WRITTEN PRELIMINARY Ph.D EXAMINATION

Department of Applied Economics

Spring - 2005

Trade and Development

Instructions

(For students electing Macro (8701) & Micro (8703) option)

• 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 ONE question from Set One
• Answer THREE questions from Set Two
• You have four hours to complete this examination
SET ONE
Answer Question I or II but not both

I. Economic Growth and External Debt

Problem

By 1990, the Moroccan economy accumulated a quantity of external debt $D(1990) = 110.7$ billion Dirhams, where $D$ is evaluated in terms of prices of the manufactured good whose price is the numeraire. For the purpose of this question/analysis, consider the case where Morocco

- agrees to not accumulate further debt and
- to pay off the debt plus interest at a constant rate $-D^*(t) = -7.2$ billion dirhams per year over a period of thirty years.

Environment

Consider the environment of the following three sector, small open economy model of Morocco in which agents produce and consume three types of final goods, indexed $j = m, s, a$, at each instant in time at price $p_j$. The services of labor, $L$, and capital, $K$, are employed in the production of all three goods while land, $T$, a sector specific factor, is also employed in the production of the agricultural good, $j = a$. The agricultural good is a pure consumption good that is internationally traded. The manufactured good, indexed $j = m$, is both a consumption and a capital good that is also internationally traded. The home good, indexed $j = s$, is a pure consumption good. Labor 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 $T$.

Analysis/results (See table attached)

The attached table of a SAM was used to calibrate the three sector growth model. The following analyses were performed.
- **Solution I** depicts the state of the economy in 1990 when the total external debt outstanding was 110.7 billion Dirhams.

- **Solution II** shows forecasts of how the economy would have evolved if the debt had been forgiven in 1990.

- **Solution III** shows the adjustment back to long-run equilibrium as debt plus interest payments of 7.2 billion dirhams per "normalized worker" would have been allocated each year to pay off the debt plus interest over a period of 30 years.

- The **Contrast** section compares $III \div I$, and $III \div II$.

**Questions**

While you may use a graphic analysis to answer this question, use an analytical approach to help clarify key points.

1. Explain and depict graphically the economy’s equilibrium in the base period (Solution I).

2. If the economy’s debt had been totally forgiven, (Solution II) explain its transition to long-run growth; in particular:
   
   (a) Why are wages rising?
   
   (b) Explain why is capital deepening having a different effects on output supply of the three sectors?

   (c) What is the "economics" behind the price of home goods rising?

   (d) Why is labor and capital being "pulled" out of agriculture?

3. Now, consider **Solution III**. Explain the economics of the key adjustments the economy must make in the first few (1 to 10 years) relative to the base years 1990 of solution I.
II. Economics of the Household

Consider an agricultural household with the following utility function:

\[ U = c^\sigma, \quad \sigma > 0 \]

where \( c \) is consumption, \( \ell \) is leisure, and \( \sigma \) is a parameter of the utility function.

This household faces the following production function:

\[ Y = L^\alpha A^\beta, \quad \alpha, \beta > 0 \]

Assume interior solutions for all the above variables: \( c > 0, \ell > 0, L > 0 \) and \( A > 0 \).

Let \( p \) be the market price for the consumption good (\( c \)). The good produced by the production function is the same as the consumption good; the notational distinction is that \( c \) is the amount consumed by the household and \( Y \) is the amount produced by the household.

For simplicity, assume that there is no land market. Thus \( A \) is the household’s endowment of land, and the household cannot rent out any of its land and it cannot rent in anyone else’s land.

1. Assume that \( w \) is the market wage for labor, and that the household can buy and/or sell as much labor as it wants at this wage. Assume also that hired labor is perfectly substitutable for household labor on the household farm, and that there are no problems of risk or incomplete information. Express the budget constraint faced by the household, using \( E_L \) to denote the household’s total endowment of labor. Use this budget constraint to solve for \( c \) as a function of the other two endogenous variables and of some or all of the exogenous variables/parameters.

2. Assume that the production function has constant returns to scale. Insert your solution for \( c \) into the utility function and derive the first order conditions with respect to the two other endogenous variables. Think carefully about whether this is a constrained or unconstrained optimization problem. Are household production decisions made independently of consumption decisions? Prove your answer using these two first order conditions.
3. Suppose that someone claims that this model is an adequate description of the decisions of rural households in some developing country. Describe two ways that you could test this claim using household survey data from developing countries.

4. Returning to the model, suppose that hired labor is less motivated, so that the “effective” amount of labor from one unit of hired labor equals $\theta$ multiplied by each unit of hired labor, where $0 < \theta < 1$. That is, the household can sell a unit of its labor in the labor market for the wage $w$ and can also hire labor for the same wage ($w$) to work on its farm, but hired labor is less productive (by the factor $\theta$) than household labor. Please answer the following question using only logic and economic reasoning, NOT WITH ANY MATH. Are the household’s consumption and production decisions separable in this situation? Be clear whether your answer holds in general or only for a specific situation.
SET TWO

Answer THREE of the following four questions III to VI

III. Measuring Inequality

This question deals with measurement of inequality, focusing on the log variance measure of inequality.

1. Name the most important criticism of the variance of the logarithm of income as a measure of inequality.

2. Suppose that income is measured with error, so that observed income, $y$, equals actual income, $y^*$, multiplied by some measurement error $\varepsilon$. Assume that $\varepsilon$ has a mean and median of 1, and that $\log(\varepsilon)$ is symmetric and has a constant variance. Also, assume that $\varepsilon$ is independent of $y^*$. Does measurement error lead to bias in any particular direction in measurements of inequality (using observed income) based on the log variance measure? Prove any claims you make using basic statistical reasoning.

3. The assumption that the measurement error $\varepsilon$ is independent of $y^*$ may be unrealistic. Suppose that people with high incomes are afraid that household survey interviewers are really working for a government tax collection agency, and thus under-report their actual income. What kind of correlation does this introduce between $y^*$ and $\varepsilon$? How does this change your answer to question 2. above?

4. Suppose that you have survey data from 2 consecutive years, Year 1 and Year 2, and you want to estimate the inequality of “long run” income, which can be defined as the sum of income from year 1 and year 2. That is, let $y_1$ be income in year 1 and $y_2$ be income in year 2. Assume that $\text{Var} [\ln(y_1)] \approx \text{Var}[\ln(y_2)]$. Using the log variance inequality measure, use your intuition to decide whether the inequality of “long-run” income (that is, $\text{Var} [\ln(y_1 + y_2)]$) is less than, equal to, or greater than inequality of “short-run” income (that is, $\text{Var}[\ln(y_1)]$, which is $\approx \text{Var}[\ln(y_2)]$). For full credit (this will be hard, so don’t spend much time on it if you haven’t finished all other questions on the exam), show an approximate expression for $\text{Var} [\ln(y_1 + y_2)]$ in terms of
\[ \text{Var}[\ln(y_1)], \text{Var}[\ln(y_2)] \text{ and } \text{Cov}[\ln(y_1), \ln(y_2)]. \] To make this work, assume that for each person \( y_2/y_1 \) is close enough to 1 so that \( \ln(y_2/y_1) \) is approximately equal to \( y_2/y_1 - 1 \). Another useful statistical result to use is that adding a constant to a variable does not change its variance or its covariance.

IV. Define and Describe What Us Meant by “R&D Spillovers.”

In a world where a large country in trade innovates, provide details of an economic framework for evaluating the magnitude and incidence of the economic consequences of international (i.e., cross-country) R&D spillovers. Use this basic framework answer the following:

1. Are benefits to consumers in innovating countries increased or decreased as a consequence of spillovers? Illustrate and discuss.

2. Does the innovating country gain or lose overall as a consequence of spillovers? Illustrate and discuss.

3. What are the implications of R&D spillovers for estimating the returns to R&D spending? Discuss.

V. Static General Equilibrium

Environment

A small open and competitive economy that produces and consumes two goods \( y_1, y_2 \), and \( c_1, c_2 \), respectively and given prices \( p_1, p_2 \). Goods are produced from a constant returns to scale technology that employs the services of the country’s three resource endowments, \( \bar{v}_1, \bar{v}_2, v_3 \). Two of the endowments \( \bar{v}_1, \bar{v}_2 \), are specific to sector one and two, respectively (think of these as fixed capital of sector 1, and land for sector 2), while the third endowment \( v_3 \) (say labor) is traded economy-wide. The sector specific endowments are rented in and out among firms within each sector. Households’ preferences over goods \( c_1, c_2 \) are homothetic, and they exchange the services of these resources \( \bar{v}_1, \bar{v}_2, v_3 \) at rental rates \( w_i, i = 1, 2, 3 \), for expenditure on goods at prices \( p_j, j = 1, 2 \).
The sector level production function can be stated as:

\[ y_j = A_j v_{3,j}^{\alpha_j} v_j^{1-\alpha_j} = f^j(v_{3,j}; \bar{v}_j), \quad j = 1, 2 \]

**Question**

1. Characterize the equilibrium of this economy

2. Show/prove analytically for sector \( j \) that the quantity supplied, as determined by the general equilibrium supply function evaluated at a point (i.e., at the level of the endogenous variables that satisfy equilibrium) is the same as the quantity supplied as determined by the partial equilibrium supply function.

3. For some change in an exogenous variable (you choice) identify the direct and indirect effects on the supply of output for a sector \( j \).

4. Now, consider a policy analysis. Suppose \( \bar{v}_1 \) and \( \bar{v}_2 \) are the quantities of water that a water authority has assigned to sector \( j = 1, 2 \), respectively, and that the total supply of water is \( \bar{v} = \bar{v}_1 + \bar{v}_2 \). Characterize the equilibrium whereby the water authorities allow farmers to trade their water rights, \( \bar{v}_1 \) and \( \bar{v}_2 \) so as to equate the shadow prices of water between the two sectors.

**VI. Economic Growth Theory: The three sector model**

**Environment**

Consider the environment of the following three sector, small open economy in which agents produce and consume three types of final goods, indexed \( j = m, s, a, \) at each instant in time at price \( p_j \). The services of labor, \( L \), and capital, \( K \), are employed in the production of all three goods while land, \( T \), a sector specific factor, is also employed in the production of the agricultural good, \( j = a \). The agricultural good is a pure consumption good that is internationally traded. The manufactured good, indexed \( j = m \), is both a consumption and a capital good that is also internationally traded. The home good, indexed \( j = s \), is a pure consumption good. Labor 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 $T$.

**Key Primitives**

The manufacturing and home good sectors ($j = m, s$) employ constant returns to scale technologies that, at the sector level, can be expressed as

$$ Y(t)_{j} = F^{j}(L(t)_{j}, K(t)_{j}), \ j = m, s $$

Hence, for purposes here, no technological change in sector’s $m$ or $s$ is assumed.

Agriculture’s sector level technology is

$$ Y(t)_{a} = F^{a}(L_{a}(t), K_{a}(t), A_{a}(t)T) $$

where land $T$ is specific to the sector but can be rented at price $\pi$ among firms within the sector. The technology $F^{a}()$ has the same properties as (1). In addition to exogenous growth in labor’s productivity at the same rate as other sectors, $A(t)$, land’s productivity can also grow exogenously as determined by

$$ A_{a}(t) = e^{nt} $$

Households are represented by the typical infinitely-lived Ramsey consumer that receives utility from the sequence $\{C_{m}, C_{a}, C_{s}\}^{t=\infty}_{t=0}$ expressed as a weighted sum of all future flows of utility

$$ \int_{t=0}^{t=\infty} u(C_{m}, C_{a}, C_{s})^{1-\theta} \frac{1}{1-\theta} e^{(n-\rho)t} dt $$

The number of household members are assumed to be proportional to the number of workers, to grow at the exogenously given positive rate $n$,

$$ L(t) = e^{nt}L(0) $$

and to discount future consumption at the rate $\rho > 0$. The elasticity of intertemporal substitution is given by $1/\theta$, where $\theta > 0$. **But, for the purposes of this exam, let $\theta \to 1$.** And, for the purpose of this analysis, we specify a constant returns to scale (CRS) Cobb-Douglas form of $u(C_{m}, C_{a}, C_{s})$.

**Questions**
1. Derive the Euler equation that depicts the household’s optimal rate of expenditure/consumption over time, and briefly discuss the "economic meaning" of this condition.

2. Characterize the intra-temporal equilibrium conditions for this economy.

3. Derive the economy’s steady state equilibrium for \((w, r, p_s, k_s)\) and briefly discuss how these values permit the derivation of the remaining endogenous variables.

4. Comparative statics; Suppose the manufacturing sector is capital intensive, and services is labor intensive. Agriculture is "in the middle", but more capital than labor intensive. Further, assume \(\dot{k}(0) < \dot{k}_{ss}\)
   
   (a) "Show" and discuss the evolution of the home good price \(p_s\)
   
   (b) "Show" and discuss the effects that explain the evolution of \(y_m\), and \(y_s\).
   
   (c) "Show" and discuss the evolution of the land rental rate.

5. What is the rate of growth of \(K, Y_m, Y_s\) and \(Y_a\) in the steady state?