UNIVERSITY OF LONDON | INTERNATIONAL PROGRAMMES

Course information 2015–16
EC2066 Microeconomics

This course is designed to equip students with the economic principles which are necessary to analyse a whole range of economic problems. It builds on the foundations of economic analysis provided in course EC1002 Introduction to economics.

Prerequisite

If taken as part of a BSc degree, courses which must be passed before this course may be attempted:

EC1002 Introduction to economics
and either
MT105a Mathematics 1
or
MT1174 Calculus

Exclusions

May not be taken with:
MN3028 Managerial economics

Aims and objectives

- To deepen the understanding of the basic theory of optimization by economic agents and the efficiency of the resulting outcome for the market as a whole
- To introduce students to the analysis of strategic interaction as well as interaction under asymmetric information
- to clarify the role of economic policies as tools to improve efficiency in the presence of market failures
- to promote the ability to think in a structured framework, and clarify the importance of formal arguments
- to demonstrate the art of modelling which requires simplifying a problem by identifying the key elements without oversimplifying the issue.

Assessment

This course is assessed by a three hour unseen written examination.

Learning outcomes

At the end of this course and having completed the essential reading and activities students should:

☑ be able to define and describe:
- the determinants of consumer choices, including inter-temporal choices and those involving risk
- firms’ behaviour
- how firms’ behaviour differs in different market structures and may help to determine those structures
- how firms and households determine factor prices.

☑ be able to analyse and assess:
- efficiency and welfare optimality of perfectly and imperfectly competitive markets
- the effects of externalities and public goods on efficiency
- government policies aimed at improving welfare.

☑ be prepared for further units which require a knowledge of microeconomics.

Essential reading

For full details please refer to the reading list.

Morgan, W., M.L. Katz and H.S. Rosen *Microeconomics*. (Boston, Mass.: Irwin/McGraw-Hill)

Syllabus

This is a description of the material to be examined, as published in the *Programme handbook*. On registration, students will receive a detailed subject guide which provides a framework for covering the topics in the syllabus and directions to the essential reading.

The unit examines how economic decisions are made by households and firms, and how they interact to determine the quantities and prices of goods and factors of production and the allocation of resources. It also investigates the principles of microeconomic policy and the role of government in allocating resources. The topics covered are:

- Consumer choice and demand, including utility functions and indifference curves, income and substitution effects.
- Taxation and the effect of taxes on the labour supply.
- Producer theory: production and cost functions, firm and industry supply.
- Market structure: competition, monopoly and oligopoly.
- Game theory: static and dynamic games, strategic interaction between agents, Nash equilibrium and subgame perfect equilibrium.
- General equilibrium and welfare: economic efficiency and equity; competitive equilibrium; welfare criteria.
- Inter-temporal choice: savings and investment choices.
- Uncertainty and the economics of information: choice under uncertainty, insurance markets, and asymmetric information.
- Welfare economics: market failures arising from monopoly, externalities and public goods.
- Government and the theory of public choice.

A knowledge of constrained maximisation and Lagrangian functions as covered in MT105A Mathematics 1 would be helpful for students taking this subject.

Students should consult the *Programme Regulations for degrees and diplomas in Economics, Management, Finance and the Social Sciences* that are reviewed annually. Notice is also given in the *Regulations* of any courses which are being phased out and students are advised to check course availability.

Examiners' commentaries 2015

EC2066 Microeconomics

Important note

This commentary reflects the examination and assessment arrangements for this course in the academic year 2014–15. The format and structure of the examination may change in future years, and any such changes will be publicised on the virtual learning environment (VLE).

Information about the subject guide and the Essential reading references

Unless otherwise stated, all cross-references will be to the latest version of the subject guide (2011). You should always attempt to use the most recent edition of any Essential reading textbook, even if the commentary and/or online reading list and/or subject guide refer to an earlier edition. If different editions of Essential reading are listed, please check the VLE for reading supplements – if none are available, please use the contents list and index of the new edition to find the relevant section.

Comments on specific questions – Zone A

Text: We use the following abbreviations:

- M, K & R – Wyn Morgan, Michael Katz and Harvey Rosen, *Microeconomics*, McGraw–Hill, second edition, 2009, ISBN: 9780077121778.
- Perloff – Jeffrey M. Perloff, *Microeconomics with Calculus* , Pearson Education, third edition (global edition), 2014, ISBN: 9780273789987.

For each question, we point out the relevant sections from the main text (M, K & R) as well as the subject guide. Additional references from Perloff are provided for a few questions.

Candidates should answer **ELEVEN** of the following **FOURTEEN** questions: all **EIGHT** from Section A (5 marks each) and **THREE** from Section B (20 marks each). **Candidates are strongly advised to divide their time accordingly.**

Section A

Answer **all EIGHT** questions from this section (5 marks each).

Question 1

Consider the simultaneous-move game below with two players, 1 and 2. Consider the following strategy combinations:

Strategy Combination 1: Player 1 plays a_2; player 2 plays b_1 with probability 1/4 and b_2 with probability 3/4.

Strategy Combination 2: Player 1 plays a_2; player 2 plays b_1 with probability 3/4 and b_2 with probability 1/4.

Show that strategy combination 1 is a Nash equilibrium of the game, while strategy combination 2 is not a Nash equilibrium of the game.

		Player 2	
		b_1	b_2
Player 1	a_1	3,2	1,1
	a_2	2,0	2,0

Reading for this question

The coverage of game theory in M, K & R (Chapter 16) is not ideal. See Chapter 9 (Game theory: an introduction) of the subject guide for a detailed discussion.

Approaching the question

You simply need to apply the definition of Nash equilibrium. In a Nash equilibrium, strategies are mutual best responses. So you need to check if this is true for each of the two strategy profiles in the question.

Let us first check strategy profile 1: player 1 plays a_2; player 2 plays b_1 with probability $1/4$ and b_2 with probability $3/4$. Given that 1 plays a_2, 2 is indifferent between b_1 and b_2. So any mixture by 2 is a best response. So indeed, playing b_1 with probability $1/4$ and b_2 with probability $3/4$ is a best response. So far so good. Next you need to check if 1 is playing a best response. Given the mixed strategy of 2, if 1 plays a_1, the payoff is $3(1/4) + 1(3/4) = 1.5$. The payoff from playing a_2 is 2. Therefore the best response of 1 is to play a_2. This shows that the strategies played by the two players are mutual best responses. Therefore strategy profile 1 is indeed a Nash equilibrium.

Now consider strategy profile 2: Player 1 plays a_2; player 2 plays b_1 with probability $3/4$ and b_2 with probability $1/4$. Player 2 is, as before, playing a best response to 1's strategy. However, given 2's mixed strategy, if 1 switches to a_1, the payoff would be 2.5 which is higher than the payoff from playing a_2. Therefore player 1's strategy is not a best response to player 2's strategy. Hence this strategy profile is not a Nash equilibrium.

To summarise, if 1 plays a_2, 2 is indifferent across pure strategies, so any mixture by 2 is a best response. However, we also need 1 to be playing a best response. For this to happen, the mixed strategy of 2 must be such that a_2 is a best response by 1 – i.e. 1 does not want to switch to a_1. This is satisfied by strategy combination 1, but not by 2.

Question 2

A firm hires workers from a competitive labour market. The firm faces the problem that employees might shirk (avoid working hard). The firm's policy is to monitor the workers occasionally and fire any worker caught shirking. This policy does not reduce shirking if the firm pays its workers the market clearing wage. However, if the firm pays a wage greater than the market clearing wage, this policy is effective in reducing shirking. Is this true or false? Explain your answer.

Reading for this question

M, K & R Chapter 17; subject guide pp. 94–97.

Approaching the question

The statement is true. The key point is that at the market clearing wage, the threat of firing is ineffective in reducing shirking because another job at the same wage is easy to obtain. If a firm pays its workers a higher-than-market-clearing wage, losing the job is now costly for a worker. They can get another job, but only at a lower wage. This reduces shirking.

While the above suffices to answer the question, one can take the analysis further. Suppose w_m denotes the market clearing wage. The natural next question is that if a single firm finds it profitable to pay a wage $w^* > w_m$, is it not the case that other firms would do the same? But if all firms now pay the same wage w^* does the incentive effect of a higher wage vanish?

In fact that is not the case. The advantage persists because of a different reason. If all firms pay $w^* > w_m$, the market does not clear. There is excess supply at w^*. In other words, there are workers who are looking for a job but have not yet found a job. Given this pool of unemployed workers, a worker who loses their job is not guaranteed to find another job quickly. They enter the pool of unemployed and it might take a while to get matched with another job. Job search itself might be costly given that there are lots of people applying for every vacancy. So now if someone gets fired, they incur a cost (waiting, costly job search) before they can find another job. Therefore the threat of firing is still effective in reducing shirking.

Question 3

The inverse demand curve for a good is

$$P = 200 - Q,$$

where P is price and Q is quantity. The private marginal cost of a monopolist is

$$MC^P = 80 + Q,$$

while the social marginal cost (i.e. the marginal externality cost) from pollution caused by the production process is

$$MC^S = Q.$$

Calculate the deadweight loss under unregulated monopoly.

Reading for this question

M, K & R Chapter 13; subject guide Chapter 8 (Competition and monopoly).

Approaching the question

The socially optimal output is obtained by setting $P = MC^P + MC^S$, i.e.

$$200 - Q = 80 + 2Q$$

which implies $Q = 40$. The monopoly output sets $MR = MC^P$. Here total revenue is $(200 - Q)Q$. Therefore, $MR = MC^P$ implies

$$200 - 2Q = 80 + Q$$

which also implies $Q = 40$. Therefore monopoly produces the efficient quantity and the deadweight loss is zero.

Question 4

Short-run average cost exceeds long-run average cost only when there are economies of scale. Is this true or false? Explain your answer.

Reading for this question

M, K & R Chapter 9; subject guide Chapter 7 (The firm).

Approaching the question

This is false. Short-run average costs exceed long-run average costs because the firm is locked into a certain input mix in the short run that may not be cost minimising when all inputs are variable. This condition holds regardless of the presence of economies of scale.

Question 5

Consider an economy with two goods, x and y with prices p_x and p_y, respectively. We observe the following choices made by Rob: if $p_x > p_y$ he chooses to consume only y, and if $p_y > p_x$ he chooses to consume only x. Suggest a utility function for Rob that represents preferences consistent with the given data.

Reading for this question

M, K & R Chapter 2.4; subject guide pp. 18–19.

Approaching the question

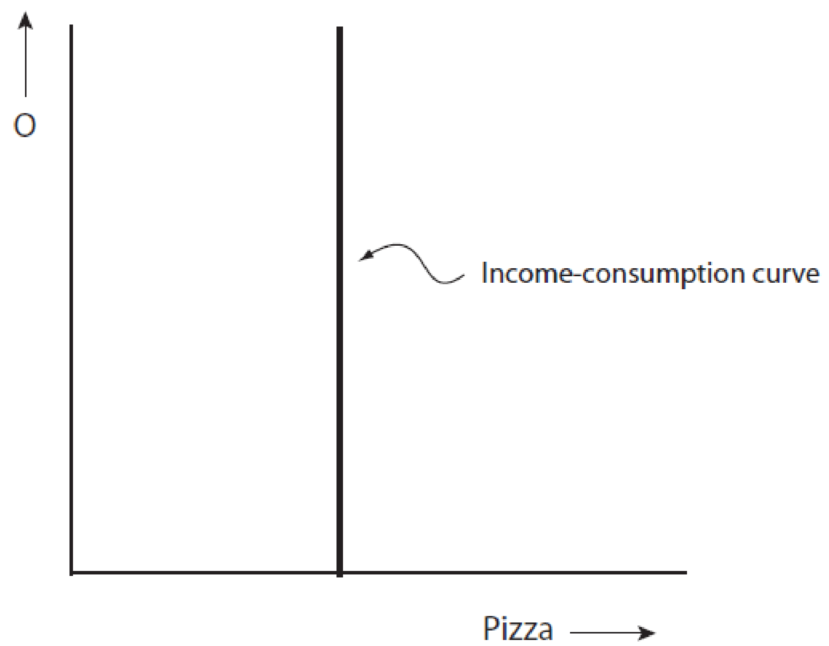
Rob's preferences can be represented most obviously by the following utility function (perfect substitutes):

$$u(x, y) = x + y.$$

Other functions that work include $\max\{x, y\}$, or any order-preserving transformations of these.

Question 6

Amal eats a lot of pizzas and also consumes good O which is a composite of all other goods. His income–consumption curve is a vertical line as shown in the picture below. Pizza cannot possibly be a Giffen good for Amal. Is this true or false? Explain your answer.



Reading for this question

M, K & R Chapter 4; subject guide Chapter 3 (Consumer theory).

Approaching the question

This is true. ICC as drawn indicates pizza consumption is constant as income rises, implying that the income effect on pizza is zero. So as price of pizza changes, only the substitution effect is present. It follows that pizza consumption falls as price rises. It is therefore impossible for pizza to be a Giffen good.

Question 7

Consider a competitive industry with several identical firms. The long run average cost of a firm producing q units of output is given by

$$\mathbf{AC}(q) = 50 - 4q + q^2.$$

Suppose market demand is

$$Q^D = 246 - P.$$

where P denotes market price. Determine the number of firms in the industry in the long run equilibrium.

Reading for this question

M, K & R Chapters 10.1, 11; subject guide Chapter 8 (Competition and monopoly). For a better discussion, see Chapter 8.4 of Perloff.

Approaching the question

LRAC is minimised when $-4 + 2q = 0$ or $q = 2$. At this level of output, LRMC = LRAC = 46. At this price, 200 units are demanded. Since each firm produces 2 units in the long run, 100 firms will operate in this industry.

Question 8

Consider an economy with two goods, x and y, and two agents, A and B. The endowments of the agents are as follows. Agent A has 2 units of x and 1 unit of y. Agent B has 1 unit of x only. Agent A's preferences are represented by the utility function

$$U_A(x, y) = \min\{x, y\},$$

while agent B's preferences are represented by the utility function

$$U_B(x, y) = x^2.$$

The price of y is 1. What is the equilibrium price of x?

Reading for this question

M, K & R Chapter 12; subject guide pp. 83–86.

Approaching the question

Since the total endowment of y is 1 unit, agent A has use for only 1 unit of x. A already has that 1 unit of y, and also more than a unit of x. B only has x. So A cannot get any y in exchange for x. The price of x must therefore be zero.

Section B

Answer **THREE** questions from this section (20 marks each).

Question 9

Suppose there are two identical firms in an industry. The output of firm 1 is denoted by q_1 and that of firm 2 is denoted by q_2. Each firm can produce output at a constant marginal cost of 20. There are no fixed costs. Let Q denote total output, i.e. $Q = q_1 + q_2$. The inverse demand curve in the market is given by

$$P = 500 - 10Q$$

(a) Find the Cournot–Nash equilibrium quantity produced by each firm and the market price. [5 marks]

(b) What would be the quantities produced by each firm and market price under Stackelberg duopoly if firm 1 moves first? [5 marks]

(c) Suppose the firms interact repeatedly over an infinite horizon and each firm has a high discount factor for evaluating future payoffs. Under these conditions, what is the highest joint profit that the firms can earn in each period? [5 marks]

(d) Suppose there are three identical firms instead of two. The output of the third firm is denoted by q_3, and now we have $Q = q_1 + q_2 + q_3$. The inverse demand curve is as before. Find the Cournot–Nash equilibrium quantity produced by each firm and the market price. [5 marks]

Reading for this question

M, K & R Chapter 15; subject guide Chapter 10 (Oligopoly and strategic behaviour).

Approaching the question

(a) Firm 1 maximises profit given by $(P - c)q_1$ which is

$$(500 - 10(q_1 + q_2) - 20)q_1 = (480 - 10(q_1 + q_2))q_1.$$

The first order condition for maximum is

$$480 - 20q_1 - 10q_2 = 0$$

from which we get the best response function of firm 1:

$$q_1 = 24 - \frac{q_2}{2}.$$

At this point we could impose symmetry: $q_1 = q_2 = q^*$ and then solve for q^*. Alternatively, we can write down 2's best response function

$$q_2 = 24 - \frac{q_1}{2}$$

and solve the two equations in two unknowns. By either method, we get

$$q_1 = q_2 = \frac{2}{3}24 = 16.$$

The total output is 32. The market price is then $P = 500 - 320 = 180$.

(b) Firm 1 is the Stackelberg leader. Firm 1 maximises $(500 - 10(q_1 + q_2) - 20)q_1$ where $q_2 = 24 - q_1/2$. Simplifying and substituting the value of q_2, 1 maximises

$$\left(480 - 10\left(q_1 + 24 - \frac{q_1}{2}\right)\right) q_1$$

which simplifies to

$$(240 - 5q_1)q_1.$$

Maximising this, we get $q_1 = 24$. Substituting in 2's best response function, $q_2 = 12$. The total output is 36, so that the market price is $P = 500 - 360 = 140$.

(c) Under the conditions specified, the firms can collude. The highest profit is obtained when the joint output each period is the monopoly output. Let Q denote the joint output each period. To solve for the highest joint profit, maximise

$$(500 - 10Q - 20)Q.$$

The first order condition is $480 - 20Q = 0$, which implies $Q = 24$. Thus the monopoly output is 24, and the joint profit each period at this output is $(480 - 240)24 = 5760$.

(d) Firm 1 maximises profit given by $(P - c)q_1$ which is

$$(500 - 10(q_1 + q_2 + q_3) - 20)q_1 = (480 - 10(q_1 + q_2 + q_3))q_1.$$

The first order condition for maximum is

$$480 - 20q_1 - 10(q_2 + q_3) = 0$$

from which we get the best response function of firm 1:

$$q_1 = 24 - \frac{q_2 + q_3}{2}.$$

At this point we could impose symmetry: $q_1 = q_2 = q_3 = q^*$ and then solve for q^*. This is the simplest method. Alternatively, we can write down the best response functions for 2 and 3 then solve 3 equations in 3 unknowns. Using the first method,

$$q^* = 24 - \frac{2q^*}{2}$$

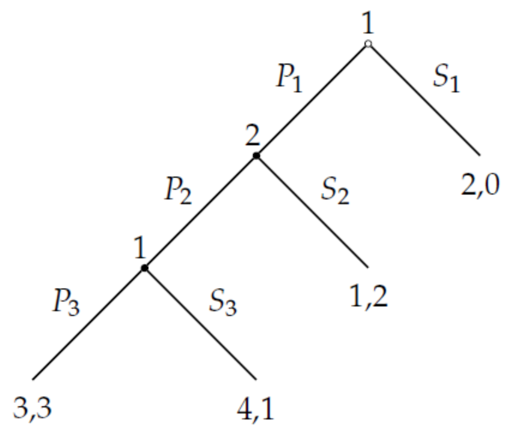
which implies $q^* = 12$. Thus $q_1 = q_2 = q_3 = 12$. The total output is 36, so the market price is $P = 500 - 360 = 140$.

Question 10

(a) Consider the following simultaneous-move game with two players, 1 and 2. Show that each player playing each pure strategy with equal probability is a mixed-strategy Nash equilibrium of the game. [6 marks]

		Player 2 L	Player 2 M	Player 2 H
Player 1	L	5,4	3,4	1,5
Player 1	M	5,2	4,3	0,2
Player 1	H	6,1	3,0	0,0

(b) Consider the following extensive-form game with two players. Initially, player 1 can either play 'P_1' to keep the game going, or play 'S_1' to end the game. If player 1 chooses 'P_1', Player 2 then chooses between 'P_2' and 'S_2'. Finally, if 2 chooses P_2, player 1 can choose between P_3 and S_3. The payoffs are written as (Payoff to 1, Payoff to 2). Identify any subgame perfect Nash equilibrium. [6 marks]



(c) **Two firms face the following strategic pricing problem. Each firm can set a high price H or a low price L. The payoffs are as follows:**

		Firm 2 L	Firm 2 H
Firm 1	**L**	**0, 0**	**5, −1**
	H	**−1, 5**	**2, 2**

Suppose this pricing game between the firms is repeated infinitely. Firms discount the future, so that, for each firm, a payoff of x received t periods from today is worth $\delta^t x$ today, where $0 < \delta < 1$.

Show that it is possible to sustain cooperation (which in this case involves each firm setting the high price H every period) in the infinitely repeated game for high enough values of δ. Your answer must specify the strategies that the firms should follow in the repeated game to sustain cooperation. **[8 marks]**

Reading for this question

The coverage of game theory in M, K & R (Chapter 16) is not ideal. See Chapter 9 (Game theory: an introduction) of the subject guide for a detailed discussion.

Approaching the question

(a) It is straightforward to check that if 2 plays the three strategies with equal probability, 1 gets the same expected payoff (of 3) for each of his 3 strategies. Similarly, if 1 plays the three strategies with equal probability, 2 gets the same expected payoff (of 7/3) for each of his 3 strategies. It follows that each player playing each pure strategy with equal probability is a mixed-strategy Nash equilibrium of the game.

(b) The subgame perfect equilibrium is as follows. Player 1 plays the strategy S_1, S_3 and 2 plays S_2. The outcome of the equilibrium is $(2, 0)$.

(You could also state 1's equilibrium strategy in a long-handed way: 1 plays S_1 initially and then in the node following 2 playing P_2, 1 plays S_3.)

(c) Note that L is a dominant strategy in the one-shot game. However, we can support cooperation in an infinitely repeated game if the players are patient enough.

Consider the following strategy for each player: start by playing H, and continue to play H so long as there is no deviation. After any deviation (by any player), switch to L next period and continue to play L in all future periods.

Let us compare the payoff from conforming to the payoff from deviating. Consider a deviation in period t by player 1. Note that the payoff until $t-1$ plays no role in comparing deviation payoff with the payoff from conforming. The payoffs only differ staring at t, so we might as well just consider the payoff starting at period t. Since this is an infinitely repeated game, the players face an infinite future starting at any period t, and the nature of calculations is exactly the same no matter when you start the calculations.

Given the strategy of each player specified above, the payoff from always cooperating (starting at t) is as follows. A player gets 2 at t, 2 at $t+1$ which is worth $\delta 2$ at t and so on. So the payoff starting at period t from conforming is

$$2 + 2\delta + 2\delta^2 + \ldots = \frac{2}{1-\delta}.$$

By deviating at period t, 1 gets 5 in period t, but then from $t+1$ onwards each player plays L and so 1 gets a payoff of 0 every period. Therefore, the payoff at t from deviating at t is

$$5 + \delta.0 + \delta^2.0 + \ldots = 5.$$

Cooperation can be sustained if such a deviation is not profitable. Therefore to sustain cooperation we need $\frac{2}{1-\delta} \geqslant 5$ which implies $\delta \geqslant \frac{3}{5}$.

Question 11

(a) Consider a market for used cars. There are 10 low quality cars and 10 high quality cars. There are 20 potential sellers with a car each, and 20 buyers. A seller values a high quality car at 8000 and a low quality car at 4000. A buyer values a high quality car at 10,000 and a low quality car at 5000. All agents are risk-neutral.

i. Suppose quality is observable to sellers but not to buyers. Buyers only know that out of the 20 sellers, 10 offer high quality cars and 10 offer low quality cars. How many cars of each quality would be sold? Write down the interval(s) of possible prices. [8 marks]

ii. Is the market outcome in part (b) efficient? If you answer yes, explain why. If you answer no, suggest (informally) a way to reduce the inefficiency. [4 marks]

(b) A firm can hire two types of workers: A-type workers who have high productivity and B-type workers with low productivity. Once hired, a worker is employed for 10 years. The market rate of interest is zero. The competitive wage for a A-type worker is 500 per year and that for a B-type worker is 300 per year.

Suppose the type of a worker is private information of the workers.

Suppose workers have the option of obtaining a few years of education before they start working. Each year of education (which includes the psychological costs of study effort) costs an A-type worker 100, while each year costs a B-type worker 250. Show that the firm can solve the problem of information asymmetry by setting wages based on the number of years a worker spends in education. Your answer must explicitly derive the relation between the firm's wage offer and a worker's years of education. [8 marks]

Reading for this question

M, K & R Chapter 17; subject guide Chapter 12 (Asymmetric information).

Approaching the question

(a) i. If all cars are offered for sale, buyers are willing to pay at most the average value 7500. But at this price high quality cars are not offered. Does this mean that low quality cars can trade at prices between 4000 and 7500? The key step is to realise that the answer is no. The reason is that buyers are rational, and therefore they would also know that at any price equal to or less than 7500, high quality cars will not be offered. Therefore they would correctly conclude that the only cars that are being offered for sale are low quality cars.

Knowing this, buyers would also not buy any cars at any price above 5000 (which is their value for low quality cars). Therefore high quality cars are not traded while low quality cars are traded at some price between 4000 and 5000.

ii. The market outcome is not efficient. There are gains from trading high quality cars since buyers value these more than sellers. This gain is not realised. A potential solution to the problem is for high quality sellers to differentiate themselves from low quality sellers by offering warranties. A warranty offer can serve as a separating device if high quality car sellers could offer a warranty that would satisfy their participation constraint, and if low quality sellers would not find worthwhile to offer the same warranty. In this case buyers no longer face any information asymmetry: they know that cars that come with a warranty are high quality and cars that come without a warranty are low quality. In this case high quality cars sell at some price between 8000 and 10000 and low quality cars sell at some price between 4000 and 5000. All gains from trade are then realised and the market outcome is efficient.

(b) Calculate the benefit and cost of education for each type. Suppose the firm would pay the higher wage to anyone who has acquired y years of education. The benefit of such education is 200 per year for 10 years. Since the market interest rate is zero, the present value of benefit is 2000.

Now, for the firm to be able to separate the types successfully, y must be such that B-types have no incentive to acquire y years of education, while A types do have an incentive to acquire such education. B-type workers do not obtain education as long as

$$2000 \leqslant 250y$$

or $y \geqslant 8$. A-type workers obtain education as long as

$$2000 > 100y$$

or $y < 20$. Therefore the firm should set a wage of 500 if it observes $y \geqslant 8$, and 300 otherwise.

Question 12

Suppose a monopolist faces an (inverse) market demand curve $P = 10 - Q$ where P is price and Q is quantity. The monopolist's marginal cost of production is constant at 6.

(a) Explain the source of the social cost under monopoly. **[5 marks]**

(b) Suppose the government levies a per-unit tax of 2 on the monopolist. Is the tax revenue greater than the extra deadweight loss caused by the tax? Explain. **[5 marks]**

(c) Let $D(Q)$ denote the deadweight loss if the monopolist produces output Q. Suppose for any output Q, the regulator imposes a fine on the monopolist equal to $2\,D(Q)$. Calculate the monopolist's optimal output under this policy. Does the policy reduce the social cost under monopoly? **[5 marks]**

(d) Suppose the long-run average cost of the monopolist is given by

$$AC(Q) = 6 + \frac{2}{Q}.$$

Specify a policy that could solve the problem of social cost. **[5 marks]**

Reading for this question

M, K & R Chapter 13; subject guide Chapter 8 (Competition and monopoly).

Approaching the question

(a) To earn maximum profit, the monopolist reduces output relative to the competitive output. This is the source of the social cost (deadweight loss) from monopoly.

(b) First calculate the optimal output and deadweight loss without a tax. The profit is maximised at $MR = MC$. Here $MR = 10 - 2Q$ and $MC = 6$. Equating, the optimal output is $Q_M = 2$. The monopoly price is $P_M = 8$.

The competitive output Q_C is such that $P = MC$, i.e. $10 - Q_C = 6$ implying $Q_C = 4$. The competitive price is $P_C = 6$.

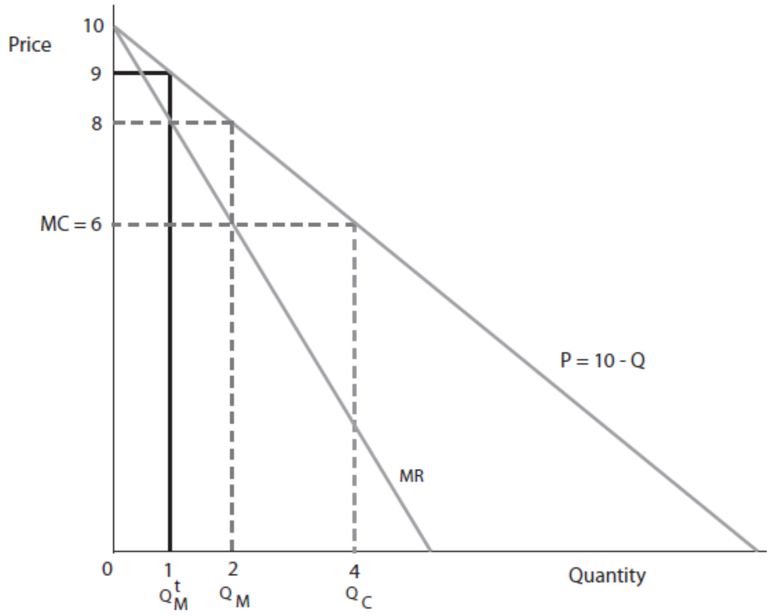
It follows that the deadweight loss under monopoly is

$$D = \frac{1}{2}(Q_C - Q_M)(P_M - P_C) = \frac{1}{2}(4-2)(8-6) = 2.$$

Now, with a per-unit tax of 2, MC becomes $6 + 2 = 8$. So the monopoly output is given by $10 - 2Q = 8$, implying $Q_M^t = 1$, and $P_M^t = 9$. The new deadweight loss is

$$D^t = \frac{1}{2}(Q_C - Q_M^t)(P_M^t - P_C) = \frac{1}{2}(4-1)(9-6) = 4.5.$$

Therefore, the extra deadweight loss caused by the tax is $4.5 - 2 = 2.5$. Since $Q^t_M = 1$, the tax revenue is 2. It follows that in this case the tax revenue is lower than the extra deadweight loss caused by the tax.



Calculating the deadweight loss from monopoly

(c) The deadweight loss at output Q (and corresponding price P) is

$$D(Q) = \frac{1}{2}(Q_C - Q)(P - P_C) = \frac{1}{2}(4 - Q)(10 - Q - 6) = \frac{1}{2}(4 - Q)^2.$$

The fine on the monopolist producing Q is $2D(Q) = (4 - Q)^2$.
The monopolist's problem now is to maximise

$$(P - 6)Q - (4 - Q)^2.$$

Since $P - 6 = 4 - Q$, the monopolist maximises

$$(4 - Q)Q - (4 - Q)^2.$$

The first order condition is

$$4 - 2Q + 2(4 - Q) = 0$$

which implies $12 - 4Q = 0$, from which it follows that the optimal output under the fine is $Q^F_M = 3$. This is closer to the competitive output and therefore the policy does indeed reduce the deadweight loss (i.e. the social cost of monopoly).

(d) The average cost shows that there is a fixed cost of 2. Combined with a constant MC, this leads to a falling long-run AC curve - the case of a natural monopoly. In this case, simply setting regulated price equal to MC would not solve the problem of social cost, as the monopolist would make a loss of 2 if price is equal to MC. Thus the monopolist would be unwilling to produce at a price that is equal to MC. Thus a policy that would restore efficiency must also subsidise the monopolist. Such a policy is as follows: set $P = MC = 6$, and give the monopolist a lump-sum subsidy of 2. This would eliminate the deadweight loss from monopoly.

Question 13

Consider an economy with two goods: food (F) and music (M). The price of M is 4 and the price of F is 1. Harvey has an income of 800. Suppose F and M are good substitutes (but not

perfect substitutes) for Harvey, and his preferences are such that he optimally consumes 100 units of M.

(a) Suppose a new club opens which Harvey can join for a fee of 300. The advantage is that once he joins the club, he can purchase M at a price of 1. Would Harvey join the club? [10 marks]

(b) Suppose Carol has the same income as Harvey, but her preferences are represented by the utility function

$$U_C(M, F) = \min(\alpha M, F)$$

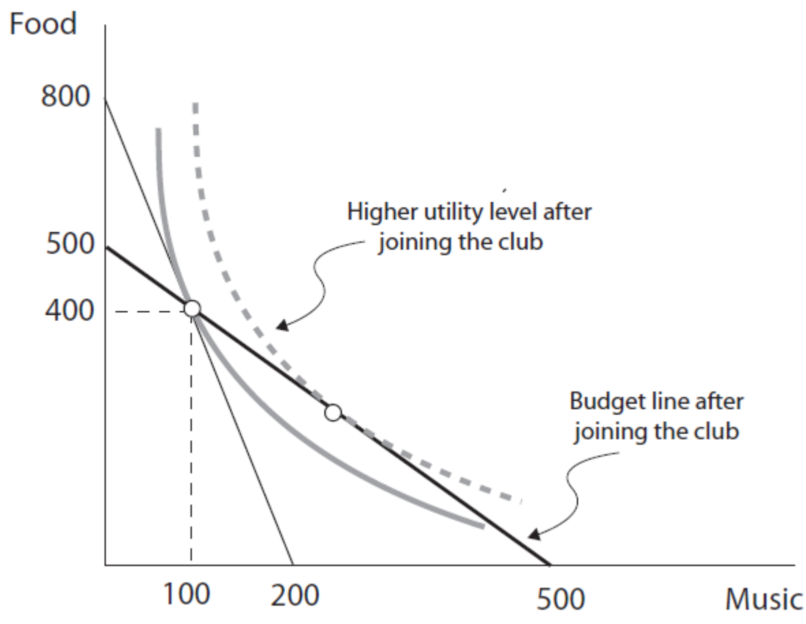
For what values of α would Carol prefer to join the club? [10 marks]

Reading for this question

M, K & R Chapters 3, 4; subject guide Chapter 3 (Consumer theory).

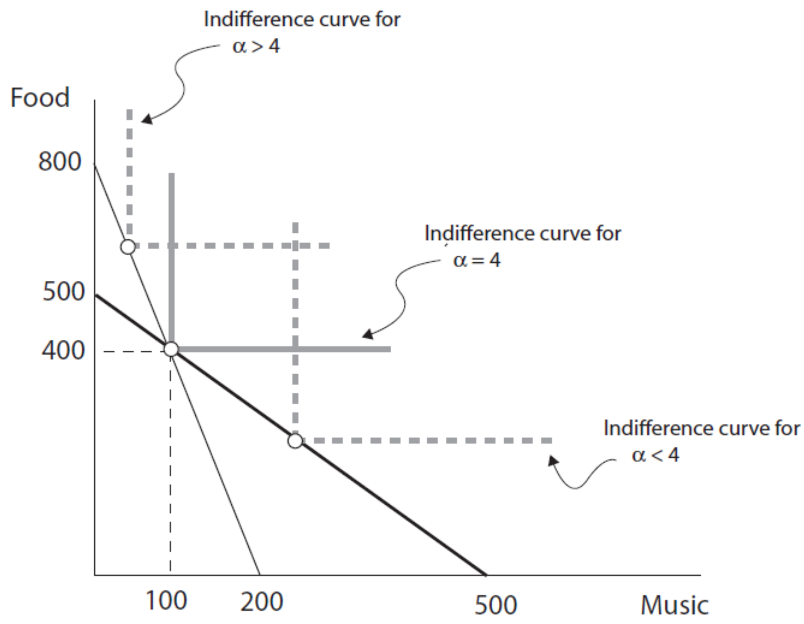
Approaching the question

(a) Harvey currently spends his income of 800 on 100 units of M (costs 400) and 400 units of F. If he joins the club, his income goes down to 500. The new budget line passes through his original consumption point: he can still buy 100 of M (cost 100) and 400 of F (cost 400). But the new budget line has a flatter slope - therefore, as the picture makes clear (his indifference curve does not have a kink at the original consumption point - the goods are substitutable), Harvey must prefer to join the club.



Harvey's decision problem.

(b) For $\alpha = 4$, Carol's choice would coincide with Harvey's original choice. In this case Carol is indifferent between joining and not joining since the new budget line crosses the same point. For $\alpha \geqslant 4$, she would prefer strictly not to join. She will strictly prefer to join for $\alpha < 4$.



Carol's decision problem.

This is clear from the picture. We can also compare the utility levels: the budget constraint is $pM + F = I$, where I is income. Since optimally $\alpha M = F$, we have

$$M = \frac{I}{p+\alpha} \quad \text{and} \quad F = \frac{\alpha I}{p+\alpha}.$$

So the utility before joining is $\frac{800\alpha}{4+\alpha}$ and utility after joining is $\frac{500\alpha}{1+\alpha}$. Comparing, joining is strictly better for $\alpha < 4$.

Question 14

(a) Lee does not have insurance against car theft. His car is worth 45. He can park his car on the street or pay to park in a garage. If parked on the street, the car is stolen with probability 1/3. If parked in a garage, the car is safe from theft. Including the value of his car, Lee has a wealth of 81. His utility from wealth W is

$$u(W) = \sqrt{W}.$$

i. Calculate the maximum amount that Lee is willing to pay to park in a garage.[5 marks]

ii. Now suppose Lee's risk preference changes so that he becomes risk neutral, The utility function representing his preference over wealth levels is given by

$$u(W) = W.$$

In this case, what is the maximum amount that Lee is willing to pay to park in a garage? [5 marks]

(b) Rachel has 100 to invest. Two assets, 1 and 2, are available for investment. An amount y invested in asset 1 yields a total return of $1.1y$. An amount x invested in asset 2 yields a risky total return of x with probability 0.5 and $1.21x$ with probability 0.5. Rachel's utility function is given by

$$U(w) = \ln(w)$$

where w is wealth after investing.

Let any portfolio be denoted by (x, y) where x is the amount invested in the risky asset (asset 2) and $y = 100 - x$ is the amount invested in the safe asset (asset 1).

How much should Rachel invest in the risky asset? **[10 marks]**

Reading for this question

M, K & R Chapter 6; subject guide Chapter 6 (Choice under uncertainty). For a good coverage of the expected utility model, as well as the derivation of risk premium for a risk-averse individual, see Perloff, Chapter 17.2.

Approaching the question

(a) i. Expected utility is

$$2/3\sqrt{81} + 1/3\sqrt{36} = 8.$$

The certainty equivalent is given by $\sqrt{CE} = 8$, i.e. $CE = 64$. Therefore the maximum willingness to pay is $81 - 64 = 17$.

ii. Expected utility is

$$\frac{2}{3}81 + \frac{1}{3}36 = 66.$$

The maximum willingness to pay is P such that $81 - P = 66$, which implies $P = 15$.

(b) Rachel's expected utility as a function of the amount of investment in the risky asset (x) is:

$$EU(x) = 0.5\ln\Big((100 - x)(1.1) + x(1.21)\Big) + 0.5\ln\Big((100 - x)(1.1) + x\Big).$$

This simplifies to

$$EU(x) = 0.5\ln\Big(110 + 0.11x\Big) + 0.5\ln\Big(110 - 0.1x\Big).$$

The first order condition for maximisation with respect to x is

$$\frac{0.055}{110 + 0.11x} - \frac{0.05}{110 - 0.1x} = 0.$$

This implies

$$(0.055 - 0.05)(110) = x(0.055(0.1) + 0.05(0.11))$$

which simplifies to $0.55 = x(0.011)$ implying $x = 50$.