

**Written Exam for the M.Sc. in Economics 2009-II-R**  
**Advanced Development Economics - macro aspects**  
**Master's Course**  
**(4-hour closed book exam)**

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Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. That is, if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by “eksamen på dansk” in brackets, you must write your exam paper in Danish. If you are in doubt about which title you registered for, please see the print of your exam registration from the students’ self-service system.

The percentage weights assigned to each question should only be regarded as indicative. The final grade will ultimately be based on an assessment of the quality of the answers to all questions in the exam in their totality.

Assignment A is “verbal discussion”. This means that full credit does not *require* the use of formal arguments. Naturally, though, formal arguments are admissible. But in general geometric arguments and plain text will do.

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**A. Verbal Discussion: Various Topics (30%)**

A1. Consider the following statement: “*In pre-industrial societies population density is a good proxy for the level of technological development.*” Do you agree or disagree? Explain why.

A2. Discuss the problems associated with estimating the *impact* of longevity on growth, and how these problems may potentially be overcome.

**B. Analytical discussion: Natural Resources and Development (70%)**

Consider a small open economy which produces two goods: a traded good,  $X_T$  and a non-traded good, denoted  $X_N$ . All markets are competitive. The resource constraint of the economy is given by  $Y = X_T + pX_N + A_T R$ , where  $Y$  is total income,  $p$  is the relative price of the non-traded good, and  $R$  is a natural resource rent. Labor is the only physical input in production, and is fully mobile between sectors.

We assume that production takes place in the two sectors in accordance with

$$X_T = A_T g(1-\eta), g' > 0, g'' < 0$$

$$X_N = A_N f(\eta), f' > 0, f'' < 0$$

$A_j, j=T, N$  is the level of productivity in the two sectors, which is assumed to be constant for now. The variable  $\eta$  signifies the employment share in the non-traded sector. Hence, the size of the labor force has been normalized to one. In the remaining we will refer to the two sectors as the “N-sector” and “T-sector”, respectively.

**B1.** Derive the inverse labor demand equations for the two sectors, and proceed to show that perfect labor mobility implies that the following association between the relative price of the non-traded good and the labor allocations hold:

$$p = \frac{A_T}{A_N} \frac{g'(1-\eta)}{f'(\eta)}$$

Illustrate graphically  $p$  as a function of  $\eta$ . Comment on the slope and on the impact of changes in the  $A_T / A_N$  ratio on its position in the diagram.

The representative consumer has the following preferences over consumption of the traded and non-traded good,  $c_N$  and  $c_T$ , respectively:

$$U = \frac{\sigma}{\sigma-1} \left[ c_T^{\frac{\sigma-1}{\sigma}} + c_N^{\frac{\sigma-1}{\sigma}} \right]$$

The budget constraint requires the household to divide its total income  $Y$  between consumption of the two goods:  $Y = pc_N + c_T$ .

**B2.** Show that the individuals demand for the non-traded good is given by the expression

$$c_N = \frac{Y}{(p^{\sigma-1} + 1)p}$$

In equilibrium the market for N goods clears:  $c_N = X_N = A_N f(\eta)$ .

**B3.** Show that the following association between  $p$  and  $\eta$  arises when there is equilibrium in the market for N-goods:

$$p = \left\{ \frac{A_T}{A_N} \left[ \frac{g(1-\eta) + R}{f(\eta)} \right] \right\}^{\frac{1}{\sigma}}$$

Illustrate graphically  $p$  as a function of  $\eta$ . Comment on the slope and on the impact of changes in  $A_T / A_N$  on its position in the diagram.

**B4.** (i) Illustrate the general equilibrium of the model. (ii) What is the so-called "Natural Resource Curse", and can the model (in its current form) motivate this outcome?

**B5.** What is the impact on equilibrium  $\eta$  from a change in  $A_T / A_N$ ? Provide an interpretation.

Based on B4 and B5 we know that the employment share in the N-sector can be written as an implicit function  $\eta = \eta(\lambda, R)$ , where  $\lambda \equiv A_T / A_N$ . Moreover, the sign of the derivatives with respect to  $\lambda$  and  $R$  are also known from the answer to B4 and B5. In the longer run the levels of productivity in the two sectors are endogenous. Specifically, they evolve as a result of learning-by-doing. Specifically productivity is sector specific and evolves in accordance with the following differential equations:

$$\dot{A}_T / A_T = \delta_N u \eta(\lambda, R) + v [1 - \eta(\lambda, R)]$$

$$\dot{A}_N / A_N = u \eta(\lambda, R) + \delta_T v [1 - \eta(\lambda, R)]$$

Where  $u$ ,  $v$ ,  $\delta_N$  and  $\delta_T$  are positive constants, and a dot of a variable signifies a time derivative.

**B6.** Comment on the interpretation of the two differential equations.

**B7.** Show that the system of differential equations can be reduced to the following non-linear differential equation

$$\dot{\lambda} / \lambda = v(1 - \delta_T) - \eta(\lambda, R) [u(1 - \delta_N) + v(1 - \delta_T)] \equiv \Pi(\lambda)$$

**B8.** Assume  $\sigma < 1$ . (i) Illustrate the phase diagram for the above differential equation. (ii) Derive the steady state employment share in non-tradables. Comment.

**B9.** Provide a graphical discussion in  $(p, \eta)$ -space of the adjustment from the short run to the long-run in terms of prices and employment shares.

**B10.** Examine the long-run impact from an increase in  $R$  on growth rate of GDP per capita. Does the model predict a "Natural Resource Curse" in the long run?