Handouts for BEE2038: Intermediate Microeconomics

Contents

Notes by instructor David Reinstein, largely based on Nicholson/Snyder, Intermediate Microeconomics and its Application, 12th edition (other editions OK too).

This text forms the basis for roughly 80-90% of this module. I recommend you purchase, or find easy access to some edition of this book (new editions should be £50, used editions should be cheaper). In future I hope to rely completely on open-source (free) resources, but I'm not there yet.

See some alternative and supplemental free texts and resources (BELOW)[#texts]

Notes to students on how to read this set of lecture notes2

Welcome to the exciting world of Microeconomics!

I hope that this module helps you see the world in a new way and gain insights about business, government, and your everyday life. If you put the time into this module, you can get a lot out of it, and you may gain skills and access approaches that you will use throughout your career. As students at a Russell group institution, I expect you to work hard and engage intellectually to gain a serious and critical understanding of key Economics concepts. Learn how and when these can be applied, what their limitations are, and how these can these are misused and misunderstood. I hope you learn these core ideas well enough that you could explain them to others and apply them to unfamiliar situations.

This is not necessary to gain a good mark: I hope that you all will be able to gain a good mark, and I will try to be lenient. But I would suggest you aspire to get *more* out of this than a mark.

You should aim not only to achieve a distinction mark, but to be able to impress me with your understanding and insight, to gird your loins for future courses applying this material, and to gain the acumen to understand key research issues, and participate in business discussions and policy debates.

I wrote these notes to outline all of the material you are responsible for, and to give you more resources and insight than I can convey in the short amount of time we have during lecture. I *don't* mean you're simply responsible for material in these printed notes: I mean that these notes will aim to *refer to* everything that you are responsible for.

These notes are meant to be a complement to the textbook (and to the lectures, tutorials/problem sets, readings and other material on the ELE) and to tie all of this together.

I am providing you these notes both as a complete file as well as divided by lecture week (approximately). Use either version.

I will try my best to stick to the structure outlined in these notes. However, each year the module adjust slightly as we go and I will need to make updates to these notes as we go along. I will try to keep you informed of any changes via the VLE forums.

Notes versus slides?:

These notes should include all of the slide material *plus* explanatory notes and enrichment material. I use some abbreviations before certain notes to help you understand how to digest this. I will also try to make the slides themselves available after the lectures, even though they are redundant– these notes have everything.

Some 'markers' and abbreviations:

- 'NS' refers to the Nicholson and Snyder text (usually chapters/numbering from the 12th edition is referenced; if you're using an earlier edition, make sure the content corresponds)

- 'Adv' indicates advanced material and discussion you are not required to know but may find interesting, and will help you in later courses/modules in Economics, and give you a hint at what is to come if you pursue this course further. Knowing this stuff might also help your mark and the impression you make when asking for letters of reference.
  - This is also included to give you a more nuanced picture: when I took a similar module as an undergraduate I tended to believe 'all the economics problems are solved and the solutions and implications are obvious.' These 'Adv' comments are often caveats and *critiques*.

'Adv, math' indicates advanced mathematical material. (I've moved most of this to footnotes).

Text in blue usually refers to questions you should try to answer on your own (and I sometimes provide suggested answers in the footnotes. Try to answer it yourself first.)

Some text is given in gray to indicate that this is a side point or a discussion. (I'm moving most of this to footnotes.)

- 'LC' indicates a lecturer comment I may make in lecture that you don't need to worry about (I meant to cut these but I sometimes forget to)
- 'Comprehension Q:' A question you should be able to answer if you are following along.
- 'T numbers' (take these loosely please) refer to the weeks of term that intended to cover specific material.
  - For example 'T1:03 - T1:04a' means 'term 2 week three (both lectures) and term 2 week 4, first lecture only'

Background

Course Information

Some quick notes on this module and how it fits into your course structure

This module is:

- Compulsory for BSc Business Economics and BA Business Economics
- Also for PPE I believe

The prerequisites are BEE1029 (for most students) or BEE1034 or BEE1030 and BEE1031

The prerequisites are very different, the students in this module may come from diverse *backgrounds*.

We will try to focus on material:

- not covered in BEE1029 or
- more rigorous and detailed versions of this, and
- real world applications, especially in business.

Some of you may have already seen some of the material covered here. If so, try to learn it in more detail, become better at explaining it to others, and learn to apply it to real-world issues.

Note: From 2020 onwards, all students in this module will come from the "CORE ESPP"

https://www.core-econ.org/espp/

You may also find this to be a useful resource, for revision, motivation, and as a supplement to the Nicholson/Snyder text

(Also, see "The Economy" 1.0) https://www.core-econ.org/project/core-the-economy/ for more straight Economics

A note on maths:

As I will explain, this course will involve a certain level of maths; things like simple algebra, understanding what functions are and how to draw them, and understanding the very basic idea that 'the derivative of a function is a function telling you the slope of the original function'. If you are math-phobic, you need to try to get over this and make maths your friend and your horse. You can ride it for miles!

You will also come to notice that I emphasize logic, precise definitions, and careful connected explanations. I *don't* want you to be saying/writing things that could be interpreted in multiple ways, like "the demand will go up".

However, this is not the core *Economics* module (bee2038: Microeconomics II). If you want a more precise, theoretically complete and mathematically rigorus treatment of this material, particularly if you are studying Economics and/or want to go to postgraduate study in a related field you probably should switch to that module.

Further suggested maths resources are given below, under (#Other-maths-resources).

2018: Note to students in Managerial economics who took the BEE1034 'Economics for Management' last term

I realise that you are facing a special challenge this year because of the changes in this particular prerequisite module, with less 'conventional Economics' covere .

In 2018 I discussed with your student-staff liaison committee chair on how to give you further support. One of the things she suggested was to point you in the direction of the text Edexcel AS/A level Economics. This should be accessible online. I have looked through this book and I agree that it will be helpful both as a prerequisite and to give you a more basic explanation (A-levels) of some of the things that we are covering in this module.

In particular (note these chapters are very short):

From "theme one: introduction to markets and market failure"

Chapter one: Economics as a social science

Chapter 3: the economic problem

Chapter 4: production possibility frontiers

Chapter 7: rational decision-making

Chapter 8: Demand (super-important!) but please don't use their somewhat imprecise language "fall/increase in demand/increase in demand)

(Chapters 9 and 10 are essentially re-covered from scratch in our module, going beyond A-level material)

Chapter 11: Supply

Chapter 12: price determination

Chapter 13: the price mechanism (much of Chapters 14, 15, and 16 cover material overlapping what we are covering, again at a more basic 'A-levels' level; you may find these helpful)

From 'Theme 3: business behaviour and the labour market'

Chapter 42: revenue

Chapter 43: Production

chapter 44: Costs (we don't get to all of this in this module)

chapter 45: profit

Chapter 46: market structure (just to get the basic idea)

Chapter 47: perfect competition

Chapter 50: monopoly (we re-cover much of this and go a bit further)

(Much of these chapters in theme 3, as well as chapter 54, overlaps what we are covering, but at the A-level)

I also highly recommend the microeconomics material from the Khan Academy; I will also give you an outline of which sections are most relevant there.

Of course I am also very accessible if you have any questions or need clarification, or just want to talk about some of the material you are struggling with. As I always say, you should feel free to come by my office hours or to make a special appointment outside of these hours I think students who have come to my office hours will definitely agree that they have found been helpful and not stressful. I also encourage you to ask specific questions on the ELE student forum which I will answer carefully. You can also ask questions directly on any of the dropbox hosted files if you get a free dropbox account, and I will try to respond to all of these.

Outline and description

Planned syllabus, coverage:

The planned module outline is below; as noted, timings may need to be adjusted, and so material may cut for time constraints. Feel free to skip over the first time you read these notes; you may want to refer to this later.

- **Module outline, background, Economic models (and maths tools), 'empirical' evidence** (*) [1a]
  - Nicholson & Snyder: Chapter 1 and 1a
  - T1:01a (Term 1, week 1, first hour; 'empirical')
- First problem set: Mathematical approaches, economic models, revision and warm-up; (to add: some practice MCQ's)

Note: I will not go over all of the fundamental math tools in lecture: please read this section and learn and practice these on your own.

I will put up slides and other resources to help you with this (and we will re-cover some of this when we apply it throughout the module).

- **Utility and choice** (Utility, preferences, indifference curves, budget constraints . . .) [1b-2]
  - NS: Ch 2
  - **T1:01b, 2**
  - Second problem set (NS chapter 2): Preferences, Utility, Consumer optimization (individual and market demand curves), and MCQ's for revision

Optional interesting reading:

- Waldfogel, Joel. "The deadweight loss of Christmas." The American Economic Review 83.5 (1993): 1328-1336.
- Reinstein, David. "The Economics of the Gift." (2014).

- **Demand curves** (individual and market, and properties of each) (*) [3-4]
  - NS: Ch 3
  - T1:3-4
  - Second problem set, second part (NS chapter 2-3): Preferences, Utility, Consumer optimization, individual and market demand curves
- **Production functions and costs** (brief) [5a]
  - T1:5a
- **Profit maximisation and supply** (Firms, MR=MC, shut-down) (*) [5b]

  - NS: Ch 8
  - T1:5a (continued)

- **Perfect competition in a single market** (Brief: Supply curve, entry/exit, CS and PS, tax incidence) (*) [5b-6]

  - NS: Ch 9
  - T1:05b-6a

- ** General equilibrium and welfare (brief)** (interrelated markets and equilibrium prices, efficiency of perfect competition, failures) [6a]

- Third problem set: Costs/production, perfect competition in a single market, Welfare/General Equilibrium

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- **Market failures: Public goods** (attributes, equilibrium underprovision, remedies) [6b-7a]

  - NS: Ch 16 – public goods section only, possible supplements on voluntary provision of PG/charity
  - T1:06b-7a
  - Fourth problem set: Public goods

- Possible supplementary reading:

Each reading is optional, but to do well on the exam you need to do at least some of these readings. Note that some of the material below is on the advanced side; try to glean what you can, and stretch your mental muscles.

Chaudhuri, 2009. Sustaining cooperation in laboratory public goods experiments: a selective survey of the literature

- **Monopolies, pricing and price discrimination** (single firm with market power; leads to another market failure) [7b-8a]

  - NS: 11.2-11.4
  - T1:07b-8a
  - Article: Should we help companies tailor prices to your wage packet?
  - With accompanying worked examples
  - More advanced: 'The Government May Want to Encourage Price Discrimination by Income' Linked here

- Fifth problem set: Monopolies and price discrimination

- **Uncertainty** (basic concepts, EU, risk aversion, investment choices) [8b,9a]

  - NS: Ch 4 (not including 4a)
  - T1:08b-9a
  - Sixth problem set: Uncertainty (Chapter 4)

- Supplementary reading:

- For a popular audience: Reinstein (2016) 'Should you hedge your bets on a Brexit?' LINK

- **Game theory (and lab experiments)** (*Strategic* interaction) [9b,10]

  - NS: Ch 5 (parts), plus supplement on experiments
  - T1:09b-10

- Seventh problem set: Game theory (chapter 5, plus a few additional concepts covered in lecture)

- **Behavioural economics** – first lecture (limits to cognition, willpower, self-interest), second lecture (applications) [11]

  - NS: Ch 17, plus supplements
  - T1:11
  - Further readings tbd
  - Eighth problem set: Behavioural economics

Overall each reading is optional, but to do well on the exam you probably need to do at least some of these readings. Note that some of the material below is on the advanced side; try to glean what you can, and stretch your mental muscles.

- Supplementary reading: theory
  - Amos Tversky & Daniel Kahneman, 1979. "Prospect Theory: An Analysis of Decision under Risk" (*Seminal*)
- Supplementary reading: applications and empirical work
  - DellaVigna, Stefano. "Psychology and economics: Evidence from the field." Journal of Economic literature 47.2 (2009): 315-372.
  - Benartzi, S. & Thaler, R.H., 2007. Heuristics and biases in retirement savings behavior. The journal of economic perspectives, pp.81-104.
  - Farber, H., 2008. Reference-dependent preferences and labor supply: The case of New York City taxi drivers. The American Economic Review. Available at: http://www.ingentaconnect.com/content/aea/aer/2008/00000098/0000000 [Accessed November 19, 2015].
  - (Behavioural insights team) EAST: Four simple ways to apply behavioural insight
  - Kellner, Reinstein and Riener, 2016. Conditional generosity and uncertain income: Field and lab evidence
  - Material linked at giveifyouwin.org

- **Revision lecture, catch-up**
  - T1:12a

From the handbook, here is the official outline of the module:

> Narrative: The module is also designed to equip students with the key microeconomic principles necessary for the analysis of a range of basic economic problems and policies. It seeks, in particular, to increase the students' abilities to, independently, pose and solve economic questions, especially those relating to policy issues. It emphasises the fundamental conceptual foundations in microeconomics and provides concrete examples of their applications.

Some additional resources:

From the Economics Network: http://www.economicsnetwork.ac.uk/teaching/Lecture%20Slides/-Intermediate%20Microeconomics

- Khan academy Microeconomics tutorials https://www.khanacademy.org/economics-finance-domain/microeconomics (all sections are relevant!)
- see also the Khan academy maths tutorials
- Microeconomics for public policy Marcos Vera-Hernandez, University College London

Lecture1: Housekeeping, models and basics (and b. maths tools – to be read at home) [1 hour]

Lecture1-i coverage (1 hour)

– Content based on Nicholson/Snyder Chapter 1: Economic Models

Goals of this lecture (and accompanying self-study)

1. Explain what this module is about and how to get the most out of it
2. Explain what Microeconomics is about and why it is useful
3. Explain what the point of 'models' are
4. Mention some *applications* of these
5. Recap some examples of microeconomic models and questions (should be largely revision)
    - Get your econ brain flowing

Me

David Reinstein, <davidreinstein.wordpress.com/>

Office hours: TBD

For an out-of-hours appointment, please go to https://calendly.com/daaronr/20min/

Office: 1.39 Streatham

Office: 1.39 Streatham, *just come by :)!*

My research interests: Applied and empirical microeconomics across a broad range of issues, and the impacts on policy and on business and nonprofit innovation

- Charitable giving, other-regarding behaviour
- Price discrimination by income
- Impact of HE institution on income and life outcomes
- Communicating with policymakers, managers, entrepreneurs; *Impact*

One reason that I am telling you about this is that I will *integrate* recent and relevant research into this module.

You also may want to get involved in research (doing it, using it) yourself; let me know if you want to chat about this.

If you are thinking of going on to postgraduate study, or are interested in a job involving research, I would strongly advise you to do a final-year undergraduate dissertation.

You can see some of my research on my webpage http://www.davidreinstein.wordpress.com/ and some of my impact projects at

giveifyouwin.org @givingtools (twitter) innovationsinfundraising.org

This module

bee2038: Intermediate Microeconomics

- Lectures
- Problem sets: There are eight problem sets, each covering a specific block of material. *The material in these problem sets either comes from exams or builds exam skills.*

Representative answers for each problem set will be given a few days after each problem set is released, or shortly before the relevant support class.

- Classes (AKA 'tutorials' AKA 'seminars') every fortnight (5 total)

Support classes will largely focus on covering (exploring, solving, discussing) the problem sets. However, there will obviously not be time to cover every question in the tutorial. Note there are only 5 tutorials but 8 problem sets; thus, tutorials may cover problems from multiple recent problem sets.

These classes are about *applying* material you have learned, not lecturing on it or learning it for the first time.

Come ready to ask questions and participate:

The classes are a smaller group setting than the lectures;

we aim to make these highly interactive and participatory. To really be helpful, we need to know what areas you might be struggling with and where your logic might be breaking down; thus we will either do cold calling or highly encourage all the students in these tutorials to ask and answer questions. Think of these as (especially) 'safe spaces'; you will be judged or marked based on your performance in the support classes, and there are no dumb questions. If you have a question many of your peers probably have the same question, so asking it provides a *public good*.

- Marks for Microeconomics component
  - First 'midterm' examination, 90 minutes, fully MCQ (but may require 'choose all that are correct'); 15 marks (30% of term mark)
  - Final examination, 120 minutes, MCQ, solved problems, short essays: 35 marks (70% of term mark)

Important: Final exam open response (essays/short answer) questions test your deep understanding and ability to explain concepts. I will help you prepare for this, and give you examples.

Five essential competencies (for economics students)

1. Apply the scientific process to economic phenomena
2. Analyse and evaluate behaviors and outcomes using economic concepts and models
3. Use quantitative approaches in Economics
4. Think critically about economic methods and their applications
5. **Communicate economic ideas in diverse collaborations**

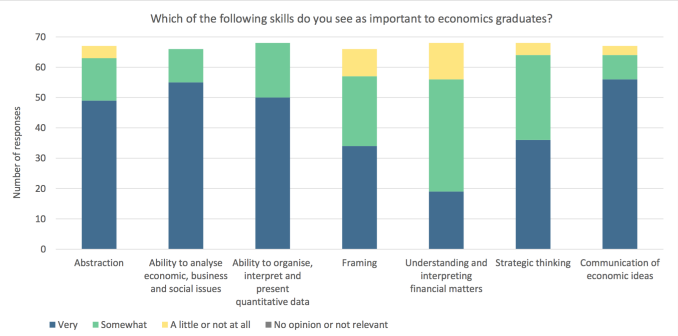
- paraphrased from Algood and Bayer, 2017 American Economic Review: Papers and Proceedings, "Learning outcomes for economists".

This module particularly emphasizes 5, and also 2 and 4.

These skills are also highly relevant to employers:

Skill	Number of references
Application of economic theory	16
Communication skills	11
Quantitative skills	6
Critical thinking	5
Economic history and the history of economic thought	5
Cost-benefit analysis	5
Data skills	3
Political awareness	3

Figure 4 - Skills and Knowledge Most Needing Further Development According to Employers



Texts and resources

- Recommended text: 'Intermediate Microeconomics and Its Application' (12th ed.)
  - Should be available at the University bookstore for around £50, with access to online materials
  - Other recent editions are also OK, but be careful as numbering can change
  - Many other resources online (see below)
- Note that there are a variety of sources and online courses — any intermediate or advanced textbook in Microeconomics will cover virtually the same material. There are now texts available for free, legally, online, such as
- Principles of Economics 2e, Openstax - very well organised, but not quite 'intermediate', not enough maths for my taste, but may be very helpful as revision and as an additional source of explanations!
- Quantum Microeconomics; consider the version either with or without calculus
  - An unconventional but very careful and interesting approach; my impression is that it is well organised and explained
- Microeconomics Markets, Methods & Models an Open Text by Douglas Curtis and Ian Irvine
  - A full-fledged text covering many of the topics of this module, without calculus
- "Introduction to Economic Analysis", by Preston McAfee, Caltech and Tracy Lewis, Duke University, available at LINK (note this text uses calculus).
- Intermediate microeconomics - M Walbert Illinois tutorials - click 'tutorials'
  - A series of tutorials for an intermediate microeconomics module. Covers many of the topics of this module. No calculus but a lot of algebra. Lots of supplementary materials too.

Introduction to Economic Analysis - MacAffee, Lewis, Dale

A 'no-fluff' text from an esteemed source. Covers much of this module, but a bit at the more advanced side (actually the level varies greatly throughout). Includes calculus and lots of parametric examples. Equations are not always formulated well. Lots of great content. Lots of solved problems.

- Some resources on CORE https://www.core-econ.org/project/core-the-economy/, mentioned above, may be helpful, but that needs further investigation, as it is aimed at year-one Economics.
- I also recommend Simple economics on the web, which contains a great number of useful interactive graphical and algebraic exercises. Play around with this, they are super-helpful and intuitive. *Thanks Frank.)*

Issues with the text and online materials: Students can contact Roxanne Watts for access to any online resources associated with the text, roxanne.watts@cengage.com (tel) 01264347322. Expect response to simple questions in 24 hours (1 business day)

Note: The module moves through select parts of textbook; coverage and order given in handout.

Lectures ≠ everything!: *Some* of the text is only *mentioned* in lecture/handout, but you still must read & learn it. On the other hand some sections of the text are skipped. Some material is covered in these handouts, or recommended readings, that is *not* in the text; this is clearly emphasized. All of this is laid out in this handout.

Feedback on your highly-esteemed but extremely humble lecturer

We will have two 'official' feedback points. There will be an 'early feedback' survey, perhaps around week 4 or 5. This gives you a chance to give me constructive suggestions that I can adapt to *during* the rest of the module.

For the Accelerate end-of-module feedback, you will be asked to rate me. *All* of these questions are seen as an evaluation of *my performance* specifically by the "associate dean".

You will be asked to express an opinion, from 'strongly agree' to 'strongly disagree', on one or more questions about the quality of this module.

In particular:

- Overall I am satisfied with the quality of the module.

If at any time you think you don't agree with any of these, please let me know how I can make it better

You can tell me directly, or anonymously at: http://vle.exeter.ac.uk/mod/feedback/view.php?id=666709

I am not particularly a fan of the "customer service" model of education. It leads lecturers to water-down the content and hinders us from presenting challenging and engaging material. and limit your educational experience. In fact, there is in fairly compelling research that suggests that these measures are not reliable and are "poorly correlated with student learning".

Responding to feedback

I listen carefully to your responses and continually adjust the material and the approach. To give you the best education, I try to follow a process of *Kaizen*, or continual improvement.

I also make changes from year-to-year, in response to your feedback.

Some changes made responding to the previous year's feedback:

0. Before 2019-20 the module was called "BEE2024 Economic Principles and policy", and it was divided into a Microeconomics term and a Macroeconomics term." To make things simpler, we have renamed this Microeconomics part "BEE2038: Intermediate Microeconomics", and we no longer share the ELE page. However the coverage is the same as before (allowing for normal year-to-year adjustments).
1. Reduced coverage, enabling better focus. In particular, I have eliminated or consolidated much of the material on the firm's production function and costs. In earlier surveys, this was the topic students liked the least. In 2019 I am removing the coverage of the history of supply and demand curves and a few other topics.
2. Better integration of the problem sets and tutorials with the lectures and the assessments. Better coordination across tutorial sessions.

3. In 2019 I will be providing more practice multiple-choice questions closely emulating the style of MCQ's that will be on the midterm and final exam
4. Materials: Greater motivation for each lecture. Less content in the slides themselves (less busy). A more complete narrative in the handout files, making these more readable

- Opportunity to feedback/discuss the handout and problem sets *directly* on these files (through Dropbox comments)

5. Lectures, tutorials and notes will have a greater focus on carefully explaining the important concepts that many students struggled with (e.g., Expected Utility)
6. I will try to provide more revision coverage and supplementary materials for managerial economics students.

The story of this module

Note: You will have seen many of these concepts before.

But do you really understand them well enough to *explain* them to a non-economist and to *apply* them to a new real-world situation?

And do you understand the *limits and critiques* of these, and how economists try to *measure and test* them?

Asessment hint: I try to ask you questions that you would not know the answer to had you not taken this module. What would be the purpose of you simply learning 'common sense' or 'conventional wisdom' ... that you already knew? If you are answering an open response/essay question by simply stating something that the average Joe sitting on a pub bench would have said, you may want to rethink the way you are answering this question. I am not designing the exams to trip you up... just to check that you have learned something.

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1. Economic basics (weeks 1-2)

Economic models and basic maths tools, introduction (NS ch. 1) Preferences, utility, indifference curves, budget constraints (NS

In weeks one and two we will go over some of the simple tools in the economists' kit. I will try to explain to you what we mean by 'economic models' and give you some examples of these which may be familiar to you. I will not go over the math tools in the lecture; you should study/revise this on your own. We *will* go over many of these again briefly as we apply these math tools to our economic models throughout the module.

We will also start thinking about, and formalisng individual decisions—over nearly all spheres of life— in a way you may not have seen before, which may even strike you as weirdly hyper-rational.

Essentially, this (sometimes confusingly called 'normative decision theory') is the way economists typically conceive of and model people's choices. Even though it seems to require precise optimization, perhaps to a strange extent, there are various reasonable justifications for this, and you might also see it as a benchmark... 'Let's understand what optimization would look like, as a starting point'.

This framework is actually fairly general; it can allow all sorts of preferences (e.g., embodying 'risk aversion' and 'altruism') and wide-ranging choices. However it *does* imply certain 'restrictions': it rules out some sort of behavior that is perhaps obviously illogical.

We will discuss how 'preferences' may define the 'utility functions'. The 'uility function' is the thing that make choices in order to maximize. In the classical framework, people make choices in order to maximise the value of their utility function. Utility functions can also be expressed in terms of 'indifference curves' (but keep the distinction in mind; the indifference curves are not themselves the utility functions).

Under this framework individuals make the 'optimal choices' ... by making the choices that yield the maximum value of the utility functions given their constraints ... in particular they have a 'budget constraint' that says they cannot spend more than they earn. You will learn how to derive these budget constraints and plot these on a graph, along with the indifference curves, and to interpret these diagrams.

2. Building the model, putting it together, examining it (weeks 3-5)

'What determines the price and quantities exchanged in an unregulated (or 'free') market?' 'Do markets yield good outcomes?'

These questions have been at the backbone of Economics for millennia, at least since Aristotle.

Classical economists such as Adam Smith built-up ideas of how seemingly random and disorganized markets can yield predictable and efficient outcomes, at least under appropriate conditions. Neoclassical and modern economists (such as Alfred Marshall, David Ricardo, Leon Walras, and Paul Samuelson) have formalized these, building models involving of systems of demand and supply and general equilibrium, and have made the case for the efficiency and desirability of the free market outcomes, at least under specified conditions. [1]

In the second (and largest) chunk of the course, we will learn some of the essential building blocks of this model, and how they are justified and put together to yield predictions for market outcomes and 'welfare'. In the process, we will get useful ideas and intuitions about the working of markets.

Demand curves: Individual and market demand (NS ch. 3)

We will learn how individual optimization implies a relationship between the price of a good (and the consumer's income) and the amount a consumer chooses to purchase of that good; her individual *demand curve*.

Adding up these individual demand curves yields the *market demand curve*, which describes the way the *total* amount of a good consumers wish to purchase depends on the market price of that good.

Production, costs, returns to scale, choice of inputs

Note: This is covered NS ch. 6-7, but reading these sections is optional. You are only responsible for the brief 'sketch' of this that I provide in this handout and in a short lecture, and any problem sets related to this.

Someone has to make this stuff, you know! We consider 'production functions' that map how inputs can be turned into outputs. If firms are seeking to maximize profits, then whatever output they want to produce ... they will try to produce it using the combination of inputs (Capital, labor, etc.) that can do this at the lowest cost. If we know production functions and input costs, we can describe a firm's cost of producing every amount of a particular good.

Profit maximisation and supply, perfect competition in a single market (NS ch. 8-9)

Economists typically assume that firms make choices to maximize profits. (Mathematically, this 'optimisation', i.e., maximisation, has some things in common with the consumer optimisation of utility, so it may look familiar).

Knowing their cost of production and the demand curve they will face, firms will thus choose to produce the *amount* that yields them the highest profit; we will explain the conditions for this.

With 'free entry/exit of firms' we have the (ideal) situation of *perfect competition*.

Supply curves, entry/exit, CS and PS, tax incidence, general equilibrium and welfare (brief)

Each firm's supply curve is added up to generate the market supply curve; we consider this in both the 'short and long run'. We define the concepts of 'consumer surplus' and 'producer surplus'; adding these yields the total value in an economy or the total 'social welfare'.

We will briefly and roughly consider the idea of an *equilibrium* in all markets; prices such that quantity demanded equals quantity supplied for all outputs and inputs. We will get some sense of the idea of what general 'economic efficiency' means.

I will state and give you some intuition behind the 'first and second welfare theorems'; the conditions under which free markets yield 'good outcomes', defined in a particular sense.

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3. How the market can go wrong (and how to maybe fix it) (weeks 6-7)

Notice I kept saying "under certain conditions" free markets yield good outcomes. These conditions may not hold, for various reasons. In the third chunk, we discuss two of these reasons, which lead to 'market failures'. It is important to

[1] Much of this work has tried to specify more and more *general* conditions for this, requiring less and less stringent assumptions.

understand these. These (sometimes) offer a justification for government intervention, and help us understand how government can best respond. These also offer insights for business models; which 'goods' may be hard to provide without government subsidies, and how can we use technological innovation to capture value and reduce the extent of market failures? (Businesses may also be able to take advantage of market failures in ways that are harmful to public welfare, But I would hate to think I'm training you to do this.)

Market failures – Public goods (NS, ch. 16, parts)

Not all goods can easily be restricted to a single consumer. 'Non-rival' and 'non-excludable' goods (e.g., a fireworks display) are called *public goods*: these will tend to be undersupplied by the free market, as we will come to understand. We will also discuss the evidence for the private provision of these, and consider government's ability to provide them.

Monopolies; price discrimination as an imperfect remedy (NS ch. 11.2-4; supplemental readings)

This is the polar opposite market structure to perfect competition; a monopoly is a single firm that exclusively dominated a particular industry. It will tend to produce less and charge more than would be socially optimal, yielding a 'deadweight loss' (aka 'DWL').

'Price discrimination' is (more or less) when a firm charges different prices to different consumers; this can reduce (or increase) the 'deadweight loss' of monopoly, as we will learn.

4. Extensions to the model and applications (weeks 8-10)

In the final chunk we extend the model to accommodate some important aspects of the real world. We investigate the implication of these for market outcomes.

Uncertainty (basic concepts, EU, risk aversion, investment choices) (NS ch. 4; supplements on finance)

We make many decisions without knowing exactly what the consequence of each choice will be. Economists typically model this using the "expected utility" framework. A warning: students often get this concept wrong, so be careful. Expected utility is not the same as 'expected monetary value'; and this allows EU to embody risk aversion.

Game theory; experimental evidence on this (NS ch. 5, supplements)

For many decisions we make the consequences depend on what *others* do; we have 'strategic interaction'. Economist usually consider this using the framework and tools of *game theory*.

Limits to cognition, willpower, self-interest; applications and evidence (NS ch 16, supplements)

People may not actually make decisions In the hyper-rational way we have been assuming. Here we carefully consider the adaptation of some insights from Psychology to Economics, yielding 'behavioral economics'

The big (small) question

> What's gonna be on the exam??

As noted, you are responsible for *all* material outlined in this handout ... the syllabus + assigned readings + materials covered in lecture and tutorials.

E.g., the exams may cover material only briefly mentioned in lecture, and will expect knowledge from prerequisites

I try to reward broad understanding, rather than merely the ability to memorize a few formulae and definitions. So try to really know this stuff and be able to discuss it and apply it, both to algebraic/numerical examples and to real-world issues.

I give you copious examples of what will be on the examinations, including practice problems at the end of each lecture, problem sets, lots of mock and sample question on the VLE, and previous examinations and midterms.

You need to work hard; here is the guideline specified...

Guided Independent Study per half: 143 hours to be divided between background reading (e.g. 40 hrs), solving/reviewing problem sets (e.g. 40 hrs) and exam revision (e.g. 43 hrs)

And now, a pep talk.

The real big question: why are you here?

To learn.

- Because you think it's interesting
  - to ponder big questions about individuals, markets, and society
  - to understand how people have tried to bring order to difficult questions
  - because you want to contribute something to the world (see above)
- Because this stuff is actually useful in the real world
  - For your professional career
  - For your life
  - If you want to go into academia (in Economics or otherwise)

Some people and organisations seem to value this information:

2017 Government Economic Fast Stream Scheme

Don't waste this experience fretting about marks. Try to actually learn and not just mimic the process, as in 'cargo cults.'

See Richard Feynman, on cargo cult science: https://www.youtube.com/watch?v=yvfAtIJbatg

So, why are you here?

Perhaps not to hear what the *lecturer* has to say, but for the lecturer to respond to what *you* say

We live in a world post-printing press and with lots of digital media. To be honest, there are some things about lecturing that are obsolete in my opinion. Anyone can hear great lectures online or read extremely informative textbooks.

However, as a student at this Russell group University...

You can interact with me, ask me questions, come up with ideas, work with other students. Impress me and get a good letter of reference. I advise everyone to come to my office hours at least once.

Resources

I highly advise you to use the forum to ask and answer questions and make suggestions and comments. Students typically find this forum very useful.

- VLE link

- Ask questions and make comments on the forum LINK, I will monitor it
- or within the pdfs with a free Dropbox account

Or, for anonymity, just complain on social media and I'll probably see it.

Email

- For specific questions comments about your degree scheme and requirements, is best to contact the Building One 'help desk', or the appropriate help desk for your degree.
- If you have a question about course material or coverage which other students will be interested in, please post this on the forum. If you email me I may respond by asking you to post this on the form.
- If you have a specific question that needs private attention then email me and I will try to respond. However, if it is a longer question I may ask you to come to my office hours or schedule a time to meet.
- Stay tuned for the 'announcements'

Also, there is a bunch of other material on the VLE. Remember to do practice questions and formative assessments!

A copy (dropbox link) of each week's 'handouts' file will be added to the VLE each week in advance of the lectures. You can go to the linked pdf file (in your browser) and leave a comment/question *directly* on shared file, others can comment/respond, and I will review/react periodically.

Note: You need a (free) Dropbox account to leave these comments; use your real name to get Kudos.

In-lecture interaction

Even though our lecture time is scarce, It seems to me that to get value out of this antiquated format known as a lecture, we should have at least some interaction. Otherwise, you may as well be watching a video.

Some things we may work with include:

- Responseware, questions, polls and 'chat'; 'Kahoot'
- In-lecture experiments and games
- Remember to install Responseware on your smart phones, or get a free turningpoint clicker!
  - Download it on app stores, or use it on a laptop https://responseware.turningtechnologies.eu/responseware/
  - the session id is 'david' (check)
  - browser mode: https://responseware.turningtechnologies.eu/responseware/

To get the most out of the lectures, I advise you to

- Ask me questions, especially at beginning and end, raise both hands if you are lost
- Draw-along and solve-along with the slides and board work. The act of trying to construct models, solve algebra, and draw and interpret diagrams yourself really helps you understand them better and use them

How to do well

1. Put in the work

- Read the handout and the relevant parts of the text (as outlined in this handout) in advance of the lecture, come with questions
  - Handouts and lectures mainly follow the text
- Do the problem set questions, suggested questions and class questions, understand the answers
- Do the *many* practice problems and mock exam questions

2. Care about the *content*

- Care about *actually* understanding this stuff. This will be rewarded. Don't try to game this. It's easier to just learn this stuff. Try to achieve *Real Understanding*: Be able to explain this stuff in your own words (in writing) and apply it to new situations

3. Interact and discuss: Peers, Forum, office hours
4. Be careful you know how to interpret the exam instructions correctly, and use your time wisely

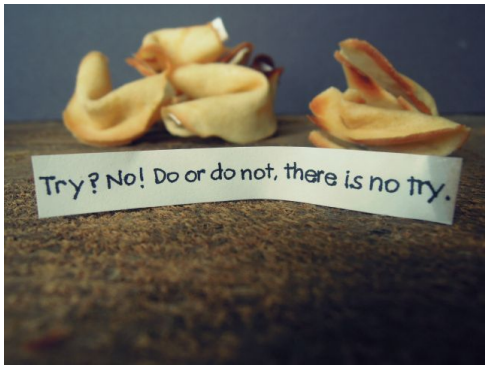
Skills to hone and build. Your success in this module will depend in large part on building and applying basic maths skills and tools (mainly at the GCSE level), and strong reading/writing/logic abilities. You should build the ability to comprehend and respond carefully and logically to nuanced questions (essay/short answer, solved problem, and multiple choice). These problem will incorporate quantitative reasoning, logic, and the ability to understand and clearly express ideas, to correctly characterise and describe theories and evidence, and to apply learned principles to new situations.

This last comment is especially relevant for non-native speakers of English.

Students in past years often worried a great deal but got very good marks, and showed good understanding

Fortune Cookie Wisdom

Here are some broad Lessons that I hope you take away from this module, And that will help you throughout... I will come back to these.



Economists do not know everything: We know very little but we have thought through many arguments

It may seem like we have the answers, but this is only where we have asked the questions very carefully

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Most non-economists do not fully understand these arguments, and they make mistakes, and they worry.

- But sometimes ignorance is bliss.

Examples: Sunk-cost fallacy, gains to trade/comparative advantage, opportunity cost, free-riding/prisoners' dilemma, double-marginalization,'raise price to raise profit', etc.

I've had many discussions about these things with my non-economist wife. Some of them make her more sanguine and content; other stress her out.

Humans are not like billiard balls, universal rules are hard to come by.

We are building models based on very precisely defined assumptions, usually assuming things like a 'single representative consumer'. These models are seductive and very helpful for clearly conveying insights.

However, when it comes to applying these things to the real world, or testing these models, be careful; people may differ and they may change and they may have multiple motives.

Major theme: Markets work well but not perfectly. Imperfections in existing markets → opportunities.

I don't want you to go away thinking that economists believe, 'markets solve everything, markets yield the best of all possible worlds'. The simplest models do aim to show the conditions under which this holds, but that is not a good characterization of most economic work. Most economists recognize the existence of market failures, and I believe that most recognize the usefulness of government intervention in many cases. Difference of opinion mainly arise over the prevalence of these market failures, and the extent to which government can do a good job of fixing them, or ends up making things worse.

I'm not telling you what *you* need to believe, I just don't want you to have a false impression of mainstream Economics.

As I also mentioned, these apparent imperfections or market failures actually can lead to opportunities to create value and profit. Things that were once market failures might be solved by technology or new frameworks.

Here are some possible examples.

Imperfection: Inefficient monopoly markups for information goods

→ 'All you can eat' → Spotify, Netflix, Kindle Unlimited

When people who value certain goods which could be shared with them at no cost, are nonetheless priced out of this market, this represents an inefficiency. The only price per unit that will lead to the efficient amount of consumption Would here be a zero price. However, firms and content providers cannot stay in business with zero prices. On the other hand, if they can get a good signal of what people would be willing to pay for 'all-you-can-eat' And then charges this to them as a subscription fee, Those consumers who subscribe will then consume the efficient amount. This represents an example of a two-part tariff, a form of price discrimination which may actually increase welfare. We will learn more about price discrimination later.

Free-riding on public goods

→ Disneyworld, resorts

We will see that markets will not provide the efficient amount of certain goods that are non-rival and non-excludable. However (as for the information goods case), 4 large enough territory some of these things like fireworks can essentially be made excludable. Disney World has fireworks every night, and they own such a large property that they can exclude people from coming anywhere near where the fireworks are being shown, so it would be hard to free ride. They then

charge an admission fee to 'be inside of Disney World' and then they want to make the experience of being inside Disney World as nice as possible, so they produce a great deal of what would otherwise be considered public goods.

Imperfection: Lack of information about 'experience goods', lack of trust in one-shot-interactions

→ Uber, AirBnb

Another potential market failure comes from Asymmetric information (we won't cover this in detail); consumers may not know the quality of a product until after they have purchased it. In some cases, this means no one may be able to sell a certain product because consumers will not trust its quality, the so-called 'lemons problem' or 'adverse selection'. Reputation systems, particular those developed on Internet sites like Uber and Air B&B, can help reduce this problem and create new markets (and profit for themselves).

Shyness and fear of 'losing face'

→ Tinder

Perhaps two people want to work together, or socialize or romance each other. However they may both be afraid of the consequences of being rejected. Even though both would like to be 'partnered', neither will make an overture to the other because the risks seem too high.

A third-party intermediary, man or machine, could be set up to only share information about 'Mutual matches'. Once again, this will create fruitful transactions and the intermediary may be also be able to profit.

If you're interested, see my research on this here, presentation slides here, my research page is here.

Asymmetric information, adverse selection

→ NHS, 'Obamacare'

This one *is* a government intervention, obviously. However, private corporations are very deeply involved in these markets and healthcare systems; even in the UK, where healthcare Is perhaps more Directly provided by the government than anywhere else in the world, there are private providers like BUPA.

Insurance markets can fail because of a problem of 'adverse selection'. A given set of insurance policies will tend to be more attractive to those people who envision their at more risk; in the context of health insurance, more likely to become sick and require hospitalization. Because of this, insurance companies will need to charge rates that reflect risks for the less healthy population. Because of this, healthier people may be 'priced out of the market', i.e., prefer to not obtain insurance. This may be inefficient because Even these healthy people may be 'risk-averse', and would benefit from purchasing 'actuarially fair insurance' (We will define these terms later).

There is a strong case to be made that a mandate to purchase insurance (or system of fines and subsidies) can improve overall outcomes in these situations. This is the logic behind several healthcare systems and proposals, including the USA Affordable Care Act passed under the Obama administration, and some aspects of the Netherlands' system as well.

Adv: Firms themselves do not typically use markets: if we look inside the firm and see all sorts of mechanisms to correct or circumvent internal markets. Understanding when and why firms do this, and the trade-offs involved, can help you be a better manager. For example, when should you 'outsource' And when should you keep a task in house? When should you offer employees very strong incentives and when should you just tell them what to do?

Chapter 1: Economic Models

What is Economics?

Note: DR: It has changed. There are different views. Ask two economists, and you'll probably get at least three answers.

> "Economics is the study of the allocation of scarce resources among alternative uses."

> "Economics is the study of mankind in the ordinary business of life." Alfred Marshall

Note: The first quote suggests an *approach* (*how* we do our research), the second suggests a *domain* (what we focus on).
Note: "Economics never tells a man how he should act; it merely shows how a man must act if he wants to attain definite ends." Ludwig von Mises

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What is Microeconomics?

The study of the (economic) choices individuals and firms make and how these choices create markets.

Largely, using theoretical and mathematical 'models' that depend on strong assumptions.

Comprehension Q: Consider some examples of 'relevant choices' for economic study.

What sort of models are we talking about? To refresh your memory... you have probably seen some of these models before in your first economics module. You should have some familiarity with the simple models of supply and demand curves yielding an equilibrium price and quantity. You may also have seen a models of trade, between two countries or two individuals, with only two goods, where for each good one has a 'comparative advantage'.

Consider: Are they 'fully realistic'? No. They are models, i.e., simplifications.

A huge body of work has gone into making these models more complex and 'general'; some of the conclusions are preserved, others are weakened or reversed. But even these more general models are simplifications.

Why learn these models?

Consider the parable of the tortoise and the hare (Aesop)...

One might question the realism of this story:

- Can hares really speak?

- Is this a rabbit or a hare?
- What other animals were racing?

Okay, the story is not so realistic. However, it conveys an important message. Is this message in any way affected by the answers to the above questions?

The same can be asked about many criticisms of simple economic models. Of course one should always consider the applicability of particular models to real-world problems, and carefully consider whether the assumptions are reasonable and relevant, and whether the departures from these assumptions will lead to any different predictions. However, in considering the general insight conveyed by the model, some criticisms can merely be distracting. At the very least, we should not reject economic models simply because they are not fully realistic, just as we do not reject Aesop's fables because they involve talking animals. The idea of 'Ceteris paribus' (all other things being equal) can help us here.

What do models give us?

There are different views of this

Via logic and mathematics:

Assumptions → Results

and sometimes these also yield testable predictions (if the assumptions hold)

Adv: When considering and evaluating these models, you can critique only the assumptions; the results are logically/mathematically proven although when the results contradict real-world evidence this hints that the assumptions may be substantially wrong.

Do these simplified models yield conclusions that are relevant to the more complicated real world? Maybe, and sometimes. We will consider the evidence.

So why learn these models?

- A starting point
- (Sometimes) make concrete predictions you can test
- Building insight, clear arguments, a way of thinking
- Discussion is framed around them and they are seen as a 'baseline'
- Understand the arguments and models to be able to effectively critique or extend them

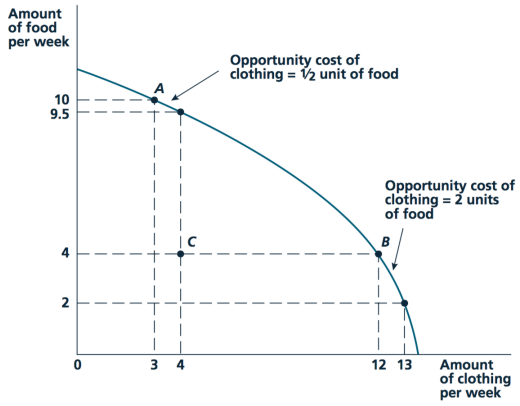
Some critics of what they call 'neoliberal economics' can be misinformed about what it is. Their criticism can sound to us mainstream economists like someone who says 'cars are dangerous and should be banned because they go too fast and have no mechanism for stopping'

Economic Models

Economic model: *Simple theoretical description that captures the essentials of how the economy works.*

The PPF: a 'model' and a way of seeing things

FIGURE 1.1 Production Possibility Frontier



The production possibility frontier shows the different combinations of two goods that can be produced from a fixed amount of scarce resources. It also shows the opportunity cost of producing more of one good as the quantity of the other good that cannot then be produced. The opportunity cost at two different levels of production of a good can be seen by comparing points *A* and *B*. Inefficiency is shown by comparing points *B* and *C*.

Above, we see a depiction of the "production possibility frontier" (PPF), explained in the figure's caption. You may be familiar with this from your previous study. The PPF describes the maximum amount of one good that can be produced conditional on a certain quality of another good being produced.

I'm not sure if I would call it a 'model', but it certainly provides a way of visualizing the trade-offs in an economy, and the way it is drawn embody certain assumptions. This graphic has a mathematical representation which we will not cover now.

Note: For comprehension: *Draw the PPF; consider its slope and what it means*. *See fig 1.1* *Advanced: Consider ... what assumptions does the PPF (implicitly) make?*

PPF illustrates key principles

Principle 1: Scarce Resources

Principle 2: Scarcity involves opportunity cost.

Notes:

- The opportunity cost of a good is measured by the alternative uses that are foregone producing it.
- The opportunity cost of a choice is the foregone 'next best' opportunity from a choice.
- I may just call this 'cost'

Comprehension question (advanced): Think of an example that illustrates the distinction between what is commonly thought of as the 'cost' and the economists' definition of an 'opportunity cost'

On the PPF the opportunity cost of more clothing is less food.

Principle 3: Opportunity costs are (often) increasing.

- What this means is that as you produce more of one good, its opportunity cost (in terms of the other good foregone) increases.

To produce more and more clothing you would have to give up increasing amounts of food.

- The "law" of diminishing marginal returns.

I'm somewhat sceptical of this being a 'law'; there are certainly increasing returns in certain regions. However, you will see it again and again as it is a fairly standard assumption.

You should read and consider these applications on your own. They will show how the economic principles and theory can be applied to the real-world and test and improve your understanding of the theory.

Application 1.1: Economics in the Natural world

The NS textbook presents many interesting applications. These offer you the opportunity to test your knowledge and understanding and apply it to real-world situations. These can also be helpful on assessments; applications may come up, and it may be useful to refer to these and supporting your points on free answer questions.

Studies of honeybees have found that they generally do not gather all of the nectar in a particular flower before moving on.

Why not?

Adv: What key features do modern human economies have that 'animal economies' don't have? Largely: trade, prices, specialisation, free choice vs instinct.

The economics of trade may also apply to the natural world in certain ways.

Adv: Above, we see the working of ant-aphid symbiosis, a form of mutualism. Relevant to the 'conditions necessary for trade to occur'? The ants 'farm' the aphids, who secrete nice substances. In return the ants protect the aphids and only sometimes eat them.

Application 1.2: Is It Worth Your Time to Be Here? (read at home, discuss)

- Consider the same for the UK/Exeter; give your best estimate
- How does the analysis differ from the one your uncle would do?

(Advanced) questions to consider: What are the limitations to the analysis as discussed in the text? How would you estimate the 'return'; Who should we compare? What years of data are these based on – does it tell us about *future* returns?

Should the government subsidise it? Won't people get the optimal education without subsidies?

Consider: Social vs private returns. Is there a case for 'market failure'?

Application 1.3: Rise and Fall of Blockbuster

Critical contemporary business challenge:

(Note edition 12 is updated and discusses Netflix, etc) Blockbuster and Netflix are selling what we call *information goods*. These have a zero marginal (distribution) cost. They are competing with online merchants.

This is characteristic of many things 'online'

In a turnabout in policy, Blockbuster agreed to give the studios a substantial share (as much as 40 percent) of the revenues from its movie rentals in exchange for price reductions of up to 90 percent.

- (Why) was this a good business move? Was it efficient from a social point of view?

Basic Supply-Demand Model

. . . Describes how a good's **price** and the **quantity exchanged** are determined

- Determined by the preferences, behaviour, and costs of potential buyers and sellers

Note: in 2019 we will not be covering the historical background to the Marshallian cross (the demand and supply you may be familiar with). However, I do expect you to understand this model itself.

Marshall's Model of Supply and Demand

Economists and philosophers have long sought to explain 'what determines the prices, and why do they change the way they do?'

In the 19th century UK prices were falling while quantities were increasing; this was a puzzle.

Alfred Marshall argued that a good's price must equal *both* the cost to produce and the value (to consumers) of the last unit produced and consumed.

He introduced the 'demand curve'; *with a downward slope.*

This slope was justified by 'satiation': for an individual, additional units of a good are usually valued less and less. For example, you might be willing to pay thousands of pounds to be able to access 100 gallons of water rather than no water at all, but if you already have access to a thousand gallons of water, you will not be willing to pay very much for an additional 100 gallons.

Furthermore, firms must cater to less and less keen consumers as they wants to sell more and more units. We come back to this later in the module.

'Willingness to pay' (wtp) becomes less and less for the next unit purchased, so will buy more only at a lower price. Equivalently, at a lower price more people find the value exceeds the price, and for additional units.

Note that we will also return to these questions in more depth in later chapters as we build up the demand and supply curves.

With 'single crossing' (a fancy condition you can ignore in this module) there is a unique price where $Q^s(p) = Q^d(p)$, and a unique quantity where the last unit's value to the consumer equals its cost to produce.

Scissors analogy

- The equilibrium model is analogised to a pair of scissors; neither *scis* cuts alone

So *don't* ask 'how does the price affect the quantity exchanged'?

- Understand why 'Just like neither scis cuts alone, neither the supply nor the demand curve determines the equilibrium price and quantity in isolation'?

Adv: Consider: What does it mean to be at equilibrium, and how do we get there?

Draw: the famous Marshallian cross Can you explain?

- The inefficiency of any price other than where $Q^D(p) = Q^S(p)$?
- If the price was set at a different value, what forces might push it to the equilibrium?

Suggested ans:

To economists, a 'shortage' is where, at the prevailing or imposed price, consumers are willing to buy more than is available. Some consumers get value from the good in excess of the price.

In such a case, firms might offer a higher price, or sellers might ask for a higher price. The price rise would reduce quantity demanded (not 'reduce demand') and increase quantity supplied (not 'reduce supply').

Harder question: Who gains or suffers with a government-imposed price floor/ceiling?

To respect yourself in the morning, you must know

- Which factors cause the supply and demand curves to shift?
- What causes 'movements along' the supply or demand curve?

Note: Caveat, to avoid later confusion: These models assume 'price-taking'; neither buyers nor sellers consider the impact of their choices on prices

How Economists 'Verify' (or Assess) Theoretical Models

This will be skipped in lecture, but we will come back to some of these ideas later.

Two methods:

1. Testing Assumptions

'*Verifying' economic models* by examining validity of *assumptions* upon which models are based. Is it reasonable to assume that people are rational, that firms maximize profits etc.?

DR: 'Verifying' is a bit too black and white'; all models have limitations.

Note: Adv: The text is somewhat dismissive of the idea of testing assumptions. However, there are many cases in which the *predictions* of the models are very hard to test; e.g., the impact of a radical change in government policy or the merger of the two largest firms. On the other hand, in many cases the key assumptions entering into models, such as 'constant relative risk aversion' or 'geometric discounting' can be very credibly tested. We can use existing micro data on thousands of household decisions, as well as experiments, to measure 'how close' behavior is to the assumption.

2. Testing Predictions

Note: Verifying economic models by asking whether models can accurately *predict* real-world events. If the model predicts events well, then the theory is useful even if the assumption may not appear to be valid.

DR: But if the assumptions are substantially wrong, it may predict well in one particular case but not in general.

Positive and normative

What's the difference between the following two statements?

1. "An increase in the minimum wage leads to greater unemployment."
2. "We should reduce the minimum wage, to lessen unemployment"

- The first is a *positive* statement: it looks at "what is"
- The second is a *normative* statement: it looks at "what should be"

Adv: Previous slides had the first statement as 'We should increase the minimum wage to help low income workers.' Consider: why do I think this was not a good parallel?

Note: We will mainly focus on positive statements. However, you are not forbidden from making normative statements, and positive results are useful in making normative judgements. But we should try to be clear which type of statement we are making. Still, much economic research has both positive and normative interpretations and implications. Some economists work on ways of clearly defining and quantifying preferences over social outcomes. Others work on determining determining 'how to optimise', with implications for which policies and decisions (for individuals, firms, governments, and nonprofits) will be most efficient and effective at attaining particular goals.

APPLICATION 1.4: Economics According to Bono

This will be skipped in lecture, but please read it; it may come up on an exam.

Do US farm subsidies help or hurt Africans in net? Think about: what do we mean 'in net'?

- No obvious theoretical or empirical answers
- Microeconomic theory helps us consider it, and look for answers
  - Should hurt African farmers
  - Should help African consumers
  - ... Which effect dominates (change in African profit less change in African consumer surplus)?
  - ... *Note*: Fig. 1 in text depicts *African* supply/demand mapped against *world* price

Review questions and problems from Chapter 1

Note: The 'review questions' are fundamental, thought-provoking, and challenging; don't expect an easy answer!

Questions/problems I liked are:

Q6. "Gasoline sells for $4.00 per *gallon* this year, and it sold for $3.00 per gallon last year. But consumers bought more gasoline this year than they did last year. This is clear proof that the economic theory that people buy less when the price rises is incorrect." Do you agree? Explain.

Q8. (This one is conceptual and somewhat tricky!) ''Housing advocates often claim that "the demand for affordable housing vastly exceeds the supply. Use a supply-demand diagram to show whether you can make any sense out of this statement. In particular, show how a proper interpretation may depend on precisely how the word affordable is to be defined."

Note: Some questions on the above material will be covered in the first problem set and the tutorial; see VLE links.

Chapter 1a – coverage outline

Note: We are not doing the Math Tools as a separate lecture: this is required *self-study.* We will briefly cover the idea of *empirical work.*

We will come back to revise this somewhat (in lecture and tutorials) as we *apply* these maths concepts.

Goals of this material:

- (Re)-aquaint you with some of maths tools we will use
  - without scaring you
- Give a flavour of what *empirical* microeconomics is
  - and you a sense of some of the key issues in empirical work

Covers:

- Nicholson/Snyder Chapter 1a: Mathematics used in Microeconomics
- I give a 'calculus for dummies' below to make this clearer
- The math is here to help you, don't let it scare you, and don't worry if you don't understand everything; we will cover it again in context.

Do: Understand what the math is <u>about</u> and how to use it. Don't worry about memorizing 'cookbook rules' that can be easily looked up.

Other maths resources

I am 'curating' some materials to help you revise the maths if you are having some difficulties there.

Firstly, note that the Nicholson and Snyder text has a very relevant and useful appendix 2 chapter 1 specifically covering the most important maths; I have also echoed these in the handout. I covered it in some previous years (can you view the recap HERE? I covered it from minute 31, about), but it didn't seem so helpful to try to cram all of this into a lecture, so I stopped doing it.

Warwick maths notes

The University of Warwick put up some decent 'refresher notes' for incoming economic students. I've re-hosted these on my Dropbox, with some comments on which parts are more relevant. (And remember, with a free dropbox account you can add comments and questions directly on these files which I will try to respond to).

WW notes 1?

WW notes?2

WW notes 3

(Less relevant: WW notes 4?)

WW notes 5: the "inequalities" stuff is relevant?

WW notes 1 WW notes 2 WW notes 3 Less relevant: WW notes 4 WW notes 5: the "inequalities" stuff is relevant

Khan A *very* good resource for maths learning/revision:

The Khan academy has really great well-designed course materials including videos and all sorts of interactive resources.really, I think this is the best place to learn this stuff!

Khan academy: https://www.khanacademy.org/math/, e.g., see their introduction to differential calculus.

Some Khan courses/sections I would recommend in particular

- Pre-algebra (you should know all of this)
- Algebra basics (all of this)
- Algebra I (nearly all of this is relevant, accepting a few things like irrational numbers)
- Algebra II ('Functions' and possibly a few other parts)
- Statistics (mainly just 'discrete random variables'; especially the 'mean')
- Helpful: Calculus as 'rates of change'; just the basic concept of a derivative

Simple stuff

Please note: if this depiction is too abbreviated, please consult the NS text, or the Khan academy and Warwick resources mentioned above!

I expect to cover this in the second lecture

(Univariate) Function A 'map' from one or more *variables* (x) (or 'variables') to an outcome ($y = f(x)$)

- for each value of x the function tells you a single value of $f(x)$; typically we assign $y = f(x)$

Note: 'Variables' are more formally called the 'arguments' of a function

Linear function A function of the form $y = a + bX$; e.g., $y = f(x) = -10 + 3x$

- Plotted as a straight line; intercept a, constant slope b

(Technically this is an 'affine' function; a linear function doesn't have an intercept)

Adv, Maths: For strictly linear functions (not including functions with constants)

$f(aX_1 + bX_2) = af(X_1) + bf(X_2)$

for any values of a, b, X_1 and X_2

In particular 'the function of the average is the average of the functions' (this also holds for affine functions). This does *not* hold in general for nonlinear functions.

Slope of $y = f(x)$ The change in y for a given change in x. 'Rise over run'.

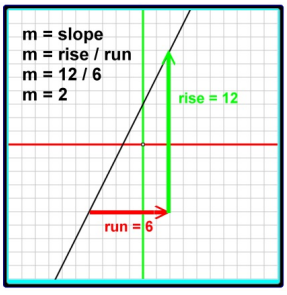
- Arc slope: slope over a range
- Point slope: slope of the tangent to a curve at a point

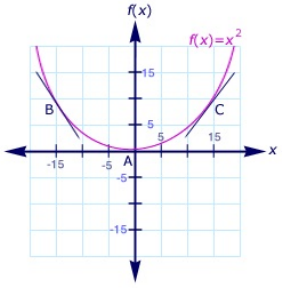
Nonlinear (univariate) function : A function $f(x)$ of a form other than $f(x) = y = a + bX$;

- E.g., a quadratic function $y = f(x) = a + bx + cx^2$
  - E,g, $y = f(x) = 10 - 2x + 3x^2$
- Or a logarithmic $y = ln(x)$ or exponential function $y = exp(x)$

Note: I will try to limit things to linear and quadratic functions, and possibly exponential and log functions. I will remind you of the rules for dealing with these whenever it is necessary.

For linear functions the slope is the same at any point. For nonlinear functions it may differ at each point.





Think of the slope of a mountain versus the slope of a wheelchair ramp.

TABLE 1A.1 Values of X and Y for Linear and Quadratic Functions

LINEAR FUNCTION		QUADRATIC FUNCTION	
X	$Y = f(X) = 3+2X$	X	$Y = f(X) = -X^2 + 15X$
−3	−3	−3	−54
−2	−1	−2	−34
−1	1	−1	−16
0	3	0	0
1	5	1	14
2	7	2	26
3	9	3	36
4	11	4	44
5	13	5	50
6	15	6	54

The point here is that increasing X by 1 has the same effect on Y wherever you start, for a linear function but a different effect depending on where you start for a nonlinear function

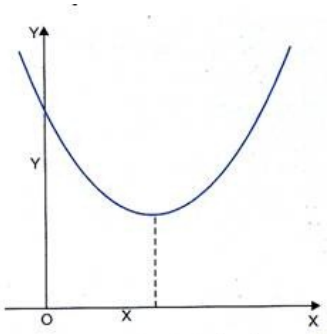


Fig.3.2. *Convex Quadratic function*

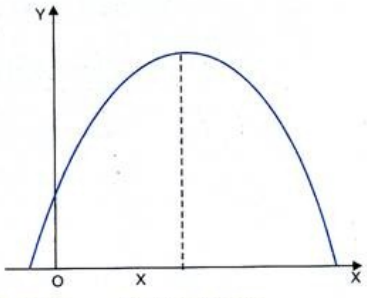


Fig.3.3. *Concave Quadratic Function*

Instantaneous rate of change (instantaneous slope) The slope of the line *tangent* to the curve at a single point

Adv, Math: This is the limit of the 'rise over run' as the run goes to zero

- Convex function: Slope everywhere increasing, unique minimum where slope = 0
- Concave function: Slope everywhere decreasing, unique maximum where slope = 0

Note: we are referring to the signed value of the slope here, not the absolute value. E.g., for the convex case depicted, it goes from a negative slope to a zero slope to a positive slope

For *these* functions the slope is different at each point.

Note: We will mainly deal with functions like these, with a single minimum or maximum that occurs at the unique point with slope zero.

Quadratic function are convex if the x^2 term has a positive sign and concave if it has a negative sign. That's because at extreme values of x the term with the largest exponent will dominate all other terms.

Example of a convex function: Tiger's golf earnings per game as function of hours of golf retraining... he had to get worse before he could get better, they say.

Or cost per smoothie as function of employees behind smoothie counter.

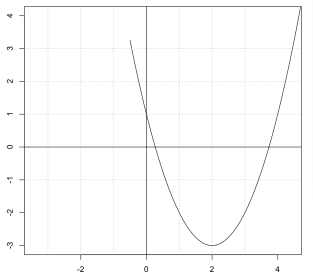
One example of a concave function: how funny I am as function of beers I drink (on the other hand, how funny I *think* I am may be an everywhere increasing function.

Derivative of a function A *derivative* of a function $f(x)$ is another function called $f'(x)$. $f'(x)$ tells us the *slope* of the function $f(x)$ at any point x.

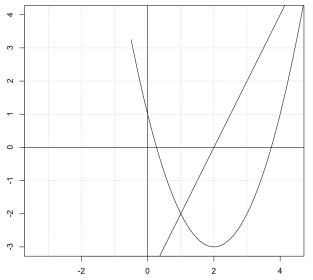
- For example, the derivative of the function $f(x) = 2x + 3$ is $f'(x) = 2$
  - For this linear function the slope is a constant, 2

We will come back to the following examples later.

- E.g., the derivative of the quadratic function $f(x) = x^2 - 4x + 1$ is $f'(x) = 2x - 4$



- derivative of the quadratic function $f(x) = x^2 - 4x + 1$ is $f'(x) = 2x - 4$



- E.g., the slope at $x = 1$ is $f'(x; x = 1) = 1 * 1 - 4 = -2$
- The slope is zero where $f'(x) = 2x - 4 = 0$, or where $x = 2$
  - *Is $x = 2$ at a min, a max, or neither? How do we know?*

Minimum, maximum, or neither?

- $f'(x)$ is a function that tells us the slope of $f(x)$, or how $f(x)$ changes in x at any point x
- In turn, the derivative of $f'(x)$ is called $f''(x)$. This tells us how the *slope* changes as x increases

Oversimplifying a bit:

(Adv, Math: Essentially, for a class of functions where the domain is not bounded)

- if the slope is always increasing, i.e., if $f''(x) > 0$ everywhere, the function is *convex* (u-shaped), and has a single minimum where $f'(x) = 0$
- if the slope is always decreasing, i.e., if $f''(x) < 0$ everywhere, the function is *concave* (inverse-u-shaped), and has a single maximum where $f'(x) = 0$

Functions of two or more variables (multivariate functions)

Utility, profit, cost, production, returns, etc.

- May depend on multiple variables/inputs
- Need to illustrate tradeoffs between these

$$y = f(x, z)$$

- y may increase and/or decrease in x and in z
- The rate of increase of y in x may depend on the values of x and z
  - Similar for the rate of increase of y in z

E.g.,

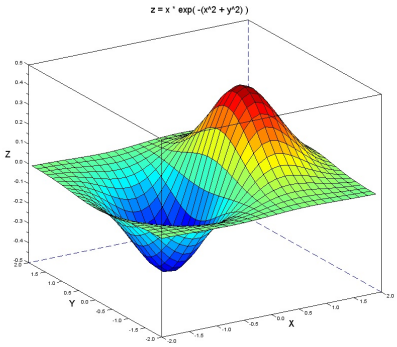
$$y = \sqrt{(xz)} = x^{1/2}z^{1/2}, x \geq 0, z \geq 0$$

Note the outcome will increase in each argument at a decreasing rate.

What does it look like? 3d: project up to y from a "map" of x and z coordinates on the desk.

This is hard to picture; 'contour lines' can help.

Projecting a function up from X,Y space into the Z axis:

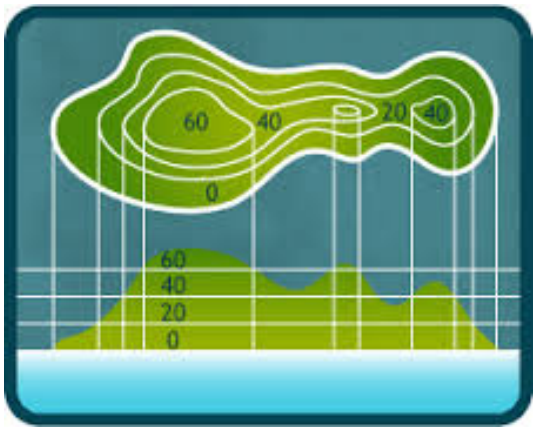


Contour lines (we will come back to this later)

Contour lines Level sets - depict combinations of variables that hold the function constant at a particular value
f(x,z) = A for some value A

Level sets: *E.g., indifference curves*, *isoquants* and *isocost* curves.

Don't worry if you find this discussion of level sets confusing. We will come back to it later in the module for a more specific case.



Note: It is difficult to depict more than 2 dimensions on a piece of paper. So we find the values for the 2 variables that give us a particular value for the third . . . which tells us how these trade off.

Consider a production function:

$$Y = f(K, L) = \sqrt{(KL)}$$

Setting this equal to 1 we can map out 'all combinations of K and L that produce output $Y = 1$'.

We do this by solving for the amount of K needed to produce 1 as a function of L and then plotting this against a range of L

$$Y = \sqrt{(KL)} = 1 \rightarrow KL = 1$$

$$\rightarrow K = 1/L$$

Setting this at Y = 2

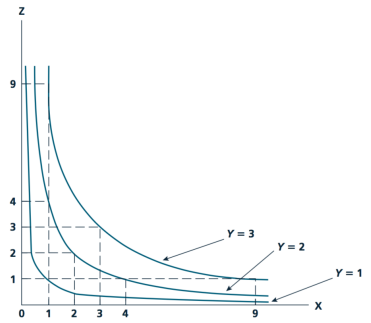
$$Y = \sqrt{(KL)} = 2 \rightarrow KL = 4$$
$$\rightarrow K = 4/L$$

TABLE 1A.2 Values of X, Z, and Y That Satisfy the Relationship $Y = \sqrt{X \cdot Z}$

X	Z	Y
1	1	1.000
1	2	1.414
1	3	1.732
1	4	2.000
2	1	1.414
2	2	2.000
2	3	2.449
2	4	2.828
3	1	1.732
3	2	2.449
3	3	3.000
3	4	3.464
4	1	2.000
4	2	2.828
4	3	3.464
4	4	4.000

Connect values of x and z that lead to the same value of y.

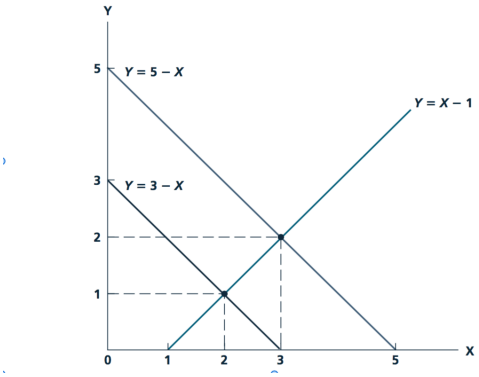
FIGURE 1A.5 Contour Lines for $Y = \sqrt{X \cdot Z}$



Contour lines for the function $Y = \sqrt{X \cdot Z}$ are rectangular hyperbolas. They can be represented by making Y equal to various supplied values (here, $Y = 1$, $Y = 2$, $Y = 3$) and then graphing the relationship between the independent variables X and Z

Simultaneous equations (Cover briefly in lecture)

FIGURE 1A.6 Solving Simultaneous Equations



E.g.,

$$X + Y = 3$$
$$X - Y = 1$$

Holds only where $X = 2, Y = 1$, the 'unique solution'

Note: Be sure you know how to solve the above.

Adv math: Note, in general, we need as many equations as unknowns (above 2 of each) to *possibly* be able to find a solution. However, some sets of equations have *no* solution, and some may have *multiple* solutions. Consider plotting overlapping lines, or parrallel lines, and looking for the point(s) of intersection.

Meaningless to ask 'how does a change in X affect Y?' in the above context. Equally meaningless: 'how does the price affect the quantity exchanged?' in a demand-supply Marshallian cross.

Empirical microeconomics/econometrics

Empirical research Uses evidence from the *real world*, i.e., observation, to answer questions (rather than introspection and theory)

Econometrics The 'science' of using data to answer economic questions
Uses statistical tools and often economic theory

Micro-data Data where the unit of observation is an individual, household, firm, etc.
(Contrasts from macro-data, data on aggregates like GDP, inflation, etc.)

Adv: Econometrics often has a different focus and different methodology than 'regular statistics'. Econometrics has taken on a larger role in economics over the past 40 years, because of greater data availability and computing power. Most published papers in economics now involve some econometric analysis.

Empirical meta-example

(A bit advanced)

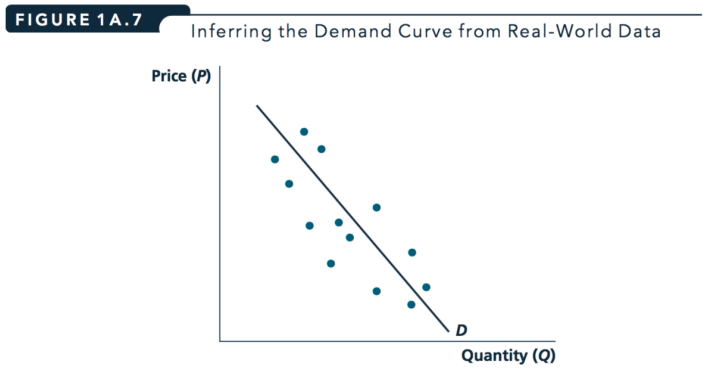
Suppose we are trying to estimate the market demand curve; suppose we hypothesize that this demand curve is a linear function. (I.e., suppose we assume that quantity demanded is a linear function of price).

$$Q_d = a - bp$$

Suppose we know that price is changing because of cost changes, shifts in supply curve, or the firm experimenting

Adv: Otherwise the problem is poorly identified, as demand and supply will jointly determine price

We observe price and quantity data for a period where *ceteris paribus* is reasonable



We try to fit the 'best' line through these points (minimizing the distances between the line and the points, or minimizing the 'error' of this predicted quantity)

We estimate the demand curve's slope and intercept. We can use this to make inferences.

This line will never fit exactly, because of unobserved differences, nonlinear demand, measurement error, randomness in behaviour.

But this fitted line is *only* meaningful if we are observing shifts in the *supply curve and not the demand curve*! (Can you explain why?)

Ceteris paribus

> All [most] economic theories employ the assumption that 'other things are held constant.'

- In above data/figure, demand may differ between weeks/stores, weather may change, etc.
- 'the points may lie on several different demand curves, and attempting to force them into a single curve would be a mistake.'
  - → We would like to carefully 'control' for other observable factors

Adv: May also use flexible functions permitting heterogeneity – differing *slopes*.

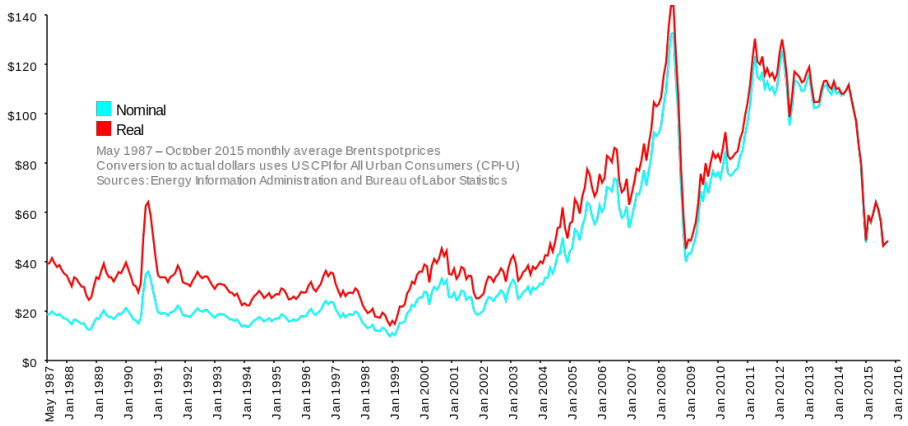
We can never control for everything or know 'true' functional form. Sadly, all *empirical* work involves imperfect compromises.

But happily there are ways to test and validate the estimates, e.g., see how well they predict future outcomes.

Application 1A.3: ... Changing world oil prices

This will be probably skipped in lecture, but please read it. This will be referred to in problem sets/tutorials.

This is a great example from perhaps the most important unified global market, with tremendous fluctuations that have huge impacts. It shows the power of empirical microeconomics. (Note edition 12 updates.)



Henceforth we will refer to:

- the *market demand* curve, as a function of price (P) and other things, as $Q_D(P, ...)$ and
- the *market supply* curve, as a function of price (P) and other things, as $Q_S(P, ...)$.

The quantity (units of a good) that firms in the market are willing to supply is a function of the price and other 'background' things. The total quantity that consumers in the market or willing to demand is a different function of the price of other things. We typically these 'supply curve', and 'demand curve', respectively, but I want to to think of these as functions that can shift. I don't want you to write 'demand went down'; that is ambiguous.

The price where these quantities are equal is the 'prevailing price in the market'. We build this up throughout the next sections in more detail.

Getting back to the example...

Empirical work has estimated the equations below, the estimated supply and demand curves expressed in dollars and millions of *barrels*, from an earlier period:

$$Q_D = 85 - 0.4P \; (D)$$
$$Q_S = 55 + 0.6P \; (S)$$

Setting $Q_S = Q_D$ and solving this yields: $85 - 0.4P = 55 + 0.6P \rightarrow P = 30, Q = 73$

Note: This is the sort of simultaneous equation you should be able to solve.

This approximates the 2000-2002 price

So what accounted for price rise in 2008 to about US$130, and then fall to US$50 by March 2009?

- China and India's economy grew, implying a growth in the world economy by 3-4% per year
- Various calculations imply that this represents a shifting out in the Demand curve from $Q_D = 85 - 0.4P$ to:

$$Q_D = 112 - 0.4P$$

Side note: I think the 'new demand' curve comes from an approximation: if the world economy grew at 4% per year over seven years, each year it was 1.05 times it's previous size. ... thus the growth is $1.047^7 = 1.316$. They assume oil's demand curve would shift out proportionally

but have the same slope. 1.316*85 is about 112. Note that the text has a typo: equation 3 on page 40, the new demand, should read $Q = 112 - 0.4P$.

With the same supply curve and the new demand curve we have

$$Q_D = 112 - 0.4P$$
$$Q_S = 55 + 0.6P$$

This $\rightarrow$ solves to $P = 57, Q = 87$

Furthermore, overall price inflation, US$ devaluation $\rightarrow$ accounts for about a price of US$94

So why was did the price move to $130?

Other changes included: Speculation, other disruptions. *Supply* may have also shifted (political turmoil, new sources of energy, etc.)

Do you know the current price of oil per barrel in USD and GBP?

Problem sets

Note: There will be 8 total problem sets, each covering a block of material. As noted above, these are aimed to help prepare you for the assessments.

Representative answers and explanations for each problem set will given about 1-week after posting. These will be put up as dropbox files you can comment/ask questions on.

The five support classes (tutorials) will cover *parts* of these.

First problem set and tutorial: coverage

See the file linked on the VLE (I put up just the questions first, and then the answers and explanations later.)

Lecture2: Utility and Choice [NS Chapter 2; 2 hours]

We now consider the very very fundamental building blocks behind the (in)famous "neoclassical economics model." Accept these"axioms" nearly everything flows from it!

Some motivation for these abstract ideas

Consider a decision you recently made? Define this decision clearly; what were the options? How do you think you decided among these options?

What did this depend on? Would other people in your place have made the same decision? If you got amnesia and forgot what you decided and then were in the same situation again. Do you think you'd make the same decision?

Suppose I asked you

'State a rule that governs how people *do* make decisions'...

I want this rule to be both

1. Informative (it rules *out* at least some sets of choices) and
2. Predictive (people rarely if ever violate this rule).

Suppose I asked an apparently similar question:

'State a rule that governs how people *should* make decisions'..

By 'should' I mean that *they will not regret having made decisions in this way.*

If people *did* follow these rules, what would this imply and predict?

Economists (and decision theorists/decision scientists) have specificall defined such rules in terms of 'axioms about preferences'

They have started from these 'reasonable axioms' and followed their logical implications for individual choices, individual responses to changes in prices and income, market prices and quantities and their responses, 'welfare' and inequality outcomes for entire economies, etc.

The 'Standard axioms' (imply that) choices can be expressed by 'individuals maximising *utility functions* subject to their *budget constraints*'.

This yields predictions for individual behavior, markets, etc.

Between first and second week; priority home-study

Make sure you are following along.

Can you answer the questions mentioned above and in the lecture?

- E.g., can you explain why (supply) demand curves slope (upwards) downwards?
- Can you solve a system of two equations (supply, demand) for an equilibrium price and quantity?
- What causes shifts versus movements along the demand curve?

At this point, you should be able to do problem set 1. Please do at least get a start on it.

After week 1, before week 2 lectures, be sure you have read/understood all of the 'handout' and corresponding material up to this point.

To prepare for the week 2 lectures, you should look ahead at the readings and handout material (below).

- In particular, read and consider the material on 'preference axioms', 'utility functions', and how the latter are depicted using indifference curves. These are difficult and somewhat abstract concepts; try to test your understanding and bring questions (or ask these on the VLE)!
- If you have time, please also start considering the budget constraints and conditions for consumer optimisation. In particular, the 'bang for the buck' condition is something you will want to look at closely to get your head around it.

Lecture 2 (2 hours), Chapter 2 – Utility and Choice – coverage outline

Key goals of these lectures (and accompanying self-study)

1. Understand what 'utility' is and how is it defined and modeled
2. Understand the assumptions economists usually make about preferences (choices) and their implications
3. Learn how to depict preferences and utility with 'indifference curves' and how to interpret these
    - ... with examples like 'perfect substitutes' and 'perfect complements'
4. Learn what 'budget constraints' are and how to compute and model them
5. Understand 'maximising utility subject to constraints'
    - and the conditions for optimisation involving price ratios and marginal rates of substitution
6. Learn how to depict this optimisation in a graph with indifference curves and budget constraints
    - ...and how to interpret this graph

Note: Part 2 (ch 2-3) involves building the demand curve from first principles, and discussing how to interpret it

Notes: We want to develop a model that can be used to show how we make choices or decisions.

In the (neo) classical economics framework, your (optimising) choices are determined by two things:

1. Preferences: what goods do you like?
2. Constraints: how much money do you have, what are the prices of the goods you buy?

- Second problem set, first part (NS chapter 2): Preferences, Utility, Consumer optimization, individual and market demand

Utility

Utility "The pleasure or satisfaction that people get from their economic activity."
Alt: The thing that people maximise when making economic decisions

Adv: There is some debate about the meaning and interpretation of utility, particularly in the Behavioural Economics literature

Adv: A defining feature of the standard Economics approach is that decisions are made as if all characteristics of outcomes can be compared and evaluated, thus we can reduce everything to a single dimension, 'utility', which is maximised.

Utility from two goods

We may specify a "utility function" of two goods (or aggregations of goods) X and Y:

$$Utility = U(X, Y; other)$$

We can get a lot of insight from considering models Of an individual's preferences over only two goods. These two 'goods' could represent, for example:

- Leisure and 'goods consumption'
- Food and non-food
- Coffee and tea (holding all else constant)

Maths revision: $U(X, Y)$ expresses a *function* with two *arguments*, X and Y.

At this point, you may want to return to the revision material covering functions of two or more variables. Math-multivariate functions

$U(X, Y)$ must take *some* value for every positive value of X and Y.

In *general* a function of X and Y might increase or decrease in either X or Y, or increase over some ranges and decrease over other ranges of these two arguments.

For example, consider the function 'altitude of land in Britain as a function of degrees longitude and latitude'.

$U(X, Y)$ expresses a *general* function; I haven't specified *what* this function is.

E.g., it could be $U(X, Y) = \sqrt{(XY)}$.

Measuring and comparing utilities

Adv: This is a difficult but well-studied issue, as it is important for methodology and welfare analysis. In more detailed discussions, we might speak of 'cardinal utility', 'ordinal utility', etc., to indicate the ways we can or cannot compare utility between individuals and in response to policy changes.

- Utility is not 'observable and measurable in utils'

Utility is seen to govern an individual's *choices* and thus it's only inferred indirectly, from the *choices* people make

Interpersonal comparisons are difficult

Who gets 'more' utility? We don't know.

Also, considering a transfer from Al to Betty: Is the reduction in Al's utility more or less than the increase in Betty's?

Revealed preference: if Al buys a cat instead of a dog, and a dog was cheaper, we assume Al gets more utility from a cat.

As we only get at utility through an *individual's* decisions, we have no reliable way to compare it across individuals.

However, there is work done in the field of public choice trying either to build this up from *axioms* (e.g., the veil of ignorance), or by eliciting people's preferences over distributions through interesting surveys, experiments, and voting behavior.

Assumptions about preferences ('axioms')

1. Completeness: Given two options, A and B, a person can state which option they prefer or whether they find both options equally attractive.
2. Transitivity (internal consistency): If I prefer A to B, and prefer B to C, then I must prefer A to C.
3. More is Better (*nonsatiation*)

Adv: Completeness and transitivity (and continuity) are necessary for people's choices to be represented by (continuous) *utility functions* Nonsatiation will help us derive results

1. Completeness

The following is forbidden: "I cannot choose between a ski holiday and a beach holiday, yet I am not indifferent between these."

Why *wouldn't* I be able to express a preference? In the case above that seems strange, but for other cases it may be extremely difficult or painful to make a choice, or very hard to compare two things. Imagine if you were asked to choose between never seeing your mother or never seeing your father. In general, economists' standard approach assumes we have a consistent preference ranking over all possibilities, and choose accordingly. Other social sciences see this differently/

Also 'forbidden' in the classical model: the *time* or *frame* in which I make the *decisions* must not affect my choices. This will be relaxed when we discuss behavioral economics.

Fancy notation: Either A preferred to B, B preferred to A, or A indifferent to B

$$A \succ B, B \succ A, \textit{ or } A \sim B$$

You don't have to know this notation, but it may be a helpful shorthand

---

2. Transitivity

$$A \succ B \textit{ and } B \succ C \rightarrow A \succ C$$

- Similar for indifference ($\sim$)
- If I prefer an Apple to a Banana and a Banana to Cherry then I prefer an Apple to a Cherry.

A similar idea holds if I am indifferent between one pair of these. If this seems confusing it may be because it is *too* obvious (although behavioral and experimental economists claim to find violations).

Adv: If you found someone who stricly preferred a apple to a bananas, a banana to a cherry, and a cherry to an apple, you could make a lot of money out of them!

In more detail...

Intuitively: Transitive preferences are 'internally consistent': If I prefer A to B, and prefer B to C, then I must prefer A to C.

Loosely, I might expect this if I think that a person has preferences that can be ranked in a normal way. The standard 'utility framework' takes this for granted. If we have any rule over preference such as 'more is better' or 'tastier is better', this should hold. Also, someone whose makes choices following preferences that are not transitive may quickly be impoverished by a shrewd trader. We do not see this happening in general.

If you found someone who strictly preferred a apple to a bananas, a banana to a cherry, and a cherry to an apple, you could make a lot of money out of them. This is easiest to illustrate if we allow these goods to be non-discrete and assume 'more is always better.'

It works as follows:

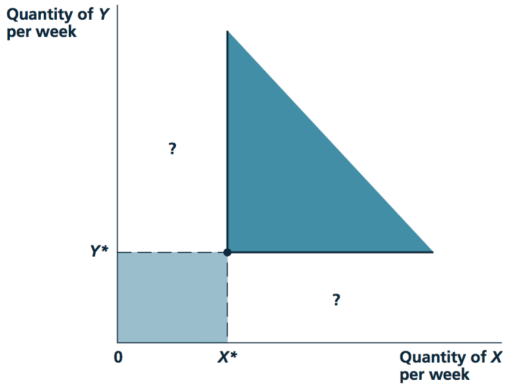
0. Obtain (or borrow) an apple, a banana and a cherry.
1. Offer to give this person an apple in exchange for their banana plus a tiny little extra small unit of banana (or 'money').
2. Next offer them a cherry for their apple plus a bit extra.
3. Next offer a banana for their cherry plus a bit extra.

. . . Keep repeating steps 1-3, until you've drained all of their resources.

(Final) Exam question: What are 'transitive preferences'? Give an example of a person making choices that seem to reflect preferences that are *not* transitive, and explain how you could 'pump money' from this person.[2]

3. More is better ('global nonsatiation')

FIGURE 2.1 More of a Good Is Preferred to Less



Perhaps this seems unreasonable? One way you might justify it: If the product is a 'bad' (e.g., pollution), redefine the product as the *absence* of the product.

The darkly shaded area above represents those combinations of X and Y that are unambiguously preferred to the combination X*, Y*. This is why goods are called 'goods'; individuals prefer having more of any good rather than less. Combinations of X and Y in the lightly shaded area are inferior to the combination X^*, Y^*, whereas those in the questionable areas may or may not be superior to X^*, Y^*.

Who cares?

If people obey the first two above assumptions/axioms, the completeness and transitivity$*$, they will make choices in a way consistent with maximising a (continuous) *utility* function. (. . . OK, maybe you still don"t care, but economists do.)

($*$technically, we also require something called 'continuity', which also yields continuous utility and demand curves that don't have jumps, but we won't discuss this).

Strictly, most results only require 'local nonsatiation'; starting from any consumption point, increasing the amount of *some* good by a tiny ϵ amount will yield a preferred point. This will yield results like 'people will spend all of their wealth' and '(roughly) people will never buy a more expensive bundle when a cheaper bundle is preferred.'

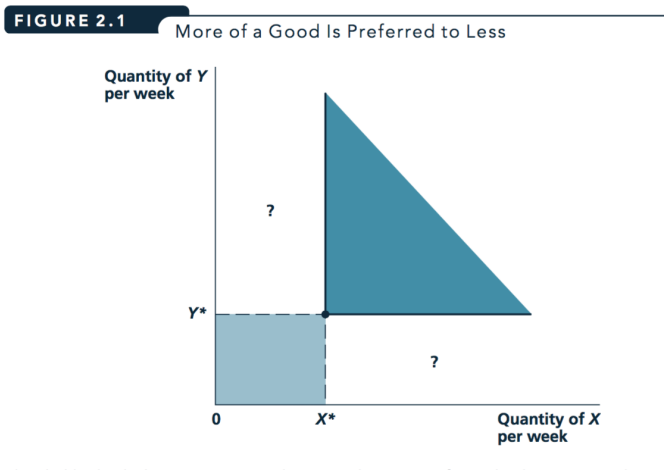
We are not saying people *actually* consult a utility function. That would be a dumb thing to say. We are considering that 'people behave as if they are maximizing utility functions'; this is (basically) equivalent to saying "people choose based on preferences that satisfy the above assumptions.

These axioms stand directly behind 'revealed preference' methods for measuring how much people value nonmarket goods, like clean air and national parks. It also gives us a vocabulary and a way to test for violations of this consistency, and make alternate predictions.

Also. . . [3]

[2] Transitivity (internal consistency): If I prefer A to B, and prefer B to C, then I must prefer A to C. If 'Intransitive Eddy' is offered 1 apple and 1 banana and 1p, he chooses the apple. If he is offered 1 banana versus 1 cherry and 1p, he chooses the banana. If he is offered 1 cherry versus 1 apple and 1p, he chooses the cherJjji Pump money from him: Buy an apple, a banana, and a cherry. Get him to buy a banana from you. Get him pay you 1p to trade his banana for your apple. Then get him to pay 1p to trade his apple for your cherry. Then get him to pay 1p to trade his cherry for your banana. Then get him to pay 1p to trade his banana for your apple. Repeat ad nauseum.

[3] Axiom 3 (nonsatiation) makes the maths more convenient, and is necessary for some results/predictions Strictly, most results only require a weaker 'local nonsatiation' condition.



- How can we compare the "?" areas? Which are preferred?

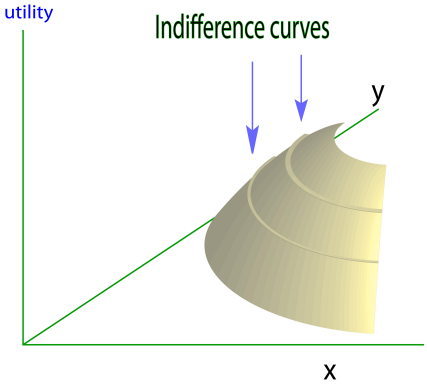
<!— @mcq –>

→ Compare utilities, depict this using *Indifference Curves*

Voluntary trades and indifference curves

Indifference curve A curve that shows all the combinations of goods or services that provide the same level of utility.

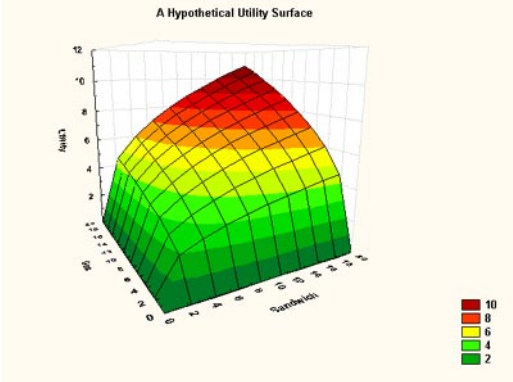
Formally (for 2 goods), the set of pairs of X, Y such that $U(X, Y) = c$ for some constant c[4]



Consider the above diagram [5] . Think of this as a map with a projection above it.

- How far East you go on this map determines how much of the x good is consumed
- How far North you go determines how much of the Y good is consumed.
- How high is the projected image... Determines how much utility is obtained from this combination of goods X and Y.[6]

[4] Recall the "level sets" from the maths revision material.
[5] Credit: www2.econ.iastate.edu
[6] Hmm... If we think of this as a traveler who loves 'getting high', and 'consumes' by driving East or North, and his utility is his altitude, maybe that helps.



The above diagram also includes color to depict the utility level, like a 'heat map'.[7]

You can find further revision of this basic content at Khan Academy

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todo: add link to Khan

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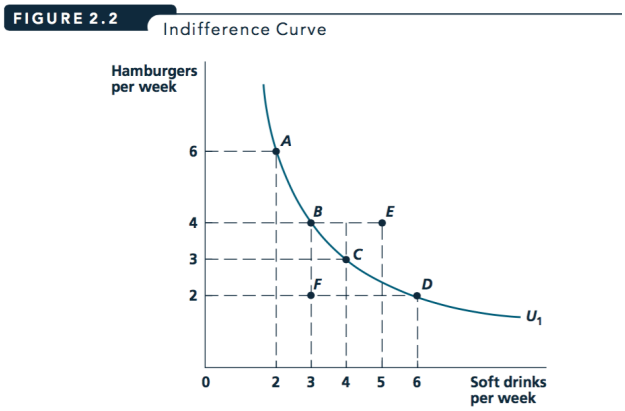
Properties of indifference curves



Note for above: Suppose you are someone that likes hamburgers and soft drinks. If this is too difficult to imagine, think of two healthy goods, like runner beans and green tea. Note that the *period* of consumption—a day, a year, or a lifetime—is not specified.

Comprehension Q: Rank order of preference between points A-E. Note: I've asked this as a MCQ on exams! (Answers to most comprehension questions are given in footnotes. Try to answer it yourself before looking at the footnote.) [8]

Q: How do we know $E \succ B$?[9]

Q: How do we know $E \succ A$?[10]

Even though these concepts are rather abstract, we can already apply this to an interesting question that has been central to economics throughout history.

Why is there 'voluntary trade' (between individuals)?

This gives us insight into why people trade with one another.

[7] This diagram is from a very useful resource from MIT, Frank's Economics on the web, an interactive tutorial that is worth checking this out to help you understand these concepts and more.

[8] Ans: $E \succ A \sim B \sim C \sim D \succ F$

[9] A: It has more soft drink, and the same amount of hamburgers. By Assumption 3: more is preferred to less.

[10] $B \sim A$ because they are on the same indifference curve If $E \succ A$ and $B \sim A$ then $E \succ A$ by transitivity of the preferences, assumption 2.

Considering figure 2.2 (above and in the NS text), an individual is ok with giving up soda for hamburgers or vice/versa *along* her indifference curve. A trade that put her *above* the IC makes her 'strictly' better off.

So consider if one individual had allocation D and another allocation A, and they had the same preferences. What trade could they make to make each of them better off?

Note that a straight line between these two points describes the combinations of 'shares of bundles A and D adding up to 1' (e.g., 1/3 of D and 2/3 of A) or 'trading a fraction of bundle D for the same fraction of bundle A, and vice versa.' E.g., a 50-50 split of each bundle yields, in this case, (6+2)/2 = 4 hamburgers and (2+6)/2=4 soft drinks.

Marginal rate of substitution (MRS): Absolute value of slope of indifference curve

The MRS measures the maximum amount of one good (Y) that you would be willing to give up in order to gain one more unit of another good (X). I.e., this would be the amount you could give up of Y when you gain one unit of X and be no worse or better off. You are 'indifferent' to making this change.[11]

Returning to fig 2.2:

- Moving from A to B: She is willing to give up 2 burgers to get 1 more soda.
  - $\rightarrow$ Here the slope -2, implying a $MRS = 2$ [12]
- From B to C? (think about it)
  - willing to give up 1 hamburger to get 1 more soda $\rightarrow MRS = 1$
- C to D?
  - $MRS = \frac{1}{2}$

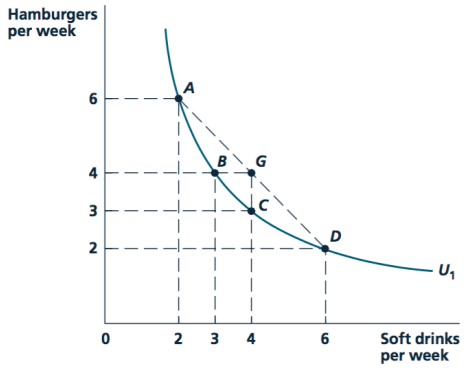
(Here this refers to 'arc slopes', not precisely the slope at points tangent to the curve.)[13]

- Note the decline in the MRS as she gets more hamburgers (and fewer sodas): this 'diminishing MRS' is a common assumption... this may reflect *satiation*; as she gets more and more hamburgers each one adds incrementally less to her utility (because she grows tired of them.)

Careful: it is very easy to get the numerator and denominator wrong in computing the MRS. Find a way to remember this for yourself.

Preference for variety/balance

FIGURE 2.3 Balance in Consumption Is Desirable



This 'preference for variety' is thought to hold for most combinations of goods, most of the time, but probably not for all pairings[14]

[11] Adv, math: This slope will equal the negative of the *ratio* of the rate at which utility increases in each good (partial derivative). Intuition: giving up a certain utility from one good must be balanced by an increase in utility from the other good. So the MRS is the ratio itself, because it's the absolute value.) Formally, the MRS at point X, Y, where $U(X, Y) = U_1$ is: $MRS(X, Y) = -\frac{dY}{dX}|U(X, Y) = U_1$, the absolute value of the total derivative of Y with respect to X, holding utility constant.

[12] Because we take the absolute value, i.e., the magnitude of the slope expressed as a positive number.

[13] However, for continuous functions this gets closer and closer to the point slope the smaller the arc.

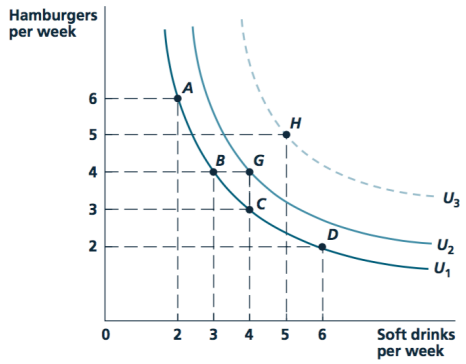
[14] Adv: This assumption generally makes it easier to find solutions where people consume both goods, and will imply smooth reactions to price changes. An extreme case is where each good is an 'absolute necessity', so as its consumption goes to zero its marginal utility goes to infinity; here people must consume some of *each* good no matter the price.

With an indifference curve with this shape ('convex') any consumption bundle that represents a 'mixture' between two equally attractive extremes will be preferred to those extremes.[15] E.g., if I like bundles A and D equally, I prefer a bundle of 1/3 of A and 2/3 of D to either A or D.[16]

the X-axis good as one gives up}

Indifference curve map

FIGURE 2.4 Indifference Curve Map for Hamburgers and Soft Drinks



- Key principles: IC's never cross, never slope upwards, and have zero thickness

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@MCQ: indifcurves_implications @MCQ: indifcurveproperties

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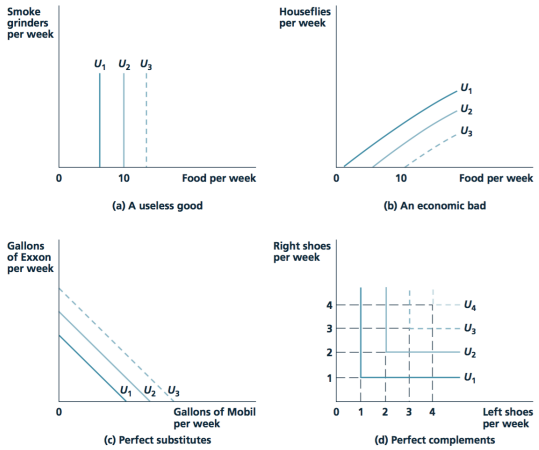
Illustrating particular preferences

N&S give some examples of preference which violate some of the above assumptions and do not exhibit diminishing MRS.



Further notes on the above diagram:

[15] Economists pretentiously call these 'convex combinations', which essentially means 'combining a positive share of each bundle, where the shares add up to 1.'

[16] How do I know the line connecting these points describes such mixtures? You can see by defining these formally and plotting this line... in multiple dimensions this is a plane or 'hyperplane'.
More inuitively, consider that the slope of this line represents the slope of the difference in these bundles: 'the reduction in hamburgers divided by the increase in soft drinks'. (Equivalently, in giving up a share of the upper left bundle to gain the lower right bundle, the number of soft drinks one gains for each hamburger sacrificed.) In giving up a certain share of one bundle to gain a share of the other bundle I am reducing my consumption of one good to gain another good at a *constant linear* rate. Here, I need to move from 6 to 2 hamburgers and from 2 to 6 soft drinks. The slope of this is just one (6-2/6-2) in this case, as seen in the dashed line.

- Smoke grinders are useless: violates 'more is better'; this good can be ignored.
- Houseflies are a *bad*. (But housefly *reduction* is a good).
- Two types of petrol: *perfect substitutes* (at 1:1); no preference for variety.
- Left and right shoes are *perfect complements* in 1:1 proportions; no benefit to more of one without the other; consumed in exact proportions.

App 2.3: Product positioning in marketing (not covered in lecture, read on your own)

- Preference for balance? (Convex indifference curves)?
  - If market research suggests a broad group indifferent between A and D (in fig 2.3), they may strictly prefer G
  - → a possible *niche* for a new profitable product

What may be a critique, exception to this logic, e.g., for a particular food?

Some suggested answers, others are reasonable...

- Convex preferences, 'preferring mixtures' is a very strong assumption, unlikely to hold everywhere, or for actual *mixtures*. I may be indifferent between liver and custard, but it doesn't mean that I prefer liver-flavoured custard, nor even necessarily equal amounts of liver and custard side by side.
- Producing an 'intermediate' attribute may be more costly; it may be easy to make crunchy but low-taste cereal or tasty but low-crunch cereal, but expensive to make a cereal with both attributes. E.g., hard to make a car that is spacious *and* fast.

These issues are decently addressed in the most recent edition 12.

- Utility/indifference curves: Also a framework for marketing analysis

Note: The utility and indifference curve construct may seem highly theoretical. Indeed, these models were developed largely to address big questions like 'who gains from trade?' Still, it helps organise thinking and analysis for at least some managers and marketing groups. According to the text, Marriot hotel used focus groups to 'construct (multidimensional) indifference curves' to consider their ideal product positioning. I have seen a similar presentation for other hotels.

Definitions: Perfect substitutes and complements

Perfect substitutes Goods A and B are Perfect Substitutes when an individual's utility is linear in these goods when she is always willing to trade off A for B at a fixed rate (not necessarily 1 for 1)

Perfect complements Goods A and B are Perfect Complements when an individual only gains utility from (more) A if she also consumes a defined (additional) amount of B, and vice-versa

These goods are 'enjoyed only in fixed proportions'. E.g., left and right shoes (1:1) bicycle frames and wheels (1:2) or, perhaps, baking powder and flour (1:40) for someone who only eats soda bread.[17]

Choices are subject to constraints

You cannot spend more than your (lifetime) income/wealth → *budget constraint*. Consider the budget constraint given in the figure below.

Notes: For example, think 'food' and 'nonfood'.

Be careful: it is very easy to get this slope ratio backwards!

[17] Warning: These are not the same as the 'complements' and 'substitutes' in demand functions which we will see you later, referring to the impact of changing prices.

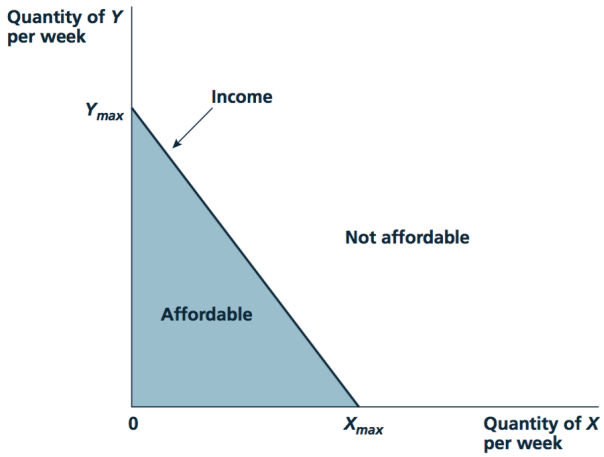


Figure 1: Budget constraint for two goods, slope $-P_x/P_y$

Budget constraint algebra

If I spend all my income (which I should do over a 'relevant lifetime'), then:

Expenditure on X + Expenditure on Y = Income (I)

$$P_X X + P_Y Y = I$$

To see how Y trades off against X, rearrange this to:

$$Y = -\frac{P_X}{P_Y} X + \frac{I}{P_Y}$$

- Intercept: $\frac{I}{P_Y}$, i.e., amount of Y you can buy if you only buy Y
- Slope: $-\frac{P_X}{P_Y}$, i.e., how much Y you must give up to get another unit of X

Notes and intuition:

The slope $-P_X/P_Y$: How much Y I must sacrifice to get another unit of X, expressed as a negative number.[18]

To get another unit of X it costs me $P_x X$, so the more costly is X the *more* Y I must give up.

For each unit of Y I give up I save P_Y, so the more costly is Y the more I can save by giving up 1 unit of it, thus, the less I need to sacrifice of Y to get another unit of X.

Work on making sure you can calculate the slope and intercept, what they mean, and have intuition for why the slope has this formula. See 'micro quiz 2.3')

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@MCQ:

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Having trouble understanding the budget constraint computations? There is a great interactive exercise [HERE](http://web.mit.edu/11.203/www/econ/), click on 'budget constraint'.

Utility maximization

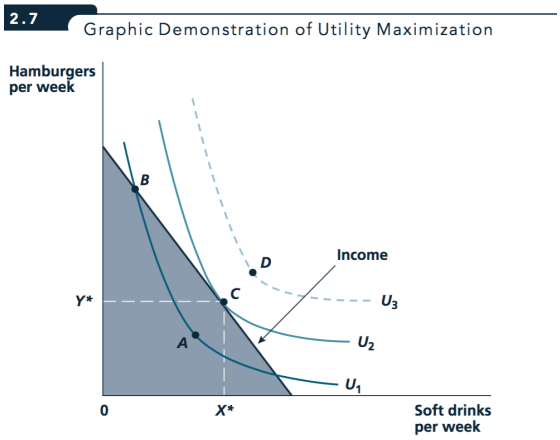
We started with an individual's preferences, one of the baseline elements of the neoclassical model. Under some conditions these can be described by utility functions, which we depicted graphically as 'mountains' with levels sets depicted by indifference curves.

So, we have a way of depicting what people prefer, but this doesn't tell us what people will *choose* to consume (and firms to produce).

We next introduced the second fundamental element of the neoclassical model, constraints, in particular, the budget constraint.

[18] Strictly speaking, the slope is how much Y you *get* when you get another X, but since this is negative we see that you 'get a negative amount', i.e., give up some amount of Y.

We put these together to describe the consumer's problem: maximizing her utility subject to her budget constraints. this is depicted in figure 2.7 below for the two good case.



Imagine that you are this consumer with these preferences and this budget constraint. You can choose any point in the shaded area, as it is on or below your budget constraint. You want to get to the highest indifference curve.

Consider: How do we know A is suboptimal (i.e., NOT optimal(? What about B? Points between B and C?

We can demonstrate that you will choose point C, yielding utility U_2.

What is special about point C?

It's the point of *tangency* between the budget constraint and an indifference *curve*.

It's also (not a coincidence) the point where the slopes are equal.

Slope of budget constraint = slope of indifference curve $\rightleftarrows$[19]

$$P_X/P_Y = MRS$$

Note that both slopes are negative, so both negative signs cancel out, leaving this condition.

Warning: The above is shorthand; recall that the marginal rate of substitution may vary everywhere along an indifference curve (remember the idea of satiation and diminishing MRS). It is a function of the *point* it is evaluated, i.e., $MRS = MRS(X, Y)$. It is only at the *point where the consumer is optimizing* that these slopes must be equal.[20]

At an optimal consumption choice (given above assumptions, see above footnote)

- Consume all of income (locate *on* budget line; follows from 'more is better')
- Psychic tradeoff (MRS) equals market tradeoff (P_X/P_Y)

Intuition: If I can give up X for Y in the market (buy less X, get more Y) at a certain rate, and the *benefit* I get from doing this is at a different rate, I can make myself better off.

Thus the original point could not have been optimal!

Think about this carefully; it is a key method of proving things in economic theory called 'proof by contradiction'.

[19] The $\rightleftarrows$ symbol means 'if and only if', i.e., the object on the right-hand side implies the object on the left-hand side, and vice versa. In some context this means a 'necessary and sufficient condition', but here it is just basically a definition.

[20] They can also be equal at some other suboptimal points, where she is not spending all of her income, or if the indifference curves have a shape very different from the one above (more or less, where they are not 'convex'). Where she is consuming some of every good, this is a *necessary* condition for such a point to represent an optimal consumption choice, but it may not be a sufficient condition. May also be optimal for her to consume *none* of certain goods, in which case this condition will not hold. We return to this later.

Example, for intuition

Suppose that at the consumption bundle you choose your MRS = 1. To remain indifferent, you would be willing to give up 1 hamburger to get 1 soda.

Suppose the price of soda is £1 and the price of a burger is £2. → Price ratio: $P_S/P_B = 1/2$

Thus if you buy one less burger you can buy two more sodas. Thus if you give up one burger, you can get one more soda to keep you indifferent *plus* an additional soda. This means you would be better off; thus the original bundle *wasn't* optimal.

Practice question: in which direction would you adjust this bundle if the price of a soda was £2 and a hamburger was £1? Explain.

More insight: Skip if you like

This next bit is fairly mathy. It should be helpful but you can skip over it if you don't find it so.

Recall $U = U(X, Y)$.

$$U_X(X, Y) := MU_X(X, Y)$$

Derivative with respect to X: rate that utility increases if we add a little X, holding Y constant

Similarly for MU_Y.

It turns out the MRS at a point is the ratio of these marginal utilities.

MRS: 'how much Y would I be willing to give up to get a unit of X'?

Ans: Depends on marginal benefit of each ... we can show $MRS(X, Y) = \frac{MU_X}{MU_Y}$

Note: The more valuable a little more X is to me at that point – the higher is MU_X – the more Y I am willing to give up to get it. That is why MU_X is in the numerator.

The more valuable a bit more Y is at that point – the higher is MU_Y – the less Y I am willing to give up to get a bit more X. That is why MU_Y is in the denominator.

Advanced maths: The derivation of the MRS is optional material.

The 'first order change in utility' (or 'total differential') is:

$$\begin{aligned} dU &= \frac{\partial U}{\partial X} dX + \frac{\partial U}{\partial Y} dY \\ &= MU_X dX + MU_Y dY \end{aligned}$$

- Where $\frac{\partial U}{\partial X}$ refers to the partial derivative of U(X,Y) with respect to X, and similarly for Y, i.e., the marginal utility.

Essentially, this approximates the total change in utility for very small changes in X and Y. Setting it equal to zero and rearranging it yields the rate, at the margin, one is willing to give up Y for X:

$$dU = MU_X dX + MU_Y dY = 0$$

$$\frac{dY}{dX} = -\frac{MU_X}{MU_Y}$$

Adv: This is a simple case of the implicit function theorem, essentially $U(X, Y) = c$ defines an implicit function $Y(X)$, whose slope is the negative of the ratio of the derivatives.

Rearranging the utility maximising condition yields more intuition:

$$P_X/P_Y = MRS = MU_X/MU_Y$$

(at each consumption point X,Y)

$$\frac{MU_X}{P_X} = \frac{MU_Y}{P_Y}.$$

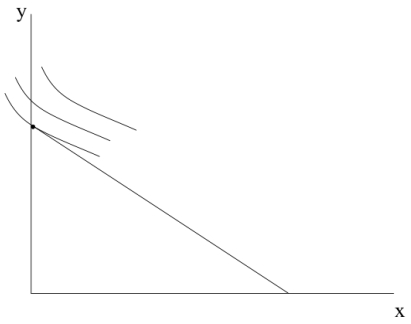
I.e., the same 'bang for each buck'.

Note: If this didn't hold true and you were spending on both goods, you would be paying 'more per util' for one good than the other, and thus should reallocate to that other good.

Note on 'corner solutions'

- The above applies to any *interior* solution
  - If you are consuming both goods and optimising, $P_X/P_Y = MRS = MU_X/MU_Y$ must hold
  - Advanced: This is a "necessary but not sufficient condition", sufficient if there is a diminishing MRS everywhere.
- But you might consume *none* of some good (say X):
  - if even with *no* X, $MU_X/P_X < MU_Y/P_Y$
  - i.e., the marginal utility of the first unit of X is less than that of Y
  - we will see examples of this (maths and graphically)

[21]

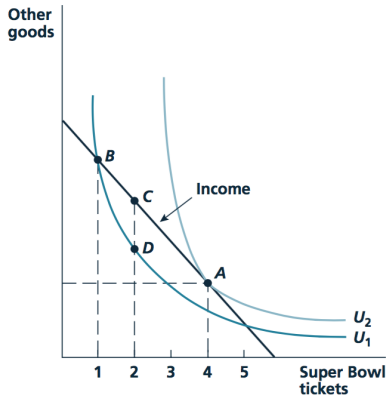


In the graph above preference for y is sufficiently strong relative to x that the the psychic trade-off is always lower than the monetary trade-off.

This must be the case for many products that we don't buy.

App 2.4: ticket scalping

FIGURE 1 Rationing of Tickets Leads to Scalping



Suppose tickets are rationed: one per customer.

This constraint (which is *additional* to the budget constraint) implies lower utility; the individual depicted above would choose A if unconstrained.

Here the budget line is not tangent to indifference curve; the slopes are not equal. The individual would be better off buying more tickets, but she cannot.

She would be willing to buy an additional ticket at full price (move to point C). Actually, she would be willing to pay *more* than full price for a second ticket. (See previous final exams and textbook questions asking, e.g., 'how much would she be willing to pay?'

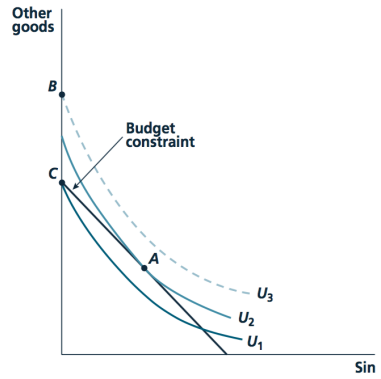
She could give up up to an additional C-D of goods for ticket 2 and still be as well off.

Adv: Tough questions (final exam-worthy): Why would NFL institute this rule? Who benefits? (Maybe poor consumers?) Why do people see scalping as unfair? Is there ever a justification to forbid a transaction between 2 consenting parties?

[21] Advanced: The same condition applies to each good you are consuming a positive amount of.

App 2.5: What's a rich uncle's promise worth? (Read this at home.)

FIGURE 1 Willie's Utility and His Uncle's Promises



Note:

Willie would choose point A with his original income, but his uncle paid him \$5k to abstain from sinful goods.

If he accepts this and only consumes 'other goods', this would get him to point B, gaining him U_3.

But now suppose that his uncle reneged on the promise, so he is at point C.

Graphically, how much \$ would have been enough to compensate for abstaining?[22]

Using the model of choice

1. Why do people spend their money on different things?
2. What do different preferences/indifference curves imply for choices?

Note: At this point in the lecture we may move to the powerpoint display, which gives a careful animation of this and several previously mentioned concepts. See the powerpoint [here]{https://www.dropbox.com/s/qhsl6qey0wjcfe5/utility_demand_supplement.pptx?dl=0}, view in presenter mode.

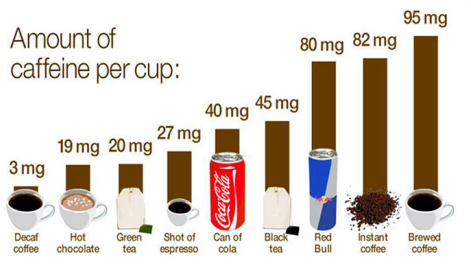
What indicates each persons' preference for one good over the other? The shape of the indifference curve. The flatter (steeper) the indifference curve the stronger the preference for the good on the Y-axis (X-axis)

Algebraic/numerical examples

Perfect substitutes, but not identical

Warning: Thinking caps on. This may be confusing.

Consider: are the following 'perfect substitutes' for someone who wants caffeine, but has no taste buds?



Yes, they are!

Recall the definition of perfect substitutes.

[22] Adv: Hard question, foreshadowing future concepts like the inefficiency of in-kind subsidies... How much would Willie need to be paid to get him to U_3 *without* the restriction? Is this more or less than \$5k?

By 'perfect substitutes' we mean pairs of goods for which *some amount* of one is always valued the same as *some amount* of the other, and this proportion is always the same.

An easy example: I might always be indifferent between three pints of mild ale and two pints of strong ale, if they have the same total alcohol content and I only want to get tipsy.

So (for perfect substitutes) buy the one that increases it more *per-£*.

Warning: On the other hand, if goods are *not* perfect substitutes, margunal utility ratios (thus, marginal rates of substitution) generally depend on consumption levels.

Numerical example:

$$U(X,Y) = 4X + 3Y$$

- Rate at which each good (X and Y) increases utility per-unit (derivative) is constant
  - $MU_X = 4$, so every additional unit of X will add four units of utility in this example, no matter what the starting point is.
  - $MU_Y = 3$, ... so every unit of Y will add 3 units...
- So (for perfect substitutes) the consumer will buy the one that increases utility more *per-£*
  - Compare MU_X/P_X to MU_Y/P_Y
  - Here, if $4/P_X > 3/P_Y$, then buy X.
  - if $4/P_X < 3/P_Y$, then buy Y
    - (if equal, buy either)
  - Rearranging, if $P_X < 4/3P_Y$, buy X ... etc.

(I sometimes call this the "bang for the buck" condition.)

Perfect complements

AKA 'Leontief preferences'

Numerical example:

$$U(X,Y) = min(2X, Y)$$

E.g., where X is bicycle frames and Y bicycle wheels. Warning: this min function seems backwards, but it's correct. I've answered this question many times in office hours and on the forum (have a look). No one believes me at first but in the end they realize that this is the case.

However, I will not ask you specifically to get this 'min' functional form for perfect complements on an exam.

- Shortcut: figure out the proportions it will be consumed in
  - determine the cost of 'one bundle of the combination' at given prices
  - ... then buy as many such bundles as you can afford

You should be able to do this without having taken economics. Suppose you were given £100 and asked to spend it to make as many sausages-with-baps as possible. No one can eat a sausage without a bap, nor vice-versa. Sausages come in packs of 4, and baps come in packs of 8.

How many packs of each will you buy, supposing both types of packs cost £1 each?

Middle-ground

A Cobb-Douglas **example**

Recall, as I noted above, that for the "general" rather than extreme cases the marginal rate of substitution at a particular point may vary everywhere, and depends on the amount of each good consumed. Below the "Cobb-Douglas" functional form is one example of such a 'middle ground' utility function, expressing neither perfect substitutes and are perfect complements. A simple case of this Cobb-Douglas utility is:[23]

$$U(X,Y) = \sqrt{(XY)}$$

Adv note, may help save you computations:[24]

Amount of Y you'd give up to get a unit of X:

$$MRS(X,Y) = MU_X/MU_Y = Y/X$$

Note: The last equality comes from this *particular* function; it is not always Y/X.

Note also that this is the same as 'the amount of Y you'd need to give up a unit of X

Checking your work: is this solution reasonable?

The more Y I have, the more I am willing to give up to get a unit of X. This seems reasonable, as it reflects satiation.

Adv, maths: This slope is derived through calculus. [25]

In general, the marginal rate of substitution (at a point) is the ratio of the marginal utilities at that point.[26]

Here[27] (for this Cobb-Douglas), utility-maximization requires, at optimal choices of X and Y:

$$MRS(X,Y) = Y/X = P_X/P_Y$$

Check that it makes sense:

As P_X increases, the right-hand-side (RHS) increases, and so to increase the left-hand-side (LHS) I must increase the units of Y consumed, and thus decrease the units of X consumed. Thus as P_X increases I consume more units of X and less Y, which is what you might expect for a standard case.

For any price ratio, you can find the ratio of units of Y & X consumed. Then, if you know the prices and total income I, you can calculate the consumption and spending on X and Y

Rearranging the optimization condition:

$$YP_Y = XP_X$$

- Question (adv.: What is weird about this condition, for this example?[28]

Combining this with the budget constraint

$$P_X X + P_Y Y = I$$

we can now solve for amounts of X and Y purchased, as functions of prices and income.

[23] The General Cobb-Douglas function is : $U(X,Y) = X^a Y^b$ where a and b arepositive constants.

[24] We are 'allowed' to square the whole thing to simplify the problem. Why? Utility is only "identified up to a monotonic transformation". In general you can transform the utility function in any way that preserves the ordering of preferences over the combinations of X and Y. (E.g., multiply/divide it by any positive amount, add any constant, take it to any power, put it into an exponential or large transformation... Doing this, replacing utility function with this "new" utility function will have no impact on the choices the person makes. The only thing that will change is the realized level utility, which is not a meaningful concept. However, this will no longer hold later in the module when we talk about uncertainty and expected utility.

[25] MU_X is the slope of $U(X,Y)$ in X at a particular point, i.e., the (partial) derivative with respect to X $MU_X = \frac{\partial}{\partial X}(XY)^{1/2} = \frac{1}{2}(XY)^{-1/2}Y = \frac{1}{2}(Y/X)^{1/2}$ Similarly, $MU_Y = \frac{1}{2}(X/Y)^{1/2}$.

[26] This is helpful and intuitive, but I am not requiring you to remember this, although it may help you do your calculations.

[27] I say 'here' both because the MRS comes specifically from this Cobb-Douglas utility function. Also, because we now have nice convex indifference curves with 'normal' slopes, unlike for perfect complements or substitutes. The more of one good you have the less you value it relative to the other good (unlike perfect substitutes) but you still value more of it somewhat (unlike for perfect complements)

[28] You always spend the same *amount* on each good, no matter the price (Note, that doesn't mean the same number of units). This 'constant expenditure shares' are a characteristic of Cobb-Douglas functions that limit their usefulness and realism. But we still use them all the time in teaching.

Calculations: Rearranging the optimization condition, $Y = XP_X/P_Y$.

From the budget constraint, $X = (I - P_Y Y)/P_X$.

Substituting in for Y yields $X = (I - P_Y(XP_X/P_Y))/P_X = I/P_X - X$ ø

$\rightarrow 2X = I/P_X \rightarrow X = I/(2P_X)$
$XP_X = I/2 \rightarrow$ this person always spends half her income on X.[29]

Advanced shortcut tip:[30]

Tutorial problems from chapter 2: see VLE

Lecture3: (Chapter 3) Demand Curves [2 hours]

Lecture 3 (Chapter 3): Demand Curves – coverage outline

In lecture at this point I give you an example of a very surprising case that nonetheless may occur, at least in theory.

Key goals of these lectures (and accompanying self-study)

1. How do you derive an *individual's* demand curve from her utility function?[31]
2. What properties do demand curves have?
3. Understand the following concepts and outcomes (and/or how to derive them):
    - Substitution and income effects (of a price change)
    - Goods that are 'substitutes' or 'complements'[32]
    - Consumer surplus (from a transaction)
    - The lump-sum principle (and the distortion of taxation)
4. What is a *market* demand curve, and how do we derive it?
5. Understand the concepts:
    - Price elasticity (of market demand for a product), and what it means to firms' pricing strategy
    - Income elasticity (. . .)
    - Cross-price elasticity (between two products)
6. Be able to discuss real world examples and applications of the above

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- Second problem set, second part (NS chapter 2-3): Preferences, Utility, Consumer optimization, individual and market demand

Demand functions

Previously, we considered how consumption choices determined by utility functions/indifference curves and budget constraints. We can now consider how an individual's choice of a good varies with each element of her budget constraint: for income and the price of each good.

We will refer to her 'quantity demanded of good X' function (or more simply, her 'demand function') as follows:

$$Quantity\ of\ X\ demanded = d_x(P_X, P_Y, I; preferences)$$

---

[29] To repeat, this is not a general result, it is a result coming from this particular version of the Cobb-Douglas utility function. Obviously, Economics does not predict that everyone spent equal shares of their income on each good!

[30] You can solve for the optimal Y by 'symmetry': as utility and budget constraint are symmetric everything we said holds replacing X with Y.
Thus $Y = I/(2P_Y)$ etc.

[31] Answer: practice, practice, practice. :)

[32] remember, this is not the same as 'perfect substitutes/complements'

Homogeneity

Homogenous (of degree zero) (demand) function A function whose outcome value does not change when *all* arguments are changed *proportionally* is *homogenous of degree zero*

$d_X(P_X, P_Y, I)$ is homogenous of degree zero in its arguments.

Multiply all prices and income by the same amount, and the *budget constraint is unchanged.* Thus (as preferences have not changed) consumption choices should not change either.

- E.g., the budget constraint $P_X X + P_Y Y = I$ is the same as the budget constraint $2P_X X + 2P_Y Y = 2I$

Intuition for this: Graphically, the budget line and indifference curves are unchanged, so her optimization problem is identical to the optimization problem before. The point of tangency between an indifference curve and her budget line is the same as before.

Consider, if your income, as well as prices, were stated in pennies rather than pounds (e.g., 5 million pennies rather than £50,000), would your choices change?[33]

This relates to the puzzle of 'why should monetary policy and inflation have any real effect?'

Response to income changes

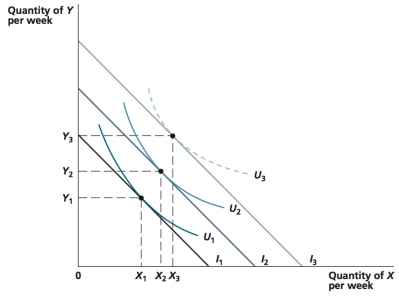
Q: What happens to the quantity purchased of some good as your income increases?

A: Depends on whether the good is normal or inferior.

(Whether it is normal or inferior depends on your preferences and the change in the slope of the indifference curves with higher income/utility, as we see below.)

Normal good A good that is bought in *greater* quantities as income increases.
Inferior good A good that is bought in *smaller* quantities as income increases.

FIGURE 3.1 Effect of Increasing Income on Quantities of X and Y Chosen

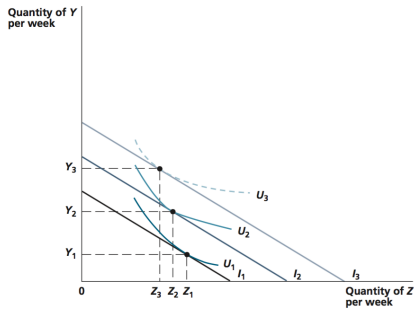


As income increases from I_1 to I_2 to I_3, the optimal (utility-maximizing) choices of X and Y are shown by the successively higher points of tangency. The budget constraint shifts in a parallel way because its slope (given by the ratio of the goods' prices) does not change.

Move to PPT slides to illustrate this, beginning with 'Changes in Income: A Normal Good'. See here

[33] Of course not! At least they 'should' not change; your optimal choices would not change. Perhaps in some specific context the way the problem is framed may affect people's choices, but that is not what is being asked here. Furthermore, we are considering 'normative' economics in the sense of 'what would rational optimizing agents do'?

FIGURE 3.2 Indifference Curve Map Showing Inferiority



Good Z is inferior because the quantity purchased declines as income increases. Y is a normal good (as it must be if only two goods are available), and purchases of it increase as total expenditures increase.

Consider: Here we see more income → less expenditure on Z! (Not just 'a lesser share' but actually *less*.)

This is because the *shape* of the indifference curves changes at higher incomes in this example. When people have a lot to spend, they want to spend it on Y and not on Z. (Again *in this example*, not in general.) Consider, if you won the lottery how much pot noodle would you buy? Pot noodle may be like good Z in this example.

Thinking in 3d: 'as you walk up this hill, its ridge gradually moves to the west'

Notes: Adv: To be precise, this is *not* about wealthy people being different than poor people nor that their taste 'changes' when they become wealthy. We are considering the same person with higher income, and thus the potential to choose a different bundle of goods. Empirically, these are hard to distinguish, however.

Adv:

Consider: all goods cannot be inferior. Why not?[34]

Substitution and income effects from a fall (or rise) in price

What happens to the quantity purchased of some good when the price of the good falls or rises?

This changes both an intercept and a slope.

The new utility-maximizing choice is on *another* indifference curve and it is a point on that curve with a different MRS.

Substitution effect ('Hicksian') The effect on consumption due to a change in price 'holding real income or utility constant.'

(More precisely, the effect on the lowest-cost consumption bundle yielding this utility.)

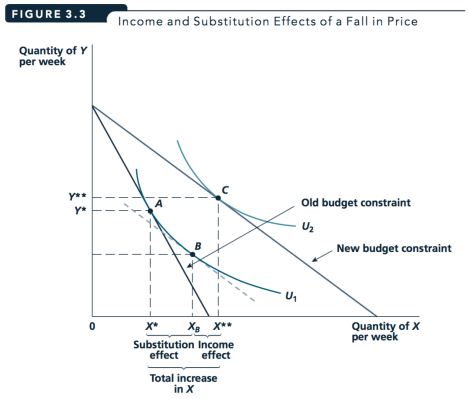
Income effect (of a price change) The remaining effect on consumption; due to the change in purchasing power and achievable utility caused by a change in price.

Note that this is *conceptual*: we never *actually* observe either of these effects alone; we always observe the net effect of both.

Advanced footnote[35]

[34] There are 'adding up' conditions. You always spend all of your income. Thus, if as your income increases, you spend less on some subset of goods, you *must* spend more on the remaining goods.

[35] This standard definition of the 'income effect' of a price change combines both of the effects we saw when looking at the impact of an income change on consumption of X. More consumption of each good is possible, but the MRS may differ at this higher consumption and utility level.



(Note: In the lecture we move to the PPT slides to illustrate this, beginning with 'Change in A Good's Price'.)

I also present the answer to a problem set question on this on YouTube: Problem set 2: substitution and income effects of price change

There are plenty of other YouTube videos covering this online, with better production value than my videos, e.g.,

Indifference Curves - Income and Substitution Effects for Inferior Goods

and

Indifference Curves - Income and Substitution Effects fo like whatr Normal Goods

Advanced footnote[36]

Some things to remember and 'remember why':

- The substitution effect *always* goes in the opposite direction as the price change
- The income effect goes in the opposite direction as the price change for a normal good
- . . . But the income effect goes in the *same* direction as the price change for an inferior good
  - Thus the substitution and income effects go in the same direction for a normal good,
  - . . . and they go in different directions for an inferior good.
  - For an inferior good the net effect is unknown, but usually the substitution effect dominates (but see Giffen goods below)

Read on your own (from NS), know:

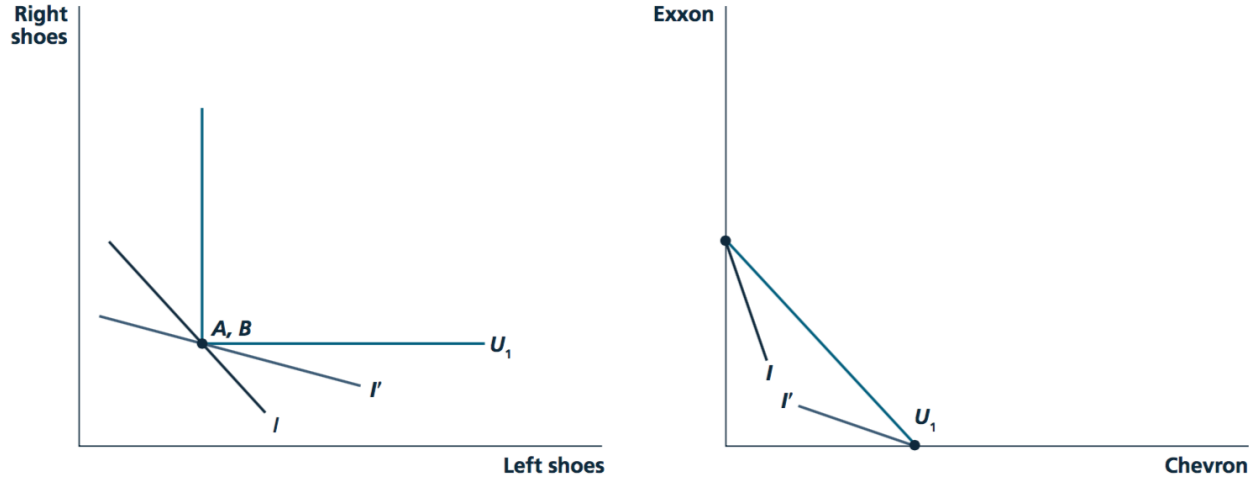
- Numerical example of response to price change
- The relative importance of substitution effects for most goods
- Substitution and income effects for inferior goods

Different substitution effects of a price change

The substitution effect of a price change will depend on the utility function, i.e., on the curvature of the indifference curves at the relevant point.

- Perfect complements: There is no substitution effect, only an income effect of a price change.
- Perfect substitutes: There may be a large substitution effect – a price change may cause a complete switch from one good (or set of goods) to another. On the other hand there may be no substitution effect for a 'small' change in price. . . see examples.
- In-between utility functions: depends on curvature of indifference curve at the relevant point.

[36] This topic is more nuanced and complicated than we will cover in the main content of this module.
To fully cover this, we would have to consider the theoretical concept of a 'compensated' aka 'Hicksian' demand curve,
where income is adjusted to hold utility constant while price ratios change.
This also allows us to consider 'net versus gross' substitution, and 'equivalent vs compensating variation'.
More advanced economics modules will cover this extensively and rigorously.



The (legendary?) Giffen good

- If the price of a good increases, can quantity demanded actually *INCREASE*?!
  - Yes, if the good is *very* inferior, not very substitutable, and is a large portion of income. We call this case a *Giffen good*.
  - It has never been seen and documented in the wild

- See Powerpoint
- Practice question: try to draw indifference curves and budget constraints illustrating this effect for a Giffen good

Second lecture on demand . . . WHAT is this????!!

. . . Recap

$$Quantity\ of\ X\ demanded = d_x(P_x, P_y, I; preferences)$$

Previous lecture: What the constrained utility-maximization implied for demand. . .

- "Homogeneity of degree zero" of $d_x(P_x, P_y, I)$
- How d_x responds to I (Rem: Inferior and normal goods)
- How d_x responds to P_x (Rem: Normal or Giffen)
  - Substitution and income effects

Goals of this chunk (demand part 2)

Util-max s.t. constraints →

Understand real-world issues:

1. A 'Fixed-basket' consumer price index (CPI) may overstate inflation
2. The lump-sum principle, the distortion of taxation

Fundamental concepts, useful for business & policy:

1. Goods may be 'substitutes' or 'complements' for one another
2. How can we consider/compute the *Consumer surplus* from a transaction?

Derive

- An *individual's* demand curve from her utility function
- The *Market* demand curve (from individual demand curves)
  - What causes *shifts* in either?

App 3.2: The CPI and its biases

The government (and many others) want to know 'how much less (or more) is a pound this year than a pound in the past?' One of the most prominent measures of this is the "consumer price index (CPI)."

The is a *very* important number: It is used for monetary policy ('inflation targeting') and for targeting many salaries and benefits. For example, my union is always raising the complaint that salaries have not risen in line with inflation. (But don't worry, student fees have.)

Getting this number substantially and consistently wrong can lead to huge problems; people may be let into poverty or the government may be led into default. However, it is hard to get this measure right. Using the classical economics framework, we can consider what this means.

The UK uses a similar CPI measure to the USA (a change from the 'RPI' in 2003, although RPI is still used for some things). The Bank of England targets a 2% increase in the CPI per year.ˆ[Something to know: what has been the inflation rate in recent years? This is an example of 'market and industry knowledge' that employers value. True, you can look this stuff up, but having a general sense of these things rolling around in your brain will ground your thinking. As an analogy, suppose you were a mariner navigating the seven seas and you had to go online every time to remember which direction was North or South.}

But does the CPI overstate the rate of inflation?

It is based on a 'typical market basket' (UK: of 700 different goods and services, excluding housing, updated yearly).

1982 vs 2019 two-good example

We can consider this with a minimal example, using only our two favourite goods, x and y.

Suppose in 1982 the "average household" consumed x_{82} units of good x and y_{82} units of good y. The prices were p^x_{82} and p^y_{82} for each of these, respectively.

Now in 2019 the average household consume x_{19} units of good x and y_{19} units of good y. The prices are p^x_{19} and p^y_{18} for each of these, respectively.

The expenditure (in pounds) in 1982 was thus b_{82}:

$$b_{82} = p^x_{82}x_{82} + p^y_{82}y_{82}$$

How much would it cost to consume the "average 1982" basket today (2019), with today's prices? ... This is defined as b_{19}:

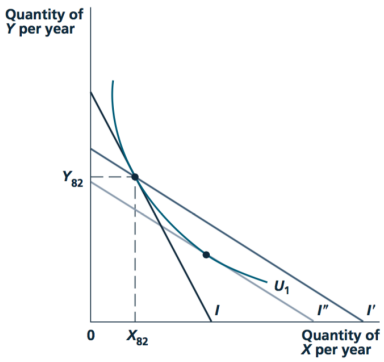
$$b_{19} = p^x_{19}x_{82} + p^y_{19}y_{82}$$

The "regular" CPI will simply take the ratio of these two numbers:

$$cpi_{19} = \frac{b_{19}}{b_{82}}$$

An unadjusted (Fixed-basket) CPI 'claims' you need I' to be as well off in 2019. I.e., to buy *the exact same basket*, including vinyl records. But, as seen in the figure below, by substituting you could be as well off with the lower level of income I'' (And income I' would actually make you *better* off).

FIGURE 1 Substitution Bias of the Consumer Price Index



In 1982 with income *I* the typical consumer chose X_{82}, Y_{82}. If this market basket is with different relative prices, the basket's cost will be given by *I′*. This cost exceeds what is actually required to permit the consumer to reach the original level of utility, *I″*.

In fact, in setting policy, the basket *is* adjusted yearly, based on a survey of consumers' spending. But even this is not necessarily the *right* adjustment, as consumers may be attaining higher or lower utility from these changes. The right adjustment depends on the consumers' utility functions, which are unobservable.

I asked a multi-part question on this on the 2016 Final exam; have a look, these are all on the ELE under 'Relevant previous year's assessments, with suggested answer guidelines' 2016 exam link

The Lump-Sum Principle

Have you seen this?

1696: An Act for granting to His Majesty several Rates or Duties upon Houses for making good the Deficiency of the clipped Money... Properties with between ten and twenty windows paid an extra four shillings (£24.79 in 2016), and those above twenty windows paid an extra eight shillings (£49.57 in 2016). <https://en.wikipedia.org/wiki/Window_tax>

Consider the 'least efficient tax': Suppose the UK government imposes a tax on all windows above 4 per house.

Suppose all UK residents put bricks over their excess windows. The government raises no revenue but people are certainly worse off.

What's going on here?

[37]

The social cost (deadweight loss, i.e., 'DWL') of taxation is greater the more taxes change 'compensated' behaviour (via the substitution effect)[38]

The most efficient tax:

- raises the most revenue for a given utility loss
- reduces utility the least for a given revenue
- ... is a 'lump-sum tax': same tax no matter what you do (including work/leisure!)

This is a rationale for the poll tax, the proposed tax that brought down Margaret Thatcher's government

A common measure of the burden: 'amount a person would be willing to pay to avoid tax', for a given revenue raised

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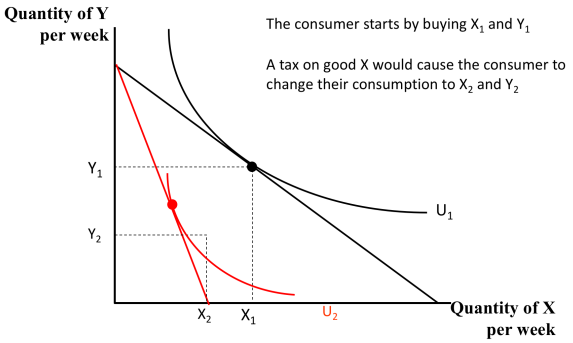
[redacted]

Lump Sum Principle



[redacted]

*A step-by-step illustration of this is given in the PowerPoint file under 'Lump sum principle'.

Key to understanding the above example illustration: how do we see that the blue and red dot both *raise the same revenue*?

You could also compute these tax revenues algebraically and see they are the same (see footnote in NS textbook), but it is better to gain intuitive insight.

The revenue can be seen as the distance on the vertical axis, representing the value in terms of Y at the pre-tax price ratio.

[37] Note: 'Taxes based on ground-floor area' are mentioned throughout the web, but I couldn't find an authoritative reference to this. If anyone finds one, please let me know!

[38] Why 'compensated' behavior? Essentially, because taxes in general will always leave people with less effective income, causing them to change their consumption choices to reflect the new, lower indifference curves. What matters for the deadweight loss is how the taxes change their behavior at this new lower-income state. This is a fundamental issue in Public Finance/taxation.

This holds whether we measure it in terms of either commodity – you just have to pick one.

The tax revenue is the difference between the individual's income and the amount he consumes; both measured in terms of one commodity only, according to the *actual opportunity cost* of that commodity, not measured with the 'after tax price'.

Note...[39]

Read on your own, know:

The potential inefficiency of in-kind programmes and subsidies (App 3.3)[40]

Potential 'expansive' exam question: Consider the *benefits* of in-kind programmes rather than cash transfers.

Changes in the Price of Another Good

Note: In the previous 2-good diagrams the impact of the change in P_X on Y was mechanical. With a new budget constraint and a new X $\rightarrow$, the individual needed to spend the remainder on Y. If expenditure on one good went up, expenditure on the other good must have gone down, and vice/versa. With 3 or more goods, this need not hold.

Complements If a rise in P_X leads the quantity demanded of Y, d_Y, to decrease (and vice-versa), then goods Y and X are (gross) *complements* to one another.

How to remember: 'complements' go together, so the quantity-demanded response to a price change is the same for both goods – the opposite direction as the price change (unless Giffen).

Substitutes If a rise in P_X leads d_Y to increase (and vice versa), then goods Y and X are (gross) *substitutes* to one another.

A tip on how to remember this:

'Substitutes' are competing to meet the same desires, so when you buy more of one, you tend to buy less of the other.
Thus the quantity demanded response to a price change go in opposite directions for the two goods
Thus, as quantity-demanded for good A typically goes in the *opposite* direction as the price of A
... quantity demanded for a substitute good B will go in the *same* direction as the price of A.[41]

Individual demand curves

- Quantity of X demanded

$$d_X(P_X, P_Y, I; preferences)$$

- 'Individual demand curve': depicts how the amount of a good an *individual* buys responds to that good's price

How do we derive this (graphically)?

We can 'map it out' by increasing $P_X \rightarrow$ budget constraint shifts in $\rightarrow$. In each case we find new point of tangency with indifference curve. We plot this in the example below (better illustrated in the PowerPoint, perhaps.)

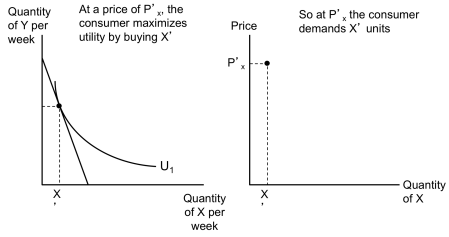
---

[39] This illustration is a single example; to see that this holds generally, take Public Economics. There are some interesting and surprising results. A caveat: If you *can't* tax one good (e.g., leisure)
you *don't* want to tax all other goods equally.
In general, you want to tax goods that distort behaviour less overall.

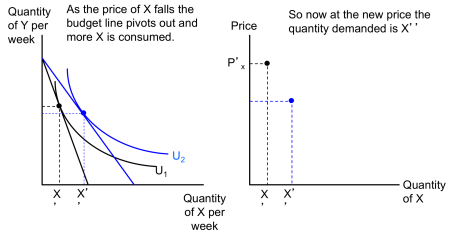
[40] In the UK, the 'welfare wall' is usually referred to as the 'benefits trap' or 'unemployment trap'. This is something successive governments have tried to remedy, recently, with the 'Universal Credit'.

[41] Adv: These 'cross-price effects' include both *substitution* and *income* effects. (See micro quiz 3.3).

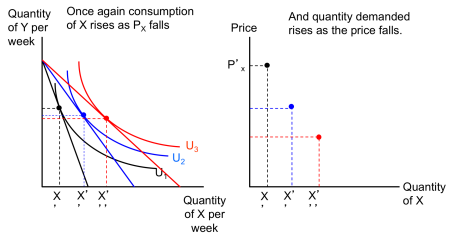
Deriving an Individual's Demand Curve



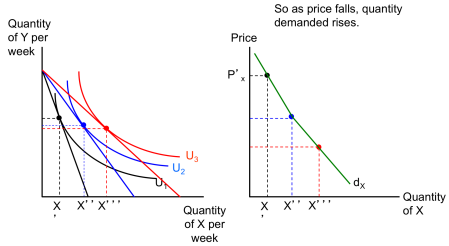
Deriving an Individual's Demand Curve



Deriving an Individual's Demand Curve



Deriving an Individual's Demand Curve



Shifts in an individual's demand curve

Q: What might cause the demand curve for a product to shift (inward or outward)?

Not:

- *Not* 'a change in the price of that good'.
- *Not* a shift in the supply curve.

Yes:

- Change in price of complements or substitutes for that good
- Change in income
- Perhaps: Change in consumer's information, preferences,[42] or other factors (weather, etc).

I'm sure you can see how I could write a multiple-choice question about this.

Be sure you understand shifts vs movements along, and 'demand' vs 'quantity demanded'.

Know the difference between shifts in a shift in a demand (or supply) curve and movements along a demand curve, and the terminology. This will almost surely be on one of the exams in some form, see e.g., micro quiz 3.4

- Hint: I suggest you avoid referring to 'supply and demand'; refer to either 'supply and demand *curves*' or 'quantity demanded or supplied'.

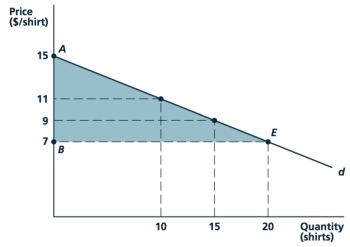
Numerical examples: these may be covered in tutorials

Consumer surplus

Consumer surplus The extra value individuals receive from consuming a good over what they pay for it.

- What people would be willing to pay for the *right* to consume a good *at its current price* rather than not being able to buy it at all.[43]
- The area between the demand curve and the market price
- A measure of consumer welfare, useful for policy analysis

FIGURE 3.10 Consumer Surplus from T-Shirt Demand Price ($/shirt)



The curve *d* shows a person's demand for T-shirts. He or she would be willing to pay $11 for the tenth shirt and $9 for the fifteenth shirt. At a price of $7, he or she receives a surplus of $4 for the tenth shirt and $2 for the fifteenth shirt. Total consumer surplus is given by area *AEB* ($80).

Advanced maths note[44]

Also. . . [45]

Also, 'introducing a new good. . . '[46]

Note: We may skip section 'consumer surplus and utility' in lecture, but please read over it for understanding

Market demand The total quantity of a good or service demanded by all potential buyers

- Sum the individual quantities demanded (at a given price)

Market demand curve Relationship between total quantity demanded of a good and its price, ceteris paribus

[42] Note: Economists disagree as to how to consider or model changes in preferences

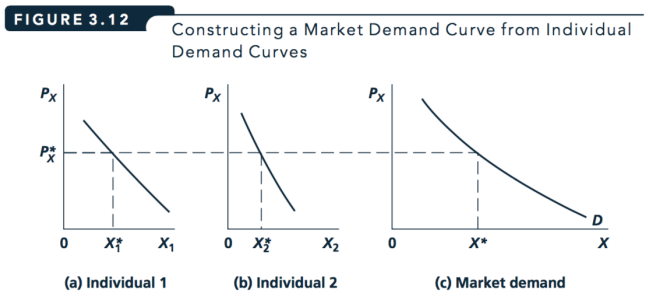
[43] In other words, if you said to a consumer 'this product will stop being produced/offered unless you pay us enough money', this is the maximum amount the consumer would be will be willing to pay to keep the product on the market, at its current price.

[44] With a linear demand curve this is a triangle, which has an area that is easy to compute. More generally, this is a 'definite integral'.

[45] This can be applied to the individual or market demand curve to obtain individual or total consumer surplus (although there are some technical issues with the latter).

[46] This concept can also be applied to measuring the value added by the introduction of a new good (see Application 3.4). This is useful to know for policy, particular in formulating subsidies for R&D and in adjusting the CPI. It also could be used to compute damages in court cases where a firm is accused of stifling innovation.

- Sum the individual demand curves ('horizontally' . . . quantities demanded at each price)



A market demand curve is the horizontal sum of individual demand curves. At each price, the quantity in the market is the sum of the amounts each person demands. For example, at P^*_X the demand in the market is $X_1^* + X_2^* = X^*$.

Numerical examples of this may be covered in tutorial

Some of our previous results about individual demand also hold for market demand, while others do not, or only if we make restrictive assumptions

Shifts in the Market Demand Curve

- Similar things that cause individual demand curve shifts
  - Increases in overall income (for normal goods)
  - Reduced prices of complements, increased price of substitutes

However, the aggregate income does not have a single effect; it cannot be easily reduced to a single variable here. You can only express the demand curve as a function of aggregate income under restrictive assumptions. In general, it depends *who* gets this income. (See 'aggregation issues').

A random example:

- 2008: 'Gas prices forcing demand for SUVs to plummet' LINK
- 2015: 'Economy, gas prices drive demand for SUVs, high-end cars' LINK

Elasticities

This is a fundamental mathematics concept that comes from Physics; it's not just for Economics.

- How to measure and compare the extent to which one thing responds to another?
- E.g., which is 'larger'?:
  - the change in quantity demanded of oranges when the price of oranges rises or
  - the change in quantity demanded of apple juice when the price of apple juice rises?

(Or the response to changes in the price of a related good, or to income.)

- Difficulty: These things are measured in different *units* and the prices have different starting values.

Elasticity: the measure of the % change in one variable brought about by a 1% change in another variable.

- a *unitless* measure; will be the same no matter how these variables are measured.

Think of *responsiveness* when talking about elasticity. Actually it's a measure from physics having to do with rubber bands, they tell me.

Advanced footnote[47]

[47] Strictly speaking we are talking about the limit of these responses, i.e., derivatives.
The elasticity is basically the derivative of $ln(y)$ with respect to $ln(x)$; useful to know if you want to run a regression computing an elasticity, or if you want to interpret such a regression.

- If a 5% fall in the price of oranges typically results in a 10% increase in quantity bought,
- we say that each percent fall in the price of oranges leads to an increase in sales of about 2 percent.
- I.e., the "elasticity" of orange sales with respect to price is about 2,

Note that elasticities may not be constant; they may depend on the starting point; e.g., linear demand implies a different price elasticity at each point.

Price elasticity of demand

Price elasticity of demand:

$$e_{Q_d,P} = \frac{percent\ change\ in\ Q_d}{percent\ change\ in\ p} = \frac{\Delta Q_d}{Q_d} / \frac{\Delta p}{p}$$

- Should always be negative (except for Giffen goods)
- A unitless measure related to the slope of the demand curve
- *Very* important for price-setting firms (more on this later)

Examples from the headlines

India's Hike Messenger takes aim at WhatsApp

> "Reliance ended up showing that there is elasticity in the market. If you drop prices, people will come on board," he said.

'Next' to add more space despite retail sales 'moving backwards'

> The retailer does not expect any impact from the drop in sterling since the Brexit vote to kick in until at least the Spring of 2017, as it had hedged some of its foreign-currency exposures in advance. Still, it expects expenses to rise by up to 5 per cent next year. 'The last time we had to increase prices (which was in 2010 when cotton prices soared) we estimated that price elasticity was around 1.1. If that remains the case today, a retail selling price increase of 5% would result in a fall in unit sales of -5.5% and a fall in like for like sales value of between -0.5% to -1.0%. In the scheme of things, we think that this drag on sales is manageable and less damaging than taking a significant hit to margin.'

Properties of price elasticity of demand:

- Goods with many close substitutes at a similar price will be highly elastic
- ... with few substitutes ... inelastic
- Typically: more elastic in the *long run* than the short run. Q : why?[48]

We refer to price elasticities with the following terminology:

$e_{Q,p}$	$abs(e_{Q,p})$	Term
< -1	> 1	Elastic
$= -1$	$= 1$	Unit Elastic
> -1	< 1	Inelastic

Note that sometimes elasticities are expressed in absolute value terms (a positive number). It should be clear from the context.

Consider an individual's expenditure on a product.

The total expenditure (the firm's revenue from this): price $\times$ quantity

[48] Ans: Over time, consumers can adjust to price changes by changing their consumption patterns. E.g., if petrol gets more expensive I can switch to a hybrid or electric car, or a bicycle.

By taking the *total differential* of this (you don't need to), and recalling the 'multiplication rule' of derivatives...

We have that for *small changes* in price, the percent *change* in total expenditure is:

```
- pct change price $+$ pct *change* quantity
```

As $e_{Q,P}$ tells you the percent change in quantity for each (small) percentage change in price, we can use this to determine the change in expenditure for a small change in price.

Considering very small increases in a good's price:

- If the (individual's) demand is *price-elastic*, quantity will decrease by a *larger* percentage than price increased. Thus her expenditure (on this good) will *decline*.
- If the (individual's) demand is *price-inelastic*, quantity will decrease by a *smaller* percentage than price increased. Thus her expenditure (on this good) will *increase* .
- If the (individual's) demand is *unit-elastic* (with respect to price), quantity will decrease by a *the same* percentage as price increased. Thus her expenditure (on this good) will *be unchanged*.

Example and (slightly more advanced) algebra...

If price rises by 20% and quantity demanded falls by 20% what happens to revenue? Suppose p=10 and q=10 so TR=100. Then when p=12 and q=8 TR=96. Huh? Price increased by 20% and quantity decreased by 20% so shouldn't TR be unchanged? No! This only works for small changes.

TR is unchanged when p*q stays the same. With a change in each δp and δq, the new revenue is

$(p + \delta p)(q + \delta q) = pq + \delta pq + \delta qp + \delta p \delta q$.

This is the same as before if $pq = pq + \delta pq + \delta qp + \delta p \delta q$, i.e., if

$\delta pq + \delta qp + \delta p \delta q = 0$, i.e., if

$\delta pq + \delta p \delta q = -\delta qp$, i.e., if

$\delta pq/p + \delta p \delta q/p = -\delta q$, i.e., if

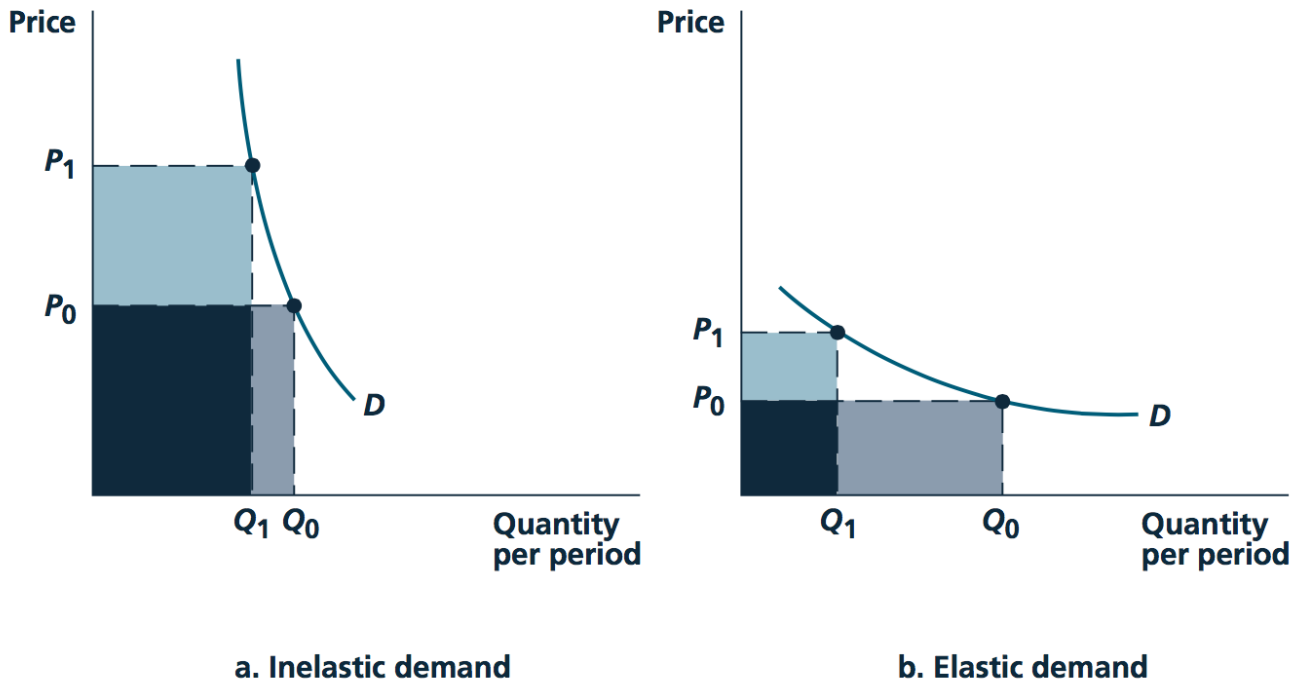
$\delta p/\delta q(q/p) + \delta p/p = -1$, i.e., if

$-e_p + \delta p/p = -1$

In the limit, as δp goes to zero, this gives us that 'unit elasticity means a small change in quantity leads to no change in revenue.'

Q: Suppose a firm is setting its price and selling to only one individual , and facing no competitors. It should basically never want to set its price at a point where demand is inelastic. Why not?[49]

[49] Ans: If it were at such a point, it could raise its price and its revenue would increase and costs would decline (because it would be selling fewer products but for greater total revenue.)
A caveat is that it might do this for a long term strategic advantage; e.g., to gain customer loyalty and market share, intending to take its profits later. we come back to a related point later in the context of monopoly pricing.



Next bits on price elasticity of demand

- Numerical example (may be covered in tutorial)
- Skip: Unit Elastic Curve
- Read on your own: Application 3.7: An Experiment in Health Insurance

Income elasticity of demand

Income elasticity of demand % change in quantity demanded of a good in response to 1% change in income (approximately).

$$e_{Q_d,I} = \frac{percent\ change\ in\ Q_d}{percent\ change\ in\ I} = \frac{\Delta Q_d}{Q_d} / \frac{\Delta I}{I}$$

Normal goods: $e_{Q,I} > 0$

Inferior goods: $e_{Q,I} < 0$

Luxury goods: $e_{Q,I} > 1$

E.g., cocaine is a luxury good, if, when I win £1000 in the lottery, I will increase my consumption of cocaine by *more* than £1000 ... (assuming, as in classical models, that I treat all sources of income the same

Q: Is a luxury good a normal good?[50]

Q: (micro quiz): Why is it that not every good can have an income elasticity of demand greater than 1? Can every good have an income elasticity of demand less than 1?

[50] Ans: Yes (do you know why?)

Some real-world discussion of this

Prof. Muellbauer letter to FT

> Sir, Professor Gordon Gemmill (Letters, December 14), surprisingly for a trained economist, assumes an income elasticity of demand of zero for housing: that is, that people do not demand more and better housing as they become richer. Nowhere in the world is this the case! My own empirical work demonstrates that around two-thirds of the rise in UK house prices, corrected for general inflation, since 1980 is because supply is not keeping up with income and population growth. Other drivers do exist ... The price effects of extra supply take time to build up. I agree on that. But just imagine what would happen if we did nothing more than we are now doing: population and income growth would drive prices even higher even though we already hold the record for rises in house prices since 1970 among the group of seven leading high-income countries. We need to build far more housing, in the right locations. And we need to start now. - Prof John Muellbauer Nuffield College, Oxford, UK

Rest of chapter 3

Read on your own:

- Some elasticity estimates (note these are a bit dated)

Tutorial and suggested problems from chapter 3

See links on VLE

Lecture4: Production and costs (brief coverage) [30 min]

Lecture (30 min) - Production and costs (brief treatment: coverage)

This year we only briefly cover the production function, inputs, and the firm's cost structure.

Key issues are highlighted on the next slides, and in the handouts.

I'm giving you the 'basic idea' so we can continue the *story.*

Recommendation: Read the following parts of NS Text ch 6-7; you can skip the parts not mentioned and skip the applications

Ch 6:

- Production function (basic idea; you can skip isoquant maps and RTS if you like)
- Returns to scale (!)
- Basic cost concepts (!)
- Skim 'Cost minimising input choice' (approximate understanding is OK)
- Cost curves (!)

... to help understand the key concepts below

The Firm's Production function

- A production function is a mathematical relationship between inputs (capital, labour, materials, etc.) and outputs.

$$q = f(K, L, M, ...)$$

$$q = f(K, L)$$

- e.g., $q = 2L^{1/3}K^{2/3}$
- Given its production choice, the firm tries to produce it at the minimum cost
  - This resembles a consumer maximizing utility subject to budget constraints[51]

Typically, a particular quantity (q) could be produced with several different combinations of inputs.

Which combination will the firm choose?

$$q = f(k, l, ...)$$

Main point: Whatever q it wants to produce, the firm uses the *minimum cost combination of inputs*!

It chooses inputs to get the best 'bang for the buck';

→ where the input mix is optimal, each input yields the same *marginal product per £*

This is very similar to the consumer optimization we discussed. For a given total input cost, the firm wants to produce as much as possible. A better way of thinking about this is that for a given production, the firm wants to incur as low a cost as possible. However, there is no 'hard budget constraint' as in the consumer optimisation case. The firm's output choice will be chosen to maximise it's profit, with no constraints other than 'non-negativity.

I'm not expecting you to know this input-choice optimisation in detail. I just wanted you to have a general sense of it as it helps us see how the model fits together.

Optimisation (given a production function and input prices)...

yields a (minimum) cost for every output q a firm chooses to produce

Total cost function: $c(q)$ or $TC(q)$.

Total costs are fixed costs plus variable costs

- **Fixed costs:** must incur to produce even the first unit (e.g., hire factory space)
- **Variable costs:** increase as one produces more units

Marginal cost $MC(q) = c'(q)$: rate that costs increase in quantity; derivative of cost function

- cost of producing one additional unit (given you already produced q units)

- **'Average cost'** $AC = c(q)/q$: the production cost per unit produced

---

Average costs (for a firm) may be increasing or decreasing in quantity

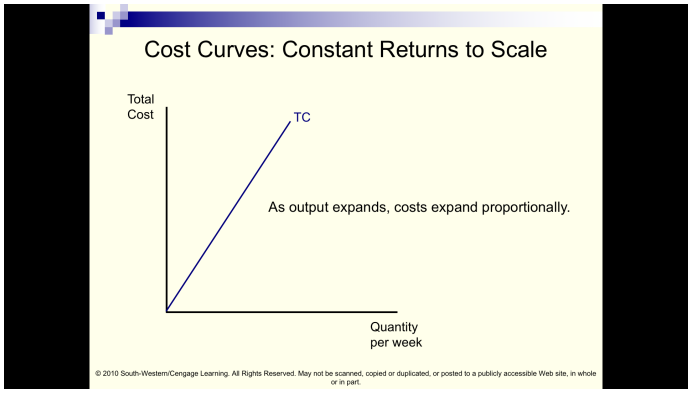
[51] A major difference: a firm *also* chooses the *level* of output, while the consumer has a fixed budget constraint ... we return to the firm in later sections.

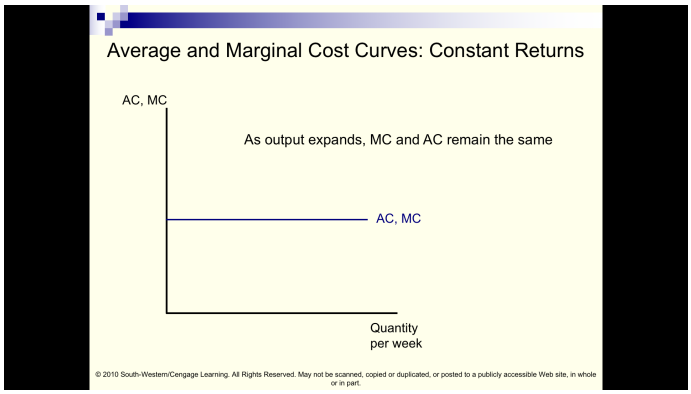
- Increasing average costs ↔ Decreasing returns to scale
- Decreasing average costs ↔ Increasing returns to scale
- Constant average costs ↔ Constant returns to scale

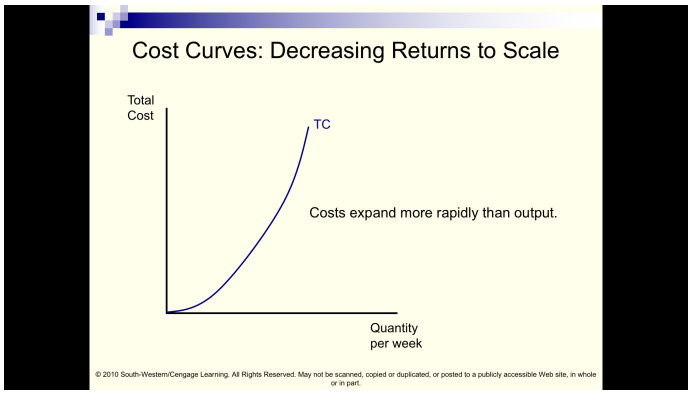
Consider: why/when would we expect DRS/IRS/CRS? (We discuss this further below.)

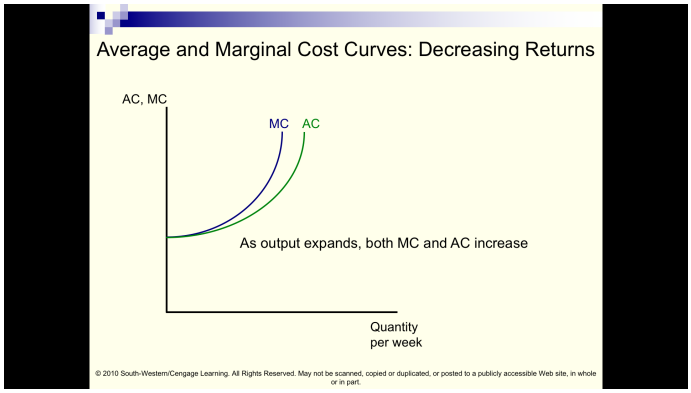
The shape of the marginal cost curve depends on the production function

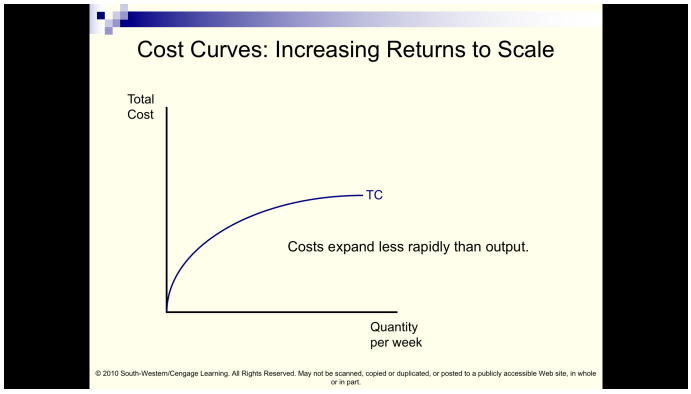
- Constant returns to scale: constant MC (and no FC)
- Decreasing returns to scale: increasing MC
- Increasing returns to scale: decreasing MC (and/or constant FC)

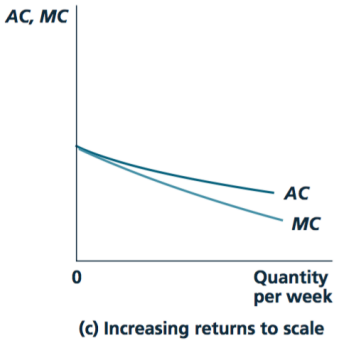












Returns to scale

Are bigger firms always more efficient? Do things get cheaper to produce the more we produce?

If so, what limits the size of firms? I.e., why don't we see only one firm in each industry?

Returns to scale The rate at which output increases in response to a proportional increase in *all* inputs.

Constant returns to scale (CRS) If inputs increase by a factor of X, output increases by a factor equal to X.

- E.g., doubling all inputs (labour, capital, land, etc) means exactly doubling all outputs

Increasing returns to scale (IRS) If inputs increase by a factor of X, output increases by a factor greater than X.
Decreasing returns to scale (DRS) If inputs increase by a factor of X, output increases by a factor less than X.

Arguments/reasons for scale (dis)economies

IRS

- Fixed costs (incorporation, buildings, management, planning, R&D) spread over more units
- Should always be able to at least 'double everything' and produce twice as much? (so at least CRS)
- Scale allows specialisation

DRS

- Limited resources in whole (or local) economy; costs begin to rise
- Managerial issues and coordination problems, bigger 'centre' to lobby for favours
  - (See 'theories of the firm')
- Harder to give incentives to top manager/CEO?
  - Larger firm → harder to make CEO liable for losses

Adv: I think the first point is valid, but it doesn't suggest that 2 firms would be more efficient than 1; these DRS would set in as a function of *total* output, not a single firm's output. The second and third arguments are complicated and perhaps harder to justify. The case for DRS is unproven, IMHO

Lecture5 (merged into the above)

(Note: in 2018-19 this topic (costs) is/was merged with the above, so these notes are blank)

Basic cost concepts (largely revision)

Fixed costs (FC) Costs that must be regularly incurred to *remain* in business (i.e., for any level of output), but that do not vary with the level of output

Variable costs (VC) Costs that increase with the quantity produced.

Sunk costs Costs that have been incurred in the past that can never be recovered.

- Sunk costs should not enter into *any* economic decisions.
- FC from previous years are sunk costs; FC for future years are not.

This is not covered at this point in the text.
However, this should be revision from last year.

Economic costs (DR) Additional amounts *paid* for something. The relevant costs (to firm or consumer) when making choices

- How much *more* you have to pay to hire another worker, produce another unit, etc
- How much *more* it cost you to buy another song on Itunes
- How much *more* will you have to pay to hire another worker, produce another unit, etc?
- How much *more* will it cost you to buy another song on Itunes

Opportunity Costs The value that the inputs used to produce something would generate in their next-best use

- We care about these from a *social efficiency* point of view.
  - The airline might charge *you* £1000 for a first-class upgrade, but if there's an empty seat the cost to the airline is almost nothing
  - Leaving (first-class) seats empty is socially inefficient

Accounting costs What was actually paid, even if long ago (may include sunk costs). *Not* relevant at the point of a decision.

NOTE: Please *don't* use accounting costs to make a decision going forward.

Average and marginal cost curves

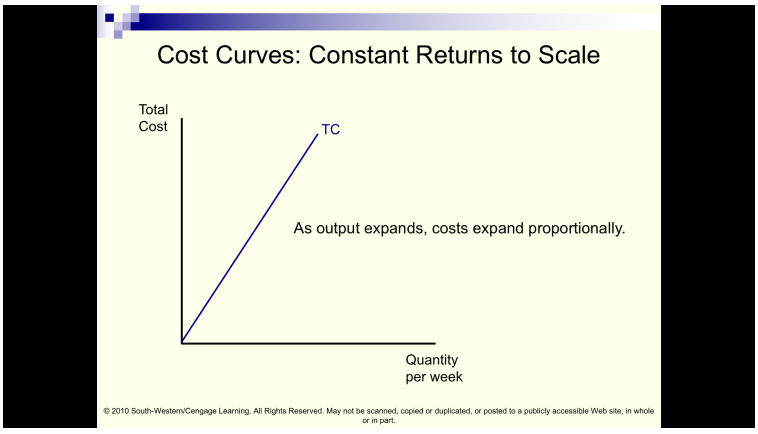
Average cost Cost per unit of output

$$AC = TC/q$$

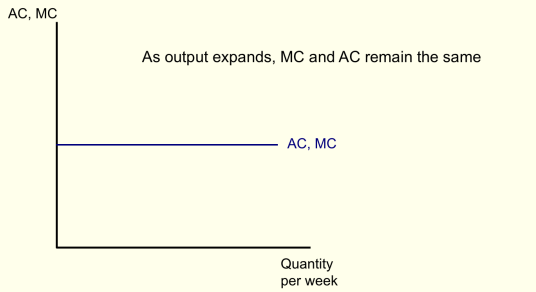
The total 'rise over run' for the TC curve at a given quantity as the firm optimally chooses its inputs along the expansion path

Marginal cost Incremental cost of last unit produced

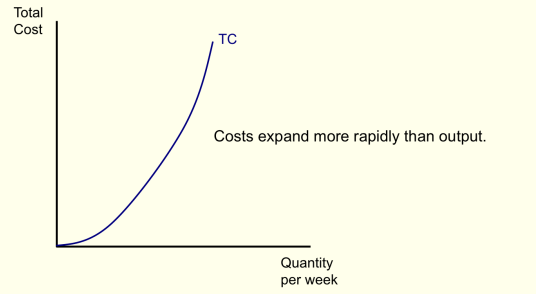
- I.e., additional cost of producing one more unit of output
- MC: Slope of (optimising) TC curve at a point
- Shape of these depends on production function
  - Constant, decreasing, increasing, efficient scale



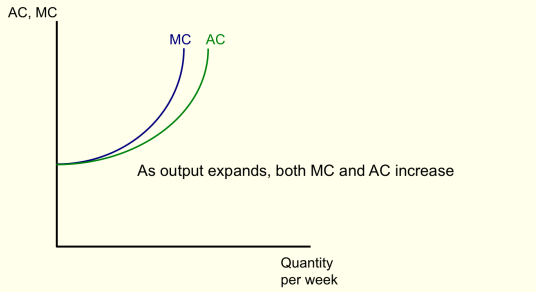
Average and Marginal Cost Curves: Constant Returns



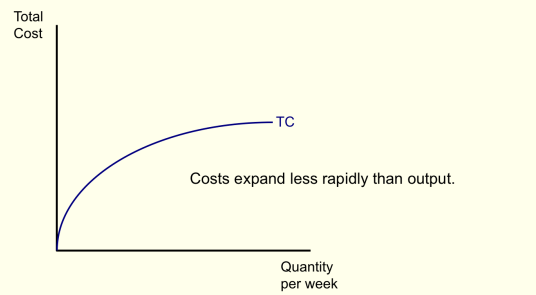
Cost Curves: Decreasing Returns to Scale

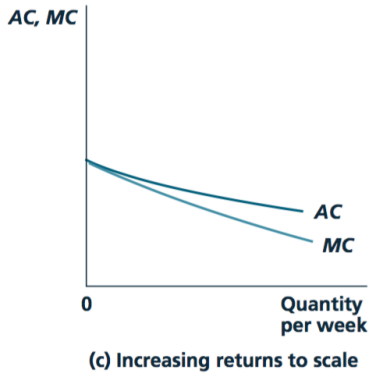


Average and Marginal Cost Curves: Decreasing Returns

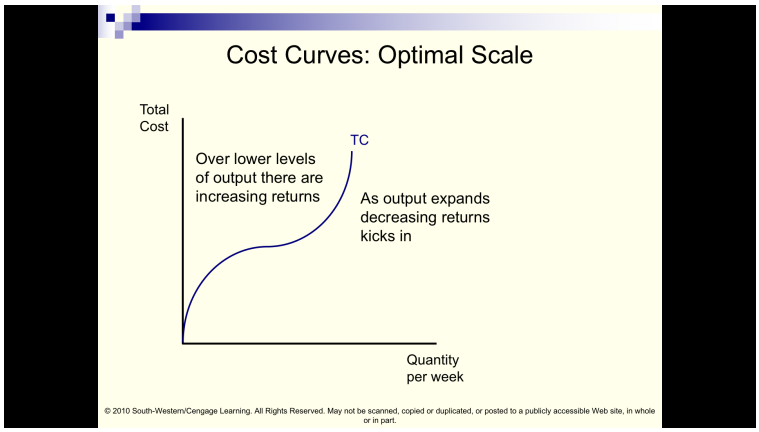


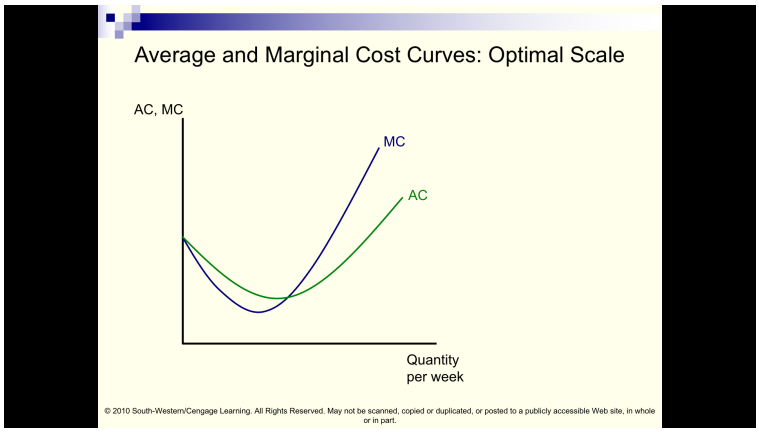
Cost Curves: Increasing Returns to Scale





(c) Increasing returns to scale





Short Run (SR) The period of time in which a firm must consider some inputs to be fixed in making its decisions.

- E.g., capital (K) is fixed but labour can vary

Long Run (LR) The period of time in which a firm may consider all of its inputs to be variable in making its decisions.

In this module, we focus on the latter, where all inputs can be adjusted. We are not highlighting this distinction because we are time-constrained in this module.

Lecture5: has been merged into the above for 2018

Lecture6: Profit maximisation and supply [NS Ch 8 (*)] [1 hour]

Lecture (1 hour) - Profit maximisation and supply - coverage

- NS: Ch 8
- T1:07a-07b
- 8.1 The nature of firms (why they exist, goals, etc)
- 8.2 Profit maximisation (largely revision)
- 8.3 Marginal revenue

NOTE: includes trivial perfect competition case and 'monopoly' case

- 8.4 Marginal revenue curve
- 8.5 Supply decisions of a price-taking firm (largely revision)

Key goals of these lectures (and accompanying self-study)

1. Understand the economist's definition(s) of a firm, and its goals
2. Learn what 'marginal revenue' is

- (and why it is less than the market price for a firm facing downward sloping demand)
- but equal to the market price for a price-taking firm

1. Understand the price and output choice (condition) for a price-taking firm

- and a firm's shut-down/entry decision
- and what *is* a 'price-taking firm'?

Context

- We considered production functions and cost

Now: what **output** to set to maximise profits

(Next: the consequences of this for the market)

Important aside: What are 'firms' and why do they exist?

Standard (classical) economics definition: A *firm* is an entity that transforms inputs into outputs.

We assume a firm's goal is to maximise profit.

Ronald Coase: Why do large entities called 'firms' exist

- Many activities, own many assets
- Often use 'command and control' within firms rather than markets

Adv: This spawned a large literature on the 'theory of the firm' emphasizing things like incomplete contracts, hold-up, relationship specific assets, lobbying costs, and more.

Marginal revenue

Marginal revenue The additional gross income a firm gains from increasing the quantity it supplies by one unit

Remember, given its choice of production the firm will always choose the highest price at which it can sell all the units it has produced

Q: Impact of increasing quantity?

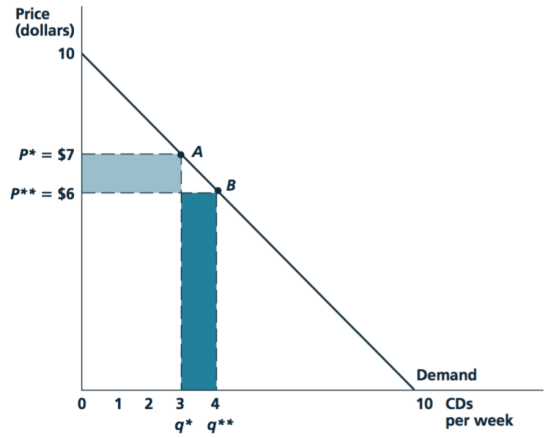
- It can sell an additional unit at some price
- But it may have to reduce prices on *all* units to do this (more on this later)

MR for firm facing 'downward-sloping demand'

NOTE: See example in table 1 in text

- Single price (assume) → sell more only by reducing price on *all units*
  - E.g., sell 51 units rather than 50 by reducing price from £1 to £0.99
- Marginal revenue is less than market price here *because*
  - Get (new) market price for additional unit → + £0.99
  - But lose £0.01 on all previous 50 units → - £0.50
  - So MR is £0.49

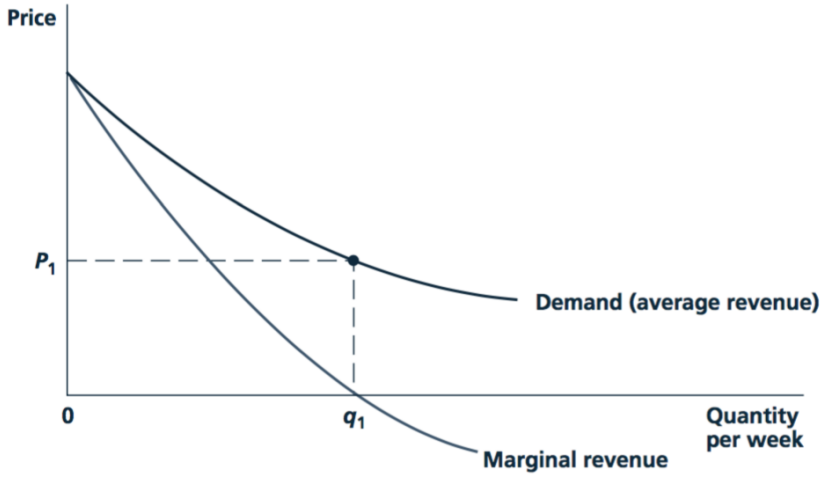
FIGURE 8.2 Illustration of Marginal Revenue for the Demand Curve for CDs ($q = 10 - P$)



For this hypothetical demand curve, marginal revenue can be calculated as the extra revenue from selling one more CD. If the firm sells four CDs instead of three, for example, revenue will be $24 rather than $21. Marginal revenue from the sale of the fourth CD is, therefore, $3. This represents the gain of $6 from the sale of the fourth CD *less* the decline in revenue of $3 as a result of the fall in price for the first three CDs from $7 to $6.

MR curves be like:

FIGURE 8.3 Marginal Revenue Curve Associated with a Demand Curve



Since the demand curve is negatively sloped, the marginal curve will fall below the demand ("average revenue") curve. For output levels beyond q_1, marginal revenue is negative. At q_1, total revenue ($P_1 \cdot q_1$) is a maximum; beyond this point, additional increases in q actually cause total revenues to fall because of the accompanying decline in price.

Q: Why might MR curves typically decrease in Q?

Ans: Demand curves slope down, so less revenue for each additional unit.
Also, the *impact* of the reduced price is greater because the more we sell the more units this affects

---

MR for a price-taking firm

A price-taking firm (perfect competition):

- gets market price P for each additional unit
- the firm is small, so its output has (virtually) no impact on P
  - (More on this later)

NOTE: The text gives a good illustration and examples of why it is fine to assume that a small producer's output has no impact on price

Thus its marginal revenue is constant at P

NOTE: Total revenue curve will be a straight line ... double quantity, double revenue

---

Profit-maximisation

- If operating, set optimal output q^*
- Under standard assumed conditions

Notes: Conditions for a 'unique maximum', e.g. everywhere decreasing marginal revenue and increasing or nondecreasing marginal costs

- ... profits are maximised at the unique q^* such that $MR = MC$

This holds *for all types of firms*

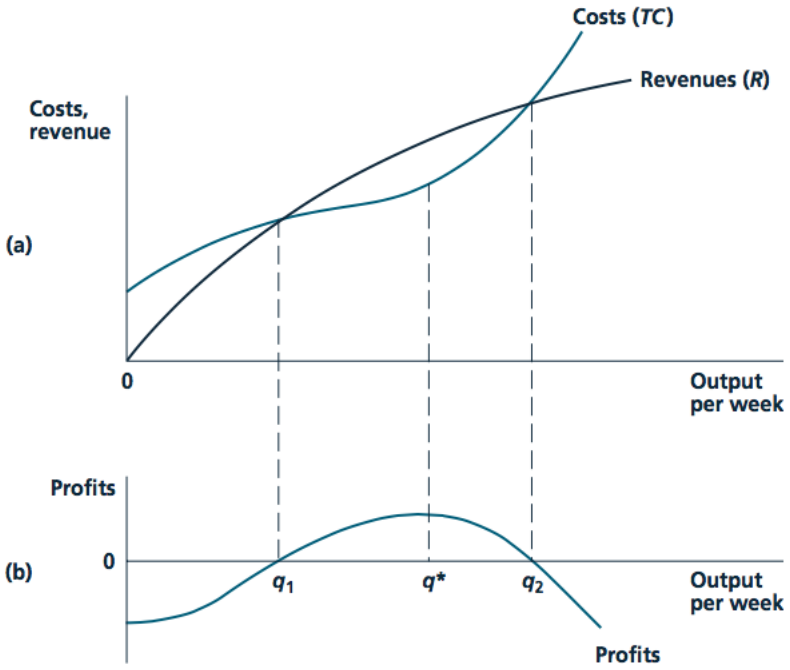
- For firms with market power ('price-setters') the MR takes into account the downward sloping demand curve.
- For a price-taker, setting $MR(q) = MC(q)$ means setting $P = MC(q)$, because $P = MR(q)$

Q: Why? Suppose actual output was greater or less than q*. Explain what is true about marginal profits as output increases or decreases.

Notes: Ans: if q>q*, MR, which is decreasing in q, will be below MC. Firm can do better if it reduces q somewhat– cost decrease will be larger than revenue decrease. If $q < q^*$, $MR < MC$ – better to increase q and revenue increases more than costs

For a firm with market power:

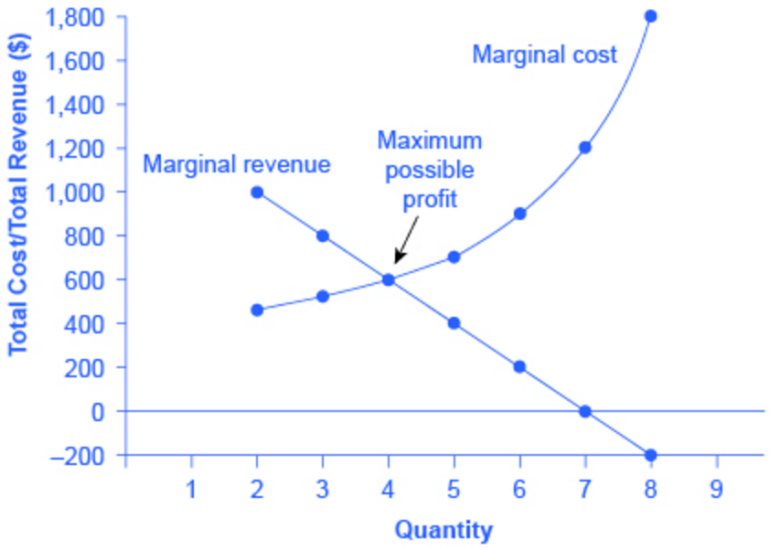
FIGURE 8.1 Marginal Revenue Must Equal Marginal Cost for Profit Maximization



Economic profits are defined as total revenues minus total economic costs and can be measured by the vertical distance between the revenue and cost curves. Profits reach a maximum when the slope of the revenue function (marginal revenue) is equal to the slope of the cost function (marginal cost). In the figure, this occurs at q^*. Profits are zero at both q_1 and q_2.

Firm wants to make the vertical distance between the revenue and cost curves as large as possible.

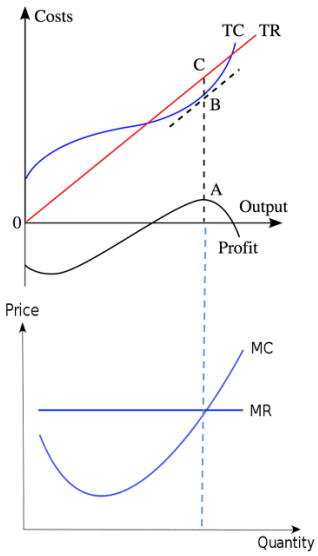
For a firm with market power:



Firm wants to make the vertical distance between the revenue and cost curves as large as possible.
If the curves had differing slopes, profits could be increased by adjusting output in the direction in which the curves diverged.

MR=mc condition for price-taking firm

$$MR(q) = P$$



Inverse elasticity markup rule, intuition

(Advanced material)

Price elasticity of demand for single firm's output (q):

$e_{q,p}$ = abs(% change in q) / (% change in P))

Demand Curve	Marginal Revenue
Elastic ($e_{q,P} < -1$)	$MR > 0$
Unit elastic ($e_{q,P} = -1$)	$MR = 0$
Inelastic ($e_{q,P} > -1$)	$MR < 0$

Rearranging the MR (derivative of revenue wrt price) yields:

$$MR = P(1 - \frac{1}{e_{q,p}})$$

Intuition: Sell another unit, gain 'P' on that unit but lose 'P × % reduction in P needed for a % increase in Q' on other units the last term is the inverse of price elasticity

$$MR = P(1 - \frac{1}{e_{q,p}})$$

Setting MR=MC → 'markup as % of price' $\frac{P-MC}{P} = \frac{1}{e_{q,p}}$

(You don't have to memorise this formula)

- It's called the 'Lerner markup rule'
  - this 'markup as % of price is also used as a measure of the extent of a firm's market power

---

Supply decisions of a price-taking firm (largely revision)

Price-taking firms:

- Can sell all output at market price P. *Will price at P.*
  - Set p<P* → Sell same amount, earn less. Not smart!
  - Set p>P* → Sell no units. Bad move!

. . . price-taking firms

- How much to produce?
  - Standard assumption: $MC(0) < P^*$, $MC(q)$ increasing in q (assumed)
  - (. . . or at least there is some region for which AVC< P^*)
  - Thus choose q for which $MC(q) = P^*$
  - 'Perfectly competitive firms price at marginal cost'
- But if P* is below your average cost for *any possible* output q you must shut down!
  - If it's below '(short run) average variable costs', shut down right away; each unit you produce adds to your loss!
  - If it's below your (long-run) average cost, shut down before incurring any more fixed costs, you will never be able to produce at a profit!

NOTE: I am not focusing on distinction between short and long run cost curves in this module

Suggested practice problems from Nicholson and Snyder Chapter 8 (12th ed)

'Problems':

- 8.1
- Supplemental: 8.5, 8.7

Lecture7: Perfect competition in a single market [NS Ch 9 (*)] [1 hour]

Lecture (1 hour) - Perfect competition in a single market - coverage

- NS: Ch 9
- T1:05
- Third problem set: Costs/production, perfect competition in a single market, Welfare/General Equilibrium

---

Key goals of these lectures (and accompanying self-study)

1. Understand how firms' supply curves aggregate to a *market* supply curve?
2. Revise: what is a 'perfectly competitive market'?
3. Understand the importance of entry and exit in such a market, and the implications for the short and long run:

- firms' economic profits
- market price and
- reaction to a shift in the demand curve

1. Understand what a *long run market supply curve* might look like, and why
2. Understand *consumer surplus* and *producer surplus* and the implications for welfare analysis
3. Understand the concept of Pareto Optimality
4. Learn the argument for why a perfectly competitive market may lead to a Pareto Optimal outcome (under certain conditions)
5. Understand the critiques of this, and the idea of 'market failure'

Motivating questions

- With many 'price taking firms', how does *aggregate* supply respond to changes in demand?
  - Can such firms make a profit in the short run? In the long run?
- If demand for a good increases (demand curve shifts out), because preferences change, or population increase
  - ... should we expect the price of the good to rise in the short or long run?

Deeper:

Should we expect 'competition' to lead to the most efficient outcomes, and if so, when and under what conditions?

- Would it be better to restrict the entry of firms, or have a single firm with a guaranteed monopoly?
- Would it be better to restrict or regulate prices?

These questions are at the core of political and economic debates throughout the 19th and 20th century. Mercantilists vs physiocrats (classical liberals), Socialists vs laissez-faire debates over 'industrial policy' and 'trust-busting', etc

---

Urgent question: Brexit

Trade with Europe may default to WTO terms

→ Very large tariffs on some goods, 'non-tariff barriers' on others

UK (and EU) firms: Unknown impact on input prices, demand curves, competition, etc.

- Can 'GE models' help predict these and help firms plan and reoptimise?
- How long will it take to return to some 'equilibrium'

- Fewer firms in UK markets → less competition → loss of consumer surplus?

. . .

We will have to decide on many new regulations bundled with new trade deals:

- Which are 'pro-competitive' or redress market failures and which restrain trade?

SKIP: Pricing in the very short run

SR supply

You should have all seen this before in previous study, so we will go quickly

- Number of firms in the market is fixed: no entry/exit
- Existing firms will respond to demand shifts by changing their quantity supplied
- Market supply curve: sum of each firm's supply curve

Recall (from earlier study): Under perfect competition each firm

- must charge market price P^*
- produces q so that $mc(q) = P^*$
  - as long as there is some output q where $AVC \leq P*$

Thus, for every price P^*, it produces the q where $mc(q) = P^*$.

This implies that its mc curve *is* its supply curve!

- (except where $AVC(q) > P^*$ for all q; where it produces zero)

Note: Where the minimum AVC exceeds P*, the firm has no way to produce profitably, so it will produce nothing.

For a further revision, this process is well mapped out in a step-by step Powerpoint you can download:

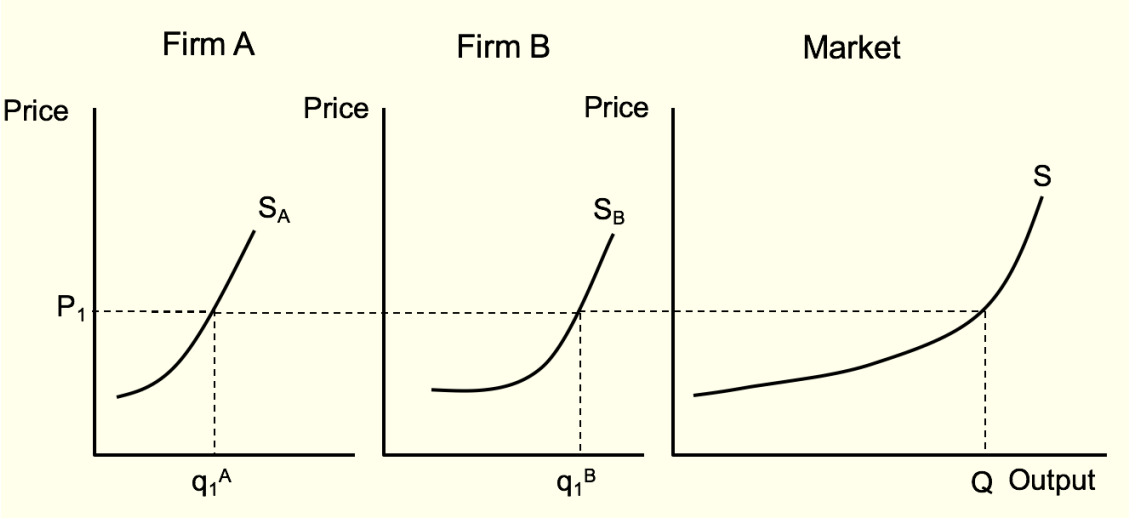
http://web.mnstate.edu/stutes/notes/mankiwjustpp/firms_competitive.ppt

(start from beginning, this is specifically referred to beginning on about slide 20 'The Firm's Long-Run Decision to Exit or Enter a Market'; use 'presentation mode')

Note: slide 19 states 'The firm considers its sunk costs when deciding to exit, but ignores them when deciding whether to shut down.' This is not stated precisely. They are referring to those 'fixed costs' which must be incurred at regular intervals (e.g., a license fee every year)... from the pov of midyear, this years' license fee is sunk, but next year's is not.

Sum each firm's supply curve *horizontally*

(Rem: supply curve is relevant part of MC curve)



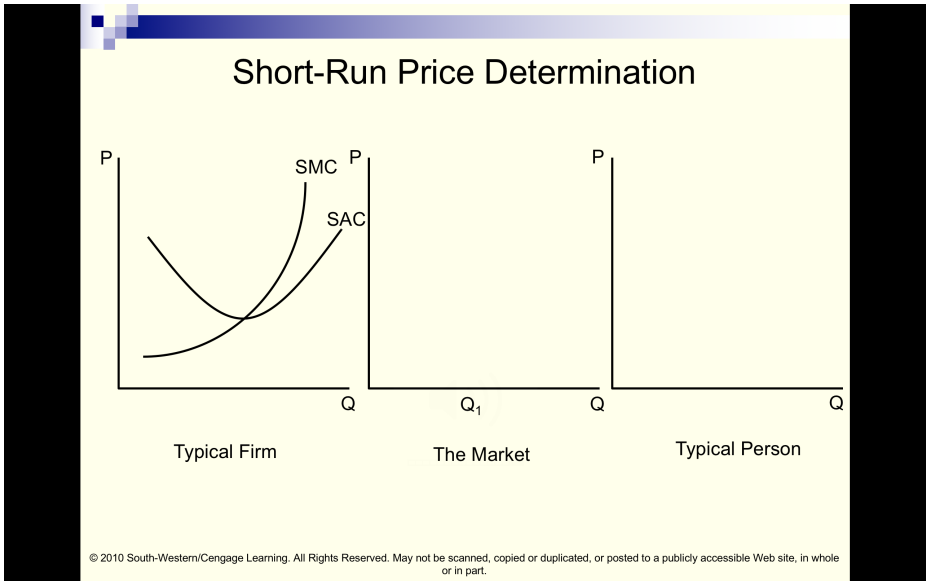
SR Price determination

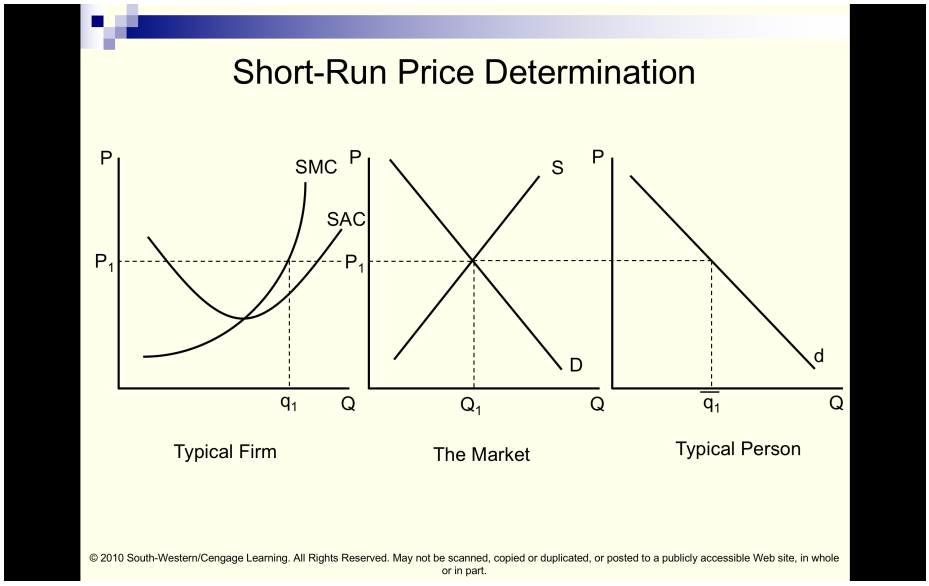
- Sum each firm's supply curve (part of MC curve) to get *market* supply curve
- Sum individual demand curves to get *market* demand curve
- At what point do these intersect?
  - At this price P^* we have $Q_D(P^*) = Q_S(P^*)$
  - Call this the (short run) *equilibrium* price

- This price may be above *average* variable or even *average total* costs for many firms ($P^* > AC$)
  - They can make real *economic* profits! (But only in the short run.)

To avoid confusion, recall that firms are producing where their *marginal* costs equal the market price.
MC are often assumed to *increase* as quantity increases; this means that only the cost of the *last* unit produced equals P.
Previous units had marginal costs below* P. *Thus* average* (variable) costs may be below P*

Illustration of SR price determination





Price signal

The price acts as a signal (leading to efficient choices):

- to firms, telling them 'how much to produce'

Note: Don't produce past the point where your marginal cost exceeds the price you can get in the market,
at the price where the market 'clears' $Q_d = Q_s$.

- to consumers, how much to purchase
  - and 'which consumers should obtain the units produced'?

Note: By the definition of the market-clearing price P,
consumers can buy all they desire at P,
i.e., buy units until the last unit they buy gives them a marginal utility of P*.

Note: Adv, foreshadowing equilibrium efficiency:
This means that each consumer values the last unit they consume at the same amount
thus, we *never* have that the 'wrong' consumer obtains the good;
no further gains from 'exchange among consumers'.
If prices were too low (e.g., because of a price ceiling), $Q_d > Q_s$
demand would have to be rationed, and consumers who valued the product more than other consumers might not get as much.

Shifts in S and D curves

- Basically this should all be revision, but read it anyway. You are required to know this material.

The Long run

Here we assume 'free entry and exit' of firms, and a large number of firms have access to the same production process.

Suppose *positive economic profits* in industry (for efficient producers)

- I.e., $P^* > AC(q)$ for some q
  - $\rightarrow$ Firms enter
  - $\rightarrow$ Supply curve shifts out
  - $\rightarrow$ equilibrium price declines
  - $\rightarrow$ profits decline
  - repeat until economic profit falls to zero
  - i.e., until $P^* = AC(q)$ for the minimum AC q

Note: Positive economic profits are sometimes called 'supernormal profits.'
Remember, economic profits are profits *after* subtracting the (opportunity) cost of capital, management, and other inputs

---

- Now suppose *negative economic profits* in industry (for efficient producers)
- I.e., $P^* < AC(q)$ for any q
  - $\rightarrow$ Firms exit
  - $\rightarrow$ Supply curve shifts inwards
  - $\rightarrow$ equilibrium price rises
  - $\rightarrow$ profits rise
  - repeat until economic profit rises to zero
  - i.e., until $P^* = AC(q)$ for the minimum AC q

For a further revision, this process is well mapped out in a step-by step Powerpoint you can download:

https://www.dropbox.com/s/vyvao528job7q0q/fc.ppt?dl=0

(This is specifically referred to beginning on slide 39; use 'presentation mode')

Long Run Equilibrium

- Firms choose output to max profit
  - Profit max: $P^* = MC(q)$

No firms in the market want to exit, and no firms out of the market want to enter

Zero economic profits:

$P^* = AC(q)$

Also:

With free entry and exit (and no limits on production)...

all firms in the market must produce the quantity that *minimizes* their average cost,

and all must have the same average cost

- I.e., $P* = minAC(q) = MC(q)$ for any firm in the market
- I.e., the MC curve intersects the AC curve at its minimum point.
  - And this is the same average cost for all firms

all firms (in) produce q that *minimizes* their AC, and all *same* average cost

Why?

Why $P* = min[AC(q)] = MC(q)$?

- No profit in equilibrium and firms produce at P=MC.
- Thus $P* = AC(q) = MC(q)$ for all firms in the market.

- Suppose here that a firm were producing at a point *above* it's minimum AC,
  - i.e., if $AC(q) > min[AC(q)]$
- it could instead produce at the q that minimised its AC, and make a profit (contradicting the above)
- ... (and so would other firms, who'd be induced to enter)

Note: We assume a large number of firms have access to this efficient technology.
As previously mentioned, entry shifts the supply curve out, equilibrium price falls,
until the point where $P^* = AC(q)$ for firms producing at this lowest AC point.

Long Run (LR) Supply

- We have the SR supply curve (upward sloping)
- But we know that in the LR this will shift out in response to a price change
- Taking this shift into account gives us the *Long Run Supply Curve*

Avoid confusion:
In the SR there are movements *along* this curve in response to price changes.
In the longer run, it does shift in response to price changes, as firms enter.
The LR supply curve, which we will now define, does *not* shift in response to price changes
But other things may cause it to shift, like changes in input costs

---

What will the LR supply curve look like?

- If demand shifts out, do more enter and produce at the same efficient minimum AC?
  - Depends on whether entry and higher aggregate production *change* the firms' cost functions
  - *Input costs* may rise; increased demand for scarce inputs, skilled workers and public resources
  - (Also, other potential 'externalities' between firms, consumers, e.g., network externalities)

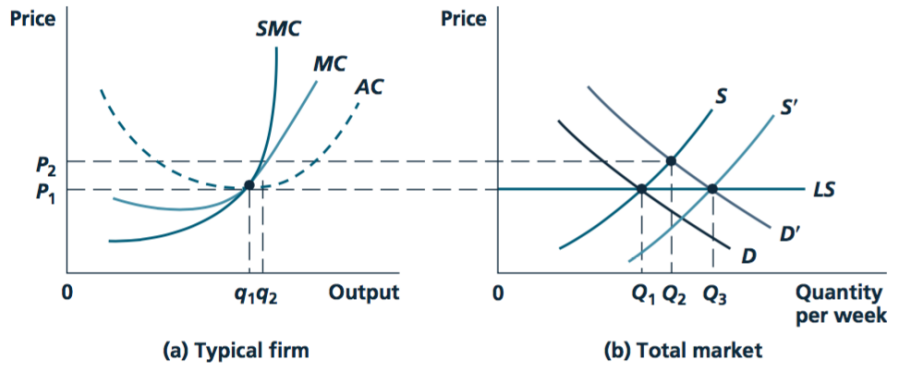
Note: DR opinion: For a variety of reasons, we shouldn't always expect the LR curve to be upward sloping. It might also be flat or downward sloping. Thus, if the demand curve for, e.g., microchips or personalised software shifts out, we may see that equilibrium price *declines* in the long run.

Relevant to impact of long run population and economic growth

Note: Economic and population growth leads to increased demands for most products (especially natural resources and other primary products). The shape of the LR supply curve tells us whether real resource prices will increase rapidly over time.
The relative slope for different products tells us which prices will rise *relative* to prices for other goods. E.g., will housing become relatively more or less expensive?

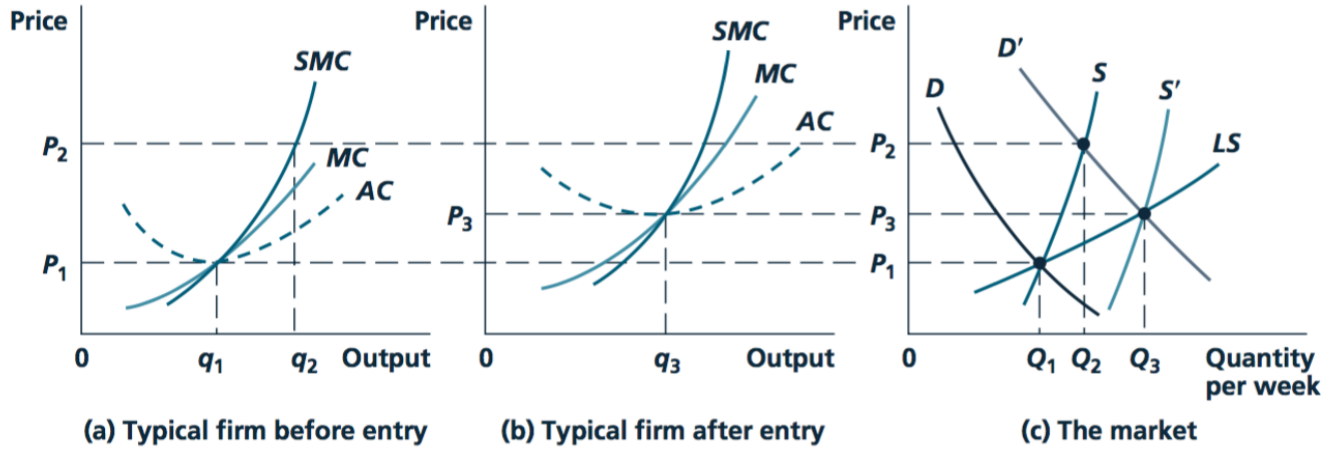
LR Supply: Constant cost case

FIGURE 9.7 Long-Run Equilibrium for a Perfectly Competitive Market: Constant Cost Case



An increase in demand from D to D' causes price to rise from P_1 to P_2 in the short run. This higher price creates profits, and new firms are drawn into the market. If the entry of these new firms has no effect on the cost curves of firms, new firms continue to enter until price is pushed back down to P_1. At this price, economic profits are zero. The long-run supply curve, LS, is therefore a horizontal line at P_1. Along LS, output is increased by increasing the number of firms that each produce q_1.

LR Supply: Increasing cost case



Note: Initial market equilibrium: P1, Q1
Increase in demand to D' → price to P2 in SR → firms produce at q2, profit →
Profit attracts new firms. → costs rise to the levels shown in (b). →
New equilibrium at P3, Q3.

Long-run elasticity of supply: % change in LR Q^s / % change P

TABLE 9.3

INDUSTRY	ELASTICITY ESTIMATE
Corn	+ 0.27
Soybeans	+ 0.13
Wheat	+ 0.03
Aluminum	Nearly infinite
Coal	+ 15.0
Medical care	+ 0.15 to + 0.60
Natural gas (U.S.)	+ 0.50
Crude oil (U.S.)	+ 0.75

{(Various estimates over the years, see text)}

Consumer and producer surplus, efficiency

Consumer surplus (reprise) The extra value individuals receive from consuming a good over what they pay for it. What people would be willing to pay for the right to consume a good at its current price.

- The area between the demand curve and the market price

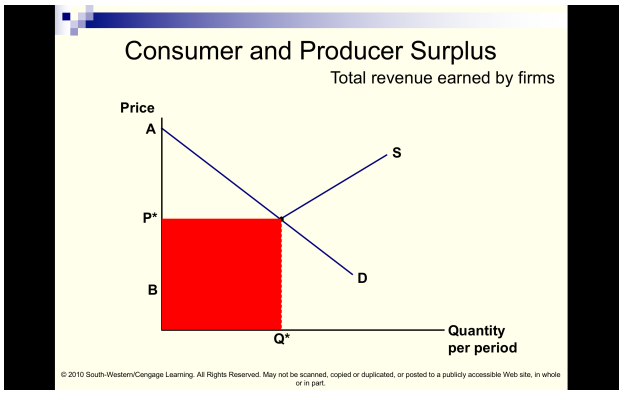
Producer surplus (reprise) The extra value producers get for a good in excess of the opportunity costs they incur by producing it. What all producers would pay for the right to sell a good at its current market price.

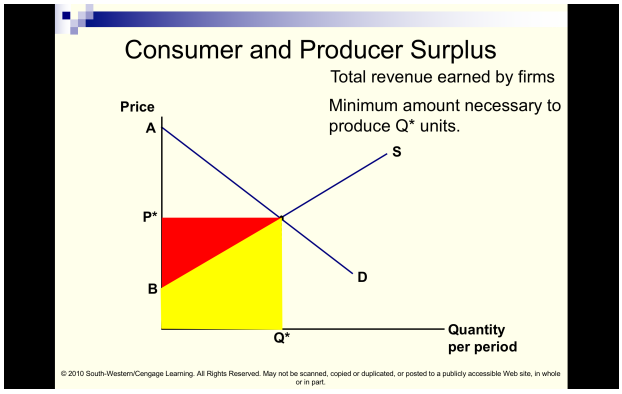
- The area between the supply curve and the market price

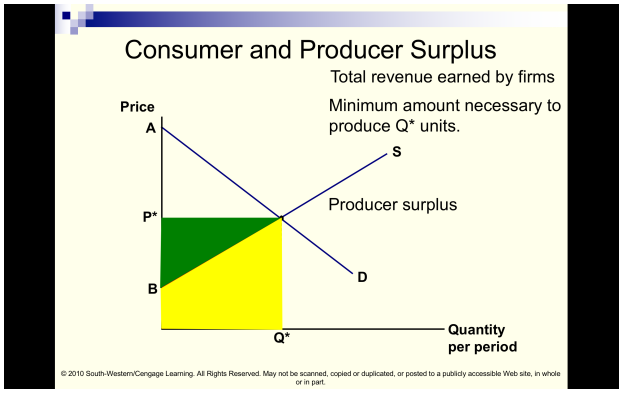
Note: Basically producer surplus is profit + unavoidable costs.
In the SR you cannot shut down and avoid the fixed costs, whether or not you sell any units.
Since you are already incurring these, they don't count against the benefit you would get from selling at the market price.

- In the LR, profits are zero, and all costs are variable, so producer surplus is zero

Adv: When a firm owns a unique resource it can arguably make a LR profit called a 'Ricardian rent'. However this could be seen as the return to an asset which should be 'charged against' these profits.



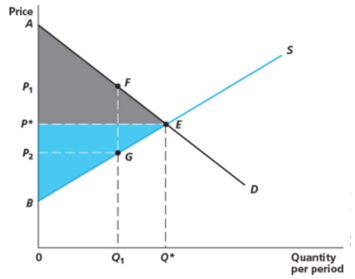




In what sense is a competitive market efficient?

Economically efficient allocation of resources: maximizes the sum of consumer and producer surplus. - At market equilibrium there are no more mutually beneficial exchanges

Basically, a *competitive* market *in equilibrium* maximizes the sum of producer and consumer surplus.



Note: Q* maximizes the sum of consumer and producer surplus.
Any other quantity yields a lower sum.
E.g., at Q1 we 'lose' the triangle FEG
. . . this is called a 'deadweight loss' ('DWL') as it is a loss to society, it just disappears.

We can use these models and concepts to study things like

- 'Who suffers from a tax' in the LR and SR?
- Who gains from technological innovation?
- Who gains and who is harmed by trade restrictions, and do the costs outweigh the benefits?

Additional potential applications: rail regulation, music copyright

Suggested practice problems from Nicholson and Snyder Chapter 9 (12th ed)

'Micro-quizes' 9.2, 9.3, 9.4,

'Problems': - 9.3a and b - 9.5? - 9.9 a-d?

Important caveat

Consider: Should price-taking firms and perfect competition be our 'baseline' dominant model?

Is it reasonable to assume?

- Free entry of firms/no 'barriers'?
- Homogenous products?
- Descreasing returns to scale at some point?

These conditions will indeed lead to perfect competition/MC pricing.

But many markets have large entry costs, first-mover advantages, and perhaps continuously increasing returns to scale. This will lead to monopoly or oligopoly in the absence of regulation.

Perhaps even more crucially, Most products are also 'differentiated'; if one firm charges slightly more than another firm, it will still capture the demand from those people whose are 'close' to it. People will pay a little extra to not travel as far. They will also pay a little extra to get the product that most suits their preferences. In this case, with free entry, we have something known as 'monopolistic competition', which has some of the characteristics of monopoly (e.g., pricing above marginal cost) and some characteristics of perfect competition (e.g., zero long-run profits). This model is another candidate for bring the dominant model; there is an active debate about this!

Key principles for efficiency and 'general' equilibrium

General equilibrium and efficiency: Coverage

- This is a very brief excerpt and summary of the material in NS chapter 10, with some additional motivation
- If you understand these slides/notes you don't have to read chapter 10

We can show that *under certain conditions* competitive markets will be efficient in equilibrium.

However:

- Some markets may not reach equilibrium 'quickly'
- These conditions may not hold → *market failure*
- Efficiency itself does not imply preferred outcomes: there can be a great deal of inequality

---

General Equilibrium analysis considers the entire economy as a system of markets which may interact with one another

- General equilibrium: a set of prices so that $Q_s(P) = Q_d(P)$ in all markets, including input markets
- Markets are interdependent
  - E.g., a government push for tomato consumption may shift tomato demand out and prices up
  - this may lead in the LR, to a shift out in tomato supply curves (firms enter)
  - this may increase the demand for *inputs* such as farm labour, raising the cost of production of other vegetables
  - etc.
- Will we return to equilibrium, and with what prices and quantities?
- Stay tuned true believers! (and take more Econ, because we won't cover it here)

Overall Pareto efficiency: no one can be made better off without making someone else worse off

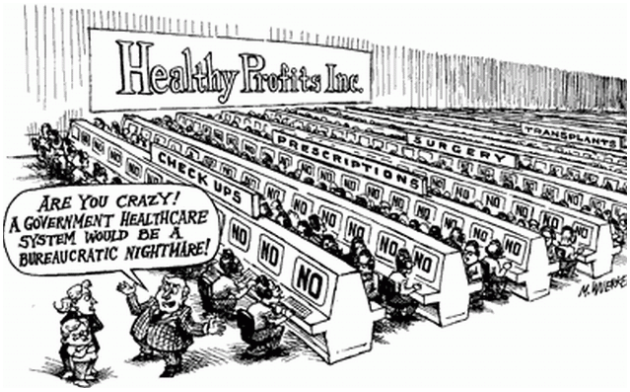
- If we *could* do so, we would not be at an efficient point

Note: Pareto efficiency is hard to disagree with, as a policy goal;
if we could move to a situation where some were better off and none made worse off, we should do it.

Overall efficiency requires several conditions: Productive, Exchange, and Top-level efficiency

Efficiency in production (being on the PPF) No way to reallocate inputs to increase production of one good without reducing production of another

Given society's resources, we are producing 'as much as possible'



Efficiency in production?

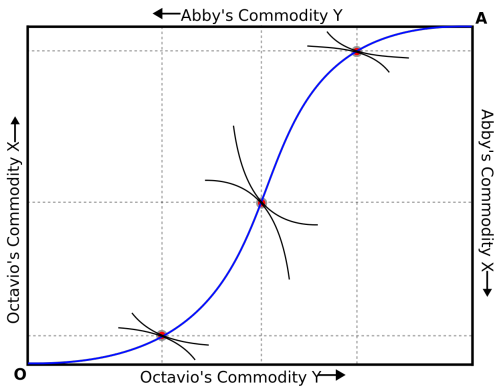
Note: Basic argument for productive efficiency of competitive equilibrium: Firms hire more of each input until its 'bang for buck' is the same as all other inputs, and a single market price for the input will ensure this is the same across firms. This 'equilibrium' input price must reflect its marginal productivity in producing the 'last unit' for each and every firm.

Efficiency in consumption (exchange efficiency) No way to reallocate output amongst consumers to make them all better off

Given what we're producing, it is going to the 'right consumers'.

Note– Basic argument for productive efficiency of competitive equilibrium: If, given the 'endowments', one person values A in units B more than someone else, an equilibrium price ensures that they will trade these amongst one another until each has the same MRS The 'Edgeworth box' offers a graphical demonstration that this yields a Pareto optimum (given the amounts produced).

Edgeworth box scavenger hunt



Does this look familiar? Where can you find it at Exeter? What does it mean?

Note: Basic argument for exchange efficiency of competitive equilibrium: An equilibrium price ensures that they will trade these amongst one another until each has the same MRS The 'Edgeworth box' offers a graphical demonstration that this yields a Pareto optimum (given the amounts produced).

Given our inputs, we can produce 'efficiently', i.e, along the PPF,

and given the amounts of each good produced, it is 'consumed by the right people' (no more room for trade) . . .

yet we may still not be at efficiency? Why?

3. Efficient allocation of resources

Firms may be producing at minimum cost, using the optimal combinations of inputs. And the outputs produced may be allocated efficiently between the consumers, such that neither consumer prefers to trade. *But we still may not be at a Pareto optimum– why not?*

We need to produce the right *combination* of goods.

Efficient allocation of resources ('top-level' condition) No way to produce more of one good and less of another to make all consumers better off

Note:

Basic argument for top-level efficiency of competitive equilibrium: Equilibrium prices from exchange reflect each consumer's marginal rates of substitution for their last unit This signals to firms the rate at which *all* consumers would be willing to trade off A for B at the margin In equilibrium firms produce at a point where the cost tradeoffs between A and B (slope of PPF) reflects these prices.

First fundamental theorem of welfare economics A general competitive equilibrium is Pareto efficient, under standard assumptions.

- Loose intuition: free exchange leaves no room for mutually-beneficial improvements, and firms and consumers optimise

Second fundamental theorem Under some fancy assumptions, any Pareto efficient outcome is a competitive equilibrium for some pattern of initial endowments

- So if we could costlessly redistribute *endowments*, we could attain any socially-desirable outcome by doing so, and then relying on the free market.

First fundamental theorem of welfare economics A general competitive equilibrium is Pareto efficient, under standard assumptions.

But these assumptions may not hold, this there may be 'market failures'

1. Imperfect Competition

- Markets may not be competitive, because of barriers to entry or increasing returns to scale
- → Prices may not reflect marginal costs, leading to 'deadweight losses'

2. Externalities, public goods, altruism

The assumptions require 'anything someone values' is bought and sold in the market on their own behalf. But:

- Externalities: All costs (and benefits) may not be priced; e.g., pollution

- Public goods (and bads): Many people may benefit from the same good (e.g., fireworks)
- Altruism/interdependent utilities: People may care about *others'* consumption

3. Asymmetric information: People may have different information about the state of the world (costs, risks, a good's quality)
4. Bounded rationality: people may not choose in their own best interests

---

Second Welfare theorem implied that if we could costlessly redistribute *endowments*, we could attain any socially-desirable outcome by doing so, and then relying on the free market.

- But redistribution via 'optimal lump-sum' taxes is not so easy, as endowments may be unobservable
- And redistribution based on things you can affect, e.g. income, may distort incentives.

Some key things for midterm (recap)

- How do economists measure and test models,
  - techniques and terms used
  - thoughts on estimating demand and supply curves

. . .

- The 'axioms' over preferences, the justification for these, and what they imply for utility functions

---

- Understand indifference curves and budget constraints well

. . .

- Conditions for consumer optimisation (obviously this is important) including for when a consumer will choose to consume none of a good

. . .

- Definitions of 'types of goods' as implied by characteristics of the demand function
- Impacts of price changes (own good, other good) and income on an individual's consumption, and what goes into this and how to depict it.
- (Producer and) consumer surplus.

. . .

- 'Applications', especially those discussed both in the assigned text and in the lectures.

- Firm's conditions for 'what quantity to choose' under different market conditions (price-taking, non-price-taking)

. . .

- Perfect competition in the LR and the SR, what profits look like, how prices move.

. . .

- Very basic idea of the efficiency of general equilibrium under perfect competition
  - When it yields a Pareto-efficient outcome,
  - very basically what the first and second welfare theorems mean.
- Components of efficiency (top-level, exchange, productive) and what these mean

Note: we are skipping 'Market Failures: Asymmetric Information'; this is not covered in this module

Lecture8: Market failure (One case: Public goods) [1 hour]

Market failures - public goods, coverage

Note: Some parts of this material relate strongly to game theory. I will give you a preview of game theory as we consider these, and we may return to these examples in our game theory section.

- NS: Ch 16 – public goods section only (skip Lindahl euiliibrium, median voter, single-peaked preferences optional)
- T1:06
- Fourth problem set: Public goods

Key goals of these lectures (and accompanying self-study)

1. Learn how economists define a public good

- Be able to assess whether something fits into this category

1. Understand what 'market failures are'
2. Learn and be able to explain why a competitive market will usually *undersupply* a public good (but may still supply *some* of it)
3. Understand the difficulties *government* may face in providing the right amount of a public good
4. Get a sense of the general patterns and evidence on *voluntary* provision of public goods, including in 'lab experiments'

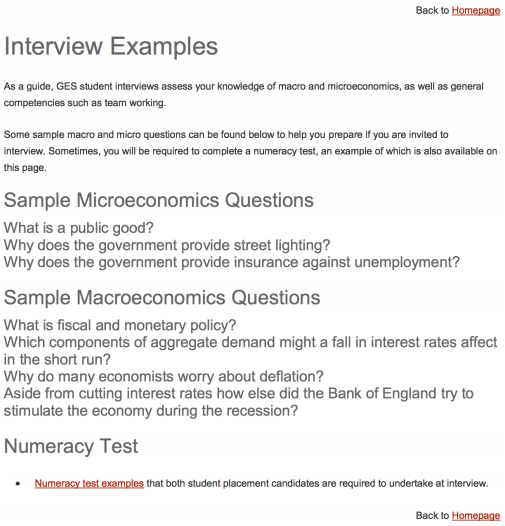
- and what 'lab experiments' in economics are

Outline: What is a public good, why do markets fail to provide these optimally, (how) can governments provide these optimally, when do people provide these voluntarily?

Motivation

- Policy: The 'public goods argument' is critical to justify many government programmes (military, environmental cleanup, research, etc)
- Management: Firms/workers can only profit from providing a public good through getting subsidies or by turning it into a private good.

Are these questions important? Some people seem to think so:



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Interview Examples

As a guide, GES student interviews assess your knowledge of macro and microeconomics, as well as general competencies such as team working.

Some sample macro and micro questions can be found below to help you prepare if you are invited to interview. Sometimes, you will be required to complete a numeracy test, an example of which is also available on this page.

Sample Microeconomics Questions

What is a public good?
Why does the government provide street lighting?
Why does the government provide insurance against unemployment?

Sample Macroeconomics Questions

What is fiscal and monetary policy?
Which components of aggregate demand might a fall in interest rates affect in the short run?
Why do many economists worry about deflation?
Aside from cutting interest rates how else did the Bank of England try to stimulate the economy during the recession?

Numeracy Test

- Numeracy test examples that both student placement candidates are required to undertake at interview.

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Market failures

- Occur when prices don't fully reflect the marginal social benefits or costs
  - Provide scope for political intervention
  - How does this happen?
  - One potential source of market failure: Public Goods

Public Goods (attributes, categories)

What are the characteristics of a public good?

Def – A **Pure Public Good** is a good that is both

1. *Non-excludable*: Once the good is provided, it is impossible/costly to prevent any individual from using/benefiting from it.

Note: This even includes individuals who have not paid for it

Opposite (and alt definition) *Exclusive goods*: ... a good is exclusive if it is relatively easy to bar people from benefitting from it once it has been produced

2. *Non-rival:* One person's consumption doesn't reduce the quantity available for others.

- The fact that some people use the good doesn't prevent others from using the *same* good.
- There is no "crowding."

Alt (equivalent def):

- Providable to additional users at zero marginal (social) cost.
- Consumption of additional units of the good involves zero marginal social cost of production. (E.g., if we had produced a film but restricted it to subscribers, the marginal social cost of letting the whole world download it is essentially zero; the exclusion would take us away from the 'utility frontier')

Q: think of some examples.

Note: In market economies, private suppliers provide the majority of goods and services to consumers. However, certain goods are publicly provided. These include for example defense, education, and health. Why does the government instead of the market provide these goods? Which characteristics differentiate goods that are privately provided from goods that are publicly provided? How do we define public goods? The terminology might induce the conclusion that 'public goods are good that are publicly provided as opposed to private goods which are privately provided.' This conclusion is simply WRONG! The public or private nature of the good is an intrinsic characteristic of goods that is not related to the provider of the good Hence, it may well be that the state provides a private good or that the market provides a public good.

In between's

Excludable and rival (depleatable)? → *Private good*

"Club goods": excludable but non-rivalrous (at least up to a congestion point).

"Common property": Nonexcludable but rivalrous

"Somewhat" nonexcludable and/or "somewhat" nonrival: → "impure public goods."

Excludable

Depleatable	YES	NO
YES	Cheese Education	rivers roads
NO	Copyright	defense

TABLE 16.1 Types of Public and Private Goods

Rival	Exclusive: Yes	Exclusive: No
Yes	Hot dogs, automobiles, houses	Fishing ground, public grazing land, clean air
No	Bridges, swimming pools, scrambled satellite television signal	National defence, mosquito control, justice, ideas

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What about?

- Recorded music
- "Information" goods (e.g., software)
- A national park
- A theatre performance
- Roads
- Clean air
- Education
- Aid to the needy
- Loud music coming from my window
- Disease control
- Economic research
- The justice system
- Fireworks in Disney World
- The 2012 Olympics in London

The basic idea

If a good is *non-rival* then additional provision is costless. Thus,

- if exclusion is possible, and *any* positive price is charged, some are deterred from consuming it
- this is inefficient: people who could benefit from the good, at no cost to others, will not consume it :(

If a good is *non-excludable* it will be difficult to charge people for it

- many might prefer to wait for *others* to buy it, and then they enjoy it anyways (free-ride), which could lead to coordination problems

and...

Even if each person provided it for their *own* benefit (on the assumption that no one else would), they would typically choose *too little* from a social POV...

Considering their own marginal benefits (and MRS) versus the price or cost, not the *social* marginal benefit (essentially, a positive externality)

But if firms cannot charge for its full value, they might not pay the fixed costs to develop/build/provide it

- Who would pay to produce a film that is freely pirated/distributed?
- Who would pay to develop a drug that must be priced at its marginal cost?
- Why contribute to police protection for your village, if your neighbours will pay for it anyways?

Note: Loosely, 'rivalryness' basically relates to whether market provision will be *efficient*; 'excludability' tells you whether firms can make *some revenue* from providing it, selling the same prooduced good to more than one person (or to a 'club' of people)

Application: drug development

Drug R&D may be a public good, or a common resource

- Expensive to develop and introduce a new drug – 'sunk costs' once developed
- But cheap to copy and produce; without patent protection may have $P = mc$ and no ex-post profit to compensate for sunk costs
  - $\rightarrow$ No incentive to develop drugs without patent protection guaranteeing 'excludability' and a limited monopoly
- But ex-post, patent protection is costly; drug produced for a few pennies sold for £1000's
  - People may not buy, or NHS may not cover
  - $\rightarrow$ Inefficient: some consumers may value drug at £100's, far above MC, yet they don't consume it
- Possible solution: Government *awards* and subsidies for drug development.

Note: In fact, governments do fund and subsidise R&D. But there are difficulties here too. Governments may free-ride off of other governments. It is also for government to know whom to fund, hard to quantify the benefits to potential drugs, and offering 'prizes' to developers offers its own challenges: how to asses if the drug is good enough to deserve the prize? And too many firms working on the same drug may be wasteful.

Public Goods and Market Failure

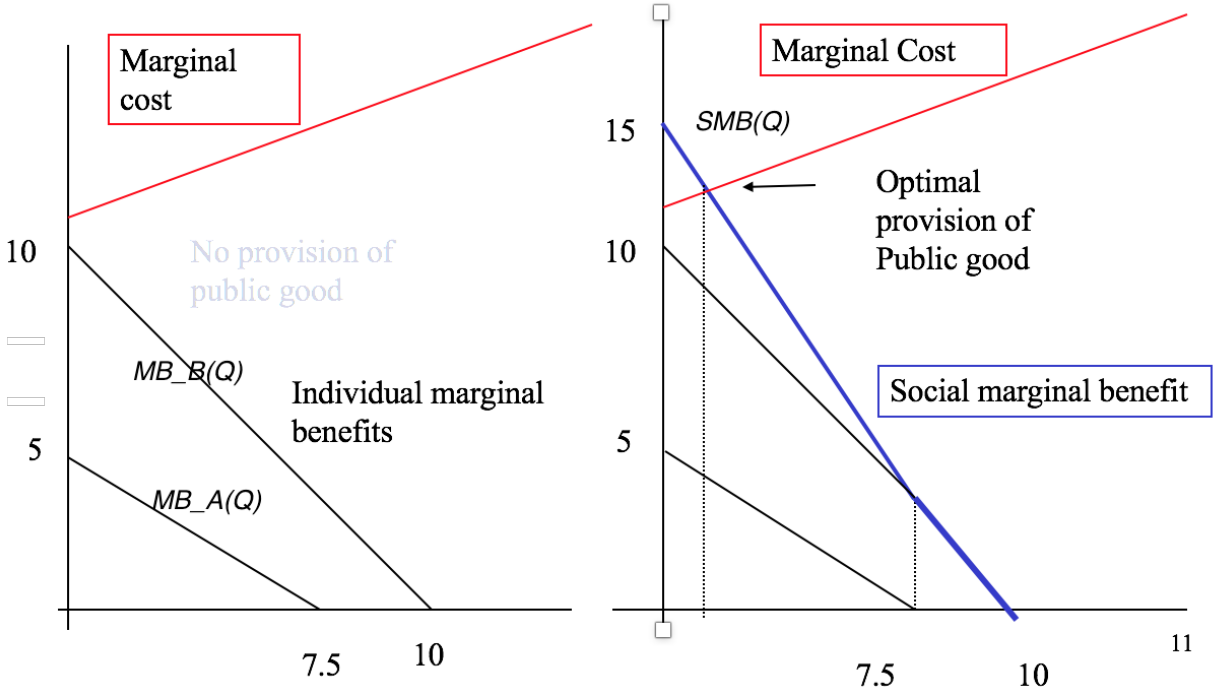
The First Welfare Theorem's assumptions/conditions do not apply to public goods. Markets do not yield a Pareto Optimal outcome.

Note: The market will not produce where the consumers' MRS equals the rate at which public and private goods 'trade off in production'. More of the public good could be produced by sacrificing some of the private good, and consumers will be better off.

- Non-excludability $\rightarrow$ no price or suboptimal price $\rightarrow$ firms don't get the correct signals for production
- Non-rivalry $\rightarrow$ each unit provides benefit to all, consumer choices don't reflect this

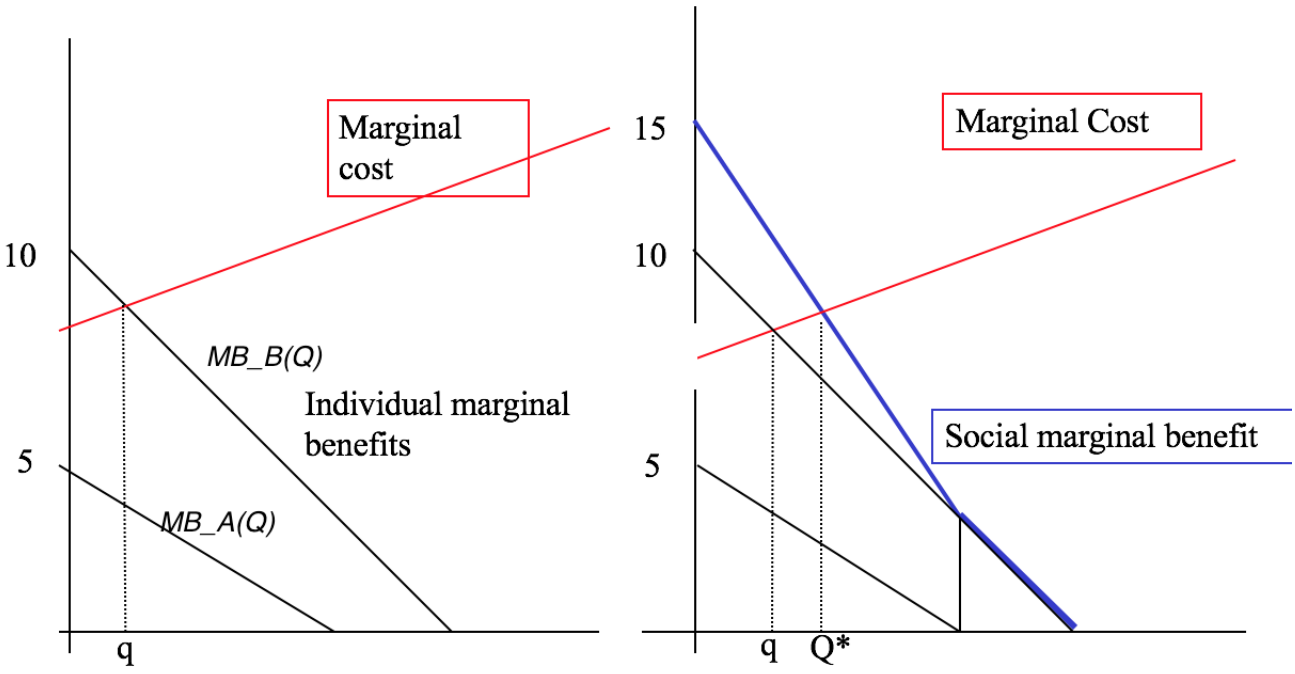
Social benefit of a private good vs a public good

- Overall value of a private good: (area under the) "horizontal sum" of individual marginal benefit curves
- For public goods the aggregate value "sums vertically"
- Social margin benefit of PG sums *vertically*



Note: Even at p=mc, neither consumer will pay for it alone. Neither flatmate will pay £80 to have the house cleaned, even though it is worth £60 to each flatmate.

Note: To avoid confusion, note that we are talking about marginal cost as the cost of providing a unit of the public good 'to everyone' E.g., one new movie produced, or one firework displayed to the whole city. Once produced, all benefit, i.e., the cost of letting additional people enjoy it is *zero*.



Q: What happens here?
Ans: The individual with the higher valuation purchases q of this public good if it is priced at marginal cost.

However, he will still purchase less than the *socially optimal* amount, Q^*

With a binary choice (provide or don't) it is a Prisoner's Dilemma:

Suppose cleaning costs 80 but each housemate values a clean house at 60. Should each offer to pay for cleaning knowing that the cost is split among those who offer?

What is the Nash equilibrium?		Column	
		Offer	*Don't offer*
Row	*Offer*	20, 20	-20,60
	Don't offer	60,-20	0,0

Solutions to the Public Goods Problem

(you can skip the Lindahl equilibrium discussion)

Food for thought, discussion

1. What is a public good? What do we call a good with only 1 of these 2 necessary properties?
2. Why does the free market *underprovide* these? Why/when do they provide some amount?
3. What is an example of a public good, perhaps one from your own life that we didn't already mention
4. What are some things you think may lead to more *voluntary* provision of public goods?

Government's role

- Pure public goods are not provided optimally by the free market, i.e., voluntarily

Note: except in really special and lucky cases

- (although people do contribute to public goods, e.g., making charitable donations, for various reasons)

This is a justification for government: to enforce contributions to public goods, and make everyone better off

Adv: or, allowing heterogeneous tastes, achieve a "potential Pareto improvement"; those who benefit could compensate those who are harmed and still all would be better off.

- **But** it's hard to determine tastes for the public good, hence difficult to determine the optimal level!

Revealing the Demand for Public Goods (brief)

Suppose some people like fireworks, and some don't. How many should the town pay for?

i. Ask everyone to state the number of fireworks they want, and we choose the average and split costs evenly?

Q: would this work?

- → Fireworks-lovers may overstate their value to skew the average.

ii. Ask everyone to state number they want; choose average; those who stated more pay more?

- → Many people understate their value to avoid having to pay. Doh!

Difficult or impossible to find a 'mechanism' that leads to 'truth-telling'.

- Direct voting on each proposal also may not lead to the optimal choice

---

Voting paradox example

Green party: Green Park $\succ$ Public housing $\succ$ Private housing

Labour: Public housing $\succ$ Private Housing $\succ$ Green Park

Conservatives: Private Housing $\succ$ Green Park $\succ$ Public housing

Suppose we have a local council with one member of each party (representing equal-sized constituencies).

- Which proposal would win if they voted on:
  - a Green park versus Public housing?
  - a Green Park versus Private housing?
  - Private housing versus Public housing?

Does a majority vote reveal a clear 'social preference'?

No, not here.

Lab evidence on *voluntary* provision of Public Goods

Typical "Public Goods Experiment"

- Four undergraduates seated at a table. Each given an 'endowment' of $5.
- Told that each can choose to invest some or all of it in a 'group project.'

- Each simultaneously puts an amount between $0 and $5 in envelope. (Or via computer terminals).
- Experimenter collects the "contributions" and doubles the total, divides this equally among the group.
- The private benefit from this "public good" = one half of total contributions.
  - (But I only get back *half* of my own contribution)

Basic results

- On average, subjects contribute halfway between everything and nothing
- Contributions decline with repetition, but not to zero
- Face to face communication improves the rate of contribution

Adv: More recent evidence finds that this decline seems to be related to issues of reciprocity, fairness and conditional cooperation. When conditional cooperators are separated (or can self segregate) a higher level of cooperation is maintained.

NOTE Skipping discussion of externalities for time constraints and previous coverage

Today I learned ('TIL')

- What is a pure public good (nonrival, nonexcludable), some examples, variations
- Why do markets fail to provide these optimally; private versus social marginal benefit
- Obstacles to government's optimal provision (how do we know how much to provide?)
- General patterns on 'public goods provision in laboratory Economics experiments'

Suggested practice problems from Nicholson and Snyder Chapter 16 (12th ed)

- 16.7 all parts
- 16.8 parts a and b
- 16.9 parts a-c

Lecture9: Monopolies and price discrimination [1-2 hours]

- ns: 11.2-11.4
- T1:07
- causes of monopoly (brief)
- profit maximization
- What's wrong with monopoly?
- Price discrimination: first coverage; types of pd
- Article: Should we help companies tailor prices to your wage packet?
- With accompanying worked examples
- More advanced: 'The Government May Want to Encourage Price Discrimination by Income' Linked here
- Sixth problem set: Monopolies and price discrimination

Price discrimination in the media

Moneybox - https://itunes.apple.com/us/podcast/money-box/id263570678?mt=2&i=1000379397237 – many mis-statements; can you identify them?

Lecture goals

1. What are monopolies and what are barriers to entry?
2. How do monopolies choose prices and quantities?
3. What are the social (welfare) consequences of monopoly?
4. What is 'price discrimination'?
5. What forms can price discrimination take, and how does it increase a monopoly's profits?
6. How does price discrimination affect social welfare, and whom does it help or hurt?
7. (Very briefly: other forms of imperfect competition)

Rem: perfect competition

- free entry and exit
  - → zero long-run economic profit
- many many tiny firms
  - → firms are price takers
- → p=mc
  - And in the long run $p = ATC$ and firms produce at $min(AC)$

these are extreme assumptions; perhaps only a theoretical ideal

- (Firms with market power might set $p > mc$)

Opposite extreme: *monopoly*

- A single firm
- Barriers to entry → No threat of entry
- Can choose price, which becomes the 'market price'
  - Still, the more it charges the fewer units demanded
  - Chooses a price (or quantity) where MR=MC (like all firms do)
  - Produces 'less than socially optimal quantity' in order to charge a high price and increase its profit

Barriers to entry

Technical barriers to entry

- IRS/ Diminishing average cost over a broad range of output
  - → 'a natural monopoly'
  - (Here multiple firms producing separately are *less efficient*, cannot produce the lowest cost)
- Special knowledge of a low-cost method of production, or key resource

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Legal barriers to entry.

- Patents and copyrights
- Exclusive franchise or license (granted by government, by another firm, by a university)
- Government support for a dominant firm, discouraging/forbidding others

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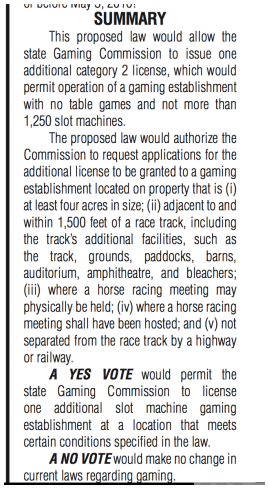
. . . from the 2016 Massachusetts ballot initiative:



SUMMARY

This proposed law would allow the state Gaming Commission to issue one additional category 2 license, which would permit operation of a gaming establishment with no table games and not more than 1,250 slot machines.

The proposed law would authorize the Commission to request applications for the additional license to be granted to a gaming establishment located on property that is (i) at least four acres in size; (ii) adjacent to and within 1,500 feet of a race track, including the track's additional facilities, such as the track, grounds, paddocks, barns, auditorium, amphitheatre, and bleachers; (iii) where a horse racing meeting may physically be held; (iv) where a horse racing meeting shall have been hosted; and (v) not separated from the race track by a highway or railway.

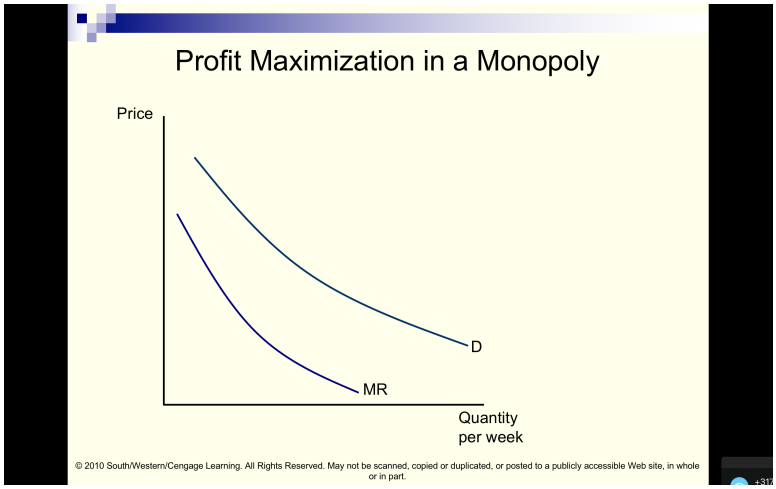
A YES VOTE would permit the state Gaming Commission to license one additional slot machine gaming establishment at a location that meets certain conditions specified in the law.

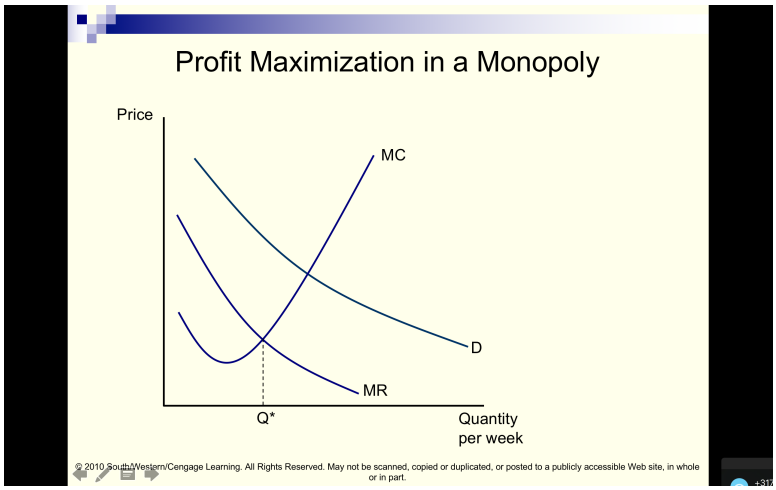
A NO VOTE would make no change in current laws regarding gaming.

Monopoly profit-maximisation

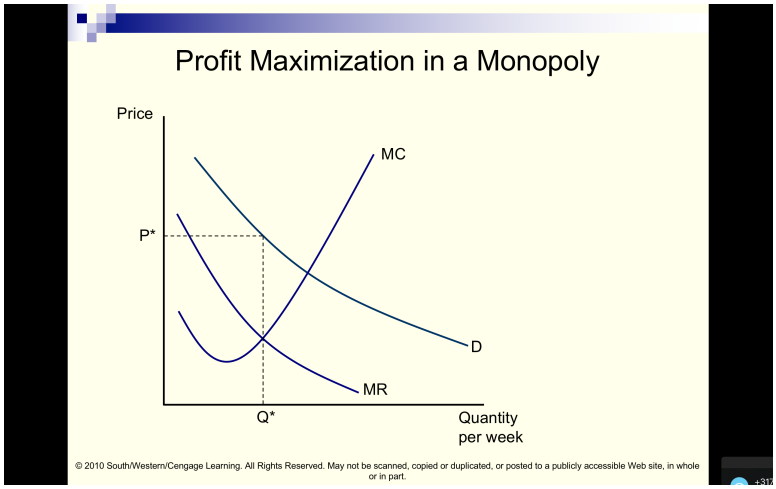
- As always, set Q to maximize $QP(Q) - C(Q)$
- leads to optimization where $MR(Q) = MC(Q)$ (assuming P>AC)
- Remember, the 'volume' benefit of increasing Q is countered by
  - Greater cost (producing more always costs more)
  - The need to reduce price (on all units) to get people to buy it

Graphically: Monopoly profit-max

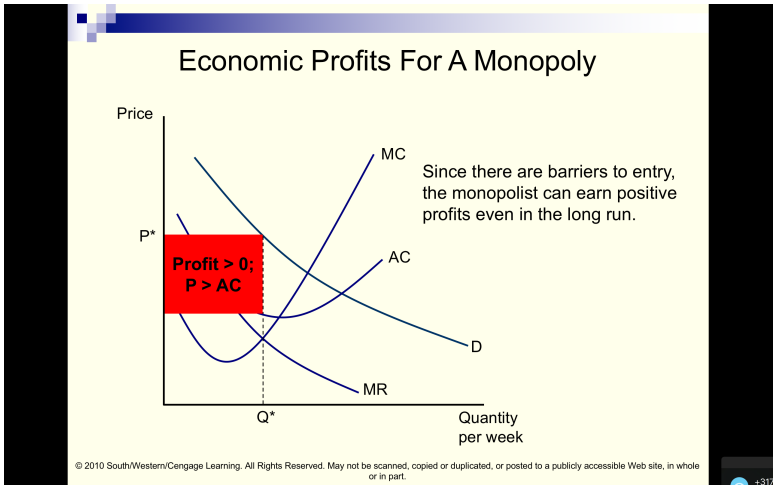




Notes: Rem: Firm's revenue is Price × Quantity.
Rectangle for a specific point on demand curve.
Firm' *profit* is this less average cost.
MR tells you how the 'revenue rectangle' will increase (or decrease) with another unit.
MC tells you the *cost* of this additional unit. Where MR>MC, increasing quantity a little bit increases revenue more than costs, thus increasing profit.

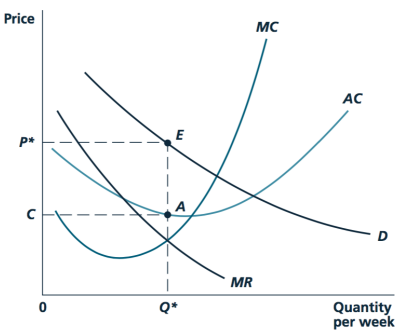


Note: Be careful here:
The price the monopoly can get at quantity Q^* is P^*
. . . project up to the *demand* curve NOT the MR curve.



Note: Again, remember that revenue is P^*Q^* but costs at Q^* are $Q^* \times AC$
so profit is $(P^* - AC)Q^*$.
By the way, the AC adds up the MC and the FC and divides by the quantity.

FIGURE 11.1 Profit Maximization and Price Determination in a Monopoly Market



A profit-maximizing monopolist produces that quantity for which marginal revenue is equal to marginal cost. In the diagram, this quantity is given by *Q**, which yields a price of *P** in the market. Monopoly profits can be read as the rectangle *P*EAC*.

Skip: 'no supply curve for a monopoly'

The deadweight loss of monopoly

Criticisms of monopoly:

1. Monopolies produce too little output: allocatively inefficient.
2. There is a redistribution of wealth from consumers to owners.

- But this could be counterbalanced by government redistribution

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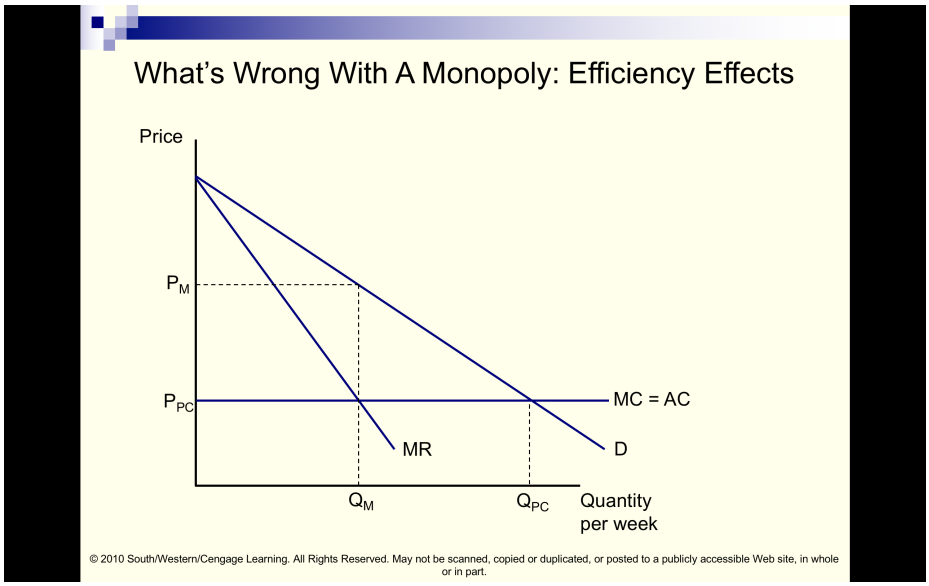
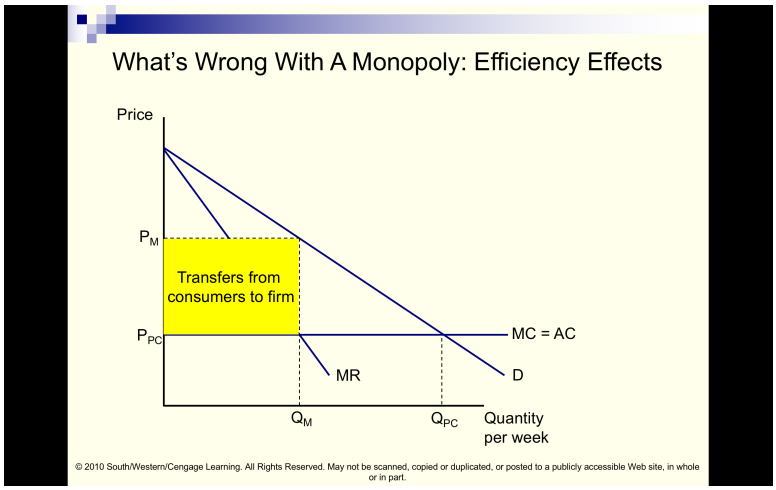
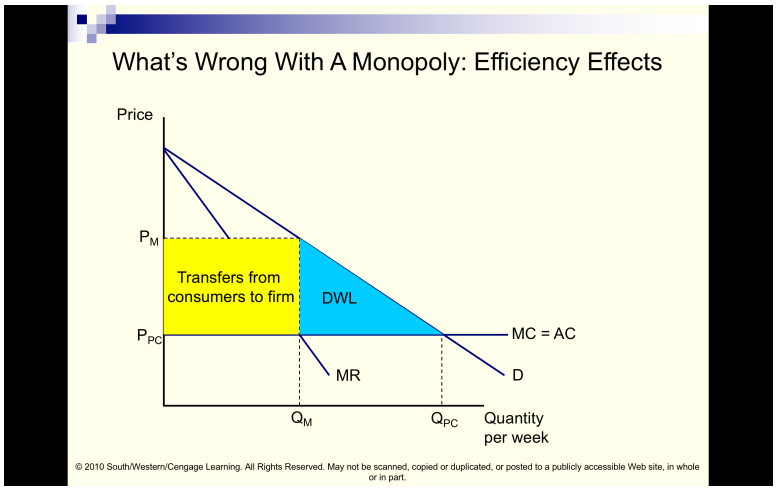
- Compared to perfect competition, a monopoly typically produces less output and charges a higher price
- Some of the consumer surplus under perfect competition is transferred to the monopolist.
- There is also a deadweight loss under monopoly



Note: The difference in monopoly vs perfect competitive quantity
. . . difference in price
. . . difference in consumer surplus
. . . difference in firm profit



Note: The differences (costs, transfers) refer to the monopoly outcomes *relative to perfect competition.*



Other criticisms: Some argue the deadweight loss (DWL) above *understates* the true harm of monopoly

- 'Secure' monopolies don't innovate as much, and spend wastefully?
- Monopolies may expend wasteful resources (lobbying, threats, lawsuits...) to preserve barriers to entry
  - Thus the above monopoly profits may turn into further deadweight losses!
- On the other side, some argue monopolies tend not to persist in the long run, are disciplined by *potential* entry, and have *greater* incentives to innovate
- Empirically, the magnitude of the social cost of monopoly is an open question
  - Estimates range from 0.5% of GDP to 5% of GDP

Price discrimination

Price Discrimination The practice of firms offering different prices to different consumers

- Or different prices for slightly different *products* or quantities,
  - where the difference in price does *not* merely reflect cost difference,
  - with the goal of distinguishing consumers' *willingness to pay* (WTP).

Note: This includes 'volume discounts', or offering an 'all you can eat' plan alongside a per-unit plan

Ticket Prices

Peak
Fri from 5pm; all day Sat & Sun; all day Bank Holidays

- Adult £11.60
- Member £9.60
- Retired £10.60
- Retired Member £8.60
- Student £10.60
- Student Member £8.60
- Child £7.40
- Family £33.60

Weekday Evening
Tue-Thu from 5pm

- Adult £10.70
- Member £8.70
- Retired £9.70
- Retired Member £7.70
- Student £9.70
- Student Member £7.70
- Child £7.70
- Family £31.80

Why such a complicated price list?

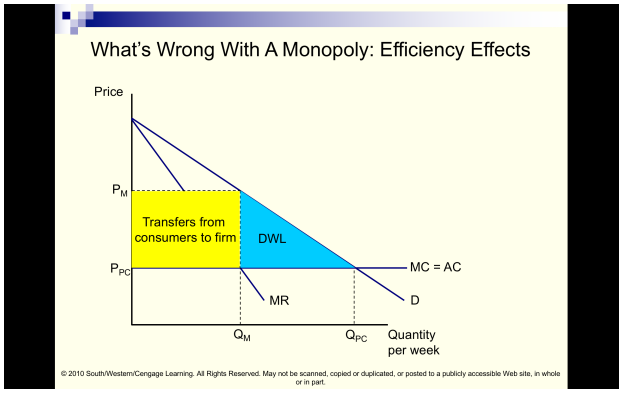
Why do firms price discriminate?

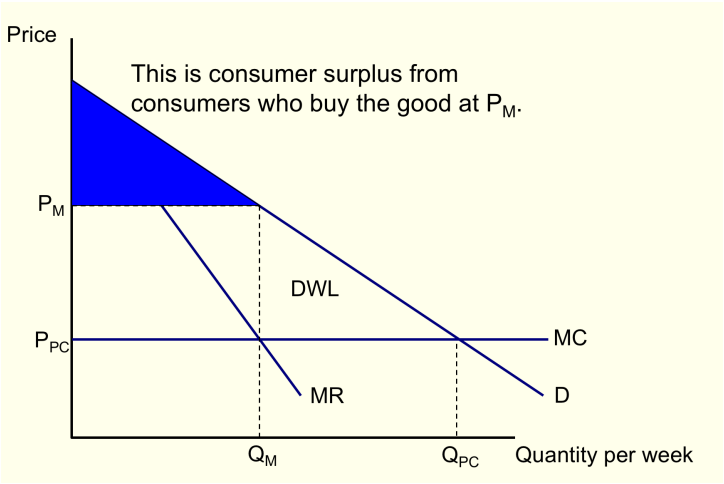
- It can increase profit
  - by 'extracting more surplus' from consumers
- In general, for a monopoly firm, the ability to identify consumers based on their WTP and charge distinct prices *will* increase profit
  - However, it may increase or decrease *social* (consumer+producer) surplus...
  - Consumer surplus itself may increase or decrease.

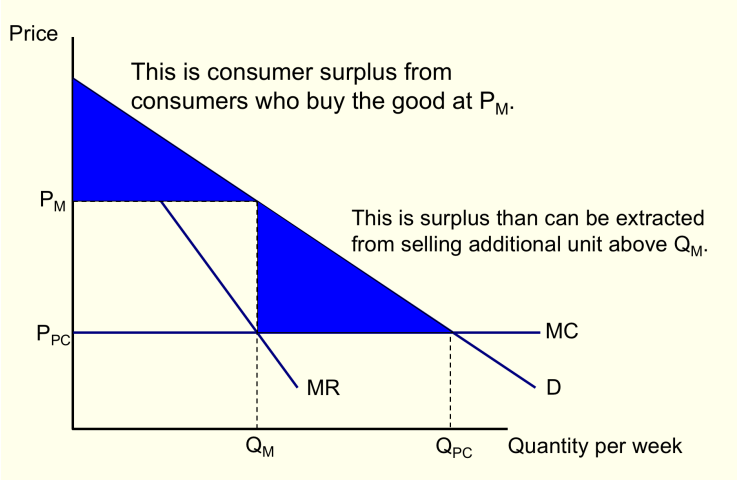
The alternative to price discrimination (previous analysis)

Offering a single price for a good for all consumers is known as 'uniform pricing'.

- This does not deal with differences amongst consumers.
- May force you to target a particular group, such as the wealthy, reducing your total sales.
- Under monopoly, this leads to a deadweight loss







- Price discrimination may seem counter-intuitive: 'how can offering some consumers lower prices increase profit?'
  - Higher prices increase your profit per unit, but at a higher price you will sell fewer units. The more you charge the less you sell.
  - Some groups of 'less keen' consumers are very sensitive to the price, and they will buy very little at a high price, so a lower price would be more profitable.
  - Some groups of 'more keen' consumers will buy a lot even at a high price. They are less 'price-sensitive', so you want to charge them more.

The three types of price discrimination

1. Individual-based (First degree; at best 'perfect')

Note: Targeting a price at each consumer; may be done on the internet or on a discretionary basis by an individual seller.
'Perfect' means the seller exactly predicts and charges each consumer her valuation.

2. Self-selection (Second degree)

Note: Here the firm doesn't know each consumer's valuations, or is not allowed to 'discriminate' by charging different prices to different people Instead, it sells different bundles, quantities, or qualities of products to get high and low-value consumers to separate themselves... E.g., first-class seats.

Note: To fully analyse these problems we need to know the techniques of 'mechanism design under asymmetric information', which we are not covering in this module

3. Group-based (Third degree; 'market separation')

Note: Here the firm finds something identifiable and inherent about the consumer
that is indicative of her likely valuations (and price-sensitivity).
It might be her age, nationality, student-status, or even perhaps her income.

First-degree and/or 'perfect' price discrimination

- The firm can offer each individual a different price for each unit they purchase.
- Assuming you know what the consumer is willing to pay, you can make the *highest possible profit*; that is called 'perfect' price discrimination.

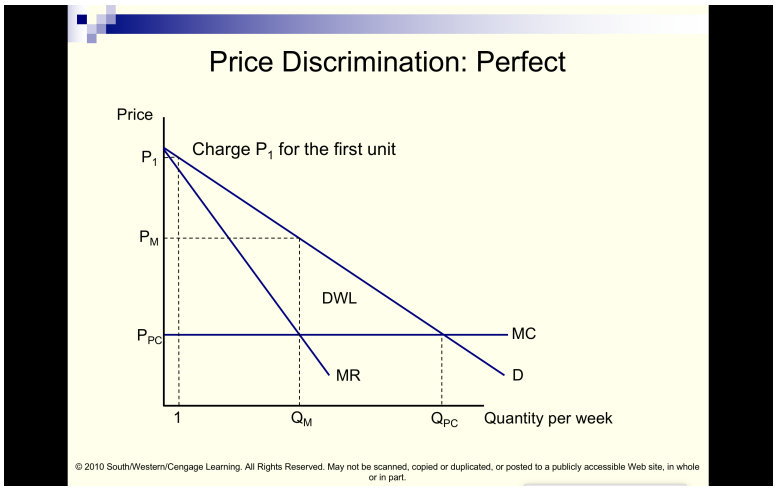
The opposite extreme is monopoly

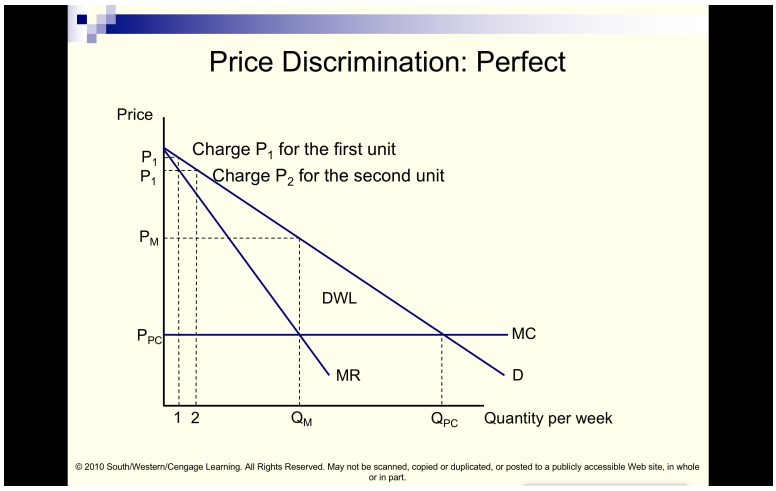
Perfect price discrimination Charging each consumer (for each unit) the *maximum* he or she would be willing to pay, i.e., her valuation

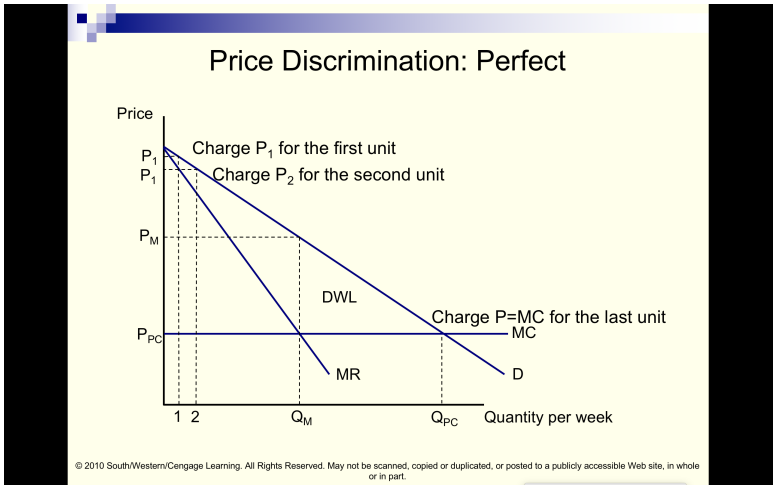
- Here the monopolist would extract *all the available surplus*; no consumer surplus remains
- Because monopolists extracts *all* the possible surplus, this is efficient
  - Because max(total value of good - cost) → max(CS+PS)
- But perfect PD is a rare/impossible extreme: requires mind reading
  - Close example: Website targets an individualised price to each consumer, based on clues like time-of-day, web clicks, cookie data, IP location.
  - But even this is not really *perfect* price discrimination:

Note: Here, the seller does not really know exactly what the consumer is willing to pay; he is using broad clues.

Note: See Shiller, B. R. (2013, or updated version). First degree price discrimination using big data.







Second-degree price discrimination

- Firm is unable to differentiate between consumers, uses quality/quantity so consumers self-select.
  - Quality- Transport- Different classes, Supermarkets- budget products
  - Quantity- Supermarkets- Larger quantities at lower prices per unit; i.e., 'nonlinear pricing'

- 8 oz coffee for £1.60 vs. 16 oz. for £2.00
- 20 p per oz vs. 12.5p per oz.
- (with linear pricing there would be the same price of 15p/oz.)
  - Result: with 2 prices monopoly can get 'high value' consumers to buy/get more in total without losing 'low-value' consumers

---

- Similar with quality: Don't know who high-valuation flyers are (wtp for travel *itself* varies)
- But may know on *average* that flyers with higher wtp for travel *also* value comfort more
  - Make second-class seats very uncomfortable, first-class luxurious, and charge more for first-class seats
  - Can get consumers with higher values for travel *and* comfort to pay more
  - without losing lower-valuing customers

NOTE: I am not going to cover the algebra nor graphical analysis of second-degree PD, nonlinear pricing, or two-part pricing

---

The 'self-selection' problem

Train companies must price first and second class such that consumers will self-select.

- If first class is too expensive then the high valuing group will not choose first class
- If second-class is too cheap, both the high and low groups will choose second class
- But if second class is too expensive, the low groups will not buy a ticket.

- The Third-Class Carriage is a c. 1862–1864 oil on canvas painting by Honoré Daumier

Lot's of discussion of this in the media, see e.g.,

THIS article in The Economist

Third-degree price discrimination (3dpd) / Market separation

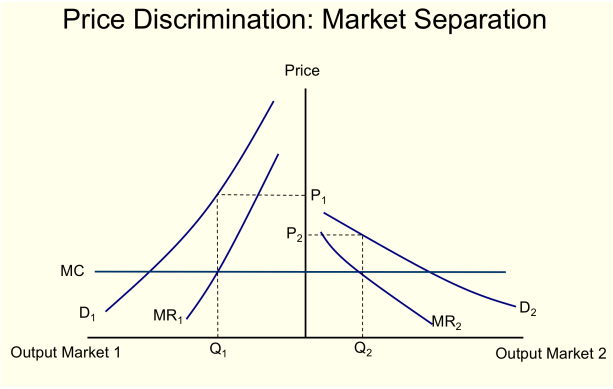
Third-degree price discrimination/Market-separation The practice of charging different prices to different groups that can be identified

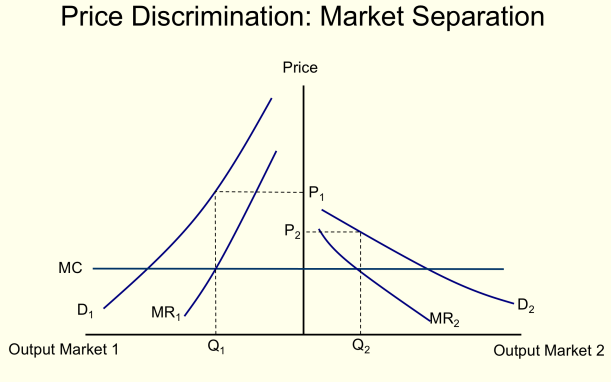
- The firm can differentiate *groups of consumers* or 'local markets', not individuals.
- Each group has a different willingness to pay *on average*
  - → Offer lower prices to lower-valuing groups, higher prices to higher-valuing groups
- Example: Students face lower prices for transport, food and other goods as they have a lower willingness to pay
  - Remember: this is *not* done out of charity but to boost profits

---

Pricing under 3dpd/market separation

- Each group or market has it's own demand → marginal revenue curve
  - So set an optimising price quantity *separately* for each group
  - E.g., a discount for the elderly, higher price for the middle-aged
  - Or a lower price in Portugal than in Germany





Note: Decent numerical example, slides 6-8 Here: http://people.hss.caltech.edu/~mshum/ec105/matt9.pdf

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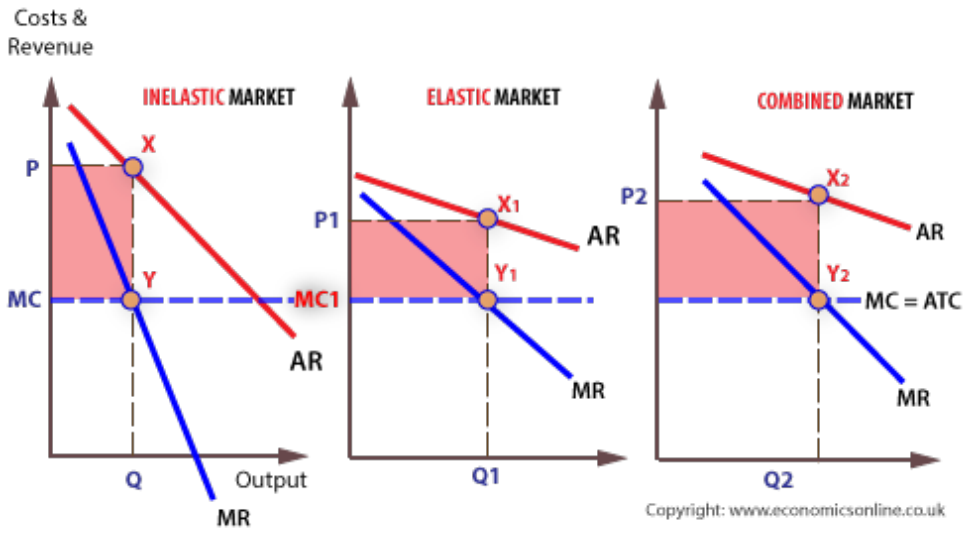
Another depiction, adding demand curves (they call it 'average revenue'):

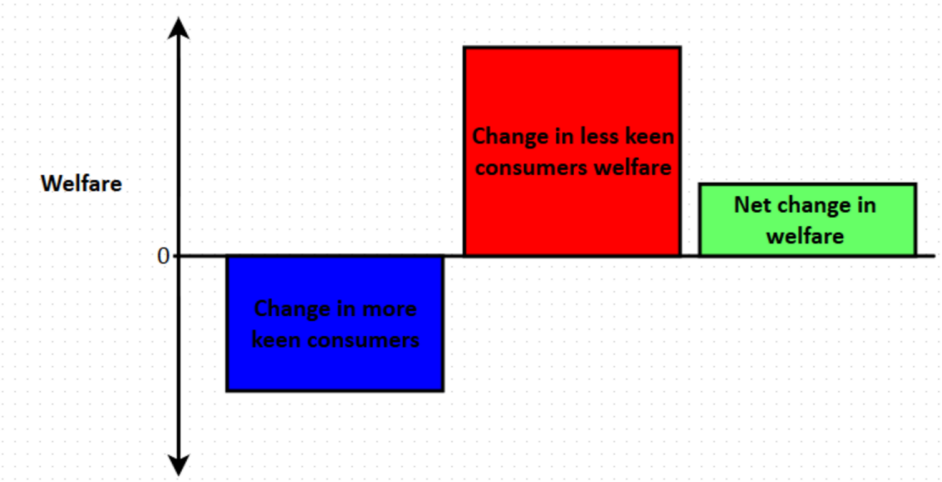


Who benefits from 3DPD?

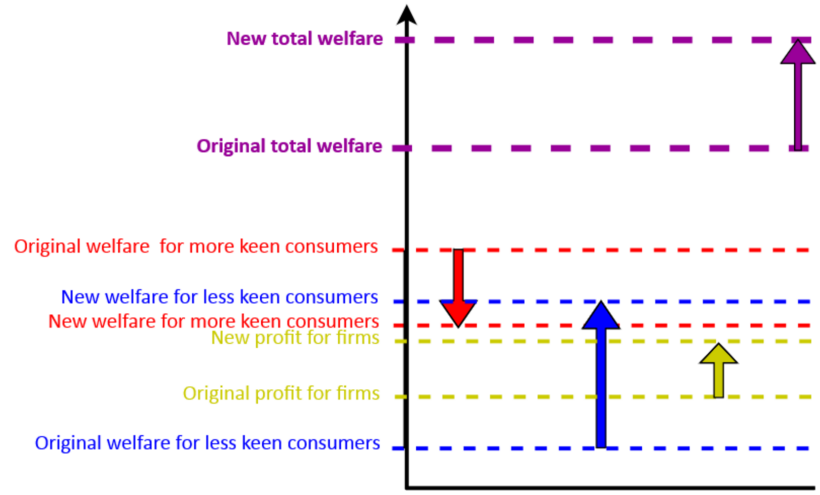
- Consumers *in identifiable group* with lower wtp face lower prices, thus they benefit
- Consumers *in identifiable group* with higher wtp face higher prices, thus they lose
- Firms can charge higher prices to high-wtp group without losing low-wtp group → increase profit

Net welfare result: theoretically uncertain

For consumers:



Overall net effect- Consumers and firms



Overall effect can be negative or positive. The diagram shows a positive total welfare effect.

Firms will always gain an increase in profit from price discrimination

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Why uncertain?

- When groups can be identified as 'low and high valuation'
  - the high-valuation groups get charged more, and thus consume less
  - low-valuation groups get charged less, and consume more
  - Exchange efficiency: *given what is produced*, PD causes it to be consumed by people who value it relatively less!
- Production: On the other hand PD can lead more to be produced/consumed

. . . of the otherwise underproduced good (rem DWL of monopoly) → top-level efficiency may increase (or decrease)

- E.g., if with a 'uniform price' only the wealthy went to a restaurant. . .
  - after PD (early-bird discounts, OAP discounts, benefits discounts) the low-income may also dine in the restaurant

  - → more value is produced
- These two effects trade off.
  - Because of the negative 'Exchange efficiency effect', quantity *produced* must increase after PD for it to be beneficial

Quantity increase is a necessary but not a sufficient condition.

But 'arbitrage' can foil price discrimination

- If, e.g., elderly who get discounts could sell the products to the middle-aged...
  - Then middle-aged would always ask them to do this, never pay high prices
  - Firm could no longer profit from this
  - Similar issues with quantity discounts, or 'web cookie' personalised pricing

- So PD only 'works' for goods that are hard to trade, like haircuts
  - Or where purchases are frequent and low-value, and resale markets are difficult

Note: The above issues are sometimes referred to as 'transactions costs'

David's idea: A new policy tool

- People with low-incomes tend to have lower-wtp for most goods
- Government can typically identify and verify incomes
- Governments could allow and encourage low-income consumers to get an ID indicating this
- Governments could allow and encourage firms to use this for price-discrimination

- Firms would increase profit
- Low-income households would benefit, reducing inequality
- Net impact on efficiency uncertain; worth investigating

See the readings on this: 'The Government may want to encourage price discrimination by income' linked here

Natural monopolies and regulation (very brief!)

- Where an industry involves a 'natural monopoly' (IRS) the most efficient production is a unified production process
  - But if a monopoly reigns it overcharges and underprovides
  - Government may want to allow/enforce monopoly privileges but *regulate* price it can charge
  - Difficulty: Government wants to regulate $p = AC$, but it doesn't know firms' actual cost function (asymmetric information)
  - Firm wants government to think it is high cost

This yields another mechanism design 'hidden information' 'principal-agent problem'

NS Problem 11.1

Plus:

d. In under 30 words and making reference to your diagram, explain why this deadweight loss would be avoided if the firm could perfectly price-discriminate.

Lecture10: Uncertainty (with a bit of finance) [(2 hours), NS Chapter 4]

Lecture (2 hours) - Chapter 4 coverage outline

- NS: Ch 4 (not including 4a)

Coverage

- 4.1 Probability and expected value (revision)
- Expected utility; additional discussion
- 4.2 Risk Aversion
- Insurance
- Diversification
- Flexibility and options

(2018: less coverage of this)

- Information (read alone)
- Pricing of risk in financial assets

Supplementary reading (postgraduate level):

Holt, C., and S. Laury (2002), Risk Aversion and Incentive Effects, American Economic Review, v. 92 (5): 1644-1655.

- For a popular audience: Reinstein (2016) 'Should you hedge your bets on a Brexit?' LINK
- Seventh problem set: Uncertainty (Chapter 4)

Note: We will not cover the two-state model, although you may find it helpful in understanding the concepts from another perspective

Key goals of these lectures (and accompanying self-study)

1. Revise the concepts of probability and expected value
2. Learn how economists consider choices involving uncertain outcomes
3. ... how to compute an 'expected utility' and what it means

- in particular, how it differs from 'expected monetary value'

1. ... how to define 'risk aversion' and how it is modeled using expected utility
2. ... why buying insurance, diversifying investments, and buying 'options' may improve welfare for risk-averse individuals

- and the implication of this for the pricing of financial assets!
- including a rough understanding of the Black-Scholes model of options pricing

---

What's up with uncertainty?

Previous discussion: Consumers make choices with known consequences

But in the real world many important economic decisions involve risk.

Here: Choices with *unknown* consequences (but known *probabilities* of each outcome)[52]

How to consider this in a utility-maximisation framework?

The standard framework for this involves maximising 'expected utility'.

Warning: Making choices to maximise expected utility is *not* the same as making choices to maximise expected monetary outcomes. This is one of the main points here. A good share of students get this mixed up!

Probability concepts: a quick review

Probability The relative frequency with which an event occurs, or can be expected to occur.

- Always between 0 and 1

Adv: Note, there are some debates, e.g., between 'Bayesians' and 'Frequentists' over the meaning of probability.

Q: If p is the probability an event occurs, what is the probability this event does *not* occur?

Ans: $1 - p$

[52] Adv: In the real world, people may also make choices in contexts with unknown probabilities; this is called 'ambiguity' or 'Knightian uncertainty'. This is out of the scope of this module.

Expected value The 'average outcome' of an uncertain variable (general definition)

The average monetary (or goods) payoff from an uncertain gamble

The sum of the value at each possible outcome, weighted by the probability that outcome will occur

Adv, maths: When outcomes are in a continuous space, e.g., the returns to a stock can take any of an infinite number of possible values, the expected value becomes a definite integral rather than a sum.

- This is *NOT* the same as expected utility (coming up); people don't necessary choose the investment with the highest expected value

---

Consider: would you prefer...

a. £100,000 with certainty or
b. A 1 in 10 chance of £1,000,001 (and otherwise you get nothing)?

Which has a higher expected monetary value?

Ans: $EV(b) = £100,000.1 > EV(a) = £100,000$

Which gives you greater expected utility?

Ans: This is unknown. We need to know the individual's *utility function* to know the answer to this.

However, it seems likely that most people would choose b, even though it has a lower expected monetary value, because they are *risk-averse*.

Definitions (loose):

1. A *Risk-neutral* person always chooses the option with the highest expected monetary value

2. A *Risk-averse* person will always prefer a sure thing to a gamble with the same expected monetary value

- She will always prefer gambles with less risk, holding the expected value constant
- She will always reject 'fair gambles' (see below) and prefer certainties
- To accept a (fair) gamble, she must expect a 'risk-premium'

3. A *Risk-lover* will always choose fair gambles over certainties, and sometimes choose a gamble that is unfair against her

---

Example: two possible outcomes

Q: What is an example of such an investment with only two outcomes?

Ans: perhaps making a loan to someone to start a business; they will either pay back the loan with a high interest, or go bankrupt and pay none of it back.

Suppose there is a simple investment. It will either pay a low (or zero or negative amount) or a high amount.

- It pays X where either $X = x_1$ or $X = x_2$, where $x_1 < x_2$

Probability it pays x_2 is p; thus probability it pays x_1 is...? $Pr(X = x_1) = 1 - p$

The expected monetary value sums the values weighted by the probabilities, i.e.,

$EV(X) = (1 - p)x_1 + px_2$

Consider

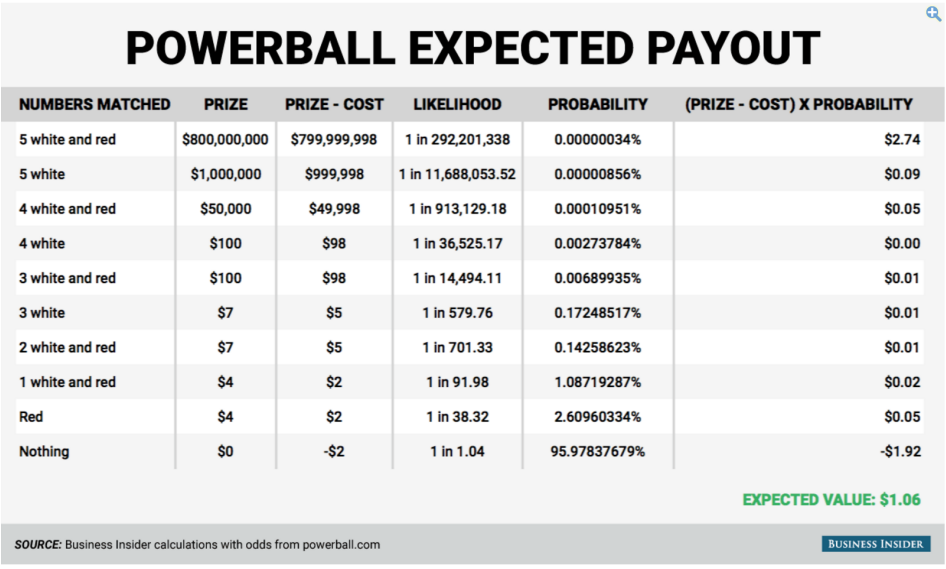
Example: two possible outcomes

It pays X where either $X = x_1$ or $X = x_2$, where $x_1 < x_2$

- Specifically, pays £1020 w/ prob. 1% & pays £10 w/ prob. 99%

Thus $EV(X) = 0.01 \times 1020 + 0.99 \times 10 = 10.20 + 9.90 = 20.10$

Consider: would you prefer this investment over one that paid £20 with certainty? Would everyone prefer it? If not, why not?



POWERBALL EXPECTED PAYOUT

NUMBERS MATCHED	PRIZE	PRIZE - COST	LIKELIHOOD	PROBABILITY	(PRIZE - COST) X PROBABILITY
5 white and red	$800,000,000	$799,999,998	1 in 292,201,338	0.00000034%	$2.74
5 white	$1,000,000	$999,998	1 in 11,688,053.52	0.00000856%	$0.09
4 white and red	$50,000	$49,998	1 in 913,129.18	0.00010951%	$0.05
4 white	$100	$98	1 in 36,525.17	0.00273784%	$0.00
3 white and red	$100	$98	1 in 14,494.11	0.00689935%	$0.01
3 white	$7	$5	1 in 579.76	0.17248517%	$0.01
2 white and red	$7	$5	1 in 701.33	0.14258623%	$0.01
1 white and red	$4	$2	1 in 91.98	1.08719287%	$0.02
Red	$4	$2	1 in 38.32	2.60960334%	$0.05
Nothing	$0	-$2	1 in 1.04	95.97837679%	-$1.92

EXPECTED VALUE: $1.06

SOURCE: Business Insider calculations with odds from powerball.com

BUSINESS INSIDER

As an aside, an interesting example: computing expected value of recent US 'Powerball' lottery Link HERE

Note: This is the net expected value of buying a $2 ticket. By this calculation each $2 ticket is worth $3.06 in expected value terms; however, with the adjustments further down in the article, we see this drops considerably and becomes negative in net after taxes.

Fair gamble A bet with an expected (monetary) value of zero is a 'fair gamble'

Actuarially fair

An investment whose cost is its expected value is 'actuarially fair'

Consider: Which of the following are fair gambles?

- A. 'Double or nothing' bets with a fair coin
- B. Roulette in a casino
- C. A gamble where you win £10 with probability 1/2 and lose £5 with probability 1/2
- D. A gamble where you win £10 with probability 1/4, lose £5 with probability 1/2, and neither lose nor win with the remaining probability?
- E. A stock option (without any transactions fees)

Ans: A and D; E is uncertain, but it is probably a fair gamble

Example: experimental measures of risk attitudes

Economists try to measure people's level of risk aversion in various ways.

We try to measure 'revealed preferences' from real-world choices. E.g., what premium are people willing to pay to buy insurance for various things, how much premium do they demand for taking on risky investments (with the same expected monetary values), and how much more do they have to be paid (on average) in jobs with variable compensation?

We also run *experiments* with real or hypothetical payoffs to measure this.

One technique is the Holt and Laury (2002) risk elicitation task:

	LLotterie A		---	Lotterie B		
	2.00€	1.60 €	---	3.85 €	0.10 €	
○	10%	90%	---	10%	90%	○
○	20%	80%	---	20%	80%	○
○	30%	70%	---	30%	70%	○
○	40%	60%	---	40%	60%	○
○	50%	50%	---	50%	50%	○
○	60%	40%	---	60%	40%	○
○	70%	30%	---	70%	30%	○
○	80%	20%	---	80%	20%	○
○	90%	10%	---	90%	10%	○
○	100%	0%	---	100%	0%	○

Asked to choose one in each row (A or B)

- Consider, when would you choose A and when would you choose B?

Lottery Pair #	Safe Lottery (*S*)				Risky Lottery (*R*)						
	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	EV^A	EV^B	Difference
1	0.1	$2	0.9	$1.60	0.1	$3.85	0.9	$0.10	$1.64	$0.48	$1.17
2	0.2	$2	0.8	$1.60	0.2	$3.85	0.8	$0.10	$1.68	$0.85	$0.83
3	0.3	$2	0.7	$1.60	0.3	$3.85	0.7	$0.10	$1.72	$1.23	$0.49
4	0.4	$2	0.6	$1.60	0.4	$3.85	0.6	$0.10	$1.76	$1.60	$0.16
5	0.5	$2	0.5	$1.60	0.5	$3.85	0.5	$0.10	$1.80	$1.98	−$0.17
6	0.6	$2	0.4	$1.60	0.6	$3.85	0.4	$0.10	$1.84	$2.35	−$0.51
7	0.7	$2	0.3	$1.60	0.7	$3.85	0.3	$0.10	$1.88	$2.73	−$0.84
8	0.8	$2	0.2	$1.60	0.8	$3.85	0.2	$0.10	$1.92	$3.10	−$1.18
9	0.9	$2	0.1	$1.60	0.9	$3.85	0.1	$0.10	$1.96	$3.48	−$1.52
10	1	$2	0	$1.60	1	$3.85	0	$0.10	$2.00	$3.85	−$1.85

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Table 1. Design of the Holt and Laury experiments (adapted from Glenn Harrison *et al.*, 2005)

At what point do people switch from choosing the safe to choosing the risky lottery?

This is a measure of their risk-aversion. A risk-neutral person would switch to B on the fifth choice. The later you switch, the more risk averse you reveal yourself to be.

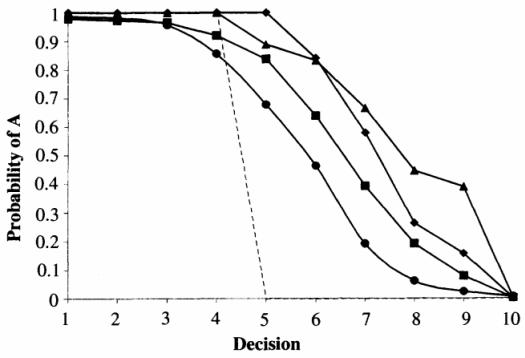


FIGURE 2. PROPORTION OF SAFE CHOICES IN EACH DECISION: DATA AVERAGES AND PREDICTIONS

Note: Data averages for low real payoffs [solid line with dots], 20x real [squares], 50x real [diamonds], 90x real payoffs [triangles], and risk-neutral prediction [dashed line].

Above: Results for different 'stake sizes'. Most people are risk-averse. People switch to the risky option later when stakes are higher.

Expected utility

Note: this concept is only covered *indirectly* in the text

- Previous utility functions: predict choices under certainty
  - No predictions for choices with uncertain probabilistic outcomes!
- People don't maximise expected monetary value; tend to be risk-averse

An *Expected Utility* (EU) framework allows for risk-aversion

- Assume each individual has a single 'utility function over *outcomes*' $u(Y)$ over outcomes Y, (with similar properties as our regular utility function)

This 'little u' function is similar to 'regular' utility, but here 'curvature matters'

When making choices involving uncertainty, she does **not** (necessarily) maximise expected monetary value.

Instead, she maximises 'Expected Utility' (EU): the sum of her (VNM) valuations '$u(\cdot)$' under each outcome weighted by the *probability* of each outcome

... I.e., she chooses to maximise the value of her $u(Y)$ function under each outcome Y weighted by the probability of each outcome p_Y

- By varying the $u(Y)$ function we can vary the risk preference; ... Risk-loving, risk neutral and risk averse individuals can all be seen as maximizing EU

Consider the choice between two gambles and one 'certainty':

1. Earn £1,000,000 with probability 0.1 & zero with prob. 0.9
2. Earn £100,000 with probability 1/2 & £50,000 with prob. 1/2
3. Earn £75,000 for certain

Imagine the realised utility $u(y)$ arises from the consumption chosen with income y (btw, the utility arising from maximisation under a particular set of income and prices is called 'Indirect Utility')

- This should be increasing (because of nonsatiation), thus $u'(y) > 0$
- But it mays increase at a *decreasing* rate, implying $u''(y) < 0$

This second assumption, called *diminishing marginal utility*, will imply 'risk aversion'!

Or, if the person is risk-neutral, it may be linear, thus $u(y) = a + by$, thus $u''(y) = 0$

Adv: Note that when we were choosing between two goods under certainty, the *level* of total utility didn't really matter, only the relative utilities. Now that we are considering gambles, the overall utility level matters, because we need to consider the extent of the tradeoff between 'rich and poor' states.

Coming back to the choice between two gambles and one 'certainty':

1. Y_1: £1,000,000 with probability 0.1 and zero with prob. 0.9
2. Y_2: £100,000 with probability 0.5 and £50,000 with prob. 0.5
3. Y_3: £75,000 for certain

Considering each *outcome* from any of these...

we know $u(1,000,000) > u(100,000) > u(75,000) > u(50,000) > u(0)$...

but now the *size of the difference* in these utilities matters for your decision!

- Consider Y1 vs Y3: Is 1 million 'more than ten times as good (utility-wise) as 75k?'
- Y2 v Y3: Relative to 75k, does an additional 25k yield a utility gain worth the (equally probable) loss of 25k?

Illustration: Why the 'size of the difference in u(y) matters' when dealing with uncertainty.

Suppose there is open-enrollment in Oxford, Bristol, Plymouth.

→ Here I only need to know the *ranking* of utilities of each to know your choices.

- If you choose Oxford over Bristol, even though Oxford costs more, I can infer that for you $U(Oxford) > U(Bristol)$

Now, in contrast suppose the policy is

A. Rank Oxford over Bristol and you have a 25% chance of getting into either, and a 50% chance of Plymouth.

B. Rank Bristol highest and you have a 100% chance of getting into Bristol.

Now even if your preferences are Oxford $\succ$ Bristol $\succ$ Plymouth, I don't know if you will choose A or B; I would need to know the *strength* of your preferences.

This means that if I observe you choose 'option A' I have learned *more* about your utility than I learned under open enrollment. I have learned that your preference for Oxford over Bristol is "stronger" than your preference for Bristol over Plymouth.

The EU framework predicts that she chooses the option that maximizes the sum of 'probabilities × realised utilities $u(Y)$ of each outcome Y'. For a two-outcome case:

$$EU = (1-p)u(Y_\ell) + pu(Y_h)$$

... where p is the probability of the higher income Y_h and Y_ℓ is the lower income.

Adv: This framework is justified by certain 'reasonable axioms' we might expect choices under uncertainty to follow, although these are perhaps not as readily acceptable as the main axioms of regular utility theory (like transitivity). ... e.g., the choices made under EU converge to the choices made under certainty as probabilities tend to 1. The EU framework yields nice consistent behavior and can be reconciled with general equilibrium theory, preserving the basic welfare theorems

---

G1: £1,000,000 with probability 0.1 and 0 with prob. 0.9

G2: £100,000 with probability 0.5 & £50,000 with prob. 0.5

G3: £75,000 for certain

For the three gambles above:

$$EU(G_1) = 0.1 \times u(1,000,000) + 0.9 \times u(0)$$
$$EU(G_2) = 0.5 \times u(100,000) + 0.5 \times u(50,000)$$
$$EU(G_3) = u(75,000)$$

If she is risk neutral, she will choose the first gamble (why?)

Ans: It has the highest expected monetary value, £100,000

If she is risk averse, she will definitely prefer gamble 3 over gamble 2 Why?

Ans: It has the same expected monetary value, £75,000, but involves less risk (no risk)

- If she is risk averse, she *might* prefer gamble 2 over gamble 1, but it depends *how* risk averse she is

Risk aversion: graphical depiction

How to illustrate this:

- Show: $EU(gamble) = (1-p)u(x_{low}) + pu(x_{high}) < u(EV(x)) = u((1-p)x_{low} + px_{high})$

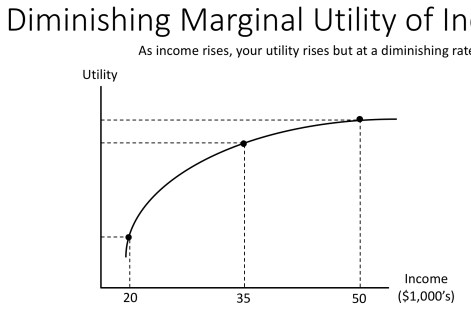
Draw a diagonal line between $u(x_{low})$ and $u(x_{high})$; the Expected Utility is in between these.

- Horizontal distance p of the way between x_{low} and x_{high}
- Project up to diagonal for average of functions (EU)
- Compare this to the vertical height of utililty function at same point $(1-p)x_{low} + px_{high}$

This is a mathematical/graphical property.

Intuition: The slope of a line tells me 'rise for a given run', the 'expectation' calculation is a linear function, so the slope is constant and the 'share of the rise' simply projects up from the 'share of the run'

[redacted]



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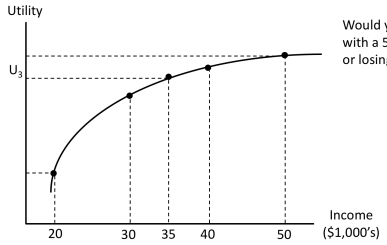
Note: You start with $35k

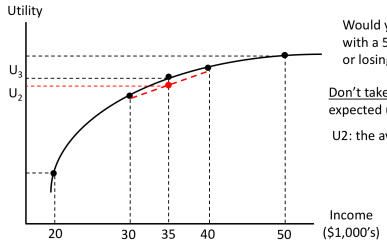
Diminishing Marginal Utility of Income



U_3 is the utility from $35,000

Would you take a fair gamble with a 50:50 chance of winning or losing $5,000

Diminishing Marginal Utility of Income



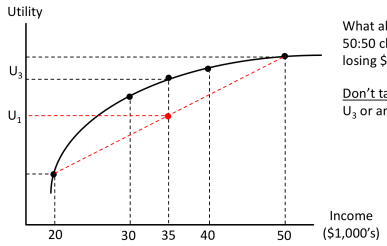
U_3 is the utility from $35,000

Would you take a fair gamble with a 50:50 chance of winning or losing $5,000

Don't take gamble: can get a sure U_3 or an expected utility U_2

U2: the average of u(30,000) and u(40,000)

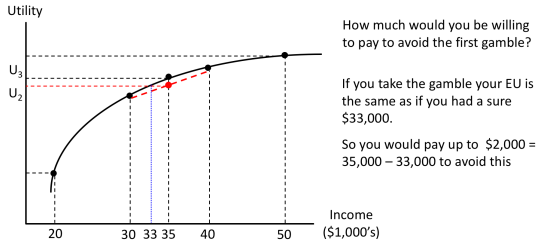
Diminishing Marginal Utility of Income



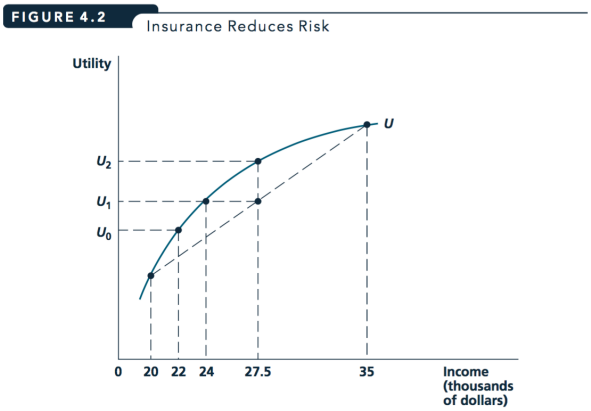
What about a fair gamble with a 50:50 chance of winning or losing $15,000

Don't take gamble: can get a sure U_3 or an expected utility U_1

Willingness to Pay to Avoid Risk



Ways of reducing risk: Insurance



Fair insurance Insurance for which the premium is equal to the expected value of the loss

Adv: We might think that such insurance is provided at its true marginal cost; however there are various reasons why the cost to firms may be above this, including transactions cost, moral hazard, and adverse selection

---

You may find this interesting (2018: but these will not be examined)

- Uninsurable (difficult to insure) risks
- Adverse selection
- Moral hazard
- The rationale for insurance 'deductibles'

Ways of reducing risk: Diversification

Diversification: Buying multiple assets (with risks that are not perfectly correlated with one another)

- Putting your eggs in multiple baskets tends to reduce risk, holding expected value profit (or loss) constant!

Illustration: Binomial distribution

- Suppose I have £1000, and I can bet on fair coin flips. My returns will then have what we call a "binomial distribution".

There is a nice illustration of binomial distributions

- If I bet all £1000 in a single flip, there is a 50% chance I will lose my entire investment.
- If I bet £500 on two flips, there is only a 25% chance I will lose my entire investment (also reduces chance of doubling by 25%).
  - The expected value is the same (0); thus this is better if you are risk averse.

"Less risky": B and A overlap with 0.5 probability; the remaining 50% of time A's outcomes are more extreme. So it is less risky in a very general sense.

- If I bet £100 each in ten flips, there is a 38% chance that I will lose 20% or more of my investment.
- If instead, I bet it on 1000 coin flips, betting £1 on each, there is only 6.00% chance I will lose 5% of my investment or more, and only 1/10th of 1% chance that I will lose 10% of my investment or more.

Result: The more I can do this "diversification", the less risk I face.

Note: For simplicity, these examples have a 'fair coin flip', zero expected-return investment.

But you might be wondering: 'why invest at all? Answer: Because this principle also applies to 'unfair coin flips'.

E.g., investments in the stock market are more profitable on average than money under the mattress

Each £1 invested in shares has a higher expected return, but also a higher risk. However by spreading across *many different* assets we can reduce this risk, as seen above

---

Example

Suppose you have £35,000 and must invest £15,000 in an Oil company or a Transportation company

- A share in each firm costs £1. (Alternatively, suppose it costs £0.9, so on average it is profitable)
- At the end of the year there is a 50:50 chance that the share price will rise to £2 and a 50:50 chance it will fall to £0.

1. If you put all your money in one company there is a 50% chance you will end up with £20,000 and a 50% chance you end up with £50,000

- Your expected value is £35,000

2. If you put half in each company your income has a 25% chance of each of the following values:

		Transit's Performance	
		Poor	**Good**
Oil's Performance	**Poor**	$20,000	$35,000
	Good	35,000	50,000

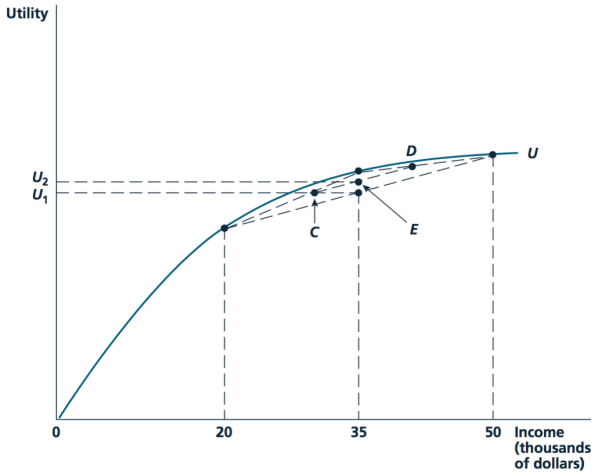
- Same expected value, but it is 'better'

How do we know it is better (for a risk-averse person)?

- Less risk with same EV: 50% of the time (when oil and transit go in opposite directions) you've less gain or loss than before.
- I.e., comparing the distribution of returns to the undiversified investment:

  - 25% of the time you gain 0 rather than gaining £15K (leaving you with £35k rather than £50k)
  - 25% of the time you gain 0 rather than losing £15K (leaving you with £35k rather than £20k)
  - The remaining 50% of the time (when both rise or both fall) is similar to the remaining 50% of the time under the undiversified investment

- See the benefit graphically (next)



Notes: This depicts the average of 2 EUs (when B does poorly, when B does well) each of which average the utility over 2 outcomes (A does poorly, A does well). The average of the average of these exceeds the average of the utility of 2 extreme outcomes.

This takes some time to interpret; have a think about it, it is not easy.

Flexibility and options contracts

2018: Less coverage of this section on 'options', less emphasized on assesment

- 'Keep your options open' (simple idea)

Option contract Financial contract offering the right (but not the obligation) to buy or sell an asset over a specified period (at a certain price).

- 'Real option': an option outside of the financial world

Attributes of options:

1. Specification of transaction: what is bought/sold, how many units maximum, at what price, etc
2. Period the option may be exercised (from when until when)
3. Price of the option

Price of options determined by

1. Expected value of underlying transaction (e.g., for a call option, expected future share price minus strike price)
2. Variability of the value of the transaction

Option G (a 'call option'): Right to buy Google share at £500 (£500 'strike price') in December 2020

- Worth more the higher the current share price
- If $P_{google} <$ £500 currently, then option G is worth more the higher the expected *variability* in P_{google}
  - Variability can only help the option-holder:
  - price increase helps her

– if price falls below £500, she doesn't need to exercise the option

Warning: If you didn't read this you probably would have guessed the opposite. On the exam, many students answer that variability *reduces* the value of the option. As you are reading this, you probably won't make that mistake... so tell your friends to read this. (2018: but this won't be focal on the exam.)

3. Duration: the longer the better – a longer duration brings a greater chance that the price will rise above strike price (£500)

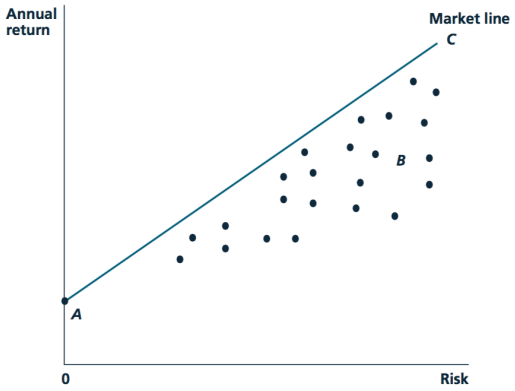
Note that the results for 'right to sell = call options' are similar, just replace the words 'buy' with 'sell' and reverse the directions ('rise' with 'fall), etc.

Q: 1. How might an airline buy options to counter its risk from rising petrol prices? 2. How could an airline pilot buy options to counter her risk of being fired in case her airline goes out of business?

Ans: 1. The airline could buy call options (rights to buy at a price) for oil and gas company shares, or for oil and gas commodity units. 2. The pilot could buy put options (rights to sell at a price) in the airline she works for; if the airline shares become worthless these put options will be very valuable.
Classic economist's argument: you should 'bet against yourself' to minimise risk; but this might give you bad incentives to perform. See column about this HERE ... "Hedging your bets in hard times"

Pricing of risk (and assets) in financial markets

FIGURE 4.4 Market Options for Investors



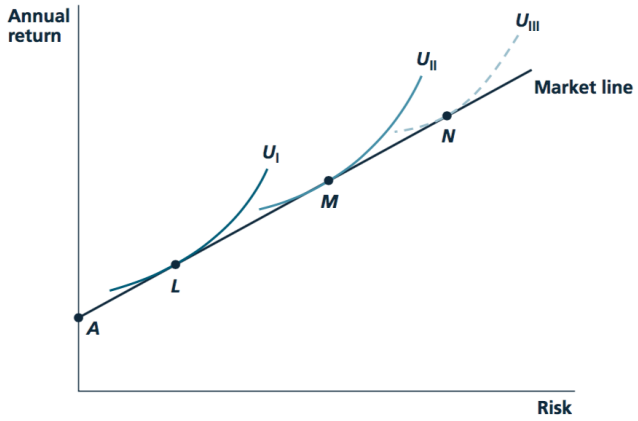
The points in the figure represent the risk/return features of various assets. The market line shows the best options a risk-averse investor can obtain by mixing risk assets with the risk-free asset A.

Market line Shows the relationship between risk and annual returns that an investor can achieve by mixing financial assets.

Note typo in diagram: "risk assets" should be "risky"

With efficient markets, line depicts 'best mix': proportional to the total 'market basket', plus borrowing/lending at the 'risk-free rate'

FIGURE 4.5 Choices by Individual Investors



Points *L*, *M*, and *N* show the investment choices made by three different investors. Investor I is very risk averse and has a high proportion of the risk-free asset. Investor II has modest toleration for risk and chooses the "market" portfolio. Investor III has a great toleration for risk and leverages his or her position.

- Different preferences for risk versus *expected* (average) return
- 'Risk' is the overall variance around the average
- Assumes 'optimal diversification': no one chooses points *below* market line

---

Extension: "Capital asset pricing model" (CAPM)

This is the leading 'baseline' model in finance.

It assumes (or in fact, derives that) investors optimally diversify.

Thus assets are priced based only on 'risk that cannot be diversified away from' ('market risk')

Holding the expected value of dividends constant, assets with higher market risk are less desirable, thus priced lower, and get higher returns

The trade-off between this risk and return has a linear relationship with slope 'Beta'

-Typical economist's investment advice: diversify to mimic the 'market basket', choose funds with low fees - Doesn't make you a hit at parties :(

Not covered: two state model

- You may find it helpful in understanding
  - But you may be confused by it, so read it at your own peril!

Suggested practice problems: see problem set

Lecture11: Game Theory [(2-3 hours), NS Chapter 5 and additional concepts/readings below]

Lecture (2-3 hours) - Game theory; coverage outline

- NS: chapter 5
- 5.2 Basic concepts
- Additional to text: Dominance, rationalizability
- 5.3 Equilibrium
  - no focus on mixed strategies
- 5.4 Illustrating basic concepts Note: Read application from a beautiful mind!
- 5.5 Multiple equilibria
- 5.6 Sequential games
- Seventh problem set: Game theory (chapter 5, plus a few additional concepts covered in lecture)
- We will not cover the continuous action space, for time constraints
- Experimental evidence (and evidence from the real world); supplements

---

Putting this in the context of this Module:

1. Basic tools, the economic approach
2. The simple classical model, welfare results
3. Market failures (Monopoly, Public Goods)
4. Extensions of simple model: 'Die roll' Uncertainty

→ and now *Strategic* uncertainty → **Game Theory**

Finally, behavioural economics

Note: Time permitting, in the latter part of these lecture we will play real and hypothetical games. I will pay small amounts of money. It will be more fun if you have the clickers available and the chat window open/available

---

'ILO: Module-specific skills'

> detailed knowledge and understanding of intermediate microeconomic theory . . . apply economic reasoning to the analysis of economic questions and policy

. . .

→ Game theory is core

Many of you have seen game theory before; we will be more precise here, and introduce several concepts you have not seen before

---

Skills:

> . . . value of using economics in assessing the external environment for business decision-making

. . .

> communicate concepts/definitions/arguments in writing
>
> . . . analytical thought and reasoned discussion

Basic concepts (strategic interaction, elements of a game))

Previous: Each individual (consumer, firm, etc) takes all others' choices as given

- market price, demand curve, etc.

Now: Consider 'strategic interaction'

- My best choice may depend on your choice
- And vice versa
- Sequential games: My earlier choices may change your later choices

Some examples

Is it better to get lunch at Comida or Pret?

What if your friends are going to Comida?

What if everyone and her cousin are going to Comida, so the queue is miles long?

What should Tim Cook charge for his new Iphone?

Does it depend on whether Samsung and LG...

... Sell their phones for £200, or £1000, or go out of business?

Think about:

> Find a situation in business, government, fiction, history or your own life ...
>
> where one party's optimal choice depends on what another party does.

Write it down, give 1-sentence explanation of why it involves 'strategic dependence'

Some possible examples:

Life:

- Ask out your crush or not?

Politics:

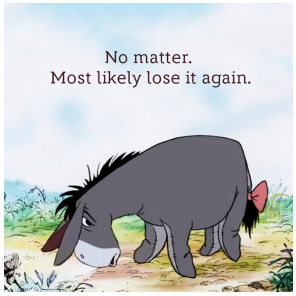
- Country makes war or peace? Soldiers fight or run away?
- Run for office or not? Party contests a seat? If so, how much to spend on campaign?

Standard Economics:

- Amount to bid at a first-price auction?
- Whether Firezza opens a new branch in Exeter, and where?
- How hard to work towards a promotion at your job?

Very interesting problems, does Econ and Game Theory have the solutions?

What game theory can do (wet blanket)



- Gives us a language and framework for analyzing strategic situations
  - 'solution concepts' make 'predictions' under given assumptions
  - 'equilibrium' defined as a baseline
- David says: Overrated as a tool for predicting how people/firms will actually behave

It often makes multiple predictions, or predicts 'mixed strategies' (randomisation). Real-world and experimental choices are often/arguably predicted poorly by classical game theory. For example, standard game theory says chess has a pre-determined outcome and is a bit boring (ok, you may agree about the latter).

Adv: But there are complicating issues making it difficult to asses the predictions of game theory. Particularly because monetary payoff may not be the same as utility payoffs ... this can make real-world predictions unclear. Particularly if there are social preferences or fairness preferences. We also see failures to coordinate, failure to take higher-order cognitive steps and preferences over the *manner decisions are made*. These make Game Theoretic predictions difficult.

Four elements describe a game

1. Players
2. Strategies
3. Payoffs
4. Information

Players the decision makers in the game

$2, 3, , N$ players

Who are the players in Chicken? 1. The north-facing car 'North' and 2. the south-facing car 'South'

Strategies a player's choices in a game (at each 'decision node')

- in simple games the same as actions
- may be a plan contingent on what another player has done
- may involve randomization

Strategies/actions in Chicken? For both N and S, two actions – Pull-off, Straight.

Payoffs The utility to each player arising from the combination of each player's strategies (and chance) in the game

- May include both 'money earned' and other considerations; all this is summarised in the payoff numbers
- The goal of each player is to obtain the largest payoff that she can obtain (not just to 'win')

Note: E.g., each player prefers to get 2 in *utility* and have the other player get 8 than for both to get 1

Note: In this context it is typically not helpful to complain 'I don't think players will maximise their payoffs, because they also care about how others do, etc.' Whatever it is they care about can be expressed in the theoretical payoffs.

However, these concerns are relevant to experiments that may incorrectly assume participants are maximising only their monetary payoffs.

Payoffs in chicken?

- Both pull-off → Tie
- N Straight, S pulls off → N 'wins', S 'loses'
- N pulls off, S straight → N 'loses', S 'wins'
- Both straight → crash

To convey this game payoffs must follow: Win ≻ tie ≻ lose ≻ crash

---

Example of payoffs in Chicken (as matrix)

		Northern	
		Pull-off	Straight
Southern	Pull-off	0,0	-1,1
	Straight	1,-1	-10,-10

Information what each player knows, at a particular point in the game, about payoffs and previous actions

- For *sequential* games, players may or may not know other players' previous actions

(in this module we will only cover the case where they *do* know previous actions taken)

Illustrating Games

The Prisoners' Dilemma: Normal form

The original story: Two individuals are arrested for a crime. They both know that they can only be convicted for a lesser crime, for which they get 2 years in jail. DA (Chief Crown Prosecutor) puts them in separate rooms and offers each the same deal. If you confess and your partner stays quiet you will only get 1 year in jail and they will get 10 years. If you both confess you will each get 3 years.

What would you do? What would most people do? What does game theory predict?

Which *outcome* is *definitely NOT* Pareto-optimal (for the prisoners)?

		B	
		Confess	**Silent**
A	**Confess**	–3, –3	–1, –10
	Silent	–10, –1	–2, –2

- Normal form payoff matrix (also called 'matrix form')
- Payoff convention: listed in the order (row's payoffs, column's payoffs)

A Prisoner's Dilemma be like

Two Players: (A and B, row and column, whatever)

Strategies (Actions): 'Cooperate' (C) or defect (D)

In normal form:

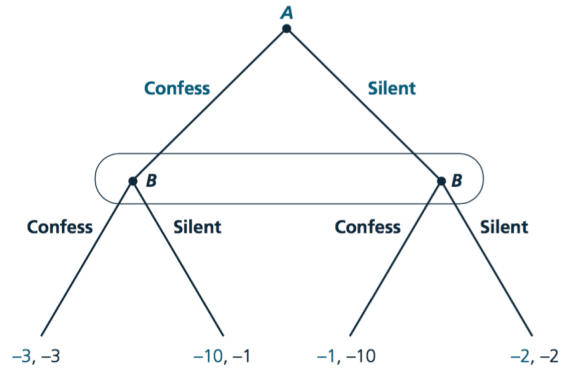
		Player 2	
		Cooperate	Defect
Player 1	Cooperate	R,R	S,T
	Defect	T,S	P,P

To be a prisoner's dilemma game the payoffs must satisfy $T > R > P > S$

I.e., Temptation > Reward > Punishment > Sucker

The Prisoners' Dilemma: Extensive form

FIGURE 5.1 Prisoners' Dilemma in Extensive Form



A chooses to Confess or be Silent, and *B* makes a similar choice. The oval surrounding *B*'s decision points indicates that *B* cannot observe *A*'s choice when *B* moves, since the game is simultaneous. Payoffs are listed at the bottom.

- Above: oval (usually dashed lines) for 'information set'
  - B may 'move second' but he doesn't know A's move (which side he is on), so it's as if simultaneous
- Order only matters if you observe earlier action
- Typically: extensive form for sequential games, normal form for simultaneous games

Note: This fancy terminology seems confusing and unnecessary. The reason for it involves more formal definitions of 'extensive' and 'normal' games and some deeper technical issues that we skip here.

Common knowledge

- What all players know, and
- all players know that all other players know,
- and all players know that all other players know that all other players know,
- and all players know that all other players know that all other players know that all other players know,

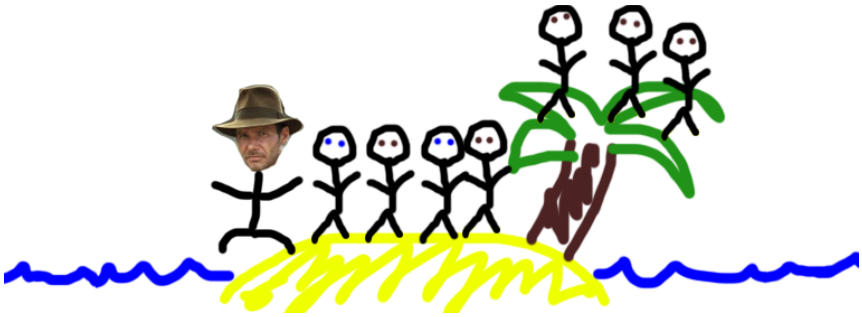
etc.

Note: By the way, we always assume that the rules of the game are common knowledge.

Why is common knowledge important?

Among other things, you may be stuck on an island 'with 100 blue-eyed people, 100 brown-eyed people, and the Guru' - XKCD_link - XKCD solution link - Rob Heaton version, more violent - Ted-ed video

Warning: this puzzle will do your head in



- Island with 1000 people.
  - 100 of them have blue eyes, 900 have brown eyes
  - There are no reflective surfaces
- By custom or law:
  - He who know own eye colour must commit suicide the next day in the town square
  - No one can discuss another person's eye colour.
- American tourist visits, says "It's so nice to see one or more people with blue eyes in this part of the world".

Q: *What effect, if any, does this faux pas have on the island?*

Ans: If his statement is 'common knowledge'

then all 100 blue-eyed people will kill themselves on day 100 after the speech.

A's *Best Response* (BR) to strategy *S*: A strategy for player A that gives him the highest payoff of all his possible strategies, given that the other player(s) play S

Note: The BR is a function of the others' strategies S; it may take a different value for each strategy the others play.

Dominant, dominated strategies and rationalizability

Note: Iterated strict dominance and rationalizability are NOT covered in the text, but I want you to learn it. As a prediction it is much easier to justify than Nash Equilibrium.

Dominant strategy A single strategy that is a best response to *any* of the other player's strategies.

- A simple prediction: a 'rational' player will play a dominant strategy, if she has one.

Dominated strategy (not in text!) Strategy A is dominated by strategy B if B yields higher payoffs for *any* of the other player's strategies

- A simple prediction: a rational player will *never* play a dominated strategy

Why?: because a dominated strategy cannot be optimal for *any* belief about what the other player(s) will do

Note: With only two strategies to choose from these concepts are the same. With more than two, if there is a Dominant strategy this means that all other strategies are dominated by it. We see this in examples below.

- Prediction of 'players play dominant strategies'
  - in Prisoner's dilemma

A \ B	Confess	Silent
Confess	−3, −3	−1, −10
Silent	−10, −1	−2, −2

- In general, this may have no clear prediction

Column (2)

Row (1)	Left	Middle	Right
Up	1,0	1,2	0,1
Down	0,3	0,1	2,0

Consider: What does 'players play dominant strategies' predict above? What about 'players never play dominated strategies'?

Rationalisability/ Iterated strict dominance (not in text!)

Extending this . . .

Rationality assumption: the players are rational.

We know rational players will not play dominated strategies The players *themselves* know this.

Common Knowledge of Rationality assumption:

The players know all other players are rational. The players know all players know all players are rational. The players know (all players know . . . ad infinitum) all players are rational.

- Thus the players know what the other players will never do, and eliminate these from consideration
- The players will not play a strategy if another strategy is always better against this reduced set of possibilities
- Etc.

This process is called 'Iterated Strict Dominance' (ISD) We will call strategies that survive ISD **'rationalizable' strategies**

Adv: There are differences between 'rationalizable' and 'survives ISD' but for our purposes these are the same

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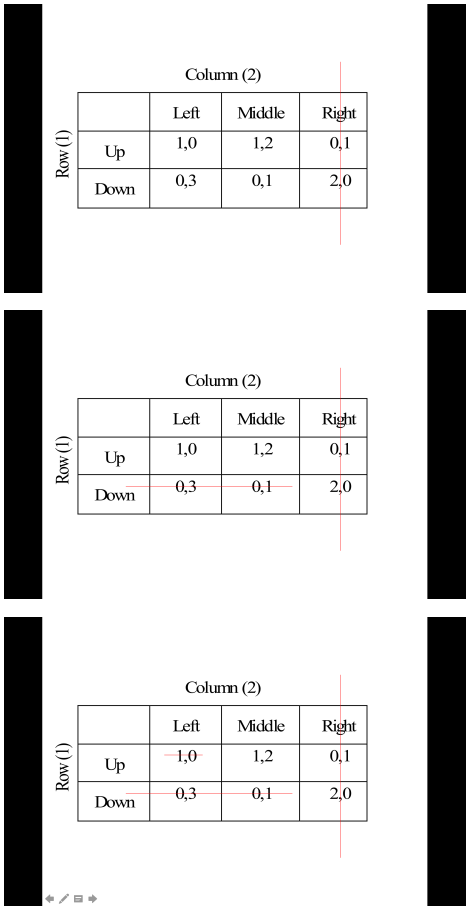
ISD example; may yield a unique prediction

Column (2)

Row (1)	Left	Middle	Right
Up	1,0	1,2	0,1
Down	0,3	0,1	2,0



- But there may be *no* dominated strategies
- or ISD may leave many possibilities

	Ballet	Boxing
Ballet	2, 1	0, 0
Boxing	0, 0	1, 2

Equilibrium

Market equilibrium (review): given the equilibrium price and quantity, no market participant has an incentive to change his or her behaviour.

In strategic settings, a similar concept:

Nash equilibrium (NE) A set of *strategies*, one for each player, that are best responses against one another

- If I play my BR to your chosen strategy and you're playing your BR to mine, neither of us has an incentive to deviate — an equilibrium.
- All games have at least one Nash equilibrium
  - But it may be an equilibrium in 'mixed strategies' (involving randomisation)
- Caveat: we might not expect such play to actually occur (particularly not in one-shot games)

In fact, 2-player games will have an *odd* number of equilibria; you can see this by looking at the crosses of the BR functions

Two ways to find the Nash equilibrium (NE)

1. Inspection: Check each outcome one by one. See if either player has an incentive to *unilaterally* deviate. If not, it's an equilibrium.

2. Underline method: For each player underline the payoff he would get if he played his best response to each of the other player's actions. Any outcome where there are *two* underlines is *the outcome of* an equilibrium strategy profile.

		B	
		Confess	**Silent**
A	**Confess**	−3, −3	−1, −10
	Silent	−10, −1	−2, −2

Caveat: this only works in a game with a countable set of actions ... a 'matrix' game, If the actions are a continuous variable (e.g., price, quantity) you must solve for point(s) where these functions meet, 2018: we will not cover games with continuous action spaces

Note this is the same 'prediction' as dominant strategies, but the interpretations are different; This is not by accident, there is a general result...

Recall again that the NE, and the prediction of 'players play dominant strategies' (also 'rationalisability') yields the single outcome that is clearly NOT pareto optimal. Lesson group and individual interests don't always align

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Find equilibrium via each method:

		B: Confess	B: Silent
A	Confess	−3, −3	−1, −10
A	Silent	−10, −1	−2, −2

Relationship between dominant strategies, rationalisability, and Nash equilibrium

- If eliminating dominated strategies yields a single prediction for each player, these strategies are a Nash equilibrium.
- Same holds for eliminating by iteration (rationalizability) ... if it leads to a unique prediction, it's a NE.
- But not every Nash equilibrium involves dominant strategies

Efficiency and the PD (redux)

Lesson: The group interests and individual interests do not always align

- If the players were allowed to communicate what would seem to be the best outcome?
- Both staying silent would be better for both than the outcome in the NE: 2 yrs vs. 3 yrs
  - But binding agreements are not allowed, and communication should not help

Coordination and anti-coordination games

Coordination: Battle of the sexes (BOS)

		B (Husband) Ballet	B (Husband) Boxing
A (Wife)	Ballet	2, 1	0, 0
	Boxing	0, 0	1, 2

- to make it more PC, assume it is a very violent ballet and a very gentle boxing match

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Anti-coordination: Matching pennies (odds/evens)

		B Heads	B Tails
A	Heads	1, −1	−1, 1
	Tails	−1, 1	1, −1

Note: Underline best responses, show no pure strategy NE here

Mixed strategies

Note: Please know the basic principles; you don't need to compute mixed strategies*

Pure strategy Consists of a single action played with certainty

Mixed strategy Assigns a probability to each possible action

Remember: there is always at least one NE. If there is no pure strategy NE, there will be a NE in mixed strategies.

Matching pennies: mixed strategies

Intuition

If you choose heads/tails half the time then I'm indifferent between heads or tails. Thus, choosing heads half the time is *among* my best responses.

If I choose heads half the time then you're indifferent between heads/tails. Thus choosing heads half the time is *among* your best responses

So, technically, each of us choosing heads half the time is a NE. (But it is called a 'weak' NE because either of us would do no *worse* if he deviated alone)

Battle of sexes: mixed strategies

		B (Husband): Ballet	B (Husband): Boxing
A (Wife)	Ballet	2, 1	0, 0
	Boxing	0, 0	1, 2

Note: Wife wants to end up at the same place as her husband but doesn't know where he is going.
- If she believes that he will always go to the ballet she should always go to the ballet.
- If she believes he will always go boxing, she should go boxing.
- What other beliefs may she have?

We want to derive the best response functions, and find the intersection(s) of these.

Let h represent the probability husband chooses Ballet

		B (Husband): Ballet	B (Husband): Boxing
A (Wife)	Ballet	2, 1	0, 0
	Boxing	0, 0	1, 2

Wife's BR:

- Wife chooses Ballet iff her Expected payoff of Ballet > Expected payoff of Boxing

I.e., $2h > 1 - h$, i.e, $h > 1/3$

- Thus, wife goes to Ballet if she believes husband goes to Ballet more than 1/3 of the time
  - If she thinks he goes below 1/3 of the time she goes to Boxing
  - If she thinks he goes *exactly* 1/3 of the time she is indifferent

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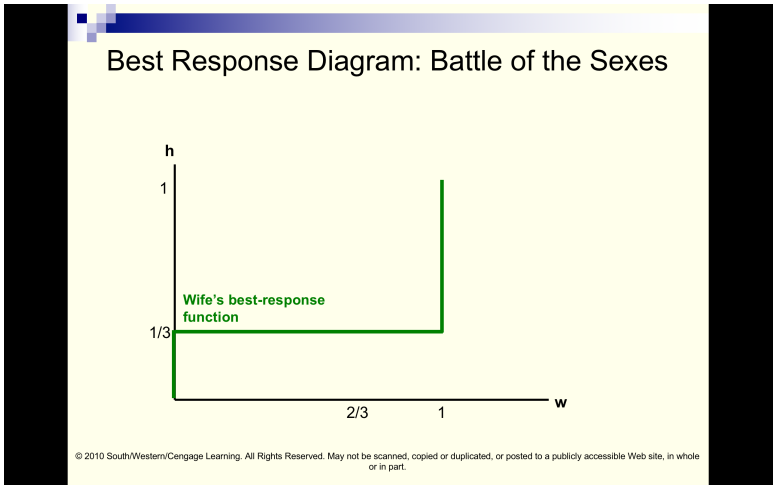

Note: This plots the value of w that best responds to h; the probability the wife goes Ballet given the probability the husband goes Boxing.

Let w: probability wife chooses Ballet

Husband's BR:

- Husband chooses Ballet iff his Expected payoff of Ballet > Expected payoff of Boxing
  - 1w > 2- 2w
  - w > 2/3
- Thus, husband goes ballet if he believes wife goes Ballet more than 2/3 of the time
  - If he thinks she goes less than 2/3 of the time he goes Boxing
  - If she thinks he goes *exactly* 2/3 of the time he is indifferent

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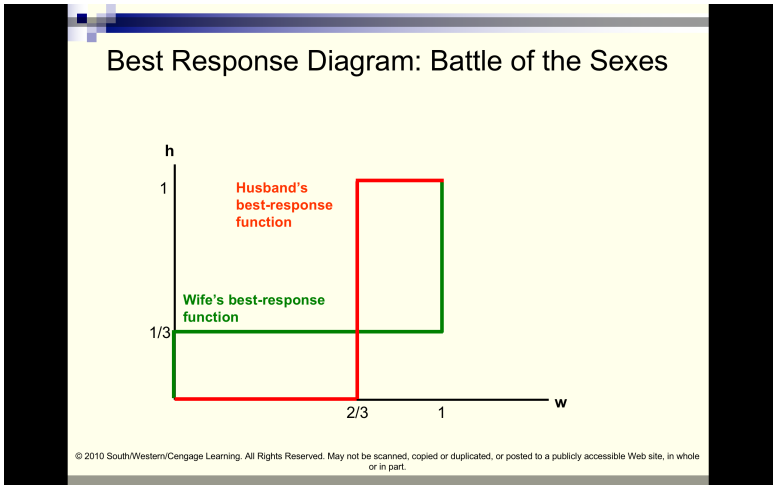
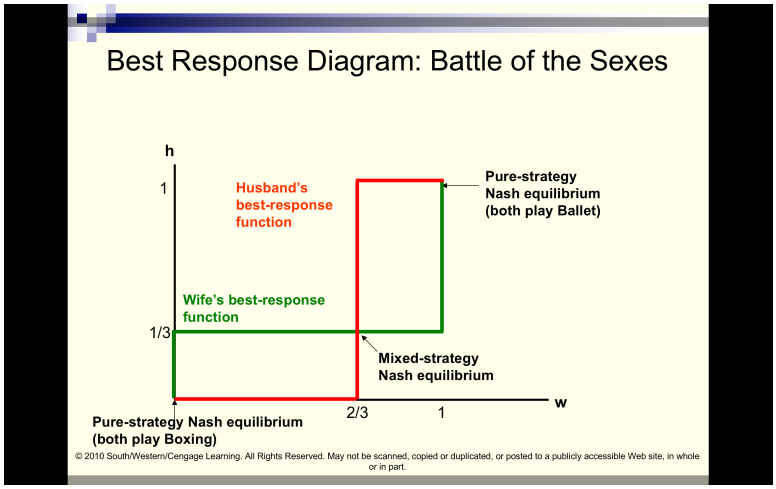




Shortcut: only someone who is indifferent will randomise. Above, $h = 1/3$ makes wife indifferent, $w = 2/3$ makes husband indifferent

What's all this rot?

- Mixed strategies are not about 'being unpredictable'; these are one shot games

Adv: Some texts and authors make this point about 'unpredictability' but others disagree (including myself). Making sure that it is impossible to predict your later play from your previous is only important if you are playing the same game repeatedly, and being observed.

Adv: It makes a bit more sense if we think about 'populations. Suppose in a population 1/3 of men go to Ballet and 2/3 of women go to Ballet: ... these ratios are 'stable'; no reason for systematic changes. On the other hand, if men always went to boxing and women to ballet this is not stable. A husband would be better off going to ballet ... so the ratios should change over time.

Computing payoffs with mixing

- Remember, formally NE specifies *strategies* (strategy 'profiles') not payoffs
  - In the BOS the pure strategy equilibria were
    - i. Husband: Boxing, Wife: Boxing
    - ii. Husband: Ballet, Wife: Ballet
  - the mixed-strategy NE was:
    - iii. Husband: go Ballet with probability h=1/3, Wife: Go Ballet with prob w=2/3.
  - The *payoffs* to these were, respectively
    i. Husband: 2, Wife: 1
    ii. Husband: 1, Wife: 2
    iii. ...

Payoff to the mixed strategy:

- Payoffs are utilities, sum utility of each outcome × probability of that outcome
  - Prob(Both go Ballet) $= w \times h = \frac{2}{3} \times \frac{1}{3} = \frac{2}{9}$
  - Prob(Both go Boxing) $= (1-w)(1-h) = \frac{1}{3} \times \frac{2}{3} = \frac{2}{9}$
  - Prob(Wife Ballet, Husband Boxing) $= w(1-h) = \frac{2}{3} \times \frac{2}{3} = \frac{4}{9}$
  - Prob(Wife Boxing, Husband Ballet) $= (1-w)(h) = \frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$

Thus, under the mixed strategy NE play:

$$U_{husb} = \frac{2}{9} \times 1 + \frac{2}{9} \times 2 + \frac{4}{9} \times 0 + \frac{1}{9} \times 0 = \frac{6}{9} = \frac{2}{3}$$

$$U_{wife} = \frac{2}{3}$$

- (Wife's payoff inferred from symmetry of problem or similarly calculated)

How do you solve a problem like multiple-equilibria?

Above (BOS), there are three equilibria: both play Boxing, both play Ballet, and the mixed strategy

- Are any of these more reasonable as predicted outcomes?

In-class experiment: BOS & coordination; need 2 volunteers

BOS: Play (volunteers)

		Column player (Husband)	
		Ballet	Box
Row player (Wife)	Ballet	£2, 0.50	0,0
	Box	0,0	£0.50, £2

'The Big Game'

Try this game

Note: symmetric payoffs

No communication

	C1	C2	C3	C4	C5
R1	2	0	0	0	0
R2	0	2	0	0	0
R3	0	0	1	0	0
R4	0	0	0	2	0
R5	0	0	0	0	2

Outcomes

Recent year (2016)

	Share chose	.. squared	Pay if match	E(Pay)
1	0.26	.068	2	0.52
2	0.21	.044	2	.42
3	0.11	.012	1	.11
4	0.16	.026	2	.32
5	0.26	.068	2	.52
Wtd avg	0.22	0.05		0.42

Multiple equilibrium and refinements

We refer to *refinement criteria* and *focal points*. For example...

1. 'Choose the equilibrium with the highest payoffs for both?' In BOS this rules out mixing (payoffs 2/3, 2/3 for h,w respectively). But it doesn't say whether we should predict Box, Box (payoffs 2,1) or Ballet, Ballet (payoffs 1,2)
2. Choose the 'symmetric equilibrium?' ... here, mixing
3. Choose the one that seems like a 'focal point'? (remember the 'big game')

Is there a focal point?

In-lecture 'experiment':

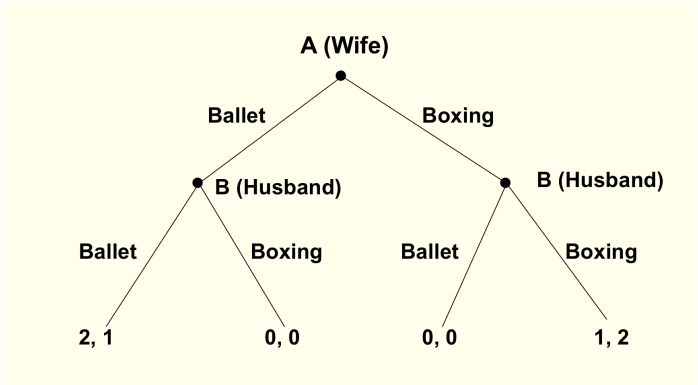
A year after graduating you come back for Alumni Weekend. You are supposed to meet the veterans of this module for a night of festivities but can't remember where or when. The internet does not exist.

- Where do you go? Students: write it down on a piece of paper Now type what you wrote in to the chat window
- What if you are meeting for a reunion in New York City, and no one has internet or phone access? Where do you go? Write it down. Type it into the chat window.

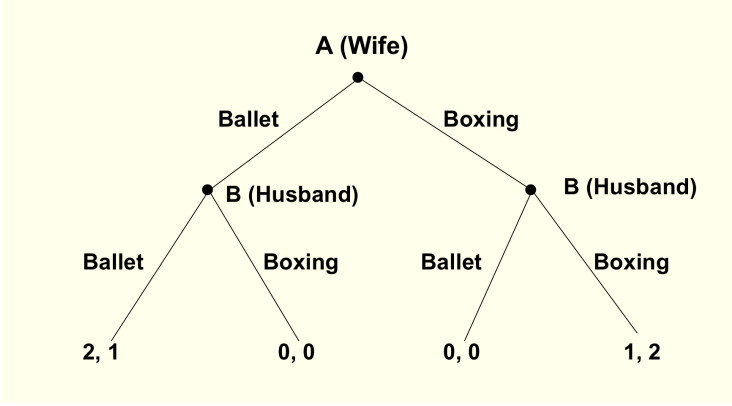
Sequential Games

Note: don't worry about the 'normal form' of sequential games; we will only use the extensive form for these

- How does the Battle of Sexes game change if Wife chooses first, Husband observes her choice, and then he chooses
  - What do you think will happen? Vote (clickers):
    - A. Wife: Ballet, Husband: Box
    - B. Wife: Ballet, Husband: Ballet
    - C. Wife: Box, Husband: Ballet
    - D. Wife: Box, Husband: Box



Note: Remember, it's a one-shot game ... unrealistic within a marriage of course



- The wife has two strategies: Ballet or Boxing
- The husband has four contingent strategies, but we focus on what he will do in each of his two possible 'decision nodes'

Notes: Here we see there is a 'first-mover advantage'.

We see a very similar strategic concern in other contexts, including 'which firm enters a market first'. Suppose that if two firms are in a market there will be a price war with consumers as well as a bidding up of input prices and salaries, and both will lose money. Perhaps by being the first firm to enter I 'scare off the other firm' and I can keep the profits. The other firm may 'threaten to enter' but that would seem to be a non-credible threat! On the other hand, suppose that I know that if I enter first the other firm can 'learn from my mistakes' and free-ride off my innovation. Here we would have a 'second-mover advantage'; but in such a game a BWI may lead to the outcome 'neither firm enters'!

These concerns also apply to politics, and the games can of course include multiple players

- Cameron's decision to allow a referendum, followed by politician's (Boris etc) decisions to choose a side?
- May's negotiations with the EU (Barnier), followed by the parliament's 'meaningful vote', followed by ??
- US Supreme court fight over Brett Kavanaugh, the sequential decisions of the last 'swing' senators

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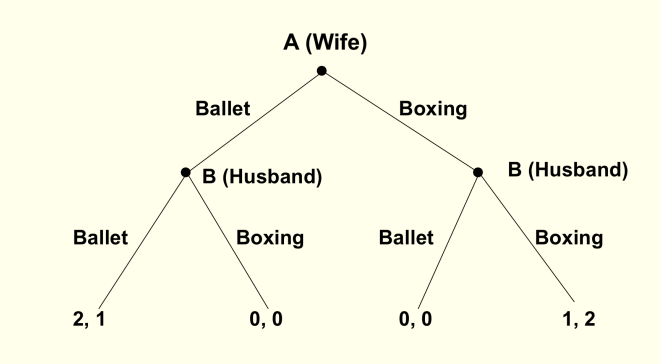

Proper subgame Part of the game tree including an initial decision not connected to another (in an oval or dashed lines) and everything branching out below it.

- I.e., each 'game' starting from a point where a player knows where he is (knows previous choices)

Notes: SPNE via backwards induction – essentially requires that each player would act optimally at each of these points

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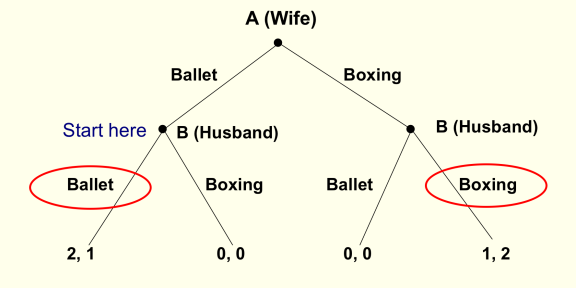
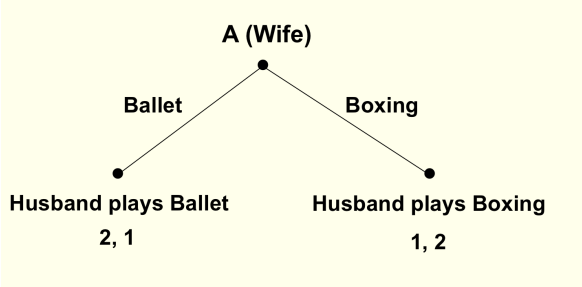
Subgame-Perfect Nash Equilibrium (SPNE) Strategies that form a Nash equilibrium on every proper subgame.

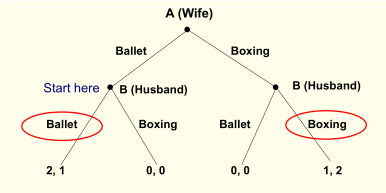
- You can solve for this with 'backwards induction' (BWI)
  - Solve for best move for last decision node (proper subgame)
    - Given these, solve for best response for previous decision node
    - Etc.

Example: BWI for BOS





Note that the SPNE in a sequential game always involves 'best responses'. I think this makes SPNE more credible as a prediction in sequential games than NE in simultaneous games.



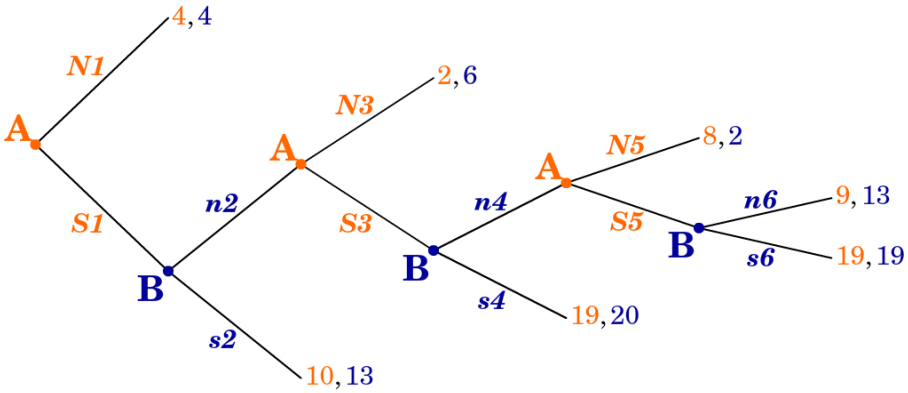
Formally specify (SP)NE strategies for above game:

NE, not SP: {Wife: Boxing; Husband: Boxing, Boxing}

SPNE: {Wife: Ballet; Husband: Ballet, Boxing}

(reading Husband's decision nodes left to right; please specify this)

It can get fancier



Note: you can 'build these games' on http://gte.csc.liv.ac.uk/gte/builder/ if you like

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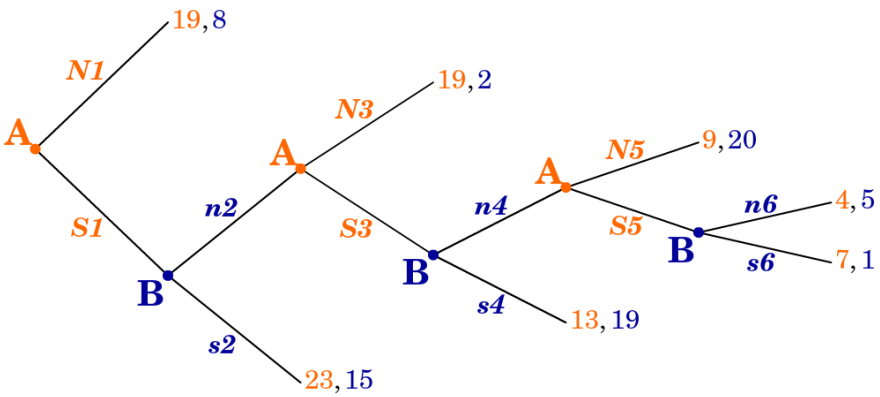
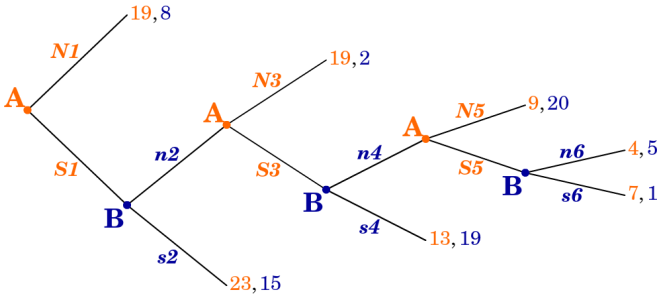


In 'normal' (matrix form), stating complete contingent strategies:

A \ B	n2,n4,n6	n2,n4,n6	n2,n4,s6	n2,n4,s6	n2,s4,n6	n2,s4,n6	n2,s4,s6	n2,s4,s6
N1,N3,N5	8 19	8 19	8 19	8 19	8 19	8 19	8 19	8 19
N1,N3,S5	8 19	8 19	8 19	8 19	8 19	8 19	8 19	8 19
N1,S3,N5	8 19	8 19	8 19	8 19	8 19	8 19	8 19	8 19
N1,S3,S5	8 19	8 19	8 19	8 19	8 19	8 19	8 19	8 19
S1,N3,N5	2 19	2 19	2 19	2 19	15 23	15 23	15 23	15 23
S1,N3,S5	2 19	2 19	2 19	2 19	15 23	15 23	15 23	15 23
S1,S3,N5	20 9	20 9	19 13	19 13	15 23	15 23	15 23	15 23
S1,S3,S5	5 4	1 7	19 13	19 13	15 23	15 23	15 23	15 23

And the 'abbreviated strategies'; leaving out decision nodes ruled out by a player's own previous choices as specified in the strategy:

A \ B	n2,n4,n6	n2,n4,n6	n2,n4,s6	n2,s4*	s2*
N1*	8 19	8 19	8 19	8 19	8 19
S1,N3*	2 19	2 19	2 19	2 19	15 23
S1,S3,N5	20 9	20 9	19 13	19 13	15 23
S1,S3,S5	5 4	1 7	19 13	19 13	15 23



The SPNE; 'state the complete contingent strategies'

A: S1, N3, N5

B: s2, n4, n6

. . .

Where actions are stated in the order of the decision nodes for each player

Repeated games: definite time horizon

2019: NOT covering repeated games, not assessed on these

Experimental evidence: What is a laboratory experiment in Economics?

E.g., FEELE lab at Exeter

- Real incentives (typically small)

- Typically student subject pool
- No deception protocol

YOUR PAYOFF		
your choice/your partner's choice	C	D
C	3	0
D	5	1

Your Choice: D C

OK

YOUR PARTNER'S PAYOFF		
your choice/your partner's choice	C	D
C	3	5
D	0	1

Various experimental goals

- Measure preferences (risk, time, social preferences. . .)
- Asses theoretical predictions (classical and behavioural), including game theory
  - Also see 'likely' outcomes where theory has no prediction or predicts multiple equilibria
  - *Critical* to assert 'control' over payoffs for this
- Understand cognitive processes in economic realm
- 'Test' institutions and mechanisms (e.g., auctions, markets)

Laboratory evidence 1: Prisoners' dilemmas

Cooper et al (1996)

- Players cooperated even in anonymous 'one-shot' games (different opponents each time)
- Cooperation declines somewhat over time, but not to zero
- Mix of other-regarding and selfish types

Notes: Results are similar for experiments involving contributions to public goods.some cooperation, declining over time but not to zero, and a mix of players who never contribute and many 'reciprocal' types.

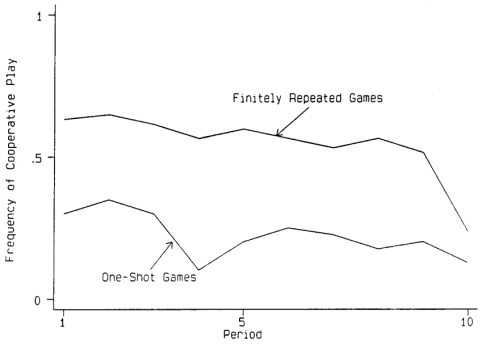


FIGURE 1

Laboratory evidence 2: Ultimatum game

- Proposer goes first, proposes a split of the 'pie', anything between 0%-100% and 100%-0% inclusive.
- Responder can accept or reject and get nothing

Q: What does SPNE predict (use backwards induction)?

Ans: It predicts the proposal offers the lowest (positive) amount and the responder accepts

What happens in experiments?

- 50-50 split is the most common offer
- Responders tend to reject offers giving them less than 30%, even when this is a lot of money

Potential explanations

- Fairness concerns; monetary payoffs may not represent actual payoffs
- Proposers may anticipate this

Issues in lab experiments

What is being measured?

- PD: Does money measure the true payoffs? Do we have the 'control' to test the model?
  - Other-regarding preferences; may be unobservable.
  - 'Experimenter demand': desire to please experimenter, aware of study goals?

Issues in lab experiments: External generalisability

- Relevance of subject-pool (participants)
  - Do they resemble the 'real world' group of interest? (e.g., firms, countries, taxpayers, voters, home-buyers)
  - Right preferences and experience?
- Relevance of environment
  - Are the (small) stakes relevant?
  - Are the right 'environmental characteristics' present?
  - Does the 'imposed model' apply?
  - Observed self-conscious environment, perhaps made aware of contrasts

Note: a recommended reading is 'Ten Little Treasures of Game Theory and Ten Intuitive Contradictions' Goeree and Holt, 2001

If you are particularly interested, skim or read the introduction of any of the 'Handbooks' like 'Handbook of Experimental Economics'

#Lecture12: Behavioural economics [1-2 hours]

Lecture12: Behavioural economics

- Covers selected parts of NS: Ch 17, plus supplements
- Eighth problem set: Behavioural economics

Thou shalt be carefully sceptical; critique do not just criticise; Consider the assumptions made; Consider the evidence

Neoclassical versus Behavioural economics

(Neo)classical:

- Firms maximise profit
- Individuals/households have a consistent utility function which they act 'rationally' to maximise
  - Mainly: focused on *own* consumption, ignores 'cognitive costs', ignores 'malleable and changing preferences'

Notes: We can not say someones *preferences* are irrational, only that either they are not acting optimally to maximize their welfare *given* these preferences or their preferences are not internally consistent (e.g., not-transitive), are not fully self-interested (altruism), or are otherwise difficult to model (e.g., depending on the *manner* they make choices and not only the outcomes.

Classical economics assumes

- Optimization of a consistent 'normal' utility function subject to known constraints
  - Only own consumption matters?
  - No cost to gather information or make calculations?

Expected utility over gambles/investments, probabilities accurately known

Geometric discounting of future payoffs with a single (or at least a consistent) discount rate

Adv: E.g., if $\delta = 0.1$ in each period then next period's payoff of 100 is worth as much as $(1 - 0.1) \times 100 = 90$ today.
A payoff of 100 in two periods is worth as much as $(1 - 0.1) \times 100 = 90$ tomorrow, or as much as $(1 - 0.1) \times (1 - 0.1) \times 100 = 81$ today.

Strategic behaviour in interactions - Common knowledge of rationality, Nash equilibrium?

We can find behaviour and outcomes that seem to contradict the above assumptions.

This 'non-classical' behaviour is (arguably) common, significant, and follows predictable patterns

Should we then *stop learning classical economics?*

Classical economists are not naïve

They know preferences change, people make mistakes, etc.

Justifications include:

- 'Most people, most of the time,' and many mistakes will be 'fixed' by the market.
- Strong predictive power
- 'Normative': how we 'should' behave to get the best outcomes
- A good starting point, framework for insight, benchmark

Behavioural Economics

Relaxes some of the assumptions above, usually one at a time

Does not typically 'reject rationality' ('bounded rationality')

Most "behavioral models" involve some sort of optimization (and often equilibrium) - There are 'pure behavioral theorists' who try to find parsimonious models to explain deviations

Most influential authors: Kahneman and Tversky

Modern consensus/entente

Both classical and behavioural economics are useful

- Different models and techniques (for different spheres?)

Notes: It is worth testing for, and admitting the possibility of 'systematic violations' of the classical assumptions. *Classical* economics is usually more relevant for firm behavior But Classical may (or may not) predict well for *aggregates* and for *firm behaviour* *Behavioural models* may predict better for individual behaviour in isolation but behavioural admits many possibilities and heterogeneous behavior, so it makes broad predictions difficult Behavioural insights are (probably) useful in making policy (and in marketing) Evidence from the lab may be informative, but some 'behavioural anomalies' may be inconsequential in larger markets in equilibrium

Limits to Human Decision Making: An Overview

There are four general ways people diverge from classical assumptions (text says three)

1. Limited cognitive ability – difficult and costly to make complex decisions
2. Limited willpower – self control problems
3. Limited self interest – care about others (fairness, altruism), issues beyond income/consumption
4. Inconsistent, changing, and 'non-outcome-based' preferences

DR: I added this final one to the textbook's account; under (e.g.) Prospect Theory people may be acting to maximise their true preferences, but their true preferences may change depending on reference points etc.

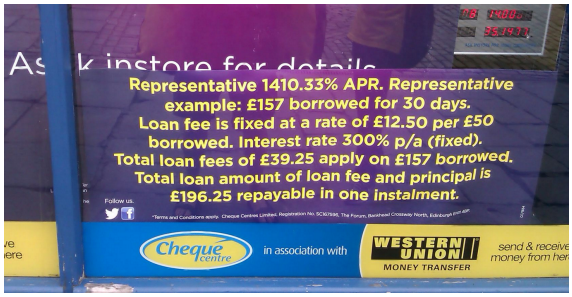
Limited cognitive ability

- Complexity of problems
  - Optimising calculations take time; this may *itself* be a cost
    - A 'simplifying decision-making rule' (rule-of-thumb) may be better if it saves these costs
  - Relevant both to individual decision-making (consumption, investment) and strategic choices
    - Game theory: recall 'iterated strict dominance' and 'backwards induction'
- People (seem to) systematically misunderstand probabilities (and other maths concepts)

Application: lack of financial literacy

- Consumers who underestimated interest rates in quizzes held the highest interest loans in real life
- Particularly when government 'truth in lending laws' were lax

Evidence from Stango and Zinman, 2011



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1. Suppose you had £100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow:

A. More than £102

B. Exactly £102

- Consumers who underestimated interest rates in quizzes held the highest interest loans in real life (Stango and Zinman, 2011) - Particularly when government 'truth in lending laws' were lax

2. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, would you be able to buy:

A. more than

B. exactly the same as, or

C. less than today

3. Do you think that the following statement is true or false? 'Buying a single company stock usually provides a safer return than a stock mutual fund.'

(True/False)

Around the world, across many studies, less than half answer *all three* correctly. Lusardi and Mitchell, 2013; In Germany and Switzerland, just over 50% get all three right. In most other surveyed countries, the numbers are far lower. E.g., in the USA 65% get the interest rate question right, 64% the inflation question, and 52% the diversification question.

Allais paradox

- Gamble A: an 89% chance of winning £1 million, a 10% chance of winning £5 million, and a 1% chance of winning nothing.
- Gamble B: £1 million with certainty.

Write down: which would you choose?

Scenario 2. Which would you choose?

- Gamble C: an 89% chance of winning nothing and an 11% chance of winning £1 million.
- Gamble D: a 90% chance of winning nothing and a 10% chance of winning £5 million.

Which would you choose?

Many people choose B over A and choose D over C:

$$B \succ A$$

$$\pounds 1m \succ (\pounds 1m \otimes 0.89 + \pounds 5m \otimes 0.1 + \pounds 0 \otimes 0.01)$$
$$D \succ C$$
$$(\pounds 0 \otimes 0.9 + \pounds 5m \otimes 0.10) \succ (\pounds 0 \otimes 0.89 + \pounds 1m \otimes 0.11)$$

i.e.,

$$\pounds 1k \succ (\pounds 1k \otimes 0.89 + \pounds 5k \otimes 0.1 + \pounds 0 \otimes 0.01)$$

But this contradicts Expected Utility theory:

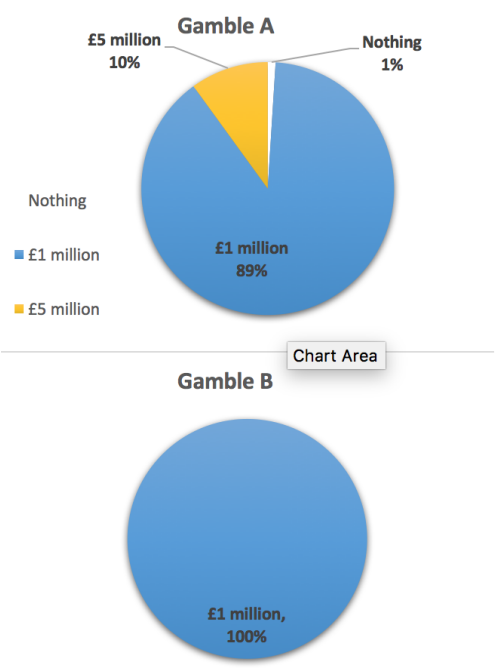
- If $B \succ A$ then $EU(A) > EU(B)$
  - $\rightarrow u(1m) > 0.89\,u(1m) + 0.1\,u(5m) + 0.01\,u(0)$
  - $\rightarrow 0.11\,u(1m) > 0.1u(5m) + 0.01\,u(0)$

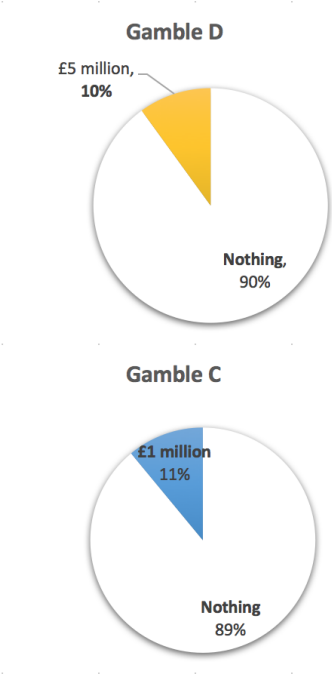
- If $D \succ C$ then $EU(D) > EU(C)$
  - $\rightarrow 0.9\,u(0) + 0.1u(5m) > 0.89\,u(0) + 0.11\,u(1m)$
  - Implying $0.1\,u(5m) + 0.01\,u(0) > 0.11\,u(1m)$
  - Contradicting the above!

Note there is a 'reversal': In choosing B over A you gave up a 10% chance of £5000 to get a 1% greater chance of £1000
... but in choosing D over C you gave up a 1% greater chance of £1000 to get a 10% change of £5000

Adv: By EU theory it shouldn't matter that for the remaining 89% of the time A differs from C: This is an 'independent state of the world'; should have no impact on your decisions for the remaining 11% of the time. By this logic, the fact that there is a 10% chance that a meteor destroys England on Friday should not affect my choice of whether to go to a fancy restaurant or get a simple curry on Friday in the 90% probability case that England is *not* hit.

Explaining it again with pie charts...





{A is D plus an additional 89% chance of £1m}

{B is C plus an additional 89% chance of £1m}

{So "A and B" are "D and C" with additional 89% chance of £1m}

{EU additive} →: {choice for *remaining* 11% state ignores difference}

By the EU calculation I make choices over which I prefer for the (remaining) 11% of the time without considering what happens 89% of the time. 'Independent states of the world'.

SO WHY do people choose B over A and D over C?

- One theory: People overweight small probabilities
  - → Gamble A: the 1% chance of 0 is treated as larger?

Kahneman and Tversky scenariae

Warning: This is not the standard Allais paradox, it is a different paradox.

KT1. Which would you choose?

You get £1000 upfront.

- Gamble $A: You have an 50% chance of winning an additional £$1,000.
- Gamble $B: An additional £$500 with certainty.

Write down: which would you choose?

KT1. Which would you choose?

You get £2000 upfront.

- Gamble *C*: You have an 50% chance of losing £1,000.
- Gamble *D*: You lose £500 with certainty.

KT1: You get £1000 upfront.

- Gamble *A*: You have an 50% chance of winning an additional £1,000.
- Gamble *B*: An additional £500 with certainty.

KT1: You get £2000 upfront.

- Gamble *C*: You have an 50% chance of losing £1,000.
- Gamble *D*: Lose £500 with certainty.

KT (hypothetical) experiment: 16% of subjects chose *A* over *B*, and 68% chose *C* over *D*

- *But A is the same as C (50/50 chance of £1000 or £2000),*
- *and B is the same as D (certain £1500)!*

Seems to depend on how we 'frame' these.

Explaining the above paradoxes with prospect theory

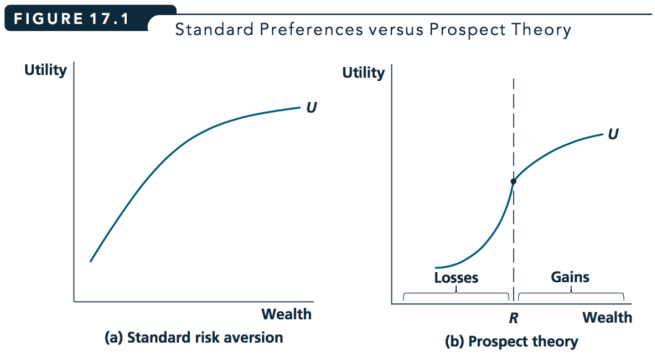
- Above choices: cannot be explained by 'regular' EU theory
  - Mistakes, misunderstanding probabilities?
  - Prospect theory, loss-aversion: *not* mistakes, but maximising something other than EU

Prospect theory – loss aversion (LA) part

1. People don't think only about *outcomes* but about 'gains or losses relative to a reference point'
2. Outcomes considered *losses* are particular painful
3. Whether an outcome is a *loss* depends on the reference point
   - which may depend on how a decision is framed
   - or on the starting point, or initial expectations

→ may make decisions to 'avoid losses'
that we wouldn't make if we saw it as 'increasing gains'

Standard and loss-averse utility



A standard utility function exhibiting risk-aversion is drawn in (a). The utility function in (b) illustrates prospect theory. The kink at *R* means that the person suffers more harm from small losses than benefits from small gains, although the sensitivity to larger losses diminishes as the curve becomes flatter as one moves left from *R*.

Notes: What leads to the paradoxes and 'inconsistent behaviour'?
The fact that the reference point can vary depending on things that are 'irrelevant' from an EU perspective

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KT experiment with prospect theory (loss aversion)

KT1: £1000 upfront.

- Gamble *A*: You have an 50% chance of winning an additional £1,000.
- Gamble *B*: An additional £500 with certainty.

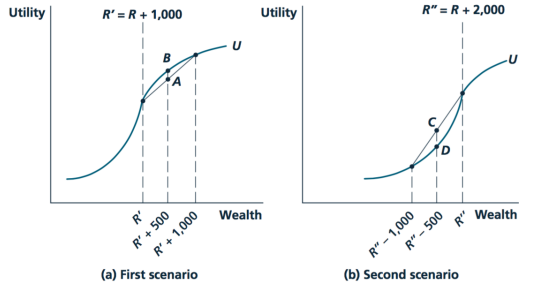
KT2: £2000 upfront.

- Gamble *C*: You have an 50% chance of losing £1,000.
- Gamble *D*: You lose £500 with certainty.

- In KT1, your reference point may be £1000.
  - Choose between A—a small certain gain and B—a larger uncertain gain; with same EV
  - . . . standard risk aversion predicts choosing B
- In KT1, your reference point may be £2000.
  - Choose between C—a possible large loss and D—a certain smaller loss (with same EV)
  - . . . standard risk aversion predicts choosing D
  - But if feeling of *loss* is very painful, may choose C>D to have a 50% chance of avoiding pain

Note: This may help explain why some problem gamblers incur larger and larger losses to try to 'make up' for bad performance earlier in the day.

FIGURE 17.2 Explaining the Kahneman and Tversky Experiment with Prospect Theory



In the first scenario, the person evaluates the choices as gains to the initial $1,000 endowment. The second scenario shifts the reference point over further by $1,000, and now the changes are regarded as losses. The person prefers *B* to *A* in figure (a) and *C* to *D* in figure (b), even though *A* provides the same final allocation as *C*, and *B* provides the same final allocation as *D*.

Framing effect The same choice, presented in two different ways, may lead to different decisions.

Allais redux: loose prospect theory (Loss Aversion) explanation

Note: We previously mentioned misweighting probabilities as an explanation for this.
An alternative explanation could be loss-aversion

- A: 89% chance of £1,000, a 10% chance of £5,000, 1% chance of 0.
- B: £1,000 with certainty.
- C: 89% chance of 0 and 11% chance of £1,000.
- D: 90% chance of 0 and 10% chance of £5,000.

- Considering A & B, the ref. point may be close to £1000, as this can be had with certainty.
  - A seem to 'risk a costly loss of £1000', thus may choose 'safer' $B > A$, notwithstanding its far lower EV (£1000 vs £1390)

- Considering D & C, ref. point may be close to 0, as EV's of each are low, & 0 is likeliest outcome
  - So 'don't worry about losses', choose D > C bc higher EV (£500 vs. £110)

Note: Skipped in lecture for time constraints: limited reasoning steps – Centipede game; you can read this if you like; remember, things like this may provide you 'ammunition' on an essay question.

Limited willpower and 'hyperbolic discounting'

2019-20: We will cover this only very briefly because of time limitations

Marshmallow test

Notes: In the 1960's-70's Stanford experiment. Children could have 1 marshmallow now or 2 in 15 minutes if they could resist temptation.
There is some evidence that this correlates to later life outcomes (test scores, degrees, BMI, etc).
Strong results; interpretation debated.

This result is now in question! The strongest results have failed to replicate. See a popular discussion here.

Monday-David wants Tuesday-David to give up 1 marshmallow for 2 marshmallows on Wednesday.

But Monday-David unwilling to give up 1 marshmallow for 2 marshmallows on Tuesday.

Similarly, Tuesday-David won't give up 1 marshmallow for 2 on Wednesday

- Inconsistency: Monday-David thinks Tuesday-David is acting sub-optimally!
  - Is David acting in his own interest? Can we even define his 'true utility'?

Hyperbolic discounting (simple version) Steep drop in 'weight w' on payoffs earned after the current period

- But constant weight (or constant discounting) for payoffs multiple periods in the future
  - This leads to inconsistencies between 'planned' and chosen behaviour

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Compare two 'streams of payoffs'

1. Work: -10 today, +2 for the next 6 days
2. Lazy: -5 today, +1 for next 6 days

Examples: Should you. . . ?

study very hard on Sunday to be prepared for the whole week,
Get a good workout to feel energized the whole week
Clean your flat on Sunday .... etc.

Grasshopper weights payoffs today, tomorrow, and every day the same: $w = 1$

- Monday, Grasshopper compares Work to Lazy, and chooses Work.
  - payoff(Work) $= -10 + (2 \times 6) = 2$
  - payoff(Lazy) $= -5 + (1 \times 6) = 1$

Ant always weights payoffs at 1 today and $w = 1/2$ on any future day

- Monday, Ant chooses Lazy:
  - payoff(Work) $= -10 + (2 \times 6)/2 = -4$
  - payoff(Lazy) $= -5 + (1 \times 6)/2 = -2$

If Grasshopper were 'choosing for Monday on Sunday', he would choose Work → Consistent

But if Ant were 'choosing for Monday on Sunday', he would choose Work → Inconsistent

- On Sunday he considers
  - payoff(Work Monday) $= (-10 + 2 \times 6)/2 = 1$
  - payoff(Lazy Monday) $= (-5 + 1 \times 6)/2 = 1/2$
- But as we saw, on Monday he chooses to be lazy
- Would he 'benefit from pre-committing?'

Application: 'put a contract out on yourself

Altruism and fairness

'Other-regarding preferences': My utility may be impacted by...

- Other people's utility, or their consumption of particular 'merit' goods
  - E.g., I suffer if I know my neighbour suffers, or her child eats too little
  - → 'aid to the poor' may become a public good; may be massively under-provided in a voluntary setting
- My perceived 'impact' on outcomes
  - If I donate to charity, I feel better
  - If my contribution improves people's lives, protects the environment (relative to my having done nothing)
  - → People may make choices reducing their own consumption, to increase other's consumption
  - Charitable giving is widespread; accounts for about 1% of UK GDP
  - 'Donations' to family members much higher

Adv: The utilities, and decisions, of family members are highly connected. There is an ongoing debate and research programme considering when to model a household's decisions as 'unitary' and when to consider the individual preferences of the household members.

... 'Other-regarding preferences': My utility may be impacted by...

- My reputation and how others perceive me
  - → People may donate and cooperate more when observed
- How 'fair' I believe the outcomes and actions taken are
  - → People reject significant positive offers in ultimatum games and bargaining
    - Anticipating this, people make offers considerably above zero
  - → People cooperate when they expect others to do so
  - → people engage in 'costly punishment' of others they believe acted unfairly

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Converting from 'material payoffs' to 'psychological payoffs'

- As noted, the 'real' payoffs in a game (or an individual decision) may not be identical to the monetary/material payoffs
  - (Note, this is a separate point than 'diminishing marginal utility' and risk-aversion)
- Motives like 'fairness' may transform monetary payoffs into 'real' payoffs in a straightforward way
  - E.g., in the ultimatum game, suppose player 1's real payoffs are:

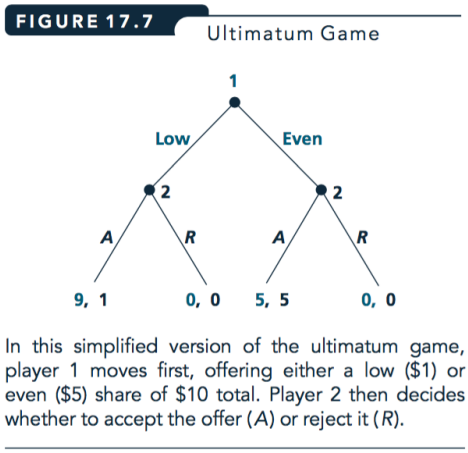
$$U_1(Y_1, Y_2) = Y_1 - |Y_1 - Y_2|$$

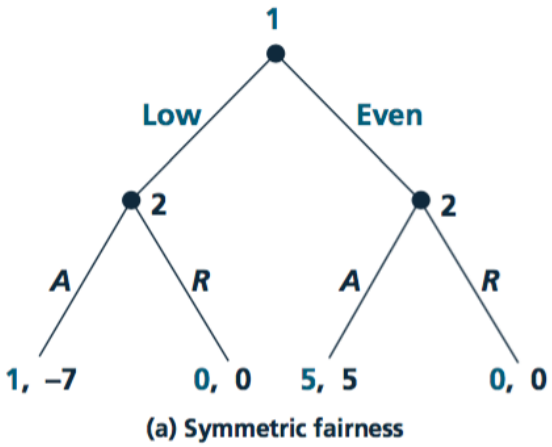
Where Y_1 is the amount 1 earns from the ultimatum game, and Y_2 is 2's income from this game.

Similarly for player 2:

$$U_2(Y_2, Y_1) = Y_2 - |Y_1 - Y_2|$$

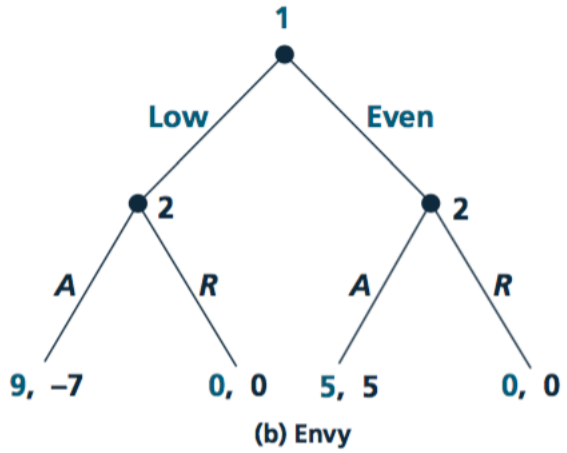
Here each player gains 1 unit of utility for each pound they earn, but loses a unit of utility for every pound of difference between the payoffs.





Notes: Here if earnings are equal, real payoffs are the same as earnings; 0,0 or 5,5
Where earnings are unequal, player-1 gets 9 and player-2 gets 1 from material payoffs.
But because of a difference of 8 in earnings, both players lose 8 in psychological payoffs
so the net real payoffs if player-1 offered 1 and 2 accepted would be 9-8=1 for player-1 and 1-8=-7 for player-2.
Using BWI here we see the subgame perfect NE will be that player-1 offers 5 and player-2 accepts.

'Envy payoffs'



Notes: Here we assume because of 'envy', real payoffs equal material payoffs minus the difference in payoffs *for the player with lower payoffs only.*
For the outcomes considered, only player-2's payoffs are adjusted from the material payoffs;
she gets 1-8 = -7 from accepting an offer of 1; her payoff is 1 but she loses 7 in envy.
Because of this she will not accept such an offer. Knowing this, player-1 will offer 5.

Supplemental (reading): Evidence on the Ultimatum Game

Guth et al. (1982) presented the first experimental test of the ultimatum game.

2 players: Proposer and Responder

Proposer has a pie of size 1. She must propose a split of the pie between the two players $(1-s, s)$

The Responder may:

- accept (in which case the split is executed)
- reject (in which case both players get zero

This is a 'take it or leave it offer' in bargaining. What do you think he/she will offer? Do you think he/she will accept? Why or why not?

Ultimatum game: theoretical predictions

Allowing 'non-credible threats', this game has as many Nash equilibria as there are possible splits of the pie

In each of them, the Responder's strategy is to 'accept only if offered X (or more)' for some $X \geq 0$, and the Proposer's strategy is to offer exactly X.

But maybe these equilibria don't seem like reasonable predictions (why?)

Q: What does SPNE predict (use backwards induction)?

- If the split is $(1, 0)$, the Responder is indifferent between accepting and rejecting
- That still means the Proposer offering $(1, 0)$ and the Responder accepting is a NE

The subgame-perfect Nash equilibrium is found by solving the game backwards:

- The Proposer (correctly) anticipates the Responder will accept any offer
  - Thus she offers zero, which is accepted 'in equilibrium'
- A 'near zero' offer would lead to a similar result, and might seem more intuitive

Note, These are basic game theoretic predictions, not Behavioral.

What happens in experiments?

- Class question: What do you think?

- 50-50 split is the most common offer
- Responders tend to reject offers giving them less than 30%, even when this is a lot of money

Potential explanations

- Fairness concerns; monetary payoffs may not represent actual payoffs
- Proposers may anticipate this

TABLE I
PERCENTAGE OF OFFERS BELOW 0.2 AND BETWEEN 0.4 AND 0.5
IN THE ULTIMATUM GAME

Study (Payment method)	Number of observations	Stake size (country)	Percentage of offers with $s < 0.2$	Percentage of offers with $0.4 \leq s \leq 0.5$
Cameron [1995] (All Ss Paid)	35	Rp 40.000 (Indonesia)	0	66
Cameron [1995] (all Ss paid)	37	Rp 200.000 (Indonesia)	5	57
FHSS [1994] (all Ss paid)	67	$5 and $10 (USA)	0	82
Güth et al. [1982] (all Ss paid)	79	DM 4–10 (Germany)	8	61
Hoffman, McCabe, and Smith [1996] (All Ss paid)	24	$10 (USA)	0	83
Hoffman, McCabe, and Smith [1996] (all Ss paid)	27	$100 (USA)	4	74
Kahneman, Knetsch, and Thaler [1986] (20% of Ss paid)	115	$10 (USA)	?	75[a]
Roth et al. [1991] (random payment method)	116[b]	approx. $10 (USA, Slovenia, Israel, Japan)	3	70
Slonim and Roth [1997] (random payment method)	240[c]	SK 60 (Slovakia)	0.4[d]	75
Slonim and Roth [1997] (random payment method)	250[c]	SK 1500 (Slovakia)	8[d]	69
Aggregate result of all studies[e]	875		3.8	71

a. percentage of equal splits, b. only observations of the final period, c. observations of all ten periods, d. percentage of offers below 0.25, e. without Kahneman, Knetsch, and Thaler [1986].

In a variety of cultures and contexts (Henrich et al, 2006):

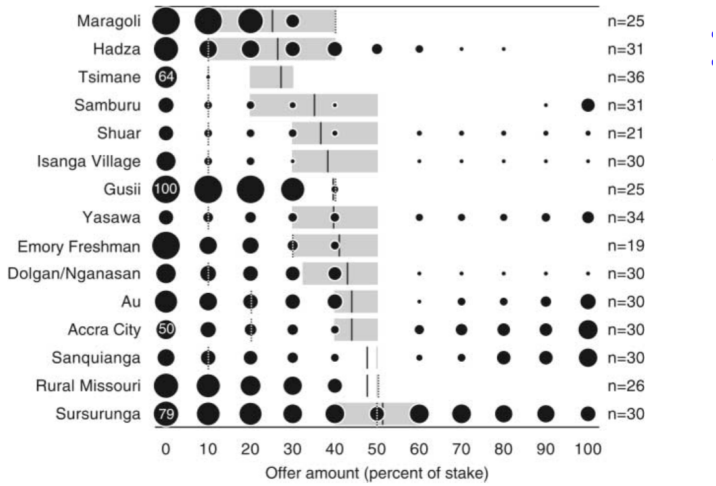


Fig. 1. UG results displayed as the distributions of rejections across possible offers in the UG, which overlay the mean offers and interquartiles. For each population labeled along the vertical axis, the areas of the black bubbles, reading horizontally, show the fraction of the sample of player 2s who were willing to reject that offer. For reference, inside some of the bubbles we noted the percentage illustrated by that bubble. The dashed vertical bars mark the IMO for each population. The solid vertical bars mark the mean offer for each population, with the gray shaded rectangle highlighting the interquartile of offers. Populations were ordered by their mean offers (from low to high). Counts on the right (*n*) refer to numbers of pairs of players.

Application: Give-if-you-win (EU vs. Prospect theory)

Bankers

"... people in the middle [of the performance distribution] will be unsure [if they're going to get a bonus] until they're announced.

[For] people who know they're going to get a bonus, the size ... is uncertain until announced." – Raj C: Hedge Fund Manager, London (2015).

Politicians

"Johnson: Bankers should assuage guilt by giving bonuses to homeless scheme." – *The Guardian*, 13 Feb 2009.

EU over outcomes predicts these choices are the same

Here, in choosing *conditional* choices 'if I win' etc., the decision for each state (win or lose) are separate.

- Max $EU = pr(win)u(win, choiceifwin) + pr(lose)u(lose, choiceiflose)$
- Choice for 'if I win' does *not* affect payoff 'if I lose'

- Before: Anticipate what my utility-maximising donation g^* would be if I win the bonus
  - Let c be own consumption, Y income pre-bonus, w the bonus amount, and g_b the committed donation 'if you win w'
  - Choose g_b to maximize utility $u(c, g)$ s.t. budget constraint $c + g \leq Y + w$
  - If asked to pre-commit 'if I win', I commit to that choice, so $g_b = g^*$

- After: After I have won the bonus w, I maximize utility $u(c, g)$ s.t. budget constraint $c + g \leq Y + w$
  - Same maximisation as above, so $g_a = g_b = g^*$

Other models predict distinct outcomes

- **Reputation:** If I give to benefit my reputation or self-esteem, *unrealised* donations may matter, not just donation outcomes
  - May be an incentive to commit *more* the less likely a donation needs to be paid
  - 'If I win the lottery megabucks, I will give it all away'
- **Loss aversion:** If I am 'loss averse' over my own consumption, it may seem 'cheaper' to commit before I win the bonus than after
  - Why? Because my *reference point* may change.
- Suppose I've £50k income and a potential £50k bonus with 50% probability
  - Before winning my reference consumption may be the EV, £75k
  - So a conditional donation to donate £10k if I have a total income+bonus of £100k may not seem like a loss
  - But after I win the bonus, my new reference consumption may be £100k
  - So each pound donated might feel like a loss

What do you think happens when you ask people to donate either Before-conditionally or After winning a prize or bonus? Do they commit more 'before' than they give 'after', or vice versa, or are these equivalent?

Field experiment

One field experiment: Essex UG students

Emails from DAs on behalf of FSS

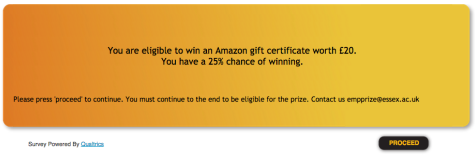
`Subject: Employability promotion - a 1 in 4 chance of winning a £20 prize for doing a short survey.`

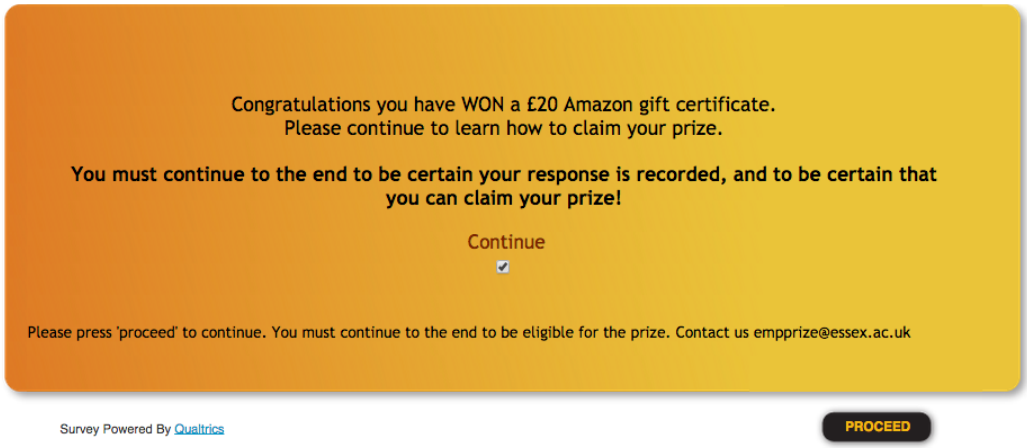
`Text: Please go to [web site] - we have 80 free dinners for two in Colchester to give away, worth £20 each and at least 40 £20 Amazon vouchers!! If you log on, you will have a one in four overall chance of winning one of these prizes!`

Details: 2 rounds over 2 academic years. 2 prizes in round 1, Amazon only in round 2. First covering Faculty of Social Science, then all departments. Sign in with email, orthogonal employability treatments.

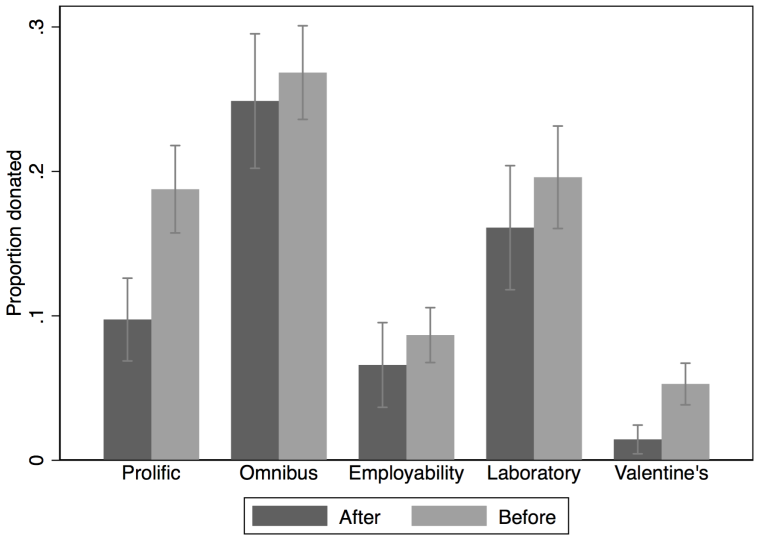
→ 352 valid responses with donation opportunities

Before charity treatments





Results: In a variety of experiments, donation incidence and amounts are often higher and never lower in the Before treatment. This is statistically significant in two of five experiments and in the 'pooled' data.



Adv: see <https://davidreinstein.wordpress.com/research-and-publications/> under 'working papers'

More details of this project at giveifyouwin.org

Table 2: Donations/commitments by experiment: Before versus After

	Pooled, shares	Auto	Pledge	Lab
After				
Incidence	0.35	0.31	0.13	0.63
Mean	0.07	1.63	0.35	1.94
Median	0.00	0.00	0.00	1.00
P75	0.10	1.20	0.00	4.00
Std. dev.	(0.14)	(3.76)	(1.04)	(2.12)
Before				
Incidence	0.39	0.31	0.35	0.74
Mean	0.10	2.02	1.26	2.74
Median	0.00	0.00	0.00	2.00
P75	0.14	1.20	1.20	4.00
Std. dev.	(0.18)	(4.71)	(2.17)	(2.60)
Observations	634	352	159	123
Incidence: p-value, exact test	0.42	1.00	0.00	0.79
Difference in means	-.02	-.39	-.92	-.8
p-value (rank sum)	0.30	0.89	0.00	0.07
p-value (t-test)	.09	.46	.00	.06

Note: This table reports on donations for the Before treatment versus the After treatment in each experiment, excluding donations from the lower income level.

Suggested practice problems from Nicholson and Snyder chapter 17 (12th ed)

- 17.2
- 17.3
- (17.5)
- 17.7
- (17.8) - has video solution
- 17.9

CUT: revisionlec2016_17.md

Lecture13: Revisiony lecture: Behavioral economics

Below, I provide some revision material and questions focusing on Behavioral economics

- Final exam format, relevant question
- Sources of evidence on various departures from classical assumptions
- Time permitting: Some MCQ's from formative assessment comment: <> (2024EE)

Sources of evidence and discussion

I want you to have a decent background on. . .

- The Allais Paradox: setup, evidence, explanations
- Inconsistent preferences, impatience and 'hyperbolic discounting' (However, the mechanics of this are not emphasized)

- 'Solving converted games'

- Some sense of the evidence 'for behavioral economics' in general

- Evidence on voluntary public goods provision and charitable giving (lab, field, etc) and factors leading to greater provision of each

- Relevance of 'behavioural biases' for public policy and business

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Evidence in general, some helpful (easier) readings

- Very good examples and applications in your text (Chapter 17), given references
- DellaVigna, Stefano. "Psychology and economics: Evidence from the field." Journal of Economic literature 47.2 (2009): 315-372.
- "EAST: Four simple ways to apply behavioural insights" (BIT, 2014)
- Nudge database

Also see popular books and web-tools by Dan Ariely ('Arming the Donkeys'), Richard Thaler, etc.

Yudkowski's blogs → 'From AI to Zombies'

Allais paradox

- Writeup in Wired magazine HERE
- Yudkowski on the Allais paradox

See also Misweighting probabilities . . . many useful readings on LessWrong.org

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Public goods contributions

- Chaudhuri, 2009. Sustaining cooperation in laboratory public goods experiments: a selective survey of the literature

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(25 marks) In this module we discussed *four* major ways in which behavioural economists argue that people diverge from classical assumptions. Briefly explain each of these four ways, citing some evidence (academic or anecdotal) for each.

There are four general ways people diverge from classical assumptions

1. Limited cognitive ability → difficult and costly to make complex decisions

It may be very costly and difficult to do the calculations that we assume are part of standard maximization. Rather than strictly finding the optimal consumption bundles, choosing the optimal number of hours to work per day, calculating the optimal investment portfolio, etc. people may use heuristics and 'rules of thumb'.

Evidence for Limited Cognitive Ability: This is too long an answer, I'm just giving you some ideas

Systematically incorrect answers to simple financial literacy questions; and responses correlate with holding an extremely high interest loans.

Many people state they have keep separate fixed budgets for different categories of expenditure (food, vacations, charity etc).

In marketing/behavioral experiments adding more choices has sometimes been found to reduce purchases within a category.

Also, adding an (unchosen) 'largest size' choice seen to increase consumption of the second largest choice (heuristic: 'choose the middle option')

See also 'taxi driver's heuristic'

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2. Limited willpower → self control problems

People struggle to make choices that they know are in their best long-term interest. (Evidence: see next part)

3. Limited self interest → care about others (fairness, altruism), issues beyond income/consumption

Evidence: Significant charitable giving (1% of UK GDP), large part of income spent on family and gifts. Rejection of positive offers in ultimatum game experiments (in various lab and naturalistic contexts). Contribution to linear public goods, cooperation in prisoners dilemmas, even in 1-shot games ...

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4. Inconsistent, changing, and 'non-outcome-based' preferences

People seem to act to maximise targets and avoid losses relative to reference points. For example several papers report evidence consistent with people (e.g., taxi drivers) setting 'earnings targets' and thus working *fewer hours* on days when their per-hour earnings are higher (and they should know this). It can be shown that if drivers were to work fewer hours on 'bad' and more hours on 'good' days they could more money working the same number of hours, and even have less variance in a number of hours they work. This cannot be reconciled with a model maximising an unchanging utility function.

(25 marks) For *TWO* of the major departures above, give a *specific example* of such behaviour, and briefly describe the nature of the evidence for this, and present one behavioural economics model explaining this behaviour.

First departure I am discussing: 'Inconsistent, changing, and 'non-outcome-based' preferences'

'Specific example of behaviour'

The Allais paradox offers evidence against Expected Utility maximisation (over outcomes) and in line with Loss Aversion and Prospect Theory.

Scenario such as

- Gamble A: 89% chance win £1 mln, 10% chance win £5 mln, & 1% chance win 0.
- Gamble B: £1 million with certainty.

vs.

- Gamble C: 89% chance of winning 0 and an 11% chance of winning £1 million
- Gamble D: a 90% chance of win 0 and 10% chance of winning £5 million.

Consistently in hypothetical and incentivised experiments people tend to choose B over A and also choose D over C.

This contradicts Expected Utility theory:

If $B \succ A$ then $EU(A) > EU(B)$

$\rightarrow U(1m) > 0.89\,U(1m) + 0.1\,U(5m) + 0.01\,U(0)$

$\rightarrow 0.11\,U(1m) > 0.1U(5m) + 0.01\,U(0)$

However, if $D \succ C$ then $EU(D) > EU(C)$

$\rightarrow 0.9\,U(0) + 0.1U(5m) > 0.89\,U(0) + 0.11\,U(1m)$

Implying $0.1\,U(5m) + 0.01\,U(0) > 0.11\,U(1m)$

Contradicting the above!

'Describe the nature of evidence for this'

Evidence: In hypothetical experiments by Kahneman and Tversky, as well in experiments with real incentives (e.g., Huck and Muller), people tend to choose B over A, and also to choose D over C. (Sometimes the same people will make of these apparently inconsistent choices but in general the differences in proportions are large enough that we can show the general pattern even if we're only asking people to make a single choice.)

'. . . and present one behavioural economics model'

Why do many people choose B over A and D over C?

One theory: Loss aversion/Prospect theory

Theory: People evaluate outcomes relative to *reference points*. Falling below these reference points is particular costly to utility; the usual specification models utility as the some of a standard risk-averse utility function and a ' gain-loss' utility function. The latter is negative where some outcome (e.g., earnings) falls below a reference point; it's slope is assumed to be greatest for 'small losses' and then more gradual for larger losses. In net this can make people risk seekers over a range of losses, willing to increase the risk of a large loss to reduce the risk of a small loss. The reference points themselves may change depending on the framing of the decision, on previous expectation, on unrealised states, and in general on things that are not relevant to future material outcomes of the decision.

Applying this to the example above ... (Allais Paradox)

- Considering A & B, the ref. point may be close to £1000, as this can be had with certainty.
  - A seems to 'risk a costly loss of £1000', thus may choose 'safer' $B > A$, notwithstanding its far lower EV (£1000 vs £1390)

- Considering D & C, ref. point may be close to 0, as EV's of each are low, & 0 is likeliest outcome
  - So 'don't worry about losses', choose D over C because higher EV (£500 vs. £110)

This could also be shown with a diagram of EU in income, and a shifting reference point ; see notes and text

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By the way, here are some more behavioural econ problems to practice . . . from Nicholson and Snyder chapter 17 (12th ed, 11th similar)

- 17.2: this will be especially helpful for understanding the EU basis of the Allais Paradox
- 17.3
- (17.5)
- 17.7: pretty good setup for time inconsistent behaviour
- (17.8) - also a good setup for time inconsistency, has video solution on CourseMate
- 17.9 - decent for understanding loss aversion. Should say 'would his choice change *if* his reference point' ('if' is missing)
