Economics, Law and Ethics
Part IB CST 75%, Part II CST 50%
2021-22

Alice Hutchings, Richard Clayton

with many thanks to Ross Anderson
Overview

• Introduction:
  – Aims and objectives
  – Outline
  – Assessment
  – Resources
  – Roadmap

• Classical economics:
  – Prices and markets
  – Basic consumer theory
  – Supply and demand
  – Efficiency, welfare and justice
Why do you think Economics, Law, and Ethics is important to you, as a computer scientist?
Why teach this course?

• Systems: economics used in protocol design, congestion control, mechanisms like blockchain...

• Theory: the combinatorial auction is now seen as the archetypal complexity-theory problem

• Professional: over half of you will become entrepreneurs or go into consultancy, management

• Law: what can make you liable online?

• Ethics: how can you navigate the many grey areas?

• Course accreditation: requirement for CS
Aims and Objectives

Aims: introduce you to basic concepts in economics, law and ethics

Objectives: On completion of this course, students should be able to:

- Reflect on and discuss professional, economic, social, environmental, moral and ethical issues relating to computer science
- Define and explain economic and legal terminology and arguments
- Apply the philosophies and theories covered to computer science problems and scenarios
- Reflect on the main constraints that market, legislation and ethics place on firms dealing in information goods and services
Outline

• Classical economics and consumer theory
• How information markets are different
• Market failures and behavioural economics
• Auction theory and game theory
• Principles of law
• Law and the Internet (Richard Clayton)
• Ethics
• Contemporary ethical issues
Assessment

• Summative assessment:
  – Two examination questions in Paper 7
  – Essay style

• Formative assessment:
  – Supervisions
  – Interacting with your peers
Moodle

- Platform for dialogue with me, and with each other
- Place to ask questions and engage with the material
Interactive sessions

• Session 1: 10-11am, Tuesday 16 November
  – Prepare by watching lectures 1-4
• Session 2: 10-11am, Tuesday 30 November
  – Prepare by watching lectures 5-8
• Zoom link to be sent out beforehand
Resources

• Shapiro and Varian “Information Rules”
• Varian “Intermediate Microeconomics”
• Course website, plus as further reading:
  – Adam Smith, “The Wealth of Nations”
  – Richard Thaler, “Misbehaving”
  – William Poundstone, “Prisoners’ Dilemma”
  – Steven Pinker, “The Better Angels of our Nature”
  – Nuffield Bioethics Council report on biodata
Studying a humanities subject

• It’s not like learning to prove theorems or program in Java, which gives a testable skill
• Wide reading is important – ideas become clearer when approached from several perspectives
• College libraries are a good place to start
• Dig into some subproblem that interests you
• Work out different viewpoints: how would a socialist / Keynesian / environmentalist / libertarian approach a problem of interest?
Roadmap

• Economics as a subject is traditionally made up of macroeconomics, microeconomics and specialised topics
• ‘Macro’ is about the performance and structure of the global economy or a nation or region. It’s about models of employment, inflation, growth, investment, trade, savings, credit, tax, GNP…
• We will touch on this only occasionally
Roadmap (2)

• Microeconomics or ‘micro’ is about how individuals and firms react to incentives, how market mechanisms establish prices, and the circumstances in which markets can fail

• Many topics of interest to computer scientists & engineers include game theory, the economics of information, the economics of dependability, and behavioural economics (economics + psychology)

• Our tools range from mathematical models to empirical social science
Classical economics

• Interlocking models of consumption, production, labour, finance, etc., in a world of free competition
Prices and markets

• As an introduction to theories of prices, consumers and markets, consider an idealised market for flats in Cambridge

• Simplify to two types – one-bed flats in town, or house-shares in Cherry Hinton. People who can afford flats will rent them, and those who can’t will cycle to distant house-shares instead

• Assume that there are 1000 flats to rent, and that people vary in their ability / willingness to pay
Accommodation market

- So there might be 1 person prepared to pay £2000, 300 prepared to pay £1000, 1000 prepared to pay £500…
- With 1000 flats to let, the market equilibrium price $p^*$ is where the supply and demand curves cross, i.e. £500
Monopoly

- If the market is rigged, the cartel might restrict supply – 800 flats at £700 pm can earn more than 1000 at £500 pm
- This is inefficient! (there are empty flats which people would pay to rent)
- How can we formalise this?
Efficiency

• A monopolist might leave some flats empty despite people being prepared to pay for them

• Definitions
  – A *Pareto improvement* is a way to make some people better off without making anyone worse off
  – A *Pareto efficient allocation* is such that no Pareto improvement is possible

• This is weak: pure monarchy and pure communism are both Pareto efficient!

• Anyway, is there any way for the monopolist to find a Pareto efficient allocation?
Discriminating monopolist

• If you know what everyone can pay, charge them just that!
• This arrangement is Pareto efficient!
• The monopolist captures all the consumer surplus …
Consumer surplus

- Consumer surplus is the total amount people saved on their reservation price
- Ordinary monopoly: green area left to consumers
- The monopolist diminished surplus by A and B
- The discriminating monopolist gets the lot!
Basic consumer theory

- Examines mechanisms of choice
- Consumers choose ‘best’ bundle of goods they can afford
- Most of the time, two goods are enough – say books versus everything else
- Assuming a budget constraint $m, p_1x_1 + p_2x_2 \leq m$
- This gives a line on which choices must lie
Preferences

- We draw ‘indifference curves’ or ‘isoquants’ joining mutually indifferent points – that is, where the consumer prefers bundle \((x_1, x_2)\) equally to \((y_1, y_2)\).

- We assume they’re well behaved – the curves don’t cross. I.e. if \((x_1, x_2)\) is preferred when \((y_1, y_2)\) is affordable, then when \((y_1, y_2)\) is preferred, \((x_1, x_2)\) is not affordable (the ‘weak axiom of revealed preference’).
Perfect Substitutes

- Sometimes I just don’t care at all whether I have good 1 or good 2
- E.g.: Tesco’s sugar or Sainsbury’s sugar
- Such goods are called perfect substitutes
Perfect Complements

- Sometimes I want exactly the same quantity of good 1 and good 2
- E.g. left shoes and right shoes
- Such goods are called perfect complements

![Diagram showing perfect complements]
Bads

- There are some goods I’d rather avoid!
- But sometimes I have to consume some of a bad in order to enjoy some of a good
Marginal rate of substitution

- The tangent to an isoquant gives the marginal rate of substitution (MRS)
- This is the exchange rate at which the consumer will trade the two: $\text{MRS} = \frac{\Delta x_1}{\Delta x_2}$
- Convex curves: you’re more likely to trade the good if you have more of it
Diminishing MRS

• The more you have of $x_1$ relative to $x_2$, the more likely you are to trade $x_1$ for $x_2$, in the strictly convex case

• i.e. you become less willing to pay for ‘one more’
Utility

• Often indifference curves can be parametrised
• Marginal utility $MU_1 = \frac{dU}{dx_1}$
• Then $MRS = -\frac{MU_1}{MU_2}$
• Utility functions can be useful for describing consumer choices
• They can often be inferred from shopping behaviour, and answer questions about the value of better / faster / …
The marginalist revolution

• Until 1871, no-one had a good theory of supply and demand. Why are essentials like water cheap, while diamonds are expensive?

• Solution: the value of the last and least wanted addition to your consumption of a good sets its value to you (Karl Menger, Stanley Jevons, 1871)

• Shifted thinking from costs of production to demand, and led to ‘classical synthesis’ of Marshall and others – interlocking models of consumption, production, labour, finance etc in a world of free competition
Concrete example

- Suppose a local coal market in 1840 had three typical suppliers / customers

<table>
<thead>
<tr>
<th>Supplier Type</th>
<th>Market Price</th>
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<tbody>
<tr>
<td>Sea coal gathering</td>
<td>8s</td>
</tr>
<tr>
<td>Blacksmiths</td>
<td>15s</td>
</tr>
<tr>
<td>Small deep mine</td>
<td>5s</td>
</tr>
<tr>
<td>Households</td>
<td>8s</td>
</tr>
<tr>
<td>Open-cast mine</td>
<td>2s</td>
</tr>
<tr>
<td>Export</td>
<td>3s</td>
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- The market price determines who produces and who consumes
- It’s determined by the marginal transaction
- It fluctuates with demand (weather) and can evolve in the long term with tech, investment…
Demand

• Assuming functions well-behaved, we can get a consumer’s demand from their utility or vice versa.

• Market demand is the sum of demand over consumers.

• In general a price change will have a substitution effect (if beer goes up, drink more wine) and an income effect (if rent goes up, you’re poorer).

• At the level of this course, we can ignore this…
Elasticity

- Given a market demand curve, elasticity measures the effect on demand of a small change in price.
- Formally, \( \varepsilon(p) = \frac{\Delta q/q}{\Delta p/p} = \frac{p\Delta q}{q\Delta p} \)
- Elasticity = 1 means there are likely to be substitutes.
- Revenue \( R = pq \), so
  \[ \frac{\Delta R}{\Delta p} = q + p \frac{\Delta q}{\Delta p} \]
  \[ = q \left( 1 + \varepsilon(p) \right) = q (1 - |\varepsilon(p)|) \]
- Key fact: price increases boost revenue iff \( |\varepsilon(p)| < 1 \)
Supply

• Firms typically have fixed costs and variable costs, so the average cost of goods initially falls with output.
• The variable costs typically rise at some point (overtime etc) and eventually rise sharply due to capacity constraints.
• Thus the supply curve typically takes the above convex shape, at least in the short run (static analysis).
Cost evolution

• In the long run, firms can fix capacity constraints by building more factories
• This gives nearly constant fixed costs and thus constant returns to scale as the firm / industry expands
Firm supply

- In a competitive market, firms are price takers
- The demand curve faced by each firm is in black – at any price above \( p^* \), demand is zero, while at any price below \( p^* \), the firm would face all the demand
- The firm’s profit is maximised when it sets output so that its marginal cost equals the price \( p^* \)
Putting it all together

- In the classical synthesis, prices are set where supply and demand curves intersect in competitive markets.
- Key: $p^*$ will be the marginal cost of the marginal supplier.
- Similar models apply in markets for labour etc.
- Intrinsic advantages of non-marginal suppliers (e.g. easily mined coal, good farmland) get built into rental values.
- By 100 years ago, people thought they understood the ‘invisible hand’ and just had to guard against monopoly.
Equilibrium

• Studying supply and demand for one good is ‘partial equilibrium analysis’. ‘General equilibrium analysis’ adds in labour, capital etc

• First theorem of welfare economics: market equilibrium is Pareto optimal

• Second theorem: any Pareto optimal allocation can be achieved by market forces provided preferences are convex

• Arrow and DeBreu, 1948. Technical conditions include rational actors, property rights, complete information, no transaction costs … (more later)
Efficiency, welfare and justice

• Efficiency does not imply justice! Giving the king all the money is Pareto efficient
• Different theories of justice are consistent with different welfare functions
  – $W = \Sigma U_i$ is classical utilitarian welfare
  – $W = \min U_i$ is Rawlsian welfare – that of the most miserable citizen
• Pigou: diminishing marginal utility of money means that transferring £1 from a rich man to a poor one will generally increase welfare
• But – there’s a methodological problem!
Efficiency, welfare and justice (2)

- Composing utilities into welfare is hard!

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<th>A</th>
<th>B</th>
<th>C</th>
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<tbody>
<tr>
<td>First</td>
<td>X</td>
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<td>Second</td>
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<td>Third</td>
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- Arrow’s impossibility theorem says there is no perfect way to aggregate personal choices into social welfare that’s consistent with democracy
Transaction costs

• Trades are not free! Time & effort; commissions; search; bargaining; policing and enforcement
• Ronald Coase (1937): why do some sectors have large companies, and others small ones? External transaction costs higher than internal ones
• Jensen-Mockling (1976): agency costs within firms also matter hugely
• Oliver Williamson (1980s-90s): incomplete contracts: frequency, specificity, uncertainty, limited rationality, opportunistic behavior
• So should tech make firms smaller on average?