Economic Growth
Class 10
Intro to technological change

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Concepts of Technology

- Types of technological change
- **Process**
  - produce higher quality versions of existing products
  - or produce an existing product at lower cost
- **Product**
  - New products are added to the basket of goods
- Nature of technological change: macro or micro
  - **Macro** changes are radical innovations (relatively rare)
    - introduction of general purpose technologies
    - such as steam engine, electricity, computer
  - **Micro** changes are smaller (the vast majority)
    - newer versions of existing items
    - better processes of production of existing product
    - reducing costs of production

Some characteristics of technology

- Nonrivalry
  - one producer improving efficiency doesn't prevent others from doing the same
  - potentially, all produces can increase efficiency

  - can be difficult to prevent others from using

- Nonrivalry can be like a externality
  - think of the production function

$$Y = f(K, L, A)$$

  - can have constant returns to scale in K and L
  - and **increasing returns to scale** in K, L, and A

- Not a pure public goods
  - may be excludable
  - especially if there are patents (government makes them excludable)
  - but may be through industral secrets

Invention and profits

- Why do people make inventions (inovations)?
- Science: search for basic knowledge
  - frequently subsidized: new knowledge not immediately exploitable
- Potential profits for invention (which may use scientific knowledge)
  - reward from British navy for method to determine longitude (a clock, finally)
  - search to solve a costly problem
    - removing seeds from cotton
    - pump the water out of mines
  - potential market size matters
    - although frequently underestimated
    - example of estimates for number of computers needed in USA

Simple model of technology (partial equilibrium)

- Marginal cost of production of one unit of the good = ψ
- Demand curve of the industry is

$$Q = D(p)$$

- where Q is the quantity sold and p is the price
- Assume $D(\psi) > 0$, so there is postive demand when price = marginal cost

- Elasticity of demand is

$$\varepsilon_D(p) = -\frac{pD'(p)}{D(p)} \in (1, \infty)$$

- this last implies that $\varepsilon_D(p) > 1$, so there exists a well defined monopolist price
- Assume that an innovation costs $\mu > 0$ and reduces marginal costs by $1/\lambda$ where $\lambda > 1$
- Marginal costs after an innovation are ψ/λ

Perfect competition

- There are N firms in the industry with access to the existing technology
- In initial equilibrium $p = \psi$ and the profits of a firm are

$$\pi_i = (p - \psi) Q_i = 0$$

  - If all firms are the same, $Q_i = D(\psi)/N$
- What are the incentives of a firm to spend μ to make an innovation

Perfect competition

- Suppose that firm 1 spends for the innovation
  - Assume the innovation is nonexcludable (so all firms can use it)
  - Profits to firm 1 are

$$\pi_1^* = (p^* - \psi/\lambda) Q_1^* - \mu$$

  - But all firms can use the innovation, so $p^* = \psi/\lambda$, and

$$\pi_1^* = -\mu$$

    and

$$\pi_{i \neq 1}^* = 0$$

- There are no incentives for any firm to innovate: no innovation occurs

Ex post monopoly power on the innovation

- Suppose that the inventing firm can prevent other firms from using its innovation
- Suppose that the innovation is **drastic** (λ is large) and the firm becomes a monopolist

- Firm maximizes (wrt p)

$$\pi_1' = (p - \psi/\lambda) D(p) - \mu$$

Ex post monopoly power on the innovation

- First order condition is

$$0 = D(p) + (p - \psi/\lambda) D'(p)$$

or

$$\frac{D(p)}{pD'(p)} + 1 = \frac{\psi/\lambda}{p}$$

or

$$p^m = \frac{\psi/\lambda}{1 - \varepsilon (p^m)^{-1}}$$

- If $p^m < \psi$, this firm will charge the price p^m and will take over the whole market

Ex post monopoly power on the innovation

- If If $p^m > \psi$ the innovation is NOT drastic (Limit pricing solution)
- The innovating firm cannot charge p^m, since the other firms charge $p^* = \psi$
- The innovating firm will have profits of

$$\pi_1' = (p^* - \psi/\lambda) \frac{D(\psi)}{N} - \mu$$

- The other firms will have zero profits
- Of course, other firms have incentives to try and steal the technology
  - stealing may be cheaper than innovating