

Economics, Law and Ethics

CST part 1b, 2018–9

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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

- Game theory: prisoners' dilemma, iterated games
- Classical economics with competitive markets
- Market failures – monopoly, asymmetric information, network effects, lock-in
- How information markets are different
- Auction theory and mechanism design
- Principles of law
- IT law (Richard Clayton, November 22nd)
- Ethics – where the law hasn't made up its mind

Resources

- Shapiro and Varian “Information Rules”
- Varian “Intermediate Microeconomics”
- Course website, plus as further reading:
 - Adam Smith, “The Wealth of Nations”
 - Richard Thaler, “Misbehaving”
 - JK Galbraith, “A History of Economics”
 - 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?
- Write proper essays! (Essay writing class in Lent)

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

Cooperation or conflict

- One way of getting what you want is to make it, or make something else of value and trade for it – ‘Economics’
- Another way is to just take it, whether by force or via the ballot box – ‘Politics’
- Choices between cooperation and conflict are made at all sorts of levels all the time
- They can evolve in complex combinations
- The main tool we use to analyse them is game theory

Game theory

- The study of problems of cooperation and conflict among independent decision-makers
- We focus on games of strategy, rather than chance
- We abstract to players, choices, payoffs, strategies
- There are
 - games of perfect information (such as chess and go)
 - games of imperfect information (which are often more interesting to analyse)

Strategic form

- Example: matching pennies. Alice and Bob throw H or T. If they're different, Alice gets Bob's penny; else he gets hers. The strategic form is

		Bob	
		H	T
Alice	H	-1, 1	1, -1
	T	1, -1	-1, 1

- This is an example of a zero-sum game: Alice's gain = Bob's loss

Dominant strategy equilibrium

- In the following game, Bob's better off playing left; similarly Alice is always better off playing bottom

		Bob	
		Left	Right
Alice	Top	1, 2	0, 1
	Bottom	2, 1	1, 0

- A strategy is an algorithm: input state, output play
- Here, each player's optimal play is a constant
- This is called a 'dominant strategy equilibrium'

Nash equilibrium

- Consider this game:

		Bob	
		Left	Right
Alice	Top	2, 1	0, 0
	Bottom	0, 0	1, 2

- Each player's optimal strategy depends on what they think the other will do
- Two strategies are in Nash equilibrium when A's choice is optimal given B's, and vice versa
- Here there are two: top left and bottom right
- This game is sometimes called 'Battle of the sexes'

Pure v mixed strategies

- With deterministic algorithms, some games have no Nash equilibrium

		Bob		
		scissors	paper	stone
Alice	scissors	0	1, -1	-1, 1
	paper	-1, 1	0	1, -1
	stone	1, -1	-1, 1	0

- Alice plays scissors \rightarrow Bob will play stone \rightarrow Alice will play paper ...
- Fix: randomised algorithm. Called a 'mixed' strategy; deterministic algorithms are called 'pure'

Prisoners' dilemma

- Two prisoners are arrested on suspicion of planning a robbery. The police tell them separately: if neither confesses, one year each for gun possession; if one confesses he goes free and the other gets 6 years; if both confess then each will get 3 years

		Benjy	
		confess	deny
Alfie	confess	-3, -3	0, -6
	deny	-6, 0	-1, -1

- (confess, confess) is the dominant strategy equilibrium
- It's obviously not optimal for the villains!
- Is this a problem? If so, what's the solution?

Prisoners' dilemma (2)

- You might answer 'serves them right'!
- But this can't apply to all instances of the dilemma
 - Defence spending
 - Fishing quotas
 - Free riders in file-sharing systems
 - Reducing carbon emissions
 - ...
- Tough but inescapable conclusion: if the game is truly as described, there is no escape. Both will cheat rather than cooperate, with bad outcome
- To fix it, you need to change the game somehow!

The evolution of cooperation

- If PD played repeatedly, there's a fix!
- 'Tit-for tat': cooperate at round 1, then at round n do what the other guy did at $n-1$
- Simulation competitions run by Bob Axelrod played off many iterated-game strategies; tit-for-tat did consistently well
- In the presence of noise, tit-for-tat gets locked into (defect, defect). So: forgive the other guy occasionally
- People have realised in the last 30 years or so that strategy evolution explains a lot of behaviour

Price-fixing

- If it costs \$250 to fly someone LHR-JFK, do airlines compete and charge \$255 or collude and charge \$500?
- Competition laws forbid price-fixing cartels, but the same behaviour can arise implicitly
- Try charging \$500 and see what other airlines do. If they 'defect' by competing, play tit-for-tat
- If you're the regulator, how do you cope?

Stag hunt

- People can hunt rabbits on their own, but have to work together to hunt a stag. If your buddy runs off after a rabbit, the stag will escape

		Frank	
Bernard		chase hare	hunt stag
	chase hare	2, 2	5, 0
	hunt stag	0, 5	10, 10

- Difference from PD: (stag, stag) is now a Nash equilibrium
- You'll only chase a rabbit if you believe your buddy will defect
- Thus while PD is payoff-dominant, stag hunt is risk-dominant

Volunteer's dilemma

- Multi-player chicken: if one person volunteers, everyone else benefits, but if no-one volunteers then everyone suffers a big loss

		Everyone else	
		someone acts	no-one acts
Me	act	benefit - cost	benefit - cost
	don't act	benefit	big loss

- The Arab Spring: “If everyone goes on the street and says ‘the government is finished’, it’s finished. If you go on the street and say ‘the government is finished’, you’re finished”
- Evolution of leadership: first move = fitness signal

Chicken

- In 'Rebel without a cause', Jim (James Dean) and Buzz (Corey Allan) drive stolen cars at a canyon and try to jump out last to prove their manhood

		Jim	
		jump	drive on
Buzz	jump	2, 2	1, 3
	drive on	3, 1	0, 0

- Here, (1,3) and (3,1) are Nash equilibria
- Bertrand Russell suggested this as a model of nuclear confrontation in the Cold War
- But what about the iterated version?

Game theory and evolution

- John Maynard Smith proposed the 'Hawk-dove' game as a simple model of animal behaviour. Consider a mixed population of aggressive and docile individuals:

	Hawk	Dove
Hawk	$(v-c)/2, (v-c)/2$	$v, 0$
Dove	$0, v$	$v/2, v/2$

- Food v at each round; doves share; hawks take food from doves; hawks fight (with risk of death c)
- If $v > c$, whole population becomes hawk (dominant strategy)
- What happens if $c > v$?

Game theory and evolution (2)

- If $c > v$, a small number of hawks will prosper as most interactions will be with doves. Equilibrium reached at hawk probability p setting hawk payoff = dove payoff

	Hawk	Dove
Hawk	$(v-c)/2, (v-c)/2$	$v, 0$
Dove	$0, v$	$v/2, v/2$

- I.e. $p(v-c)/2 + (1-p)v = (1-p)v/2$
 $\Leftrightarrow pv - pc + 2v - 2pv = v - pv$
 $\Leftrightarrow -pc = -v$
 $\Leftrightarrow p = v/c$

Broader implications

- Nash, Axelrod, Maynard Smith and others opened up many applications
- Politics: models of conflict, and of when religions are dominated by fundamentalists
- Criminologists: model the Mafia as alternative contract enforcement, and tattoos as signalling
- Computer science: how do you get AS operators to tell the truth about Internet routing? How do you get them to secure BGP? Will bitcoin converge, fork or collapse? ...

Broader implications (2)

- In pre-state societies, if you see a man you don't recognise, you'd better kill him first (Diamond, "The World Until Yesterday")
- Now we live in largely peaceful societies (Pinker, "The Better Angels of our Nature")
- Evolutionary basis of morality: fairness from tit-for-tat, hierarchy from hawk-dove, maybe conservative / liberal preferences too (Haidt)
- Cooperation developed by states, religions, literature, markets, rights, TV ...

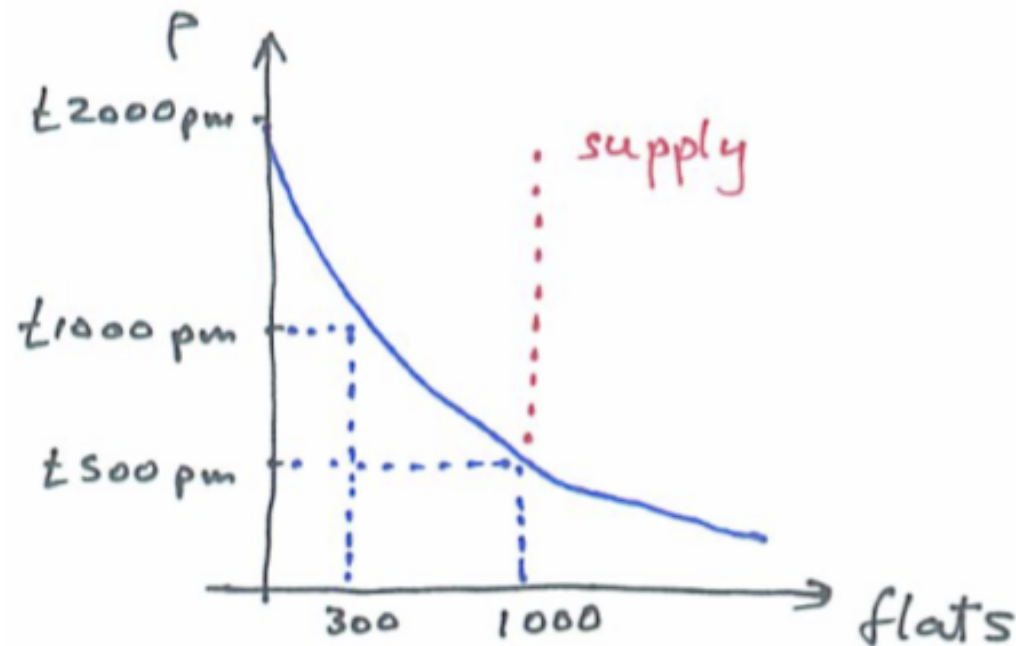
Broader implications (3)

- If institutions that involve social cooperation are replaced by online mechanisms, what happens then?
- TV caused people to become more solitary when it replaced clubs, churches and pubs as the social focus (“Bowling Alone”)
- What if more of our cooperative social mechanisms are replaced by echo chambers?
- The spread of broadband was correlated with a rise in political polarisation...

Prices and markets

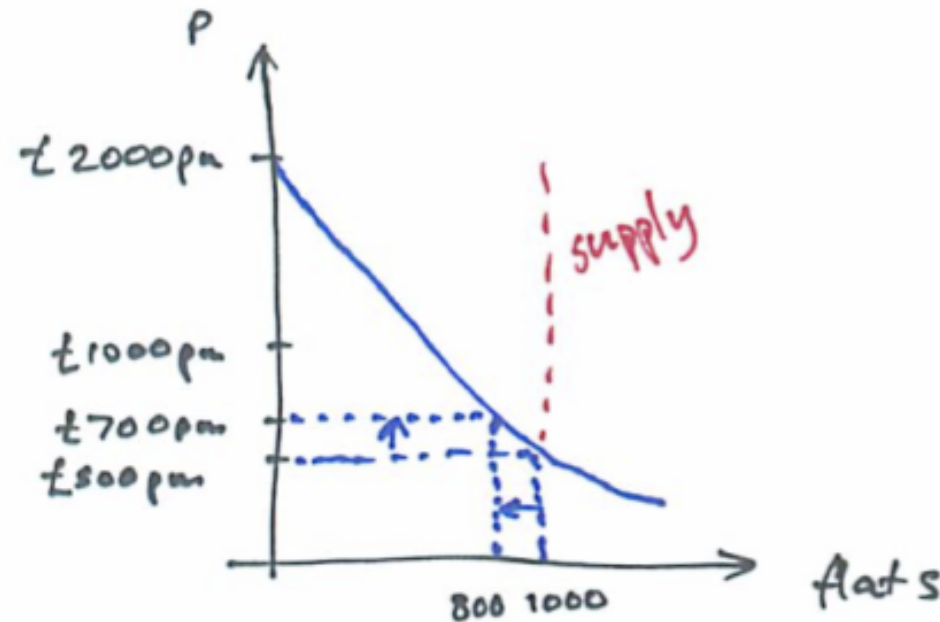
- As an introduction to theories of prices, consumers and markets, consider an idealised market for flats in Cambridge
- Simplify to two types – one-bed flats in town, or house-shares in Cherry Hinton. People who can afford flats will rent them, and those who can't will cycle to distant house-shares 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 $\pounds 2000$, 300 prepared to pay $\pounds 1000$, 1000 prepared to pay $\pounds 500$...
- With 1000 flats to let, the market equilibrium price p^* is where the supply and demand curves cross, i.e. $\pounds 500$

Monopoly

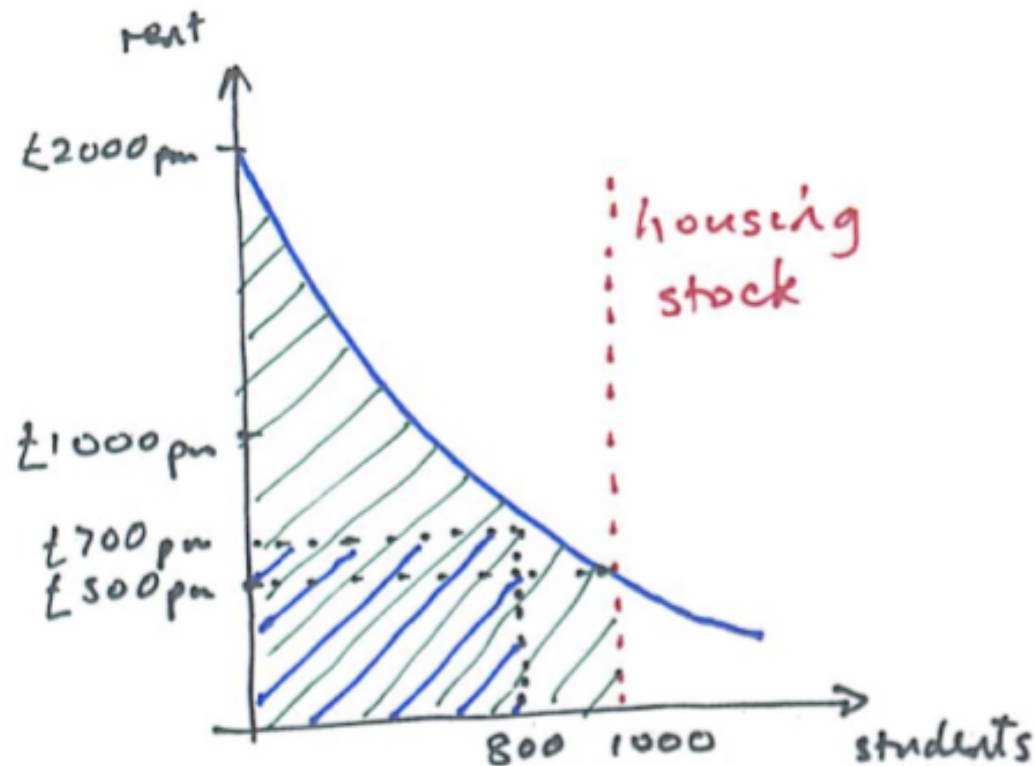


- If the market is rigged, the cartel might restrict supply – 800 flats at £700 pm can earn more than 1000 at £500 pm
- This is inefficient! (there are empty flats which people would pay to rent)
- How can we formalise this?

Efficiency

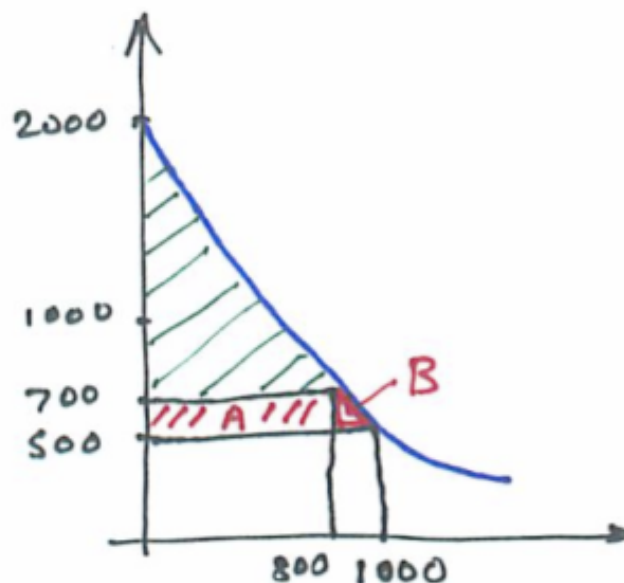
- A monopolist might leave some flats empty despite people being prepared to pay for them
- Definitions
 - A *Pareto improvement* is a way to make some people better off without making anyone worse off
 - A *Pareto efficient allocation* is such that no Pareto improvement is possible
- This is weak: pure 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



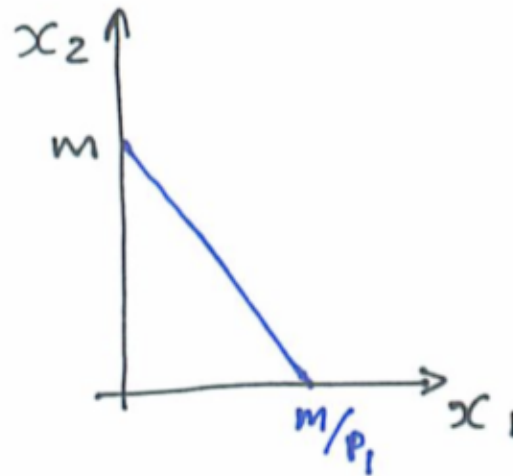
- Consumer surplus is the total amount people saved on their reservation price
- Ordinary monopoly: green area left to consumers
- The monopolist diminished surplus by A and B
- The discriminating monopolist gets the lot!

Monopoly and technology

- Monopolies are common in the information goods and services industries
- We'll study why in some detail later
- For now, monopolists have an incentive to price discriminate, to mop up all the available surplus
- Hence the many prices of Windows!
- But it's not just tech. Think airline tickets, cars, and even food.
- So what factors determine the structure of markets?

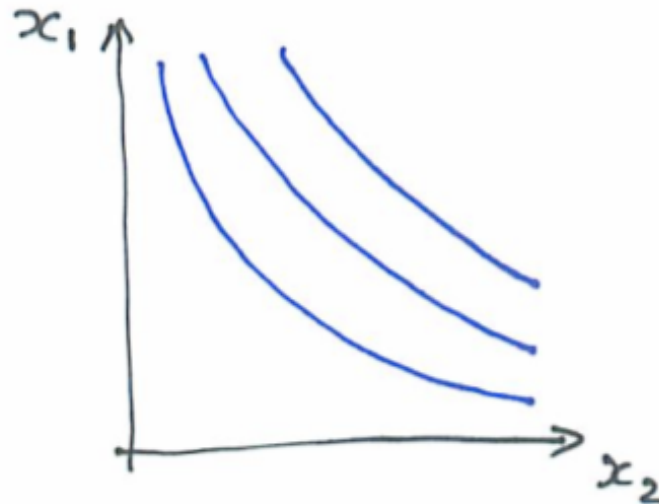
Basic consumer theory

- 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



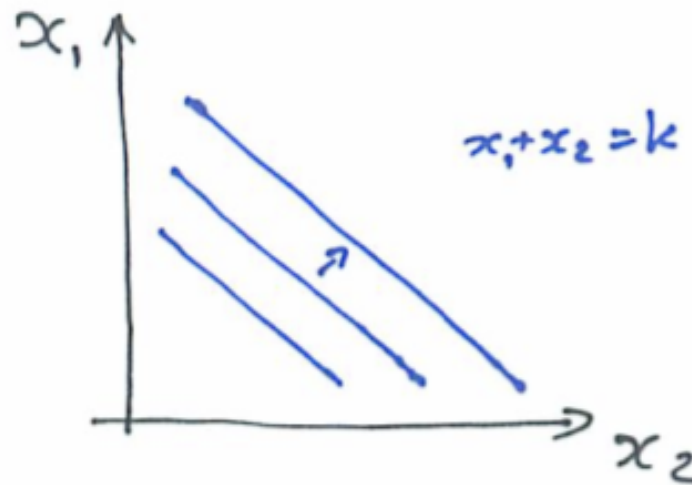
Preferences

- 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')



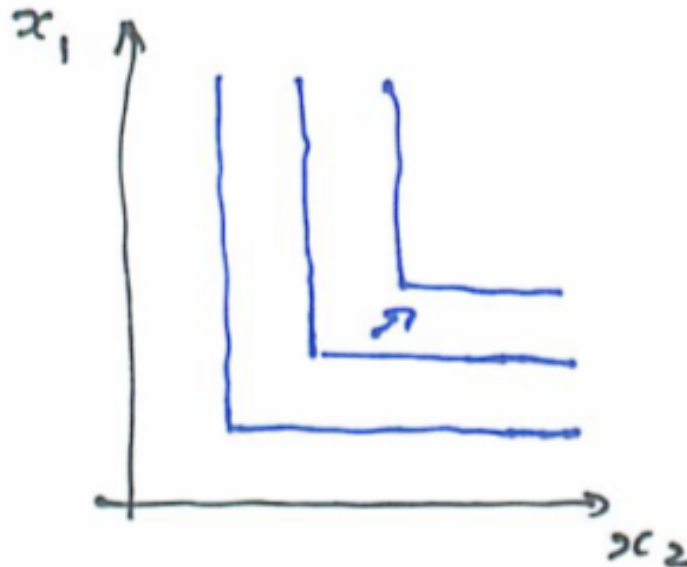
Substitutes

- 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 substitutes



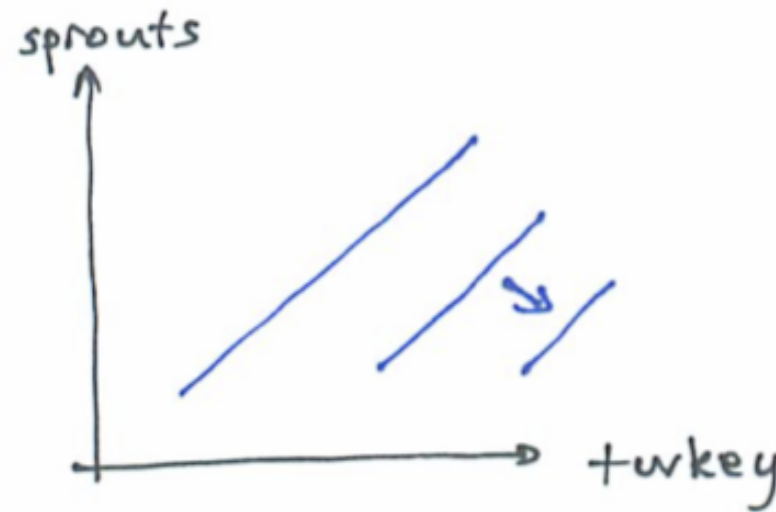
Complements

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



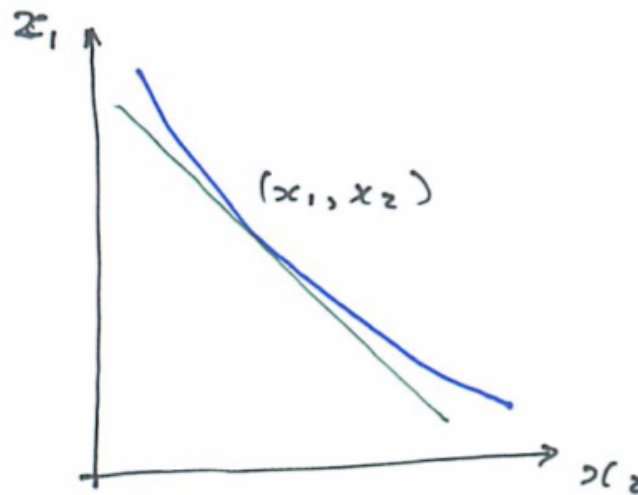
Bads

- 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



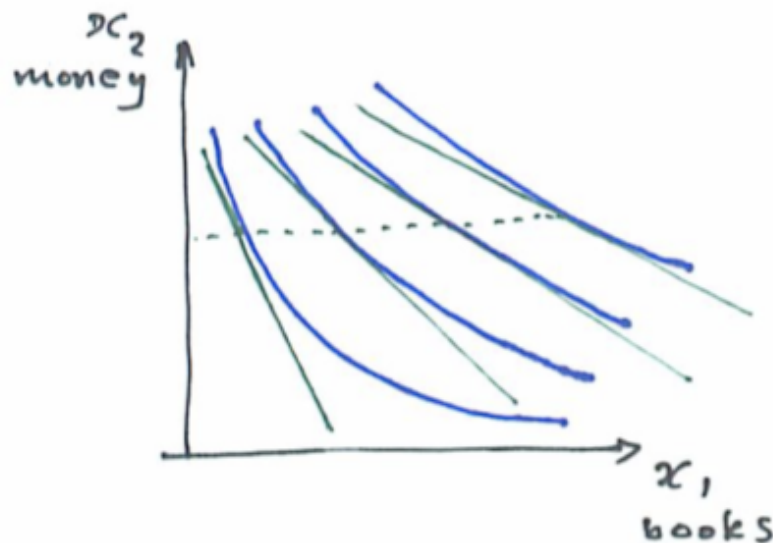
Marginal rate of substitution

- 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: $MRS = \Delta x_1 / \Delta x_2$
- Convex curves: you're more likely to trade the good if you have more of it



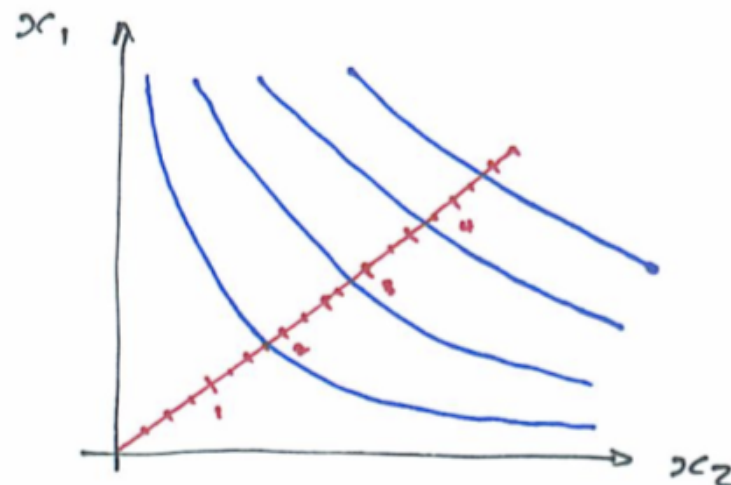
Diminishing MRS

- 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'



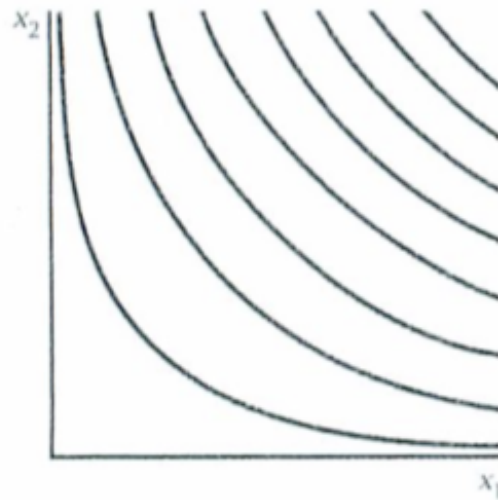
Utility

- Often indifference curves can be parametrised
- Marginal utility $MU_1 = dU/dx_1$
- Then $MRS = -MU_1/MU_2$
- 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 / ...

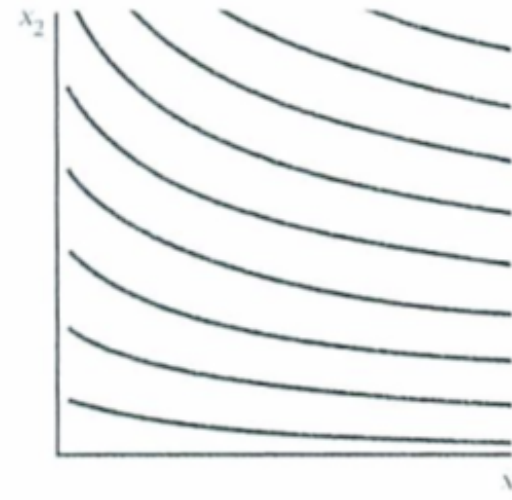


Cobb-Douglas utility

- Commonly used: $U(x_1, x_2) = x_1^c x_2^d$
- If the utility is believed to depend on a number of observed factors, take logarithms and look for a fit



A $c = 1/2$ $d = 1/2$



B $c = 1/5$ $d = 4/5$

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

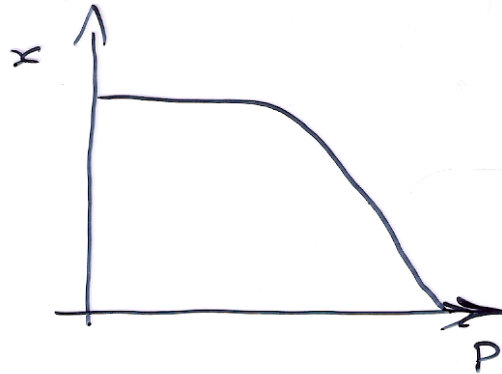
Concrete example

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

Sea coal gathering 8s	Blacksmiths 15s
Small deep mine 5s	Households 8s
Open-cast mine 2s	Export 3s

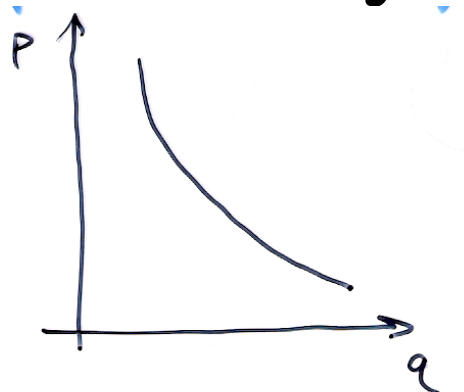
- The market price determines who produces and who consumes
- It's determined by the marginal transaction
- It fluctuates with demand (weather) and can evolve in the long term with tech, investment...

Demand



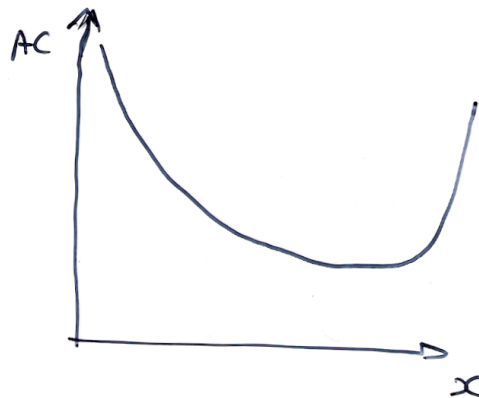
- Assuming functions well-behaved, we can get a consumer's demand from their utility or vice versa
- Market demand is the sum of demand over consumers
- In general a price change will have a substitution effect (if beer goes up, drink more wine) and an income effect (if rent goes up, you're poorer)
- At the level of this course, we can ignore this...

Elasticity



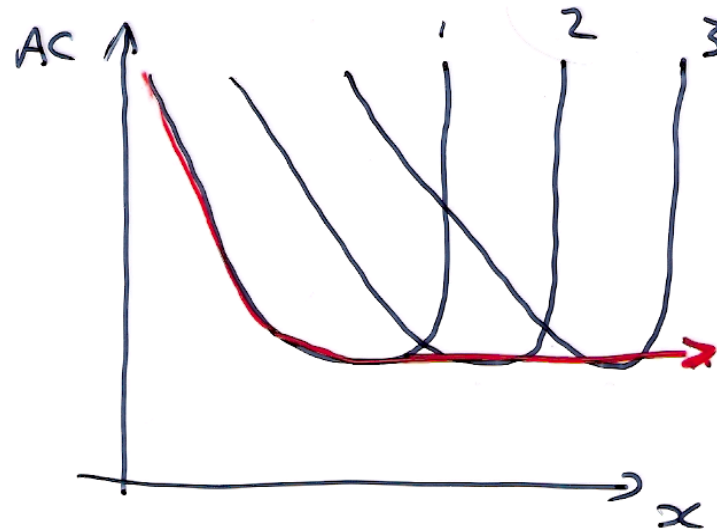
- Given a market demand curve, elasticity measures the effect on demand of a small change in price
- Formally, $\epsilon(p) = (\Delta q/q)/(\Delta p/p) = p\Delta q/q\Delta p$
- Elasticity = 1 means there are substitutes
- Revenue $R = pq$, so
$$\begin{aligned}\Delta R/\Delta p &= q + p \Delta q/\Delta p \\ &= q (1 + \epsilon(p)) = q (1 - |\epsilon(p)|)\end{aligned}$$
- Key fact: price increases boost revenue iff $|\epsilon(p)| < 1$

Supply



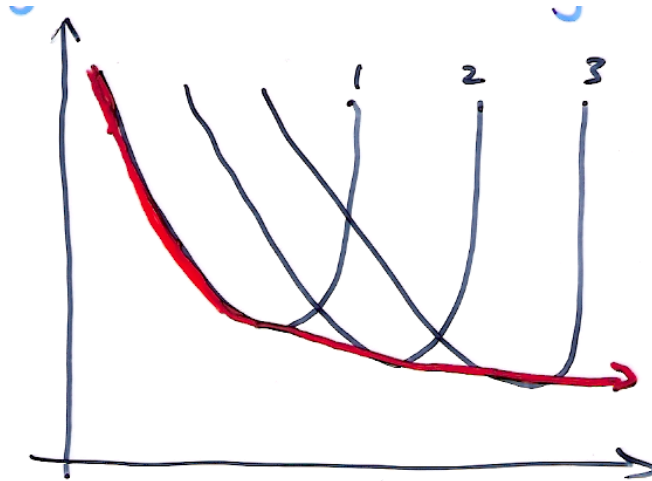
- Firms typically have fixed costs and variable costs, so the average cost of goods initially falls with output
- The variable costs typically rise at some point (overtime etc) and eventually rise sharply due to capacity constraints
- Thus the supply curve typically takes the above convex shape, at least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

Cost evolution



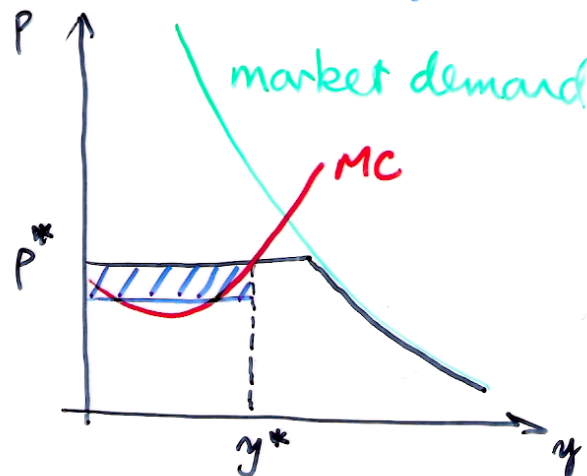
- In the long run, firms can fix capacity constraints by building more factories
- This gives nearly constant fixed costs and thus constant returns to scale as the firm / industry expands

Effects of technology



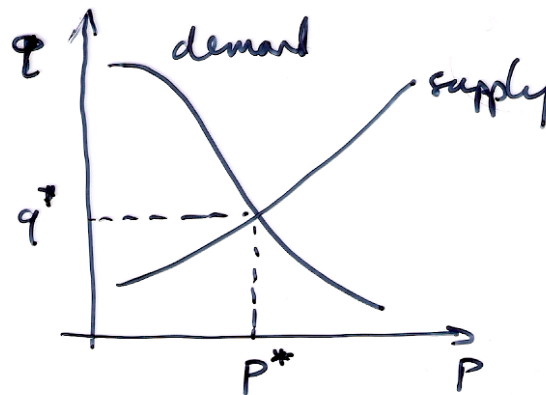
- In a traditional industry, technology can improve the process; larger / newer factories may be better
- Some industries have natural limits (not everyone wants to drive a Ford)
- In information goods and services industries, marginal costs may never rise – so firms like Microsoft enjoy ever-increasing returns to scale

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
 - $W = \sum U_i$ 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!

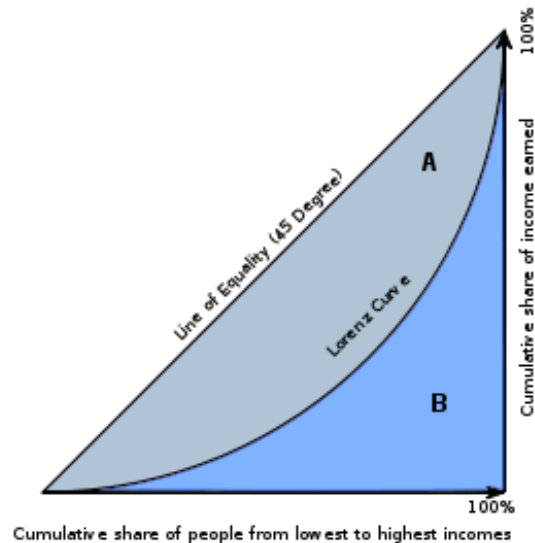
Efficiency, welfare and justice (2)

- Composing utilities into welfare is hard!

	A	B	C
First	X	Y	Z
Second	Y	Z	X
Third	Z	X	Y

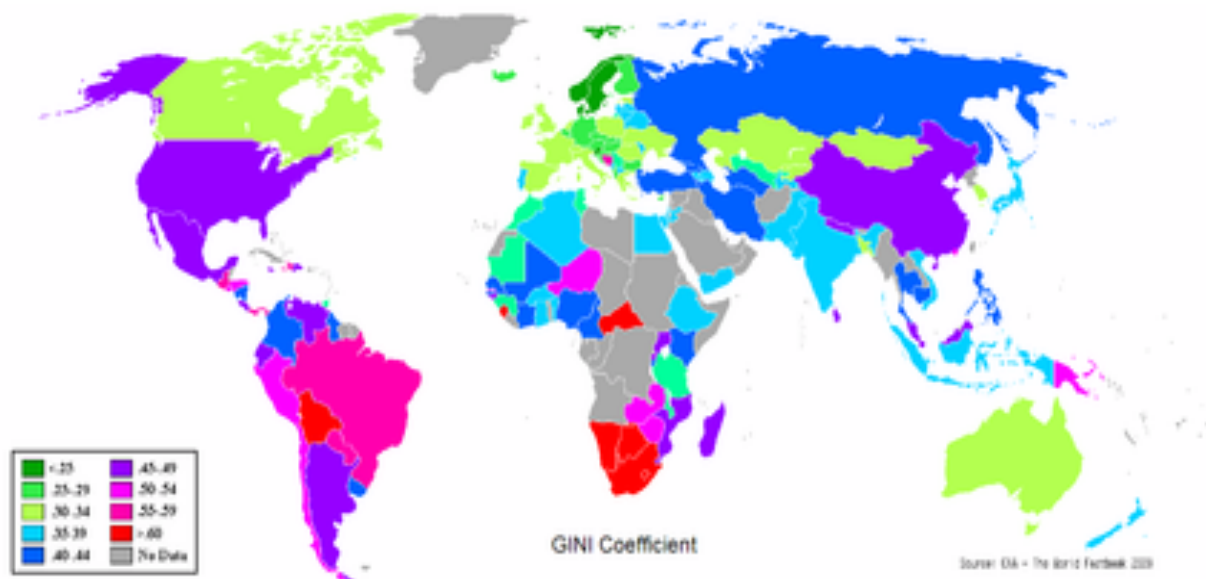
- Arrow's impossibility theorem says there is no perfect way to aggregate personal choices into social welfare that's consistent with democracy

Income distribution



- The Gini coefficient is used to measure inequality
- $Gini = A/(A+B)$ in the above graph where B is the cumulative income distribution
- Gini = 0: communism; Gini = 1: the king has the lot

Income distribution (2)

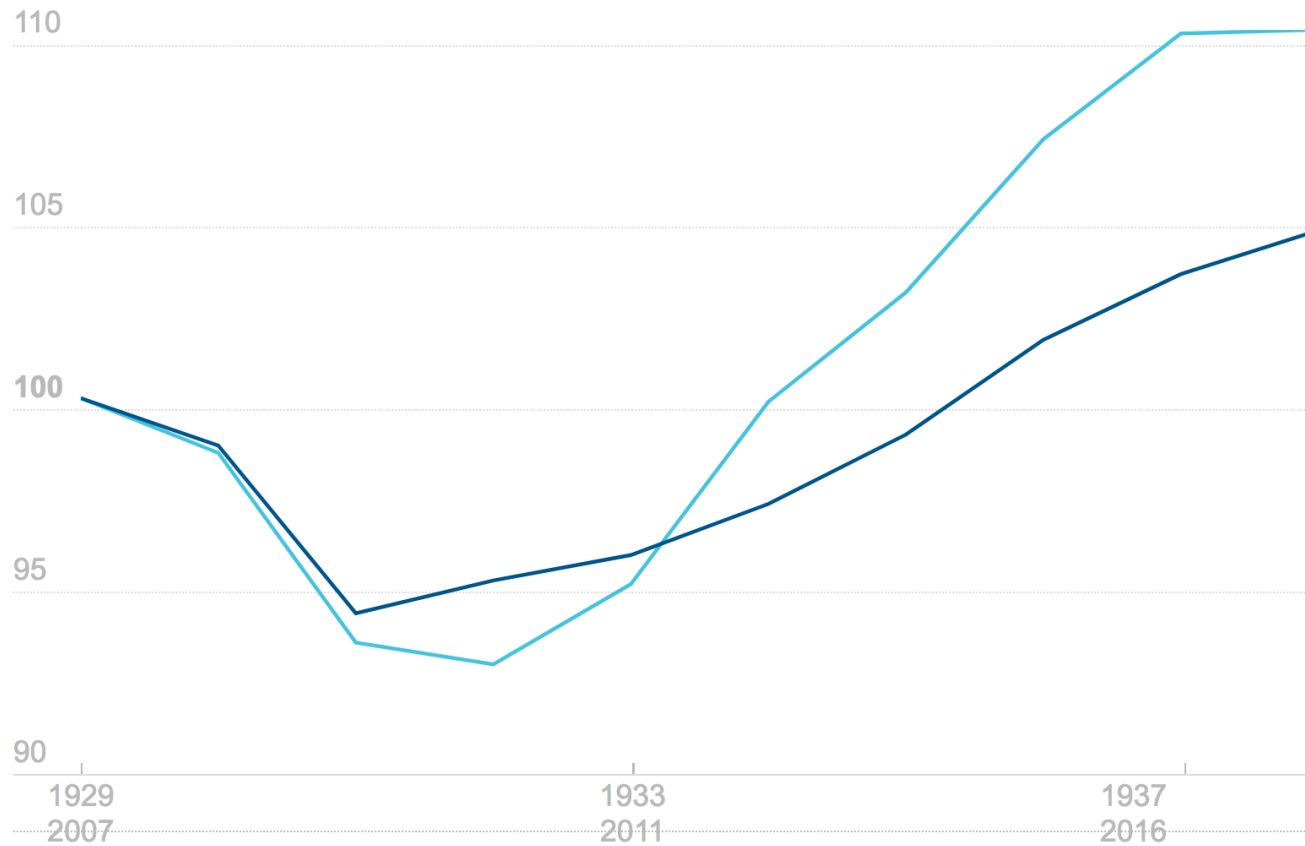


- Generally speaking, Gini falls with development
- Ranges from 0.247 in Denmark to .707 in Namibia
- Conflict theory explanation: over time, the poor fight harder for welfare than the rich resist them
- Democracy cuts both ways though: e.g. farm subsidy that gives each farmer £20000 but costs each nonfarmer £200 ⁵⁶

The Business Cycle

GDP per 20- to 64-year-old. Index, 100 = level in pre-recession year

■ 1929-1938 ■ 2007-2016



Guardian graphic | Source: House of Commons Library, Bank of England, Central Statistics Office, ONS

The business cycle (2)

- The business cycle was a puzzle for classical economists. Why the pattern of boom and bust?
- Say's law: supply and demand are equal
- Mill and Ricardo argued that demand for goods + savings = supply of goods + investment, and savings = investment, so demand = supply
- 1930s: Keynes' more sophisticated model of 'liquidity preference'. People want a certain level of savings – maybe 3 months' salary. In a recession, liquidity preference rises
- Many other dynamic effects, different timescales...

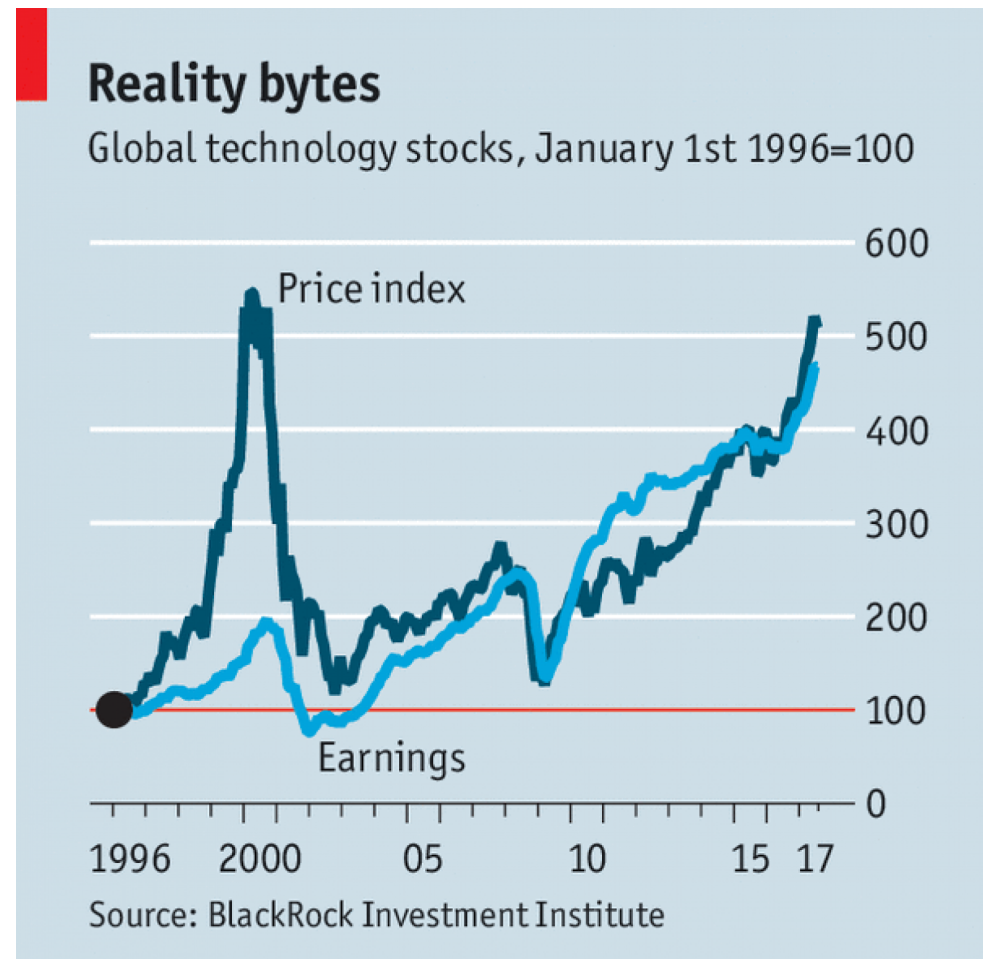
The business cycle (3)

- Credit actually introduces instability
- In a boom, people and firms borrow assets that appreciate faster than the interest they pay
- A bank that takes in £100 in deposits might lend out £94; so £6 of capital underwrites £94 of lending – a multiplier of $94/6 = 15.7$
- In a recession many things happen at once:
 - Some loans go bad, eating into capital
 - The bank's share price falls, further eating capital
 - The regulator raises capital requirements from 6% to 8%
 - The government competes for the available loans
- So the money supply could contract sharply
- This time round, governments fixed that (quantitative easing)

Recession and tech

- Great Recession kicked off by US mortgage crisis of 2007 which led to collapse of money markets
- Recessions may be fed by bubbles bursting but are often tied up with technology change
- Railways 1840s, electricity 1880s, cars 1920s, tech now – boom creates capacity, bust slashes prices
- We've killed whole industries (telephone switchgear), taken over others (bookselling), marginalized others (local newspapers, music publishers) and are disrupting most of the rest
- Schumpeter: 'creative destruction'

Recession and tech (2)



Economist.com

Trade

- Adam Smith “Wealth of Nations” (1776):
‘If a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them with some part of the produce of our own industry, employed in a way in which we have some advantage’
- Ricardo, 1817: it’s comparative advantage that matters

Trade (2)

- Ricardo considered the following costs:

	wheat	wine
England	15	30
Portugal	10	15

- Portugal has an absolute advantage at producing both
- But England has a comparative advantage in wheat – each unit costs $1/2$ unit of wine versus Portugal's cost of $2/3$ a unit of wine

Trade (3)

- Suppose England has 270 units of labour, Portugal 180

	wheat	wine
E	8	5
P	9	6
Total	17	11

	wheat	wine
E	18	0
P	0	12
Total	18	12

- Mill: welfare gains from trade come from cheap imports
- Heckscher-Olin model: capital v labour (outsourcing)
- Under perfect competition, free trade optimal; almost all economists agree it's also a pragmatic optimum; but there can still be losers. English vintners?

Growth

- Adam Smith: $\text{output} = f(\text{land, labour, capital})$; so growth means land improvement / colonisation, education / specialisation, capital accumulation
- Keynes: it's all about capital formation
- Neoclassical school (Solow, Swann...): it's all about technology and population growth
- Modern view (Becker, Romer): mostly know-how
- Chad Jones: US growth 1950–93 due 50% to worldwide R&D, 30% better education, 20% to population growth in idea-producing countries
- Prescription: spend four times as much on R&D!

Tragedy of the commons

- 100 peasants each graze a sheep on the common
- If one peasant adds one more, he gets 100% more, while the others get 1% less
- Overgrazing, overfishing ...
- Welfare theorems assume complete property rights, atomistic principals and full information
- Where this fails, private cost \neq social cost
- Observed forever, documented by 1830s, used to justify enclosure movement, inspired Malthus

Externalities

- Externalities are goods / bads people care about, but not traded: typically side-effects
- Consumption externalities include smoking in restaurants, domestic heating emitting CO₂
- Production externalities include a steelworks polluting a fishery downstream, or emitting CO₂
- Positive externalities include education (1 more year = 2% crime reduction), file formats,...
- In the presence of externalities, competitive equilibria are unlikely to be Pareto efficient
- Can in theory fix with property rights (Coase) but this is hard with many players, or delays

Public goods

- A public good is non-rivalrous and non-excludable
- Example: scientific knowledge. The producer can appropriate a small part of the benefit (e.g. PhD thesis); the rest spills over to all
- Example of a public bad: CO₂ emissions. Again, everyone gets to 'consume' the same amount
- Strong temptation for people to free-ride!
- If production is decided communally, there are potential 'impossibility theorem' issues
- Alternatives? Prizes / taxes? Cap-and-trade? ...

Club goods

- Traditional communities can simply limit scale
- E.g. fishermen in Turkey: 40 fishermen gather in tea-house, arrange rota, signed by mayor
- Self-enforcing: if you find another boat in a good spot when it's your turn, chase them
- Elinor Ostrom studied many examples to work out the conditions under which this is sustainable
- Internet routing used to work this way!
- But what happens when the club breaks down?

Enter politics ...

- Buchanan: ‘Politics is a structure of complex exchange among individuals, a structure within which persons seek to secure collectively their own privately defined objectives that cannot be efficiently secured through simple market exchanges.’
- But politics has costs too!

Monopoly rents

- Absent barriers to entry, firms will enter a market until excess profits competed away
- What if we regulate prices?
 - In 1986, New York taxi licenses cost \$100,000 yet drivers earned \$8 an hour
 - License owner makes \$17k p.a. net – 17% ROI
 - Politicians put up fares, supposedly to help drivers
 - Extra \$10,000 p.a. just added \$60K to the value of a license, so helped the owners instead!
- Economists define a rent as an excess, undeserved income resulting from barriers to competition
- ‘Rent-seeking’ drives much of politics

Competition and information

- The marginal cost of producing information is zero, so that's the market clearing price!
- Example – machine-readable phone books
 - 1986 – Nynex charge \$10,000 per disk
 - ProCD had the phone book retyped in Peking and started selling for \$300
 - ABI joined in
- Now it's a few bucks for a CD, or free online
- Hence Free Software Foundation slogan: 'information wants to be free'
- So how can you make money out of selling information – software, books, music, ...?

Lock-in

- Often, buying a product commits you to buying more of it, or spending money on one or more of:
 - durable complementary assets, such as apps for a computer or phone, tunes for your iPod
 - skills, e.g. fluency with Win/Mac/Linux or Office
 - services, e.g. network service for a PC or mobile phone, directory service for a PVR
- Same applies to services – facilities management firms make it hard to switch to their competitors
- Not new (fewer people change their bankers than their spouses) but has very pronounced effects in information goods markets

Lock-in (2)

- ‘Fundamental theorem’ (Shapiro, Varian); the net present value of your customer base is the total cost of switching
 - Suppose you’re an ISP and it costs £25 to set up a new customer
 - Suppose it costs a customer £50 of hassle to switch
 - If your new business model makes the customer worth £100, offer them £60 cashback to switch
 - They’re £10 ahead, you’re £15 ahead
- So the value of Microsoft is what it would cost people to switch to Google Docs and Linux ...

Lock-in (3)

- The incumbent will strive to maximise switching costs, competitors to minimise them
 - file format wars
 - loyalty programs
 - phone number portability
- Incumbents promote complementary goods and services that increase lockin – from tied printer cartridges to G Suite and Facebook Connect
- Asymmetric switching costs – a phone network has to supply a phone to win a customer, but to keep one can offer extra minutes which cost it nothing

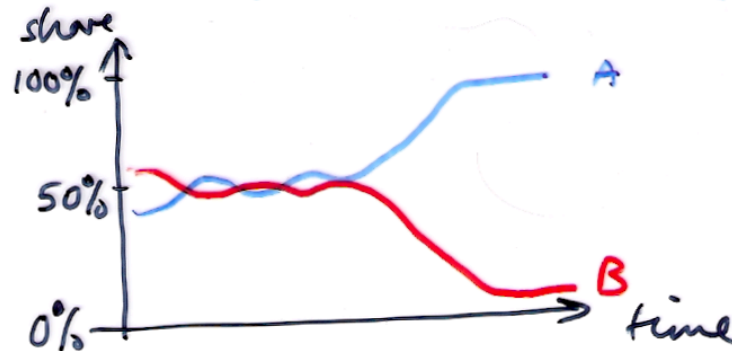
Network externalities

- Many networks become more valuable to each user the more people use them
- Metcalfe's law: the value of a network is proportional to the square of the number of users
- It's actually more complex than this (local effects are stronger) but still more than linear
- Overall effect: past some threshold, network use takes off rapidly (and creates lock-in)
 - Telephone – late 19th century
 - Fax – 1985–88
 - Email – 1995–99

Network externalities (2)

- As well as 'real networks' like fax and email there are 'virtual networks' such as PCs and software
 - Most people used to buy PCs rather than Macs because of software
 - Back in 1985 companies started to write software for PCs first and Macs second, as they thought the PC was winning
 - So it won – people bought PCs for the software
- It works for bads as well as for goods: malware writers target Windows although Mac (and Linux) are also vulnerable

Network externalities (3)



- So markets with network effects can 'tip'
- It's particularly common with two-sided markets
- Other examples:
 - Rail gauges in the 19th century
 - Colour TV standards in the 1950s
 - VHS v Betamax, Blu-Ray vs HD-DVD, ...
 - Paypal v other online payment startups 15 years ago
 - Facebook v Myspace, Bebo, Friendster, ... 10 years ago

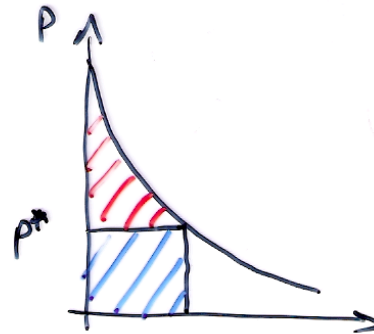
Strategic issues

- Each of these factors – high fixed costs plus low marginal costs, significant switching costs due to technical lock-in, and network externalities – tends to lead to a dominant-firm market model
- Given all three, monopoly is even more likely
- Hence the race for market share whenever a new product or service market opens
- Hence the 1990s Microsoft philosophy ‘ship it Tuesday and get it right by version 3’
- Business driver: is your customer acquisition cost (CAC) still less than your lifetime value (LTV)?

Strategic issues (2)

- Ethics: how bad are monopolies?
- Policy: do you hope that the incumbents become obsolete, or do you regulate?
- EU law: a fairly-won monopoly is OK but using dominance in one field to get it in another is illegal
- US: monopoly used to be measured by consumer surplus (which doesn't work for Google, Facebook, Amazon, Wikipedia...)

Price discrimination



- Recall: an efficient monopolist sells to each customer at her reservation price – ‘selling to value’
- Pigou’s three degrees of price discrimination:
 1. Personalised pricing (e.g. haggling, loyalty cards ...)
 2. Versioning (e.g. first / business / economy class)
 3. Group pricing (e.g. student and OAP discounts)
- Around forever – but getting more powerful and pervasive
- Tech simultaneously increases the motive and the means (and drives the erosion of privacy)

Price discrimination (2)

- Versioning can include ‘pricing for sharing’, e.g. scientific journals charge libraries more than private readers
- Disney DVDs are cheaper than titles people rent
- Versioning can include marketing – e.g. magazines cheap for students but expensive for business
- Much of the promised efficiency gain from e-commerce was based on hope of more effective price discrimination
- But discrimination is often unpopular!

Cruel, mean or lavish ...

It is not because of the few thousand francs which would have to be spent to put a roof over the third-class seats that some company or other has open carriages with wooden benches. What that company is trying to do is prevent the passengers who can pay the second class fare from travelling third class; it hits the poor, not because it wants to hurt them, but to frighten the rich. And it is again for the same reason that the companies, having proved almost cruel to the third-class passengers and mean to the second-class ones, become lavish in dealing with first-class passengers. Having refused the poor what is necessary, they give the rich what is superfluous. (Jules Dupuit, 1849)

Bundling

- One way to conceal discrimination in ‘bundling’: selling a number of products together, as with Microsoft Office
- Suppose Alice and Bob have the following reservation prices for Word and Excel

	Word	Excel
Alice	£50	£75
Bob	£75	£50

- With separate pricing, MS would charge £50 per product and get £100 per customer, or £75 and get £75
- By selling them together, it gets £125
- Can sell different bundles, e.g. annual sub with Office 365

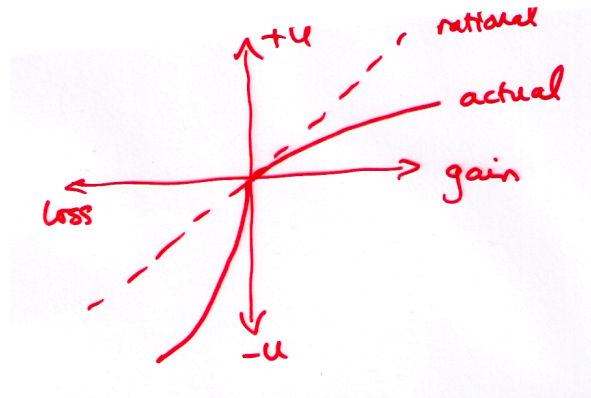
Asymmetric information

- Akerlof won the Nobel for the ‘market for lemons’
 - 100 used cars for sale – 50 good cars worth \$2000, 50 lemons worth \$1000
 - Buyers can’t tell difference – so price \$1000
- One fix is for sellers to offer a warranty – this is cheaper for owners of good cars, so can act as a ‘signal’ for the hidden information
- Why is a Cambridge degree valuable? It’s hard for employers to tell smart diligent employees from interview, so many use education as a signal
- Signaling theory is important for recommender systems – Google, eBay, Grameen

Asymmetric information (2)

- Do Volvo drivers have more accidents because:
 - Bad drivers buy a Volvo to survive accidents better
 - Volvo drivers compensate for safety by driving faster?
- The first effect is ‘adverse selection’ and the second ‘moral hazard’: examples of ‘hidden information’ versus ‘hidden action’
- Lemons market: adverse selection
- Insurance markets can also be trashed by moral hazard; hence excess, no-claims bonus, ...
- Moral hazard can also lead to surveillance, such as insurance company black boxes monitoring drivers

Bounded rationality



- Recall Prospect Theory from 1a SSE: people offered £10 or a 50% chance of £20 usually prefer the former; if offered a loss of £10 or a 50% chance of a loss of £20 they usually prefer the latter!
- And recall the Asian disease problem – framing actions as ‘saving’ can make them more attractive
- The misperception of risk is a big deal: it’s how terrorism works (and a lot of other political marketing)
- ‘Behavioural economics’ studies all this stuff

Bounded rationality (2)

- Herb Simon coined ‘bounded rationality’ in the 1950s along with ‘satisfice’
- People try to make just-good-enough decisions
- A satisficer will work hard until his lifestyle goals are met, then slack off.
- Most of us are satisficers, and VCs don’t like this!
- Another common rationality bound is ‘hyperbolic discounting’: people disregard far-future events (most people have inadequate pensions)
- The endowment effect: people generally demand a higher price for something they already own

Cultural biases

- Some biases we acquired from evolution are modulated by culture
- Caliskan noted that machine translation from gender-neutral Turkish text gave male doctors, but female nurses
- She ran experiments and found all MT systems were sexist, racist, homophobic ... inhaling prejudice with their training data
- See paper, linked from web page

The power of defaults

- Most people just go with the flow. So:
- Marketing: firms make people opt out of getting spam / buying extra insurance ...
- Libertarian paternalism: governments make people opt out of some policy options, from pensions (US, UK) to organ donation (Spain) to use of medical records in research (most countries)
- Recall from SSE: why do people worry too much about terrorism, but not enough about IT security?

Agency effects

- Classical economics sees institutions as rational
- But decisions are made by individual managers, who optimise their own utility too
- ‘New institutional economics’: study managers’ behaviour. Should you give them stock options to align their interests with shareholders?
- ‘Public-choice economics’: apply this incentive analysis to civil servants and elected politicians (“Yes, Minister”). What’s the cost of democracy?
- Why do public-sector IT projects fail more often?

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?

Auctions

- Around for millennia; standard way of selling livestock, fine art, mineral rights, bonds...
- Many other sales from corporate takeovers to house sales are also really auctions
- Auctions are a big success of the Internet, from eBay to Google
- Some unpleasant side-effects
- Rapidly growing interest in theoretical computer science: auction resources in distributed systems
- Many issues of asymmetric info, signaling, strategic play... – plus some solid theory!

Types of auction

- English, or ascending-bid: start at reserve price and raise till a winner is left (art, antiques)
- Dutch, or descending-bid: start high and cut till somebody bids (flowers)
- First-price sealed-bid auction: one bid per bidder (government contracts)
- Second-price sealed-bid auction, or Vickrey auction: highest bidder wins and pays second-highest bid (postage stamps)
- All-pay auction: everyone pays at every round until one remaining bidder gets the goods (war, litigation, winner-takes-all market race)

Strategic equivalence

- A Dutch auction and a first-price sealed-bid auction give the same result: the highest bidder gets the goods at his reservation price
- They are 'strategically equivalent'
- Ditto the English auction and the second-price sealed-bid auction (modulo the bid increment)
- But the two pairs are not strategically equivalent!
 - in a second-price auction it's best to bid truthfully
 - in a Dutch / first-price auction, you should bid low if you think your valuation is much higher than everybody else's

Revenue equivalence

- This is weaker – not ‘who will win’ but ‘how much money on average’
- According to the revenue equivalence theorem, you get the same revenue from any well-behaved auction under ideal conditions
- These include risk-neutral bidders, no collusion, Pareto efficiency (highest value bidder gets goods), reserve price, independent valuations, ...
- Then bidders adjust their strategies and the English, Dutch and all-pay auction yield the same
- So when you design an auction, you must focus on any ways the conditions aren’t ideal

What goes wrong (1)

- In a ‘private-value auction’, each bidder’s value v_i is exogenous (think: sculpture). In a second-price auction, everything you buy is a bargain
- In a ‘public-value auction’, each item has a true price which bidders estimate at $v + \varepsilon_i$ (think mineral leases; spectrum auctions). The buyer is the sucker who overestimated the most!
- This is called ‘the winner’s curse’
- Many real auctions lie somewhere between these two extremes

What goes wrong (2)

- Bidding rings – bidders collude to buy low, have a private auction later, split the proceeds
- First-price auctions are harder to rig; with second-price, New Zealand bids of \$7m and \$5000
- Entry detection / deterrence: an early (1991) ITV franchise auction required bidders to draw up a detailed programming plan. In Midlands & Central Scotland, industry knew there was no competition; bids under 1p per head (vs £9–16 elsewhere)
- Predation: ‘we’ll top any other bid’ in takeovers
- Sniping and other boundary effects

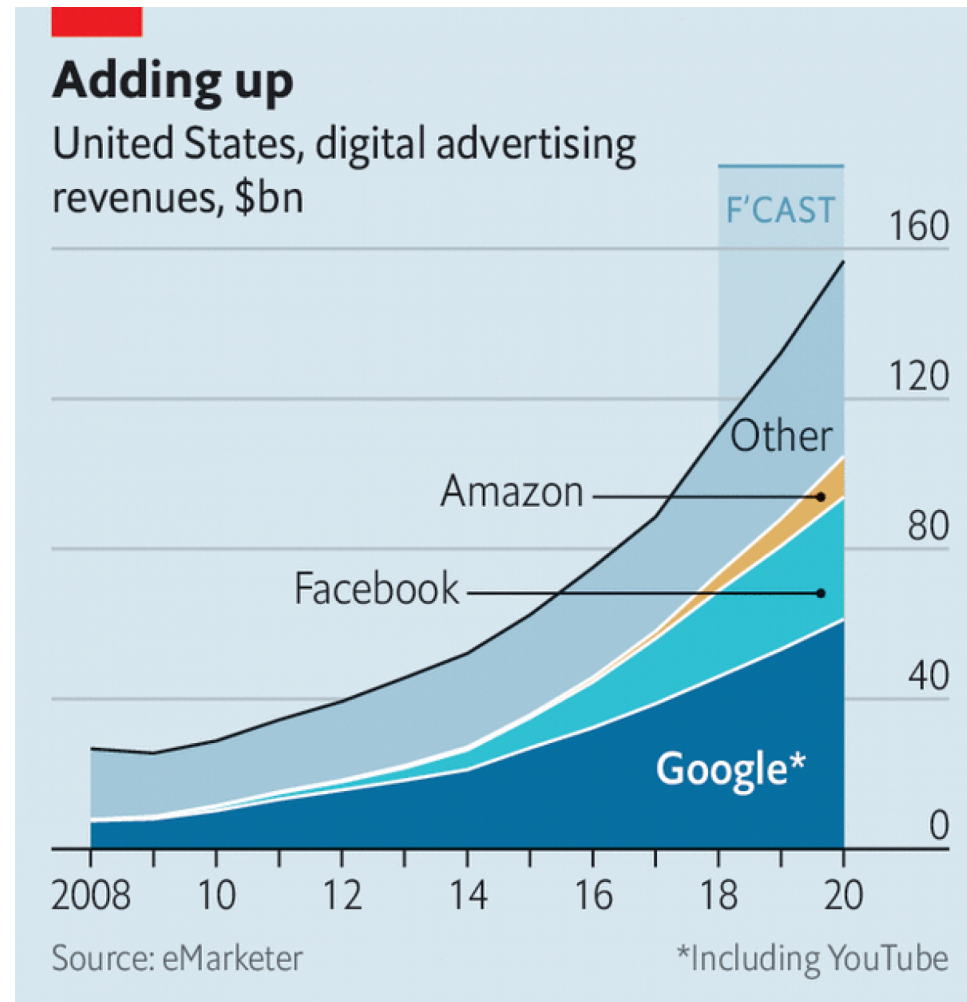
What goes wrong (3)

- Risk aversion: if you prefer a certain profit of £1 to a 50% chance of £2, you'll bid higher at a first-price auction
- Signaling games: show aggression by a price hike
- E.g. in simultaneous auctions, as in the USA, signal "we want SF, LA, SD and if you compete with us there we'll push prices up in your patch")
- Budget constraints: if bidders are cash-limited, all-pay auctions are more profitable
- Externalities between bidders – e.g. arms sales

Combinatorial auctions

- Externalities lead to preferences for particular bundles of goods: landing slots at airports, spectrum, mineral rights...
- Bid (\$x for A+B+C) or (\$y for A+D+E) or...
- Critical app for CS: routing in presence of congestion (bid for AB and BC, or AD and DC...)
- The allocation problem is NP-complete; practical algorithms work up to a few thousand objects
- Also: how can we make the auction strategy-proof (i.e. truth-telling is the best strategy)?
- New field of 'algorithmic mechanism design'

Ad auctions



Ad auctions (2)

- Pioneered by Google
- Basic idea: second-price auction mechanism but tweaked to optimise platform revenue
- Bidders bid prices p_i , platform estimates ad quality e_i , and then ad rank $a_i = p_i \cdot e_i$
- Ad quality $e_i = \text{relevance} \cdot \text{clickthrough rate}$
- So how do we work out who wins the auction and how much they pay?

Ad auctions (3)

Advertiser	Quality Score	Bid	Ad Rank	Rank	CPC
Jerry	4	\$2.00	8	1	\$1.50
Elaine	2	\$3.00	6	2	\$2.00
George	1	\$4.00	4	3	\$3.00
Kramer	3	\$1.00	3	4	\$0.70

- Here George bids \$4 and Jerry \$2 but Jerry wins the auction because of higher ad quality – the platform expects he'll get four times the clicks
- George pays a cost per click of only \$1.50 (bid times competitor ad rank / own ad rank)

Ethical aspects of ad auctions

- Translated to social media, ad ‘quality’ can easily segue into ‘virality’
- Then if your ads are good clickbait, and your followers follow them, you pay less
- See Martinez ‘How Trump conquered Facebook – without Russian ads’ (web page)
- Many sites tend to serve ever more provocative and extreme content...

Introduction to Law

- Two lectures
- This lecture:
 - how can you end up being liable for things you do online (contract vs tort)
 - how do you make the agreements you want to, and enforce them
 - when you need advice, and the context in which to understand it
- Next (Richard Clayton): IT-specific laws

What is law?

- We can't get all we want by private action because of externalities etc
- Politics: “a structure within which persons seek to secure collectively their own privately defined objectives that cannot be efficiently secured through simple market exchanges” (Buchanan)
- The main mechanism is law

What is law (2)?

- Many origins and flavours (state vs religion, common vs Roman vs Napoleon ...) but two main divisions: criminal and civil
- Criminal: Alice harms Bob seriously, so the state prosecutes Alice
- Civil: Alice harms Bob, or breaks a contract with Bob, so Bob sues Alice
- Significant overlap

Criminal law

- In general a crime requires
 - A guilty act (actus reus)
 - A guilty mind (mens rea) – so legal advice or going to the ethics committee may shield you!
But some offences are ‘strict liability’
- Prosecution must prove the case beyond reasonable doubt
- CPS guidelines matter (e.g. ‘hacking tools’) and agreements (e.g. with the IWF)

Civil law

- Contract – making the agreements you want
- Tort – avoiding infringement of the rights of others, and giving adequate notice to others of your rights that you may want to enforce
- Regulation – specific things you need to do to enforce your rights or avoid penalties
- International – choice of law and venue
- Arbitration, costs etc

Contract

- A contract consists of offer and acceptance by competent persons for a lawful purpose involving consideration
- Can be made in writing, orally, by conduct
- We make dozens of informal contracts every day; but an online business will usually want to formalise its standard terms and conditions (you may want advice here!)

Contract (2)

- When a shop offers goods in the window this isn't the offer but an 'invitation to treat'. The customer makes the offer for the good and the shopkeeper accepts
- When offering goods online it's wise to make this clear, in case you run out of stock
- Linking clearly to terms and conditions is in general enough (as with a railway ticket)

Contract (3)

- Many national laws require some contracts to be in writing (real estate; insurance; guarantees; in the USA, goods over \$500)
- Many jurisdictions have electronic signature laws; in general electronic writing is fine as the essence of signature is intent
- The US ESIGN Act of 2000 made clickwrap licenses explicitly enforceable

Limits

- Consumer Rights Act 2015 extends previous legislation to software (you're now liable for malware you give your customers)
- Retailer has one chance to repair or replace (at customer's choice) else refund
- Can't enforce unfair contracts against retail customers
- Can't exclude liability for death or injury (a separate EU rule, applying to all products)

Globalisation

- It can be tiresome for a firm in England to be sued by a customer in Australia
- Make clear whose law is to apply, and separately where cases should be heard
- Enforcement of foreign judgments is not straightforward (the USA is almost rogue)
- One fix is to specify arbitration of disputes

Arbitration

- A contract can specify binding dispute resolution by an arbitrator
- It can also specify applicable law and set other parameters such as limits on costs
- The Convention on the Recognition and Enforcement of Foreign Arbitral Awards makes awards enforceable everywhere, even in the USA

Costs

- US system – each side pays its own costs.
Can be expensive for some firms
- UK system – loser generally pays the winner's costs. May make it uneconomic for most customers to sue you, but a dispute with a rich one can be ruinous
- UK rules on costs are bad for consumer protection, and for free speech (later)

Tort

- Tort is the second main way you can become liable online, after contract
- A tort (in Scotland called a delict) is a wrong which unfairly causes someone else to suffer loss or harm
- Examples are negligence (whether in product liability or in giving advice), defamation and copyright infringement

Negligence

- Arises if you break the duty of care owed by a reasonable person and cause harm directly
- Usual yardstick is the standard of the industry. Some exceptions apply
- Liability often tied up with insurance rules; e.g. car crashes, medical malpractice
- NB: if your software harms a non-customer or a child, you didn't disclaim liability to her as she didn't make a contract with you

Defamation

- Libel (if spoken, slander) is a tort, and the UK is a popular venue for forum shoppers
- Direct defamation; innuendo; linking
- Burden of proof on defendant in UK
- Also the UK system of costs shifting – loser pays winner's costs
- Defamation Act 2013 excludes trivial claims, creates public interest defence, and makes claimants pursue the author first

Patents

- Mechanism to tackle the underprovision of R&D from externality in research
- Protects an invention which must be
 - Novel (“prior art” disallows)
 - Useful (no perpetual motion machines)
 - Non-obvious (to “someone skilled in the art”)
- Typical duration – 20 years
- Traditionally only physical inventions; can’t protect ‘the theories above, or the facts beneath’
- But the economic case is weak, except possibly in pharmaceuticals; to IT firms, patents are a nuisance

Patents (2)

- Software patents in theory not allowed in Europe: EPC Art 52 “The following shall not be regarded as inventions ... rules and methods for performing mental acts, playing games or doing business, and programs for computers”
- Don't you believe it! The courts keep stretching it
- In general, innovation in CS is incremental: a large program can use thousands of ideas, while a blockbuster drug is a single patentable molecule
- So far only four CS patents earned serious money
- Microsoft has just open-sourced its collection!

Trademarks

- Marks capable of distinguishing your goods or services from others (e.g. 'IBM')
- May be registered (®) or not (™) – registering can make litigation easier
- Registered trademark owners usually win domain name disputes
- Can sue infringers, but have to show a misrepresentation that damages your business
- Pitfalls – some companies are very aggressive about registration and enforcement (McDonalds)

Copyright

- Since Statute of Anne (1709–10), copyright has protected your literary works – extending from novels and drama to art, music
- Is the main protection for the software you write
- No need to register – but asserting copyright (“© RJ Anderson 2018”) can make litigation easier
- Duration – has steadily increased and is now author’s lifetime + 70 years (was 50 years for sound recording rights, now 70)
- Protects against copying etc; but “fair use” and “fair dealing” get-outs for criticism, parody...
- Moral rights remain yours even if copyright sold

Copyright (2)

- There are many orphan works – books, pictures etc whose owners aren't known
- Stalled Google Books project – see web page!
- How do you avoid software becoming a similar 'anti-commons' of competing claims?
- Stallman – GPL; BSD license
- Creative Commons gives a general framework for sharing (attribution, commercial use, share-and-share alike, ...)
- Collecting societies vs YouTube etc

Other 'IPRs'

- Specialist rights
 - Database rights (EU only)
 - US Semiconductor Chip Protection Act
 - Plant breeder's rights
 - Design rights
- Rights based on contract
 - Materials transfer agreements
 - Confidential information; NDAs
- Limits – e.g. an employer can't restrict knowledge that's become part of the 'tools of your trade'

DRM

- Copyright owners panicked at printing, audiocassette, videocassette ... and the Internet
- Huge push to introduce DRM over last 20 years
- But it shifted power to Apple, Google, Amazon from old-style record companies
- US law made it illegal to mess with DRM mechanisms even when used for technical lock-in
- Lexmark v SCC case allowed reverse engineering for compatibility
- October 2018: US Copyright Office said it's also OK for repair, but selling tools is illegal
- Open-source tools a grey area still...

Strategy

- 'IPR' often a combination (biochip h/w patent + software copyright + MTA on reagents ...)
- IT industry strategy: patent portfolios mostly defensive, used to get access by cross-licensing
- Compound models, e.g. GPL the linux version, sell the Windows version, charge for support...
- Startups: VCs like to see some IP (mantra is 'global sustainable competitive advantage')
- Incumbents worry about lock-in: network effects, two-sided markets, distribution moats, control of platforms and interfaces. Challengers can be more creative, but must try to think ahead!

Ethics

- In our field, laws are often ten years behind, and even then often don't fit reality very well
- Practical ethics: in what circumstances should we restrain our actions more than the law requires?
- Analogy: medical ethics (used to) require doctors to observe stricter confidentiality than either the law of confidence or data protection law required
- The philosophy of ethics asks “What are true moral values?” and “Why?”

Philosophies of ethics

- Authority theories mostly derive from religion. But God usually talks via scriptures or a priesthood; so how do you resolve disputes?
- Intuitionist theories say we can tell what's good and bad, like we can tell something is green. But again, our intuitions can differ, and how do you resolve disputes?
- Egoist theories say we act rationally in our own self-interest. We've seen the limits on that...

Philosophies of ethics (2)

- Consequentialist theories include Hume, Bentham and Mill's utilitarianism: maximise $W = \sum U_i$ (or, 'greatest happiness of the greatest number')
- But how do you work out consequences in detail?
- Social choice: it's hard to define W in a way that's consistent with democracy
- Cheney's 'ticking bomb' justification for torture
- Modern debate: act vs rule utilitarianism

Philosophies of ethics (3)

- John Rawls ‘Theory of Justice’: we should make moral decisions about a society behind a “veil of ignorance” of whether we’ll be born high or low
- Deduces: we should maximise $W = \min U_i$
- Same problems as before with bounded rationality
- What if a small minority is badly off?
- Would you rather be reincarnated in the USA or (say) Portugal – poorer but with better welfare?
- Randomised algorithms, anyone?

Philosophies of ethics (4)

- Aristotle: consequentialist theories are ‘for beasts’: you’d be happier if you were stupid
- People should act in accordance with nature and duty: they will do good and be happy
- It’s not just the consequences of actions that make them right or wrong, but the motives of the actors
- The many flavours include Kantian theory of duty: act only on maxims that you’d like to be universal and treat people as ends not means

Current debates include:

- Evolutionary psychology (monkeys do tit-for-tat; Machiavellian brain hypothesis, the moral roots of ethics in the way our brains have evolved)
- Neuroethics (from moral development of children to consciousness as an epiphenomenon ...)
- Experimental ethics: e.g. whether you'd divert a runaway trolley to save two people but kill one
- What is nature, versus nurture / culture?
- See Haidt video on the web page

Live policy debates

- Censorship
 - All countries have some (e.g. child porn). But then along come Hollywood, libel lawyers, and now the push to get Facebook etc to be censors
- Export control
 - Is it ethical for GCHQ to allow DPI equipment exports to Iran / Saudi Syria?
- Surveillance
 - From Ed Snowden to the ACM ethics code

Live policy debates (2)

- Privacy
 - Economic analysis alone is insufficient as privacy is very context-dependent. Data protection regulation changed with GDPR
 - Privacy often a touchstone issue in ethics
- Freedom of Information
 - Like privacy laws, FOI laws push back on the ‘natural’ flow of data from the weak to the strong. We have rights not just to data but to the basis of decisions that affect us

Privacy

- 2014 report on Big Data by the US President's Council of Advisers on Science and technology
- Spread of gesture, speech and video interfaces will lead to cameras, microphones everywhere
- Can't stop data collectors; can't regulate processors (they claim); so have to regulate uses
- Problem: US privacy law regulates only a few uses (such as video rentals) and is weak even there

Privacy (2)

- Google v González, European Court of Justice, 13 May 2014
- Search on Mr González returned reference to a lawsuit against him in 1998
- Google said, that's not our problem.
- ECJ: Oh yes it is! He can ask either the newspaper or Google to take old stuff down

Health privacy

- David Cameron said in 2011 that NHS records would by default be made available for research (the ‘transparency’ agenda ...)
- Don’t worry: our records would be anonymised, and we’d have an opt out
- Opt-out is needed because of European privacy law (I v Finland, ECHR, 2010)
- But anonymisation doesn’t really work for rich linked data (e.g. ‘atrial fibrillation, Hammersmith, Mar 19 2003’)

Health privacy (2)

- The Hospital Episode Statistics (HES) database has a record of every finished consultant episode going back 15 years (about a billion in total)
- Mar 2014: formal complaint to ICO that PA put HES data in Google cloud despite many rules on moving identifiable NHS data offshore
- Apr 2014: HSCIC reveals that HES data sold to 1200 universities, firms and others since 2013
- HES ID leaks postcode, dob in most cases
- 2018: many patients' opt-outs were simply ignored

How can researchers deal ethically with privacy?

- See Nuffield Bioethics Council project on biodata for four principles
 - Ethics based on respect for persons
 - Satisfy human-rights and other applicable law
 - Set reasonable expectations in discussion with people with morally relevant interests
 - Effective and justified systems of governance and accountability

What about fake news?

- What's the equivalent for propaganda?
- Tim Wu's "The Attention Merchants" gives history of advertising and propaganda from 1830s tabloids through Hitler to sitcoms
- Auction theory tells us about polarisation
- Social network theory about echo chambers
- Politicians are now paying real attention...
- Do you want Google to be the censor?

AI: justifying your decisions

- We saw Caliskan's work on how AI inhales racial and other prejudice with training data
- Broader problem: many AI systems cannot explain their actions
- “Computer says no” doesn't work in public sector where people have a right to an explanation, judicial review exists and many kinds of discrimination are explicitly illegal

Ethics in research

- Your part 2 project may involve human experimental subjects
- Independent review by uninvolved scientists greatly reduces risks of both civil litigation, and criminal prosecution if things go wrong
- Pay attention to the procedures for ethics committee approval
- And if they say no, don't do it – unlike in the Cambridge Analytica case!

Conclusion

- Technology is constantly changing status, money and power. How do we navigate?
- Economic incentives have their limits
- Lawmakers take 10–20 years to catch up
- Human-rights law can give broad principles but it's a floor rather than a ceiling
- So even if your business model is legal today, it might not be tomorrow
- Does it pass the “front page test”?