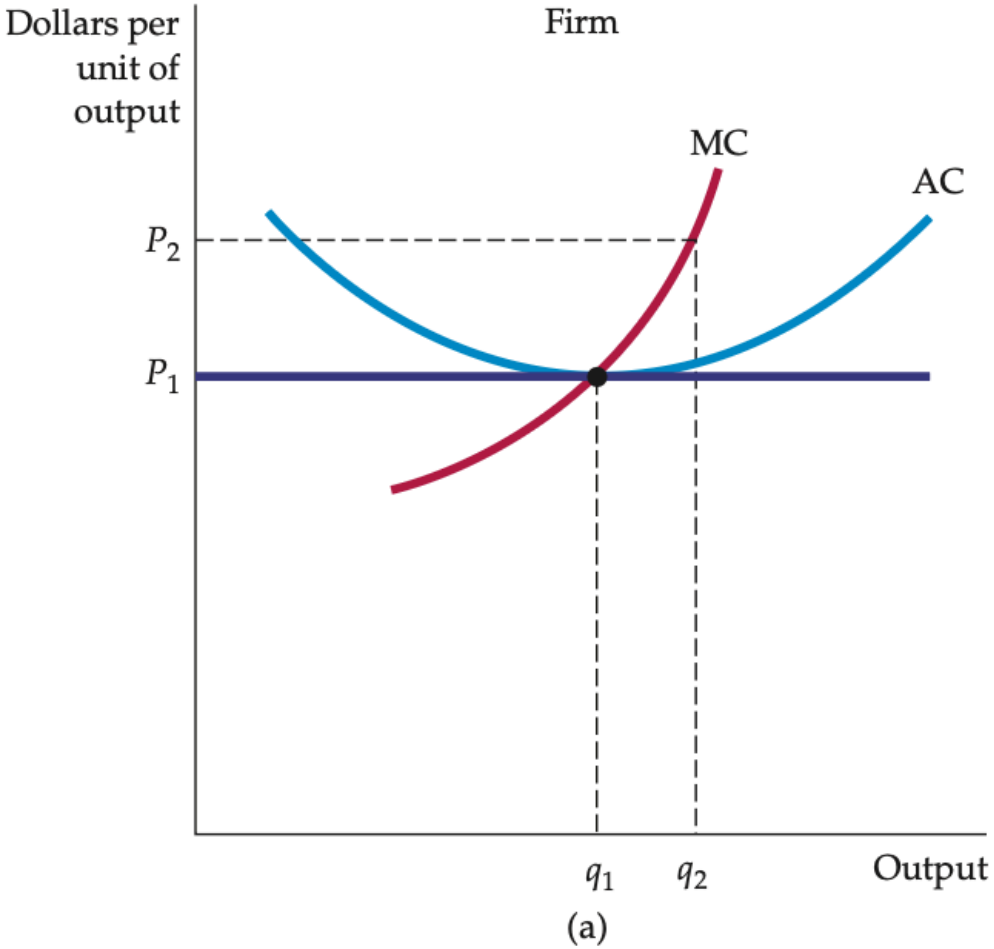
Remember: Zero economic profit \neq zero accounting profit. Firms still earn a normal return on invested capital, they just don't earn above-normal returns.

Shape of the Long-Run Supply Curve

The long-run supply curve depends on what happens to costs as firms enter:

- **Constant cost industry:** Entry doesn't affect input prices → LS is horizontal
- **Increasing cost industry:** Entry bids up input prices → LS slopes upward
- **Decreasing cost industry:** Entry lowers costs (agglomeration, thicker labor markets) → LS slopes downward

Graph for Constant Cost Industry



Increasing Cost Industry

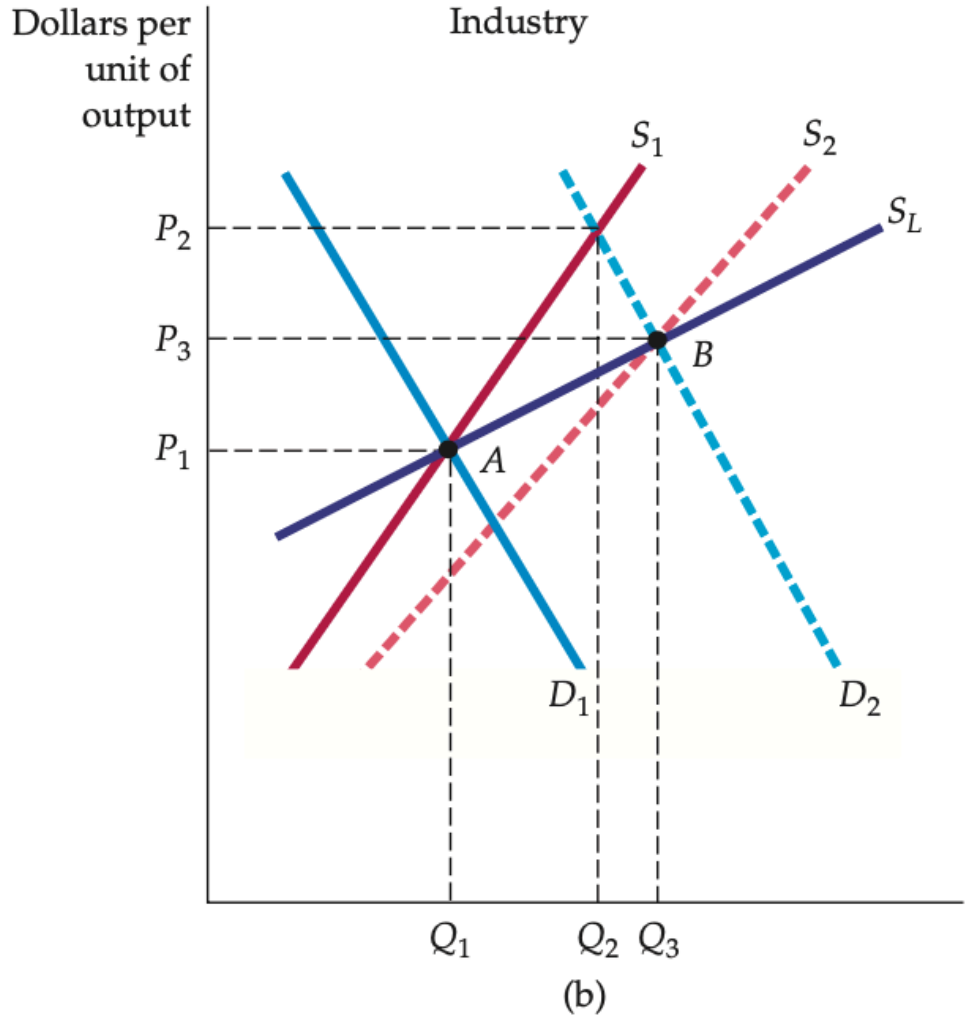
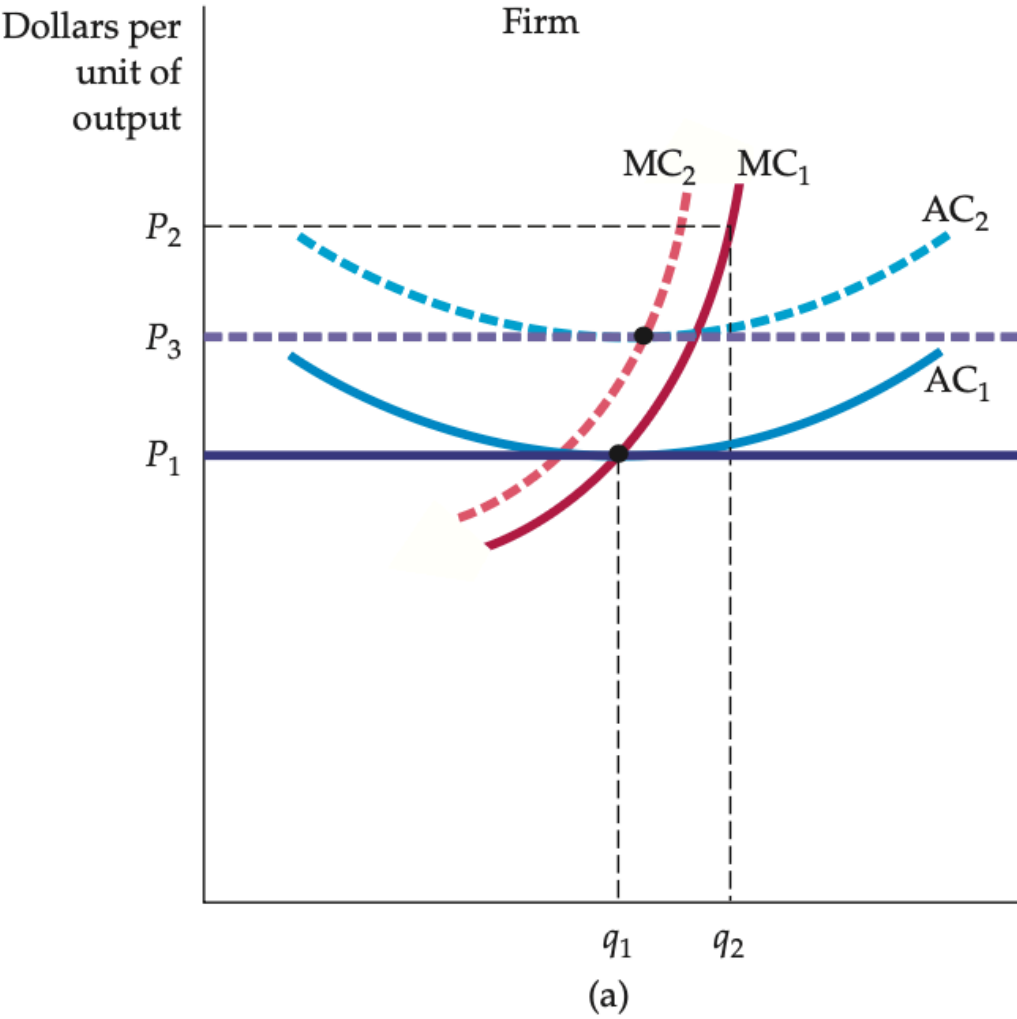
Why might entry increase costs?

- New and existing firms compete for scarce inputs (specialized labor, raw materials)
- Expansion may impose external costs (congestion, environmental)
- Growing demand for tax-financed services

Result: Long-run equilibrium price rises with industry output

Example: Housing construction in a growing city, as more homes are built, land prices and construction labor costs are bid up

Graph for Increasing Cost Industry



Decreasing Cost Industry

Why might entry decrease costs?

- Larger pool of trained labor (thicker labor markets)
- Critical mass of industrialization enables specialized suppliers
- Better transportation and communication networks

Example: Silicon Valley, clustering of tech firms reduced costs for all through knowledge spillovers, specialized suppliers, and deep labor pools

Result: Long-run supply slopes downward (expansion makes production cheaper)

Producer Surplus and Rents

Producer Surplus in the Long Run

Producer surplus: Area below market price and above supply curve

- In the **constant cost** case: long-run supply is horizontal → producer surplus is zero
- In the **increasing cost** case: supply slopes upward → positive producer surplus

Key question: Who captures these rents? Must look at the input markets to find the ultimate beneficiaries.

Ricardian Rent

David Ricardo's insight (1817): Land of varying fertility

- At low prices, only the most fertile land is farmed
- As demand grows, less fertile (higher cost) land is brought into production
- Owners of the most fertile land earn **rents** i.e. returns above what's needed to keep their land in production

The long-run supply curve slopes upward because of these differences in costs across producers

Capitalization of Rents

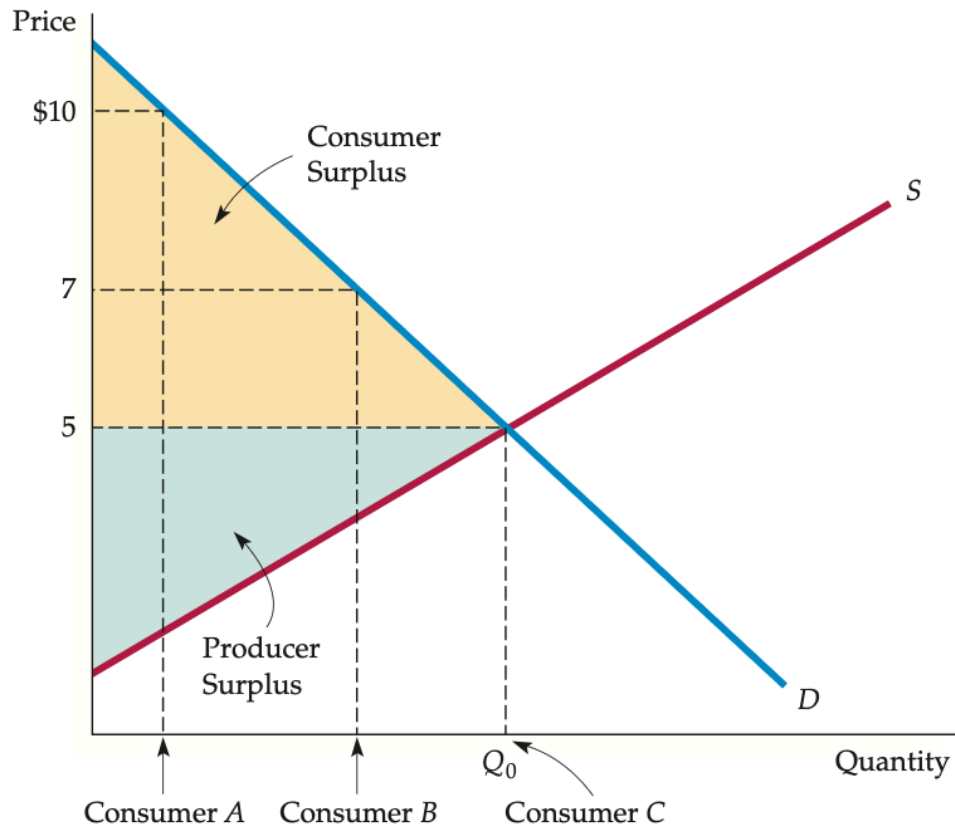
In practice, Ricardian rents get **capitalized into input prices**

- More fertile farmland sells at higher prices
- Well-located commercial real estate commands higher rents
- Experienced workers in high-demand fields earn wage premiums

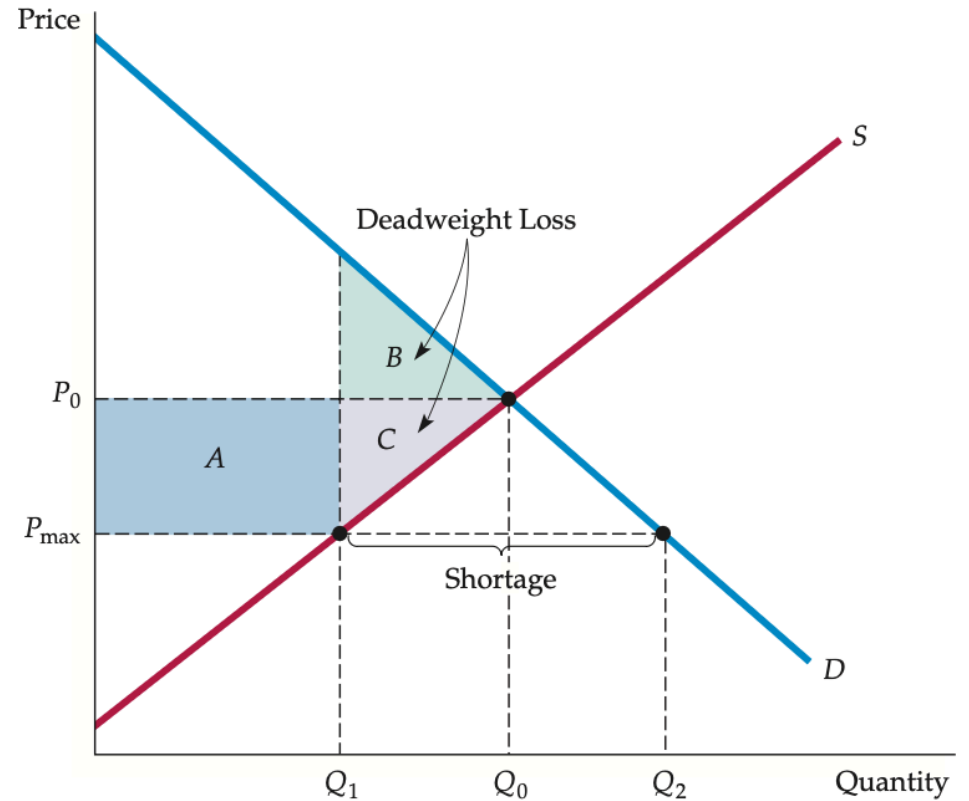
Implication: Once rents are capitalized, even low-cost firms may appear to earn zero economic profit and the “advantage” is reflected in the price they paid for the input

Welfare Analysis

Efficiency of Competitive Markets



Total surplus (CS + PS) is maximized at the competitive equilibrium.



Departures from competitive outcome create **deadweight loss** — surplus lost and captured by no one.

Efficiency of Competitive Markets: Math

The social planner's problem: choose q to maximize

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First-order condition:

$$\frac{dW}{dq} = U'(q) - p(q) = 0 \implies U'(q) = p(q)$$

Since $p(q)$ is long-run supply curve, $p(q) = MC(q) = AC(q)$, social planner chooses q where marginal benefit equals marginal cost, which is exactly the competitive equilibrium condition.

Tax Incidence

A per-unit tax t creates a wedge between what buyers pay and sellers receive:

$$p^D = p^S + t$$

Who bears the tax? Depends on relative elasticities:

$$\frac{dp^D/dt}{dp^S/dt} = -\frac{e_{S,p}}{e_{D,p}}$$

Rule of thumb: The more inelastic side of the market bears more of the tax

- If demand is inelastic (necessities) → consumers bear most of the tax
- If supply is inelastic (fixed factors) → producers bear most of the tax

Deadweight Loss of Taxation

All non-lump-sum taxes involve deadweight losses. A linear approximation:

$$DWL \approx -\frac{1}{2} \cdot \frac{e_{S,p} \cdot e_{D,p}}{e_{S,p} - e_{D,p}} \cdot \frac{t^2}{p} \cdot Q$$

Three key insights:

- DWL is proportional to the **square** of the tax rate — doubling the tax more than doubles the welfare cost
- Higher elasticities → larger DWL (more behavioral distortion)
- Efficient taxation: spread taxes across many goods with low rates rather than taxing one good heavily (Ramsey rule intuition)

Who Pays the Payroll Tax?

The U.S. payroll tax (Social Security + Medicare) is nominally split 50-50 between employers and employees

But economic incidence depends on labor supply elasticity:

- Labor supply is relatively inelastic (people need to work)
- So workers bear most of the tax, regardless of the statutory split
- Employer's "share" is largely passed through as lower wages

Empirical evidence (Gruber 1997, Saez et al. 2012) confirms: the incidence falls primarily on workers