University of Minnesota
Department of Economics
Ph.D. Preliminary Examination
INDUSTRIAL ORGANIZATION
Spring 2012

May 25, 2012
10:00 a.m.-2:00 p.m.

There are three parts to the exam: Parts A, B, and C. You are required to answer all three parts. Part A and part B each consist of one question. Part C has two questions, of which you are to pick one.

In summary, complete both questions 1 and 2 below, and your choice of questions 3 or 4. All three answers will be equally weighted.

Your copy of the exam questions should have 6 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.
Answer question 1.

**Question 1**

Consider the following model of the timing of exit. Each period has three stages. In stage 1, each existing firm simultaneously decides whether or not to exit the industry or remain in the industry in the current period. The exit decision is permanent. In stage 2, there is entry of a fixed integer $N_{new}$ number of firms. Note that $N_{new}$ is exogenous and in particular does not depend upon the number of existing firms. In stage 3, there is a market game described further below.

Any existing firm that chooses to remain in the industry in stage 1 must pay a fixed cost $f_a$ in the period that depends upon the age of the firm. Assume the fixed cost (weakly) increases in age, $f_a \leq f_{a+1}$.

At the beginning of each period, the number of existing firms of each age is public information. Each existing firm draws a private shock about the firm’s profitability if it chooses to remain in the industry in the period. Let $\varepsilon_{i,a,t}$ be the this private component of profitability for firm $i$ of age $a$ at time $t$. Suppose that $\varepsilon_{i,a,t}$ is drawn i.i.d. across firms and across time from a continuous distribution with density $g(\varepsilon_{i,a,t})$ with full support, $\varepsilon_{i,a,t} \in (-\infty, \infty)$.

Suppose there is a maximum age $\bar{a} < \infty$ such that all existing firms at stage 1 with $a = \bar{a}$ are constrained to exit.

We now turn to the market game. All firms have marginal cost equal to zero. The inverse demand curve in the industry is $p(Q) = A - Q$. In stage 3, the existing firms who choose not to exit in stage 1, combined with new firms who entered in stage 2, play a Cournot game.

If an existing firm chooses to exit, the firm receives a one-time exit payment of payment of $\psi$. 

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(a) Define a Markov-perfect equilibrium in this model and characterize the solution. (Restrict attention to symmetric equilibria where firms in the same situation behave the same way.)

(b) State and prove a result about how the probability of exit differs within a given period across two firms of different ages.

(c) Suppose we follow this industry over many periods and have data on the age at which each firm exits. Discuss strategies of how you might estimate this model. Discuss the issue of identification. In particular, discuss what kind of observed patterns in the data will lead you to estimate whether particular parameters are big or small in magnitude.
PART B

Answer question 2.

Question 2
(a) Assume utility is given by

\[ u_{ij} = \alpha_i (y_i - p_j) + x_j \beta_i + \epsilon_{ij} \quad j = 0, \ldots, J, \]

with \( \epsilon_{ij} \) type 1 extreme value, \( y_i \) income, \( x_j, p_j \) observed characteristics and price. What is the expression for individual i’s demand for good \( j \)? What is the own-price demand elasticity for good \( j \) for individual \( i \)? What is the cross-demand elasticity for good \( j \) with respect to the price of good \( l \) for individual \( i \)? How does the independence of irrelevant alternatives manifest itself in these formulas?

(b) What is the expression for aggregate demand for good \( j \)? What is the expression for the aggregate demand elasticity for good \( j \)?

(c) What is the demand side assumption used for identification in Berry-Levinsohn-Pakes? Explain the specific economic conditions under which it will and will not hold in the U.S. automobile market?

(d) Suggest a Hausman-type instrument for price in the U.S. automobile market and explain the specific economic conditions under which it will and will not hold.

(e) BLP supplement their demand side model with supply side restrictions to improve the precision of the demand side estimates and to recover estimates of marginal costs. Derive the set of first-order conditions for prices that are consistent with profit maximization. Is it sufficient to impose these first-order conditions to identify marginal costs and to achieve demand side efficiency gains?
PART C

Answer either question 3 or question 4.

Question 3

(a) Prove that the cost share of an input \( s_x = \frac{p_x \cdot x}{\text{Revenue}} \) times the markup \( \mu = \frac{p}{mc} \) equals the production function parameter of that input \( \beta_x \):

\[
\beta_x = \mu \cdot s_x.
\]

(b) Prove that adjustment costs for an input lead to a failure of the argument in 1.

(c) A portmanteau specification test is a test that tells you that one or more of the maintained assumptions do not hold but it does not point you directly to the assumption(s) that fail. Suppose you had access to plant-level data. Provide a portmanteau specification test for the assumptions you used in deriving \( \beta_x = \mu \cdot s_x \) and explain how you would carry it out.

(d) Define plant-level productivity \( \omega \) as output \( q \) (in quantities) minus predicted output given the input levels \( x \):

\[
\omega = q - x \beta.
\]

True, False or Partly True: "Economic growth is maximized when resources are shifted to the most productive plants."
Consider the following model of differentiated products industry. Suppose differentiated goods are indexed by $x$ and let $q(x)$ be a quantity of good $x$. There is a composite industry good that is CES in the differentiated products, 

$$Q = \left[ \int_0^\infty q(x)^{\frac{1}{\gamma}} dx \right]^2,$$

i.e., the elasticity of substitution is 2. Suppose consumers have an inelastic demand for $\bar{Q}$ units of the composite good.

Three are three sectors. Sector 1 consists of goods $x \in [0, \omega]$ for a parameter $\omega \geq 0$. Sector 1 is the competitive sector. Knowledge of how to produce the good is freely available and all firms can produce at marginal cost of 1 dollar. Entry is free into the industry and there is no fixed cost of entry.

Sector 2 consists of goods $x \in (\omega, \eta]$. This is the regulated monopoly sector. Each good is controlled by a monopolist. The monopolist has marginal cost of 1 dollar per good and zero fixed cost. Prices are regulated so that each monopolist must set a price equal to $\lambda$ dollars per unit in this sector.

Sector 3 is the monopolistic competition sector. It consists of goods $x > \eta$. There is free-entry into this sector. However, each entrant must pay a fixed cost of $\phi > 0$ dollars to enter. Marginal cost equals 1 dollar, like in the other sectors.

(a) Define an equilibrium in this model, taking the parameters $\omega$, $\eta$, and $\lambda$ as fixed. Solve for the equilibrium.

(b) Present an analysis of how welfare in the industry depends upon the parameters $\omega$ and $\lambda$. Consider how welfare measures change if $\omega$ and $\lambda$ are changed individually, and if there is a coordinated change in both $\omega$ and $\lambda$. 