Production/Marketing Exam
Spring 2008

Directions: Answer four questions:

Choose one of the two required questions (Q1 or Q2)

Choose three out of the remaining six questions (Q3, Q4, Q5, Q6, Q7, Q8).
Q1:
Consider a cost function of the form
\[
\ln \{c(w, y)\} = a_0 + y + \sum_{j=1}^{4} a_j \ln w + \frac{1}{2} \sum_{i=1}^{4} \sum_{j=1}^{4} b_{ij} \ln w_i \ln w_j
\]
where \( y \) is the output of a production process, \( w \) is the price vector for the production factors capital, labor, energy and materials, and the following parameter restrictions hold:
\[
b_{ij} = b_{ji},
\]
\[
\sum_{j=1}^{4} a_j = 1
\]
\[
\sum_{j=1}^{4} b_{ij} = 0
\]
Let \( x = (x_1, x_2, x_3, x_4) \) be the vector of production factors.

a) Show that the three parameter restrictions listed are necessary to guarantee that the cost function here is linearly homogeneous.

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.

c) Uzawa has shown that the Allen-Uzawa elasticities of substitution can be written
\[
\sigma_{ij} = -\frac{c(w, y)}{\partial c(w, y)/\partial w_i} \frac{\partial^2 (c(w, y))}{\partial w_i \partial w_k} \frac{\partial c(w, y)}{\partial w_k}
\]
where \( w \) is the input price vector, \( x \) is the factor vector, and where output is fixed at an arbitrary level. Using your result in b) above, derive an expression for the elasticities of substitution in terms of shares and the parameters of the function.

d) Comment on the various econometric issues that are involved in the estimation of translog cost functions and other flexible forms. Explain why the cost functions appear to be more frequently used in empirical industrial organization studies than production functions.
Q2:

Assume the direction $g = (1,1)$ and consider the following quadratic output distance function:

$$
\tilde{D}_o(x_1, y_1, y_2 : 1,1) = \alpha_0 + \alpha_1 y_1 + \alpha_2 y_2 + 0.5\alpha_{11}(y_1)^2 + 0.5\alpha_{22}(y_2)^2 + 0.5\alpha_{12}y_1 y_2 + 0.5\alpha_{21}y_2 y_1 + \beta x_1 + \gamma_{11}y_1 x_1 + \gamma_{21} y_2 x_1.
$$

a) Assume symmetry in the relevant output coefficients and derive the sufficient conditions for translation to hold.

b) Is this function linearly homogeneous in outputs? Justify your answer.

c) Given the following revenue maximization problem

$$
\max_{y_1, y_2} \left\{ p_1 y_1 + p_2 y_2 : \tilde{D}_o(x_1, y_1, y_2 : 1,1) \geq 0 \right\}
$$

i) Derive the first-order necessary conditions for the optimal choice of $y_1$ and $y_2$. \textbf{Note:} do not try to solve for the optimal levels of these variables.

ii) If you had data on output price and on output and input levels, and estimated $\tilde{D}_o(\cdot)$, what sign would you want to see on $\alpha_1, \alpha_2, \alpha_{11},$ and $\alpha_{22}$? Explain your answer.
Q3:

In recent years, health concerns have led many consumers to seek out natural and organic food products. In October 2002, the U.S. Department of Agriculture (USDA) put in place a set of national standards that foods must meet in order to bear the label “organic”. However, the USDA does not enforce standards for labels such as “natural”, “free-range” and “hormone-free”. Consumers have heterogeneous preferences for natural/organic food.

The informative and persuasive views of advertising offer different ways to analyze the effects of food labels and labeling standards on consumer behavior and market outcomes.

a) Briefly summarize the key features of the two views: How does advertising affect the demand for the advertised product? How should advertising affect prices and product quality in equilibrium?

b) Use each theory to develop conceptual models for how prices and quality for food products as a whole should differ before and after the regulatory change in 2002. Consider the effects of heterogeneous preferences on your predictions.

c) Outline an empirical methodology for assessing the explanatory power of each view in understanding the effects of food label standards. In your discussion, set up your null hypothesis or hypotheses, identify the unit of analysis, the key variables for which you would collect data, and the basic structure of a statistical model you would use to analyze the data.
Q4:

Answer both Part 1 and Part 2 of the question. Part 1 has to do with the traditional inter-regional spatial competition (e.g., Takayama-Judge) and Part 2 deals with the intra-regional spatial competition (e.g., Benson, Capozza and Van Order).

Part 1: A point-space interregional spatial model assumes that consumers and producers of a given region are located at a single point.

   a) Assume perfect competition. Graphically present a point-space model in which two regions (each with indigenous supply and demand) trading with each other a homogeneous good to illustrate how the equilibrium price and quantities are determined. Explain your analysis.

   b) Graphically analyze the effect on the equilibrium solution of an increase in transportation costs. Include in the discussion factors determining the differential impacts on regional prices of the cost shock.

   c) Outline how to conduct comparative static analysis of the cost shock mathematically for a model with N regions.

Part 2: An intra-regional spatial model assumes that consumers and/or producers of a given region are spatially dispersed.

   d) 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 Loschian type. Show how the equilibrium prices and quantities are determined. Include in the discussion graphs and equations as appropriate.

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

   f) Outline how to conduct comparative static of the cost shock of the above model mathematically.
Q5:

You are to investigate the retail-farm price spread in a specific food industry. The general philosophy you take is that the observed price spread is, in part, an outcome of the optimizing behavior of the processors who produce the food item using farm and non-farm inputs.

a) Assume perfect competition. Set up a model in the line of Gardner to demonstrate how you would analyze the effect of a demand shock on the retail-farm price spread.

b) Consider the possibility that the processors possess market power on the output side. Set up a model in the line of Holloway to analyze the issue of market conduct within the framework of a vertical marketing channel.

c) Acknowledge the literature on asymmetry, rigidity and threshold pattern in price adjustments to shocks by discussing the issues therein.

d) Continue on part c) by presenting a corresponding time-series econometric model to evaluate the farm-retail price linkage in the food industry in question.

e) Discuss how you would estimate the model presented in part d).
Q6:

Business format franchising is common in many retail and services industries. Franchisors often employ a mix of contract forms, operating some stores directly and franchising others. Franchise contracts typically involve payments of a fixed franchise fee and royalties on sales from the franchisee to the franchisor. In return, the franchisee receives the right to sell the franchisor’s product or service and use its trademarks and business plans. Franchise contracts may also include area development plans whereby a single franchisee is awarded franchise rights for a contiguous geographic region.

Principal-agent models and property rights models provide different ways of examining the determinants of firm boundaries.

a) Briefly summarize the key features of these two theories of firm boundaries: How are integration and non-integration defined in each class of models? What are the tradeoffs between integration and non-integration in each class of models?

b) Use each theory to develop explanations for the following questions: When will a franchisor choose to operate stores directly and when will it choose to franchise its stores? When will area development plans be especially valuable to the franchisor and/or franchisees?

c) Outline an empirical methodology for assessing the power of the two theories in explaining contract form in franchise systems. In your discussion, set up your null hypothesis or hypotheses, describe your sample (industry/industries, cross section/time series/panel), identify the unit of analysis, the key variables for which you would collect data, and the basic structure of a statistical model you would use to analyze the data.
Q7:

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

a) Identify the unconditional and the conditional CAPM models, clearly state your notation and the underlying assumptions, and discuss the implications of each model for expected asset returns and prices. Explain why the conditional CAPM could hold period-by-period. Explain why stock might be mispriced by the unconditional CAPM.

b) 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 that 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 factors truly risk factors with associated risk premia, or just market inefficiencies? What economic arguments can you provide for one view versus the other? What econometric approach would you suggest to provide some insight into this question?
Since the publication by Williamson (1968) of his seminal paper on antitrust there has been a growing recognition by regulators of the need to assess tradeoffs between merger-related efficiency gains and merger-induced increases in market power. In recent years, a series of researchers including Anderson, de Palma and Thisse (1992), Berry (1994), Shapiro (1996), Hausman and Leonard (1997), Nevo (2000), Ivaldi and Verboven (2005) and others have developed the theory of differentiated product markets into a commonly used tool for merger analysis.

To make this more concrete, consider the case of industrial shippers. Formally, let $U_{gh}^n$ be the utility that a shipper $n$ receives when selecting carrier $h$ in market $g$ ($g = 1, 2, ..., G$). The markets in this case might be markets for bulk shipments, intermodal shipments, general freight shipments, and so on. Let $V_{gh}$ be the systematic component common to shippers in market $g$, and $\nu$ the unobserved characteristics of shipper $n$. We then have

$$U_{gh}^n = V_{gh} + \nu_{gh}^n.$$  \hspace{1cm} (1)

The systematic utility that a shipper in market $g$ receives from using carrier $h$ can be further decomposed into a mean utility component ($\bar{V}_{gh}$) common to all shippers who use $h$, a price effect, and a random component ($\xi_{gh}$) representing the unobserved components in $V_{gh}$. The expression for $V_{gh}$ then is

$$V_{gh} = \bar{V}_{gh} - \alpha_g p_{gh} + \xi_{gh},$$  \hspace{1cm} (2)

or, letting $X_g$ represent a matrix of demand-related variables in market $g$ and $\beta_g$ a vector of parameters,

$$V_{gh} = X_g \beta_g - \alpha_g p_{gh} + \xi_{gh}.$$  \hspace{1cm} (3)

Of course, we do not observe shipper utility. The unobserved component of the utility, $\nu_{gh}^n$, is itself decomposed as

$$\nu_{gh}^n = \zeta_h^n + (1 - \sigma_g) \xi_{gh}.$$  \hspace{1cm} (4)
The second and the third term, $\zeta^n_h$ and $\epsilon^n_{gh}$, are random variables reflecting shipper $n$'s deviation from the mean valuation.

Assume that the term $\zeta^n_h$ is the unobserved part of shipper $n$'s utility that affects $n$'s choice of carrier mode (truck, rail, etc.) whereas the term $\epsilon^n_{gh}$ is the unobserved part of shipper $n$'s utility that affects the choice of a particular firm $h$ within a mode. The parameter $\sigma_g$ then lies between 0 and 1 and measures the correlation of the shippers' utility across firms within a particular mode. If $\sigma_g = 1$, there is a perfect correlation of preferences for firms within the choice of mode; these firms are perceived as perfect substitutes. As $\sigma_g$ decreases, the correlation of preferences across firms within a mode decreases. If $\sigma_g = 0$, there is no correlation of preferences.

Each customer $n$ chooses the firm $h$ (in our case a railroad or another transport mode) that maximizes utility. To compute the probability that a customer chooses $h$, Berry (1994), Nevo (2000), and the others assume that the random variables $\zeta^n_h$ and $\epsilon^n_{gh}$ are distributed such that $\zeta^n_h$ and $\zeta^n_h + (1 - \sigma_g)\epsilon^n_{gh}$ have extreme value distributions. In our example, normalizing the mean utility level for the other (non-rail) transport modes to 0, means that the probability $s_{gh}$ that a shipper chooses railroad $h$ in market $g$ would be given by the following formula:

$$s_{gh} = \frac{\exp\left(V_{gh}/(1 - \sigma_g)\right)}{D_g^{1-\sigma_g}} \cdot \frac{D_g^{1-\sigma_g}}{1 + D_g^{1-\sigma_g}},$$

(5)

where $D_g$ is defined by:

$$D_g = \sum_{h=1}^{H} \exp\left(V_{gh}/(1 - \sigma_g)\right).$$

(6)

For this model to be consistent with (random) utility maximization, $\alpha$ has to be positive and $\sigma_g$ has to lie between 0 and 1. At the aggregate level, the choice probability $s_{gh}$ coincides with the market share of a particular rail firm.

Equation (5) can be restated as
\[
\ln s_{gh} - \ln s_{g0} = X_g \beta_g - \alpha_g p_{gh} + \sigma_g \ln s_{gh|H} + \xi_{gh}.
\]

(7)

where \( s_{gh} \) is the market share of railroad \( h \) as a portion of the total rail market. Since market shares, product characteristics and prices are observed, this is the type of equation that Berry (1994), Nevo (2000), Ivaldi and Verboven (2005) and the others estimate.

a) Interpret the parameters in the vector \( \beta \) and the parameter \( \alpha \). Why might the value of these parameters be of interest to antitrust authorities?

b) Notice that the parameter \( \sigma \) can be estimated from share data, price data, and product characteristic data--all of which is typically available to antitrust authorities. Explain how this parameter is related to the degree of product differentiation? Why might this parameter be of interest to an antitrust authority?

c) Can you provide some intuition as to how the share equation (5) is derived? Can you show how equation (7) relates to equation (5)?

d) In Nevo (2000), cost elasticities are estimated using equation (7). Marginal costs (\( m_{cr} \)) are then recovered from the estimated demand system by assuming a pre-merger Nash Bertrand equilibrium of the form

\[
s_j(p) + \sum_r (p_r - m_{cr}) \frac{\partial s_j(p)}{\partial p_j} = 0
\]

where \( r \) is the set of brands and \( s_j \) is the observed share of brand \( j \) and \( p \) is the observed price vector. Comment on whether Nevo is able to estimate the Williamson tradeoff using this method?

e) What additional data and specification changes would one need to estimate the Williamson tradeoff?