WRITTEN PRELIMINARY Ph.D EXAMINATION

Department of Applied Economics

Summer – 2008

Trade, Development and Growth

For students electing

Macro (8701) & Micro (8703) option

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
· You are requested to answer a total of FOUR questions
· Answer TWO questions from Set One
· Answer TWO questions from Set Two
· You have four hours to complete this examination
SET ONE

Answer TWO of the following THREE Questions (2 out of questions I, II or III).

I. Growth Theory

A. Environment

Consider the environment of the three sector, small open economy. For consistency in notation, agents produce and consume three goods, indexed \( j = m, s, a \), at each instant in time at price \( p_j \). The services of labor, \( L(t) \), and capital, \( K(t) \), are employed in the production of all three goods while land, \( H \), a sector specific factor, is also employed in the production of the agricultural good, \( j = a \). The manufactured good, indexed \( j = m \), is both a consumption and a capital good that is internationally traded. The rural good is also traded internationally. The home good, indexed \( j = s \), is a pure consumption good and only traded within the domestic economy. Labor services experience an exogenous rate of augmentation \( x \). These services are not traded internationally and domestic residents own the entire stock of domestic assets. Households earn income from providing labor services \( L \) in exchange for wages \( w \), earn interest income at rate \( r \) on capital assets \( A \), and receive rents from agriculture’s sector specific resource, land \( H \). From these earnings, they save and spend \( E = q_m + p_a q_a + p_s q_s \) on the manufactured good \( q_m \), the agricultural good \( q_a \) and the service good \( q_s \), per worker.

B. Primitives

\( (m = \text{manuf.}, \ a = \text{ag}, \ s = \text{service}) \)

\[
Y_m = Y^m(AL_m, K_m) = A_m(A(t)L_m(t))^{\alpha} K_m^{1-\alpha}; \quad \text{Non-farm economy}
\]

\[
Y_a = Y^a(AL_a, K_a, A_a H) = A_a(A(t)L_a(t))^{\alpha} K_a^{1-\alpha} (A_a(H))^1; \quad \text{Farm economy}
\]

\[
Y_s = Y^s(AL_s, K_s) = A_s(A(t)L_s(t))^{\alpha} K_s^{1-\alpha}; \quad \text{Service economy}
\]

with the restriction that \( A_a(H) = A(t)L(t) = e^{(x+n)t} \), and the rate of growth in workers is \( n \).

Felicity is

\[
q = q_m^{\lambda_1} q_a^{\lambda_2} q_s^{1-\lambda_1-\lambda_2}
\]

The rate of time preference is \( \rho \).

(this problem is continued on next page)
C. The household

1) The Euler Equation for the case where the inter-temporal elasticity of substitution \(1/\theta\) is unity:
   a) Derive this equation
   b) Discuss its economic meaning in the context of transition growth

D. Equilibrium

1) Characterize, in general terms, i.e., not algebraically, the intra-temporal equilibrium of this economy.

2) Show (as opposed to solve for) how you would obtain the steady-state solutions for \(\hat{w}, r, p, \) and \(\hat{k}\)

E. Selected comparative statics

Make assumptions regarding the relative factor intensity of the three technologies, and assume a level of capital stock \(\hat{k}(0)<\hat{k}^{ss}\). From the intra-temporal equilibrium above, suppose you have derived the supply functions:

\[
\begin{align*}
\hat{y}_m &= y^m(p_s, \hat{k}) \\
\hat{y}_s &= y^s(p_s, \hat{k}) \\
\hat{y}_a &= y^a(p_a, \hat{w}, r^k)H
\end{align*}
\]

1) Show whether the price of the home good \(p_s\) converges to its long run equilibrium \(p_s^{ss}\) from above or below this value.

2) In transition growth, discuss the "expected" effects of changes in \(\hat{w}\) and \(r^k\) on \(\hat{y}_a/\hat{y}_a\)

3) In long-run equilibrium, what is the rate of growth in \(K, Y_m, Y_a, Y_s,\) and \(w\)?
II. Agriculture's Role in Economic Growth: a growth accounting-like exercise

The World Bank's 2008 Word Development Report (WDR) identifies a number of pathways through which agriculture stimulates economic growth. In small open economy models in which agriculture's price is determined in world markets, the direct effect of growth in agricultural output leading to lower food prices does not occur. However, the other effects remain. This question deals with these effects.

As a point of departure, consider an economy in transition growth. Consider an economy whose production technologies are neoclassical CRS, land specific to agriculture, and an intra-temporal GDP function that can be stated as

\[ GDP = G(p_m, p_a, p_s, L, K, A(t)H) \]

where:
- \( p_m, p_a \) are exogenous prices for manufacturing and agriculture
- \( p_s \) is an endogenous price of home goods
- \( L \) is exogenous, and for purposes here, a constant
- \( K \) is endogenous
  - \( A(t)H \) is land augmentation at rate \( \eta \), and the stock of land \( H \) is exogenous

Our key focus is on how an exogenous increase in agricultural technological change \( A(t) \) affects economy-wide GDP, and by implication, the welfare of the economy in the process of growth.

Drawing upon your knowledge of growth accounting, growth theory and the envelope properties of the GDP function

- Make explicit assumptions about the relative factor intensity in the three sectors of this economy
- Assume that \( K(0) < K^{ss} \)
- Assume agents have homothetic preferences so that \( \dot{K}/K \geq \dot{L}/L \)
- Posit, based on these assumptions, the following reduced form functions (where we only note the exogenous variable of interest)
  \[ p_s = P^*(A(t), \cdot) \]
  \[ K = K(A(t), \cdot) \]

- and postulate/indicate the sign of \( \partial P^*(A(t))/\partial t \), \( \partial K(A(t))/\partial t \).

1) Provide a brief economic justification for the signs you have chosen for \( \partial p_s(A(t))/\partial t \), \( \partial K(A(t))/\partial t \)
2) Evaluate and explain the effect on GDP of an increase in \( A(t) \). These are some of the "path ways" discussed in the WDR

(this problem is continued on next page)
3) Evaluate and explain the direct and indirect effects of an increase in $A(t)$ on either
   a) agricultural supply OR
   b) farm profits, BUT NOT BOTH

4) Evaluate and explain the effect of an increase in $A(t)$ on payments to labor, $w$

5) Evaluate and explain the effect of an increase in $A(t)$ on the returns to capital $r^k$

6) Given these effects, discuss (as opposed to show) how an increase in $A(t)$ is likely to
   affect the representative agent's discounted present value of utility, i.e.

   \[ \int_0^\infty \frac{\mu^{1-\theta} - 1}{1 - \theta} e^{-\rho t} dt \]

   Hint: indicate what is likely to be with a small $\eta$ as opposed to a large $\eta$. 

III. Analysis of trade reform and economic growth

The shock in prices of petroleum, metals and agricultural commodities are at levels not seen since the first primary commodity price shocks of the early 1970s. The UN and other agencies have expressed major concerns for how these shocks are likely to impact low income economies that are net food importers. Many of the net food importing countries are responding to the food price shocks by importing agricultural commodities at world prices, and then selling those commodities to their domestic food distribution system at prices lower than world prices. The financial loss from importing at world prices and selling at lower domestic prices has been paid for by the government. The sources of revenues vary, some governments borrow on world markets, some cross subsidize (tax their exports and use this revenue to pay for the subsidy on food imports), and various other combinations.

For the purpose of this question, consider:

- A country that borrows on world markets to finance the higher world price of food SUCH THAT THE RELATIVE DOMESTIC PRICE OF THE EXPORTED GOOD TO THE IMPORTED GOOD (food) REMAINS UNCHANGED. Effectively, by borrowing from external sources, the country's internal terms of trade remain unchanged.

1) Use a graphic analysis to show the nature of the equilibrium of a country pursuing this food subsidization policy.

2) Presume that the country continues this strategy for a number for $t^*$ years and accumulates foreign debt. Also, the country experiences economic growth. Depict and briefly discuss the new equilibrium at $t^*$.

3) Now, suppose that at $t^* + 1$, foreign creditors demand repayment of the accumulated debt. Depict and discuss this "new" equilibrium.

4) Suppose the country had not pursued a food subsidization strategy but instead had permitted world prices to prevail in the domestic economy, even though these prices implied a negative external terms of trade change. Depict and discuss what the country's equilibrium might have been in $t^* + 1$ RELATIVE to the equilibrium in $t^* + 1$ above.
SET TWO

Answer TWO of the following THREE questions (2 out of questions IV, V and VI)

IV. Models of rural credit markets in developing countries.

Consider a rural credit market model in which both lenders and borrowers are risk neutral. The borrowers use the credit to invest in agricultural production, which is risky. If the harvest is a “success”, which happens with probability \( \pi \), total output is \( R \) and the borrower has to pay the interest rate \( i \) (which includes principle plus interest) to the lender. If the harvest is a “failure”, which happens with probability \( 1-\pi \), total output is 0 and the borrower does not have to pay anything to the lender.

Assume that there are two types of borrowers, denoted by 1 and 2. Type 2 borrowers invest in riskier investments (smaller \( \pi \)), but the return on those investments is higher:

\[
\begin{align*}
\pi(1) &> \pi(2) \\
R(1) &< R(2)
\end{align*}
\]

Unlike in class, assume that the expected value of the riskier investment is higher:

\[
\pi(1)R(1) < \pi(2)R(2)
\]

You could think of the type 2 people as those who will invest in a “new technology”, which is riskier but has a higher expected return than the old technology, but this interpretation is not essential for answering this question.

a) Assume that the (expected) utility of the borrowers depends solely on expected income. Show the (expected) utility of both types of borrowers, which you can denote as \( U(j) \), as expressions of \( \pi(j) \), \( R(j) \) and \( i(j) \), where \( j = 1 \) or 2 and it is possible that the interest rate is different for the two types of borrowers.

b) What are the expected profits (which you can denote as \( \Pi(j) \), where \( j = 1 \) or 2) of lenders from lending to the two types of borrowers. These should be functions of \( \pi(j) \), \( R(j) \) and \( i(j) \) [but you do not necessarily need all of these].

(this problem is continued on next page)
c) Consider a situation where there is only one lender, and that lender can identify which borrowers are type 1 and which are type 2 (he or she is a “fully informed monopolist”). Assuming that this lender wants to maximize his or her profits, what interest rate will he or she charge to each type of borrower? Assume that borrowers always have the option of working in the labor market for a wage of \( W \) (there is no risk associated with working for this wage) if they think that the interest charged by the lender is “too high”. Given these interest rates, which type of borrower will the lender prefer to lend to? Give the intuition for this result (please be brief when giving the intuition, one or two sentences is enough). [Note, your answers should be functions of \( \pi(j) \), \( R(j) \) and \( W \).]

d) Now assume a different situation regarding the lenders. Assume that there are many lenders that compete against each other, and that they cannot distinguish between type 1 and type 2 borrowers (the “adverse selection” situation). Recall that in this situation the lender has no choice but to set one interest rate for both types of borrowers. For a given interest rate charged to both types of borrowers, which type of borrower has the highest utility? Which type of borrower is better for the lender in terms a yielding a higher profit at the given interest rate?

e) Continuing with the situation of part d) define \( i^*(1) \) as the highest interest rate that type 1 borrowers are willing to pay (if the interest rate is higher then they will work for wage \( W \)), and define \( i^*(2) \) as the highest interest rate that type 2 borrowers are willing to pay. Using your answer to part c) above, which “maximum” interest rate is higher?

f) Continuing with the situation of parts d) and e), let \( \rho \) be the risk-free rate of interest that lenders can use to “put their money in the bank” instead of lending to borrowers of each type. Continue to assume that there is competition among lenders. Show what \( \rho \) equals when both type of lenders are willing to borrow, and when only one type of lender is willing to borrow. Assume that the proportion of borrowers who are type 1 is \( p(1) \), and thus the proportion of borrowers who are type 2 is \( 1 - p(1) \). Your answer should be an expression of \( \rho \) as a function of some (or maybe even all) of the parameters of the model. Are there any values of \( \rho \) that are “socially inefficient” in that capital is allocated to two or more sets of activities that do not have the same return to society? Explain why these values of \( \rho \) are socially inefficient.
V. Factor Productivity and Technical Change

1) Using the relationships between a partial-, a multi-, and a total-factor productivity index, describe what Abramovitz meant by the notion that productivity is a “measure of our ignorance.”

2) Using a Laspeyres indexing procedure to aggregate inputs will cause measured multi-factor productivity to increase in response to changes in relative factor prices, even in the absence of technical change. True or false? Illustrate graphically and explain in a one output, two input world.

3) Setting aside the problem of aggregation bias, identify and carefully discuss at least two additional reasons for measured multi-factor productivity growth to deviate from zero.
Consider a community of sugarcane farmers. They all face the same technology for output per acre:

\[ \text{Output per acre} = f(l), \text{ where } l \text{ is labor per acre, and } f'(\cdot) > 0, f''(\cdot) < 0 \]

There are N “big” farmers, each of whom owns B acres of land, and M “small” farmers, each of whom owns S units of land.

All of these farmers take their sugarcane to a sugarcane cooperative that runs a sugarcane processing plant. The (per unit) cost of producing one unit of sugar from one unit of sugarcane is a function of the total amount processed:

\[ c = c(Q), \text{ where } c'(\cdot) < 0 \text{ and } Q = \text{total sugarcane processed by the mill} \]

Let \( p^* \) be the (exogenous) price of sugar, \( p \) be the price of sugarcane paid by the mill to farmers, and \( w \) be the wage rate for labor. [Note that in the lectures \( w \) was assumed to equal 1, but here that assumption is not made. Another change from the lecture is the \( c(\cdot) \) is a function of \( Q \), not a function of some “capacity”.]

a) Assume that both types of farmers maximize their profits, taking \( w \) and \( p \) as exogenous. For simplicity, suppose that they hire all the labor they use, and do not use any household labor. Show the first order condition for the farmer’s maximization problem (in terms of labor hired per acre of land).

b) How does the demand for labor (per acre of land) change as the relative price of sugarcane \( (p/w) \) changes? [Hint: it may be more intuitive to express the relative prices as \( w/p \) instead of \( p/w \).] Explain whether there is a well defined demand for labor (per acre of land) function that is a function of the relative price of sugarcane. If there is, express labor demand (per acre) as a function of the relative price of sugarcane and write the farmer’s profit function (per acre) as a function of that relative price and the price of sugarcane. If not, explain why it is not well defined.

(this problem is continued on next page)
c) Show how the total amount of sugar produced by all of the farmers, $Q$, is a function of the number of the two types of farmers, the acres that each type has, and the relative price of sugarcane paid by the sugarcane mill. Assume that all farmers in this area bring their sugarcane to this mill. Using your answer to part b), show the direction of the impact on $Q$ of an increase in $w$. Show the direction of the impact on $Q$ of an increase in $p$.

d) Next, let’s work out the price of sugarcane that the mill pays to the farmers ($p$) that is socially optimal. For this community, show what the social benefit is (to the community) for each acre of sugarcane that is processed into sugar. [Hint: this expression should have $p^*$, $c(Q)$ and $w$ in it.] Differentiate this with respect to $p$ to obtain a first order condition for maximizing the social benefit of processing one acre of sugar cane. [Hint: You will need to express $Q$ as a function of $p$ before differentiating.] For extra credit, show that this first order condition can be interpreted as indicating that the mill should set the marginal revenue of processing another unit of sugar cane equal to the marginal cost.

e) The government has heard news reports of “big” land owners effectively taking control of sugar cooperatives, raising prices, and distributing profits only to “big” land owners (giving none of the profits to “small” land owners). So the government passes a law stipulating that all sugarcane processing cooperatives must set the price $p$ to farmers so that profits of the cooperative equal zero, and that no “payments” of any kind can be made to anyone. Will this price be the same as the optimal price derived in part c)? Give the intuition behind your answer. [Note that, unlike the model in class, there is no $G(K)$ function here, that is there are no fixed capacity costs.]