

**Development Economics**  
**Problem set 2**  
**City University**  
**Spring 2007**

**Geography, institutions and growth**

**Question 1: The impact of geography on growth.**

Suppose that an economy has the aggregate production function at each period  $t$ :

$$Y(t) = AK(t)$$

$Y$  is output, and  $K$  is capital.  $A$  is constant parameter that represents total factor productivity, that is, how advanced the technology used to produce in the country is.

Assume that population is constant and normalized to 1 (so that aggregate and per capita variables are the same, no need to worry about that in this exercise)

Let  $I(t)$  denote investment at  $t$  and  $d$  the rate of depreciation of capital.

Furthermore, the savings rate is assumed fixed at  $s$ , so that total savings at  $t$ ,  $S(t)$ , simply equal  $sY(t)$ .

Finally, assume that the price of one unit of investment (relative to output) equals  $P$  (fixed price of capital). Then, since you know that savings must equal investment,  $sY(t)$  (the total amount of savings) equals  $P.I(t)$  (the total amount invested) at each period  $t$ :  $sY(t) = P.I(t)$

1. Write the equation of capital accumulation, that is, how capital evolves over time:  $K(t+1)$  as a function of  $K(t)$ .
2. Use the production function to show that the growth rate of  $Y$  is the same as the growth rate of  $K$ . Hint: by definition, the growth rate of any variable  $X$  is given by  $[X(t+1) - X(t)] / X(t)$ .
3. Find the growth rate of capital (which is the same as that of output, as shown at the previous question) as a function of the parameters  $s$ ,  $A$ ,  $P$  and  $d$ .
4. In this little model you've just solved, how can you discuss the effect of geography on growth?

## Question 2: Institutions and economic performance

During last lecture, we discussed the impact of a country's institutions on its economic performance. In particular, many economists argue that well defined property rights constitute a key economic institution. In this exercise, we will see how the lack of property rights can have serious consequences for economic performance.

This exercise is taken from Appendix 1 in Debraj Ray's text book, page 761; by the way, this appendix is a good reference if you want to learn some basics of game theory)

“Suppose that groundwater is used for irrigation in a village. Overuse of groundwater can reduce the level of the water table, making it more costly for all farmers to extract water. This is the typical problem of the commons (the tragedy of the commons): groundwater is a common property resource, and the costs of using it may not be fully internalized. A simple example can be provided to make the point.

Suppose that water can be extracted at two levels, *high* and *low*, and that there are two farmers. The **revenue** from crop production for each farmer increases with the use of groundwater: say it is **\$2,000** if the high level is applied and **\$1,000** if the low level is applied.

The **cost of extraction depends on** whether the *other farmer's use* is high or low. Suppose that the extraction cost for each farmer is **\$500** for low and **\$1,300** for high, but an **additional fixed cost of \$500** is incurred *if the other farmer is extracting high* (deeper wells will have to be dug because the other farmer's action reduces groundwater levels).”

The game taking place here can be summarized in the following table.

		Farmer 2	
		Low	High
Farmer 1	Low	500, 500	0, 700
	High	700, 0	200, 200

1. Using the information on costs and revenues in the text above, explain the numbers in the table.
2. Show that the only Nash equilibrium of this game is the outcome where both farmers extract high. Is this their preferred outcome?