

14.461 Advanced Macroeconomics: Technological Change

Problem Set 2

Due October 12th

- 15.27
- Testing Michael Porter Hypothesis in the framework of directed technological change:

Porter hypothesis claims that tighter environmental regulations will spur faster innovation and increase productivity. In this question we want to test this hypothesis in a framework of directed technological change we saw in the class for analyzing the effect of labor scarcity on technological progress. (See slides 88-151 of Lectures 5-7)

Consider economy M you saw in the lecture. Here θ corresponds to “green technology” and let us replace labor (L) with pollution (p) but pollution is not input anymore and it is a by product of production. In this economy output is given by

$$Y^i = \alpha^{-\alpha}(1 - \alpha)^{-1}G(Z^i, \theta)^\alpha q^i(\theta)^{1-\alpha}$$

and the relation for pollution is:

$$p = \alpha^{-\alpha}(1 - \alpha)^{-1}P(Z^i, \theta)^\alpha q^i(\theta)^{1-\alpha}$$

The rest of the framework is the same as in the lecture.

- Assume $C(\theta)$ the cost of producing green technology is increasing in θ and final good producers pay a tax equal to τ units of final good on each unit of pollution they are producing. Derive the demand for machines from the final good producers.
 - Define the equilibrium and derive the condition for equilibrium choice of green technology.
 - Assume $\tau = 0$. What is the condition required for having faster innovation by slightly increase in the pollution tax rate?
 - Can *Porter hypothesis* in general be rationalized in the framework of this model? Discuss the intuition.
- Consider a variant of the Ricardian model of technology and skills presented in Lecture 8. Suppose a model of small open economy in which there are only two types of workers (L, H) and continuum of tasks $i \in [0, 1]$ and the production function for each task is:

$$y(i) = A_L \alpha_L(i) [l(i)^{\beta_L(i)} k_L^{1-\beta_L(i)}] + A_H \alpha_H(i) [h(i)^{\beta_H(i)} k_H^{1-\beta_H(i)}]$$

Which simply means production requires both labor and capital as input.

- (a) Find out the condition on $\alpha_L(i)$, $\alpha_H(i)$, $\beta_L(i)$ and $\beta_H(i)$ such that in the equilibrium there will be a single cutoff below which all tasks are done by combination of unskilled labor and capital.
 - (b) Let assume the condition in part *a* holds. Moreover assume $\beta_L(i)$ and $\beta_H(i)$ are linear in i (note in general their slopes can be different). What is the effect of decrease in the interest rate on the skill premium. Discuss the intuition.
 - (c) Let assume $\beta_L(i) = \beta_H(i)$. What is the effect of change in interest rate on skill premium. What is the intuition?
4. Consider the Ricardian model of technology and skills from Lecture 8, with three types of skills, L , M and H . Construct a parametric example (in terms of the $L(i)$, $M(i)$ and $H(i)$ schedules) where a factor-augmenting increase in the productivity of H workers, i.e., an increase in A_H , reduces the wages of M workers.