WRITTEN PRELIMINARY Ph.D. EXAMINATION

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MANAGERIAL, MARKETING AND PRODUCTION ECONOMICS

Instructions:

- On each question, identify yourself by code letter – do not write your name.
- Start each question at the top of a new page.
- This Exam has four sections:
  - Answer only one question from section A
  - You must answer at least one question from section B
  - You must answer at least one question from section C
  - You may answer at most one question from section D
- When finished you should have answered FOUR questions, with at least one question from the first three sections.
- You have four hours to complete this examination.
Section A – Production

From this section, answer **either** question I or II.
QUESTION I.

Consider a cost function of the form

\[
\ln\{c(w, y)\} = \ln a_0 + \ln y + \sum_{j=1}^{4} a_j \ln w + \frac{1}{2} \sum_{i=1}^{4} \sum_{j=1}^{4} b_{ij} \ln w_i \ln w_j
\]

where \(y\) is the output of a production process, \(w = (w_1, w_2, w_3, w_4)\) is the input price vector for the production factors capital, labor, energy and materials, the levels of which are denoted \(x_1, x_2, x_3,\) and \(x_4\) respectively. Assume the following parameter restrictions hold:

\[
\begin{align*}
(I.2) & \quad b_{ij} = b_{ji}. \\
(I.3) & \quad \sum_{j=1}^{4} a_j = 1 \\
(I.4) & \quad \sum_{j=1}^{4} b_{ij} = 0
\end{align*}
\]

(a) Explain why the parameter restrictions (I.2) – (I.4) are necessary.

(b) Derive expressions for the shares of cost devoted to each \(x_i\) under profit maximizing conditions. Explain how these can be useful in an econometric study of costs. Would it be best to use all four share equations? Why or why not?

(c) Does the functional form presented here allow you to test for returns to scale? If \textit{in fact} the technology you are studying is characterized by positive returns to scale what effect would that have on your parameter estimates for equation (I.1).

(d) Comment briefly on the advisability of using a function like this to conduct empirical studies of the following industries: i) agricultural production, ii) railroad production, iii) oil refining.
QUESTION II.

Consider the directional technology distance function given by

\[
D_T(x, y; g_x, g_y) = \sqrt{x_1x_2} - \sqrt{(y_1)^2 + (y_2)^2},
\]

where, \( x = (x_1, x_2) \in \mathbb{R}^2_+ \) is a vector of inputs, \( y = (y_1, y_2) \in \mathbb{R}^2_+ \) is a vector of outputs, and \( g_x = (1,1) \in \mathbb{R}^2_+ \) and \( g_y = (1,1) \in \mathbb{R}^2_+ \) are directional vectors.

1. Given equation (II.1), and consider the following input-output combinations:

\[
(x, y) = (x_1, x_2, y_1, y_2) = (1,1,1,1), \quad (x, y) = (2,2,1,1), \quad (x, y) = (1,1,\sqrt{4.5},\sqrt{4.5})
\]

Which of these input-output combinations are technically feasible? Explain your answer.

2. Assuming efficient production, derive the revenue function corresponding to the technology (II.1), where the revenue function is defined as

\[
R(p_1, p_2, x_1, x_2) = \max_{y_1, y_2} \{p_1 y_1 + p_2 y_2 : D_T(x, y; g_x, g_y) \geq 0\}
\]

and where \( p_1 \) and \( p_2 \) are output prices.

(a) Is this revenue function (give concise, complete explanations):

i) linearly homogeneous in output prices,

ii) concave in output prices,

iii) nondecreasing in output prices?

(b) How much does revenue increase with a small increase in \( x_1 \)?

(c) What is the supply function for \( y_1 \)?
Section B – Marketing

From this section, answer at least question III or IV.
QUESTION III.

The market power versus efficiency debate in industrial organization is long standing. Traditionally, it is argued that concentration in product (or factor) markets may lead to a restriction of output (or input) relative to the competitive level and thereby misallocate resources and result in welfare loss. This may be referred to as the welfare triangle effect of concentration. On the other hand, it has been argue that concentration in product (or factor) markets may lead to a cost-efficiency gain that is more than enough to offset the undesirable welfare loss due to resource misallocations. This may be referred to as the cost-efficiency effect of concentration. Yet, a third argument is that the traditional welfare triangle measures only the lower bound of the true costs of market power because, in addition to resource misallocations, there are other “ills” associated with high industry concentration. For example, Hicks suggests that the reduction in competitive pressure in concentrated markets may result in lessened effort by managers to maximize operating efficiency. This may be referred to as the quiet life effect of concentration.

Consider a food-processing industry consisting of $N$ oligopsonistic firms converting a single material input into a final output utilizing a fixed proportions technology. The processing technology also requires a number of non-material inputs, used in variable proportions. To simplify, the firms are assumed to be price takers in their purchase of non-material input markets as well as in their sale of the final output.

(a) Within the framework of New Empirical Industrial Organization (e.g., Appelbaum), develop a conceptual model based on which you can empirically disentangle the welfare-triangle effect and cost-efficiency effect of market power. State your assumptions and hypotheses.

(b) Discuss how you would estimate the model and test the hypothesis that you developed in the previous subquestion.

(c) Elaborate in more detail the concept associated with the quiet life effect hypothesis of concentration. Then, present a procedure for testing the hypothesis, within the context of the oligopsonistic food processing industry mentioned in the question statement.

QUESTION IV.

An intra-regional spatial model assumes that consumers and/or producers of a given region are spatially dispersed (e.g., Benson, Capozza and Van Order).

(a) Consider the case in which potential consumers are located at different points on a homogeneous plain at a uniform density. Assume that the spatial firms’ conjectural variation is of the L. Schian type. Show how the equilibrium prices and quantities are determined. Include in the discussion graphs and equations as appropriate.

(b) Graphically analyze the effect on the equilibrium solution of an increase in transportation costs. Explain your analysis.

(c) Outline how to conduct a comparative static analysis of the cost shock of the above model mathematically.
Section C – Managerial

In this section, answer at least question V, VI, or VII.
QUESTION V.

Wholesale distribution centers and supermarkets are key, vertically linked segments in the supermarket industry supply chain. A variety of ownership forms are observed in the industry. In some cases, a single company owns one or more distribution centers and the supermarkets those centers serve. In other cases, independently owned stores purchase from a wholesale distribution center owned by another company. Finally, groups of independently owned supermarkets sometimes form a cooperative that enables them to collectively own and manage the distribution center that serves them. In other words, we observe downstream integration (distribution center owns stores), no integration, and upstream integration (stores own distribution center).

Since the publication of Ronald Coase’s seminal article, “The Nature of the Firm” in 1937, economists have been concerned with understanding the economic forces that determine firm boundaries in cases such as this. Building directly on concepts introduced by Coase, Oliver Williamson and others have focused on transaction costs as the key determinant of whether technologically distinct, vertically linked activities are connected by market transactions or managed within a firm. In some cases, economists working in this tradition also explore intermediate organizational forms along the continuum between market and hierarchy. More recently, Oliver Hart and others have hypothesized that the investment incentives created by the allocation of residual control rights are the key determinants of economic efficiency under alternative vertical integration structures when it is not possible to write complete contracts.

(a) Briefly summarize the key features (assumptions, unit of analysis, and general predictions) of these two theories of the determinants of firm boundaries – transaction cost economics and property rights (or incomplete contract) theory.

(b) Use each theory to develop hypotheses about the key factors that determine whether the vertical linkage between wholesale distribution center and supermarket is governed by a market-based relationship (no integration), downstream integration, or upstream integration.

(c) Outline the basic methodology for a study of the determinants of organizational form in the supermarket industry. In your discussion, identify the unit of analysis, key variables for which you would collect data, and the basic structure of the statistical model you would use to analyze your data. Would your model allow you to distinguish between the predictive power of these two theories?
QUESTION VI.

Banks began adopting automated teller machines (ATMs) in the 1970s as a way to automate banking services. Consider the effect of network effects on the banks’ adoption decisions.

(a) Briefly describe, in words, why there are network externalities in this industry and how banks’ overall size affects their propensity to be early adopters.

(b) A bank’s decision to adopt ATM technology depends on the flow of benefits and costs from doing so. The per period benefit to a bank customer is represented by \( a + b(N) \), where \( a \) represents network-independent benefits and \( b(N) \) represents the network effect. The network effect term, \( b(N) \), is increasing in \( N \), network size, with \( b(0)=0 \). If the bank has \( n \) customers, the aggregate per-period adoption value is given by \( n[a + b(N)] \). Assume that the cost to adopt ATMs is given by \( C(N, T) \), which consists of variable costs dependent on network size and fixed costs dependent on \( T \), the time of adoption. Including a growth factor, \( g \), for the benefits provided by ATM technology and a proportionality factor, \( \lambda \), for the share of these benefits captured by the bank, and discount factor, \( \delta \), the net present value of a bank’s profits from adopting ATMs at time \( T \) is given by the equation,

\[
\pi = \sum_{t=0}^{\infty} \lambda n[a + b(N)] g^t - C(N,T)
\]

(i) Derive the inequality describing when a bank will choose to adopt ATMs at time \( T \) rather than wait until time \( T+1 \). Explain how this inequality shows a network effect and its effects on adoption.

(ii) Explain how Saloner and Shepard (1995) use this model to identify an empirical relationship between network effects and banks’ propensity to adopt early.

(c) How would you adapt this model to examining banks’ adoption of internet banking technology?

QUESTION VII.

In recent times, patent records have provided a rich source of data for examining the economics of research and development. Describe how economists have used patents and patent citation data to address the following problems, making sure to reference specific published research and provide details on the models and estimation techniques.

(a) Estimating the value of patents.

(b) Estimating the spillover effects of research and development activities.
Section D – Financial Economics

You may answer one question from this section
QUESTION VIII.

Financial economists are interested in developing models that adequately explain asset returns and prices. Early equilibrium models emphasized the unconditional (static) Capital Asset Pricing Model (CAPM) and subsequent studies have introduced the conditional (time-varying) CAPM.

(a) Specify the unconditional CAPM, identify your notation and underlying assumptions, and briefly discuss the implications of that model for expected asset returns and prices.

(b) Specify the conditional CAPM, then point out the differences between that model and the unconditional CAPM.

(c) Critics of the unconditional CAPM have hypothesized additional factors (anomalies) such as size (market capitalization) and value (book value/market value) and showed that the market portfolio is not an adequate predictor of returns and a three-factor model performs better. Briefly state the economic rationale for why each of these additional factors might be “priced” in the market.

Are these truly risk factors with associated risk premia, or just market inefficiencies? Explain. Is there an econometric approach that you could use to empirically investigate this question?

QUESTION IX.

The binomial option pricing model developed by Cox, Ross and Rubenstein has been used widely to compute the prices of various option contracts and instruments.

(a) Identify the binomial option pricing model by specifying its key underlying assumptions. Illustrate and briefly discuss how the approach works for a call option that is two periods prior to expiration. Carefully define your terms and notation.

(b) Now consider a stock that pays no dividends and has the characteristic that \( u = 2 \) and \( d = \frac{1}{2} \). Also, assume that one plus the risk-free rate of interest satisfies, \( R_f = \frac{5}{4} \). Let there be three dates, 0, 1, and 2. At the initial date 0, the stock price is \( S_0 = 4 \). Assume there exists an \textit{Asian} (average price) call option that matures at date 2 and has a strike price, \( k = 5 \), and a terminal value equal to

\[
    c_2 = \max \{ [(S_1 + S_2)/2] - k, 0 \},
\]

where \( S_1 \) and \( S_2 \) are the prices of the stock at dates 1 and 2, respectively. Solve for the no-arbitrage value of this call option \( c_0 \) at date 0.

(c) Now assume that the stock pays dividends with a known dividend yield of \( \delta \). Briefly discuss what modifications you would need to make to the option formulation.