Econ 201: Introduction to Economic Analysis

October 30 Lecture: Innovation and Technological Change

Jeffrey Parker
Reed College
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