

## Introduction

### Plan for the Term:

You will have one 1.5 hour tutorial per week in groups of 2-4 and maths classes in a large group of 17 in weeks 1-3 and 6-8. There will also be three more maths classes and one tutorial in the first two weeks of Hilary Term to complete the microeconomics course. The tutorials will be in room 9 at 10 Longwall Street on Wednesdays/Thursdays. If you press the button outside on the street I will buzz you in (simply push the door open when you hear the buzzer). We will arrange tutorial times for different groups during the beginning of term meeting. The maths classes will be on Wednesdays in Lecture Room 4 in New College, from 16:30-18:00.

### Written Work:

Please hand in work for tutorials to my pigeon hole in New College by 5pm on the day before the tutorial. (Ask the porters to do this for you.) For maths classes (apart from the first one), you can bring your work along to the class and mark it yourself as we go through the questions during the class. You are welcome to hand in your work after the maths class if there is anything you want me to take a look at.

### Guidance:

For a tutorial, there are 3 or 4 questions. Some are problem questions, others are “mini-essay” questions. You should spend about the same amount of time on a set of economics questions as you would for a weekly essay in politics. Therefore a mini-essay would be expected to be about a quarter to a third of the length of a full-length essay (e.g. 500-800 words). You should make judicious use of models, diagrams and equations to illustrate your mini-essay answers. Creating your own diagrams is an important part of the learning process. Try not to directly copy diagrams from the textbook. If you wish to word process your work, diagrams may either be done by computer or hand-drawn.

### Reading:

The two main textbooks for the course are:

- Varian, *Intermediate Microeconomics - A Modern Approach* (8th edition - earlier editions are also fine, and cheaper to obtain).
- Katz and Rosen, *Microeconomics* (2nd edition).

Each of these textbooks has strengths and weaknesses, so you should look at the relevant reading for both textbooks each week.

### Mathematics:

The economics department’s Maths Workbook is your key resource for mathematical methods for economics. It is available at the following URL:

[http://www.economics.ox.ac.uk/index.php/intranet/undergraduate\\_maths\\_workbook](http://www.economics.ox.ac.uk/index.php/intranet/undergraduate_maths_workbook)

In addition to the maths workbook, there are a number of mathematics for economics textbooks that cover the same material. The maths workbook is an excellent summary, but you should read one or more of these textbooks alongside it for more in-depth discussion. The textbooks are listed below in ascending order of difficulty and depth of treatment.

- Jacques : *Mathematics for Economics and Business, 5th edition*
- Renshaw : *Maths for Economics*
- Anthony & Biggs : *Mathematics for Economics and Finance*
- Simon & Blume : *Mathematics for Economists*

## My Website:

My website contains earlier tutorial questions and model answers which may be useful as an additional resource in working through this new set of questions. The URL is:

<http://users.ox.ac.uk/~sedm1375>

If you do decide to use my notes, watch *very carefully* for the differences between the old and new problem set!

## Weblearn:

A great deal of useful information about the course, including lecture slides, is available on the economics department's Weblearn page:

[https://weblearn.ox.ac.uk/portal/hierarchy/socsci/econ/curr\\_student/undergrad/courses](https://weblearn.ox.ac.uk/portal/hierarchy/socsci/econ/curr_student/undergrad/courses)

## Revising for the Collection

When you return after the vacation, you will sit a collection paper on Friday of 0th week of Hilary Term. This is an important check on your progress. In preparing for this exam, it is highly advisable to practise some past paper questions. These are available at:

<http://www.oxam.ox.ac.uk>

## Week 1 Tutorial - Indifference Curves, Income and Substitution Effects, The Law of Demand

### Reading:

- Katz and Rosen, Chapters 1 - 4.1
- Varian, Chapters 1-3, 5-6, 8

### Questions:

Answer the following questions, using indifference curve diagrams (i.e. a two-good model) to illustrate your argument:

1. Define and explain the axioms of completeness, reflexivity, transitivity, convexity and non-satiation (monotonicity). Explain how these axioms can be used to prove that indifference curves must be downwards-sloping and convex, and can never cross.
2. Explain why the axioms listed above are necessary in order to have “well-behaved” preferences. What is the difference between an interior and boundary (or corner) solution to the consumer’s utility maximization problem? Do well-behaved preferences guarantee an interior solution? What properties does an interior solution have if preferences are well-behaved?
3. Explain what is meant by a normal good and an inferior good.
4. Use indifference curve analysis to derive the Marshallian demand curve (i.e. the standard demand curve where income and prices of all other goods are held constant along the curve) for:
  - (a) a normal good
  - (b) an inferior good with a downwards-sloping demand curve
  - (c) a Giffen good.

Distinguish between income and substitution effects. [*Hint: Use the Hicksian decomposition, which holds utility constant, for greater clarity. Katz and Rosen is clearer on this than Varian.*] Why must a normal good always have a downwards-sloping demand curve? Hence, why must a Giffen good always be inferior? Explain how this relates to the Law of Demand [*Hint: Compare Varian and Katz and Rosen’s definition of the Law of Demand. How do they differ?*]

## Week 2 Tutorial - Income and Substitution Effects, Application to Labour Supply

### Reading:

- Katz and Rosen, Chapters 1 - 5.1
- Varian, Chapters 1-3, 5-6, 8-9

### Questions:

Answer the following questions, using indifference curve diagrams (i.e. a two-good model) to illustrate your argument:

1. Consider a two-good model with leisure  $r = 1 - l$  ( $l$  is labour supply, and we standardize the amount of time available to 1 unit) on the x-axis and consumption  $c$  on the y-axis. Explain intuitively what it means for consumer preferences over leisure and consumption to be well-behaved. What does this imply about the consumer's attitude towards labour?

By decomposing the effect of a wage change into income and substitution effects, find the implications for the slope of the labour supply curve if:

- (a) Leisure and consumption are both normal goods.
- (b) Consumption is an inferior good, leisure is normal.
- (c) Leisure is an inferior good, consumption is normal.

Explain why consumption and leisure cannot *both* be inferior. Which of the above cases seems most reasonable, and why?

2. Consider a consumer with a constant wage rate  $w$ , a proportional income tax at rate  $t$  and a fixed unearned income  $m$ . Explain mathematically and intuitively why the consumer's budget line will have the equation  $c = (m + w(1-t)) - rw(1-t)$ . Sketch the consumer's budget line. In each of the following cases, sketch the original and new budget lines on the same diagram to compare them:

- (a) The consumer receives an increase in non-means-tested benefits equivalent to an increase in  $m$  with no change in  $t$  or  $w$ .
- (b) The government introduces a higher rate of income tax when the consumer earns more than  $\frac{3}{4}w$  before tax.
- (c) The worker is offered overtime pay at a higher wage rate if he or she works for more than  $\frac{1}{2}$  of the available time.
- (d) The government introduces an additional means-tested benefit which is of fixed cash value, but completely withdrawn if the consumer works for more than  $\frac{1}{4}$  of the available time.

3. Using income and substitution effects, analyse the effect on hours worked and amount consumed for the four changes from the previous question. In each case, can we conclude that the consumer is better off, worse off, or equally well off after the change? [*Hint: Consider separately the cases where the consumer initially works more or less than the kink/discontinuity in the budget constraint.*]

## Week 3 Tutorial - Income and Substitution Effects, Application to Intertemporal Choice

### Reading:

- Katz and Rosen, Chapters 1 - 5.2
- Varian, Chapters 1-3, 5-10

### Questions:

Answer the following questions, using indifference curve diagrams (i.e. a two-good model) to illustrate your argument:

1. Analyse a consumer's choice between consumption in period 1 ( $c_1$ ) and in a later period 2 ( $c_2$ ) allowing for the possibility of saving and borrowing at a given interest rate  $r$  in period 1. Assume that the consumer receives an income of  $m_1$  in period 1 and  $m_2$  in period 2.
  - (a) Explain why consumers with well-behaved preferences will want to smooth out consumption between the two periods? How does this relate to borrowing and saving decisions?
  - (b) What is meant by the present and future value of an endowment? How does this relate to the horizontal and vertical intercept of the budget line?
  - (c) Consider a borrower. How would the following changes affect the amount of period 1 and period 2 consumption (i.e.  $c_1$  and  $c_2$ ), the amount borrowed ( $c_1 - m_1$ ), the present and future value of the endowment, and the welfare of the borrower.
    - A decrease in the interest rate  $r$ .
    - An increase in current (period 1) income  $m_1$ .
    - An increase in future (period 2) income  $m_2$ .
  - (d) Repeat the above analysis but for a saver instead of a borrower. [*Hint: Note that amount saved is  $m_1 - c_1$ .*]
2. Explain how the Laspyres and Paasche *price indices* can be used to determine whether a consumer is better or worse off after a simultaneous change in prices or income. When is the overall effect indeterminate?
3. Explain how the Laspyres and Paasche *quantity indices* can be used to determine whether a consumer is better or worse off after a simultaneous change in prices or income. When is the overall effect indeterminate?

## Week 4 Tutorial - Utility functions and consumer optimization

### Reading:

- Katz and Rosen, Chapters 1 - 5.2
- Varian, Chapters 1-6

### Questions:

1. For each of the following utility functions, sketch two different indifference curves (on one diagram) and determine whether the consumer preferences represented are consistent (i.e. complete, reflexive and transitive), convex and monotonic (i.e. satisfy the non-satiation axiom).
  - $U_A(x, y) = x + 4y$
  - $U_B(x, y) = \frac{x}{y}$
  - $U_C(x, y) = \min\{x, 4y\}$
  - $U_D(x, y) = x^{\frac{1}{2}}y^{\frac{1}{2}}$
  - $U_E(x, y) = \min\{x + y, 2x + \frac{1}{2}y\}$
2. Consider a consumer with the quasi-linear utility function  $U(x, y) = x^\alpha + y$  and who has income  $m$  so that their budget line is given by  $m = xp_x + yp_y$ .
  - (a) Show that the marginal rate of substitution is  $MRS_{x,y} = -\frac{MU_x}{MU_y} = -\alpha x^{\alpha-1}$ .
  - (b) Comment on the fact that the MRS does not depend on the value of  $y$ . Find the formula for an indifference curve and sketch two different indifference curves on the same diagram.
  - (c) Using the condition for (interior) utility maximization  $|MRS_{x,y}| = \frac{p_x}{p_y}$ , show that, if we normalize the price of good  $y$  to 1 ( $p_y = 1$ ), the Marshallian demand curve is  $x_D(m, p_x) = \left(\frac{\alpha}{p_x}\right)^{\frac{1}{1-\alpha}}$ . Comment on the fact that this does not depend on income  $m$ . Sketch the income offer curve for this consumer.
  - (d) Analyse the effect of a price increase by decomposing into income and substitution effects.
3. Consider a consumer with the Cobb-Douglas utility function  $U(x, y) = x^\alpha y^\beta$  and who has income  $m$  so that their budget line is given by  $m = xp_x + yp_y$ .
  - (a) Show that the marginal rate of substitution  $MRS_{x,y} = -\left(\frac{\alpha}{\beta}\right)\left(\frac{y}{x}\right)$ .
  - (b) Hence show, using the condition for (interior) utility maximization  $|MRS_{x,y}| = \frac{p_x}{p_y}$ , that the Marshallian demand functions for good  $x$  and good  $y$  are  $x_D(m, p_x, p_y) = \left(\frac{\alpha}{\alpha+\beta}\right)\left(\frac{m}{p_x}\right)$  and  $y_D(m, p_x, p_y) = \left(\frac{\beta}{\alpha+\beta}\right)\left(\frac{m}{p_y}\right)$ .
  - (c) By decomposing the effect of a change in the price of good  $x$  into an income and substitution effect, analyse the impact of a change in  $p_x$  on the amount demanded of good  $x$  and good  $y$ .

## Week 5 Tutorial - Welfare Analysis, Consumers' Surplus, CV and EV.

### Reading:

- Katz and Rosen, Chapters 1 - 5.4
- Varian, Chapters 1-10 and 14-16

### Questions:

1. Explain the relationship between compensating variation (CV), equivalent variation (EV) and consumers surplus (CS). Under what circumstances will they be identical? Is consumers surplus an acceptably accurate measure of consumer welfare changes? Why is it more commonly used than the other two measures?
2. Show, using the two-good leisure-consumption model, that the equivalent variation of an income tax is greater than the revenue raised from the tax. Explain how replacing the income tax with a lump-sum tax which raised the same revenue would affect the consumer's labour supply, consumption and welfare. Given that income taxes cause a deadweight loss and lump sum taxes do not, why are lump-sum taxes so rarely used in the real world?
3. Consider a market for good  $x$  with demand of  $x_D(p_D) = 1000 - 100p_D$  and supply of  $x_S(p_S) = 100p_S$  (where  $p_D$  is the price paid by consumers and  $p_S$  the price received by suppliers).
  - (a) Find the market equilibrium quantity and price [*Hint: With no taxes,  $p_D = p_S$ .*]. Find the consumers' surplus, producers' surplus and total surplus (sum of consumers' and producers' surplus).
  - (b) Suppose that a *unit tax* of size  $T$  is imposed, so that  $p_D = p_S + T$ . Find the new market equilibrium quantity, consumer price and producer price.
  - (c) Sketch the new post-tax market equilibrium, showing the new consumers' surplus, producers' surplus, the tax revenue and the deadweight loss from the tax.
  - (d) Find an expression for the value of the deadweight loss and the tax revenue, in terms of the tax  $T$ . Sketch these two curves on separate diagrams with the tax  $T$  on the x-axis. Comment on the nature of the curves (e.g. upwards or downwards sloping, convex or concave) and the intuitive implications of this.
  - (e) Returning to the case with no tax, suppose instead that good  $x$  can be imported from abroad at a constant price of 2. Calculate the domestic consumers', producers' and total surplus if imports are permitted and not permitted.
  - (f) To what extent can we draw general conclusions from this model about the welfare effects of taxes and import controls? [*Hint: Would our conclusions be changed if we replace these specific demand and supply curves with a general downwards-sloping demand curve and upwards-sloping supply curve? What real world concerns are not captured in this model?*]

## Week 6 Tutorial - Production Functions and Cost Curves

### Reading:

- Katz and Rosen, Chapters 7 - 9
- Varian, Chapters 18-21

### Questions:

- (a) What is the production function of the firm? What are isoquants, and what determines their spacing?
  - (b) Explain, using the Cobb-Douglas production function  $F(K, L) = K^\alpha L^{1-\alpha}$  as an example, how diminishing returns to a factor can apply to a firm that experiences constant returns to scale. [*Hint: Demonstrate that the Cobb-Douglas production function exhibits constant returns to scale by scaling up all inputs by the same factor, then partially differentiate to find the marginal product of labour (MPL) and marginal product of capital (MPK).*]
  - (c) Is the concept of increasing returns to scale the same thing as economies of scale? Why might it be possible to argue that decreasing returns to scale cannot occur in practice? Why do they, however?
2. Assume that a firm's production technology exhibits constant returns to scale at all levels of output (and with 0 fixed cost) and that labour and capital inputs are imperfect substitutes. Using isoquants and isocost lines for all three parts:
  - (a) Derive the firm's long run total cost curve, assuming factor prices are held constant. Draw this, as well as long run average and marginal cost curves.
  - (b) Suppose that in the short run capital stock is fixed, and the firm is committed to producing a certain level of output. What happens to labour demand, and total cost of production if wages rise?
  - (c) Suppose the firm's profit maximising output level falls as a result of wage rise. What happens in the long run to the demand of labour and other inputs?
3. Consider a firm producing a good with a technology which exhibits increasing returns to scale at low levels of output and decreasing returns to scale at high levels of output, with the cost function  $C(Q) = Q^3 - 3Q^2 + 4Q$ .
  - (a) Sketch long-run total, average and marginal cost curves for the firm. Explain the relationship between the three curves. In particular why does the marginal cost curve cut the average cost at its lowest point?
  - (b) Imagine that the firm's existing capital stock is consistent with achieving the minimum point of the long-run *marginal* cost curve (where returns to scale change from increasing to decreasing), but that it is unable to alter its capital stock in the short run. Draw two diagrams, one with the short-run and long-run total cost curves, and another with the short-run and long-run average and marginal cost curves making sure that these two diagrams correspond.

## Week 7 Tutorial - Market Structure: Perfect Competition and Monopoly

### Reading:

- Katz and Rosen, Chapters 10, 11 and 13
- Varian, Chapters 22-24

### Questions:

1. Suppose that a monopoly firm faces the demand curve  $x_D(p) = \frac{a}{b} - \frac{1}{b}p$  and has a constant marginal cost of  $c$ .
  - (a) By finding the revenue function and differentiating, show that the marginal revenue function is  $MR = a - 2bx$ . Find a formula for elasticity of demand  $\epsilon_D$  and show that when  $MR = 0$ ,  $|\epsilon_D| = 1$ .
  - (b) Show the monopolist's profit maximizing price and quantity on a diagram, and find an expression for the deadweight loss caused by monopoly power.
  - (c) Sketch the revenue function and the profit function on the same diagram with quantity sold  $x$  on the x-axis.
2. Consider a monopoly firm which faces the demand curve  $x_D(p) = ap^{-\gamma}$  with a constant marginal cost of  $c$ .
  - (a) Sketch the (inverse) demand curve (quantity on the x-axis).
  - (b) Show that the absolute value of the elasticity of demand  $|\epsilon_D|$  is equal to  $\gamma$  everywhere along the demand curve.
  - (c) Show that the monopoly's mark-up  $\frac{p_m - c}{p_m} = \frac{1}{\gamma}$  (where  $p_m$  is the monopoly's profit-maximizing price) and explain how and why the market power of the monopolist depends upon the elasticity of demand. [*Hint: Rearrange the demand function to get the inverse demand function, then use this to construct the profit function in terms of  $x$ , then differentiate, substitute in the demand function and rearrange the first order condition.*]
3. Explain carefully the causes and welfare consequences of monopoly power. Can the government always ensure competition in every industry? What other potential policy remedies are there for monopoly power?
4. Contrast the reactions of a perfectly competitive firm and the industry as a whole, to those of a monopoly firm when the following changes occur:
  - (a) The market demand curve shifts inwards;
  - (b) The market wage for workers decreases (assume that the firm must take this price as fixed)
  - (c) A unit tax of size  $T$  is introduced.

Consider both short and long run responses in each case, and consequences for consumer welfare, and firms' profits.

## Week 8 Tutorial - Market Structure: Oligopoly and Monopolistic Competition, Price Discrimination

### Reading:

- Katz and Rosen, Chapters 13-15
- Varian, Chapters 24, 25 and 27

### Questions:

1. Consider a duopoly with the industry demand curve  $x = 1 - p$ . Assume that products are perfectly homogeneous so that  $x = x_1 + x_2$  where  $x_1$  is the amount produced by firm 1 and  $x_2$  is the amount produced by firm 2. Assume that both firms have a marginal cost of  $c$ .
  - (a) First consider simultaneous quantity competition - the Cournot model. Show that firm 1's reaction function is  $x_1(x_2) = \frac{1-c}{2} - \frac{1}{2}x_2$  and that firm 2's reaction function is  $x_2(x_1) = \frac{1-c}{2} - \frac{1}{2}x_1$ . Hence show that the monopoly quantity is  $\frac{1}{2}(1 - c)$ , the competitive quantity is  $(1 - c)$  and the total Cournot industry quantity is  $\frac{2}{3}(1 - c)$ . Explain intuitively why the Cournot industry output is larger than the monopoly output but smaller than the competitive output.
  - (b) Now consider the Stackelberg model with firm 1 as the quantity leader. Show that, in Stackelberg equilibrium, the leader produces  $\frac{1}{2}(1 - c)$  and the follower produces  $\frac{1}{4}(1 - c)$ . Explain intuitively using a diagram why the leader always produces more than the follower in Stackelberg equilibrium if the firms have identical costs.
  - (c) Explain why, in Bertrand equilibrium, both firms must price at marginal cost, with industry output equal to the competitive quantity  $(1 - c)$ .
  - (d) Given that the Cournot, Bertrand and Stackelberg models give different results, how do we know which one to use in modelling a real-world oligopoly?
2. Explain how product differentiation and free entry lead to long run equilibrium in a monopolistically competitive market. What are the welfare properties of such an equilibrium?
3. Second Degree Price Discrimination: Explain how a monopolist can increase its profits by using non-linear pricing or product differentiation.
4. Third Degree Price Discrimination: How does a monopolist selling its product in two different markets maximise its profits if able to separate the markets and charge a different price in each? Compare the welfare consequences of this with the case when customers in the two markets can engage in arbitrage (thus forcing the monopolist to charge the *same* price on both markets).

## Hilary Term Week 2 Tutorial - General Equilibrium, Welfare Economics and Market Failure

### Reading:

- Katz and Rosen, Chapters 12 and 18
- Varian, Chapters 31-34

### Questions:

1. Using an Edgeworth box and production possibilities diagrams, demonstrate and explain how overall Pareto efficiency is achieved in a production economy where all markets are perfectly competitive. What assumptions are you making in order to obtain this result?
2. Critically assess the following opinion: Market economies are inherently inequitable, and there is little a government can do to change this. [*Hint: try to explain what role the fundamental theorems of welfare economics play when we shape our views on the merits of a market economy; no need to discuss details of market failure in this question - save this for question 3.*]
3. Why are pollution problems often best understood as externalities? Can we rely on private agents to negotiate these away?
4. Explain how a Pigovian tax or subsidy can correct a market failure caused by an externality. What determines the optimal rate of tax or subsidy?

## Maths Classes

We will work through a selection of questions from the Maths Workbook in the maths classes:

- Michaelmas Week 1 - **Algebra** : Ch. 1 questions 3-14, Ch. 2 questions 5-7
- Michaelmas Week 2 - **Basic Differentiation** : Ch. 2 questions 8-9, Ch. 5 quick questions 1, 2, 4
- Michaelmas Week 3 - **Functions, Natural Logarithms and the Exponential Function** : Ch. 4 quick questions 1-5
- Michaelmas Week 6 - **More Differentiation** : Ch. 4 long question 1, Ch. 6 quick questions 1-3 and 6, Chapter 7 quick question 1 and long question 2
- Michaelmas Week 7 - **Production Theory** : Ch. 4 long question 2, Ch. 5 long question 1 and quick questions 3 and 5, Ch. 6 long questions 2 and 3
- Michaelmas Week 8 - **Elasticity and Monopoly** : Ch. 5 long question 2, Ch. 6 long question 1, Ch. 7 question 1, Ch. 8 questions 1 and 3.

*Please attempt the problems for the 3 classes in Hilary Term during the vacation and hand in to Richard Povey's pigeon hole by 5pm on Thursday of 0th week in Hilary Term.*

- Hilary Week 1A - **Constrained Optimization** : Ch. 9 quick questions 1-4, long questions 1, 2 and 5.
- Hilary Week 1B - **Sequences and Series, Financial Economics** : Chapter 3 long question 1 and questions overleaf
- Hilary Week 2 - **Unconstrained Optimization** : Ch. 8 questions 2 and 5-8

## Financial Economics Questions

1. Suppose that a bank account pays 0.5% interest per month.
  - (a) If 100 is deposited at the beginning of the year, then how much will be in the account at the end of the year (i.e. after 12 monthly interest payments) if there are no further deposits or withdrawals.
  - (b) What rate of interest paid once at the end of the year would be equivalent to the 0.5% interest every month for 12 months.
  - (c) What constant rate of interest over the year with continuous compounding would be equivalent to the 0.5% interest per month?
  - (d) Explain why your answers to (b) and (c) are different and why neither of them is equal to  $0.5 \times 12 = 6\%$ .
  
2. Suppose that a government bond pays a return of  $X$  per year for the next 30 years.
  - (a) Suppose that the current interest rate is  $r$  per year (e.g. if  $r = 0.05$  then the interest rate is 5% per year). What is the present discounted value of the government bond? Justify why this will be the equilibrium market price of the bond.
  - (b) Suppose now that  $r = 0.05$  and  $X = 100$ . Calculate the present discounted value of the bond.
  - (c) What will be present discounted value of the bond be if the interest rate  $r$  increases to 0.07 with  $X$  remaining at 100. Explain the economic intuition behind this.
  - (d) Answer part (a) again but this time assume instead that the bond is a consol so that it pays  $X$  per year forever. Why isn't the present discounted value infinite?