International Macroeconomics **T. J. Kehoe**
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Examination

Please answer **two** of the three questions. You can consult any journal articles, working papers, and notes, but I ask you not to discuss these questions with anyone else while you are taking the exam. Please submit the answers to the exam 24 hours after you start it.

1. Consider an economy in which there are two types of goods, primary goods and manufactured goods. Primary goods are homogeneous and are produced using land services and services and land subject to the production function

$$y_0 = t_0^{1/2} \ell_0^{1/2}$$

Manufactured goods are differentiated by firm using capital services and labor services. There are *n* firms and the production function for firm *j* is

$$y_j = \max[\theta k_j^{1/2} \ell_j^{1/2} - f,\ 0].$$

where *f* is the fixed cost. Suppose that there is a representative consumer with preferences given by the utility function

$$\log\ c_0 + (1/\rho)\log \sum\nolimits_{j=1}^{n} c_j^{\rho}$$

where $1 \geq \rho > 0$. There is an endowment of $\bar{t}$ units of land, $\bar{\ell}$ units of labor, and $\bar{k}$ units of capital.

a) Suppose that the number of manufacturing firms is variable, that these firms are Cournot competitors, and that there is free entry and exit in manufacturing. Define an (autarkic) equilibrium. Explain carefully how you would calculate this equilibrium (You do not need to calculate it.)

b) Suppose now that there are two such countries, one with endowments $(\bar{t}^1, \bar{\ell}^1, \bar{k}^1)$ and and the other with endowments $(\bar{t}^2, \bar{\ell}^2, \bar{k}^2)$, but otherwise identical. Define a trade equilibrium.

c) Suppose that $\bar{t}^1 / \bar{k}^1 > \bar{t}^2 / \bar{k}^2$. Explain what changes you would expect to see in prices, average output levels, and utility levels as these two countries, initially in autarky, open to trade. Explain carefully what patterns of specialization are possible and what pattern of trade you would expect to see.

d) Suppose now that the manufacturing firms are Bertrand competitors, redefine the trade equilibrium in part b.

e) What sort of economic phenomena is this sort of model capable of accounting for? What sort of phenomena does it have a difficult time in accounting for?

2. Consider a two-sector growth model in which the representative consumer has the utility function

$$\sum_{t=0}^{\infty} \beta^t \log(a_1 c_{1t}^b + a_2 c_{2t}^b)^{1/b} .$$

The investment good is produced according to

$$k_{t+1} = d(a_1 x_{1t}^b + a_2 x_{2t}^b)^{1/b} .$$

In particular, the deprecation rate is $\delta = 1$. Feasible consumption/investment plans satisfy the feasibility constraints

$$\begin{aligned} c_{1t} + x_{1t} &= \phi_1(k_{1t}, \ell_{1t}) = k_{1t} \\ c_{2t} + x_{2t} &= \phi_2(k_{2t}, \ell_{2t}) = \ell_{2t} . \end{aligned}$$

where

$$\begin{aligned} k_{1t} + k_{2t} &= k_t \\ \ell_{1t} + \ell_{2t} &= \ell_t . \end{aligned}$$

The initial value of k_t is $\bar{k}_0$. ℓ_t is normalized to 1.

a) Define an equilibrium for this economy.

b) Explain how you can reduce the equilibrium conditions of part a to two difference equations in k_t and c_t and a transversality condition. Here $c_t = d(a_1 c_{1t}^b + a_2 c_{2t}^b)^{1/b}$ is aggregate consumption. (You do not need to go through all of the algebra, but you need to explain all of the logical steps carefully.)

c) Suppose now that there is a world made up of two different countries, each with the same technologies and preferences, but with different constant populations, $L_t^j = \bar{L}^j$, and with different initial capital-labor ratios $\bar{k}_0^i$. Suppose that goods 1 and 2 can be freely traded across countries, but that the investment good cannot be traded. Suppose too that there is no international borrowing. Define an equilibrium for the world economy.

d) State and prove versions of the factor price equalization theorem, the Stolper-Samuelson theorem, the Rybczynski theorem, and the Heckscher-Ohlin theorem for this particular world economy.

e) Let $s_t = c_t / y_t$ where $y_t = p_{1t}k_{1t} + p_{2t} = r_t k_t + w_t = d(a_1 k_t^b + a_2)^{1/b}$ is income per capita. Transform the two difference equation in part b into two difference equations in k_t and s_t. Prove that

$$\frac{y_t^i - y_t}{y_t} = \frac{s_t}{s_{t-1}}\left(\frac{y_{t-1}^i - y_{t-1}}{y_{t-1}}\right) = \frac{s_t}{s_0}\left(\frac{y_0^i - y_0}{y_0}\right).$$

where $y_t^i = p_{1t}k_t^i + p_{2t} = r_t k_t^i + w_t = d(a_1 k_t^{i\,b} + a_2)^{1/b}$ is income per capita in country i.

f) Discuss the economic significance of the result in part e.

3. Consider an economy where the consumers have Dixit-Stiglitz utility functions and solve the problem

$$\max \;(1-\alpha)\log c_0 + (\alpha/\rho)\log \int_0^{\mu} c(v)^{\rho}\,dv$$
$$\text{s.t. } p_0 c_0 + \int_0^{\mu} p(v)c(v)dv = w\overline{\ell} + \pi$$
$$c(v) \geq 0\,.$$

Here π are profits of the firms, which are owned by the consumers.

a) Suppose that the producer of good v takes the price function $p(v)$ as given. Suppose too that this producer has the production function

$$y(v) = \max\left[z(v)\left(\ell(v) - f\right), 0\right].$$

Solve the consumer's profit maximization problem to derive and optimal pricing rule.

b) Suppose that there is a measure μ of potential firms. Firm productivities are distributed on the interval $z \geq 1$ according to the Pareto distribution with distribution function

$$F(z) = 1 - z^{-\gamma}\,.$$

Define an equilibrium for this economy.

c) Suppose that μ is large enough so that not all firms can earn nonnegative profits in equilibrium. Find an expression for the cutoff productivity level $\overline{z}$ such that firms with productivity $\overline{z}$ earn zero profits. Find an expression for profits π.

d) Suppose now that there are two countries that engage in free trade. Each country i, $i = 1, 2$, has a population of $\overline{\ell}_i$ and a measure of potential firms of μ_i. Firms' productivities are again distributed according to the Pareto distribution, $F(z) = 1 - z^{-\gamma}$. A firm in country i faces a fixed cost of exporting to country j, $j \neq i$, of f_x where $f_x > f_d = f$ and an iceberg transportation cost of $\tau - 1 \geq 0$. Define an equilibrium for this economy.

e) Suppose now that the two countries in part d are symmetric in the sense that $\bar{\ell}_1 = \bar{\ell}_2 = \bar{\ell}$ and $\mu_1 = \mu_2 = \mu$. Suppose too that μ is large enough so that not all firms can earn nonnegative profits in equilibrium. Explain now why there are two relevant cutoff levels of firm productivity, $\bar{z}_d$ and $\bar{z}_x$. Find expressions for these cutoff productivity levels. Find an expression for profits π.

f) Discuss the strengths and weaknesses of this model. In particular: What economic phenomena can this sort of model help to account for? What sort of phenomena can it not account for? How can we modify the model?