

## Module 5

### Lecture 35

#### Topics

#### 5.3 Growth Theory III

##### 5.3.1 Endogenous Growth Models

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- The endogenous growth theories emerged out of the neo-classical theories. There are two sets of views outlining the origin of the emergence of endogenous growth theory.
- One version says that it came out to resolve the problem of convergence while the other says that it came out as attempts to construct alternatives to perfectly competitive models.
- We have already discussed the convergence debate in the last lecture. We have seen that the hypothesis of *absolute convergence* is not consistent with the data. The model fits well in the data if the countries are homogeneous so that their technology and other relevant parameters are similar.
- Data shows that in 1960s the growth rate of a poor country such as Philippines and a rich country such the US were growing at around same rate --both around 2%. But there was no sign that poor countries are growing faster than the rich countries -- hence to sign of convergence.
- However, such convergence could be found among the states in the US. Then why do we not see such convergence across countries?
- If the countries have similar technologies, the workers in the respective countries should be earning the same real wages. The only reason they are not earning the same wage can be that they work with different amount of capital.

- Is it really the case that a worker in the US is earning more than the worker in India because there is more capital in the US?
- Romer did one comparison between the U.S. and Philippines in the 1960s. At that time the output per worker in Philippines was equal to 10% of that in the US. If one assumes that the level of technology is the same in both places then for Philippines to grow at a same rate as the US, the theory predicts that the savings in the US has to be 30 times larger than that in the U.S. This calculation is based on the assumption that the labor share of Philippines is 0.6. If it is assumed to be 2/3 then the US must have a savings rate 100 times larger than that in Philippines.
- Clearly, the savings rate predicted by the theory was way larger than the values that exist in reality.
- A key assumption however, in this calculation is that the level of technology is the same in both the countries. If we assume that, the other way of explaining wage differential is by taking into account the difference in capital the workers work within these two countries.
- If  $\beta$  (share of labor) is between 0.6 and 0.7 the variation in investment between rich and poor countries are too small to explain why rich and poor countries seem to grow at the same rate.
- One way of reconciling the problem is by assuming that the share of labor is less so that labor is less important in production. This makes diminishing return to capital set more slowly.
- However, assuming  $\beta$  less than the actual wage share would mean that

$$\frac{L \cdot MP_L^{Model}}{Y} < \frac{L \cdot w}{Y} \quad (1)$$

- This implies that  $w > MP_L$ . A major theoretical challenge is then to find a reason why labor is paid more than its marginal productivity and likewise why capital is paid less.
- This divergence between private and social return can be explained if there exists some sources of externality. Romer identified one such externality in form

of knowledge spill over. He assumed that capital investment along with increasing capital stock also increases the stock of knowledge which amounts to technological improvements. A firm's production function can be written as

$$Y_j = A(K, L)L_j^\alpha K_j^{1-\alpha} \quad (2)$$

- This equation shows that technology is the function of the aggregate capital and labor does not depend on individual firm's decision to hire labor or capital. This is precisely the source of the divergence between private and social return
- Suppose that  $A(K, L) = K^\gamma L^{-\gamma}$ . This means that the aggregate production looks something like  $Y = L^\beta K^{1-\beta}$ . This result implies that we can assume lower value for labor coefficient ( $\beta$ ) than labor's share in the national income.
- With this model in the background Romer estimated the value for  $\beta$  and the resulting exercise produces results that were consistent with the convergent hypothesis for countries such as the US and Philippines.
- In another attempt to reconcile data with the growth models Barro and Sala-i-Martin (1992) proposed another solution. They assumed that the level of technology is different at different regions, and technology diffuses from high technology regions to low technology regions.
- The speed of convergence in this model depends on the rate of technology diffusion.
- A third and a more conventional approach was proposed by Mankiw, Romer and Weil (1992). They showed that a lower value of  $\beta$  is possible to justify in the neo-classical framework with same technology in all countries. The only change they make is to add human capital as one factor of production along with physical capital and labor.
- In this model the labor coefficient goes down from 0.6 to 0.33. This is justifiable because payment to laborers is partly payment for labor and partly return to human capital. This model's predictions matched well with the data.
- The section above traces the origin of endogenous growth models in attempts to resolve convergence debate. There is however, another approach which traces back the origin of endogenous growth to the papers which did not assume perfectly competitive markets.

- These group of scholarly work rejected the neo-classical growth models on the following grounds:
  1. There are many firms in an economy rather than one economy wide giant form using an aggregate production function.
  2. Discoveries are public good in nature { many people can use them at the same time.
  3. Standard homogeneous production function in a neo-classical setting cannot explain innovation { who do it and who pay them to do so?
  4. Discoveries are the result of some learning by doing exercises.
  5. Many individuals and firms earn rents from their discoveries
  
- Objections 1 to 3 can be accommodated in a standard neo-classical growth model but not 4 and 5. The endogenous growth models started their journey by trying to accommodate fact 4.
  
- How do we account for innovation? Early versions of endogenous models written in 1960s stated that innovation is conducted by the governments and financed by tax money.
  
- Recent versions of endogenous growth models however model innovations undertaken by firms in order to earn rent. A subset of these models incorporate both fact 4 (learning by doing) and fact 5 (the existence of monopoly rents)
  
- These are sometimes referred to as Neo-Schumpeterian models. This is because of Schumpeter's emphasis on temporary (as long as new technology does not replace the old one) monopoly power as the main incentive for doing innovation.
  
- In the next lecture we detail the development of the Neo-Schumpeterian growth models.