Econ 201: Introduction to Economic Analysis

October 30 Lecture: Innovation and Technological Change

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Daily dose of The Far Side

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In sudden disgust, the three lionesses realized they had killed a tofudebeest—one of the Serengeti's obnoxious health antelopes.

Preview of this class session

- The world's material living standards have improved over the decades and centuries largely through technological progress
- Technological knowledge has properties of public good
- As public good, there are limited natural, market incentives for research and development (R&D) and innovation
- Appropriability mechanisms provide profit to innovators
- Josef Schumpeter characterized the technological transformation of an economy as "creative destruction"
- William Baumol created a model of dynamic equilibrium under imperfect competition with R&D and technological change

Innovation and technological change

- **Invention** (novel ideas) vs. **innovation** (useful applications)
- From where does innovation come?
  - **Research and development** (R&D) as purposeful search for innovations
- **Product vs. process** innovations
- Innovating firms may gain market advantage
  - Rents (temporary economic profits) from new product or cost reduction
- What happens in long run?
  - Does entry dissipate rents?
  - Can firm retain market power?
- These are questions that have short history in modern economics

Knowledge as a public good

- **Nonrivalry**
  - New ideas can be used by others at low cost
  - There might be costs of dissemination, but they are usually small
  - Bell Labs' course on transistors
  - Static efficiency requires that nonrival goods be shared at zero price
- **Nonexcludability**
  - Usually very difficult to keep valuable technological knowledge secret
  - Harder for product innovation than for processes
  - Coca-Cola formula is a rare example of successful long-run secrecy
  - If idea is nonexcludable, then rivals will get it and use it (often at zero price)

Sources of innovation

- Innovation is an **incremental process**
  - Inventions/ideas are often single events by single researchers
  - Innovation leading to new products/processes (based on inventions) occurs bit by bit over time
  - Laser was invented in 1950s but did not have large-scale applications until 1970s
- Most innovation happens within firms
  - **Intentional R&D spending** in corporate labs
  - Shop-floor, **problem-solving innovations** by workers
  - Toyota's *kaizen* model of continuous improvement and constant feedback from production workers to engineers

How do firms profit from innovation?

- **Product innovation**
  - Innovator has monopoly position with new or improved product
  - Can rivals get access to the new information and use it?
  - If so, then competition breaks out and firm's monopoly profits don't last
- **Process innovation**
  - Innovator has lower LRAC curve than rivals
  - Price set higher by rest of market
  - Innovator gets profit as long as others can't get access to low-cost technology
  - If rivals get access, price falls to new min LRAC and no profit

- Innovator can only **appropriate** rents from innovation as long as it can limit rivals' access to it
- Without prospect of profit, no incentive to innovate

Appropriability mechanisms: Patents

- **Appropriability mechanisms** are methods for firm to slow down imitation by rivals, retain profits
  - Without appropriability there is no incentive to spend on R&D
- **Patents/intellectual property**
  - Legal right to exclusive use of innovation for 20 years
  - Can be licensed for a fee if firms doesn't want to produce
  - Effectiveness varies greatly across goods/industries
    - Great in chemicals due to precision of formula
    - Not so good in mechanical fields: Easy to "invent around" patent
  - Patents require disclosure of invention
    - Easy to leave out important details
  - Quality of patents varies enormously

Appropriability mechanisms: Secrecy

- Trade secrets are often most effective appropriability mechanism
- Laws of trade secrets offer some limited protection against leakage
  - Non-disclosure agreements
  - Non-compete clauses in labor contracts
  - Laws against industrial espionage
- If idea gets out legally (parallel invention) then no protection
- Secrets are more easily kept for process innovations than for new products
  - Products can often be reverse engineered

Other appropriability mechanisms

- Continuous innovation
  - Outracing rivals to maintain lead in product or process development
  - Get to next generation before rivals have eaten into profits from current one
- Control of complementary assets
  - If innovator can control market for specialized inputs before releasing innovation, it may profit by limiting access
  - Rivals may not compete because they need to develop supply chains that innovator has already established
- All of the appropriability mechanisms are temporary
  - Patents expire, secrets leak, rivals catch up, new sources of inputs
  - Can firm make enough profit while protected to pay for R&D?

“Knowledge dilemma”

- Static vs. dynamic efficiency
- High appropriability:
  - Monopoly power and static inefficiency of resource allocation given existing knowledge
- Low appropriability:
  - More efficient static resource allocation but little incentive for technological progress
- Which is more important?
  - Deadweight-loss triangles with current products/costs
  - Rapid development of new products and processes

Schumpeter and creative destruction

- Josef Schumpeter developed theory of creative destruction in 1950
  - Economic processes are essentially dynamic: most important factors in economics are change over time, not static efficiency
  - New innovations (creative) destroy the market power of older firms
- After decades of neglect, Schumpeterian ideas have reemerged
  - Schumpeterian growth theory in 1990s
  - Baumol's theory of "Red-Queen equilibrium" in the 2000s
- Firms with market power earn profit on production
  - They (and potential entrants) do R&D to innovate
- Successful innovations undermine the incumbents' market power

Long-run Red-Queen equilibrium

- Current technological leaders have monopoly power and earn profits on production
  - They use these production profits on R&D along with new entrants
  - Profits are essential to funding next wave of innovation
- Successful innovators overtake incumbent monopolies and become new incumbents
- Each monopoly gets toppled in turn; today's tycoon is the next victim of technological displacement
  - How many of the Fortune 500 from 1920 are still there?
- In long run, profits go to zero because R&D offsets rents
- Static inefficiency, but (maybe) dynamic efficiency

Is this important?

- We have spent 25 classes on static efficiency and 1 on dynamics of technological change
- Which is more important to how we live?
- If we started in 1920 and focused only on eliminating static inefficiencies with existing knowledge and technology, what would our standard of living be?
- Static efficiency is desirable, but surely we gain much more from technological progress than from reducing deadweight losses in short run
- Jeff thinks that innovation is really important!

Review

- Technological knowledge is public good
- Appropriability mechanisms are necessary for profit from costly innovation
- Patents, trade secrets, continuous innovation are examples
- Schumpeter's theory of creative destruction
- Modern applications model dynamic equilibrium with technological progress

Daily diversion

From the Devil's Dictionary:

Revolution, *n.*, in politics, an abrupt change in the form of misgovernment.

What comes next?

- Monday is final microeconomics class, covering the distribution of income
- Case study for Monday discusses government policies to redistribute income, and their costs in terms of economic efficiency
- Optional problems are available for exam preparation
- Exam will be Friday, November 6