Economics, Law and Ethics
Part IB CST 75%, Part II CST 50%
2020-21

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with many thanks to Ross Anderson
Overview

• Introduction:
  – Aims and objectives
  – Outline
  – 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: ethics now mandatory for CS and economics for engineers
Aims and Objectives

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

• Objectives: at the end, you should have a basic appreciation of economic and legal terminology and arguments; understand some of the applications of economic models to systems engineering and their interest to theoretical computer science; and understand the main constraints that markets, 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
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
Moodle

• Platform for dialogue with me, and with each other

• Place to ask questions and engage with the material
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?
- Write proper essays!
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
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 $\text{MU}_1 = \frac{dU}{dx_1}$
- Then $\text{MRS} = -\frac{\text{MU}_1}{\text{MU}_2}$
- 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>Sea coal gathering</th>
<th>8s</th>
<th>Blacksmiths</th>
<th>15s</th>
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<tbody>
<tr>
<td>Small deep mine</td>
<td>5s</td>
<td>Households</td>
<td>8s</td>
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<td>Open-cast mine</td>
<td>2s</td>
<td>Export</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, $\varepsilon(p) = (\Delta q/q)/(\Delta p/p) = p\Delta q/q\Delta p$.
- Elasticity = 1 means there are likely to be substitutes.
- Revenue $R = pq$, so $\frac{\Delta R}{\Delta p} = q + p \frac{\Delta q}{\Delta p}$.
- $\Delta R/\Delta p = q + p \frac{\Delta q}{\Delta p}$
  $= q (1 + \varepsilon(p)) = q (1 - |\varepsilon(p)|)$
- Key fact: price increases boost revenue iff $|\varepsilon(p)| < 1$. 

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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).
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.
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 $p^*$. 

Firm supply
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
  – $W = \sum U_i$ 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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• 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?