UNIVERSITY OF DELHI

M.A. Economics: Summer Semester 2017-2018

Course 801: Industrial Organization

Maximum marks: 70 **Time: 2 ½ hours**

Instructions: Check that this question paper has 3 pages, with questions numbered 1 to 4. Answer Question 1 and any ***two*** other questions. Read the questions carefully before answering. Keep your answers short and precise, *taking care to explain the relevance of the assumptions wherever appropriate in your mathematical derivations*.

1. (COMPULSORY) (*Hint: use symmetry in both parts to simplify the derivations*)

(a) Suppose that there are two identical firms (1 and 2) with zero marginal costs. They produce a homogenous product, which is demanded by a unit mass of identical consumers, each of whom has inelastic unit demand with a reservation price of Rs 2. Prices are constrained to take only integer values. Using standard game-theoretic reasoning, determine whether or not each possible price pair (p_1, p_2) can be regarded as a Bertrand-Nash equilibrium. (Assume that the market is equally shared if firms charge identical prices>0

(b) M identical consumers, each having inelastic unit demand with reservation price v are uniformly distributed on a circle of unit circumference. A consumer located at distance d from a firm can buy its product by paying the price plus linear 'transport costs' of td. Assume that v is high enough such that the possibility of non-purchase can be ignored for all consumers. In this context,

i) Derive the Bertrand-Nash equilibrium prices, quantities and profits for a given number ($n > 1$) of identical firms at equidistant locations, with constant marginal cost $c < v$.

ii) Suppose firms can enter with an entry cost of F and simultaneously locate themselves at equal intervals on the circumference of the circle, before competing in prices. Using the expressions derived in part (i), prove that the number of firms in a free-entry equilibrium is twice the socially optimal number.

(10, 20)

2. Two firms play an infinitely repeated game, with discount factor δ. In any period, they can either collude, earning π^c each, or compete, earning the Nash equilibrium profit π^n each. Deviation from collusion earns π^d for the deviating firm, but it is punished by a grim trigger strategy with Nash reversion from the very next period. Collusion requires communication, which creates evidence that lasts for that period only. There is an antitrust agency that audits the industry and finds the evidence with probability $\rho < 1$. This results in a fine F on each firm, including a deviating firm. However, $\pi^c - \rho F > \pi^n$, so auditing by itself is not sufficient to deter collusion. The firms resume colluding again from the next period even after a successful audit, but evidence is generated again for that period, which can be discovered by audit with the same probability. In this setting, answer the following questions:
   a) Suppose the antitrust agency offers a reward R to a firm that reports the evidence. (Note that $-\rho F < R \leq 0$ implies a reduced fine, while $R > 0$ implies positive reward.) The firms use Nash reversion to deter such reporting. Set up and explain the relevant incentive compatibility condition to sustain collusion in equilibrium. Use this to derive the minimum value of R (call it R_{min}) required to deter collusion. Show how changes in δ and ρ affect R_{min}, and provide an intuitive explanation for these relationships.
   b) Suppose that instead of rewarding a firm that reports collusion, the agency offers a bounty of B to any employee who reports the evidence. In each firm, k employees have access to the evidence. Show that collusion is easier to deter, the larger is B or k, and provide an intuitive explanation for these relationships.
   c) What could be the practical difficulties the agency might face in offering positive rewards for reporting collusion?

(10, 5, 5)

3. Consider a two-period model in which an incumbent is a monopolist in the first period, and a potential entrant decides whether or not to enter in the second period after observing the incumbent's first-period price. The

incumbent's marginal cost can be high ($0 < c_H < ½$) with probability p or low ($c_L = 0$) with probability $1 - p$. It is revealed only to the incumbent in the first period, but becomes known to the entrant if it enters. The entrant's entry costs of e and marginal cost of zero are common knowledge. Inverse demand in each period is given by $P = 1 - Q$. If entry takes place, the firms compete in quantities. In this setting, answer the following questions:

a) Calculate the Cournot-Nash equilibrium duopoly profits for both firms for the two possible realizations of costs. Then write down the expressions corresponding to the following statements: (i) The entrant's profits can cover its entry cost if it competes against an incumbent which is known to have high costs, but not if the incumbent is known to have low costs. (ii) If the entrant does not know the incumbent's cost type, its expected profits based on the prior probabilities p and $1 - p$ are strictly less than its entry cost.

b) Suppose the incumbent's objective is to maximize the sum of its profits in both periods without discounting. Using the expressions derived in part (a), set up the incentive-compatibility condition for a high-cost type incumbent which can deter entry by imitating the behavior of a low-cost type in the first period. Verify that this condition holds, and characterize the corresponding Perfect Bayesian Equilibrium.

c) How would you assess the entry-deterring equilibrium of part (b) from the perspective of social welfare, relative to the equilibrium that would arise under complete information?

(8, 8, 4)

4. A monopolist manufacturer with marginal cost $c < 1$ sells its product to a single downstream retailer at a wholesale price of w. The retailer resells to consumers at a retail price of p, without incurring any retailing costs or providing any services. Market demand is given by $Q = 1 - p$. In this context,

a) Prove that vertical integration increases social welfare.

b) If integration is not possible, specify any two vertical contractual restraints that the manufacturer can impose on the retailer so as to reproduce the vertically integrated solution under symmetric information and deterministic demand. Briefly discuss how asymmetric information can complicate these restraints.

(10, 10)