

**PRELIMINARY EXAMINATION FOR THE Ph.D. DEGREE**

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. Firm 1 (with discount factor  $\delta = 1$ ) has a planning horizon of two periods. In period 1 it will be the only firm in the market. In period 2 there will be a potential entrant (firm 2) offering an identical product. If entry occurs competition will be in output levels (Cournot competition). Inverse demand in both periods is  $P = 1 - Q$ . Firm 1 has no fixed costs, while firm 2 has a fixed cost equal to  $\frac{4}{81}$ . Both firms have a constant marginal cost. Firm 2's marginal cost is  $\frac{1}{3}$ , while firm 1's marginal cost in period 1 is  $\frac{2}{3}$ . Firm 1 can reduce its marginal cost in period 2 to  $c \in \left[0, \frac{2}{3}\right]$  by spending  $\alpha \cdot \left(\frac{2}{3} - c\right)$  dollars in period 1, where  $\alpha > 0$ . The potential entrant will enter if and only if it expects to make positive profits.

[Please note: in answering the following questions what is most important is setting up the relevant equations/inequalities and paying attention to whether the relevant functions are convex or concave. Do not waste too much time in calculations. Get back to the actual calculations only after you have answered the required four questions.]

- What is the minimum amount firm 1 needs to spend in period 1 in order to make sure that the potential entrant will stay out?
- Determine the value of  $\alpha$ , call it  $\alpha^*$ , such that for  $\alpha < \alpha^*$  firm 1 will want to deter entry, while for  $\alpha > \alpha^*$  firm 1 will prefer not to deter entry.
- If firm 1 decides **not** to deter entry, what marginal cost will it choose for period 2 (alternatively, how much will it spend in period 1 in order to reduce its period 2 marginal cost)?
- If firm 1 decides to deter entry, what marginal cost will it choose for period 2? (Alternatively, how much will it spend in period 1 in order to reduce its period 2 marginal cost?)

2. There are  $N$  consumers, with the same income, denoted by  $E$ , but different preferences concerning quality. Each consumer is characterized by a different value of a parameter  $t$ , which is uniformly distributed in the interval  $[0,1]$ . A firm produces a product of quality  $x$ , where  $x$  belongs to the interval  $[4,10]$ . Each consumer buys at most one unit. If a consumer identified by the value  $t \in [0,1]$  of the parameter does not buy the good, his utility is equal to  $E$ , while if he buys one unit of a product of quality  $x$  at price  $p$  his utility is equal to:  $E - p + x t$ .

- (a) Consider first the case of a **single-product** monopoly with **zero production costs**. What quality level  $x$  would the monopolist choose? What price would it charge and how many units would it sell? Prove your claims.
- (b) Continue to assume that **production costs are zero**. Would a monopolist prefer to offer only one quality or to offer two qualities? That is, would the firm choose to be a single-product firm or a multi-product firm? Give a verbal argument without trying to prove your claim (we'll come back to this in point (g)).

From now on we continue to assume that the industry is a monopoly and also that the monopolist is offering **only one product**. However, we relax the assumption of zero production costs and we assume instead that the firm has the following cost function:

$$C(q,x) = c q$$

where  $q$  is output and  $c$  is a positive constant with  $0 < c < 4$  (note that production costs are independent of quality, that is, it does not cost more to produce a higher quality product).

- (c) Calculate monopoly price, output and profits for every possible  $c$  and  $x$ .
- (d) In 2006 the firm had  $x = 4$  and  $c = 2$ . What price and output did the firm choose? What were its profits?

On January 1<sup>st</sup> 2007 Mr. Brilliant, the head of the research department of the firm, went to see Ms. Boss, the owner of the firm. He explained to Ms. Boss that he could either invest his budget in a project that would lead to an improvement in the quality of the product from  $x = 4$  to  $x = 5$  or, alternatively, he could invest it in a project that would lead to (no quality improvement, but) a reduction of the unit cost from  $c = 2$  to  $c = 1.3$ . He asked Ms. Boss what he should do.

- (e) Suppose that Ms. Boss had to maintain the same level of production as in 2006 (e.g. because of capacity constraints). However she could vary the price of the product freely. What did she instruct Mr. Brilliant to do?
- (f) Suppose now that Ms. Boss was free to vary both production and price. What did she instruct Mr. Brilliant to do?
- (g) Now try to prove your claim for part (b).

## 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. This question deals with Haile and Tamer, "Inference with an Incomplete Model of English Auctions", (*JPE*, 2003) and Haile, Hong, and Shum, "Nonparametric Tests for Common Values in First-Price Sealed-Bid Auctions", (2005).

- (a) Consider a single-object "button" auction (à la Milgrom and Weber) with independent private values. There are  $N$  potential bidders. Assume  $N$  is exogenous and known. Bidders are symmetric and risk-neutral. Each bidder draws his or her private value  $v_i$  from a common distribution  $F(v)$  with a support  $[0, \infty)$ . The seller's value for the object is  $v_0$  and she wants to maximize her revenue from the auction by setting a reserve price  $r$ . Write down the seller's maximization problem and derive a condition for the optimal reserve price  $r^*$  from the F.O.C. of the max problem.
- (b) Write down the two axioms (or behavioral assumptions regarding bidding strategies) of Haile and Tamer (2003).
- (c) Construct, as fully as you can, the nonparametric (partial) identification result (i.e. the bounds) of Haile and Tamer (2003) from the two axioms.
- (d) Discuss, as fully as you can, the advantages of the incomplete approach taken by Haile and Tamer (2003) in the identification and estimation of ascending auctions.
- (e) In Haile, Hong, and Shum (2005), their nonparametric test of common values depends on the following theorem. Prove the theorem.

**Theorem** Under standard assumptions of symmetry, affiliation, nondegeneracy and an additional assumption of exogenous participation,  $v(x, x, n)$  is invariant to  $n$  for all  $x$  in a PV model, but strictly decreasing in  $n$  for all  $x$  in a CV model, where  $v(x, x', n) = E[V_i | X_i = x, \max_{j \neq i} X_j = x']$ .

6. This question deals with Chiappori and Salanié, “Testing for Asymmetric Information in Insurance Markets”, (2000, *JPE*) and Finkelstein and Poterba, “Adverse Selection in Insurance Markets: Policyholder Evidence from the U.K. Annuity Market”, (2004, *JPE*).

- (a) In Chiappori and Salanié (2000), what is the prediction from theory regarding asymmetric information (in the context of automobile insurance markets), which they want to test? Describe their null and alternative hypotheses in detail. What is the limit of this testing approach?
- (b) Give a brief overview of the empirical strategy employed by Chiappori and Salanié (2000), especially focusing on the parametric methods. What is their main empirical finding?
- (c) In Finkelstein and Poterba (2004), the authors basically do the similar testing for asymmetric information as Chiappori and Salanié (2000) did; however, Finkelstein and Poterba (2004), in a sense, extend the test. Describe, as fully as possible, the major (additional) contributions of Finkelstein and Poterba (2004) in testing for asymmetric information.
- (d) Briefly describe the data set used by Finkelstein and Poterba (2004) and provide a brief overview of their empirical methodology for testing asymmetric information. What are their empirical results regarding the test?
- (e) Compare the empirical findings from these two papers. What are possible explanations for the differences in their findings regarding asymmetric information?