

# Lecture 1 - Introduction to classical economics

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# Economics, Law, and Ethics for computer scientist?

1. **Systems design:** Economics used in network protocols, congestion control, blockchains, and platform architectures.
2. **Theoretical foundations:** Combinatorial auctions illustrate key concepts in complexity theory and algorithmic game theory.
3. **Professional impact:** Economics supports entrepreneurship, consultancy, management roles many CS graduates pursue.
4. **Legal awareness:** Know how online actions can create liability and how regulation affects digital systems.
5. **Ethical reasoning:** Navigate decisions in grey areas where laws may not exist or are ambiguous.
6. **Accreditation requirement:** Ethical and legal literacy is mandatory for professional recognition in computer science.

# Overview

## Aim

- Introduction to basic concepts in economics, law and ethics.

## Objectives

- Reflect on and discuss economic, moral and legal issues relating to computer science.
- Define and explain economic and legal terminology and arguments.
- Use economic, legal, and ethical frameworks to analyse computer-science problems.
- Assess how markets, regulation, and ethics constrain the behaviour of firms providing information goods and services.

# Course outline

1. Introduction to classical economics
2. Economics of information goods
3. Market failures and behavioural economics
4. Auctions and game theory
5. Principles of Law
6. Law and the Internet
7. Ethics
8. Contemporary Ethical Issues

# Course roadmap: Economics block

1. How incentives and competition shape equilibrium, and are equilibria societally fair?
2. Why are digital and information goods different?
3. Why markets fail to deliver good outcomes?
4. What if we allocate goods with auctions? What if the number of agents is small, and their strategic behaviour matters?

# How do markets work at their best?

## Lecture 1 overview

- We start with the benchmark: *perfect competition*.
- Examine how prices, quantities, and welfare emerge when everyone is a price-taker.
- This will serve as our benchmark for all next lectures on digital markets and market failures.

# Perfect competition: A simplified example

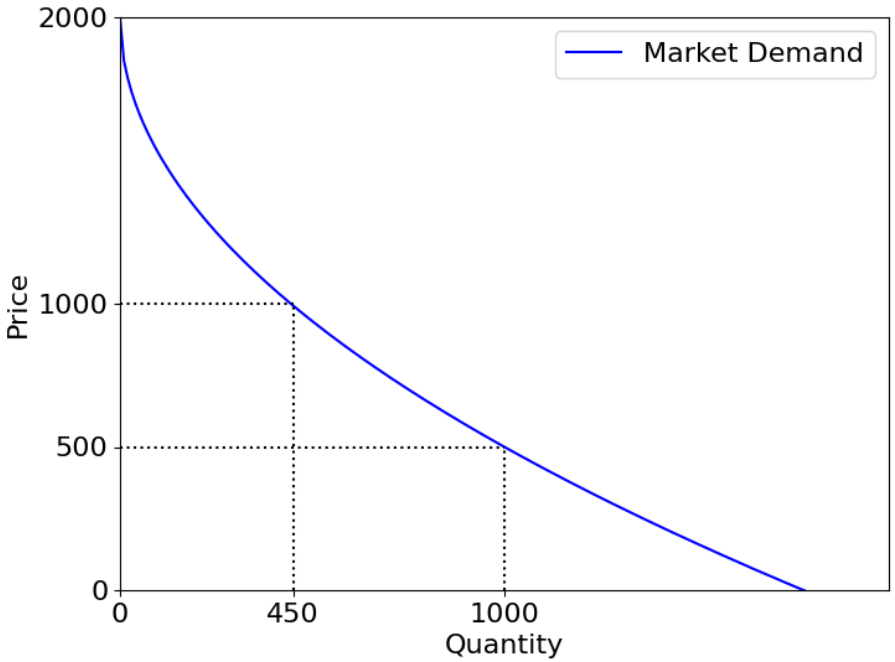




## Cambridge rental market in Eddington

- Renters differ in their willingness to pay.
- Flats differ in the cost to build and maintain.

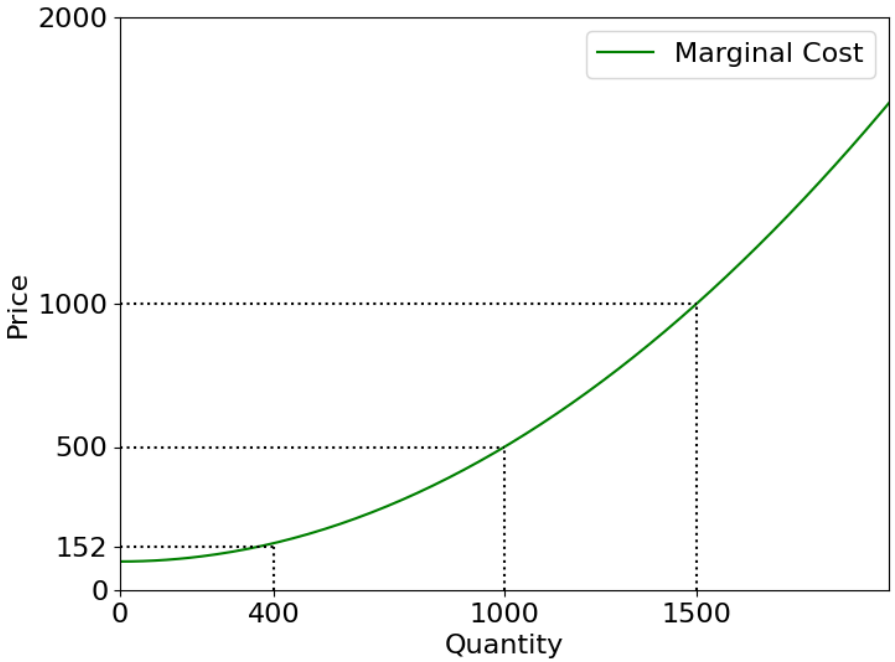
# Demand curve




**Interpretation: How many renters willing to pay for each price?**

- 1 renter WTP £2000
- 450 renters WTP £1000
- 1000 renters WTP £500

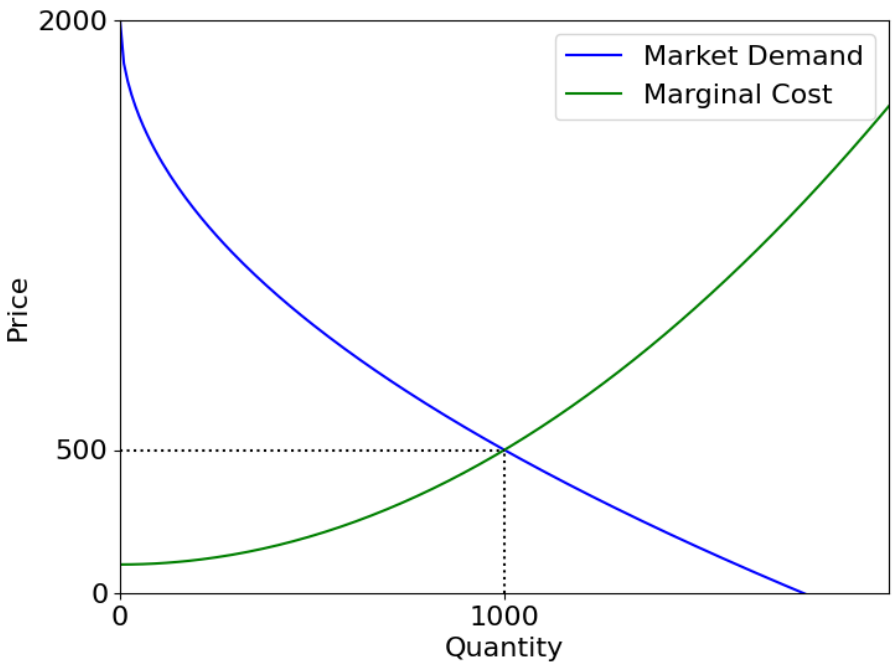
# Supply curve




**Interpretation: What is the cost of an additional flat?**

- $400^{th}$ flat costs £152
- $1{,}000^{th}$ flat costs £500
- $1{,}500^{th}$ flat costs £1000

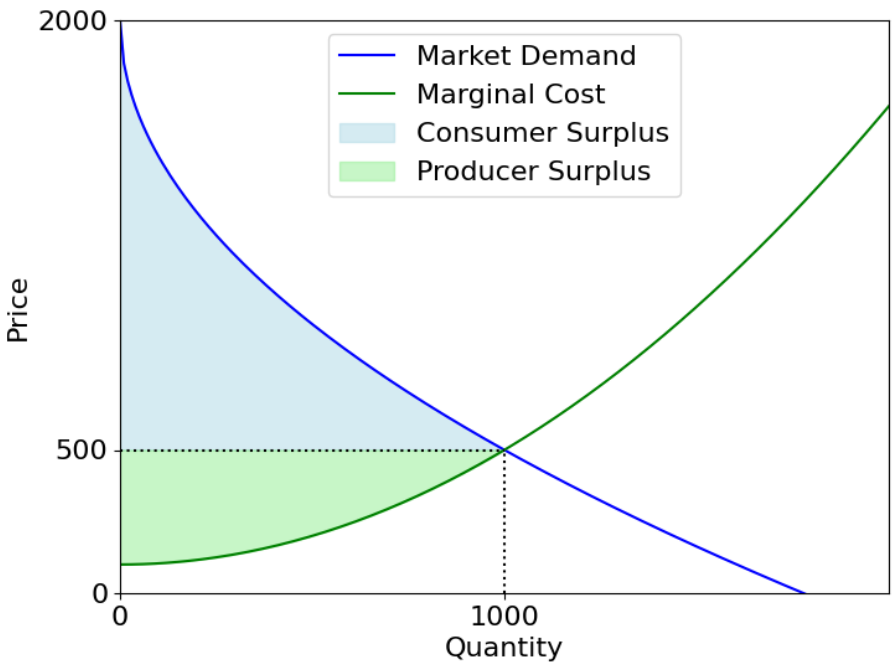
# Competitive equilibrium




**Interpretation:**

- Supply and demand curves cross (market clearing)
- Equilibrium price $p^* = 500$
- Equilibrium quantity $q^* = 1,000$

# Welfare under perfect competition




**Surpluses:**

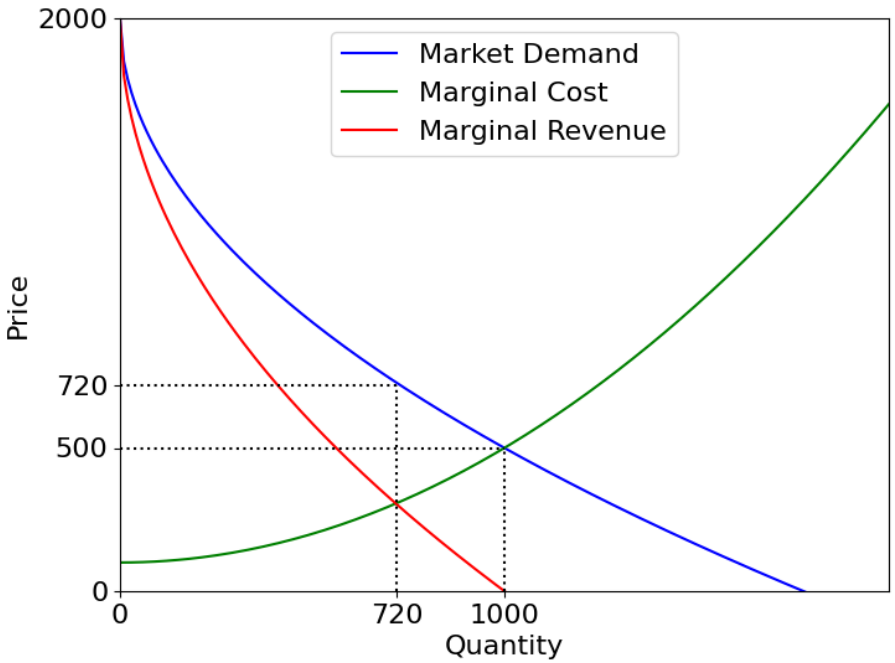
- Consumer surplus is the total amount people saved on their reservation price (blue area)
- Producer surplus is the total amount firms saved on their marginal costs (green area)

# When competition breaks down

## Overview

- We've seen that perfect competition maximises total welfare.
- Key assumption is many firms, price takers.
- But what happens when there is only one firm?
- Next, how monopoly changes prices, quantities, and fairness.

# Monopoly pricing



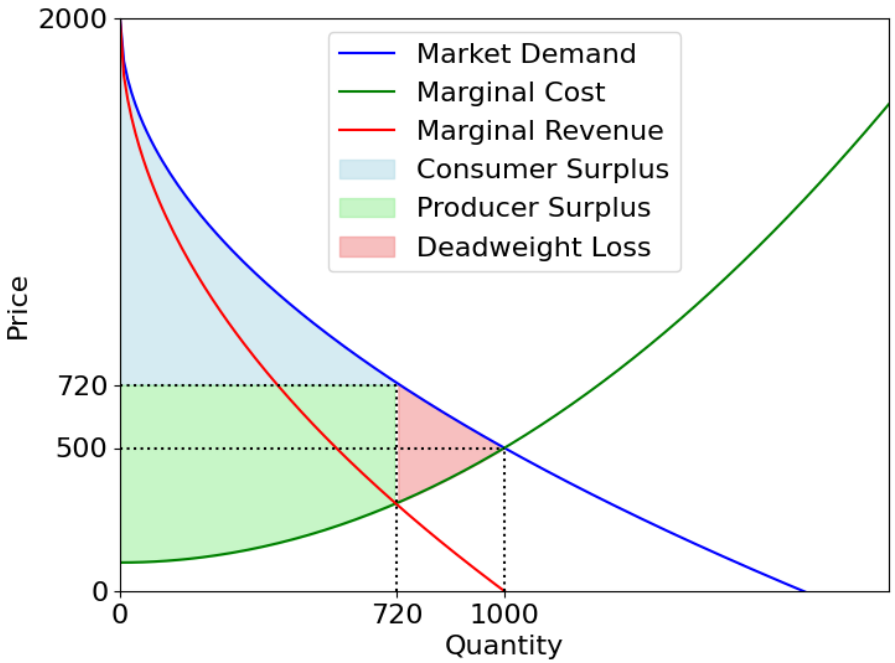

**Reasoning:**

- Maximise marginal revenue: additional profit for every additional flat
- Monopolist restricts supply to 720 and price of £720
- They earn more ($720 \times 720 > 1,000 \times 500$)

## Socially undesirable

There are empty flats which people would pay to rent!

# Welfare under monopoly




**Surpluses:**

- Consumer surplus decreased (blue area)
- Monopolist surplus increased (green area)
- Total welfare decreased (red area)

## Monopolist reasoning

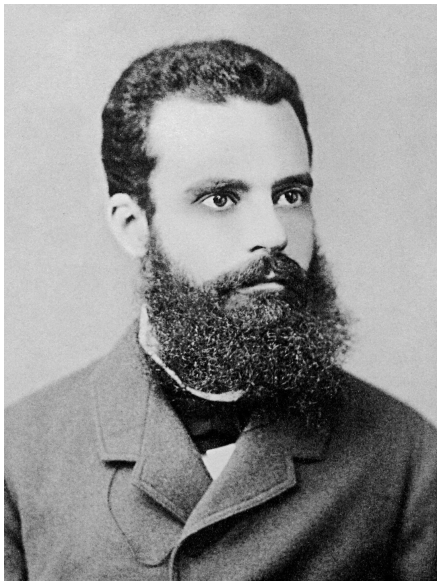
The monopolist is willing to shrink the size of the pie if they can secure a larger piece of the smaller one.

# From outcomes to principles

## Overview

- Markets create outcomes, but are these outcomes *fair*?
- Economists use *social welfare functions* to evaluate different outcome distributions.
- We now move from positive economics (what happens) to normative economics (what should happen).

# Pareto social welfare



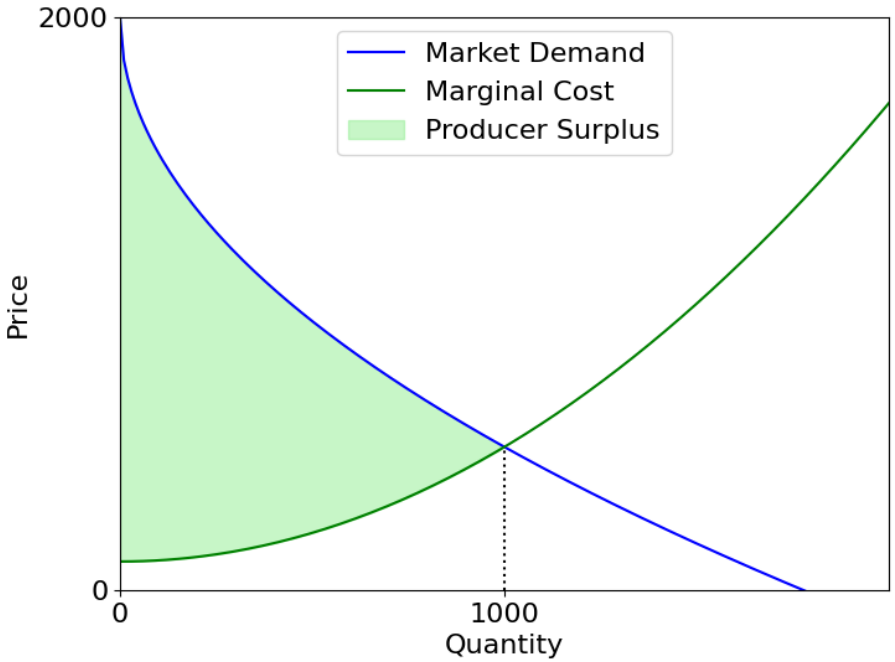
**Definitions:**

- **Pareto improvement**: A way to make some people better off without making anyone worse off.
- **Pareto efficient**: An allocation where no Pareto improvement is possible.
- **Weak notion**: Pure monarchy, pure communism both Pareto efficient.

Vilfredo Pareto (1906)

*People enjoy a maximum of ophelimity, when it is impossible to move a small step away such that the ophelimity enjoyed by each individual increases, or such that it diminishes.*

# Monopoly and price discrimination



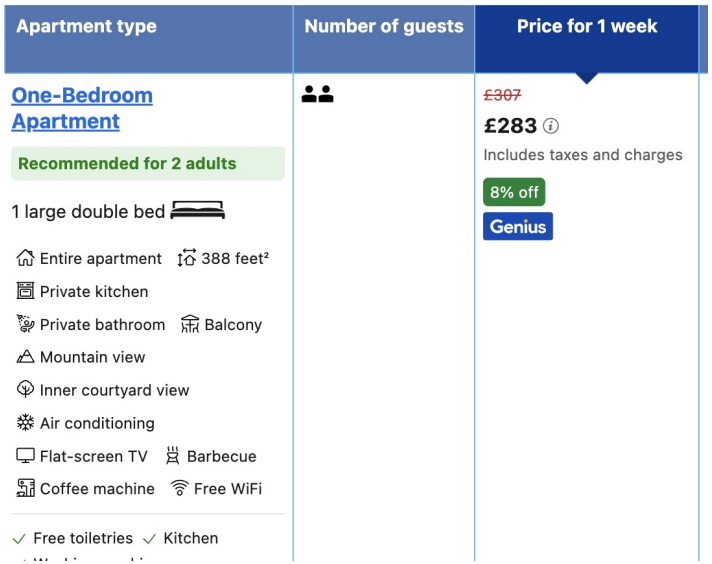

**Surpluses:**

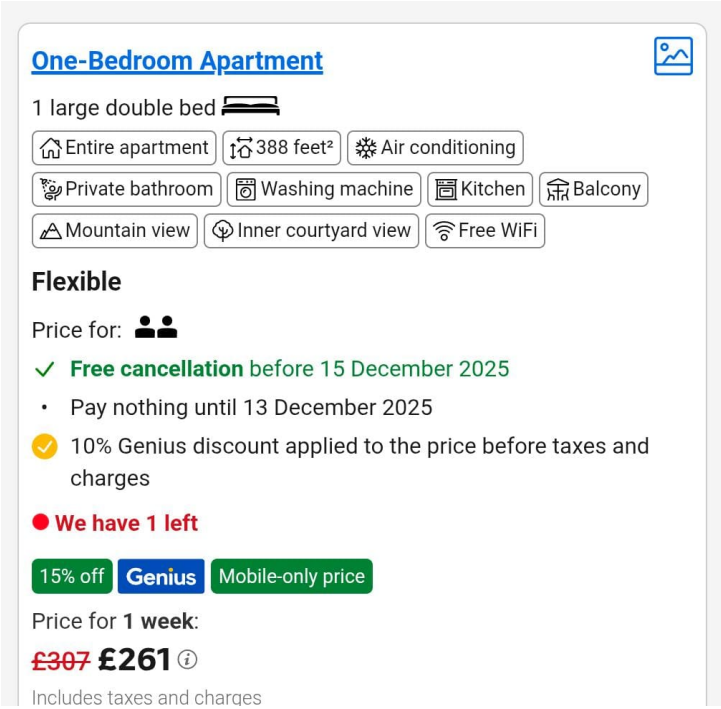
- Consumer surplus disappeared (blue area)
- Monopolist surplus maximised (green area)
- Total welfare unaffected
- Pareto efficient

## Discriminating monopolist reasoning

If you know what everyone can pay, charge them just that.

# An example of (partial) price discrimination




## Booking.com

Same hotel at higher prices on laptop vs. mobile. Digital markets make discrimination easy, algorithms can infer willingness to pay.

# Welfare economics fundamental theorems

## General vs. partial equilibrium

Partial equilibrium studies one market in isolation. General equilibrium studies the whole economy with interacting markets.

## 1st welfare theorem

Given fixed resources, competitive (market) equilibrium is Pareto efficient.

## 2nd welfare theorem

Any Pareto efficient allocation can be supported as a competitive (market) equilibrium for some endowments.

# Welfare theorem assumptions

**Assumptions needed:**

1. Everyone is a price-taker
2. No transaction costs
3. Perfect information
4. No externalities
5. Rational behaviour

# Welfare theorem assumptions

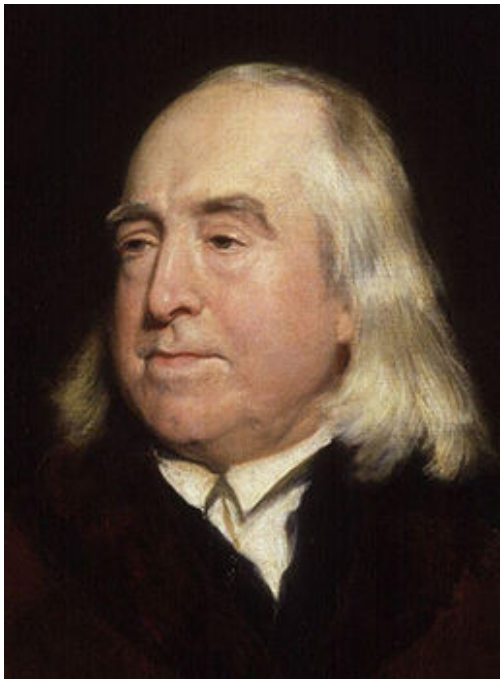
**Assumptions needed:**

1. Everyone is a price-taker
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**Assumptions violations:**

1. Monopoly, oligopoly
2. Search, bargaining
3. Asymmetric information
4. Environmental pollution
5. Mistakes, non-selfish

# Utilitarian social welfare: $W = \sum U_i$



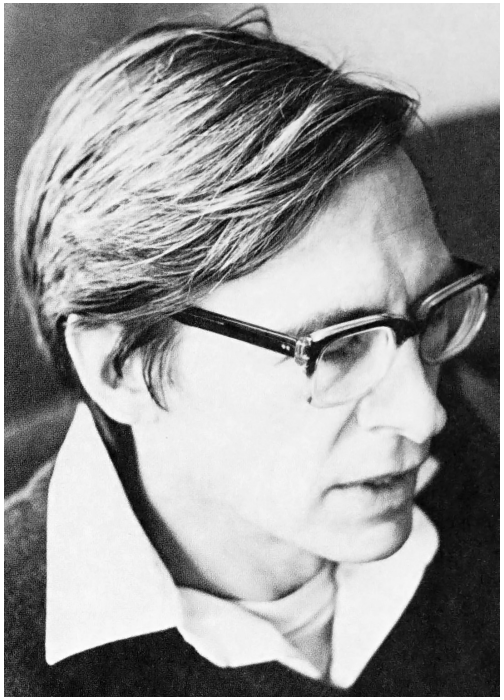
**Interpretation:**

- Maximising the total well-being of everyone
- Treats everyone's utility as equally weighted
- Large gains offset small losses
- Ignores inequality

Bentham (1789)

*It is the greatest happiness of the greatest number that is the measure of right and wrong.*

# Max-min social welfare: $W = \min\{U_i, U_2, \cdots, U_N\}$



**Interpretation:**

- Determined by the welfare of the worst-off
- Extreme focus on equity and justice
- Everyone sacrifices to help the least well-off
- Ignores potential large aggregate gains

Rawls (1971)

*Social and economic inequalities are to be arranged so that they are to the greatest benefit of the least advantaged.*

# Egalitarian social welfare: $W = \sum \frac{U_i^{1-\varepsilon}}{1-\varepsilon}$



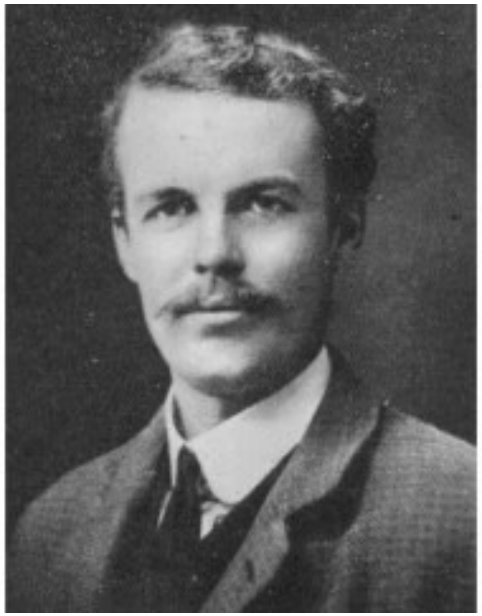
**Interpretation:**

- Balances utilitarian and max-min
- $\epsilon$ measures inequality aversion
- Hard to estimate $\epsilon$

Atkinson (1970)

*The level of utility per person that if everyone had it, gives the same welfare as the current distribution.*

# A more general social welfare principle





## Pigou–Dalton (1920)

Diminishing marginal utility means that transferring money from rich to a poor person generally increases social welfare.

# The challenge of defining fairness

## Different perspectives

- Utilitarian: maximise total happiness.
- Rawlsian: maximise the welfare of the worst-off.
- Atkinson: balance efficiency and equality.

**Question**

Can we design a *single rule* that fairly combines everyone's preferences?

# Fair social welfare is impossible



- **Unrestricted Domain:** Allows all possible preferences.
- **Pareto Efficiency:** If all prefer $X$ over $Y$, society must choose $X$.
- **IIA:** Ranking between $X$ and $Y$ depends only on $X$ and $Y$.
- **Non-Dictatorship:** No single person dictates the outcome.

## Arrow (1951)

*It is futile to search for a social welfare function which always makes a choice, does not exclude any outcome, and no single person ensures their preferred outcome.*

# Example: Pizza toppings paradox

3 hungry students must choose a pizza with **exactly one** topping: Pepperoni ($P$), Mushroom ($M$), or Bacon ($B$).

## Individual preferences

- **Student 1:** $P \succ M \succ B$
- **Student 2:** $M \succ B \succ P$
- **Student 3:** $B \succ P \succ M$

## Pairwise majority vote

- $P$ beats $M$ (2 vs 1)
- $M$ beats $B$ (2 vs 1)
- $B$ beats $P$ (2 vs 1)

Group preference: $P \succ M \succ B \succ P$

**Implication:** No matter which topping they order, 2 out of 3 students hate the choice; agreement mathematically impossible unless someone acts like a dictator or bans an ingredient.

# How should we measure social welfare today?

## Recent research

Modern economics studies not only inequality itself, but also whether people view the origins of inequality as fair.

- People's views on inequality depend strongly on how incomes are generated. Differences due to effort, education, or entrepreneurship are often viewed differently from differences due to luck, inheritance, or unequal opportunities.
- Researchers are developing new social welfare functions that combine concerns for efficiency with society's fairness preferences, allowing policy evaluation to reflect both outcomes and perceptions of justice.

*Examples: Saez & Stantcheva (2016); Kreiner, Hvidberg & Stantcheva (2023)*

# Summary and next lecture

## Lecture 1 summary

- Perfect competition maximises welfare under strong assumptions.
- Monopoly reduces total surplus but increases producer profits.
- Social welfare can be judged in multiple ways, but no rule satisfies all fairness criteria.

## Next time: How information markets are different

- Digital goods have zero marginal cost and network effects.
- Information asymmetries reshape competition.
- We explore why digital markets tend to concentrate power, even when they appear competitive.