Lecture 15 – AAE 374

- Overview
- Ten Questions on Technology
- Technology and Development Concepts
- US Technological Leadership
  - Early Roots
  - Before WWII
  - After WWII
- Questions for Weds.

Overview of Technology Unit

- Concepts and historical processes of technological change in:
  - U.S., Europe and Japan (just a bit)
  - East Asia
- Concepts of TD Group
- Big Picture of U.S. Technological Leadership
  - Late 19th Century through WWII - US
  - After WWII – US
  - Post WWII Convergence of Japan and Europe
- Patents/WTO – Weds, October 29
- Increasing Returns and Endogenous growth model, Nov 3, 5
- External increasing returns and dynamic comparative advantage (technology and trade) Nov 10 - 12
- Dynamic comparative advantage (E Asia)

Ten Questions for Technology Unit

- Why is technological change so important to growth and development?
- How many technological change “revolutions” do you think the world has experienced?
- What are the cutting-edge technologies of the current era that might define our era in history?

Ten Questions for Technology Unit

- What factors are crucial to the capacity or ability of regions or countries to achieve technological change?

- Comparing countries that are “catching up” with technological leaders, what factors are crucial to both and perhaps more crucial in one case or the other?

Ten Questions for Technology Unit

- What role do markets play in technological change?
- What role do corporations play in technological change? How might they inhibit or discourage technological change?
- What role do government or public entities play?
- What are some other important institutions that promote technological change?
- If markets, firms, government, and other institutions play an important role in the process of technological change, how can countries integrate them in effective ways?

Technology and Development

- Technology and Development Researchers
  - Economic historians in U.S. with a lead role
  - Europe a wider participation of economists and others with more emphasis on catching up to U.S.
- U.S. industrial policy is a dirty word but is present via defense, public research expenditures, and other ways.
- TD research mainstreamed in economics via endogenous growth theory with leading names like:
  - Paul Romer
  - Joseph Stiglitz
  - Paul Krugman

Technology & Development Concepts

- National Technology
  - Most like Ricardo, HO, or Solow?
- Technological Capability
  - How would this concept contribute to US economic policy debates?
- Technological Leadership
  - What would US strengths be in 21st century?

Technology & Development Concepts

- Technological Congruence
  - Key for Nelson/Wright on US technology leadership
- Path Dependence
  - Previous choices shape current ones
  - QWERTY, IPODS and Palm pilots.
- External and Internal Economies
  - Key to endogenous growth arguments for industrial policy.
- Network Externalities
  - Silicon Valley, Universities, Stem cell research in WI?,

US Technological Leadership

US productivity advantage arises in late 19th century and lasts until 1970s, or almost 100 years.

Individual Inventors in 19th cent. (Eli Whitney, Thomas Edison...)

U.S. leadership identified in late 19th century
("American invasion of Europe")

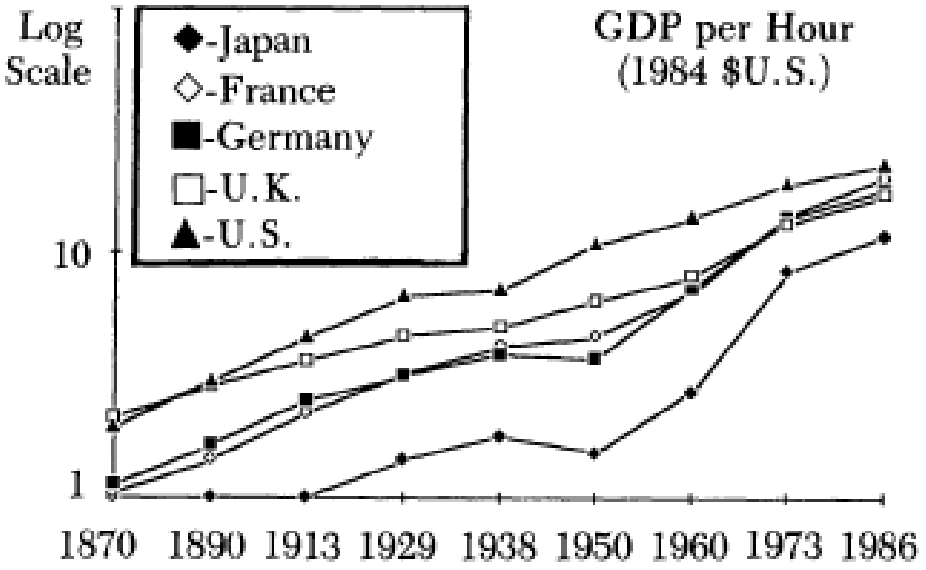

Figure 1. Gross Domestic Product per Hour, 1870–1986

Source: Angus Maddison (1987, 1989)

How Does US Leadership Arise?

- Story starts in 19th century:
  - Broad demand for manufactured goods via highly productive agriculture and abundant land for settlers/immigrants.
  - European technologies readily accessed via immigration and exchange.
  - Good transport options in Eastern and Midwest landscape (lakes, rivers, etc.).
  - Free enterprise and experimentation encouraged.

- "American System of Manufacturers" goods produced:
  - specialized machines
  - highly standardized
  - interchangeable component parts

Sources and Eras of US Technology Leadership

- Key to U.S. leadership = technologies that exploit abundant natural resources
  - land, trees, animals, and water
  - later minerals & fuels.
- U.S. leadership from 1880-1940s:
  Mass produced consumer goods and capital goods.
- 1900-1950: Rise of private labs and R&D
- Post World War II – Public and private R&D takeoff with information revolution as latest expression.

U.S. Technological Leadership 1880s-1940s

- Rise of Mass Production - Key elements:
  - Indigenous technological community adapting European technologies to US,
  - Development of an American industry problem-solving network
  - Machine tool industry – cutting edge engine for breakthroughs in various industries.
- Evidence of mass production clear by end of 19th cent.
  - New and branded consumer products
  - Mass-produced light machinery (sewing machines, cameras, typewriters)
  - Electrical equipment
  - Standardized industrial machinery (boilers, pumps, trains, printing presses, farm machinery)

US Leadership in Auto Exports

Note the takeoff in 1920s:

Ford assembly line, famous also because idea of workers being able to afford cars they made.

More true after WWII than before.

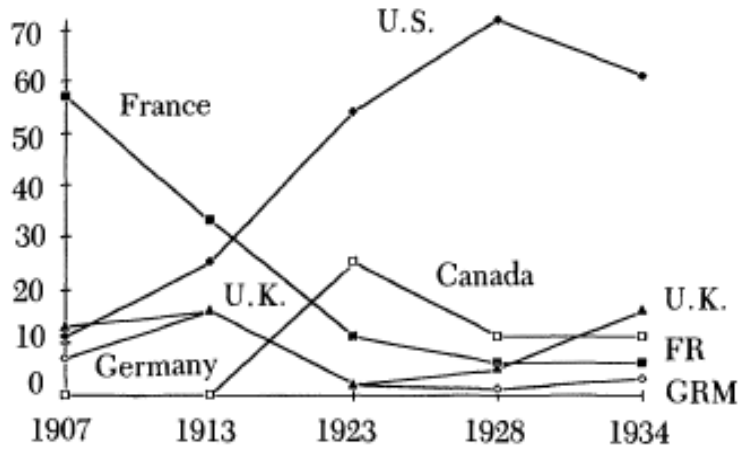

Figure 4. Shares of World Motor Vehicle Exports, 1907–1934

Source: James Foreman-Peck (1982, p. 868).

U.S. Technological Leadership 1880s-1940s (continued)

- Why in U.S.?
  - Not because US led the way in science and technical education.
  - Europe, esp. Germany, had more advanced mathematics and scientific training; U.S. lagged until after WWII.
  - Early technologies oriented toward low education workers (esp. immigrants).

U.S. builds infrastructure for science-based industry.

Takeoff in private lab investments. GE, Dupont, Dow, AT&T, Kodak examples.

US investments in public universities date back to 19th century, land grant institutions but not yet making big R&D push like after WWII

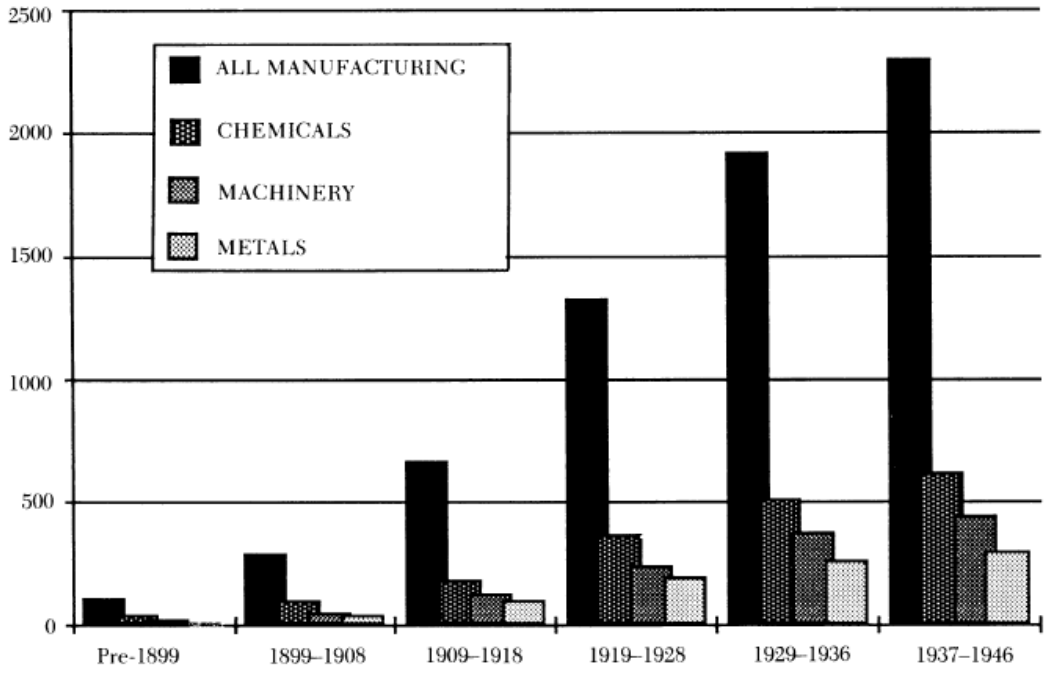

Figure 3. Laboratory Foundations in U.S. Manufacturing

Source: David Mowery and Nathan Rosenberg (1989, Table 4.1)

U.S. Technological Leadership Post World War II

- What is their core argument?
  - U.S. major investments in high-tech industries, where team-based research in firms and labs make the pursuit of innovation in science and technology a routine part of doing business.

Key Ingredients

- University-trained scientists and engineers where learning through experimentation cum science is the approach.
  - GI-Bill and lots of research $$ to universities.
  - Growth of the Research-Oriented universities.
- R&D Investments surge
  - Key government support in space systems, electronics, information technologies, jet engines, medical sciences. NSF, NIH, DoD, AEC are all major spenders in R&D.
  - Private investment in transport equip (cars, trucks), chemicals, cons electronics, and pharmaceuticals.
  - Huge govt role in computers & semi- conductors

Post World War II Convergence of U.S., Japan, and Europe

Rising share of high tech exports from other countries rather than US.

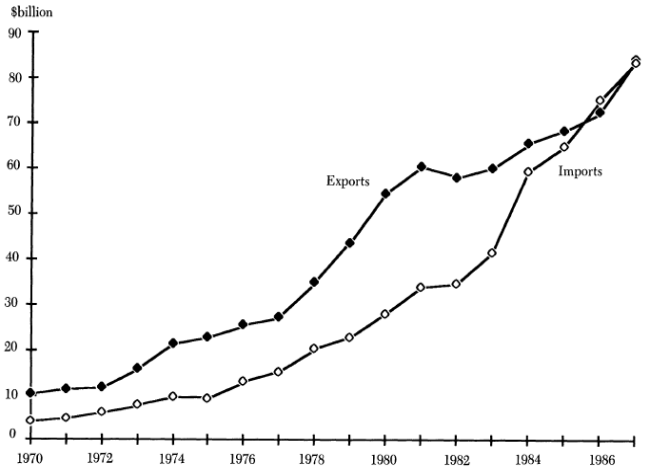

Figure 11. U.S. Trade in High-Technology Products, 1970–1987

Source: U.S. National Science Board (1989, Appendix Table 7–14)

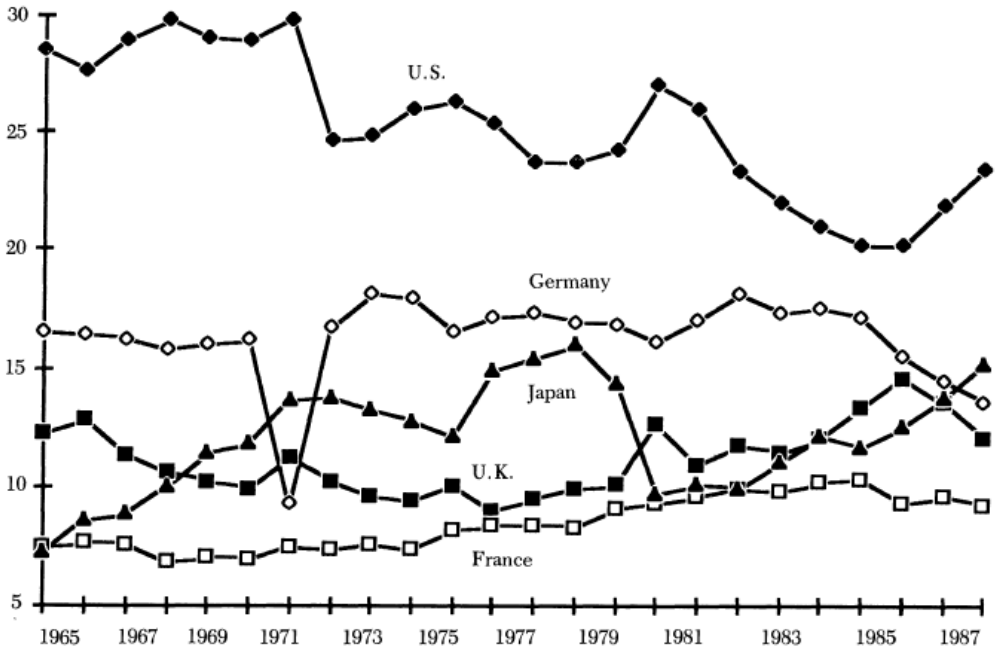

Figure 10. Country Shares of World High-Technology Exports, 1965–1988

Why convergence or loss of U.S. leadership? Take 1

- Falling transport costs and trade barriers
- Internationalization of businesses/ trade makes technology accessible to countries with “social capability”
- Human capital investments close gap
- R&D efforts elsewhere (Fig 5.9)
- Declining spillover from military R&D in U.S.

Additional Aspects

- High social capability of Europe and Japan. 2 World Wars knocked them back a lot in first half of 20th century and helped keep U.S. ahead, but they had the core institutions and technological capacities to pursue rapid catch-up.

- European Union played a key role, too

Questions for Weds Discussion

- What is TRIPS?
- Why is there such a strong push for the protection of intellectual property rights in the area of pharmaceuticals?
- What are the potential private and social benefits of that protection?
- What are the costs?
- How might those calculations vary for wealthier versus poor countries?
- What challenge does this pose to international rules or regulations that relate to intellectual property rights?
- What is Lanjouw's policy approach?