University of Minnesota

Department of Economics

Ph.D. Preliminary Examination

INDUSTRIAL ORGANIZATION

Fall 2008

Monday, August 22, 2008

10:00 a.m.-2:00 p.m.

Answer any three of the following four questions. The answers will be equally weighted in the examination grade. Your copy of the exam questions should have 7 pages.

Analytical solutions can be derived for some of the problems this examination contains. If the algebra involved proves too cumbersome, however, essentially full credit will be given for careful explanations of the steps that could be followed to derive analytical solutions. If you feel that additional assumptions are required before a unique solution to the problem can be found, specify what they are and why you need them.

Please indicate clearly which questions and which part of the question you are answering. Note also that irrelevant material, even if correct, will receive no credit.

QUESTION 1: EMPIRICAL MODELS OF ENTRY

1. Diagram and explain the issues associated with the construction of the likelihood function in the Bresnahan and Reiss "Entry" setting.

2. Describe their approach and how it addresses the problem.

3. Propose two alternative approaches and explain the conditions under which they will work.

QUESTION 2: THE RISK-AVERSE MODEL.

Consider a first-price sealed-bid auction model where there are $i = 1, ..., N$ symmetric bidders with independent private values $v_i \sim F(v)$. Bidders are risk averse and have the exponential vNM utility function $U(x) = x^\theta$. In this specification, $1 - \theta$ is the coefficient of relative risk aversion, with $\theta = 1$ corresponding to risk neutrality.

1. Let $G(b_i)$ denote the cdf of the equilibrium bid distribution and $g(b_i)$ denote the pdf. Express bidder i's valuation v_i as a function of b_i, $G(b_i)$, $g(b_i)$, θ and N.

2. True or false. The distribution of valuations F and the vNM utility function are identified given $G(b_i)$, $g(b_i)$ and N. If the distribution of values are not identified, describe an empirical strategy that would ensure identification. Carefully prove your answer.

3. Describe a strategy for constructing an estimate, $\widehat{F}$, of the distribution of valuations.

4. Suppose that the bidders are asymmetric. That is, $F_i(v)$ differs across bidders and therefore $G_i(b)$. Is it still possible to identify the model. If so, sketch a proof of why identification is possible.

QUESTION 3: MATCHING

Consider the following two-sided matching game between venture capitalists and startup companies. Let $i \in \{1, ..., I\}$ index venture capitalists and $j \in \{1, ..., J\}$ index startup companies. A venture capitalist can match with only one company, and a startup company can match with only one venture capitalist. Hence, we have a one-to-one, two-sided matching game. For simplicity, assume that $I = J$ so that there are equal numbers of venture capitalists and startup companies in the matching market. The outside option of non-matching yields the level of utility low enough to ensure that everyone will match in equilibrium.

Venture capitalists have preferences over investments in companies, and startup companies have preferences over matches with individual venture capitalists. To state these preferences, let each potential match have a surplus, and let the surplus of the match between i and j be denoted S_{ij}. The surplus represents the expected net present value, at the time of the investment decision. In an empirical application, one will typically assume that S_{ij} is a function of i's characteristics (X_i), j's characteristics (X_j), and their interactions (X_{ij}) to capture match-specific synergies. I.e., $S_{ij} = f(X_i, X_j, X_{ij})$. These surpluses are assumed to be distinct (i.e., no tie), and the same surpluses determine the preferences of both the VCs and the companies. The surplus is divided between the VC and the company according to a fixed sharing rule determined by $\lambda \in (0,\ 1)$, where the VC receives the fraction λ, and the company receives (1 - λ). Note that λ is NOT subscripted by i or j, meaning that the uniform sharing rule applies to all potential matches. This model, thus, features non-transferable utility (NTU).

Then VC i's utility from matching with company j, U_{ij}, is given by:

$$U_{ij} = \lambda S_{ij}$$

Similarly, company j's utility from matching with VC i, V_{ij}, is given by:

$$V_{ij} = (1 - \lambda)S_{ij}$$

According to these preferences, VC i prefers an investment in company j to an investment in company j' when $S_{ij} > S_{ij'}$, and company j prefers a match with VC i to a match with VC i' when $S_{ij} > S_{i'j}$. Note that these preferences do not depend on λ, and λ is not estimated by the empirical model.

Let μ denote matching. If i is matched with j under matching μ, we write $\mu(i) = j$. Using this notation, a match between VC i and company j can be stated in two equivalent ways: as $\mu(i) = j$, or as $\mu(j) = i$.

1. Define stable matching of this game. Write down a system of inequalities that matching μ needs to satisfy for it to be stable.

2. Show that for the particular utility functions of this model, we have a unique stable matching.

3. Propose a simple algorithm to find the unique stable matching given S_{ij} for $\forall i, j$.

4. Explain why estimating this model using a usual discrete choice framework (probit or logit) is not a good idea.

5. Briefly describe an estimation method you would use for this model.

QUESTION 4: OLIGOPOLY

Suppose the inverse demand in an industry is $P(Q_t) = A - Q_t$. There are two firms. Let q_j^t denote the output of firm j in time t so that $Q^t = q_1^t + q_2^t$. Marginal cost is zero. When a firm moves and picks output, the output choice is fixed for two periods. Firms alternate in moves, with firm 1 picking in odd periods and firm 2 picking in even periods.

1. Suppose there are two periods, $t = 1, 2$. In period 1, firm 1 sets $q_1^1 = q_1^2$ and firm 2's output is fixed at $q_2^1 = q^\circ < A$ which is taken as given for the problem. In period 2, firm 2 picks q_2^2. Let β denote the discount factor. Characterize the subgame perfect equilibrium of this game. Determine how the equilibrium sequence of outputs varies with the parameter β. Explain the intuition for why the equilibrium sequence of outputs varies with β.

2. Now change things so that firm 1 picks output levels in both periods, q_1^1 in period 1 and q_1^2 in period 2. Like before, firm 2's output in period 1 is exogenous and here it equals $q_2^1 = \frac{A}{3}$. In period 2, the two firms simultaneously pick output levels for the period. Assume $\beta > 0$. Solve for the equilibrium sequence of output's. Prove that firm 1's discounted profit in (a) is greater than in (b). What is the intuition for this result?

3. Now return to the case where output levels are fixed for two periods. Suppose there is an infinite horizon. The two firms alternate moves, firm 1 picking its location in odd periods, firm 2 in even periods, so the decisions are fixed for two periods. Define a Markov-perfect equilibrium for this game.

4. Outline the steps you would use to determine the stationary equilibrium output levels for $\beta > 0$. What are the stationary output levels for $\beta = 0$?

5. Suppose demand is constant elasticity rather than linear, so an analytic solution is not available. Briefly sketch how you would go about solving the MPE of the model through numerical methods.