

**Part I: Multiple-choice questions. Select exactly one alternative for each question. Each correct answer gives 5 points and each incorrect answer -1 point.**

1. A market has 5 firms. One of them has a market share of 40%, a second 30%, and the other three 10% each. Which of the following statements is true?
  - (a) The 3-firm concentration ratio is 50%
  - (b) The 4-firm concentration ratio is 60%
  - (c) The firm has a *Herfindahl-Hirschman Index* (measured from 1 to 10,000) of 2,800
  - (d) The Herfindahl-Hirschman Index is higher than if a monopoly controlled the entire market.
  - (e) None of the above.
  
2. Three identical firms are competing à la Cournot in a market. In equilibrium, the *Lerner Index* for each firm is given by  $1/6$ . What is the absolute value of the price elasticity of industry demand?
  - (a) 1.
  - (b) 2.
  - (c) 3.
  - (d) 4.
  - (e) None of the above.
  
3. Consider the following extensive form game. Player 1 first chooses between L and R. If she chooses R, she thereafter gets to choose between l and r. Without observing player 1's choice, player 2 thereafter chooses between T and B. The game is depicted in Figure 1 (with firm 1's payoff to the left). Which of the following statements is true?
  - (a) The game can be solved using backward induction.
  - (b) The game has a unique subgame-perfect equilibrium.
  - (c) The game has a unique Nash equilibrium.
  - (d) Player 2 has four strategies.
  - (e) None of the above.

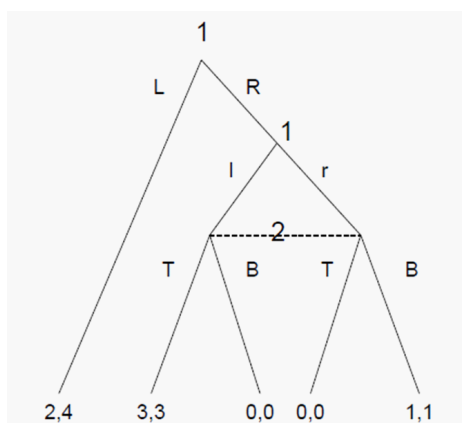


Fig. 1.

4. In the analysis of deterrence and accommodation of entry, the incumbent was assumed to first make an irreversible investment that could either make the incumbent "tough" or "soft". Given this investment a potential entrant decides whether to enter or not. Depending on whether the firms' decision variables in the second stage are strategic substitutes or complements the incumbent may over- or under-invest (in comparison to what it would do absent the strategic interaction). Given that competition takes place in strategic substitutes, which of the following alternatives is correct?
- (a) An incumbent wishing to deter entry will choose a *fat cat* strategy, given that the investment makes the incumbent tough.
  - (b) An incumbent wishing to accommodate entry will choose a *puppy dog* strategy, given that the investment makes the incumbent tough.
  - (c) An incumbent wishing to deter entry will choose a *top dog* strategy, given that the investment makes the incumbent soft.
  - (d) An incumbent wishing to accommodate entry will choose a *lean and hungry look* strategy, given that the investment makes the incumbent soft.
  - (e) None of the above.
5. Which of the following alternatives is false?
- (a) Under Cournot competition, a merger with no efficiency gains will lead firms outside the merger to expand output.
  - (b) Under Cournot competition with equal sized firms, a merger with no efficiency gains must be profitable if the merger involves two thirds of the firms in the market.
  - (c) A merger with synergies could be both profitable and detrimental to consumers
  - (d) Under price competition, a merger without efficiency gains reduces welfare.
  - (e) "Coordinated effects" refers to how a merger affects the risk for collusion.
6. Which of the following alternatives is false?
- (a) A drastic innovation makes it optimal for the innovator to set the monopoly price for the good.
  - (b) A process innovation reduces the cost for producing a good.
  - (c) The replacement effect implies that a competitive firm places a smaller value on a minor process innovation than a monopoly does.
  - (d) It is not profitable to license a drastic innovation to competitors.
  - (e) None of the above.

## Part II: Questions that require answers with calculations/motivation

7. Consider the following version of the Hotelling model where two firms, 1 and 2, are located at the endpoints of a unit interval and consumers are distributed uniformly over this interval. A consumer located at a distance  $x$  from firm 1 obtains a utility of  $4 - x - p_1$  by purchasing one unit from firm 1 at the price  $p_1$  and  $3 - (1 - x) - p_2$  by purchasing one unit from firm 2 at the price  $p_2$ . All consumers have a reservation utility of zero and zero valuation of additional units. Both firms have a marginal cost of 1.
- (a) (10 points) Find a Nash equilibrium of the game where the two firms set prices simultaneously.
  - (b) (10 points) Suppose the transportation cost increases substantially, such that a consumer located at a distance  $x$  from firm 1 now obtains a utility of  $4 - 4x - p_1$  by purchasing one unit from firm 1 at the price  $p_1$  and  $3 - 4(1 - x) - p_2$  by purchasing one unit from firm 2 at the price  $p_2$ . Find an equilibrium of the game where the two firms set prices simultaneously.
8. Consider a monopoly firm producing two goods,  $A$  and  $B$ , at zero cost. A unit mass of consumers have preferences over the two goods. A consumer is identified by the couple  $(\theta_A, \theta_B)$ , where  $\theta_A$  and  $\theta_B$  are the valuations over the goods. Assume  $(\theta_A, \theta_B)$  is distributed uniformly over the unit square (i.e. the valuations for  $A$  and  $B$  are independent and uniform over  $[0, 1]$ ).
- (a) (10 points) Illustrate using a diagram which consumers buy the goods if the goods are sold separately at the prices  $p_A$  and  $p_B$ , both between zero and one. Then, calculate the profit-maximizing prices  $p_A$  and  $p_B$ .
  - (b) (10 points) Illustrate using a diagram which consumers buy the goods if the goods are sold using *pure bundling* (with one unit of each good) at a price  $p$ , between zero and one. Then, calculate the profit-maximizing price  $p$ .
9. Consider a market with  $n$  firms producing a homogeneous good. Suppose the market is an infinitely repeated game.
- (a) (10 points) Firms compete in prices and the equilibrium non-collusive profit is 0. The monopoly profit in the market is  $\pi$  and the discount rate is  $\rho$ . If firms tacitly collude they share the profit equally. If a firm deviates it can secure the monopoly profit (less an infinitesimally small amount) for itself. (i) Derive an expression for the critical discount factor for sustaining tacit collusion. Discuss how this discount factor depends on market concentration. (ii) How would the condition change if interaction only took place every second period? Discuss the role of the frequency of interaction.
  - (b) (5 points) Suppose firms compete in quantities instead. Explain what a stick-and-carrot strategy is and why it can facilitate collusion in this case.
10. In the model of network externalities presented in the textbook, network effects are linear and consumer heterogeneity is represented by a uniformly distributed taste parameter  $\theta \in [0, 1]$ . Two scenarios are considered: Heterogeneous network effects and heterogeneous stand-alone benefits.

- (a) (10 points) In the heterogeneous network effects case, the utility of a consumer with taste  $\theta$  is  $U(\theta) = a + \theta vn^e$ . The constants  $a$  and  $v$  measure the strength of the stand-alone benefit and the network effect respectively, and  $n^e$  is the expected network size. A consumer buys the good if the expected utility exceeds the price,  $p$ . (i) What is the inverse demand for the network good when expectations are fulfilled? Illustrate the inverse demand in a graph. (ii) Point out different possible equilibria in the graph and discuss stability and efficiency.
- (b) (5 points) In the heterogeneous stand-alone benefit case, the utility of a consumer with taste  $\theta$  is  $U(\theta) = \theta a + vn^e$ . Illustrate possible equilibria when stand-alone benefits are strong relative to the network effects, and vice-versa, in two graphs.