Romer's Model of Expanding Varieties (Part 3)

3. R&D Sector

- A research firm hires researchers to invent new designs (or variety of intermediate good).
- The R&D firm gets a perpetual patent for the invention.
- Sells the patent at price P_A to a firm in sector 2.
- How is P_A determined?
- Using no-arbitrage condition—which is a powerful method, widely used by practitioners (by traders, etc.)
- No-arbitrage: Assuming that two assets have the same level of risk and investors can invest in both then both choices should yield the same return.
- The "law of one price" in exchange rate analysis is also an application of the no-arbitrage principle.

3. R&D Sector (cont'd)

- So, how much is a patent worth (P_A)?
- Suppose that a risk-free asset is also available with interest rate r.
- An investor decides whether (1) to invest P_A dollars in the risk-free asset or (2) to buy a patent, produce an intermediate good for one period, and then sell the patent after a year.
- Equating the return from two options yields:

$$rP_A = \pi + \dot{P}_A$$

3. R&D Sector (cont'd)

- Rearranging yields: $r = \dfrac{\pi}{P_A} + \dfrac{\dot{P}_A}{P_A}$
- Begin by assuming that the solution to the model will display BGP. In this case, r will be constant.
- For r to be constant we need both terms on the RHS to be constant. So π and P_A must grow at the same rate.
- We found before:

$$\pi = \alpha(1-\alpha)\frac{Y}{A} \to \alpha(1-\alpha)\frac{yL}{A}$$

Along BGP y/A is constant $\to \pi$ grows at rate n

Therefore, P_A grows at rate: $\dfrac{\dot{A}}{A} = n$

- So we have:

$$r = \frac{\pi}{P_A} + n \to P_A = \frac{\pi}{r-n}$$

3. Closing the model

- The only thing that is left to solve is the fraction of labor that works as researchers (sector 3) as opposed to workers (sector 1).
- We can pin down this fraction again applying the no-arbitrage principle.
- That is, an individual must be indifferent between the two options. This will pin down what fraction works in which sector.
- We will not do this here (see the textbook if interested)

Efficient Level of R&D

- Romer (1990) model is different from other models we have seen so far: the equilibrium allocation is not Pareto optimal
- In other words, a social planner who pools the resources of all individuals and make all decisions will attain better outcomes for everyone compared to the equilibrium
- Notice that this means Adam Smith's invisible hand is not working perfectly in this economy.
- In particular, this social planner would choose more resources to be devoted to R&D, which would imply faster growth.

Why R&D Level is not Optimal? $\dot{A} = \delta L_A^\lambda A^\phi$

♦ There are three distortions in this economy:

- ▪ Knowledge spillover (standing on giant's shoulders $\phi > 0$): researchers contribution to future innovations not compensated. Under-provision of research
- ▪ Crowding out (Stepping on others' toes): Replication of research is not penalized. Overprovision of research.
- ▪ Monopoly distortion (consumer surplus effect): To the extent that monopolists cannot price-differentiate, they are only able to get a fraction of consumer surplus..
  - • In other words, the social return to innovation is higher than the private return to monopolist. So monopolist does not invest sufficiently in R&D.
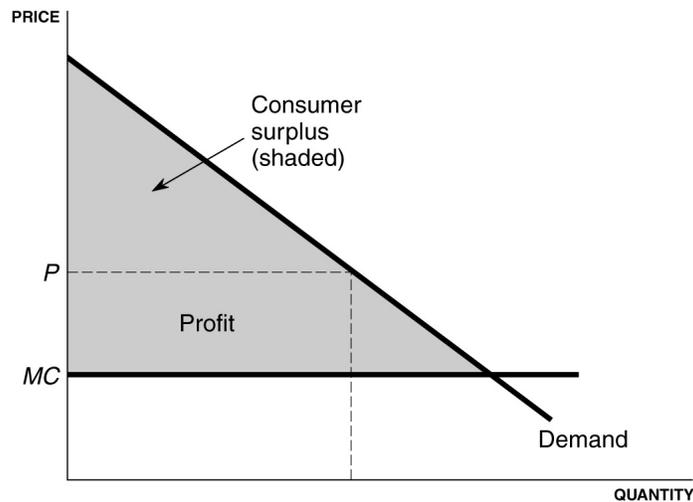
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FIGURE 5.4 **THE "CONSUMER-SURPLUS EFFECT"**

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