WRITTEN PRELIMINARY Ph.D. EXAMINATION

Department of Applied Economics

University of Minnesota

June 16, 2014

MANAGERIAL, FINANCIAL, MARKETING
AND PRODUCTION ECONOMICS FIELD

Instructions:

- Write your code letter, not your name, and the page sequence on all sheets of paper and be sure to turn in these sheets at the end of the exam.

- Start each new question at the top of a new page. Please write legibly and on only one side of each page.

- This is a closed book exam. No notes, articles, books, or other sources may be used at the exam. You may not access the Internet for any reason while taking this exam. Accessing notes, articles, the internet, or other materials during the exam will result in a failing grade on the exam.

- The exam has two sections, and you are expected to answer exactly two questions in each section.

  Furthermore, you must answer Question 1, in Section I. You may answer any two of the three questions in Section II.

- You have four hours to complete this examination.
Section I – Production Economics

**Question 1.** A subsistence household in India grows rice for consumption and income. Assume the household’s rice production technology is summarized by the production function

\[ y = 5x^{0.4}h^{0.4}z^{0.2} \]  

(1.1)

Here \( y \) represents rice yield in pounds, \( x \) represents the level of labor demanded in man-hours, \( h \) represents the level of water used (in 1,000 cubic meters), and \( z \) represents cultivated area in acres. Cultivated area is fixed for the household, with \( z = 1 \), and the household is endowed with 200 units of labor. Furthermore, the wage rate is \( w = 10 \) rupee per unit of labor, the unit price of water is 0.2 rupee per unit of water and the output price is \( p = 5 \) rupee per pound.

A market exists for labor and water, but not for land. In an attempt to avoid confusion, note the household is indifferent between using its labor endowment in agricultural production or in off-farm labor activities. Also, for simplicity, assume the entire 200 units of labor are allocated to farm or off-farm work – i.e., this model ignores leisure.

1. Given the household’s production technology and land endowment, how many units of labor and water will maximize the household’s land rent? To be clear, a market exists for labor, but not for land. the household can

2. How much would the household be willing to pay for an additional unit of land (i.e., what is the shadow value of land)?

3. Let household preferences be given by \( U = q_1^{0.2}q_2^{0.8} \), where \( q_1 \) is the amount of rice consumed and \( q_2 \) is an index of all other consumption goods. How much rice will the household purchase from, or sell to, the market? Explain how you arrived at your answer.

4. For this question, ignore all information you have regarding the factor and output price, and the level of endowments – the only information you have is equation (3.1), i.e., knowledge of the household’s production technology. If the household sold all its rice on the market and earned 100,000 rupee, explain how you would figure out how much income it earned.
**Question 2.** Let \( x \in \mathbb{R}_+^N \) represent a vector of inputs and \( y \in \mathbb{R}_+^M \) represent a vector of outputs, and define the graph of a technology by
\[
T = \{(x, y): x \text{ can produce } y\}
\]
Furthermore, define the input requirement set by \( V(y) = \{x: (x, y) \in T\} \), and define the producible output set by \( P(x) = \{x: (x, y) \in T\} \).

1. The directional input distance function is defined as
\[
\bar{D}_I(x, y, g) \equiv \max_{\beta} \{\beta \in \mathbb{R}: (x - \beta g) \in V(y)\}
\]
where, \( g \in \mathbb{R}_+^N \) is a directional vector. What assumption(s) would you impose on \( V(y) \) to ensure \( \bar{D}_I(x, y, g) \geq 0 \iff x \in V(y) \).

2. The cost function is defined as
\[
C(w, y) \equiv \min_x \{w \cdot x: \bar{D}_I(x, y, g) \geq 0\}
\]
What assumptions would you impose on \( V(y) \) to ensure a cost function exists?

3. Prove \( x \in V(y) \iff y \in P(x) \iff (x, y) \in T \).
**Question 3.** Consider the directional input distance function given by

\[
\bar{D}_1(x_1, x_2, y_1, y_2; g) = (y_1^2 + y_2^2)^{0.5} - x_1^{0.5}x_2^{0.5}
\]  

(3.1)

Here, \(x_1\) and \(x_2\) represent the levels of inputs 1 and 2 used in production, while \(y_1\) and \(y_2\) are the levels of goods 1 and 2 produced. Let \(p_1\) and \(p_2\) represent the unit price of goods \(y_1\) and \(y_2\), respectively and let \(w_1\) and \(w_2\) represent the unit price of factors goods \(x_1\) and \(x_2\).

1. Given the multioutput technology (3.1) above, derive the cost function for producing a given level of good 1 and good 2.

2. Let the level of output 2 be fixed at \(y_2 = \bar{y}_2\). Given your answer to part 1 of this question, assume an interior solution and derive the optimal level of \(y_1\) (this is the restricted profit maximizing level of output 1).

3. Is the cost function you derived in part 1 of this problem homogeneous of degree one in input prices? Explain your answer.

4. Is the input demand function for \(x_1\) homogeneous of degree one in input prices? Explain your answer.

5. Is the good 1 supply function homogeneous of degree one in input prices? Explain your answer.
Section II – Marketing Economics (Industrial Organization)

Question 1. Product Space Approach to Demand Estimation in Differentiated Product Markets

Preliminaries: Suppose you seek to estimate price-cost markups, PCM, in a differentiated product industry. You set up a structural model of competition and found out that you can calculate PCMs simply from the estimates of own- and cross-price elasticities of demand for products. To this end, you collected price and quantity data for a panel of $J$ products across $N$ cities for $T$ periods. One of your colleagues suggested that you estimate the following AIDS model to obtain the elasticities:

$$s_{int} = \alpha_{in} + \beta_{i} \ln \left( \frac{y_{nt}}{p_{nt}} \right) + \sum_{j=1}^{J} \gamma_{ij} \ln p_{jnt} + \varepsilon_{int},$$

where $s_{int}$ is the $i^{th}$ brand revenue share in city $n$ in period $t$, $p_{int}$ is price, $y_{nt}$ is overall expenditure, $p_{nt}$ is price index, $\alpha, \beta, \gamma$ are model parameters to be estimated, $\varepsilon$ is the error term.

1. Carefully explain the potential dimensionality and endogeneity problems with this estimation strategy. Why should we be concerned about these problems?

2. Propose an alternative estimation strategy to address these problems:
   a. show how your strategy solves the potential dimensionality problem,
   b. show how your strategy solves the potential endogeneity problem.

In your discussion,

- please carefully explain how you modify the econometric model in each case. Please clearly describe any additional variables and/or regression equations that you may introduce.
- if there are any additional assumptions about the underlying utility function and/or econometric model for your strategy to work, please thoroughly explain. Discuss the conditions under which these assumptions are reasonable, or might be tenuous?
Question 2. Characteristics Space Approach to Demand Estimation

Preliminaries: Suppose you seek to empirically distinguish between the three sources of price-cost margins, PCM, in a differentiated products market (e.g., Nevo 2001, Econometrica), which are a firm’s ability: i) to differentiate its brands from those of its competitors, ii) to charge more by producing imperfect substitutes, and iii) to charge more due to price collusion.

1. Analysis of firm behavior:
Suppose that there are \( F \) firms each producing a subset, \( \gamma_f \) of the \( J \) different brands in a market. Derive a structural model of price competition that will allow differentiating between each of the sources of PCM.

2. Analysis of consumer behavior:
If you derived the behavioral equations in Part 1 correctly, you will note that PCMs can be obtained solely from the own- and cross-price elasticities of demand. Suppose that you observe aggregate market shares, price and product characteristics of a panel of \( J \) RTE cereal brands in \( T \) city-quarter specific markets. Assume that consumers have preferences over characteristics and each consumer purchases one of the \( J \) brands or an outside option. Denote the utility of individual \( i \) from product \( j \) in market \( t \) as:

\[
    u_{ijt} = x_j \beta_i - \alpha_i p_{jt} + \xi_{jt} + \epsilon_{ijt},
\]

where,

\[
    \begin{pmatrix}
        \alpha_i \\
        \beta_i
    \end{pmatrix} = \begin{pmatrix}
        \alpha_i \\
        \beta_i
    \end{pmatrix} + \begin{pmatrix}
        \Pi \alpha_i \\
        \Pi \beta_i
    \end{pmatrix} D_i + \begin{pmatrix}
        \Sigma \alpha_i \\
        \Sigma \beta_i
    \end{pmatrix} v_i,
\]

where \( p \) is price, \( x \) and \( \xi \) are the observed and unobserved characteristics, \( D \) and \( v \) are the observed and unobserved individual characteristics, \( \beta, \alpha, \Pi, \Sigma \) are parameters to be estimated. We can rewrite the utility specification as the individual specific deviations from the mean utility level:

\[
    u_{ijt} = \delta_{jt}(x_j, p_{jt}, \xi_{jt}; \theta_1) + \mu_{ijt}(x_j, p_{jt}, v_i, D_i; \theta_2) + \epsilon_{ijt},
\]

where \( \delta_{jt} = x_j \beta - \alpha p_{jt} + \xi_{jt} \) is the mean utility \( \mu_{ijt} = [p_{jt}, x_j]'(\Pi D_i + \Sigma v_i) \) is the mean-zero heteroskedastic deviation from the mean utility, \( \theta_1 = (\alpha, \beta) \) and \( \theta_2 = (vec(\Pi), vec(\Sigma)) \).

Assume that \( \epsilon_{ijt} \sim \text{i.i.d. Type I Extreme Value} \), so that the model is random coefficients logit. Also, suppose \( E(\xi p) \neq 0 \) however you have a vector of instruments, \( Z \), such that \( E(\xi Z) = 0 \). The utility from outside good is normalized to zero, \( u_{i0t} = 0 \).

1. Which parameter restrictions will yield the multinomial logit model? Why?
2. Show that estimating the following regression equation:

\[
    \log(s_j) - \log(s_0) = x_j \beta - \alpha p_j + \xi_j \text{ via 2SLS provides consistent estimates of the logit model (The logit probabilities are given as Pr}(y_{ijt} = 1) = s_{jt} = \exp(\delta_{jt})/\sum_k^l \exp(\delta_{kt})).
\]

3. Outline the Berry, Levinsohn and Pakes (1995, Econometrica) method to estimate the full model (random coefficient logit). Please be as specific as possible. How is it related to the estimation algorithm of the multinomial logit in 2?
Question 3: Policy Impact in the Presence of Market Power

Suppose an agricultural commodity is produced by many producers and then sold to a concentrated downstream processing sector. Also, suppose that the commodity is exported from a developing country and then is processed and sold in a developed country. Currently, the developing country has a per-unit tariff, T, on the agricultural exports.

The government in the developing country is considering removing the tariff on the exports in order to raise the growers’ income. However, there are concerns that the buying firms will capture a large portion of the benefits because of the oligopsonistic and/or oligopolistic nature of the processing sector. You are hired as a consultant to analyze the policy. Denote consumers’ inverse excess demand as:

\[ P_r = D(Q_r), \]

where \( P_r \) and \( Q_r \) are market price and quantity of the retail product. Similarly, denote inverse excess farm supply as:

\[ P_f = S(Q_f), \]

where \( P_f \) is the price received by the growers, \( Q_f \) is the total volume of the farm shipments. A representative processor’s variable cost function is given as:

\[ C^w = c^w q_f + (P_f + T) q_f, \]

where \( c^w \) is per unit processing cost, \( P_f \) is the per unit cost of farm input, \( T \) is per-unit import tariff on raw product, and \( q_f \) is processing firms’ purchase quantity. Similarly, a representative retailer’s variable cost function is given as:

\[ C^r = (c^r + P^w)q^w \]

where \( c^r \) is per unit retailing cost cost, \( P^w \) is the wholesale price, \( q^w \) is the wholesale purchase quantity. Assume a fixed proportions processing technology, \( Q^r = Q^w = Q_f = Q \) and \( q^r = q^w = q_f = q \). Use this framework to answer the following questions:

1. Graphical Analysis: Use linear retail demand and farm supply schedules. Provide a graphical analysis of the equilibrium in which processors may have both oligopoly and oligopsony market power, while retailers are competitive. Please define any new notation you use. Your analysis should include a verbal discussion of the equilibrium price and quantity outcomes in comparison to the perfectly competitive outcomes.
2. Again consider the scenario in which processors may have both oligopoly and oligopsony market power. Write out the profit maximization problem of a representative processor under assumptions of Cournot competition. Derive and interpret the first order condition.
3. Rewrite the first order condition in terms of the conjectural elasticities. What do the conjectural elasticities indicate?
4. What is the change in producer price when you change (or eliminate) the per-unit tariff? How does this change compare to the change in producer price if the markets were perfectly competitive?