Aalto University
School of Business

Intermediate Microeconomics

Introduction, Competitive Markets

Professor Marko Terviö

Department of Economics
Aalto BIZ

Fall 2024

ECON-2110

Introduction

- Why study microeconomics?
  - Better than “gut instinct”/“common sense” in predicting consequences of economic decisions (not perfect!)
  - Economic literacy. Understanding the economy we live in, as participants, citizens and voters.
  - Ideas and skills for economic decision-making

- Main challenge in all economics:
  The interaction of “soft” humans within the “hard” constraints of the physical world
  - Scarce resources $\rightarrow$ Mathematically exact elements
  - Human behavior $\rightarrow$ Mathematically fuzzy elements

Economics BSc Core Courses

- Intermediate Microeconomics
  (ECON-2110 & ECON-2210) Fall 2024, Marko Terviö

- Intermediate Macroeconomics
  (ECON-C3110) Spring 2025, Nigel McClung
  (ECON-C3210) Spring 2025, Laurence Malafry

- Econometrics
  (ECON-C4110 & ECON-C4210) Spring 2025, Otto Toivanen

- Mathematics for Economists
  (ECON-C1100) Fall 2024, Mitri Kitti

How to Succeed in This Course

1. Read both the syllabus and the course web page at MyCourses
2. After the lecture make sure you understand all concepts and bullet points from the lecture slides. Ask me questions!
3. Working on problem sets (PS) is essential. Working in small groups is allowed and indeed encouraged, but make sure to write up your own answer in your own words.
4. After model solutions (MS) are released make sure to understand them. MS often have additional insights or time-saving methods.
5. Teaching assistants hold a live session weekly and check Zulip every business day. Ask questions where you need more clarification or more examples!
6. Textbook provides additional examples and review questions on most topics covered in class

Examples of Microeconomic Questions

- A company with market power invents a longer-lasting version of its coffee machine. What course of action would maximize its profits?

- A permit quota system for establishing new pharmacies is replaced by free entry. What are the gains and losses from this reform? What if quotas are retained but sold to highest bidder? What if pharmacy permits are tradable?

- When can a company benefit from creating a lower quality version of its product? Would consumers be better off if this were made impossible?

Typical Concepts in Microeconomics

. . . that usually mean something quite different outside economics

- (Economic) efficiency (*taloudellinen tehokkuus*)
- Equilibrium (*tasapaino*)
- Incentives (*kannustimet*)
- Margins (*marginaalit*)
- (Opportunity) cost (*vaihtoehtoiskustannus*)
- Scarcity (*niukkuus*)
- Trade-off (?)

What is your opportunity cost for the Aalto BSc degree?

What is the impact of bike theft on economic efficiency?

Economic Models

- Framework

  - Preferences

  - Technology and resources

  - Information

- Simplifications

  A more realistic can be less useful

- Models helpful in predicting impact of changes

  - Schematic model: get direction right, intuitive understanding

  - Empirical model: get quantity right & quantify the uncertainty

- All models have a finite scope of applicability

  There is no quest for a “theory of everything” in Economics

Basic models of markets

- Competitive market
- Monopoly/Monopsony (market power)
- Oligopoly/Oligopsony (strategic interaction)

Demand and Supply in Competitive Markets

"Demand" is a relation between quantity and price.

What quantity Q would buyers want to buy at price P? $\Longleftrightarrow$

At what price P would buyers want to buy Q units?

Demand curve is defined for a time period, at given levels of...

- Wealth
- Prices of other goods
- Preferences or technology
- Population

A change in any of the above can shift the demand

Supply is similar, but "wealth" hardly applicable if sellers are firms

Definition of a market

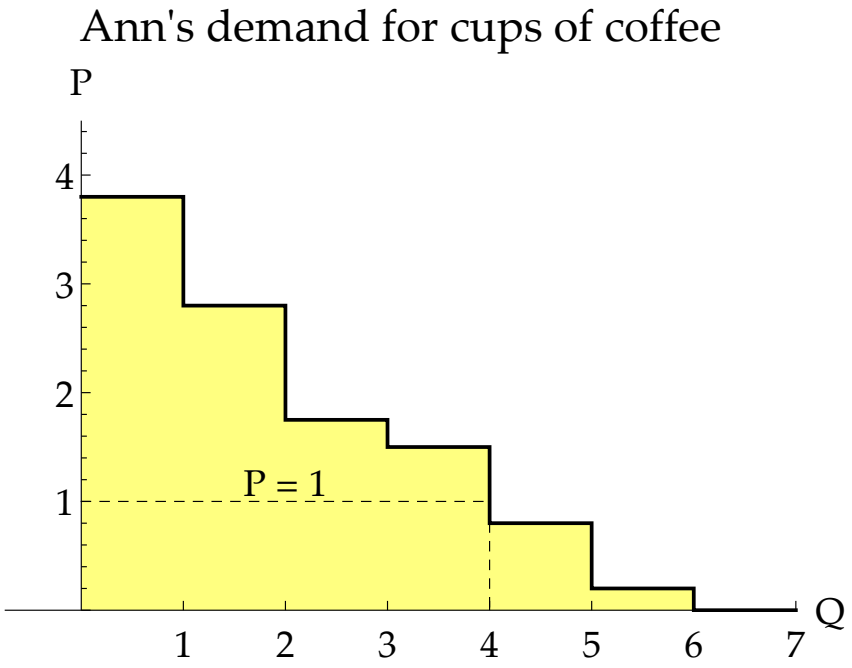
- Goods are perfect substitutes for buyers
- In a competitive market participants only decide *how much* to buy or sell at the market price:
  no one thinks that their own decisions *affect the market price*

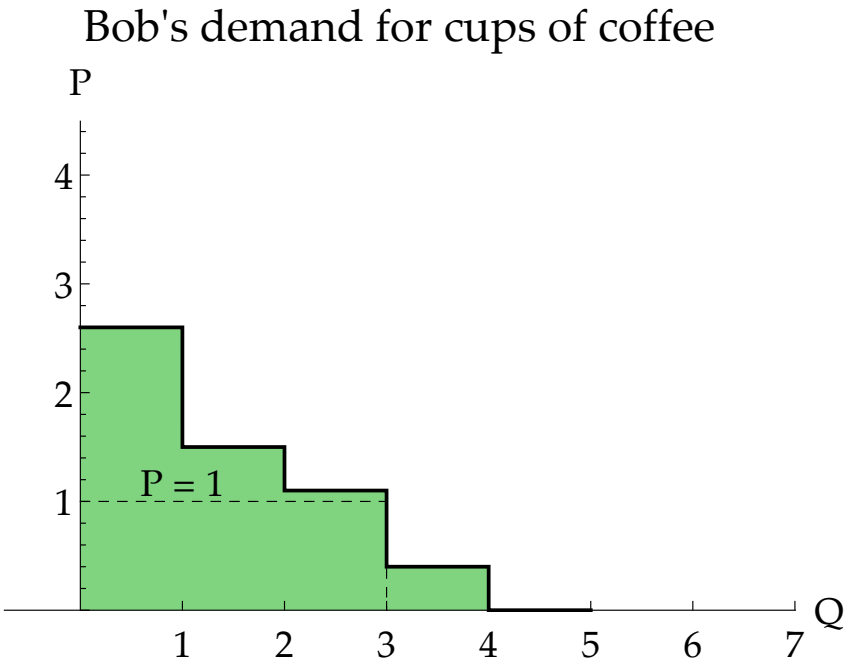
Market definition can be tricky in practice. Example from futures markets:

Green coffee beans produced in Brazil, variety ‘coffea arabica’ type six or better, to be delivered in the city of São Paulo.

In a competitive market buyers and sellers do not take into account their own impact on market price; they are “price takers”
Both “market” and “competitive” are usually just useful abstractions

Demand: Discrete Example

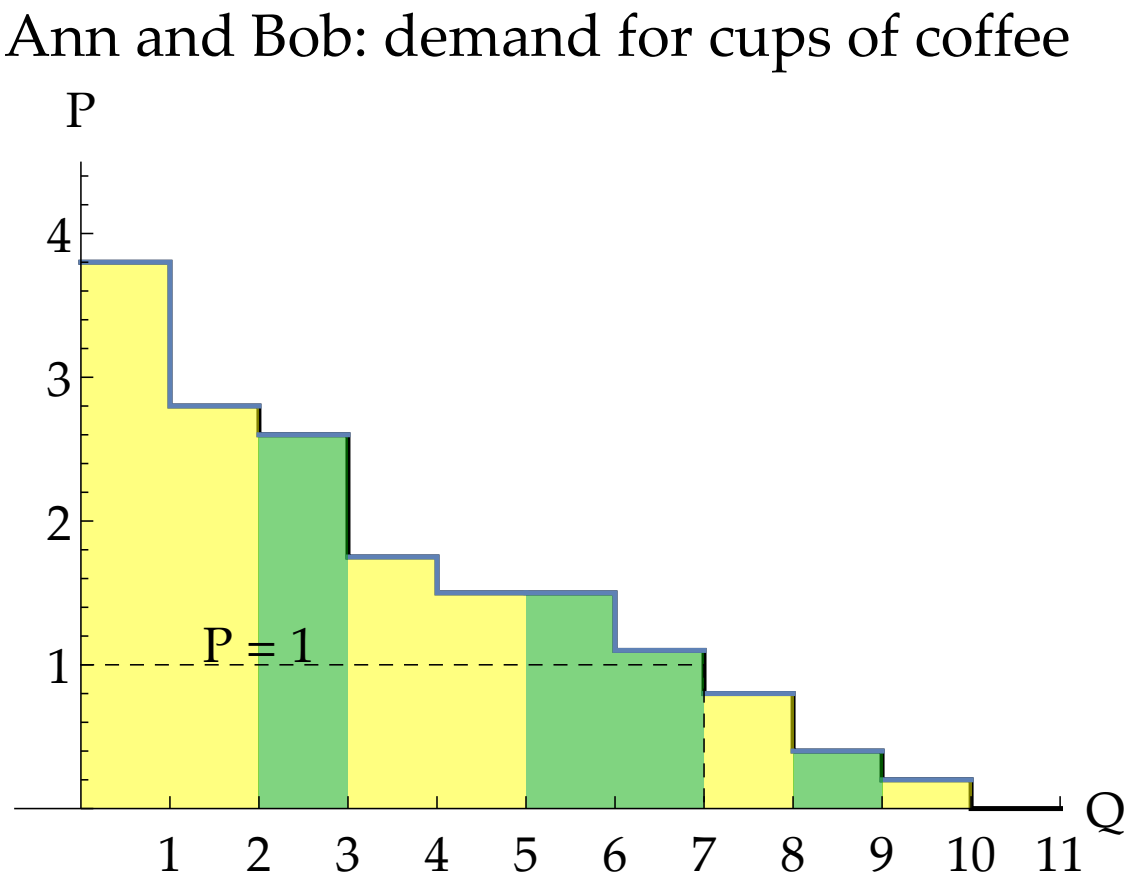




	1	2	3	4	5	6	7
Ann	3.8	2.8	1.75	1.5	0.8	0.2	0
Bob	2.6	1.5	1.1	0.4	0	0	0

Maximum price at which Ann will buy 2 cups is 2.80 €/cup, aka Ann's "reservation value", "valuation" or "willingness-to-pay" (WTP) for 2nd cup.

Demand Aggregation: Discrete Example



What is your demand for coffee? What would shift it?

Demand and Supply Framework: Linear Example

Demand (D)

$$Q^d(p) = 800 - 4p \iff P^d(q) = 200 - \tfrac{1}{4}q$$

Supply (S)

$$Q^s(p) = 6p - 30 \iff P^s(q) = 5 + \tfrac{1}{6}q$$

Choke prices

$$P^d(0) = 200$$

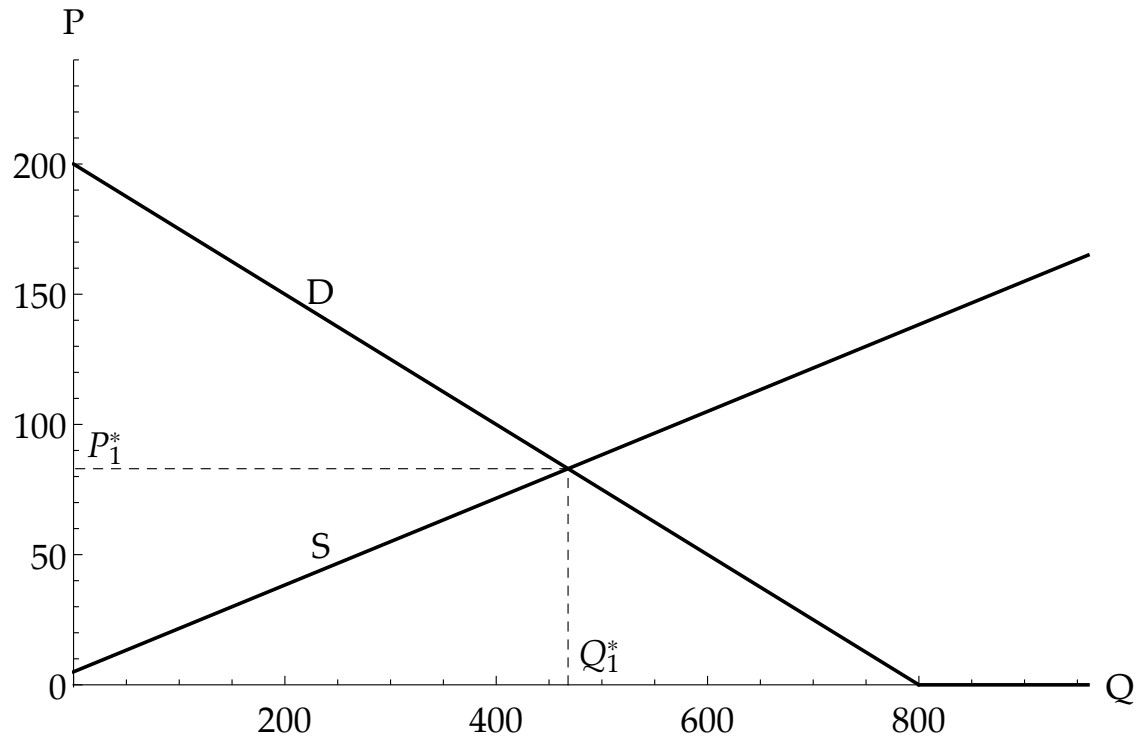
$$P^s(0) = 5$$

Pedantic notation $Q^d(p) = \max\{0, 800 - 4p\}$ rarely used

Equilibrium: $\{p, q\}$ st. $P^d(q) = P^s(q) \iff Q^d(p) = Q^s(p)$

Demand and Supply Framework: Linear Example

Market Equilibrium



$$P^d(q) = P^s(q) \Longrightarrow 200 - 0.25q = 5 + 0.167q \Longrightarrow$$
$$q = (200 - 5)/(0.167 + 0.25) = 195/0.4167 = 468$$

$$Q_1^* := 468 \quad P_1^* := P^d(Q_1^*) = 200 - 0.25 \times Q_1^* = 83$$

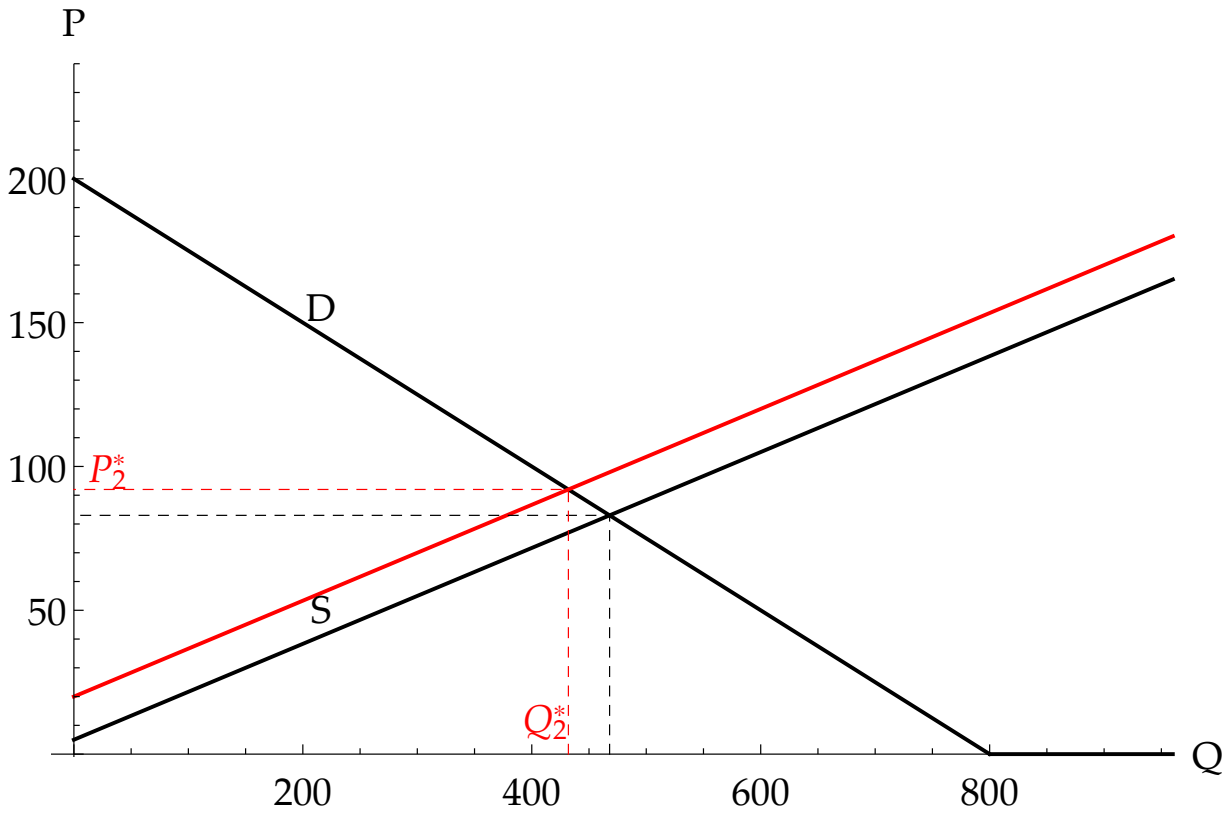
Market equilibrium

The most famous graph in economics

- In equilibrium no participant can gain by changing their behavior
- In market equilibrium, buyers and sellers are trading quantities that are optimal for them, taking as given the market price
- The market mechanism: the adjustment of prices and quantities to market equilibrium
- Changes in market equilibrium can be used to infer about changes in demand and supply
- Marshall's scissors (1890) vs theories of value

Supply Shift: Linear Example

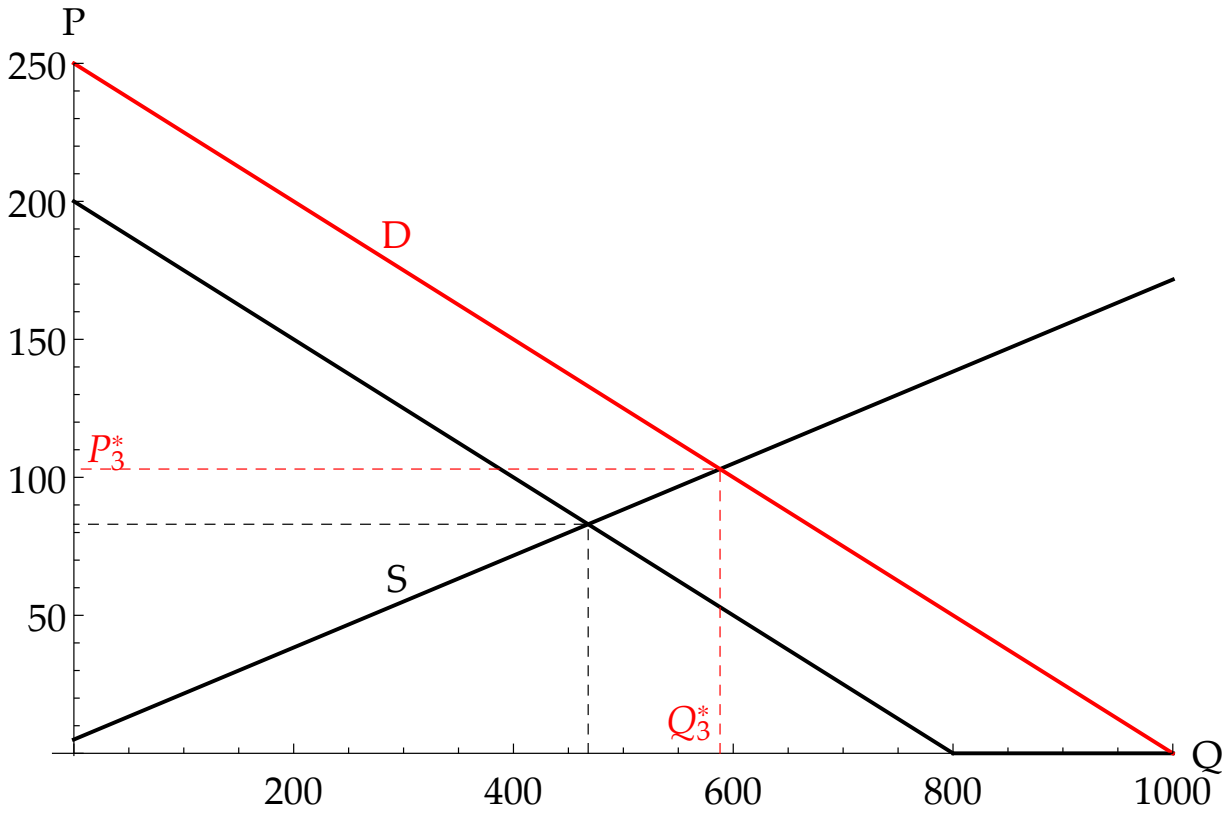
$Q_2^s(p) = 20 + (1/6)p \iff P_2^s(q) = 6q - 120$



New equilibrium $P^d(q) = P_2^s(q) \implies 200 - 0.25q = 20 + 0.167q \implies$
$Q_2^* := 432 \quad P_2^* := P^d(Q_2^*) = 200 - 0.25 \times Q_2^* = 92$

Demand Shift: Linear Example

$P_2^d(q) = 250 - (1/4)q \iff Q_2^d(p) = 1000 - 4p$



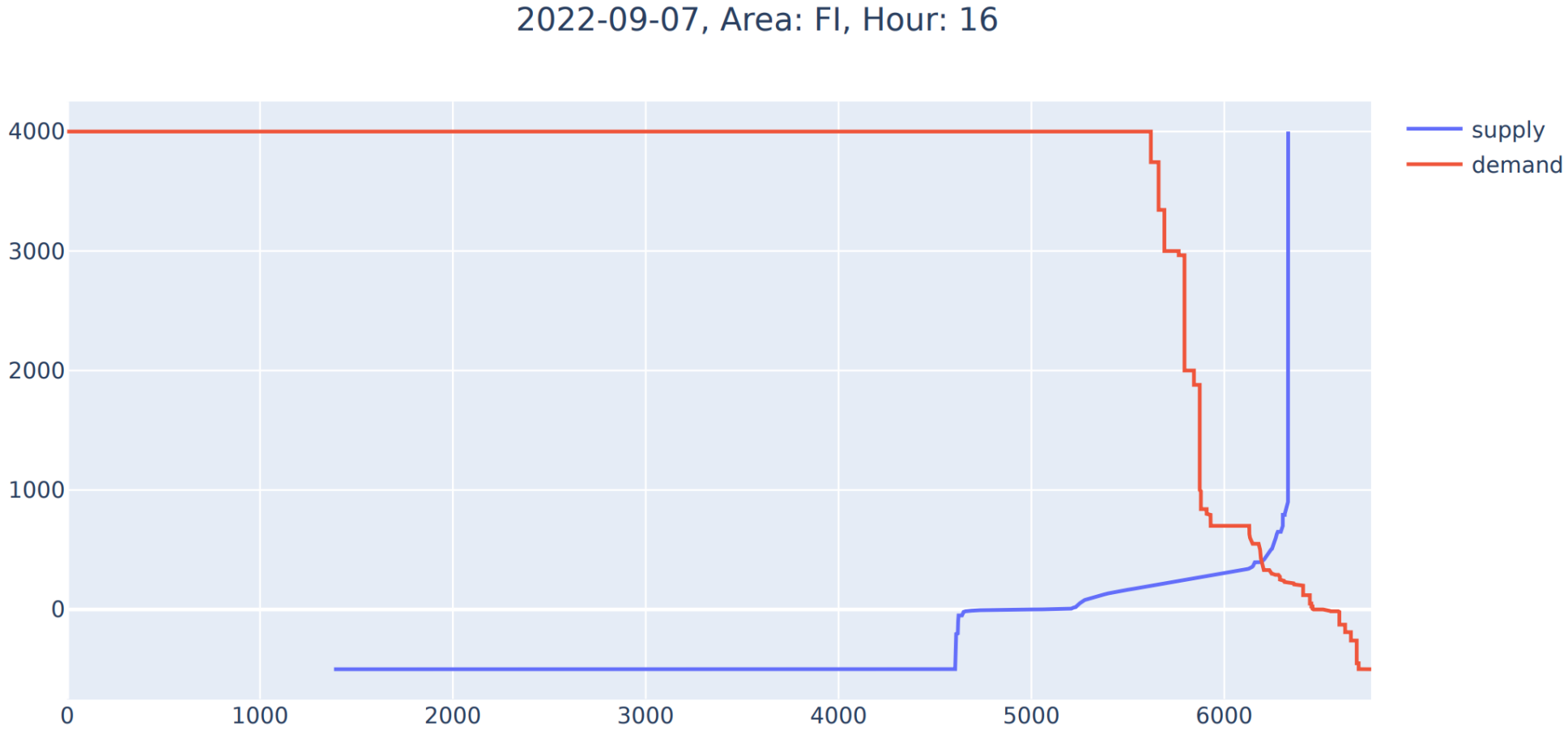
New equilibrium $P_2^d(q) = P^s(q) \implies 250 - 0.25q = 5 + 0.167q$

$Q_3^* := 588 \quad P_3^* := P_2^d(Q_3^*) = 250 - 0.25 \times Q_3^* = 103$

Market shocks: summary

- Demand shock shifts p^* and q^* to the same direction
- Supply shock shifts p^* and q^* to opposite directions
- "A change in demand" is a shift in the demand curve, not a mere change in quantity demanded (ditto for supply)
- A shock that would {increase, decrease} the quantity traded is called {positive, negative}
- "Price change" is not a primary cause of any change in markets. What caused the price to change?

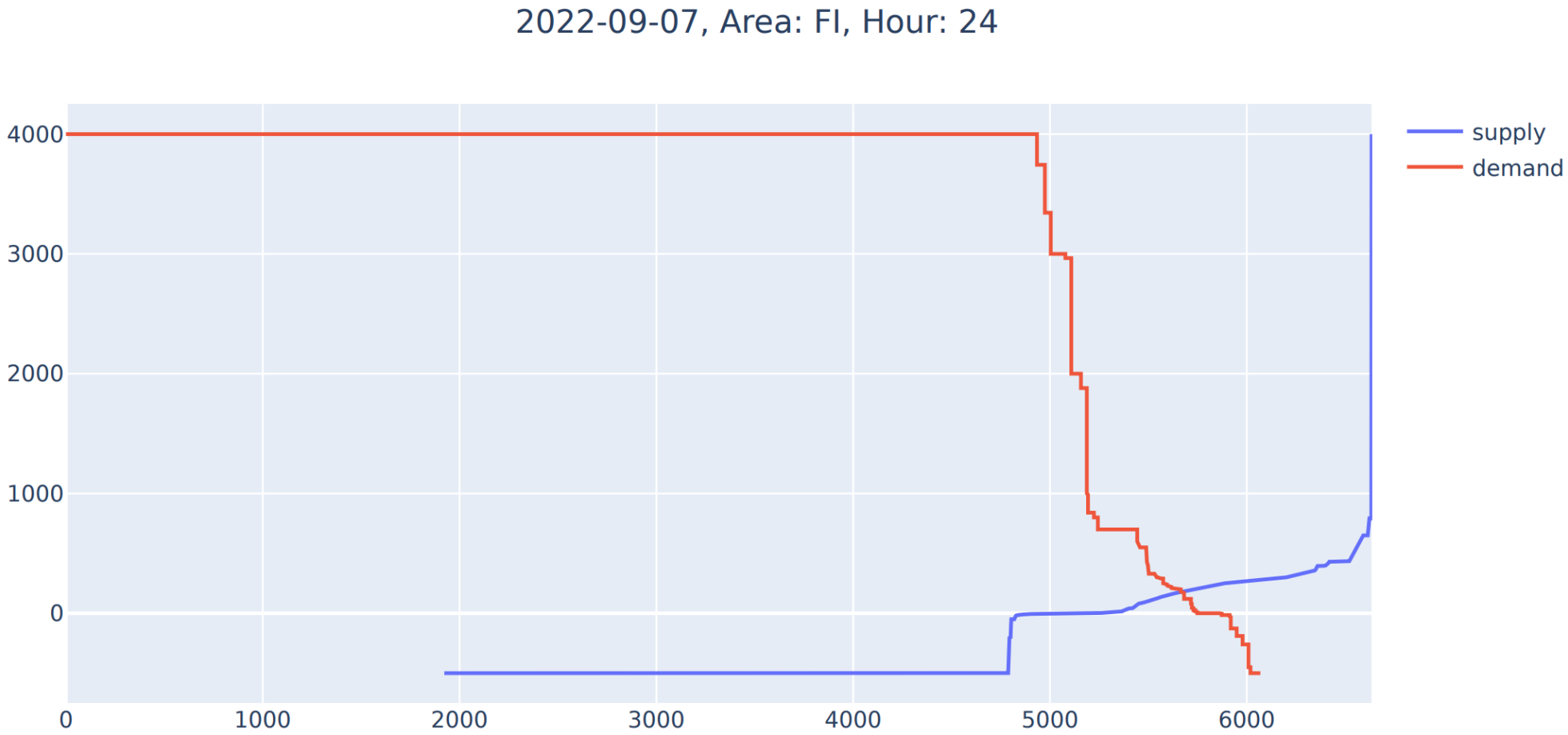
NordPool Electricity Market



Vertical: price €/MWh, Horizontal: Quantity MWh

Figure from https://www.nordpoolgroup.com/en/Market-data1/data-downloads/aggregated-market-data

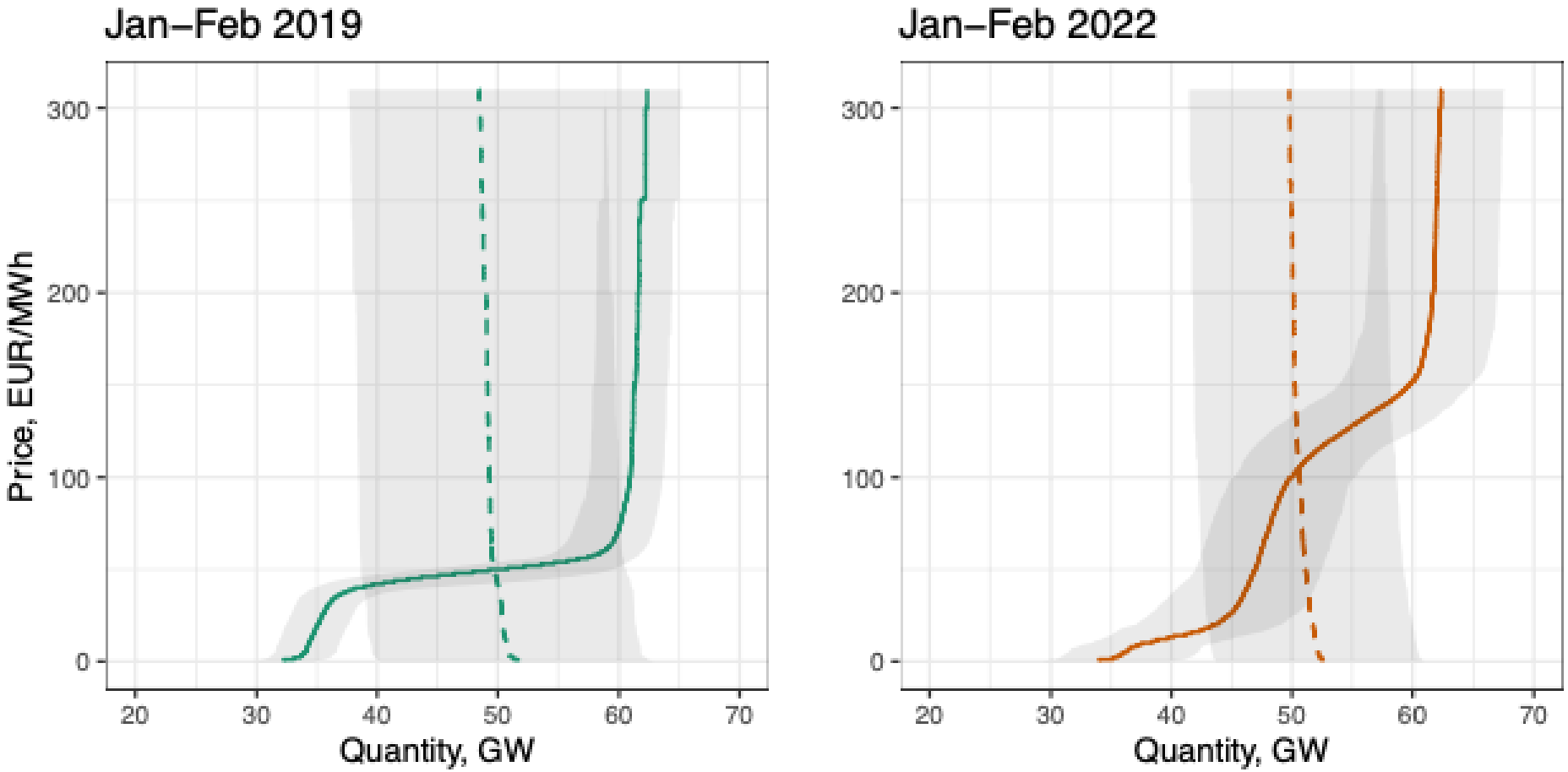
NordPool Electricity Market



Vertical: price €/MWh, Horizontal: Quantity MWh

Figure from https://www.nordpoolgroup.com/en/Market-data1/data-downloads/aggregated-market-data

NordPool Electricity Market: Two-month averages



Notes. Average bid curves in the Nordic market in Jan-Feb 2019 (left panel, green) and in Jan-Feb 2022 (right panel, orange). The shaded areas represent 5% and 95% range of the observed quantities at each price.

Figure by Iivo Vehviläinen

Aggregation of demand

Market demand is the sum of individual demands

$Q^d(p) = \sum_i Q_i^d(p)$

Simplest special cases:

- N identical consumers $Q_i^d(p)$
  $\rightarrow$ Market demand $Q^d(p) = N \times Q_i^d(p)$
- N potential buyers with unit demand (buy one-or-none) and reservation price p that follows a distribution with CDF $F(z)$, where $F(z) := \Pr(p \leq z)$
  $\rightarrow$ Market demand $Q^d(p) = N \times (1 - F(p))$

Cardinal mistake of demand aggregation: adding up P instead of Q

Aggregation of demand: linear example, 2 groups

Students: $Q_1^d(p) = 10 - 2p$

Others: $Q_2^d(p) = 14 - p$

Choke prices: 5 for students, 14 for others.

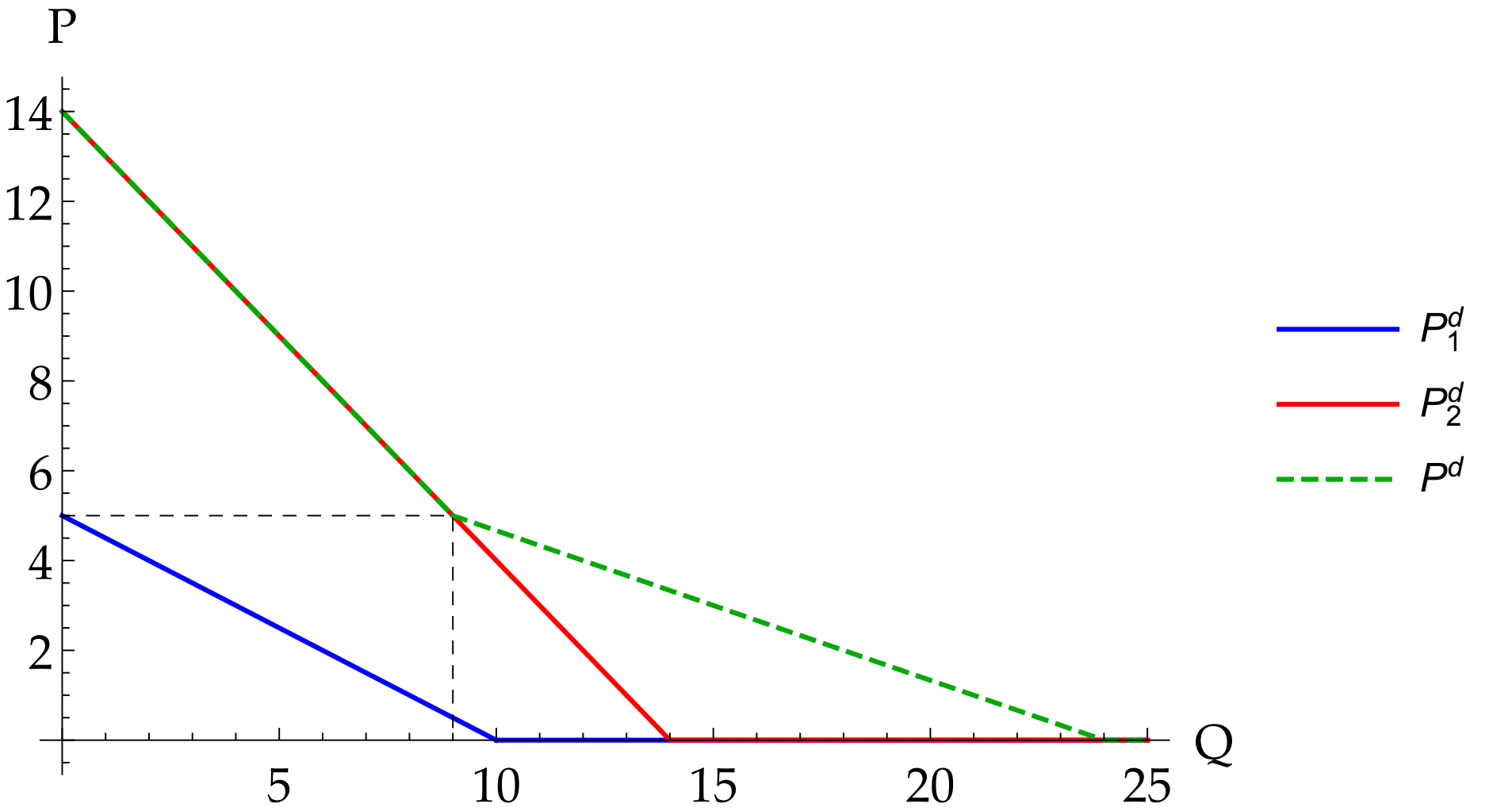
Market demand:

$$\begin{aligned} Q^d(p) &= 0 && \text{for } p \geq 14 \\ &= Q_2^d(p) = 14 - p && \text{for } 14 > p \geq 5 \\ &= Q_1^d(p) + Q_2^d(p) = 24 - 3p && \text{for } 5 > p \geq 0 \end{aligned}$$

Invert piecewise:

$$\begin{aligned} P^d(q) &= 8 - (1/3)q && \text{for } 24 > q \geq 9 \\ &= 14 - q && \text{for } 9 > q \geq 0 \end{aligned}$$

Aggregation of demand: linear example, 2 groups

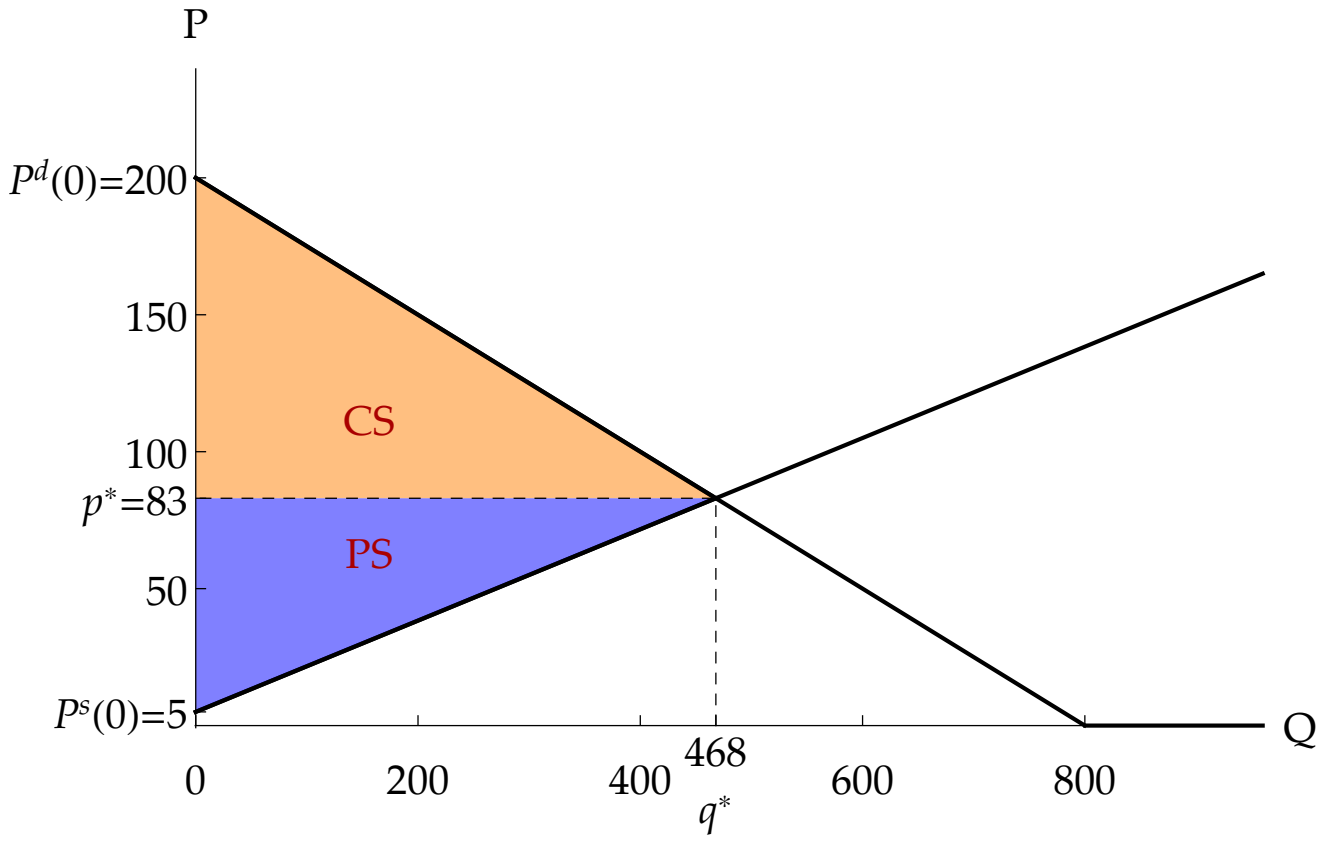


Consumer and Producer Surplus

- Individual (consumer or firm) surplus from one unit traded is the difference between actual and reservation price
- Market (aggregate) surplus is the sum of all individual surpluses
- What is Ann's consumer surplus (CS) if coffee costs her 1€/cup? Bob's? Combined? (In example on p. 11)
- Market surpluses are
  - Consumers: $\mathrm{CS} = \int_0^{q^*} (P^d(q) - p^*)\mathrm{d}q$
  - Producers: $\mathrm{PS} = \int_0^{q^*} (p^* - P^s(q))\mathrm{d}q$
- Total expenditure by buyers = Total revenue by sellers = $P \times Q$
- Total (market) surplus = $\mathrm{CS} + \mathrm{PS}$

Consumer and Producer Surplus

Example p. 14 continued. For linear {demand CS , supply PS} is the area of a triangle



$$\text{CS} = (P^d(0) - p^*)\frac{q^*}{2} = (200 - 83) \times 468/2 = 27378$$

$$\text{PS} = (p^* - P^s(0))\frac{q^*}{2} = (83 - 5) \times 468/2 = 18252$$

$$\text{Expenditure} = \text{Revenue} = p^* q^* = 38844$$

Elasticity

Elasticity is a unit-free measure of responsiveness

Elasticity is a ratio of relative changes

Example of an elasticity: Price elasticity of demand

$$\varepsilon^d = \frac{dQ^d/Q^d}{dP/P}$$

(elasticity of demand) = (% change in quantity)/(% change in price)

Other elasticities defined similarly, e.g., (price) elasticity of supply, income elasticity of demand, elasticity of intertemporal substitution (of consumption), (tax) elasticity of taxable income

Elasticity

The exact value of elasticity aka point elasticity depends on the exact point where it is evaluated

$$\varepsilon^d = \frac{\frac{\partial Q^d(p)}{\partial p}}{\frac{Q^d(p)}{p}}$$

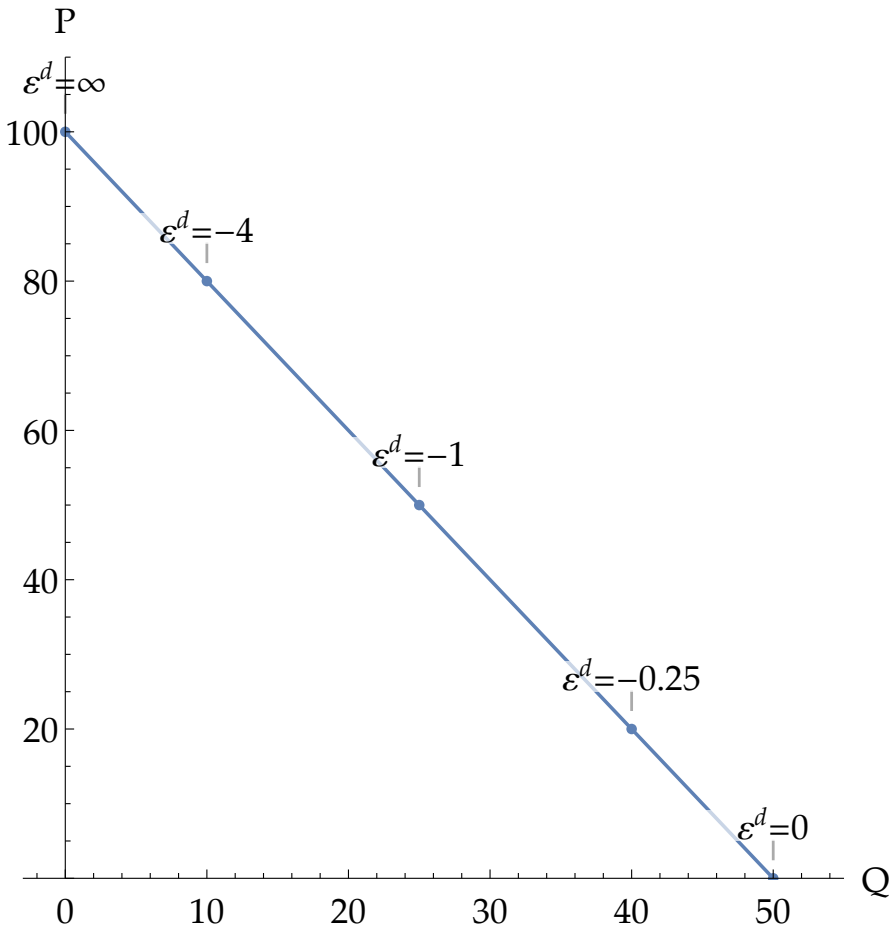
Example: $P^d(q) = 100 - 2q \Leftrightarrow Q^d(p) = 50 - 0.5p$

$$\frac{\partial Q^d(p)}{\partial p} = -0.5$$

$$\varepsilon^d(p) = \frac{-0.5}{(50 - 0.5p)/p} = \frac{-0.5p}{50 - 0.5p} = \frac{p}{p - 100}$$

Equivalently, $\varepsilon^d(q) = \varepsilon^d(P^d(q)) = \frac{100-2q}{(100-2q)-100} = \frac{q-50}{q}$

Elasticity: example with linear demand



$P^d(q) = 100 - 2q$, point elasticity $\varepsilon^d(q)$ at $q = \{0, 10, 25, 40, 50\}$.

Elasticity: Discrete approximation example

Suppose supply shifts, while demand stays the same.

Quantity and price before Q_1, P_1 and after Q_2, P_2.

Denote changes $dQ = Q_2 - Q_1$, $dP = P_2 - P_1$ and averages $\bar{Q} = (Q_1 + Q_2)/2$, $\bar{P} = (P_1 + P_2)/2$

$$\varepsilon^d = \frac{dQ/\bar{Q}}{dP/\bar{P}}$$

Example. $Q_1 = 120$, $P_1 = 7.60$, $Q_2 = 140$, $P_2 = 6.04 \Longrightarrow$
$dQ = 20$, $dP = -1.56$, $\bar{Q} = 130$, $\bar{P} = 6.82$

$$\varepsilon^d = \frac{20/130}{-1.56/6.82} \approx -0.67$$

Elasticity and Revenue

Back of the envelope formula, implied by rearranging definition ε^d

$$\frac{dQ}{Q} = \frac{dP}{P}\varepsilon^d$$

(% Change in quantity) = (% Change in price)$\times$(Elasticity of demand)

If price goes up (due to some change in supply side) what happens to revenue ($R = P \times Q$)? Answer: $\frac{dR}{R} = \frac{dP}{P}(1 + \varepsilon^d)$

The direction of change depends on whether $|\varepsilon^d| > (<)\ 1$.
Demand is *elastic* if $\varepsilon^d < -1$, *inelastic* if $\varepsilon^d > -1$, *unit elastic* if $\varepsilon^d = -1$.

Elasticity: Revenue formula

Whence the revenue formula $\frac{dR}{R} = \frac{dP}{P}(1 + \varepsilon^d)$?

For relative change in revenue, totally differentiate $R = P\,Q$

$$
\begin{aligned}
\frac{dR}{R} &= \frac{(dP)Q + P(dQ)}{R} \\
&= \frac{(dP)Q}{PQ} + \frac{P(dQ)}{PQ} \\
&= \frac{dP}{P} + \frac{dQ}{Q} \\
&= \frac{dP}{P} + \frac{dP}{P}\varepsilon^d \quad (\text{ from definition } \varepsilon^d) \\
&= \frac{dP}{P}(1 + \varepsilon^d)
\end{aligned}
$$

Log-linear functional form

Linear form often a good local approximation, over a small range

$$Q^d(p) = \alpha - \beta p \iff P^d(q) = \frac{\alpha}{\beta} - \frac{1}{\beta} q$$

Log-linear form often a better fit to data. (Below ε refers to $|\varepsilon^d|$)

$$\log Q^d(p) = \phi - \varepsilon \log p \iff \log P^d(q) = \frac{\phi}{\varepsilon} - \frac{1}{\varepsilon} \log q$$

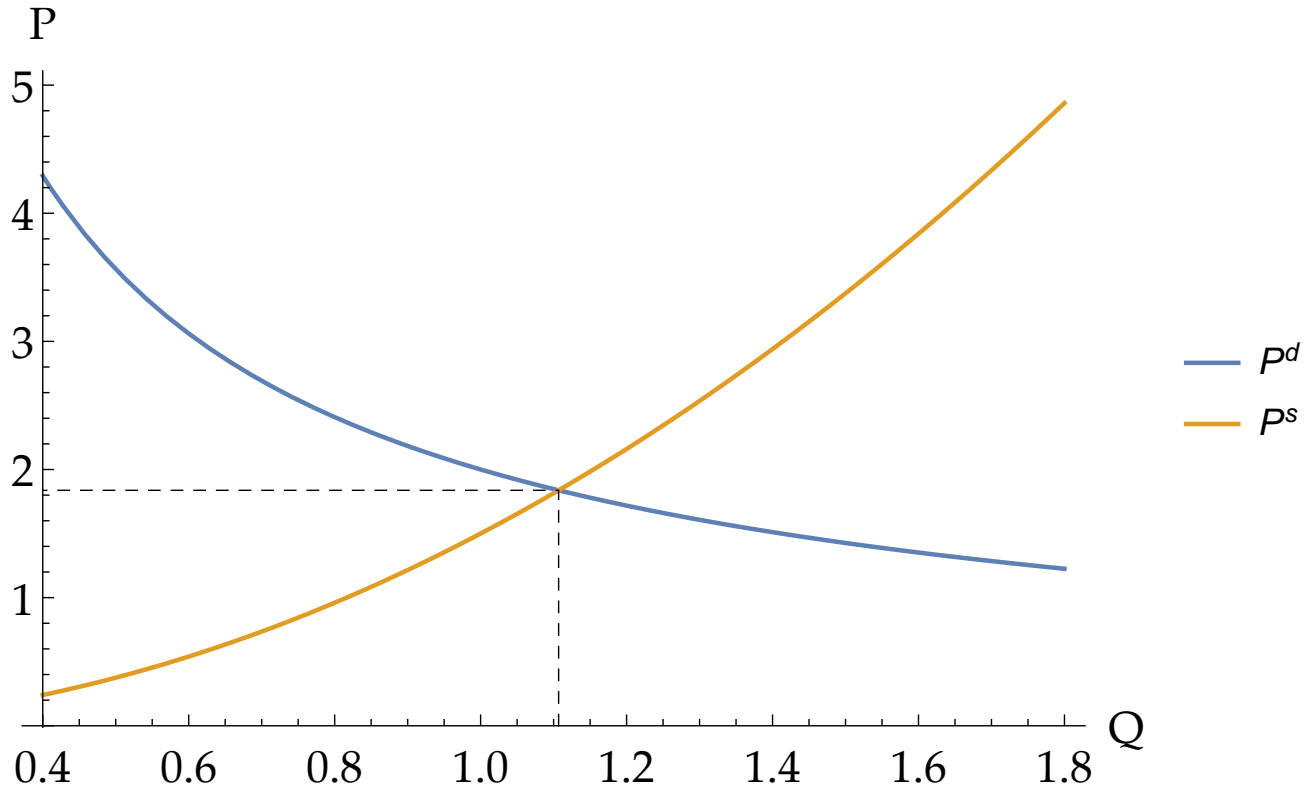
$$Q^d(p) = e^{\phi} p^{-\varepsilon} \iff P^d(q) = e^{\frac{\phi}{\varepsilon}} q^{-\frac{1}{\varepsilon}}$$

Ratio of relative changes $\frac{\partial \log Q^d}{\partial \log p} = -\varepsilon$ at all $p > 0$

Hence alternative name “Constant elasticity” functional form

Log-linear example: Market equilibrium

aka Constant Elasticity



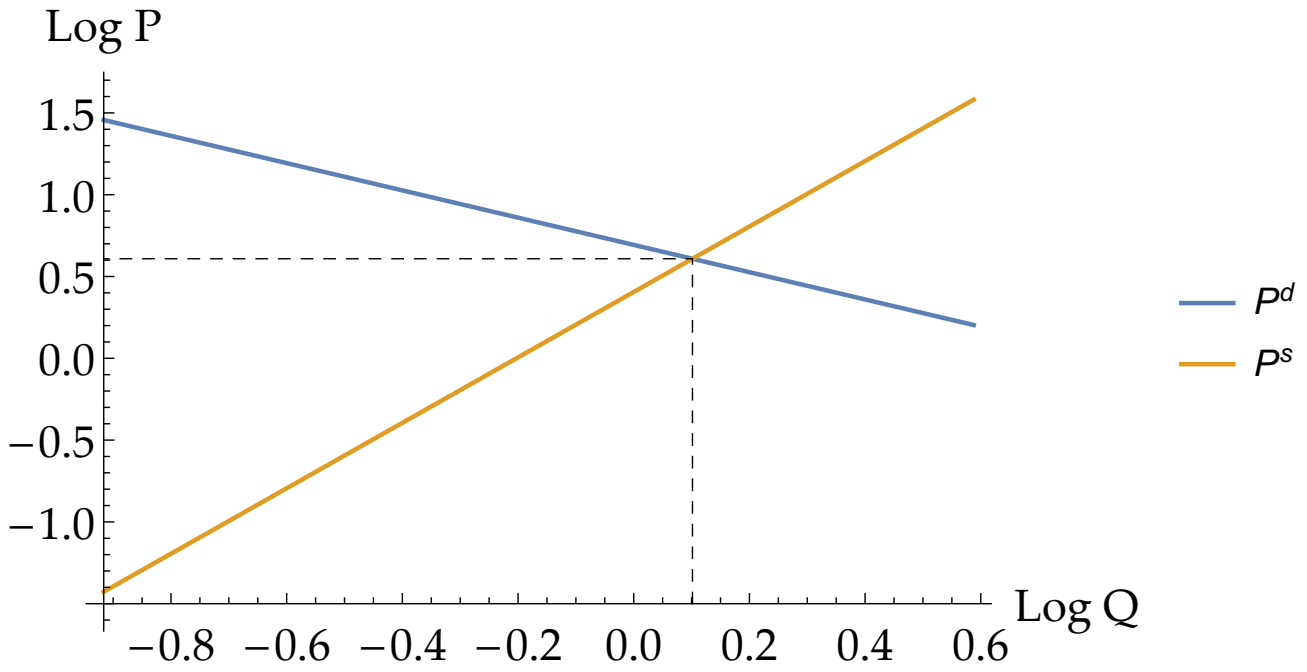
CE-demand defined by $\varepsilon_d = -6/5 = -1.2$, $P^d(1) = 2 \implies P^d(q) = 2q^{-(5/6)}$

CE-supply defined by $\varepsilon_s = 1/2 = 0.5$, $P^s(1) = 1.5 \implies P^s(q) = 1.5q^2$

Market equilibrium: Log-linear example

aka Constant Elasticity

Same figure drawn on log scales



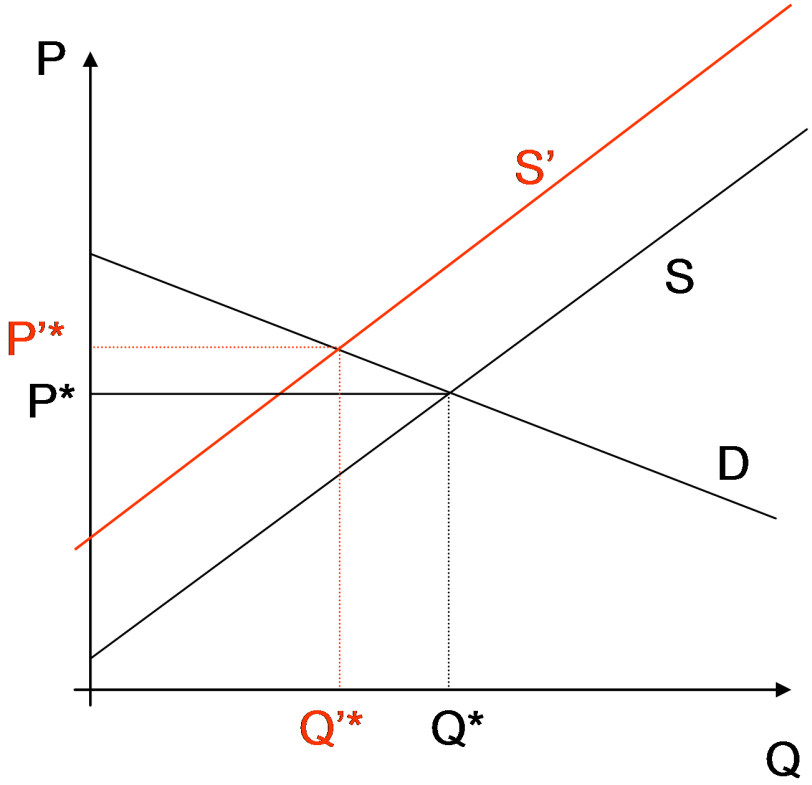
Equilibrium $\log P^d(q) = \log P^s(q) \iff \log 2 - (5/6)\log q = \log 1.5 + 2\log q \implies$
$\log q^* \approx 0.1015 \implies q^* = e^{0.1015} = 1.107 \implies p^* \approx 1.838$

Elasticity and market response to shocks

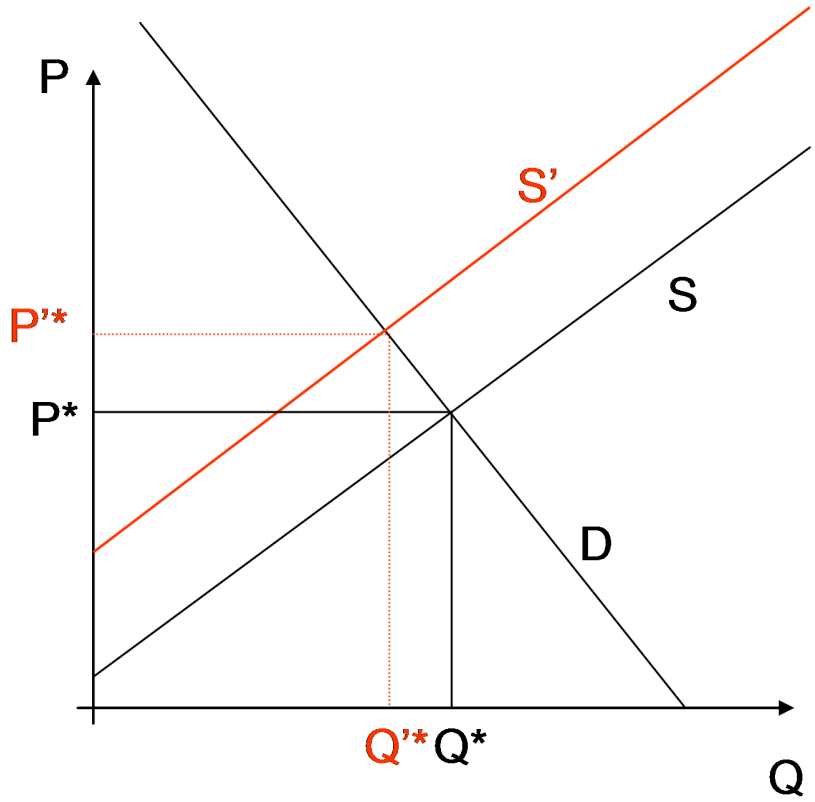
- Response to a supply shock depend on the elasticity of demand
  More elastic demand $\rightarrow$ smaller P response, larger Q response
- Response to a demand shock depend on the elasticity of supply
  More elastic supply $\rightarrow$ smaller P response, larger Q response
- Long run (LR) elasticities are typically larger than short run (SR)
  Price reaction larger in SR than LR

Elasticity of demand and supply shocks

Illustration: The same supply shock hits two markets with different demands

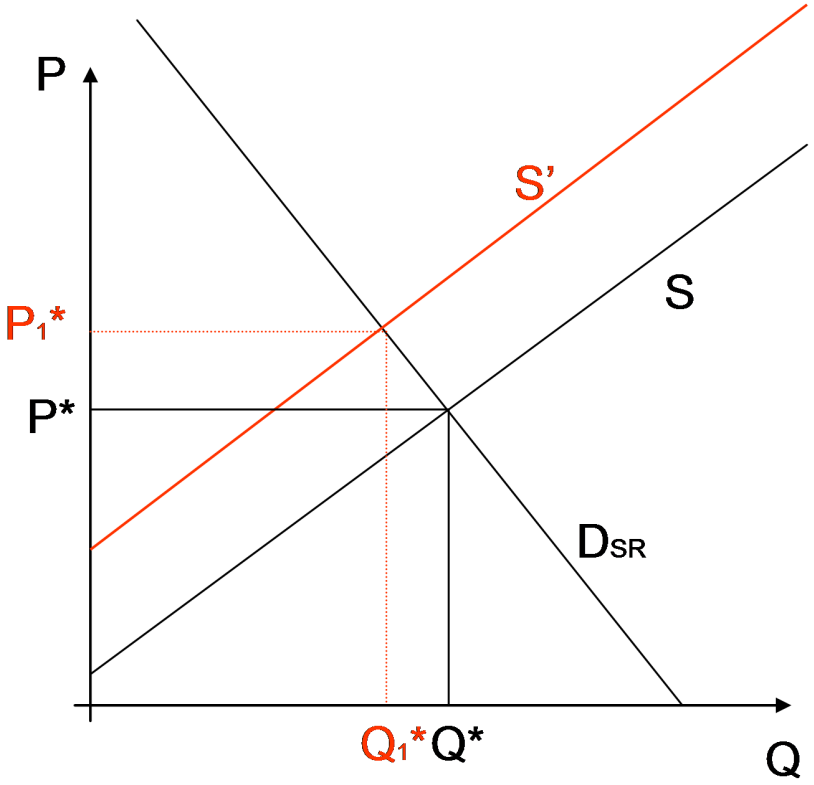


Relatively elastic demand
➔ Q* responds a lot, P* not

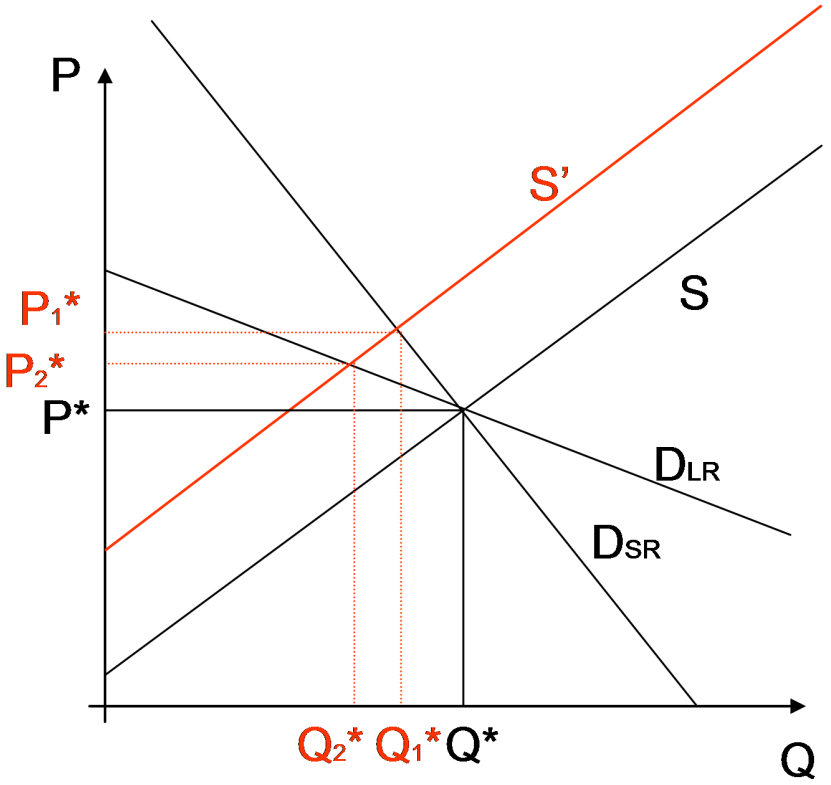


Relatively inelastic demand
➔ P* responds a lot, Q* not

Short and long run effects of supply shocks



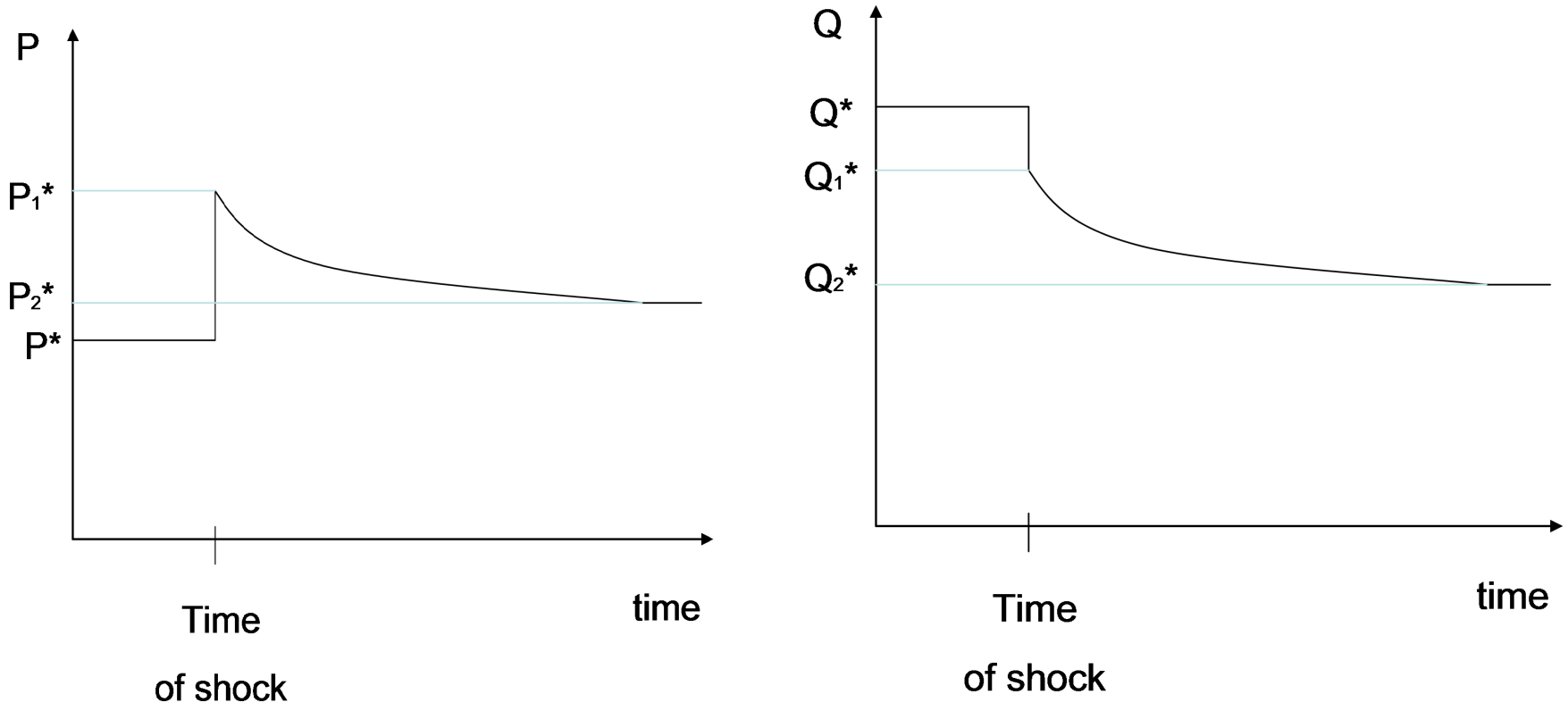
Short run (SR) effect



Long run (LR) demand more elastic

➔ P* responds less, Q* more, than in SR

Effects of a negative supply shock over time



Substitutes and Complements

Intuitive definitions:

- Substitutes are alternatives in consumption (coffee and tea)
- Complements are consumed together (coffee and sugar)

Empirical definition:

X and Y are substitutes (complements), if the demand for X decreases (increases) in response to a decline of the price of Y

Cross price elasticity $\varepsilon_{x,y} = \frac{dQ_x/Q_x}{dP_y/P_y}$

Positive for substitutes, negative for complements

Extreme case: perfect substitutes, perfect complements

Similar definitions exist for production inputs

Demand and Supply Framework: Key skills

- Demand and supply curves

  Discrete case

  Continuous framework:

  Linear & log-linear, unit demand with value distribution
- Market equilibrium, CS, PS
- Demand and supply inversion, aggregation
- Elasticity, back-of-the-envelope formulae
- Shocks and shifts in market equilibrium
- Short run vs Long run

  Shifts and elasticity, time series graphs
- Cross market effects: substitutes, complements, cross-elasticity

Ann & Bob ponder Demand & Supply

Ann and Bob argue over the cause of a recent increase in the use of illicit drugs.
Ann believes that television shows that glamorize drugs have induced more young people to start using drugs.
Bob believes that lax border security has made it easier to smuggle drugs into the country.

Suppose the explanations offered by Ann and Bob are the only possible causes behind increased drug consumption. How do you know who has the correct answer?