University of California, Davis
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Time: 3 hours
Reading time: 20 minutes

PRELIMINARY EXAMINATION FOR THE Ph.D. DEGREE

Industrial Organization

June 27, 2006

Answer **four** of the six questions. You must choose at least one question from each of the three sections (A, B, and C) of the exam.

Section A

1.. Consider the following multi-stage game. In the first stage an incumbent monopolist decides whether to be passive or committed. Commitment costs $\$C$ and is irreversible. In stage two Nature (i.e. a random mechanism) selects the opportunity cost of entry $k \in K$ (that is, the profit that the potential entrant could make in the best alternative investment) according to the cumulative distribution function F [thus, for every number x, $F(x)$ is the probability that the opportunity cost of entry k is less than or equal to x].

In stage three the potential entrant observes the opportunity cost of entry which Nature selected and decides whether to enter or not. If she doesn't enter, the incumbent remains the only firm in the market. Monopoly profits are given by $\$M$. If entry occurs, a duopoly game between the two firms follows. Let D_I and D_E be the incumbent's and entrant's profits, respectively, at the Nash equilibrium of the duopoly game following entry with a passive incumbent, and H_I and H_E be their respective profits at the Nash equilibrium of the duopoly game following entry with a committed incumbent (H_I *includes* the commitment cost C).

(a) Assume that $K = [a, b]$ (the closed interval between a and b, $0 < a < b$) and $a < H_E < D_E < b$. Under what conditions is there commitment at every subgame-perfect equilibrium? Under what conditions are the subgame-perfect equilibria characterized by the fact that the incumbent is passive?

(b) Draw the extensive form of this multistage game for the case where $K = \{k_1, k_2\}$ (substitute each duopoly game with the corresponding equilibrium payoffs).

(c) Suppose that $K = \{1, 4, 6, 12\}$, all the values in K are equally likely, $M = 12$, $C = 1$, $D_I = D_E = 5$, $H_I = H_E = 2$. Would a rational incumbent choose commitment (identify rationality with subgame-perfect equilibrium behavior)?

(d) Suppose that $K = \{1, 2, 4, 7\}$, Prob{1} = Prob{2} = Prob{4} = 1/5, Prob{7} = 2/5, $M = 8$, $C = 2$, $D_I = D_E = 7/2$, $H_I = H_E = 3/2$. Would a rational incumbent choose commitment?

(e) *Briefly* explain what kind of commitments an incumbent monopolist can use to deter entry and give a *brief* intuitive explanation of the reason why entry becomes unattractive if the commitment is undertaken.

2. There is a large number *N* of consumers, with identical preferences but different incomes. Incomes are uniformly distributed in the interval [0,1]. There are two possible quality levels for the good: H (high) and L (low). Each consumer buys at most one unit of at most one good. A consumer with income $t \in [0,1]$ has the following utility function:

$$\begin{cases} t & \text{if she does not buy the good} \\ U(k)[t - p_k] & \text{if she buys one unit of a good of quality } k \in \{L,H\} \text{ at price } p_k \end{cases}$$

Use the following notation: x = U(H) and y = U(L) and assume that x =10, y = 2 and *N* = 1,200.

There are two firms, A and B. For both firms the cost of producing a low quality good is zero. For firm A the unit cost of producing a high quality good is constant and equal to 0.3. For firm B the unit cost of producing high quality is constant and equal to 0.4. Find **all** the (pure-strategy) subgame-perfect equilibria of the following two games.

GAME 1 The two firms play the following two-stage game. In stage 1 they simultaneously decide whether to produce high quality or low quality. In stage 2, after having observed the stage 1 choices of both firms, they simultaneously choose prices (Bertrand competition). Assume that if the two firms have both chosen high quality then the Bertrand-Nash equilibrium (BNE) is given by both prices equal to the higher of the two costs with firm A serving the whole market.

GAME 2 The two firms play the following two-stage game. In stage 1 they simultaneously decide whether to produce high quality or low quality. In stage 2, after having observed the stage 1 choices of both firms, they simultaneously choose output levels (Cournot competition).

[Recall that if $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ then $A^{-1} = \begin{pmatrix} \frac{d}{ad-bc} & -\frac{b}{ad-bc} \\ -\frac{c}{ad-bc} & \frac{a}{ad-bc} \end{pmatrix}$]

Section B

3. Consider an industry with two firms that produce a homogeneous product.

a. The prices charged by the two firms are highly correlated over time. An economist points to this fact as proof that the two firms are colluding. Do you agree? Why?

b. Suppose you observe marginal costs (or a good proxy for). How could you test if the firms are colluding?

c. If the firms are colluding, how could you test if the collusion follows a pattern predicted by any particular theory? (you can choose any reasonable theory of collusion you like) Your tests can rely on existing work, but be clear about what data you are using, specifically how you plan to use the data, precisely what you are testing, and what are the alternative hypotheses.

d. Now assume that you do not observe marginal costs. Without any additional assumptions can you empirically identify the degree of market power in this industry? Explain. (Hint: it may help to demonstrate the identification problem using a graph or using linear demand and cost functions and the associated profit maximization condition.)

e. List two possible sets of assumptions that would allow you to identify the degree of market power. Explain.

f. Now suppose you are trying to estimate the demand system for a differentiated products industry. What are the difficulties of estimating the own- and cross-price demand elasticities?

g. Briefly describe/outline methods available to solve two of the problems you named in (f).

h. This is a general IO question. Analyze this "email strategy" for lowering gasoline prices:

"For the rest of this year, DON'T purchase ANY gasoline from the two biggest companies (which now are one), EXXON and MOBIL. If they are not selling any gas, they will be inclined to reduce their prices. If they reduce their prices, the other companies will have to follow suit.

But to have an impact, we need to reach literally millions of Exxon and Mobil gas buyers. It's really simple to do! Now, don't wimp out at this point..."

4. This question deals with Ellison (Rand '84) and Borenstein and Shepard (Rand '96). Both of these papers empirically test the validity of certain theoretical models of collusion.

Set up

a. Briefly describe the Rotemberg-Saloner and Green and Porter models of tacit collusion. Pay particular attention to what is known by the firms and the behavior of demand. Also, characterize the movements of price in the market.

b. Discuss the main differences between the RS/HH and GP models. Is the nature of "price wars" the same in the two classes of models? If not, how do price wars differ and what within the theoretical models generates this difference?

c. Closely related to the Rotemberg and Saloner model is the Haltiwanger and Harrington model. Briefly discuss how the Haltiwanger and Harrington model differs from the Rotemberg and Saloner model.

Borenstein and Shepard

d. What empirical prediction of the RS/HH models do Borenstein and Shepard test? Explain why this prediction is inconsistent with a model of pricing with switching costs.

e. Describe the context of the paper: What is the industry? What are the data? Is this a good setting to test the RS/HH model?

f. How do the authors propose to test the theory? Describe the empirical model. Is the model structural or reduced form? What is the dependent variable? What is/are the main independent variables of interest?

g. What econometric difficulties are implied by the prediction that current margins should be correlated with expected future prices and quantities? How do the authors deal with these problems? Be as detailed as possible.

Ellison

h. What empirical predictions of the RS/HH and the GP models does Ellison test?

i. Describe the context of the paper: What is the industry? What are the data? What characterizes equilibrium prices in this industry? *A priori*, which theory seems to be most consistent with the industry and the data (and why)?

j. How does the author propose to test the two theories? Is the model structural or reduced form? What is(are) the dependent variable(s). Are all of the dependent variables observed?

k. What alternative explanation does Ellison have to deal with? Can he completely rule this out?

l. This is a general IO question. Analyze this “email strategy” for lowering gasoline prices (answer only once):

“For the rest of this year, DON'T purchase ANY gasoline from the two biggest companies (which now are one), EXXON and MOBIL. If they are not selling any gas, they will be inclined to reduce their prices. If they reduce their prices, the other companies will have to follow suit.

But to have an impact, we need to reach literally millions of Exxon and Mobil gas buyers. It's really simple to do! Now, don't wimp out at this point...”

Section C

5. A regulated firm has a marginal cost function MC(Q) (not constant) and fixed costs F. The regulator decides to allow the firm to price discriminate to cover its fixed costs. Inverse demand is P(Q).

a) Show whether 1st degree price discrimination is efficient in this case. Which mechanism we studied is closest to 1st degree price discrimination? Explain how that mechanism works.

b) Discuss the efficiency of the following scheme: the firm is allowed to capture fraction k(Q) of the surplus created by the Q^{th} unit sold? Note: surplus created by the Q^{th} unit is P(Q)−MC(Q). Assume k(Q) is a known, non-constant function, and that $0<k<1$ for all Q. What condition needs to be satisfied to induce the firm to produce?

c) Discuss the efficiency of the following scheme: the firm is allowed to capture fraction m(Q*) of the surplus created by the Q^{th} unit sold, where Q* is the total output of the firm? Surplus is as defined above. Assume m(Q) is a known, non-constant function, and that $0<m<1$ for all Q*, and that $dm/dQ^*>0$.

6. A regulator is designing a mechanism to maximize the social surplus from consumption of a public good. The mechanism has three parts: a net (of cost) transfer *t*, and cost level *C* to which the firm will be held, and a quantity *q* that the firm must produce. The firms cost function is $C(q,\beta,e) = (\beta - e)q$, where effort *e* and parameter β are known to the firm but not the regulator and cost is observable *ex post*. The regulator believes that β has cumulative distribution function $F(\beta)$ with support $B = [\underline{\beta}, \overline{\beta}]$. Gross consumer surplus is S(q), and the firm's utility function is $U = t - \psi(e)$, where ψ is the disutility of effort function. The social cost of a dollar transferred to the firm is $(1+\lambda), where $\lambda > 0$. There is no uncertainty in the model.

a) Give the individual rationality and incentive compatibility constraints for this problem if a direct revelation mechanism is used.

b) Find the optimal mechanism $M^* = \left\{t(\hat{\beta}), C(\hat{\beta}), q(\hat{\beta})\right\}$, where $\hat{\beta}$ is the firm's report of β to the regulator. Note that you may not be able to derive explicit expressions for all parts of the mechanism.

c) Explain the differences between Baron & Myerson's model and Laffont & Tirole's (1984) model. What are the assumptions that differ between the models, and what implications do these assumptions have for the optimal mechanisms? Which model is this question closest to?