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. Consider a homogeneous-product industry facing the following demand function: $Q = 83 - P$. Initially there are three firms in this industry. The cost function of firm $i \in \{1,2,3\}$ is denoted by $C_i(q_i)$. We will consider a number of different alternatives.

(a) Suppose that all the firms have the same cost function given by $C(q) = 3q$. Find the Cournot-Nash equilibrium and the corresponding profits.

(b) Remaining within the assumptions of part (a), suppose that firms 2 and 3 decide to merge. Because of a contract with the labor union, the merged firm must use both production facilities (the production facility of the old firm 2 and the production facility of the old firm 3); however, the firm can distribute its total output between the two production facilities in any way it likes.
(b.1) Write the profit function of the merged firm and find a Cournot-Nash equilibrium of the industry after the merger.
(b.2) Was the merger profitable?

(c) Now suppose that in the initial situation where there were three firms, the cost functions were as follows: $C_1(q_1) = 3q_1$, $C_2(q_2) = 3q_2$ and $C_3(q_3) = 7q_3$. Once again, firms 2 and 3 merge, but this time the merged firm is free to use either only one or both of the production facilities.

(c.1) Find the pre-merger and the after-merger Cournot-Nash equilibrium.
(c.2) Was the merger profitable?

(d) Now suppose that in the initial situation where there were three firms, the cost functions were as follows: $C_1(q_1) = 3q_1$, $C_2(q_2) = 3q_2$ and $C_3(q_3) = \left(\frac{q_3}{3}\right)^2$. Once again, firms 2 and 3 merge and the merged firm is free to use either only one or both of the production facilities.

(d.1) Write the cost function and the profit function of the merged firm.
(d.2) Suppose that in the after-merger industry firm 1 produces 20 units and the merged firm has a total output of 40 units. What are the profits of the two firms?
(d.3) Is the situation described under (d.2) an equilibrium?

2. Two firms, 1 and 2, interact over two stages as follows. In the first stage the firms simultaneously choose the magnitudes, k_i (i = 1, 2). In the second stage, after observing the k_i's, they simultaneously choose the magnitudes x_i (i = 1, 2). [For example, k_i could be the capacity and x_i the output level of firm i.] Firm i's profit is given by the function $\pi_i(x_1,x_2\ ;\ k_i)$. Thus, the x_i's are the direct instruments of competition in that they enter the rival's profit function directly, while the k_i's have only an indirect effect: k_i affects π_j ($j \neq i$) only indirectly by influencing the second-period choices of x_1 and x_2. A strategy for firm i is a pair ($k_i\ ;f_i(k_1,k_2)$) where k_i is its first-stage choice and $x_i = f_i(k_1,k_2)$ is its second-stage choice as a function of the first-stage choices made by both firms.

(a) Define formally what a subgame perfect equilibrium (SPE) of this two-stage game is. [Hint: the notion of SPE is defined in terms of strategies, *not* in terms of outcomes.]

In what follows, assume that

(A1) $\pi_i(x_1,x_2\ ;\ k_i)$ is continuously differentiable,

(A2) for $i \neq j$ $\dfrac{\partial \pi_i}{\partial x_j} \neq 0$,

(A3) there exists a unique SPE,

(A4) $f_i(k_1,k_2)$ is a continuously differentiable function and

(A5) all the equilibrium values are interior points.

Show that the strategic role for k_i results in a distortion of its equilibrium level away from the level that would be optimal were x_j unaffected by k_i ($i \neq j$). [E.g., when k_i is interpreted as capacity, this means over- or under-investment in capacity as may be the case.] More precisely,

(b) state an assumption (in terms of derivatives) which captures the fact that, at the SPE, the first-period choice of k_i by firm i influences firm j's second-period choice of x_j ($j \neq i$),

(c) consider the single-stage version of this game where the firms choose (k_i, x_i) simultaneously (i = 1,2).

(c1) Define what a Nash equilibrium of this game is.

(c2) Assuming (b) above and also that there is a unique Nash equilibrium of the single-stage game (whose values are interior points), show that the value of k_i chosen at this equilibrium differs from the value of k_i chosen at the subgame-perfect equilibrium of the two-stage game.

(d) When the firms produce a homogeneous product, the demand function is P = 1 − Q, costs of production are zero, k_i denotes capacity and costs \$$c$ (with $0 < c < 1$) per unit (same for both firms) and x_i is output (subject to $x_i \leq k_i$), find the Nash equilibrium of the single-stage game where the two firms simultaneously choose output and capacity at the same time.

Section B

3. TowerPower is an electricity utility regulated under rate-of-return regulation. The firm has an unusual generation technology involving treadmills, long-distance runners, and nuclear power plants. TowerPower's production function resulting from its technology is Q = g(K,L) = 10K + 20L. The regulatory constraint is the usual one from the Averch-Johnson model: the rate of return on capital must be less than a "fair" rate $f > r$. The price of capital is r and the price of labor is w. Fixed cost is F.

a) Express the regulatory constraint as an inequality.
b) Plot a few isoquants in (K,L) space.
c) Find an expression for the slope of the zero profit locus (ZPL).
d) Using (c), plot the zero profit locus in (K,L) space. To do this, start by finding where the slope of the ZPL is zero and where it is infinite, and sketch in those loci on your graph. Then you can tell where the slope of the ZPL is positive and where it is negative. Assume that r/10 < w/20.
e) Find an expression for the slope of the rate of return constraint.
f) Plot the rate of return constraint locus as in (d). Does it lie within, without, or cross the ZPL?
g) State the A-J effect as precisely as you can.
h) Does the A-J effect hold in this model? If not, what standard assumption of the A-J model is violated here?

4. The city of Remote, Oregon (yes, there really is such a town!) has decided to regulate the prices of the local telephone company (telco). The telco produces two services: local access (x) and local toll (y). The city's goal is to maximize social surplus, but it doesn't want the company to go out of business. Furthermore, the city regulator doesn't understand nonlinear or two-part tariffs, and outright subsidies are not possible.

a) Describe (in words) how the regulator should set the prices of the telco.
b) What difficulties might the regulator have implementing this form of regulation? Mention at least three.
c) Assume the cost function of the telco is $C(x,y)$, with
$$C > 0,\ \frac{\partial C}{\partial x} > 0,\ \frac{\partial C}{\partial y} > 0,\ \frac{\partial^2 C}{\partial x \partial y} = 0 \quad \forall (x,y) \geq 0\ .$$
Demand is separable; demand for x is $x = Q_x(p_x)$ and demand for y is $y = Q_y(p_y)$. Express the regulator's problem mathematically, and characterize the solution.
d) Now change one assumption from above: the cost function is as before except
$$\frac{\partial^2 C}{\partial x \partial y} = a > 0\ .$$
Does the form of the solution in (c) change?
e) Compared to the case in (c) where $a = 0$, when a is positive do you expect the regulated prices to be higher or lower (or the same)?

Section C

5. Suppose you were interested in studying the role of price discrimination in determining airline ticket prices for first and business class customers. Business class seats are much larger than coach seats, but slightly small than first class seats. In addition, the service is not quite as high as in first class. You have data on a set of airlines containing a 10% sample of all ticket prices sold to first class and business class travelers (you can ignore coach travelers in this question). You have cross-sectional data for each airline in each geographic market. In each geographical market there are some airlines that sell both first class and business class seats, some that sell only first class and some that sell only business class. Assume that you can control for exogenous cost and demand differences across the markets.

(a) First, explain, in general, the conditions that are required for a firm to be able to price discriminate.

(b) Explain Shepard's (JPE, 1991) test for price discrimination. What are her testable implications for price discrimination to be present?

(c) How you would apply it using these data. What data would you use? What would be your dependent variable? What would be your independent variable(s)? What is the null hypothesis?

(d) Explain the empirical context of Shepard and her results.

(e) Briefly explain Borenstein and Rose's (JPE, 1994 single-starred paper) test for price discrimination. What is their dependent variable? What is their independent variable of interest? What is the null hypothesis? Can it be applied to these data?

6. The table below is an abridged version of the results from Genesove's (JPE, 1993) paper on adverse selection.

(a) Give an intuitive explanation of the theory of adverse selection. A formal model is helpful, but not necessary.

(b) Is adverse selection welfare decreasing or enhancing? Why?

(c) Describe the empirical context of Genesove's paper. What is the industry? What are the data?

(d) How does Genesove propose to test for adverse selection?

(e) Which are the variables of interest in the regression? What is the null hypothesis? Provide an interpretation of the empirical tests. Which coefficients support Genesove's empirical predictions, and which do not? How does he characterize the strength of the results?

(f) What is the main alternative explanation for his results that he must deal with? How does he attempt to convince the reader this alternative is not true. Are you convinced? Why or why not?

	Model 3
Intercept	-1.34 (.30)
LNRBROOK	1.18 (.03)
NCD*1988	.10 (.17)
NCD*1987	-.09 (.09)
NCD*1986	-.01 (.06)
NCD*1985	.004 (.07)
NCD*1984	.14 (.08)
One-Owner*1988	.11 (.24)
One-Owner*1987	-.05 (.08)
One-Owner*1986	.06 (.06)
One-Owner*1985	.16 (.07)
One-Owner*1984	.15 (.07)
Week	-.006 (.004)
Order: ORDER	 .90 (.30)
ORDER2	-1.37 (.56)
ORDER3	.58 (.30)
Mileage: LNMILES	 -.21 (.03)
MILES100	-.96 (.13)
Condition of Sale: AS-IS	 -.16 (.05)
LISTEN	-.11 (.05)
TITLE	-.05 (.04)
R2	.71