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# Economics I

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## **Bachelor of Statistical Data Science**

Indian Statistical Institute

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## Contents

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|           |                                                      |           |
|-----------|------------------------------------------------------|-----------|
| <b>1</b>  | <b>Introduction: What is Economics?</b>              | <b>3</b>  |
| <b>2</b>  | <b>The Ten Principles of Economics</b>               | <b>3</b>  |
| 2.1       | How People Make Decisions . . . . .                  | 3         |
| 2.2       | How People Interact . . . . .                        | 4         |
| 2.3       | How the Economy as a Whole Works . . . . .           | 4         |
| <b>3</b>  | <b>The Circular Flow Model</b>                       | <b>5</b>  |
| <b>4</b>  | <b>Production Possibilities Frontier (PPF)</b>       | <b>5</b>  |
| <b>5</b>  | <b>Demand</b>                                        | <b>6</b>  |
| 5.1       | Perfectly Competitive Markets . . . . .              | 6         |
| 5.2       | The Law of Demand . . . . .                          | 6         |
| 5.3       | Demand Schedule and Curve . . . . .                  | 7         |
| 5.4       | Market Demand = Horizontal Summation . . . . .       | 7         |
| 5.5       | Demand Shifters (Determinants of Demand) . . . . .   | 7         |
| <b>6</b>  | <b>Supply</b>                                        | <b>8</b>  |
| 6.1       | The Law of Supply . . . . .                          | 8         |
| 6.2       | Supply Shifters (Determinants of Supply) . . . . .   | 8         |
| 6.3       | Market Supply = Horizontal Summation . . . . .       | 8         |
| <b>7</b>  | <b>Market Equilibrium</b>                            | <b>9</b>  |
| 7.1       | Shortage and Surplus . . . . .                       | 9         |
| 7.2       | Shifts in Equilibrium — Examples . . . . .           | 9         |
| <b>8</b>  | <b>Elasticity</b>                                    | <b>9</b>  |
| 8.1       | Price Elasticity of Demand (PED) . . . . .           | 10        |
| 8.1.1     | Determinants of PED . . . . .                        | 10        |
| 8.1.2     | PED Along a Linear Demand Curve . . . . .            | 10        |
| 8.2       | PED and Total Revenue (TR) . . . . .                 | 11        |
| 8.3       | Cross-Price Elasticity of Demand (CPED) . . . . .    | 11        |
| 8.4       | Income Elasticity of Demand (IED) . . . . .          | 11        |
| 8.5       | Price Elasticity of Supply (PES) . . . . .           | 11        |
| <b>9</b>  | <b>Price Controls</b>                                | <b>11</b> |
| 9.1       | Price Ceiling . . . . .                              | 11        |
| 9.1.1     | Welfare Effects of a Binding Price Ceiling . . . . . | 12        |
| 9.2       | Price Floor . . . . .                                | 13        |
| <b>10</b> | <b>Taxes</b>                                         | <b>13</b> |
| <b>11</b> | <b>Consumer and Producer Surplus</b>                 | <b>14</b> |
| 11.1      | Consumer Surplus (CS) . . . . .                      | 14        |
| 11.2      | Producer Surplus (PS) . . . . .                      | 14        |
| 11.3      | Total Surplus = Economic Efficiency . . . . .        | 14        |

|                                                    |           |
|----------------------------------------------------|-----------|
| <b>12 Costs of Production</b>                      | <b>14</b> |
| 12.1 Types of Costs . . . . .                      | 15        |
| 12.2 Production Function . . . . .                 | 15        |
| 12.3 Cost Definitions and Relationships . . . . .  | 16        |
| 12.4 Long-Run Average Total Cost (LRATC) . . . . . | 17        |
| <b>13 Perfect Competition</b>                      | <b>17</b> |
| 13.1 Characteristics . . . . .                     | 17        |
| 13.2 Revenue in a Competitive Firm . . . . .       | 17        |
| 13.3 Profit Maximisation: $MR = MC$ Rule . . . . . | 17        |
| 13.4 Short-Run Shut-Down Decision . . . . .        | 18        |
| 13.5 Long-Run Entry and Exit . . . . .             | 18        |
| <b>14 Consumer Theory</b>                          | <b>19</b> |
| 14.1 Budget Constraint . . . . .                   | 19        |
| 14.2 Indifference Curves . . . . .                 | 20        |
| <b>15 Macroeconomics: GDP</b>                      | <b>21</b> |
| 15.1 What is GDP? . . . . .                        | 21        |
| 15.2 The Expenditure Approach . . . . .            | 21        |
| 15.3 Nominal vs. Real GDP . . . . .                | 21        |
| 15.4 GDP Deflator . . . . .                        | 22        |
| 15.5 Per Capita GDP . . . . .                      | 22        |
| 15.6 Rule of 72 . . . . .                          | 22        |
| 15.7 Limitations of GDP . . . . .                  | 22        |
| <b>Summary: Key Formulae</b>                       | <b>23</b> |

# 1 Introduction: What is Economics?

## Definition

**Economics** is the study of human behaviour — specifically, how individuals, firms, and societies allocate scarce resources to satisfy unlimited wants.

## 2 The Ten Principles of Economics

### 2.1 How People Make Decisions

#### Principle 1 — People Face Trade-offs

Resources are scarce, so choosing more of one thing means choosing less of something else.

##### Individual trade-offs:

- Income vs. leisure time
- Studying vs. socialising

##### Society-wide trade-offs:

- Guns vs. butter (defence vs. consumption)
- Efficiency vs. equity

#### Principle 2 — The Cost of Something Is What You Give Up

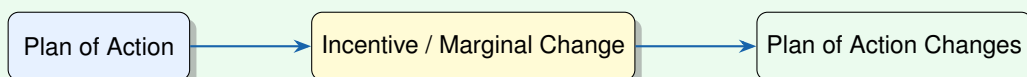
The **opportunity cost** of an action is the value of the next-best alternative foregone.

| Action         | Opportunity Cost                                                                   |
|----------------|------------------------------------------------------------------------------------|
| Going to class | Time — not the number of minutes, but <i>what you could have done</i> in that time |
| Buying a pizza | Whatever else you would have spent the money on <i>plus</i> the effort involved    |

#### Principle 3 — Rational People Think at the Margin

A **rational person** makes decisions by comparing **marginal benefit (MB)** with **marginal cost (MC)**.

**Marginal changes** are small, incremental adjustments to an existing plan.



#### Decision Rule

A decision is taken **if and only if**

$$MB \geq MC$$

*Example — Studying one more hour:*

MB = extra knowledge / grade improvement from that hour of studying.

The decision to study more is rational as long as  $MB \geq MC$ .

### Principle 4 — People Respond to Incentives

Because people compare costs and benefits, they *respond* when those costs or benefits change.

| Incentive Type | Description                                           |
|----------------|-------------------------------------------------------|
| Economic       | Financial rewards or penalties (prices, wages, taxes) |
| Social         | Peer approval, norms, reputation                      |
| Moral          | Ethical obligations, altruism                         |

*Note:* Not everyone responds to the same incentives in the same manner.

## 2.2 How People Interact

### Principle 5 — Trade Can Make Everyone Better Off

Trade allows specialisation: each person/country produces what they do *relatively* best, then trades for other goods  $\Rightarrow$  expanded consumption possibilities for all.

### Principle 6 — Markets Are Usually a Good Way to Organise Economic Activity

In a **free (competitive) market**, prices coordinate the decisions of millions of buyers and sellers — essentially a *capitalist economy*. Prices signal scarcity and direct resources to their highest-valued uses.

### Principle 7 — Governments Can Sometimes Improve Market Outcomes

Markets fail when there are externalities, public goods, information asymmetries, or market power. Government intervention can (in principle) correct these failures.

## 2.3 How the Economy as a Whole Works

### Principle 8 — A Country's Standard of Living Depends on Its Ability to Produce

Living standards are determined by **productivity** — the quantity of goods and services produced per unit of input — which other people want to buy.

### Principle 9 — Prices Rise When the Government Prints Too Much Money

Excessive money creation leads to **inflation**: too many dollars chasing too few goods.

### Principle 10 — Society Faces a Short-Run Trade-off Between Inflation and Unemployment

In the **short run**, reducing inflation by tightening monetary policy typically raises unemployment — captured by the Phillips Curve relationship.

## 3 The Circular Flow Model

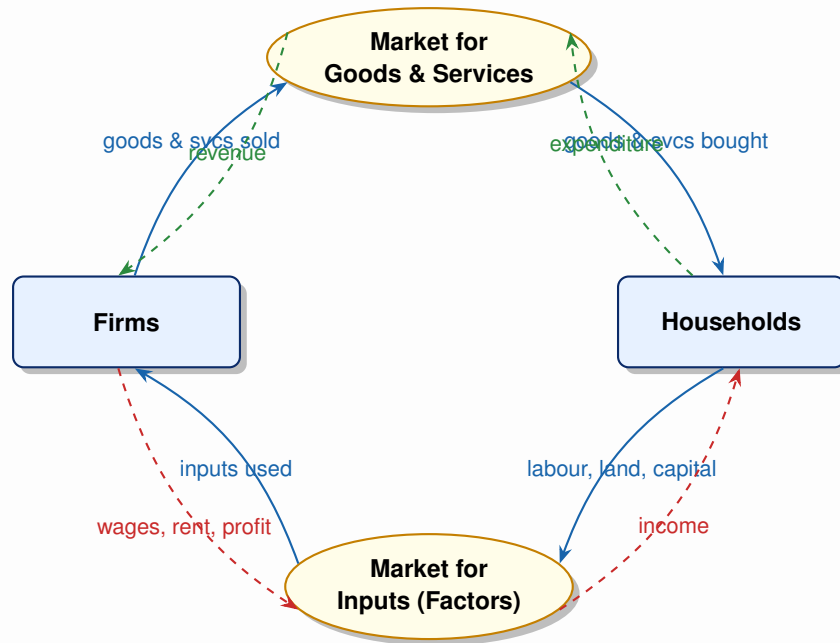


Figure 1: The Circular Flow of Income in a Simple Economy

## 4 Production Possibilities Frontier (PPF)

### Definition — PPF

The **Production Possibilities Frontier** shows all combinations of two goods that an economy can produce using all available resources efficiently.

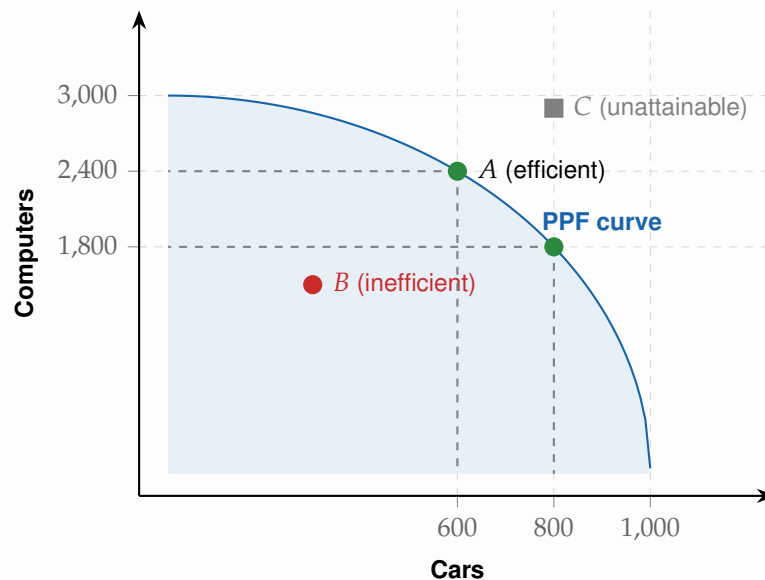


Figure 2: PPF for Cars and Computers

## Key PPF Concepts

- **Points on the PPF** → efficient (all resources used)
- **Points inside the PPF** → inefficient (some resources idle)
- **Points outside the PPF** → currently unattainable
- **Downward slope** → reflects the trade-off between the two goods

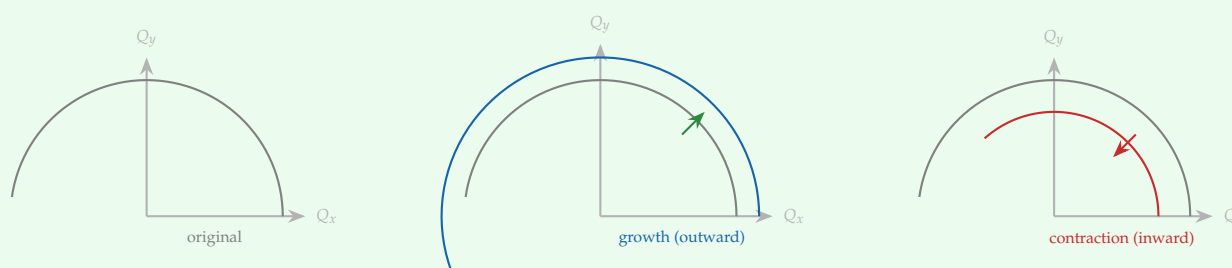
### Opportunity Cost on the PPF:

Moving from (800, 1800) to (600, 2400): giving up 200 cars gains 600 computers, so cost of 200 cars = 600 computers, i.e.

$$|m| = \frac{600}{200} = 3 \text{ computers per car}$$

*The opportunity cost is not constant — it increases (bow-out shape) because resources are not equally suited to both uses.*

**PPF can shift** outward (economic growth) or inward (resource loss/disaster):



## 5 Demand

### 5.1 Perfectly Competitive Markets

#### Perfectly Competitive Market

- Many buyers and sellers, each *small* relative to the market
- Goods are **identical** (homogeneous)
- No barriers to entry or exit
- *Examples:* Cotton, NYSE, gasoline

### 5.2 The Law of Demand

#### Law of Demand

*Ceteris paribus* (all other factors held constant):

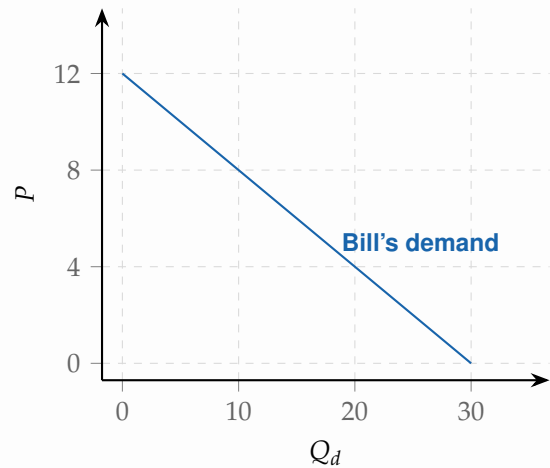
$$P \uparrow \Rightarrow Q_d \downarrow \qquad P \downarrow \Rightarrow Q_d \uparrow$$

Two reasons:

1. **Income effect:** A price rise reduces purchasing power.
2. **Substitution effect:** A price rise makes other goods relatively cheaper.

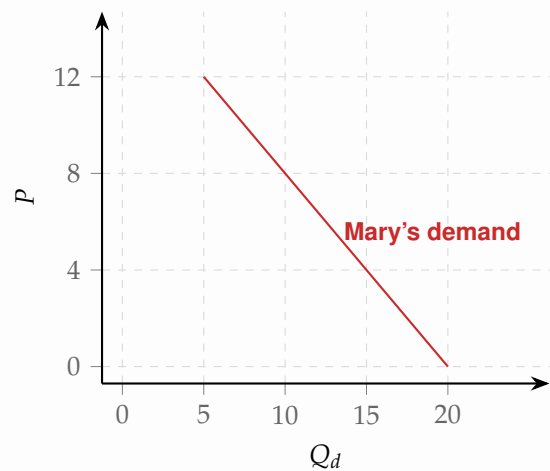
### 5.3 Demand Schedule and Curve

| Bill's Demand Schedule for Pizza |                             |
|----------------------------------|-----------------------------|
| Price of Pizza (\$)              | Qty Demanded (pizzas/month) |
| 0                                | 30                          |
| 4                                | 20                          |
| 8                                | 10                          |
| 12                               | 0                           |



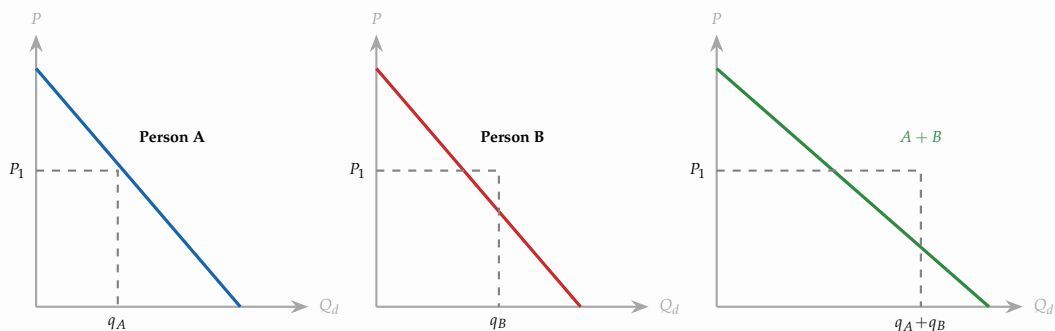
Mary's Demand Schedule for Pizza

| Price (\$) | $Q_d$ |
|------------|-------|
| 0          | 20    |
| 4          | 15    |
| 8          | 10    |
| 12         | 5     |



### 5.4 Market Demand = Horizontal Summation

The **market demand curve** is the *horizontal sum* of all individual demand curves.



### 5.5 Demand Shifters (Determinants of Demand)

#### 5 Demand Shifters

##### 1. Income

- Normal goods:  $I \uparrow \Rightarrow D \uparrow$  (and  $I \downarrow \Rightarrow D \downarrow$ )
- Inferior goods:  $I \uparrow \Rightarrow D \downarrow$  (and vice versa)
- What is a normal good for one person may be inferior for another.

##### 2. Prices of Related Goods

- *Substitutes* (e.g. Coke & Pepsi):  $P_{\text{Coke}} \uparrow \Rightarrow D_{\text{Pepsi}} \uparrow$
- *Complements* (e.g. hot dogs & buns):  $P_{\text{hotdog}} \uparrow \Rightarrow D_{\text{buns}} \downarrow$

3. **Tastes** — influenced by advertising, friends, medical advice, etc.

4. **Expectations** — expected future prices affect current demand.

5. **Number of Buyers in the Market** — more buyers  $\Rightarrow$  market demand shifts right.

*Important:* Shifters 1–4 shift the *individual* demand curve. Shifter 5 shifts the *market* demand curve but NOT the individual curve.

### Change in $Q_d$ vs. Change in Demand

- **Change in quantity demanded** (movement along curve): caused by a change in **price**.
- **Change in demand** (shift of the curve): caused by any of the 5 shifters above.

## 6 Supply

### 6.1 The Law of Supply

#### Law of Supply

*Ceteris paribus:* An increase in price causes an increase in quantity supplied (think of yourself as the seller — higher prices make production more profitable).

$$P \uparrow \Rightarrow Q_s \uparrow \qquad P \downarrow \Rightarrow Q_s \downarrow$$

### 6.2 Supply Shifters (Determinants of Supply)

#### 5 Supply Shifters

1. **Input Prices** — Input  $P \uparrow \Rightarrow Q_s \downarrow$  (higher costs reduce supply)
2. **Technology** — improvement  $\Rightarrow Q_s \uparrow$
3. **Prices of Substitutes in Production** — if another good becomes more profitable, firms switch
4. **Expectations of Sellers** — expected future price  $\uparrow \Rightarrow$  hold inventory now  $\Rightarrow$  current supply  $\downarrow$
5. **Number of Sellers** — more sellers  $\Rightarrow$  market supply shifts right

*Important:* Like demand, shifters 1–4 shift the *individual firm's* supply curve. Shifter 5 shifts the *market* supply curve, but NOT the individual firm's curve.

### 6.3 Market Supply = Horizontal Summation

Analogous to demand:  $Q_s^{\text{mkt}} = Q_s^A + Q_s^B + \dots$

## 7 Market Equilibrium

## Equilibrium

$P^*$  is the **only** price at which  $Q_d = Q_s$ . At this price the market clears.

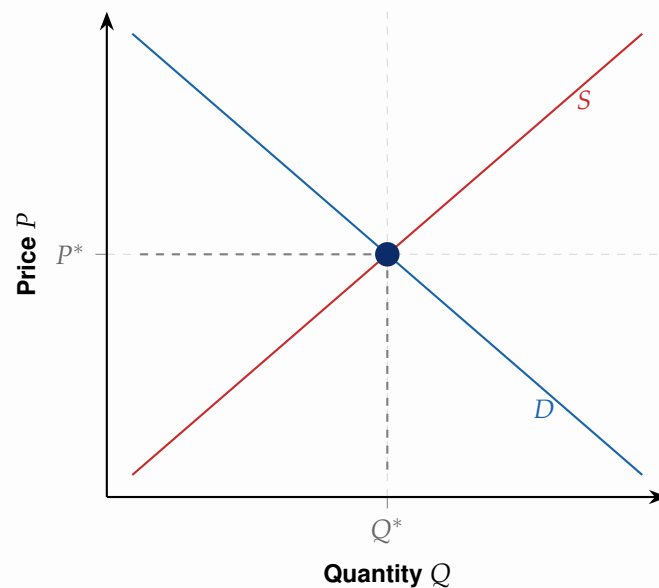


Figure 3: Market Equilibrium at  $P^*$ ,  $Q^*$

### 7.1 Shortage and Surplus

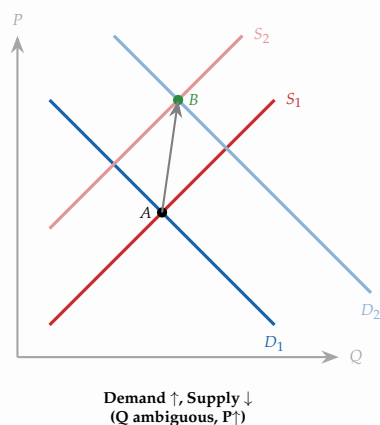
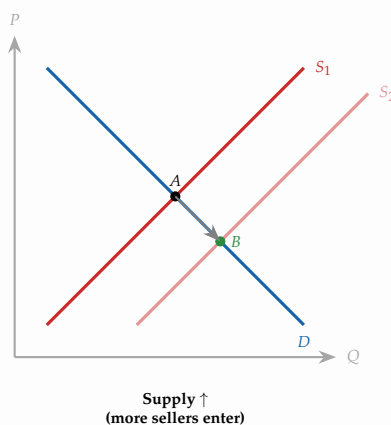
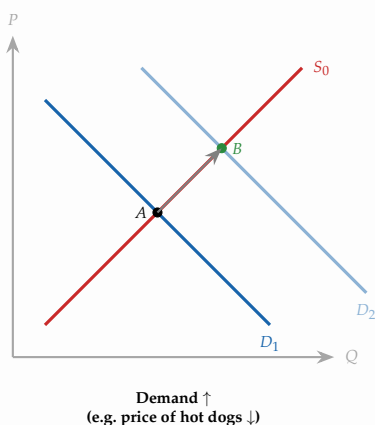
#### Shortage (Excess Demand)

If  $P < P^*$ :  $Q_d > Q_s$ .  
Sellers can charge more  $\Rightarrow$  upward pressure on  $P \Rightarrow$  continues until  $P = P^*$ .

#### Surplus (Excess Supply)

If  $P > P^*$ :  $Q_s > Q_d$ .  
Sellers must cut price  $\Rightarrow$  downward pressure on  $P \Rightarrow$  continues until  $P = P^*$ .

### 7.2 Shifts in Equilibrium — Examples



## 8 Elasticity

## 8.1 Price Elasticity of Demand (PED)

### PED Formula

$$PED = \frac{\% \Delta Q_d}{\% \Delta P} = \left| \frac{P}{Q} \cdot \frac{dQ}{dP} \right| = \left| \frac{\Delta Q_d}{\Delta P} \cdot \frac{P_{avg}}{Q_{avg}} \right|$$

$PED < 0$  always (Law of Demand)  $\Rightarrow$  we report absolute value.

| Value of $ PED $ | Classification      | Interpretation                          |
|------------------|---------------------|-----------------------------------------|
| $> 1$            | Elastic             | $Q_d$ responds strongly to price change |
| $= 1$            | Unit elastic        | $\% \Delta Q_d = \% \Delta P$           |
| $< 1$            | Inelastic           | $Q_d$ responds weakly to price change   |
| $= 0$            | Perfectly inelastic | $Q_d$ fixed regardless of price         |
| $= \infty$       | Perfectly elastic   | Consumers buy any amount at one price   |

Example:  $P$  rises by 10%,  $Q_d$  falls by 20%:  $PED = -20/10 = -2 \Rightarrow |PED| = 2 > 1$  (elastic).

### 8.1.1 Determinants of PED.

- Availability of close substitutes (more substitutes  $\Rightarrow$  more elastic)
- Passage of time (longer run  $\Rightarrow$  more elastic)
- Necessity vs. luxury (necessities more inelastic)
- Definition of the market (narrowly defined  $\Rightarrow$  more elastic)
- Share of income spent on the good (larger share  $\Rightarrow$  more elastic)

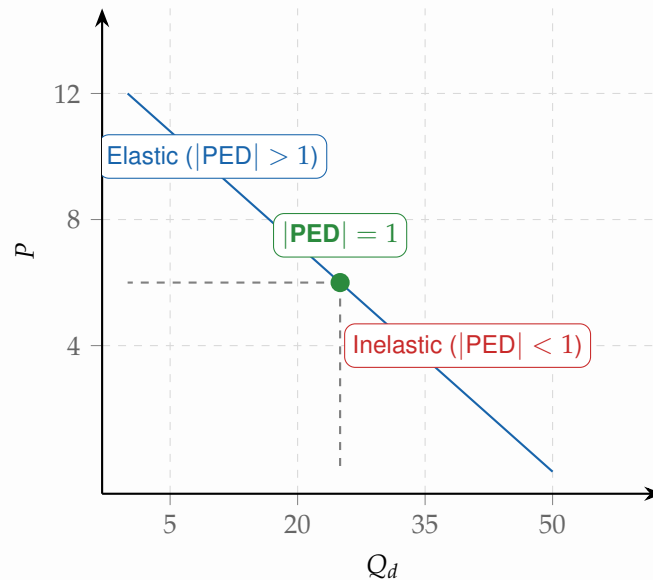


Figure 4: Elasticity varies along a linear demand curve

### 8.1.2 PED Along a Linear Demand Curve.

## 8.2 PED and Total Revenue (TR)

$$TR = P \times Q$$

| Demand                              | If $P \uparrow$                        | If $P \downarrow$ |
|-------------------------------------|----------------------------------------|-------------------|
| Inelastic ( $ \text{PED}  < 1$ )    | TR $\uparrow$ (P & TR move together)   | TR $\downarrow$   |
| Elastic ( $ \text{PED}  > 1$ )      | TR $\downarrow$ (P & TR move opposite) | TR $\uparrow$     |
| Unit elastic ( $ \text{PED}  = 1$ ) | TR unchanged                           | TR unchanged      |

## 8.3 Cross-Price Elasticity of Demand (CPED)

### CPED Formula

$$\text{CPED} = \frac{\% \Delta Q_1}{\% \Delta P_2}$$

- $\text{CPED} > 0 \Rightarrow$  goods are **substitutes**
- $\text{CPED} < 0 \Rightarrow$  goods are **complements**

## 8.4 Income Elasticity of Demand (IED)

### IED Formula

$$\text{IED} = \frac{\% \Delta Q}{\% \Delta I}$$

- $\text{IED} > 0 \Rightarrow$  **Normal good**
- $\text{IED} < 0 \Rightarrow$  **Inferior good**

## 8.5 Price Elasticity of Supply (PES)

### PES Formula

$$\text{PES} = \frac{\% \Delta Q_s}{\% \Delta P}$$

$\text{PES} > 0$  always (Law of Supply).

# 9 Price Controls

## 9.1 Price Ceiling

### Price Ceiling

A **price ceiling** is a legal *maximum* price sellers may charge.

- **Non-binding:** ceiling is set *above*  $P^* \Rightarrow$  no effect on market.
- **Binding:** ceiling is set *below*  $P^* \Rightarrow$  creates a **shortage** ( $Q_d > Q_s$ ).

When binding, alternative rationing mechanisms emerge: queuing, discrimination, black markets.

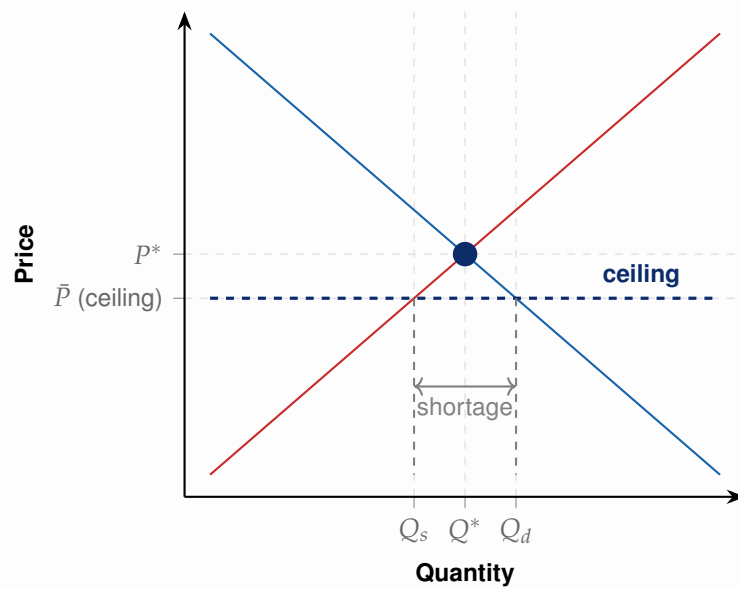
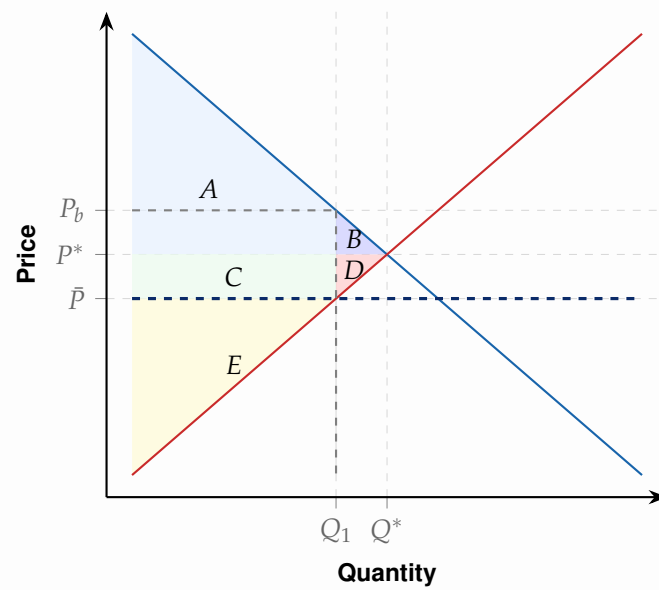


Figure 5: Binding Price Ceiling Creates a Shortage

### 9.1.1 Welfare Effects of a Binding Price Ceiling.



|                  | No Ceiling  | With Binding Ceiling  |
|------------------|-------------|-----------------------|
| Consumer Surplus | $A + B$     | $A + C$ (upper bound) |
| Producer Surplus | $C + D + E$ | $E$                   |
| Deadweight Loss  | 0           | $B + D$               |

*Area C = transfer from producers to consumers.*

## 9.2 Price Floor

### Price Floor

A **price floor** is a legal *minimum* price. When binding (above  $P^*$ ), it creates a **surplus** ( $Q_s > Q_d$ ).

*Example:* Minimum wage in the labour market.

|     | No Floor    | With Binding Floor |
|-----|-------------|--------------------|
| CS  | $A + B + C$ | $A$                |
| PS  | $D + E$     | $B + D$            |
| DWL | 0           | $C + E$            |

*Area B = transfer from consumers to producers.*

## 10 Taxes

### Key Results on Taxation

1. **Tax on buyers** reduces their willingness to pay by the tax amount  $\Rightarrow$  demand shifts down.
2. **Tax on sellers** increases their cost of production by the tax amount  $\Rightarrow$  supply shifts up.
3. A tax on buyers is *exactly equivalent* to a tax on sellers.
4. **Tax incidence** (who really bears the burden) depends on relative elasticities, *not* on who legally pays.
5. Tax burden falls more heavily on the inelastic side of the market.

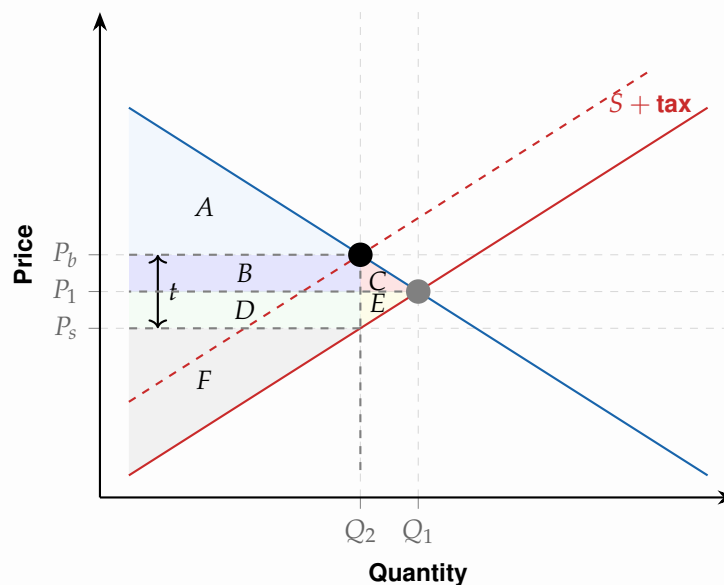


Figure 6: Tax on Sellers: Welfare Effects

|                    | No Tax                  | With Tax $t$          |
|--------------------|-------------------------|-----------------------|
| Consumer Surplus   | $A + B + C$             | $A$                   |
| Producer Surplus   | $D + E + F$             | $F$                   |
| Government Revenue | 0                       | $B + D = t \cdot Q_2$ |
| Total Surplus      | $A + B + C + D + E + F$ | $A + B + D + F$       |
| Deadweight Loss    | 0                       | $C + E$               |

## 11 Consumer and Producer Surplus

### 11.1 Consumer Surplus (CS)

#### Consumer Surplus

**Willingness to Pay (WTP)** is the maximum a buyer would pay for a good — the measure of value to the buyer.

$$CS = WTP - \text{Price Paid} = \text{Area under the demand curve and above the price}$$

| Bidder | WTP    |
|--------|--------|
| A      | \$1000 |
| B      | \$800  |
| C      | \$600  |
| D      | \$400  |

If market price is \$800: only A and B buy. A gets  $CS = 1000 - 800 = \$200$ ; B gets  $CS = \$0$ .

### 11.2 Producer Surplus (PS)

#### Producer Surplus

$$PS = \text{Price Received} - \text{Cost of Production} = \text{Area above supply curve and below the price}$$

### 11.3 Total Surplus = Economic Efficiency

$$\text{Total Surplus (TS)} = CS + PS = \text{Economic Surplus}$$

A competitive market maximises total surplus — it is **efficient**. Any quantity other than  $Q^*$  reduces total surplus (creating deadweight loss).

## 12 Costs of Production

## 12.1 Types of Costs

### Total Cost Components

$$TC = FC + VC$$

- **Fixed costs (FC):** Do not depend on quantity produced (e.g. rent, insurance). *No FC in the long run.*
- **Variable costs (VC):** Depend on quantity produced (e.g. raw materials, wages).

### Explicit vs. Implicit Costs

- **Explicit costs:** Direct monetary payments (raw materials, wages, rent, electricity).
- **Implicit costs:** Opportunity costs of owner-provided inputs (e.g. foregone salary from next-best employment, foregone interest on capital).

$$\text{Economic Profit} = TR - \underbrace{(\text{explicit} + \text{implicit costs})}_{TC}$$

$$\text{Accounting Profit} = TR - \text{explicit costs only}$$

*Investments are not costs — sunk costs are irrelevant to future decisions.*

### Example: Understanding Sunk Costs

Suppose you face two disastrous scenarios:

1. Losing your car and your house.
2. Losing your car but keeping your house.

Because losing the car occurs in *both* scenarios, it is a **sunk cost** in this decision context. When evaluating the two options, the loss of the car should be “erased” from the decision-making process, leaving only the choice regarding the house.

## 12.2 Production Function

### Law of Diminishing Marginal Product

As more units of a variable input are added (holding all others fixed), the marginal product of that input eventually decreases.

**Production Function Table**

| Workers | Ovens | Output (Q) | Average Product (AP) | Marginal Product (MP) |
|---------|-------|------------|----------------------|-----------------------|
| 0       | 1     | 0          | —                    | —                     |
| 1       | 1     | 50         | 50                   | 50                    |
| 2       | 1     | 90         | 45                   | 40                    |
| 3       | 1     | 120        | 40                   | 30                    |
| 4       | 1     | 140        | 35                   | 20                    |
| 5       | 1     | 150        | 30                   | 10                    |

$$AP = \frac{\text{Total Product}}{\text{No. of Workers}}, \quad MP = \frac{\Delta Q}{\Delta \text{Workers}}$$

### 12.3 Cost Definitions and Relationships

$$AFC = \frac{FC}{Q}, \quad AVC = \frac{VC}{Q}, \quad ATC = \frac{TC}{Q} = AFC + AVC, \quad MC = \frac{\Delta TC}{\Delta Q}$$

**Cost Table**

| Q  | TC    | FC   | VC    | AFC  | AVC  | ATC  | MC   |
|----|-------|------|-------|------|------|------|------|
| 0  | 3.00  | 3.00 | 0     | —    | —    | —    | —    |
| 1  | 3.30  | 3.00 | 0.30  | 3.00 | 0.30 | 3.30 | 0.30 |
| 2  | 3.80  | 3.00 | 0.80  | 1.50 | 0.40 | 1.90 | 0.50 |
| 3  | 4.50  | 3.00 | 1.50  | 1.00 | 0.50 | 1.50 | 0.70 |
| 4  | 5.40  | 3.00 | 2.40  | 0.75 | 0.60 | 1.35 | 0.90 |
| 5  | 6.50  | 3.00 | 3.50  | 0.60 | 0.70 | 1.30 | 1.10 |
| 6  | 7.90  | 3.00 | 4.80  | 0.50 | 0.80 | 1.30 | 1.30 |
| 7  | 9.30  | 3.00 | 6.90  | 0.43 | 0.90 | 1.33 | 1.50 |
| 8  | 11.00 | 3.00 | 8.00  | 0.38 | 1.00 | 1.38 | 1.70 |
| 9  | 12.90 | 3.00 | 9.90  | 0.33 | 1.10 | 1.43 | 1.90 |
| 10 | 15.00 | 3.00 | 12.00 | 0.30 | 1.20 | 1.50 | 2.10 |

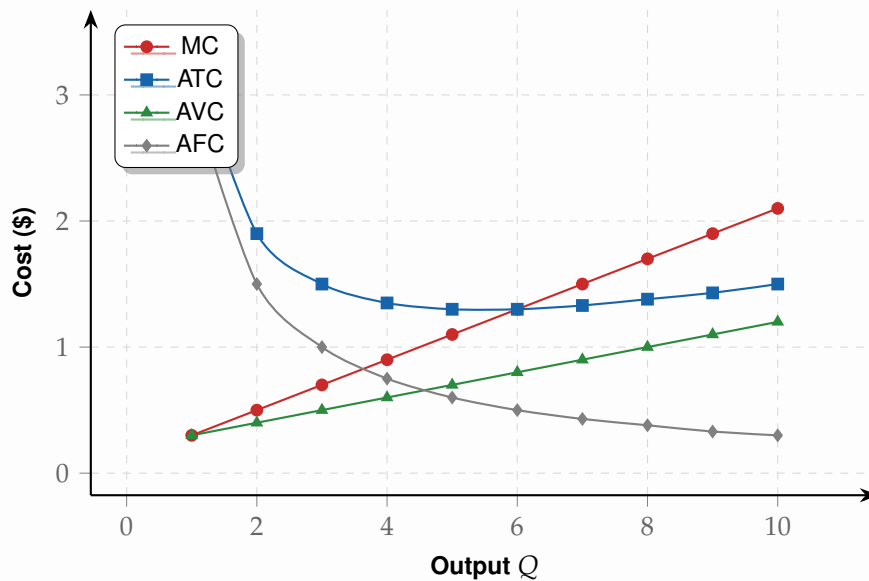


Figure 7: Cost Curves: MC rises, ATC is U-shaped, MC crosses ATC at its minimum

#### Key Properties of Cost Curves

- **MC is rising** due to the Law of Diminishing Marginal Product.
- **ATC is U-shaped**: falling AFC pulls ATC down at first; rising AVC eventually dominates.
- **MC crosses ATC and AVC at their minimum points** (the *efficient scale*).
- **No fixed costs in the long run** — all costs are variable, so only MC, ATC, AVC matter.

## 12.4 Long-Run Average Total Cost (LRATC)

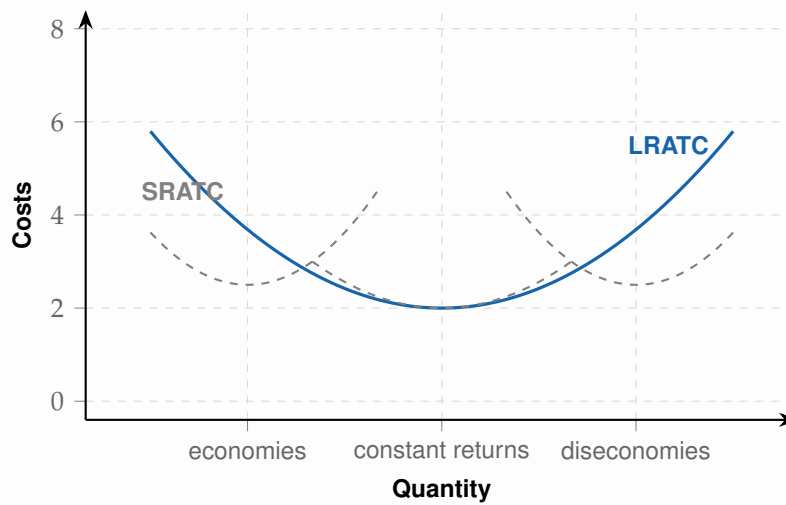


Figure 8: LRATC as the envelope of SRATC curves

## 13 Perfect Competition

### 13.1 Characteristics

#### Perfectly Competitive Market

- Many buyers and sellers
- Goods are identical (homogeneous)
- No barriers to entry or exit
- Buyers and sellers are **price takers** (no individual market power)

### 13.2 Revenue in a Competitive Firm

$$TR = P \times Q, \quad AR = \frac{TR}{Q} = P, \quad MR = \frac{\Delta TR}{\Delta Q} = P$$

#### Key result for a price taker

$$P = AR = MR$$

The demand curve facing an individual competitive firm is *perfectly elastic* (horizontal at the market price).

### 13.3 Profit Maximisation: MR = MC Rule

#### Profit-Maximising Rule

Produce the quantity  $Q^*$  where

$$MR = MC$$

$$\pi = TR - TC = (P - ATC) \times Q$$

- If  $P > ATC$  at  $Q^*$ : **economic profit** ( $\pi > 0$ )

- If  $P = ATC$  at  $Q^*$ : **break-even** ( $\pi = 0$ )
- If  $P < ATC$  at  $Q^*$ : **economic loss** ( $\pi < 0$ )

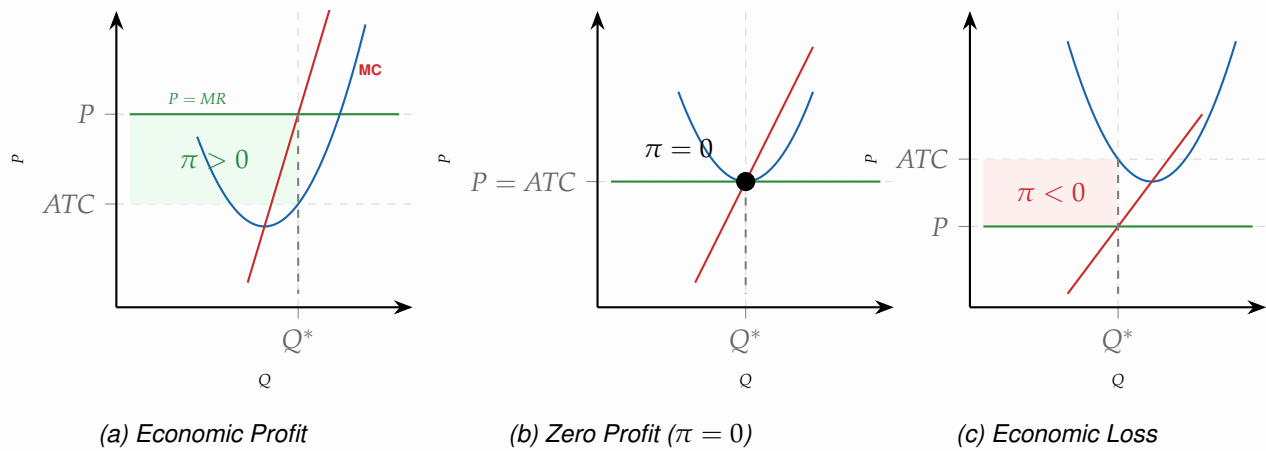


Figure 9: Short-Run Profit Possibilities (MC Intersects ATC at Minimum)

### 13.4 Short-Run Shut-Down Decision

#### Shut-Down Rule (Short Run)

A firm should shut down in the short run if:

$$TR < VC \Leftrightarrow P < AVC$$

If  $P \geq AVC$ , produce at  $Q$  where  $P = MC$  (even at a loss — better to cover variable costs and some fixed costs).

**The short-run supply curve of a competitive firm** is the portion of the MC curve that lies *above* the minimum AVC.

#### Numerical Proof: Shut-Down Decision

| Firm Costs  | Case 1: $TR = 1200$                 | Case 2: $TR = 900$                 |
|-------------|-------------------------------------|------------------------------------|
| $FC = 500$  | Produce: $\pi = 1200 - 1500 = -300$ | Produce: $\pi = 900 - 1500 = -600$ |
| $VC = 1000$ | Shut down: $\pi = -FC = -500$       | Shut down: $\pi = -FC = -500$      |
| $TC = 1500$ | <b>Result:</b> Produce at a loss.   | <b>Result:</b> Shut down.          |

### 13.5 Long-Run Entry and Exit

#### Long-Run Entry/Exit Decision

| Condition               | Decision           | Effect                                                                                |
|-------------------------|--------------------|---------------------------------------------------------------------------------------|
| $P > ATC$ ( $\pi > 0$ ) | Firms <b>enter</b> | Supply $\uparrow \Rightarrow P \downarrow \Rightarrow \pi \downarrow$ until $\pi = 0$ |
| $P < ATC$ ( $\pi < 0$ ) | Firms <b>exit</b>  | Supply $\downarrow \Rightarrow P \uparrow \Rightarrow \pi \uparrow$ until $\pi = 0$   |

### Long-Run Equilibrium in a Competitive Market

$$P = MR = MC = ATC \Rightarrow \pi = 0$$

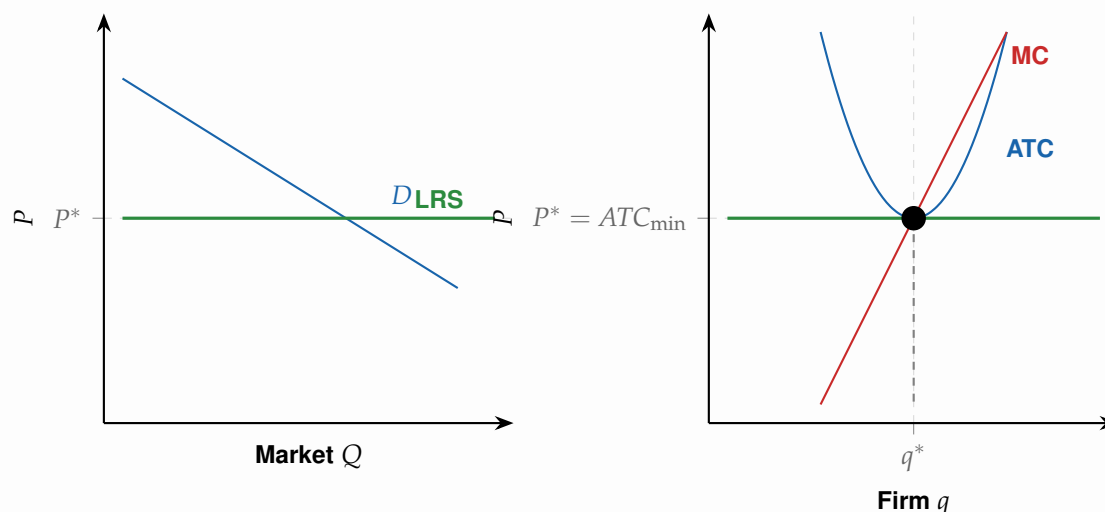


Figure 10: Long-Run Competitive Equilibrium:  $P = MC = ATC$ ,  $\pi = 0$

### Why the Long-Run Supply Curve Might Slope Upwards

While the basic model assumes a perfectly horizontal LRS at  $P = \text{minimum } ATC$ , it can slope upwards in reality due to:

- **Increasing Cost Industries:** As market quantity ( $Q$ ) expands, the increased demand for inputs drives up input prices (e.g., wages, raw materials), pushing the  $ATC$  curves of all firms upward.
- **Varying Efficiencies:** Some firms may have access to better technology or cheaper inputs than others. As price rises, less efficient firms (with higher costs) are enticed to enter the market, driving the supply curve up.

## 14 Consumer Theory

### 14.1 Budget Constraint

#### Budget Constraint

Given income  $I$ , prices  $P_x$  and  $P_y$ :

$$P_x \cdot Q_x + P_y \cdot Q_y = I \Rightarrow Q_y = -\frac{P_x}{P_y} Q_x + \frac{I}{P_y}$$

The slope of the budget line is  $-P_x/P_y$ .

Example:  $I = \$500$ ,  $P_{\text{pizza}} = \$10$ ,  $P_{\text{coke}} = \$2$ :

$$10Q_p + 2Q_c = 500 \Rightarrow Q_c = -5Q_p + 250$$

| Pizza | Coke | Spending on Pizza | Spending on Coke | Total |
|-------|------|-------------------|------------------|-------|
| 50    | 0    | \$500             | \$0              | \$500 |
| 40    | 50   | \$400             | \$100            | \$500 |
| 30    | 100  | \$300             | \$200            | \$500 |
| 20    | 150  | \$200             | \$300            | \$500 |
| 10    | 200  | \$100             | \$400            | \$500 |
| 0     | 250  | \$0               | \$500            | \$500 |

## 14.2 Indifference Curves

### Indifference Curve

Shows all combinations of goods that give the consumer the **same level of utility**. Properties:

- Downward sloping (more is preferred to less)
- Convex to the origin (diminishing MRS)
- Higher curves represent higher utility
- Indifference curves **never cross**

### Special Case: Perfect Substitutes

For goods that are **perfect substitutes** (e.g., two identical brands of bottled water), the consumer is always willing to trade them at a fixed, constant ratio. As a result, the indifference curve is **strictly linear** (a straight line) rather than convex to the origin.

$$MRS = \text{slope of indifference curve} = \frac{P_x}{P_y} \quad (\text{at optimum})$$

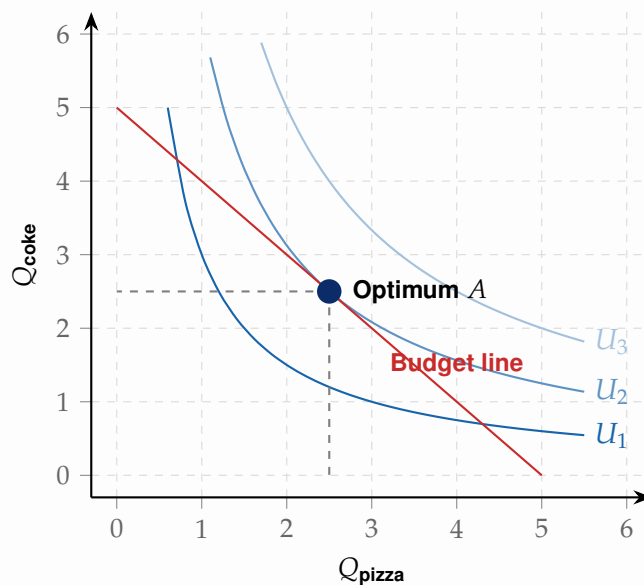


Figure 11: Consumer Optimum: Tangency of Budget Line and Highest Indifference Curve

## 15 Macroeconomics: GDP

## 15.1 What is GDP?

### Gross Domestic Product (GDP)

GDP is the **market value of all final goods and services produced within a country in a given period of time**. It measures both:

- The total income of everyone in the economy, *and*
- The total expenditure on the economy's output.

## 15.2 The Expenditure Approach

### GDP Equation

$$Y = C + I + G + NX$$

| Component | Description                                            |
|-----------|--------------------------------------------------------|
| $C$       | Consumption (household spending on goods and services) |
| $I$       | Investment (business equipment and structures)         |
| $G$       | Government Purchases                                   |
| $NX$      | Net Exports = Exports – Imports                        |

## 15.3 Nominal vs. Real GDP

### Nominal vs. Real GDP

- **Nominal GDP:** Values output at *current* prices — changes reflect both price and quantity changes.
- **Real GDP:** Values output at *base-year* prices — changes reflect *only* quantity changes.

### Numerical Example (base year = 2001)

| Year | $Q_{\text{hotdogs}}$ | $P_{\text{hotdogs}}$ | $Q_{\text{hamburgers}}$ | $P_{\text{hamburgers}}$ | Nominal GDP |
|------|----------------------|----------------------|-------------------------|-------------------------|-------------|
| 2001 | 100                  | \$1                  | 50                      | \$2                     | \$200       |
| 2002 | 150                  | \$2                  | 100                     | \$3                     | \$600       |
| 2003 | 200                  | \$3                  | 150                     | \$4                     | \$1200      |

### Real GDP (2001 prices):

| Year | Real GDP                              |
|------|---------------------------------------|
| 2001 | $100 \times 1 + 50 \times 2 = \$200$  |
| 2002 | $150 \times 1 + 100 \times 2 = \$350$ |
| 2003 | $200 \times 1 + 150 \times 2 = \$500$ |

## 15.4 GDP Deflator

### GDP Deflator

$$\text{GDP Deflator} = \frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100$$

This is a **price index** measuring the overall price level relative to the base year.

| Year | Calculation                   | GDP Deflator |
|------|-------------------------------|--------------|
| 2001 | $\frac{200}{200} \times 100$  | 100          |
| 2002 | $\frac{600}{350} \times 100$  | 171          |
| 2003 | $\frac{1200}{500} \times 100$ | 240          |

From 2002 to 2003:

$$\text{Inflation rate} = \frac{240 - 171}{171} \times 100 \approx 40.4\%$$

$$\text{Real GDP} = \frac{\text{Nominal GDP}}{\text{GDP Deflator}} \times 100$$

## 15.5 Per Capita GDP

$$\text{GDP per capita} = \frac{\text{GDP}}{\text{Population}} = \frac{\$17.9 \text{ trillion}}{321 \text{ million}} \approx \$55,882 \quad (2015)$$

### Component Breakdown (2015):

Using  $Y = C + I + G + NX$ , the per capita components break down mathematically as:

$$\$55,882 \approx \underbrace{\$38,218}_C + \underbrace{\$9,402}_I + \underbrace{\$9,919}_G - \underbrace{\$1,657}_{NX}$$

## 15.6 Rule of 72

### The Rule of 72

The standard of living **doubles** in approximately

$$\text{Years to double} = \frac{72}{\text{GDP growth rate (\%)}}$$

In the US since the mid-1960s, growth  $\approx 3\%$ /year  $\Rightarrow$  doubles every  $72/3 = 24$  years.

## 15.7 Limitations of GDP

### What GDP Ignores

- Quality of education
- Health of children
- Quality of culture
- Quality of environment
- Equality / equity
- Economic activity outside markets (home production, volunteering)

## Summary: Key Formulae at a Glance

| Concept                              | Formula                                     |
|--------------------------------------|---------------------------------------------|
| <b>Opportunity Cost</b>              | Next-best alternative foregone              |
| <b>Profit Maximisation</b>           | $MR = MC$                                   |
| <b>Profit</b>                        | $\pi = TR - TC = (P - ATC) \cdot Q$         |
| <b>Shut-Down (SR)</b>                | Shut down if $P < AVC$                      |
| <b>Exit (LR)</b>                     | Exit if $P < ATC$                           |
| <b>LR Equilibrium</b>                | $P = MR = MC = ATC, \pi = 0$                |
| <b>Price Elasticity of Demand</b>    | $PED = \% \Delta Q_d / \% \Delta P$         |
| <b>Cross-Price Elasticity</b>        | $CPED = \% \Delta Q_1 / \% \Delta P_2$      |
| <b>Income Elasticity</b>             | $IED = \% \Delta Q / \% \Delta I$           |
| <b>Consumer Surplus</b>              | $CS = WTP - P$                              |
| <b>Producer Surplus</b>              | $PS = P - \text{cost}$                      |
| <b>Total Surplus</b>                 | $TS = CS + PS$                              |
| <b>Budget Constraint</b>             | $P_x Q_x + P_y Q_y = I$                     |
| <b>Marginal Rate of Substitution</b> | $MRS = P_x / P_y$ at optimum                |
| <b>GDP (Expenditure)</b>             | $Y = C + I + G + NX$                        |
| <b>GDP Deflator</b>                  | Nominal GDP / Real GDP $\times 100$         |
| <b>Real GDP</b>                      | Nominal GDP / GDP Deflator $\times 100$     |
| <b>Rule of 72</b>                    | Years to double = $72 / \text{growth rate}$ |