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UNIVERSITY OF LONDON

EC3099 ZA

BSc degrees and Diplomas for Graduates in Economics, Management, Finance and the Social Sciences, the Diplomas in Economics and Social Sciences

Industrial Economics

Wednesday, 3 May 2017: 14:30 to 17:30

Candidates should answer **FOUR** of the following **EIGHT** questions: **TWO** from Section A, and **TWO** from Section B. All questions carry equal marks.

If more questions are answered than requested, only the first answers attempted will be counted.

PLEASE TURN OVER

SECTION A

Answer two questions from this section.

1. Consider two owner-managed firms that enter into a long-run relationship as buyer and seller of a good, respectively. Both firms can make a relation-specific investment that increases the gains from trade. Discuss under what circumstances it is efficient for the two firms to merge. Then show, with reference to a suitable economic model, that if a vertical merger is to occur, efficiency requires that the residual rights of control rest with the party whose investment has the larger effect on the joint profit.

[25 marks]

2. 'When collusion among firms breaks down in an industry, concentration is expected to rise'. Under what conditions (if any) is this statement true? Discuss with reference to economic theory and any relevant empirical evidence.

[25 marks]

3. Describe the 'chain-store paradox' as a game involving an incumbent monopolist and N potential entrants. First derive the subgame-perfect equilibrium under complete information. Why is this result a 'paradox'? Then explain how incomplete information about the incumbent's 'type' can lead to entry deterrence as an equilibrium and thereby resolve the paradox. Discuss the economic intuition behind your answer. Finally, describe how the presence of incomplete information can form the basis for a theory of predatory pricing.

[25 marks]

4. Describe the economic issues involved in assessing the degree of market power of firms. Then discuss the problems faced by competition authorities in the design and implementation of policy against the abuse of market power by dominant firms.

[25 marks]

SECTION B

Answer two questions from this section.

5. Consider a market with two horizontally differentiated products and inverse demands given by $p_i(q_i, q_j) = a - 2/3 q_i - 1/3 q_j$, where $i = 1, 2, j \neq i$. This implies that demands are given by $q_i(p_i, p_j) = a - 2p_i + p_j$. Suppose firm 1 has zero marginal cost and firm 2 has positive marginal cost c , where $7c < 5a$. The two firms compete in prices.

- (i) Compute the firms' profits at the Nash equilibrium if the two firms choose prices simultaneously. [7 marks]
- (ii) Compute the firms' profits at the subgame-perfect equilibrium of the sequential game (a) when firm 1 is the leader, and (b) when firm 2 is the leader. [9 marks]
- (iii) Derive the pure strategy equilibrium (or equilibria) of the multi-stage game in which the firms simultaneously choose whether to play 'early' or 'late' prior to setting prices. If they both make the same choice (either 'early' or 'late'), the simultaneous-move game follows; if they make different choices, a sequential game follows with the firm having chosen 'early' being the leader. [9 marks]

6. Answer both parts of this question.

(a) Consumers believe that a certain product they are buying is of high quality with probability p and low quality with probability $1 - p$, where $0 < p < 1$. A high-quality good is valued by consumers at v_H and costs c_H to produce, while a low-quality good is valued at $v_L \leq v_H$ and costs $c_L \leq c_H$ to produce.

- (i) Derive an expression for the price consumers would be willing to pay for the product if high-quality firms do nothing to signal their quality.
- (ii) Let $c_H = 0.9v_H$ and $v_H = 2v_L$. For what values of p would consumer beliefs about quality be consistent? That is, for what values of p is there actually a positive probability that some firms are producing high-quality goods?

[10 marks]

(b) Consider a market for second-hand cars where cars can be of low (L) quality, medium (M) quality or high (H) quality. A seller's valuation, $V_S(q)$, of a car of quality q is $V_S(L) = 1000$, $V_S(M) = 2000$ and $V_S(H) = 3000$, respectively. A buyer's valuation of a car of quality q is $V_B(q) = \alpha + V_S(q)$, where $\alpha > 0$. Assume also that low-quality cars and medium-quality cars each represent $1/4$ of the total, with half the cars being of high quality. Find the value of α such that, in the market equilibrium:

- (i) only the low quality cars would be traded
- (ii) only the medium and low quality cars would be traded
- (iii) all three types of cars would be traded.

[15 marks]

7. Answer both parts of this question.

(a) Consider a Cournot homogeneous good oligopoly with three firms and inverse demand function $P = 1 - Q$, where Q is the total quantity produced. Marginal costs are given by $c_1 = 0.1$, $c_2 = 0.35$ and $c_3 = 0.4$. There are no fixed costs. A merger between firms 2 and 3 is proposed. The merged firm will have marginal cost $c_2 = 0.35$. Show that this merger will reduce industry output but will also increase total welfare. Explain the intuition for your answer.

[10 marks]

(b) Suppose that two innovation opportunities exist, each costing £100 in initial outlay, but generating different possible returns. Investment A generates a return of £150 with probability 0.5 and £100 with probability 0.5, while investment B generates a return of £180 with probability 0.5 and £10 with probability 0.5. Define and calculate the expected return for each investment. Then compare and contrast the investment choice of a self-financed investor and an investor financed by debt. Finally, explain what your analysis implies for the financing of new technological investment.

[15 marks]

8. A monopoly manufacturer of a good sells to a monopoly retailer. The consumers' demand for the good is $q = 1 - p$, where q is quantity sold and p is the final price. The retailer has zero cost and the manufacturer's cost function is $C(q) = q^2/2$. The timing is as follows: first the manufacturer chooses a tariff to charge the retailer, and then the retailer chooses the final price.

(i) What is the aggregate profit of this industry under vertical integration?

[5 marks]

(ii) Suppose a linear tariff, $T(q) = p_w q$, where p_w denotes the per unit price, is charged by the manufacturer in the vertically separated structure. What are the manufacturer's and the retailer's profits?

[10 marks]

(iii) Now suppose a two-part tariff, $T(q) = A + p_w q$, where p_w denotes the per unit price and A is a fixed fee, is charged by the manufacturer in the vertically separated structure. What are the manufacturer's and the retailer's profits? Compare the manufacturer's profit with the one you derived in part (ii) and give an intuitive explanation for your answer.

[10 marks]

END OF PAPER

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UNIVERSITY OF LONDON

EC3099 ZB

BSc degrees and Diplomas for Graduates in Economics, Management, Finance and the Social Sciences, the Diplomas in Economics and Social Sciences

Industrial Economics

Wednesday, 3 May 2017: 14:30 to 17:30

Candidates should answer **FOUR** of the following **EIGHT** questions: **TWO** from Section A, and **TWO** from Section B. All questions carry equal marks.

If more questions are answered than requested, only the first answers attempted will be counted.

PLEASE TURN OVER

SECTION A

Answer two questions from this section.

1. Consider two owner-managed firms that enter into a long-run relationship as buyer and seller of a good, respectively. Both firms can make a relation-specific investment that increases the gains from trade. Discuss under what circumstances it is efficient for the two firms to merge. Then show, with reference to a suitable economic model, that if a vertical merger is to occur, efficiency requires that the residual rights of control rest with the party whose investment has the larger effect on the joint profit.

[25 marks]

2. Answer all parts of this question.

(a) Is it a good idea to have a junior clerk in a bank on an incentive contract? Is it a good idea to have the chief executive officer of a bank on an incentive contract? Why or why not?

[8 marks]

(b) Which model, Cournot or Bertrand, do you think provides a better approximation to competition in each of the following industries: steel manufacturing, hotels, insurance. Why?

[7 marks]

(c) Consider the linear location model where consumers are uniformly distributed along a linear city and have linear travel costs, the price is exogenously fixed and the firms compete by simultaneously choosing locations. However, assume there are four firms in the market rather than just two. Derive the Nash equilibrium of this game and interpret the result.

[10 marks]

3. A significant number of resale price maintenance (RPM) cases that have been the subject of antitrust policy involve the pricing of consumer products. Discuss possible explanations for the imposition of RPM in such products. Who do you think would have an incentive to impose RPM, the manufacturer, the retailer, or both? Explain your answer.

[25 marks]

4. 'When collusion among firms breaks down in an industry, concentration is expected to rise'. Under what conditions (if any) is this statement true? Discuss with reference to economic theory and any relevant empirical evidence.

[25 marks]

SECTION B

Answer two questions from this section.

5. Consider a homogeneous good market with N firms which set their output sequentially (firm i in period i). The industry faces an inverse demand $P(q) = a - Q$ where $Q = q_1 + q_2 + \dots + q_N$. Suppose that the firms have identical constant marginal costs of production c , where $c < a$.

- (i) Using backward induction, show that the output of firm i in the subgame-perfect equilibrium is given by $q_i = \frac{1}{2} (a - q_1 - q_2 - \dots - q_{i-1} - c)$, $i = 1, \dots, N$. [15 marks]
- (ii) Compute the aggregate output of the N firms. [5 marks]
- (iii) Describe the equilibrium outcome when the number of firms $N \rightarrow \infty$ and comment on the implications of $N \rightarrow \infty$ for profits. [5 marks]

6. Answer both parts of this question.

- (a) Consider a Cournot homogeneous good oligopoly with three firms and inverse demand function $P = 1 - Q$, where Q is the total quantity produced. Marginal costs are given by $c_1 = 0.1$, $c_2 = 0.35$ and $c_3 = 0.4$. There are no fixed costs. A merger between firms 2 and 3 is proposed. The merged firm will have marginal cost $c_2 = 0.35$. Show that this merger will reduce industry output but will also increase total welfare. Explain the intuition for your answer. [10 marks]
- (b) Suppose that two innovation opportunities exist, each costing £100 in initial outlay, but generating different possible returns. Investment A generates a return of £150 with probability 0.5 and £100 with probability 0.5, while investment B generates a return of £180 with probability 0.5 and £10 with probability 0.5. Define and calculate the expected return for each investment. Then compare and contrast the investment choice of a self-financed investor and an investor financed by debt. Finally, explain what your analysis implies for the financing of new technological investment. [15 marks]

7. Answer both parts of this question.

(a) Consumers believe that a certain product they are buying is of high quality with probability p and low quality with probability $1 - p$, where $0 < p < 1$. A high-quality good is valued by consumers at v_H and costs c_H to produce, while a low-quality good is valued at $v_L \leq v_H$ and costs $c_L \leq c_H$ to produce.

- (i) Derive an expression for the price consumers would be willing to pay for the product if high-quality firms do nothing to signal their quality.

Question continues on next page

(ii) Let $c_H = 0.9v_H$ and $v_H = 2v_L$. For what values of p would consumer beliefs about quality be consistent? That is, for what values of p is there actually a positive probability that some firms are producing high-quality goods?

[10 marks]

(b) Consider a market for second-hand cars where cars can be of low (L) quality, medium (M) quality or high (H) quality. A seller's valuation, $V_S(q)$, of a car of quality q is $V_S(L) = 1000$, $V_S(M) = 2000$ and $V_S(H) = 3000$, respectively. A buyer's valuation of a car of quality q is $V_B(q) = \alpha + V_S(q)$, where $\alpha > 0$. Assume also that low-quality cars and medium-quality cars each represent $\frac{1}{4}$ of the total, with half the cars being of high quality. Find the value of α such that, in the market equilibrium:

- (i) only the low quality cars would be traded
- (ii) only the medium and low quality cars would be traded
- (iii) all three types of cars would be traded.

[15 marks]

8. As the owner of the only tennis club in an isolated island, you must decide on annual membership fees and fees for court times. There are two types of tennis players. "Serious" players have demand $Q_1 = 6 - P$, where Q_1 is court hours per week and P is the court fee per hour for each individual player. There are also "occasional" players with demand $Q_2 = 3 - P/2$. Assume there are 1000 players of each type. Because you have plenty of courts, the marginal cost of court time is zero. You have fixed costs of 5,000 per week. Serious and occasional players look alike, so you must charge them the same prices.

(i) Suppose that to maintain a "professional" atmosphere, you want to limit membership only to serious players. How should you set the annual membership fee and the court fee (assuming there are 52 weeks per year) to maximise your profit? What will your profit be?

[10 marks]

(ii) A friend tells you that you could make greater profits by encouraging both types of players to join, while still setting a single court fee and a single annual membership fee. How would you set the annual membership fee and the court fee in this case? Is your friend right? Explain.

[12 marks]

(iii) Another friend suggests there may be a way of making even greater profit than in parts (i) and (ii) by offering a range of packages rather than just a single two-part tariff. Is your friend right? Explain briefly and informally.

[3 marks]

END OF PAPER

Examiners' commentaries 2017

EC3099 Industrial economics

Important note

This commentary reflects the examination and assessment arrangements for this course in the academic year 2016–17. 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 (2015). 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.

General remarks

Learning outcomes

At the end of this course and having completed the essential reading and activities you should be able to:

- describe and explain the determinants of the size and structure of firms and the implications of the separation of ownership and control
- describe and explain the pricing behaviour by firms with market power and its welfare implications
- apply analytical models of firm behaviour and strategic interaction to evaluate various business practices, including tacit collusion, entry deterrence, product differentiation, price discrimination and vertical restraints
- recognise and explain the basic determinants of market structure and the key issues in competition policy and regulation.

Format of the examination

This course is assessed by a three-hour examination. The examination consists of eight questions divided into two sections, each of four questions. Section A includes essay-type questions, while Section B includes problem-type questions. You will be required to answer **four** questions, **two** from each section.

What are the examiners looking for?

Some examination questions will be problem-type questions, while others will be essay-type questions.

In general, problem-type questions are quite specific as to what you are supposed to do, and a good answer generally involves some use of mathematics. When you answer problem-type questions in an examination, all the necessary steps must be shown. Moreover, you should take care to explain what the mathematics show – do not simply list equations.

Essay-type questions can be more or less specific, although a good answer to an essay-type question must include some rigorous economic analysis, usually with reference to some economic model or models.

Reading and preparation for the examination

It is important to read more widely than just the subject guide. In essay-type questions in particular, you get a higher mark by including relevant material not in the subject guide. Whatever the question, exposure to a wider set of readings is usually necessary to understand in depth the economics involved and to be able to provide correct and comprehensive answers in the examination.

While there is no single best way to organise your study, it may be useful, for each topic in the syllabus, to start with the relevant chapter of the subject guide, then read the essential and some of the recommended reading for that particular topic, then come back to the subject guide and attempt the various learning activities and sample examination questions.

Planning your time in the examination

Use your time efficiently bearing in mind that all questions carry equal weight in the final mark. Your answers must be as detailed and comprehensive as possible given the time constraints (unless you are specifically asked to discuss something briefly), but you should not include material which is not relevant to the question.

Steps to improvement

Your answers to problem-type questions should not simply list mathematical results but they should also explain what the mathematics mean.

Your answers to essay-type questions must be focused, not too descriptive and must contain rigorous economic analysis.

Examination revision strategy

Many candidates are disappointed to find that their examination performance is poorer than they expected. This may be due to a number of reasons, but one particular failing is ‘**question spotting**’, that is, confining your examination preparation to a few questions and/or topics which have come up in past papers for the course. This can have serious consequences.

We recognise that candidates might not cover all topics in the syllabus in the same depth, but you need to be aware that examiners are free to set questions on **any aspect** of the syllabus. This

means that you need to study enough of the syllabus to enable you to answer the required number of examination questions.

The syllabus can be found in the Course information sheet available on the VLE. You should read the syllabus carefully and ensure that you cover sufficient material in preparation for the examination. Examiners will vary the topics and questions from year to year and may well set questions that have not appeared in past papers. Examination papers may legitimately include questions on any topic in the syllabus. So, although past papers can be helpful during your revision, you cannot assume that topics or specific questions that have come up in past examinations will occur again.

If you rely on a question-spotting strategy, it is likely you will find yourself in difficulties when you sit the examination. We strongly advise you not to adopt this strategy.

Examiners' commentaries 2017

EC3099 Industrial economics

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This commentary reflects the examination and assessment arrangements for this course in the academic year 2016–17. 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).

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Comments on specific questions – Zone A

Candidates should answer **FOUR** of the following **EIGHT** questions: **TWO** from Section A, and **TWO** from Section B. All questions carry equal marks.

If more questions are answered than requested, only the first answers attempted will be counted.

Section A

Answer two questions from this section.

Question 1

Consider two owner-managed firms that enter into a long-run relationship as buyer and seller of a good, respectively. Both firms can make a relation-specific investment that increases the gains from trade. Discuss under what circumstances it is efficient for the two firms to merge. Then show, with reference to a suitable economic model, that if a vertical merger is to occur, efficiency requires that the residual rights of control rest with the party whose investment has the larger effect on the joint profit.

(25 marks)

Reading for this question

Subject guide, Chapter 1.

Tirole (1988), introductory chapter.

Church and Ware (2000), Chapter 3.

Approaching the question

A good answer to this question should start by outlining the transaction costs–property rights approach as a theory that provides an explanation for the size and structure of firms. The main ideas of the property rights approach should then be discussed, with an emphasis on the issue of asset ownership (the residual rights of control) and incentives for vertical integration. This discussion should lead to a statement of the main conclusions on issues such as when integration is useful and when it is not, and which party should own the merged firm in case of integration.

Key ideas include the following. Integration reduces opportunistic behaviour because if, say, firm A acquires firm B, then the manager of firm B loses control of the physical assets of firm B, so he has much less bargaining power. Efficiency requires that highly complementary assets are under common ownership, whereas independent assets should be separately owned. And efficiency also requires that in the case of a vertical merger the residual rights of control rest with the party whose investment has the larger effect on the joint profit.

A very good answer would outline an appropriate formal model to illustrate some of these ideas, especially the question of who should acquire whom for efficiency in the case of a vertical merger. A model of this kind, which examines how ownership changes the division of the ex-post surplus and hence the ex-ante investment, is described in the subject guide, Chapter 1, section 'Property rights'.

Question 2

'When collusion among firms breaks down in an industry, concentration is expected to rise.' Under what conditions (if any) is this statement true? Discuss with reference to economic theory and any relevant empirical evidence.

(25 marks)

Reading for this question

Subject guide, Chapter 9.

Sutton (1991), various chapters.

Approaching the question

You should begin with a discussion of the relationship between short-run competition and market structure with reference to a theoretical framework such as the one outlined in Chapter 9 of the subject guide.

In an exogenous sunk cost industry, the key result of a positive effect of the intensity of short-run competition on market structure can be illustrated using a simple two-stage game: at stage 1 firms decide whether or not to enter at a certain sunk cost, while at stage 2 they are faced with various possible competition regimes, including Bertrand competition, Cournot competition and perfect collusion. Using a linear demand function and a constant marginal cost (the same for all firms), one can show that the number of firms that enter is lower under Bertrand or Cournot competition than under collusion. In other words, market concentration should increase when collusion breaks down in an industry. The intuition for this result should be clearly explained. An important feature of this model is that entry is not restricted, i.e. the number of firms is an endogenous variable. Some discussion of whether the result extends to endogenous sunk cost industries is also required.

The second part of the question asks for a discussion of empirical evidence. Some evidence provided by Symeonidis is discussed in the subject guide: a major shift in UK competition policy in the late 1950s has made it possible to compare a group of previously collusive industries (which experienced an increase in the intensity of price competition) with a control group of

non-collusive industries (which were not affected by the change in policy). Furthermore, entry was not restricted in most cartelised industries. Any other available evidence may also be discussed.

A very good answer might also indicate the main policy implications of this analysis. One such implication is that competition policy authorities should perhaps be less concerned with concentration than with ensuring that competition remains effective, i.e. firms do not collude and do not create barriers to entry.

Question 3

Describe the ‘chain-store paradox’ as a game involving an incumbent monopolist and N potential entrants. First derive the subgame-perfect equilibrium under complete information. Why is this result a ‘paradox’? Then explain how incomplete information about the incumbent’s ‘type’ can lead to entry deterrence as an equilibrium and thereby resolve the paradox. Discuss the economic intuition behind your answer. Finally, describe how the presence of incomplete information can form the basis for a theory of predatory pricing.

(25 marks)

Reading for this question

Subject guide, Chapter 5.

Tirole (1988), Chapter 9.

Church and Ware (2000), Chapter 21.

Approaching the question

You should begin by describing the chain-store game, then derive the subgame-perfect equilibrium under complete information: the potential entrants always enter and the incumbent always accommodates entry. This theoretical result is seen as a paradox because it is not consistent with most empirical and experimental evidence. You should then explain how incomplete information about the incumbent’s ‘type’ can lead to entry deterrence as an equilibrium, describe the main properties of this ‘perfect Bayesian equilibrium’ and discuss the intuition for this result: in the presence of incomplete information a firm may have an incentive to strategically manipulate its rivals’ beliefs, i.e. create a reputation for itself – in this case, a reputation for toughness.

The final part of the answer should describe an interpretation of the incomplete information approach as the basis for predation, i.e. an exit-inducing strategy rather than an entry-deterrence strategy, and conclude with a brief description of a reputation theory of predation as rational firm behaviour which is consistent with empirical evidence.

Question 4

Describe the economic issues involved in assessing the degree of market power of firms. Then discuss the problems faced by competition authorities in the design and implementation of policy against the abuse of market power by dominant firms.

(25 marks)

Reading for this question

Subject guide, Chapter 10.

Church and Ware (2000), various chapters.

Approaching the question

The answer to this question should contain two main parts. The first part should discuss the economic issues involved in assessing the market power of firms. You must explain the reasons why this assessment is often not straightforward. These reasons may include difficulties in defining the relevant market, the lack of accurate information about cost and demand parameters, difficulties in assessing the extent to which market power may persist in time, and so on. Next, you must describe what the competition authorities can do to assess market power. Typically, competition authorities must examine a series of indices, and make an assessment based on these. Therefore, you need to describe what these indices may be. You may discuss these issues in the context of a particular antitrust case that you are familiar with, if you think that this will clarify your arguments – however, this is not strictly necessary.

The second part of the answer should focus more specifically on competition policy against the abuse of market power by dominant firms. Here you need first to explain what is meant by abuse of market power and give examples of such practices. Then you can go on to discuss competition policy towards such practices. One of the main issues is that it is often difficult for the authorities to assess whether certain practices constitute an abuse of market power. You should discuss this, giving examples. You may also briefly discuss how competition authorities in various parts of the world are tackling these problems in practice.

Section B

Answer two questions from this section.

Question 5

Consider a market with two horizontally differentiated products and inverse demands given by $p_i(q_i, q_j) = a - 2/3q_i - 1/3q_j$, where $i = 1, 2, j \neq i$. This implies that demands are given by $q_i(p_i, p_j) = a - 2p_i + p_j$. Suppose firm 1 has zero marginal cost and firm 2 has positive marginal cost c , where $7c < 5a$. The two firms compete in prices.

- i. Compute the firms' profits at the Nash equilibrium if the two firms choose prices simultaneously. (7 marks)

- ii. Compute the firms' profits at the subgame-perfect equilibrium of the sequential game (a) when firm 1 is the leader, and (b) when firm 2 is the leader. (9 marks)

- iii. Derive the pure strategy equilibrium (or equilibria) of the multi-stage game in which the firms simultaneously choose whether to play 'early' or 'late' prior to setting prices. If they both make the same choice (either 'early' or 'late'), the simultaneous-move game follows; if they make different choices, a sequential game follows with the firm having chosen 'early' being the leader. (9 marks)

Reading for this question

Subject guide, Chapters 3 and 5.

Tirole (1988), Chapters 5 and 8.

Church and Ware (2000), Chapters 8 and 13–16.

Approaching the question

- i. The Nash equilibrium of the simultaneous-move game is given by the solution of the system:

$$\frac{\partial \pi_1}{\partial p_1} = 0 \Leftrightarrow p_1 = \frac{a + p_2}{4} \quad \text{and} \quad \frac{\partial \pi_2}{\partial p_2} = 0 \Leftrightarrow p_2 = \frac{a + 2c + p_1}{4}.$$

We obtain:

$$p_1^* = \frac{5a + 2c}{15} \quad \text{and} \quad p_2^* = \frac{5a + 8c}{15}.$$

Hence:

$$\pi_1^* = \frac{2(5a + 2c)^2}{225} \quad \text{and} \quad \pi_2^* = \frac{2(5a - 7c)^2}{225}.$$

- ii. If firm 1 is the leader, it maximises its profit $\pi_1 = p_1(a - 2p_1 + p_2)$ anticipating the reaction function of firm 2, $p_2 = (a + 2c + p_1)/4$. This gives $p_1^L = (5a + 2c)/14$ and $\pi_1^L = (5a + 2c)^2/112$. Also, $p_2^F = (19a + 30c)/56$ and $\pi_2^F = (19a - 26c)^2/1568$.

If firm 2 is the leader, it maximises its profit $\pi_2 = (p_2 - c)(a - 2p_2 + p_1)$ anticipating the reaction function of firm 1, $p_1 = (a + p_2)/4$. This gives $p_2^L = (5a + 7c)/14$ and hence $\pi_2^L = (5a - 7c)^2/112$. Also, $p_1^F = (19a + 7c)/56$ and $\pi_1^F = (19a + 7c)^2/1568$.

- iii. At the first stage of the game, the two firms simultaneously choose whether to move early or late, anticipating their and their rival's payoffs for each pair of actions. In particular, the payoff matrix is given by:

		Firm 1	
		Early	Late
Firm 2	Early	π_1^*, π_2^*	π_1^L, π_2^F
	Late	π_1^F, π_2^L	π_1^*, π_2^*

The equilibrium (equilibria) of the multi-stage game is the Nash equilibrium (equilibria) of the reduced-form game with payoffs given by the matrix above. Comparing the various profit expressions across the different cells, we can determine that there are two pure-strategy Nash equilibria of the reduced-form game: (early, late) and (late, early).

Question 6

Answer both parts of this question.

- (a) Consumers believe that a certain product they are buying is of high quality with probability p and low quality with probability $1 - p$, where $0 < p < 1$. A high-quality good is valued by consumers at v_H and costs c_H to produce, while a low-quality good is valued at $v_L \leq v_H$ and costs $c_L \leq c_H$ to produce.

- i. Derive an expression for the price consumers would be willing to pay for the product if high-quality firms do nothing to signal their quality.
- ii. Let $c_H = 0.9v_H$ and $v_H = 2v_L$. For what values of p would consumer beliefs about quality be consistent? That is, for what values of p is there actually a positive probability that some firms are producing high-quality goods?

(10 marks)

- (b) Consider a market for second-hand cars where cars can be of low (L) quality, medium (M) quality or high (H) quality. A seller's valuation, $V_S(q)$, of a car of quality q is $V_S(L) = 1000$, $V_S(M) = 2000$ and $V_S(H) = 3000$, respectively. A buyer's valuation of a car of quality q is $V_B(q) = \alpha + V_S(q)$, where $\alpha > 0$. Assume also that low-quality cars and medium-quality cars each represent $1/4$ of the total, with half the cars being of high quality. Find the value of α such that, in the market equilibrium:
- i. only the low quality cars would be traded
 - ii. only the medium and low quality cars would be traded
 - iii. all three types of cars would be traded.

(15 marks)

Reading for this question

Subject guide, Chapter 6.

Tirole (1988), Chapter 2.

Church and Ware (2000), Chapter 6.

Approaching the question

- (a) i. Consumers are willing to pay their expected valuation $pv_H + (1 - p)v_L$.
- ii. Since consumers cannot observe quality, the price of all goods will be the same, irrespective of quality, and (under Bertrand competition) equal to $pv_H + (1 - p)v_L$. A high-quality firm will only produce if it receives non-negative profits, i.e. if $pv_H + (1 - p)v_L \geq c_H$. This implies $p \geq 0.8$. For any value of p lower than this, high-quality firms would not produce, so all goods would be of low quality.
- (b) A buyer knows the fraction of cars of each type, but does not know the quality of any particular car. Suppose all types of cars are traded. The buyer's expected valuation of a car is:

$$EV = \frac{1}{4}(\alpha + 1000) + \frac{1}{4}(\alpha + 2000) + \frac{1}{2}(\alpha + 3000) = \alpha + 2250.$$

However, if $\alpha + 2250 < 3000 \Leftrightarrow \alpha < 750$, H cars are not traded, because no buyer would be willing to pay 3000, the seller's valuation for an H car.

Buyers can deduce this and conclude that H cars are not available if $\alpha < 750$. Their expected valuation for the 'average' car then becomes:

$$EV = \frac{1}{2}(\alpha + 1000) + \frac{1}{2}(\alpha + 2000) = \alpha + 1500.$$

However, if $\alpha + 1500 < 2000 \Leftrightarrow \alpha < 500$, M cars are not traded either.

Knowing this, buyers infer that only L cars are available if $\alpha < 500$. Their valuation for those cars is $\alpha + 1000 > 1000$, so indeed the L type cars are the only ones bought and sold in this case.

To summarise:

- i. if $0 < \alpha < 500$, only L type of cars are traded
- ii. if $500 \leq \alpha < 750$, only L and M types of cars are traded
- iii. if $\alpha \geq 750$, then all three types are on the market.

Question 7

Answer both parts of this question.

- (a) Consider a Cournot homogeneous good oligopoly with three firms and inverse demand function $P = 1 - Q$, where Q is the total quantity produced. Marginal costs are given by $c_1 = 0.1$, $c_2 = 0.35$ and $c_3 = 0.4$. There are no fixed costs. A merger between firms 2 and 3 is proposed. The merged firm will have marginal cost $c_2 = 0.35$. Show that this merger will reduce industry output but will also increase total welfare. Explain the intuition for your answer.

(10 marks)

- (b) Suppose that two innovation opportunities exist, each costing £100 in initial outlay, but generating different possible returns. Investment A generates a return of £150 with probability 0.5 and £100 with probability 0.5, while investment B generates a return of £180 with probability 0.5 and £10 with probability 0.5. Define and calculate the expected return for each investment. Then compare and contrast the investment choice of a self-financed investor and an investor financed by debt. Finally, explain what your analysis implies for the financing of new technological investment.

(15 marks)

Reading for this question

For (a):

Subject guide, Chapters 3 and 9.

Tirole (1988), Chapter 5.

Church and Ware (2000), Chapters 8 and 23.

For (b):

Subject guide, Chapters 6 and 10.

Tirole (1988), Chapters 2 and 10.

Church and Ware (2000), Chapter 6.

Approaching the question

- (a) The derivation is straightforward. At the pre-merger Cournot–Nash equilibrium, $q_1 \approx 0.36$, $q_2 \approx 0.11$ and $q_3 \approx 0.06$. Industry output is $Q \approx 0.54$ and total welfare (the sum of consumer surplus and total industry profit) is $W \approx 0.29$. After the merger, $q_1 \approx 0.38$, $q_2 \approx 0.13$, $Q \approx 0.51$ and $W \approx 0.30$. The intuition is that the more efficient firm (firm 1) expands output after the merger, while the combined output of the less efficient firms falls. Since c_1 is considerably lower than c_2 , the average cost of the industry falls significantly and this causes industry profit to rise sufficiently to more than compensate for the fall in consumer surplus.
- (b) The net expected value of investment A is:

$$0.5 \times (150 - 100) + 0.5 \times (100 - 100) = 25.$$

The net expected value of investment B is:

$$0.5 \times (180 - 100) + 0.5 \times (10 - 100) = -5.$$

A self-financed investor would choose A since it has the largest net expected value. An investor financed by debt would choose B since in case the return is low (£10), he/she would default and not return the full loan of £100. In particular, assuming that the most that can

be returned is the payoff of the investment, the expected return of project B for an investor financed by debt is:

$$0.5 \times (180 - 100) + 0.5 \times (10 - 10) = 40 > 25.$$

To analyse the implications of this adverse selection problem for the financing of innovations, one needs also to examine the point of view of the lender: he/she would never want to finance project B. However, if the lender cannot know whether any given borrower has project A or project B, the majority of investors seeking funding will have project B. As a result, the lender will be reluctant to lend in general and technological innovation will be underfinanced. Note that adverse selection is caused not by the uncertainty per se but by the asymmetry of information: the lender cannot know the payoffs of investments but the investor can.

Question 8

A monopoly manufacturer of a good sells to a monopoly retailer. The consumers' demand for the good is $q = 1 - p$, where q is quantity sold and p is the final price. The retailer has zero cost and the manufacturer's cost function is $C(q) = q^2/2$. The timing is as follows: first the manufacturer chooses a tariff to charge the retailer, and then the retailer chooses the final price.

- i. **What is the aggregate profit of this industry under vertical integration?**
(5 marks)
- ii. **Suppose a linear tariff, $T(q) = p_w q$, where p_w denotes the per unit price, is charged by the manufacturer in the vertically separated structure. What are the manufacturer's and the retailer's profits?**
(10 marks)
- iii. **Now suppose a two-part tariff, $T(q) = A + p_w q$, where p_w denotes the per unit price and A is a fixed fee, is charged by the manufacturer in the vertically separated structure. What are the manufacturer's and the retailer's profits? Compare the manufacturer's profit with the one you derived in part (ii) and give an intuitive explanation for your answer.**
(10 marks)

Reading for this question

Subject guide, Chapter 8.

Tirole (1988), Chapter 4.

Church and Ware (2000), Chapter 22.

Approaching the question

- i. Under vertical integration, the problem is one of computing the profit-maximising price and corresponding profit of a monopolist with demand function $q = 1 - p$ and cost function $C(q) = q^2/2$. The profit is equal to $1/6$.
- ii. Under a linear tariff, the manufacturer's profit function is given by:

$$\Pi^M = p_w q - q^2/2 = p_w(1 - p) - (1 - p)^2/2$$

and the retailer's profit function is:

$$\Pi^R = (p - p_w)q = (p - p_w)(1 - p).$$

Now use ‘backward induction’. At stage 2 the retailer chooses p to maximise Π^R , taking p_w as given. This gives $p = (1 + p_w)/2$, the optimal choice of the retailer for any given level of p_w . At stage 1 the manufacturer anticipates that the retailer will set a final price $p = (1 + p_w)/2$. Therefore, the manufacturer chooses p_w to maximise Π^M subject to the constraint $p = (1 + p_w)/2$. The solution to this maximisation problem is $p_w^* = 3/5$. It follows that $p^* = 4/5$. Substituting into the profit functions we obtain $\Pi^{M^*} = 1/10$ and $\Pi^{R^*} = 1/25$.

iii. Under a two-part tariff, the manufacturer’s profit function is:

$$\Pi^M = p_w q - q^2/2 + A$$

while the retailer’s profit function is:

$$\Pi^R = (p - p_w)q - A$$

where A is a fixed fee. At stage 2, the retailer chooses p to maximise Π^R , taking p_w and A as given. This gives again $p = (1 + p_w)/2$. At stage 1 the manufacturer chooses p_w and A to maximise Π^M subject to two constraints. The first of these constraints is again $p = (1 + p_w)/2$. The second constraint is that the retailer’s profit must be non-negative. In particular, note that the manufacturer can always appropriate all the retailer’s profit by choosing an appropriate value of A . So the second constraint in the maximisation problem of the manufacturer is $\Pi^R = (p - p_w)q - A = 0$. The solution to the maximisation problem is $p_w^{**} = 1/3$. It follows that $p^{**} = 2/3$ and $A^{**} = 1/9$. Substituting into the profit functions we obtain $\Pi^{M^{**}} = 1/6$ and $\Pi^{R^{**}} = 0$.

The manufacturer’s profit is higher under the two-part tariff: $1/6 > 1/10$. This is a general result. The two-part tariff mitigates the double-marginalisation problem and, therefore, leads to the efficient outcome, i.e. the highest possible aggregate profit (all of which is appropriated by the manufacturer).

Examiners' commentaries 2017

EC3099 Industrial economics

Important note

This commentary reflects the examination and assessment arrangements for this course in the academic year 2016–17. 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 (2015). 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 B

Candidates should answer **FOUR** of the following **EIGHT** questions: **TWO** from Section A, and **TWO** from Section B. All questions carry equal marks.

If more questions are answered than requested, only the first answers attempted will be counted.

Section A

Answer two questions from this section.

Question 1

Consider two owner-managed firms that enter into a long-run relationship as buyer and seller of a good, respectively. Both firms can make a relation-specific investment that increases the gains from trade. Discuss under what circumstances it is efficient for the two firms to merge. Then show, with reference to a suitable economic model, that if a vertical merger is to occur, efficiency requires that the residual rights of control rest with the party whose investment has the larger effect on the joint profit.

(25 marks)

Reading for this question

Subject guide, Chapter 1.

Tirole (1988), introductory chapter.

Church and Ware (2000), Chapter 3.

Approaching the question

A good answer to this question should start by outlining the transaction costs–property rights approach as a theory that provides an explanation for the size and structure of firms. The main ideas of the property rights approach should then be discussed, with an emphasis on the issue of asset ownership (the residual rights of control) and incentives for vertical integration. This discussion should lead to a statement of the main conclusions on issues such as when integration is useful and when it is not, and which party should own the merged firm in case of integration.

Key ideas include the following. Integration reduces opportunistic behaviour because if, say, firm A acquires firm B, then the manager of firm B loses control of the physical assets of firm B, so he has much less bargaining power. Efficiency requires that highly complementary assets are under common ownership, whereas independent assets should be separately owned. And efficiency also requires that in the case of a vertical merger the residual rights of control rest with the party whose investment has the larger effect on the joint profit.

A very good answer would outline an appropriate formal model to illustrate some of these ideas, especially the question of who should acquire whom for efficiency in the case of a vertical merger. A model of this kind, which examines how ownership changes the division of the ex-post surplus and hence the ex-ante investment, is described in the subject guide, Chapter 1, section ‘Property rights’.

Question 2

Answer all parts of this question.

- (a) Is it a good idea to have a junior clerk in a bank on an incentive contract? Is it a good idea to have the chief executive officer of a bank on an incentive contract? Why or why not? (8 marks)
- (b) Which model, Cournot or Bertrand, do you think provides a better approximation to competition in each of the following industries: steel manufacturing, hotels, insurance. Why? (7 marks)
- (c) Consider the linear location model where consumers are uniformly distributed along a linear city and have linear travel costs, the price is exogenously fixed and the firms compete by simultaneously choosing locations. However, assume there are four firms in the market rather than just two. Derive the Nash equilibrium of this game and interpret the result. (10 marks)

Reading for this question

For (a):

Subject guide, Chapter 2.

Tirole (1988), introductory chapter.

Church and Ware (2000), Chapter 3.

For (b):

Subject guide, Chapter 3.

Tirole (1988), Chapter 5.

Church and Ware (2000), Chapter 8.

For (c):

Subject guide, Chapter 6.

Tirole (1988), Chapter 7.

Church and Ware (2000), Chapter 11.

Approaching the question

- (a) The basis of the answer to this question is the economic theory of incentives within a firm, when the effort of employees may be observable or unobservable. It is useful to briefly describe this theoretical background. The effort of a junior clerk (i) is more likely to be observable or easy to monitor and (ii) matters much less for the firm's overall performance than the effort of the chief executive officer (CEO). On both counts, it makes more sense to provide incentives (i.e. make compensation partly a function of the firm's performance) to the CEO than to the junior clerk, and it is, therefore, not surprising that this is what we generally observe in practice.
- (b) The answer should briefly describe the results of economic models of price competition with capacity constraints and argue that it is valid to interpret the distinction between price competition (Bertrand) and quantity competition (Cournot) as a difference in the flexibility of production: if capacity constraints exist, or more generally if costs rise steeply with output in the short run, in a particular industry, then the Cournot model is more appropriate for this industry; if not, then the Bertrand model is more appropriate. On this basis, the Cournot model would be a better approximation for steel manufacturing and hotels, the Bertrand model for insurance.
- (c) You need to consider all possible configurations of the four firms along the line and show that all except one of these cases cannot be sustained as Nash equilibria because at least one firm has a profitable deviation. The unique Nash equilibrium is for two of the firms to locate $1/4$ of the total distance to the right of the left end of the line and for the other two firms to locate $1/4$ of the total distance to the left of the right end of the line. An explanation should be given for why no profitable deviation exists in this case, i.e. why none of the firms can increase its profit by moving.

Question 3

A significant number of resale price maintenance (RPM) cases that have been the subject of antitrust policy involve the pricing of consumer products. Discuss possible explanations for the imposition of RPM in such products. Who do you think would have an incentive to impose RPM, the manufacturer, the retailer, or both? Explain your answer.

(25 marks)

Reading for this question

Subject guide, Chapter 8.

Tirole (1988), Chapter 4.

Church and Ware (2000), Chapter 22.

Approaching the question

A good answer should start by defining 'resale price maintenance' (rpm). You should then discuss various theoretical arguments that can be used to justify the imposition of rpm on consumer products. You should explain why rpm may in some cases increase efficiency in a

market (taking care to explain what efficiency means in this context) and in other cases restrict competition. For instance, rpm may be used by a manufacturer in order to solve the double marginalisation problem or as a ‘quality certification’ device. On the other hand, rpm may be used to facilitate collusion between manufacturers or retailers. It should also be clear from your discussion that rpm can be in the interest of manufacturers or retailers or both. A very good answer would refer to specific theoretical models that involve the use of rpm. Finally, you may also want to refer to some empirical evidence that supports your theoretical arguments for the imposition of rpm on consumer products.

Question 4

‘When collusion among firms breaks down in an industry, concentration is expected to rise.’ Under what conditions (if any) is this statement true? Discuss with reference to economic theory and any relevant empirical evidence.

(25 marks)

Reading for this question

Subject guide, Chapter 9.

Sutton (1991), various chapters.

Approaching the question

You should begin with a discussion of the relationship between short-run competition and market structure with reference to a theoretical framework such as the one outlined in Chapter 9 of the subject guide.

In an exogenous sunk cost industry, the key result of a positive effect of the intensity of short-run competition on market structure can be illustrated using a simple two-stage game: at stage 1 firms decide whether or not to enter at a certain sunk cost, while at stage 2 they are faced with various possible competition regimes, including Bertrand competition, Cournot competition and perfect collusion. Using a linear demand function and a constant marginal cost (the same for all firms), one can show that the number of firms that enter is lower under Bertrand or Cournot competition than under collusion. In other words, market concentration should increase when collusion breaks down in an industry. The intuition for this result should be clearly explained. An important feature of this model is that entry is not restricted, i.e. the number of firms is an endogenous variable. Some discussion of whether the result extends to endogenous sunk cost industries is also required.

The second part of the question asks for a discussion of empirical evidence. Some evidence provided by Symeonidis is discussed in the subject guide: a major shift in UK competition policy in the late 1950s has made it possible to compare a group of previously collusive industries (which experienced an increase in the intensity of price competition) with a control group of non-collusive industries (which were not affected by the change in policy). Furthermore, entry was not restricted in most cartelised industries. Any other available evidence may also be discussed.

A very good answer might also indicate the main policy implications of this analysis. One such implication is that competition policy authorities should perhaps be less concerned with concentration than with ensuring that competition remains effective, i.e. firms do not collude and do not create barriers to entry.

Section B

Answer two questions from this section.

Question 5

Consider a homogeneous good market with N firms which set their output sequentially (firm i in period i). The industry faces an inverse demand $P(q) = a - Q$ where $Q = q_1 + q_2 + \dots + q_N$. Suppose that the firms have identical constant marginal costs of production c , where $c < a$.

- i. Using backward induction, show that the output of firm i in the subgame-perfect equilibrium is given by $q_i = 1/2(a - q_1 - q_2 - \dots - q_{i-1} - c)$, $i = 1, \dots, N$. (15 marks)
- ii. Compute the aggregate output of the N firms. (5 marks)
- iii. Describe the equilibrium outcome when the number of firms $N \rightarrow \infty$ and comment on the implications of $N \rightarrow \infty$ for profits. (5 marks)

Reading for this question

Subject guide, Chapter 5.

Tirole (1988), Chapter 8.

Church and Ware (2000), Chapters 13–16.

Approaching the question

- i. We proceed by backward induction. In period N , firm N chooses q_N to maximise its profit:

$$\pi_N = (a - Q - c)q_N$$

taking q_1, q_2, \dots, q_{N-1} as given. From the first-order condition $\partial\pi_N/\partial q_N = 0$ we obtain:

$$q_N = \frac{1}{2}(a - q_1 - q_2 - \dots - q_{N-1} - c).$$

In period $N - 1$, firm $N - 1$ chooses q_{N-1} to maximise its profit:

$$\pi_{N-1} = (a - Q - c)q_{N-1}$$

taking q_1, q_2, \dots, q_{N-2} as given and anticipating:

$$q_N = \frac{1}{2}(a - q_1 - q_2 - \dots - q_{N-1} - c).$$

Substituting this expression for q_N into π_{N-1} and solving the first-order condition $\partial\pi_{N-1}/\partial q_{N-1} = 0$ we obtain:

$$q_{N-1} = \frac{1}{2}(a - q_1 - q_2 - \dots - q_{N-2} - c).$$

We can keep working backwards for one or two more firms until the general expression becomes clear. This is given by:

$$q_i = \frac{1}{2}(a - q_1 - q_2 - \dots - q_{i-1} - c), \quad i = 1, \dots, N.$$

Therefore, for firm 1, we have $q_1^* = (a - c)/2$. From these two equations we get $q_2^* = (a - q_1 - c)/2 = (a - c)/4$, $q_3^* = (a - c)/8$, and so on for all the other firms. The general expression is:

$$q_i^* = \frac{a - c}{2^i}, \quad i = 1, \dots, N.$$

- ii. The aggregate output is the sum of all the individual outputs:

$$Q^* = (a - c)(1/2 + 1/2^2 + 1/2^3 + \dots + 1/2^N) = (a - c)(1 - 1/2^N).$$

- iii. For $N \rightarrow \infty$, $Q^* = (a - c)$. This implies $p = c$, so profits of all firms are zero.

Question 6

Answer both parts of this question.

- (a) Consider a Cournot homogeneous good oligopoly with three firms and inverse demand function $P = 1 - Q$, where Q is the total quantity produced. Marginal costs are given by $c_1 = 0.1$, $c_2 = 0.35$ and $c_3 = 0.4$. There are no fixed costs. A merger between firms 2 and 3 is proposed. The merged firm will have marginal cost $c_2 = 0.35$. Show that this merger will reduce industry output but will also increase total welfare. Explain the intuition for your answer.

(10 marks)

- (b) Suppose that two innovation opportunities exist, each costing £100 in initial outlay, but generating different possible returns. Investment A generates a return of £150 with probability 0.5 and £100 with probability 0.5, while investment B generates a return of £180 with probability 0.5 and £10 with probability 0.5. Define and calculate the expected return for each investment. Then compare and contrast the investment choice of a self-financed investor and an investor financed by debt. Finally, explain what your analysis implies for the financing of new technological investment.

(15 marks)

Reading for this question

For (a):

Subject guide, Chapters 3 and 9.

Tirole (1988), Chapter 5.

Church and Ware (2000), Chapters 8 and 23.

For (b):

Subject guide, Chapters 6 and 10.

Tirole (1988), Chapters 2 and 10.

Church and Ware (2000), Chapter 6.

Approaching the question

- (a) The derivation is straightforward. At the pre-merger Cournot–Nash equilibrium, $q_1 \approx 0.36$, $q_2 \approx 0.11$ and $q_3 \approx 0.06$. Industry output is $Q \approx 0.54$ and total welfare (the sum of consumer surplus and total industry profit) is $W \approx 0.29$. After the merger, $q_1 \approx 0.38$, $q_2 \approx 0.13$, $Q \approx 0.51$ and $W \approx 0.30$. The intuition is that the more efficient firm (firm 1) expands output after the merger, while the combined output of the less efficient firms falls. Since c_1 is considerably lower than c_2 , the average cost of the industry falls significantly and this causes industry profit to rise sufficiently to more than compensate for the fall in consumer surplus.
- (b) The net expected value of investment A is:

$$0.5 \times (150 - 100) + 0.5 \times (100 - 100) = 25.$$

The net expected value of investment B is:

$$0.5 \times (180 - 100) + 0.5 \times (10 - 100) = -5.$$

A self-financed investor would choose A since it has the largest net expected value. An investor financed by debt would choose B since in case the return is low (£10), he/she would default and not return the full loan of £100. In particular, assuming that the most that can be returned is the payoff of the investment, the expected return of project B for an investor financed by debt is:

$$0.5 \times (180 - 100) + 0.5 \times (10 - 10) = 40 > 25.$$

To analyse the implications of this adverse selection problem for the financing of innovations, one needs also to examine the point of view of the lender: he/she would never want to finance project B. However, if the lender cannot know whether any given borrower has project A or project B, the majority of investors seeking funding will have project B. As a result, the lender will be reluctant to lend in general and technological innovation will be underfinanced. Note that adverse selection is caused not by the uncertainty per se but by the asymmetry of information: the lender cannot know the payoffs of investments but the investor can.

Question 7

Answer both parts of this question.

- (a) Consumers believe that a certain product they are buying is of high quality with probability p and low quality with probability $1 - p$, where $0 < p < 1$. A high-quality good is valued by consumers at v_H and costs c_H to produce, while a low-quality good is valued at $v_L \leq v_H$ and costs $c_L \leq c_H$ to produce.
- Derive an expression for the price consumers would be willing to pay for the product if high-quality firms do nothing to signal their quality.
 - Let $c_H = 0.9v_H$ and $v_H = 2v_L$. For what values of p would consumer beliefs about quality be consistent? That is, for what values of p is there actually a positive probability that some firms are producing high-quality goods?
- (10 marks)
- (b) Consider a market for second-hand cars where cars can be of low (L) quality, medium (M) quality or high (H) quality. A seller's valuation, $V_S(q)$, of a car of quality q is $V_S(L) = 1000$, $V_S(M) = 2000$ and $V_S(H) = 3000$, respectively. A buyer's valuation of a car of quality q is $V_B(q) = \alpha + V_S(q)$, where $\alpha > 0$. Assume also that low-quality cars and medium-quality cars each represent 1/4 of the total, with half the cars being of high quality. Find the value of α such that, in the market equilibrium:
- only the low quality cars would be traded
 - only the medium and low quality cars would be traded
 - all three types of cars would be traded.

(15 marks)

Reading for this question

Subject guide, Chapter 6.

Tirole (1988), Chapter 2.

Church and Ware (2000), Chapter 6.

Approaching the question

- (a) i. Consumers are willing to pay their expected valuation $pv_H + (1 - p)v_L$.
- ii. Since consumers cannot observe quality, the price of all goods will be the same, irrespective of quality, and (under Bertrand competition) equal to $pv_H + (1 - p)v_L$. A high-quality firm will only produce if it receives non-negative profits, i.e. if $pv_H + (1 - p)v_L \geq c_H$. This implies $p \geq 0.8$. For any value of p lower than this, high-quality firms would not produce, so all goods would be of low quality.
- (b) A buyer knows the fraction of cars of each type, but does not know the quality of any particular car. Suppose all types of cars are traded. The buyer's expected valuation of a car is:

$$EV = \frac{1}{4}(\alpha + 1000) + \frac{1}{4}(\alpha + 2000) + \frac{1}{2}(\alpha + 3000) = \alpha + 2250.$$

However, if $\alpha + 2250 < 3000 \Leftrightarrow \alpha < 750$, H cars are not traded, because no buyer would be willing to pay 3000, the seller's valuation for an H car.

Buyers can deduce this and conclude that H cars are not available if $\alpha < 750$. Their expected valuation for the 'average' car then becomes:

$$EV = \frac{1}{2}(\alpha + 1000) + \frac{1}{2}(\alpha + 2000) = \alpha + 1500.$$

However, if $\alpha + 1500 < 2000 \Leftrightarrow \alpha < 500$, M cars are not traded either.

Knowing this, buyers infer that only L cars are available if $\alpha < 500$. Their valuation for those cars is $\alpha + 1000 > 1000$, so indeed the L type cars are the only ones bought and sold in this case.

To summarise:

- i. if $0 < \alpha < 500$, only L type of cars are traded
- ii. if $500 \leq \alpha < 750$, only L and M types of cars are traded
- iii. if $\alpha \geq 750$, then all three types are on the market.

Question 8

As the owner of the only tennis club in an isolated island, you must decide on annual membership fees and fees for court times. There are two types of tennis players. 'Serious' players have demand $Q_1 = 6 - P$, where Q_1 is court hours per week and P is the court fee per hour for each individual player. There are also 'occasional' players with demand $Q_2 = 3 - P/2$. Assume there are 1000 players of each type. Because you have plenty of courts, the marginal cost of court time is zero. You have fixed costs of 5,000 per week. Serious and occasional players look alike, so you must charge them the same prices.

- i. Suppose that to maintain a 'professional' atmosphere, you want to limit membership only to serious players. How should you set the annual membership fee and the court fee (assuming there are 52 weeks per year) to maximise your profit? What will your profit be? (10 marks)
- ii. A friend tells you that you could make greater profits by encouraging both types of players to join, while still setting a single court fee and a single annual membership fee. How would you set the annual membership fee and the court fee in this case? Is your friend right? Explain. (12 marks)
- iii. Another friend suggests there may be a way of making even greater profit than in parts (i) and (ii) by offering a range of packages rather than just a single two-part tariff. Is your friend right? Explain briefly and informally. (3 marks)

Reading for this question

Subject guide, Chapter 7.

Tirole (1988), Chapter 3.

Church and Ware (2000), Chapter 5.

Approaching the question

- i. When only 'serious' players are to join the tennis club, the club maximises its profit by setting a court fee equal to marginal cost, and appropriating the entire consumer surplus of serious players through a fixed entry fee. This amounts to first-degree price discrimination applied to each individual serious player (this is feasible since all serious players are identical). The tennis club should charge no court fee, since the marginal cost is zero. With zero court fee, the consumer surplus of a serious player is 18 per week, or 936 per year. The tennis club should, therefore, charge an entry fee of 936 per year. (We assume that when a player is indifferent between joining and not joining, she joins.) Only serious players will join, since the entry fee will be larger than the consumer surplus of occasional players. Weekly profits will be 13,000.
- ii. This scheme is a form of second-degree price discrimination. Note that in this case the court fee should not be equal to marginal cost. Formally, the tennis club sets P and F to maximise its profit. For any given P , the entry fee must be set equal to the consumer surplus of an individual occasional player:

$$F = Q_2(6 - P)/2.$$

This allows the serious players to enjoy a positive consumer surplus, while the occasional players are just indifferent between joining and not joining. The entry fee should not be set at a lower level since then occasional players will be enjoying a positive consumer surplus and the club will not be maximising its profit. And it cannot be set at a higher level since then occasional players will not join.

Total profit is given by:

$$1000P(Q_1 + Q_2) + 2000F - 5000$$

where F is given by the expression above, $Q_1 = 6 - P$ and $Q_2 = 3 - P/2$. Maximisation of the expression for profit with respect to P gives $P = 1.50$ per hour. Plugging this back into the expression for profit gives 15,250 per week, which is larger than 13,000, the profit under part (i).

- iii. Optimal non-linear pricing involves offering two different packages and allowing for each type to self-select into one or the other package. A good answer should include a brief discussion of the main properties of such a scheme.