Tuesday, January 22nd, 2008

Core Preliminary Exam in Agricultural Economics

Purdue University

Directions:

- Please write clearly in large letters. Provide a wide margin around the edges of each page. Use blue or black ink, or bear down if you write in pencil so that the lines are dark. This will ensure that photocopies of your exam will be readable by graders.

- This exam consists of three questions each with multiple parts. Please answer all parts of all three questions.

- On each page, please write the question number, the page number in sequential order, and your identifying exam number. Do not write your name on the exam.

- You have four hours to complete the exam. You should use your time wisely and be sure to allocate time to optimize your ability to display your knowledge to the examining committee. Please write what you know. Partial credit may be given for incomplete answers.

- At the start of the exam you may ask questions of the proctor aimed at clarifying the meaning of the question, but questions related to concepts will not be answered.

- You are welcome to disassemble the exam when questions run over onto multiple pages so that you can view the question in its entirety.

GOOD LUCK! DON’T PANIC, JUST THINK!
Question 1

Consider a profit-maximizing agricultural producer who owns the proverbial “goose that lays golden eggs.” Both the goose and the owner live for $T$ years. The goose requires no feed and produces one golden egg on the same date each year. This egg may be sold immediately on a competitive market at a price $p$, or stockpiled indefinitely without decline in quality for later sale. The owner discounts his profit at the rate $\delta$. The owner's goal is to maximize the net present value of profits over the planning horizon.

a. Write down the goose-owner's optimal control problem, defining any necessary variables. Be sure to clearly identify the state and control variables. Let the co-state variable be represented by $\lambda$. Write down the Hamiltonian and the first-order necessary conditions for the problem. Interpret them.

b. Assume price is constant over the planning horizon. What is the economically optimal decision rule for the owner? Why? Briefly discuss your logic and intuition.

c. Now allow the real price to grow at the constant rate $\alpha$, where $\alpha > \delta$. Modify the set up and derive a new optimal decision rule for the decision maker. What changes? Why?

d. Now consider a case where there is no price inflation ($\alpha = 0$) but the producer has market power over the supply and storage of golden eggs and faces inelastic demand in every period. How does market power alter the program you developed in part a? What are the implications of market power for the producer’s incentive to store? What are the implications for the consumers of golden eggs?
Cross-country growth regressions have investigated the underlying causes of diverging economic growth rates, and have been used to assess the contribution of technical progress to growth and development. Panel data are assembled from *World Development Indicators* and other sources for a large number of countries, averaging economic performance over typically five years and correcting GDP and other variables using PPP exchange rates. The dependent variables of these models have sometimes been per capita GDP, sometimes growth rates, and sometimes the Solow residual from a theory-based growth model. Models almost always include proxies for physical and human capital. Key additional factors proposed to influence growth and so explain divergence are trade liberalization, institutions, and geography. Endogeneity of economic growth rates with trade as well as institutions have been recognized as a serious problem in this literature.

a. How does one compute the Solow residual? How is it related to growth theory? To technical progress? To divergence of growth rates across countries?

b. Why do analysts correct variables using PPP exchange rates? Comment on the accuracy and utility of this conversion.

c. How are coefficients on trade (e.g. the Sachs-Warner index) and institutions interpreted in the various models?

Instruments proposed to correct for endogeneity include the predictions of a gravity model for trade (Frankel and Romer) and settler mortality rates in the 1800s for institutions (Acemouglou).

d. Briefly explain what econometric problems result if trade and institutions are endogenous but this feature is not accounted for in the econometric estimation. Briefly explain the theoretical requirements for an instrument used to correct for endogeneity in an econometric model? Do you think these are likely to be good instruments?

e. For the present case simply assume that the trade variable is suspected of being endogenous. Explain a simple way in which you could test to see if the proposed instrument(s) for this variable is/are uncorrelated with the trade variable.

f. Carefully describe at least one method by which you could test for the endogeneity of the trade variable.

g. How would you use this methodology to assess the contribution of technical change in agriculture to economic growth? What information would you require to do this?
Question 3

Motivation: Considerable debate has arisen recently regarding fertilizer subsidies in Sub-Saharan Africa. Under World Bank advice, fertilizer subsidies in Malawi were removed in the 1990’s. Recently, they have been reinstated and production has surged. This question encourages you to think rigorously about this issue.

Set-up: Consider a farm household with strictly concave utility \( u = u(c_a, c_m, c_l) \) arising from consumption of an agricultural product \( c_a \), a non-agricultural product \( c_m \), and home-time \( c_l \). The household uses purchased inputs \( x \) and labor \( l \) to produce the agricultural good using the strictly concave production function \( y_a = f(x, l) \), where \( y_a \) is the agricultural good. The household allocates its time endowment \( E \) between labor supplied \( l' \) and home-time consumed \( c_l \), such that \( c_l + l' = E \). Labor supplied by the household is perfectly substitutable for hired labor \( l^h \) such that the total labor demand by the farm is \( l' + l^h = l \). Similarly, total household demand for the agricultural good can be written as \( c_a = y_a - b_a \) where \( b_a \) is net sales/purchases of the agricultural good to the market. All prices are determined exogenously and are as follows:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p_x )</td>
<td>Price of agricultural input</td>
</tr>
<tr>
<td>( p_m )</td>
<td>Price of non-agricultural good</td>
</tr>
<tr>
<td>( p_a )</td>
<td>Price of agricultural good</td>
</tr>
<tr>
<td>( w )</td>
<td>Labor wage (time value)</td>
</tr>
</tbody>
</table>

a. Construct an optimization program that maximizes the household utility objective subject to the full income of the household.

b. Derive the first order conditions defining optimal consumer and factor demands by the household for (a). Interpret each condition. A comprehensive discussion is required

c. A household model is said to be separable if it can be solved as a two-stage optimization problem whereby farm profits are first maximized by choice of input levels, and then household utility is maximized by choice of consumer demands, subject to the income of the household (inclusive of optimal farm profits). Demonstrate that the solution you provided in (b) is indeed separable. What is the role of fertilizer subsidies in this context? Are they likely to be beneficial to the country as a whole?

d. Assume the household is constrained not only by its full income, but also by a limitation on available credit \( K \). The only use of credit by the household is for the purchase of the variable input \( x \). Solve the optimization program with this added constraint and interpret the first order conditions.

e. Show that the solution in part (d) is non-separable.

f. Discuss the role of fertilizer subsidies in the context of this non-separable problem. Are they likely to be beneficial to the country?

THIS IS THE END OF THE EXAM. MAKE SURE YOU HAVE ANSWERED ALL PARTS OF ALL QUESTIONS.