WRITTEN PRELIMINARY Ph.D. EXAMINATION

Department of Applied Economics
University of Minnesota

Spring 2004

PRODUCTION AND MARKETING ECONOMICS

Instructions:

-- Identify yourself by your code letter, not your name, on each question.

-- Start each question's answer at the top of a new page.

-- Answer the first question.

-- Answer three of the remaining five questions.

-- You have four hours to complete this examination.
1. Consider the case of Country X in which processing-quality tomatoes are produced all year round by many small growers who take their input and output prices as given. The tomatoes are processed into a single product, tomato sauce, via a quasi fixed-proportions technology wherein substitution between the raw agricultural input and the processing inputs (e.g., labor, energy, and capital) is prohibited, but substitution among the processing inputs is possible. The processed products are sold in the domestic market, as well as to the foreign market. Due to similarities in processing technologies and grading standards, it is assumed that the processed products are homogeneous regardless of their country origins. Since there are only few tomato processors in Country X, it is suspected that those processors may possess market power in both the procurement of tomato inputs as well as the sale of tomato sauce in the domestic markets. However, due to the above homogeneous product assumption (in conjunction with a small country assumption), the processors take output price as given when it comes to the export sales of tomato sauce.

The government is considering a policy encouraging the adoption by the growers of a mechanical harvesting technology. Based on experiences in other countries, it has been argued that substantial benefits could accrue to tomato growers if the new technology is adopted. However, concerns have been raised that a significant portion of the benefit may actually go to the tomato processors due to the oligopsonistic and oligopolistic nature of the domestic industry.

a. Present a conceptual model that can be used as a foundation for the empirical investigation of the domestic market power of the processors in Country X.

b. Discuss how you would empirically specify and estimate your model.

c. Discuss how you would proceed with the measurement of welfare implications of the technology adoption.

Suppose you are concerned about the previous assumption that processed tomato products are homogeneous regardless of their country origins. You are to conduct a test of product range to ascertain whether there exists a stable price premium (possibly zero) between tomato products produced in Country X and elsewhere.

d. Present a method that you can use for this investigation and discuss how you would empirically implement the analysis.
2. Consider the input distance function given by

\[ D_1(x, y) = \frac{\sqrt{x_1 x_2}}{\sqrt{y_1^2 + y_2^2}}. \]

Here, \( x = (x_1, x_2) \in \mathbb{R}_2^+ \) is a vector of inputs and \( y = (y_1, y_2) \in \mathbb{R}_2^+ \) is a vector of outputs.

a. Assuming efficient production, derive the cost function corresponding to \( D_1(\cdot) \).

b. Is this cost function (give concise, complete explanations):

   i) linearly homogeneous in prices,
   ii) concave in prices, and
   iii) nondecreasing in input prices?

c. What is the corresponding inverse demand function for \( x_1 \)?

d. What is the supply function of \( y_1 \)?

e. Does the technology satisfy constant returns to scale?

3. The Precision Agriculture (PA) hypothesis asserts that farmers can increase their profitability by varying management inputs such as fertilizer and pesticides within a field in response to within field variation in factors such as soil type, drainage, and topography.

a. Propose a conceptual model and use it to demonstrate necessary conditions for the PA hypothesis to hold. At a minimum, your model should include a careful description of the production process, a careful description of a farmer’s optimality conditions, and a discussion of the implications of these optimality conditions in terms of the PA hypothesis.

b. Suppose you want to test PA hypothesis for variable rate seeding (e.g. number of seeds per acre) of corn based on information about within field variation in soil organic matter. Describe how you would implement your conceptual model empirically. Your discussion should include a description of what data you would want to collect, your choice of statistical model (e.g. functional form and form of error), and the statistic used to test your hypothesis.
4. Let $A_c$ and $A_s$ be the number of corn and soybean acres planted by a farmer. The profit per acre from planting corn is $\pi_c$, a random variable with mean $\mu_c$ and variance $\sigma_c^2$. The profit per acre from planting soybean is $\pi_s$, a random variable with mean $\mu_s$ and variance $\sigma_s^2$. The covariance between corn and soybean profit is $\sigma_{cs}$ with correlation coefficient $\rho$. Assume the farmer's expected utility is $EU = E(\pi) - (\lambda/2)V(\pi)$ where $\pi$ is the net return, $E(\pi)$ is the expected return, $V(\pi)$ is the variance of expected returns, and $\lambda \geq 0$ is the coefficient of constant absolute risk aversion.

a. Find the farmer’s optimal amount of corn acreage assuming he has a total of $A$ acres available to plant between corn and soybeans.

b. An input can be defined as risk decreasing, if an increase in risk aversion (i.e. an increase in $\lambda$) increases the use of the input. Based on this definition and assuming we have an interior solution, characterize the conditions under which an increase in corn acreage is risk decreasing. Under these conditions, what has to be true about $\sigma_c$, $\sigma_s$, and $\rho$, for an interior solution to be optimal.

c. Find the farmer’s optimal corn acreage assuming the competitive price of crop acreage is $r$ per acre. Assuming we have an interior solution, characterize the conditions under which increasing corn acreage is risk decreasing.

d. How do the risk decreasing conditions in parts b) and c) compare? Explain the intuition of your result.

5. This question has two parts. Answer both parts.

Part 1: Consider an optimal portfolio choice problem with one risky security and a risk free security. The agent's preferences have an expected utility representation with strictly increasing and differentiable utility function. Consumption takes place at a single date (when security payoffs are realized) and the agent's only endowment is her wealth at the time of the security trade. The agent is strictly risk averse. Show that the agent will invest a strictly positive fraction of her wealth in the risky security, if the expected return on the risky security is strictly greater than the risk-free rate of return.

Part 2: Consider two-period security markets with a single good that is consumed in both periods, a risk-free security, and many risky securities. Assume agents are expected-utility maximizers with time-separable utility functions.

a. State the investor's maximization problem, then derive the basic pricing equation for the consumption-based asset pricing model. Make sure that you clearly identify each of the assumptions and the notation used in your derivation.
b. Suppose that the agent's utility function is quadratic. Show that the consumption-based model implies that a security whose return is negatively correlated with the agent's second period consumption has expected return lower than the risk-free rate of return. Discuss the intuition of this result.

6. The regional manager of a supermarket chain is considering the opportunity to build a new store in a rapidly developing area where there is currently little competition. The store can be built immediately (i.e., in year 0), one year from now (i.e., in year 1), or not at all. Regardless of when it is built, the cost will be $3 million to acquire the site and build the store. If the store is built immediately (i.e., in year 0), it will generate $0.4 million in profits that year. Profitability is uncertain in year 1 and in all subsequent years over an infinite planning horizon. There is a 0.5 probability that it will be $0.6 million per year for \( t = 1, 2, \ldots, \infty \) and a 0.5 probability that it will be only $0.2 million per year for \( t = 1, 2, \ldots, \infty \).

[NOTE: Recall that the net present value of an infinite stream of uniform net returns starting at time \( t = 1 \) is given by the formula:

\[
\sum_{t=1}^{\infty} \frac{\pi}{(1 + r)^t} = \frac{\pi}{r}
\]

where \( \pi \) is the uniform net return and \( r \) is the discount rate.]

a. When, if at all, should the store be built if the discount rate is 10% — i.e., if \( r = 0.10 \)? Justify your answer by calculating the net present value of each possible store development policy.

b. What is the value, if any, of the option to delay the decision about construction until year 1? Justify your answer.

c. Now consider an additional factor. If the manager delays the decision to build the store until year 1, there is a 50% probability that the store site will be developed by another company. If this occurs, it will be impossible for the supermarket chain to build the new store. How does this affect the optimal store development policy? Justify your answer by calculating the net present value of each possible policy.

d. Under the conditions described in part (c), what is the maximum the supermarket chain would be willing to pay for an exclusive option to develop the store site? Justify your answer.