

# Demand and Supply

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## Demand and supply function

- Factors influencing the position of the demand and supply functions
- Shifts in demand and supply

## Market equilibrium

- Intersection of demand and supply
- Market equilibrium changes from shifts in demand and supply

## Elasticities

- Increases or decreases in the quantity demanded from percentage changes in price or income

## Consumer and producer surplus

# Demand

# Consumer Demand Overview

Demand

Supply

Market  
Equilibrium

Elasticity

Consumer and  
Producer  
Surplus

## Demand function derived from consumer theory

- Aggregation across all consumers leads to market demand: Total units potentially purchased by consumers in a given time period
- Market equilibrium determines actual units purchased

## Substitutes and complements

- Substitutes: Goods that can serve as a replacement (to a certain degree), e.g., beef vs. chicken
- Complements: Goods that are usually purchased in combination, e.g., milk and breakfast oats

## Variables Influencing Demand

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Variables influencing shape and position of the demand function

- From consumer theory: Own-price, price of other good, and income
- In general: Own-price ( $P$ ), price of substitutes ( $P_S$ ), price of complements ( $P_C$ ), income ( $I$ ), and other factors (e.g., advertising, taxes, subsidies, weather)

General representation of the demand function:

$$Q^D = f(P, P_S, P_C, I, \dots)$$

# Three Representations of the Demand Function

## Demand

## Supply

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Equilibrium

## Elasticity

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- ① Functional form (e.g., demand for natural gas):

$$Q = 200 - 4 \cdot P - \frac{T}{2}$$

- ② Table representation (e.g., demand for ice cream):<sup>1</sup>

Price	0.50	1.00	1.50	2.00	2.50
Quantity	3.00	1.50	1.00	0.75	0.50

- ③ Graphical representation

- Draw the demand for natural gas (above) for  $T = 80$  and  $T = 20$ .

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<sup>1</sup>Careful with estimating of the demand curve based on price and quantity data only. Serious identification issues.

## Law of Demand

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The law of demand states that when the price of a good increases and everything else remains the same, the quantity demanded decreases.

- Movement along the demand curve represents a change in the quantity demanded
- “everything else remaining the same” is called *ceteris paribus* in economics

Shift in demand

- A change in any variable that affects demand, except for the good's price, results in a change in demand

There is a difference between *change in quantity demanded* (movement along the curve) and *change in demand* (shift of the curve).

# Shifting the Demand Curve

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Factor	Right shift	Left Shift
Income or wealth	↑	↓
Price of substitute	↑	↓
Price of complement	↓	↑
Population	↑	↓
Expected price	↑	↓



# Supply

## Firm Supply Overview

Supply function derived from producer and cost theory

- Aggregation across all firms leads to the market supply: Total units potentially sold by firms in a given time period
- Like for demand: Market equilibrium determines actual units sold
- Quantity supplied that maximizes profits

Variables influencing shape and position of the supply function

- From producer theory: Input prices, i.e.,  $w$  and  $r$
- In general: Input prices and other factors such as taxes, subsidies, weather, etc.

General representation of the supply function:

$$Q^S = f(P, w, r, t, s, \dots)$$

Quantity supplied depends on output price ( $P$ ), wages ( $w$ ), capital cost ( $r$ ), taxes ( $t$ ), subsidies ( $s$ ), etc.

## Supply Curve

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Similar to the demand function, there is a difference between *change in the quantity supplied* and *change in supply*

- If the output price changes  $\Rightarrow$  Change in the quantity supplied (movement along the curve)
- If anything else changes  $\Rightarrow$  Change in supply (shift of the curve)

Factor	Right shift	Left Shift
Price of input	↓	↑
Price of alternatives	↓	↑
Number of firms	↑	↓
Expected price	↓	↑

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# Market Equilibrium

## Equilibrium price

- The equilibrium price is determined by the intersection of demand and supply.  
At the equilibrium price, demand equals supply.

## Market imbalances:

- Excess supply: Price is above the equilibrium price
- Excess demand: Price is below the equilibrium price

# Market Equilibrium: Numerical Example I

Demand as a function of income:

$$Q^D = 300 - 2 \cdot P + 4 \cdot I$$

Supply as a function of the price

$$Q^S = 3 \cdot P - 50$$

What is the market equilibrium if the income level is  $I = 25$ ? What if  $I = 50$ ?

## Market Equilibrium: Numerical Example II

Consider the demand for masks based on the number of infections ( $C$ ) from a communicable disease:

$$Q^D = 7 + C - P$$

And the supply of masks is written as

$$Q^S = 1 + 2 \cdot P$$

Initially,  $C = 0$  and thus, the equilibrium price and quantity are  $P = 2$  and  $Q = 5$ .  
What are the equilibrium price and quantity if  $C = 6$ ?

# Changes in the Market Equilibrium

- ① Shift in demand for heat pumps due to high natural gas prices
- ② Shift in supply for heat pumps due to government subsidies to firms
- ③ Shift in demand and supply for heat pumps due to high natural gas prices and government subsidies to firms

Simultaneous shift of demand and supply  $\Rightarrow$  Ambiguous effect on price and quantity



## Summary Table

Demand

Supply

Market Equilibrium

Elasticity

Consumer and Producer Surplus

If both curves shift, the effect of quantity and price is ambiguous.

	Demand $\uparrow$	Demand $\circ$	Demand $\downarrow$
Supply $\uparrow$	$P?, Q \uparrow$	$P \downarrow, Q \uparrow$	$P \downarrow, Q ?$
Supply $\circ$	$P \uparrow, Q \uparrow$	$P \circ, Q \circ$	$P \downarrow, Q \downarrow$
Supply $\downarrow$	$P \uparrow, Q ?$	$P \uparrow, Q \downarrow$	$P?, Q \downarrow$

To determine the exact effect, we need mathematics.

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# Elasticity

Elasticity measures the percentage change in one variable ( $y$ ) divided by the percentage change in some other variable ( $x$ ). Examples for a good with a own-price elasticity of -0.6:

- Price increase of 1%  $\Rightarrow$  Change in quantity demanded by  $-0.6 \cdot 1\% = -0.6\%$
- Price decrease of 3%  $\Rightarrow$  Change in quantity demanded by  $-0.6 \cdot -3\% = 1.8\%$

Other elasticities of interest besides own-price elasticity:

- Income elasticity: Impact of economic growth on market demand
- Cross-price elasticities: Substitutes or complements

## Calculating Elasticities

**Own-price elasticity:** Change in quantity demanded of good  $i$  with respect to price of good  $i$ :

$$\epsilon_P = \frac{\% \Delta Q_i}{\% \Delta P_i} = \frac{P_i}{Q_i} \cdot \frac{\Delta Q_i}{\Delta P_i}$$

**Income elasticity:** Change in quantity demanded of good  $i$  with respect to income:

$$\epsilon_I = \frac{\% \Delta Q_i}{\% \Delta I} = \frac{I}{Q} \cdot \frac{\Delta Q}{\Delta I}$$

**Cross-price elasticity:** Change in quantity demanded of good  $i$  with respect to price of good  $j$ :

$$\epsilon_P = \frac{\% \Delta Q_i}{\% \Delta P_j} = \frac{P_j}{Q_i} \cdot \frac{\Delta Q_i}{\Delta P_j}$$

# Elasticity in the Case of Linear Demand I

Linear demand function:

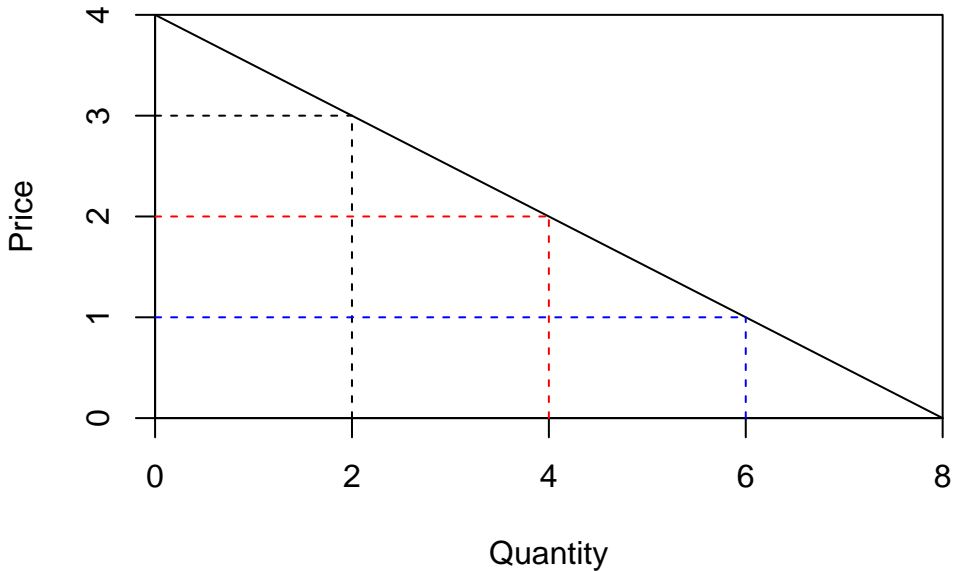
$$Q = 8 - 2P$$

In this case:

$$\text{constant} = \frac{\Delta Q_i}{\Delta P_i}$$

What is the elasticity at  $p = 4$ ?  $p = 3$ ?  $p = 2$ ?  $p = 1$ ?  $p = 0$ ?

## Elasticity in the Case of Linear Demand II



## Elasticity:

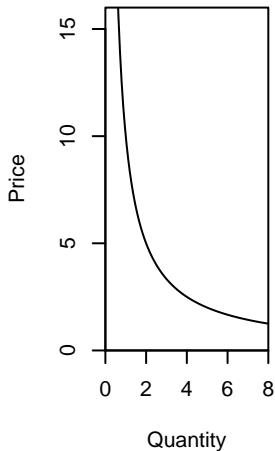
- Demand is elastic if the percentage change in quantity is greater than the percentage change in price.
- Demand is inelastic if the percentage change in quantity is less than the percentage change in price.
- Demand is unitary elastic if the percentage change in quantity is equal to the percentage change in price.

## Complements or substitutes

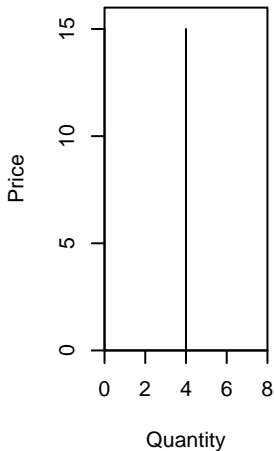
$\epsilon_p < 0 \Rightarrow$  complements  $\epsilon_p > 0 \Rightarrow$  substitutes

## Special Cases

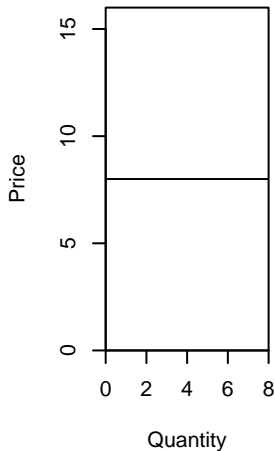
**Isoelastic**



**Perfectly Inelastic**



**Perfectly Elastic**





# Connection between Revenue and Elasticities I

Demand function:

$$Q = 5 - 0.5 \cdot P$$

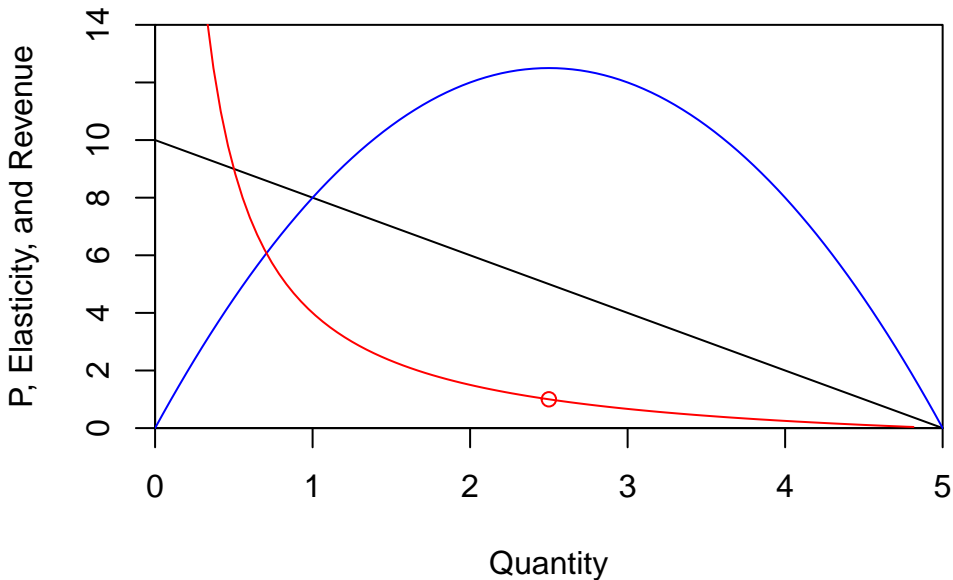
Revenue function:

$$R = Q \cdot (10 - 2 \cdot Q)$$

Elasticity:

$$\epsilon^D = \frac{0.5 \cdot (10 - 2 \cdot Q)}{Q}$$

## Connection between Revenue and Elasticities II



# Policy Applications of Elasticities

## Public transportation and U.S. Postal Service

- Small marginal cost, i.e., costs are not very sensitive to the number of riders.
- Are current prices in the elastic or inelastic section of the demand?

## Private and public investment decision

- How does the demand evolve in the future given a new investment?

## Cross-price elasticity:

- Negative  $\Rightarrow$  Complement
- Positive  $\Rightarrow$  Substitute

## Antitrust laws

- Office Depot and Staples, Alcoa (aluminum market), DuPont (cellophane), Continental Can acquiring a glass manufacturer

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# Consumer and Producer Surplus

Consider a demand and supply functions of the following form:

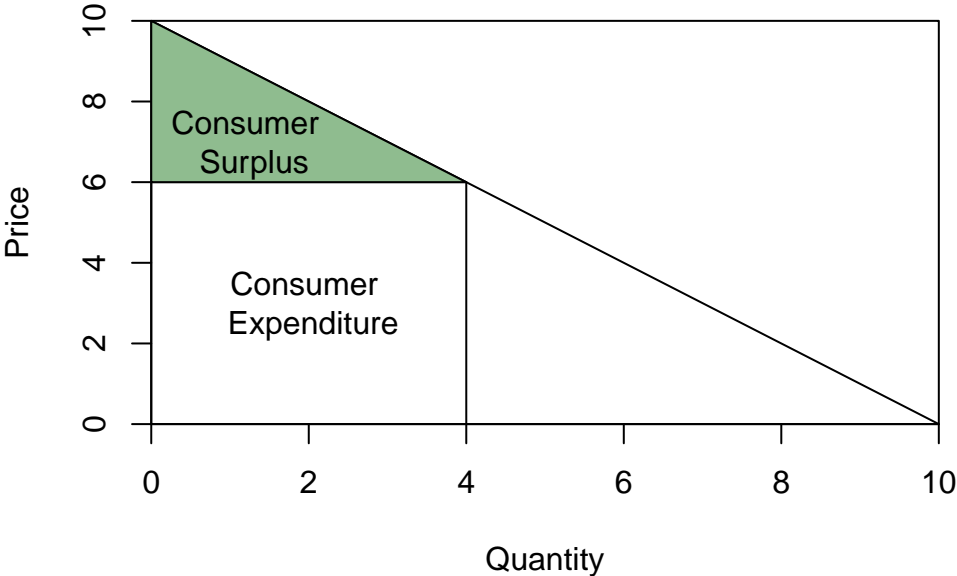
$$Q^D = 10 - P$$

$$Q^S = P - 2$$

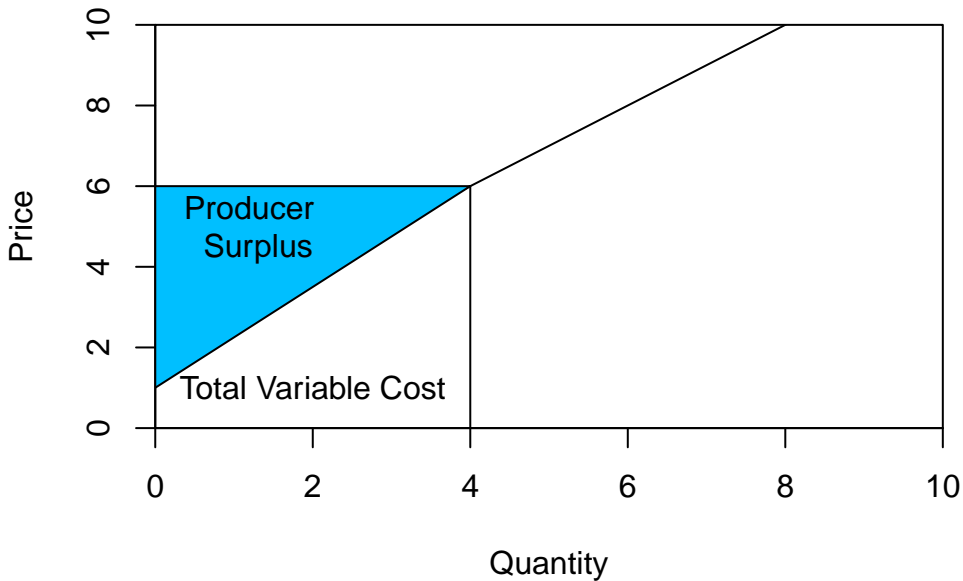
Market equilibrium:  $P = 6$  and  $Q = 4$

- Some consumers are willing to pay more than \$4 since the choke price is at \$10.
- Some producers would supply the good even if the price was below \$4.
- Those consumers and producers realize a surplus when the market price is \$4.

Consumer Surplus



## Producer Surplus



Social Welfare

