Breakthrough Innovations: The case of antibiotics

SDGs: Innovative technologies to promote healthy lives and well-being

Panel 2 – Technology as a driver of medical progress and access

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“In 1931, humans could fly across oceans and communicate instantaneously around the world. They studied quantum physics and practiced psychoanalysis, suffered mass advertising, got stuck in traffic jams, talked on the phone, erected skyscrapers, and worried about their weight. In Western nations people were cynical and ironic, greedy and thrillhappy, in love with movies and jazz, and enamored of all things new; they were, in most senses, thoroughly modern. But in at least one important way, they had advanced little more than prehistoric humans: They were almost helpless in the face of bacterial infection.”

Thomas Hager
The Demon Under the Microscope, 2006
World Intellectual Property Report
Breakthrough Innovation and Economic Growth

Economic Research Working Paper No. 26
Intellectual property rights and pharma-audicious: The case of emulEvaling
Bhavna N. Sampat

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How innovation has spurred growth

Innovation

- Capital deepening
- Growth in labor force and human capital
- Firm productivity growth
- Transformation of economic structures

Long-run economic growth
Economic contribution of antibiotics

Figure 2.4: Antibiotics had a great impact on human health

Mortality from infectious diseases compared with cardiovascular diseases and in different geographical regions

1930s – Sulfa drugs

- Dawn of the antibiotic revolution as a response to soldiers’ infections in WWI

- In 1932, Bayer created the first treatment against infections: Streptozon, later renamed Prontosil.

- Globally research began using samples from Bayer, becoming a research tool for follow-on invention.

- In 1935, the Institut Pasteur discovered that sulfanilamide had the therapeutic effect.

- Leading to the rapid development of new sulfa-related medicines.

- In 1937, sulfa drugs sold under more than 20 trade names.

- By 1945, thousands of new sulfa drug variants were available.
1940s – Penicillin

- In 1929, A. Fleming published his discovery of penicillin and potential medical uses, but failed to purify enough penicillin to test it.
- In 1940, Florey, Chain and Heatley succeeded in purifying penicillin and tested it, but failed to mass produce it.
- In 1941, the US Department of Agriculture developed a medium for the mass production of penicillin.
- The US government convinced several large US firms to rapidly mass produce it, which explored other antibiotics.
- In 1957, Sheehan (MIT) developed the first pure chemical synthesis of penicillin and the intermediate compound 6-APA, making possible any new penicillin structure.
- This led to the production of synthetic penicillins which are still in use today.
1950-60s – Streptomycin

- In 1939, Merck financed the soil chemist S. Waksman research on actinomycetes.
- In 1943, Schatz and Waksman found Streptomycin, a bacterium effective against tuberculosis.
- In 1950, it was available in the market and proved useful against many other diseases.
- But the discovery was also a new research tool enabling scientists to search soil samples and other natural sources for antibiotics.
- Other firms also searched soil samples finding antibiotics with broader spectrum than penicillin as well as other benefits.
- A new innovative pharmaceutical industry was constituted.
Science’s push

- Downstream innovations were built on pre-existing science.
- Demonstrated strong links between science and industry.
- The channels for academic contribution varied:
  - Fundamental research
  - Developing embryonic ideas
  - Working with industry to develop a potential product
- Governments also played a direct role in stimulating innovation
  - Fueling a massive development and production program in the US.
  - Spurred a more rapid exploitation of existing publicly funded science.
Mass production and commercialization

- Private companies were responsible for scaling up production and establishing the commercial channels.

- Pharmaceutical industry was completely transformed
  - Have internalized and formalized the R&D process.
  - Transformed into vertically integrated firms with research, manufacturing and sales arms
  - Patents, trademarks and marketing are essential aspects of the business model.

- There were also significant economies of scale that encouraged concentration and slow entry of firms.
Shift in the innovation ecosystem

Figure 2.5: The changing face of antibiotic innovation

First filings related to sulfas, penicillins and streptomycins by type and geographical origin of applicant, 1930-1970

Source: WIPO based on PATSTAT database (see technical notes).
Antibiotics and the regulatory framework

- Earlier sulfa drugs contributed to the passage of the Food, Drug, and Cosmetic Act of 1938, which gave the US Food and Drug Administration (FDA) powers to regulate drug safety and efficacy.

- Over prescription of antibiotics and aggressive marketing contributed to a new wave of regulation of product approval regulation in the US and Europe.

- Such changes have increased the cost of development and approval, but also penalized the less innovative firms.

- Need for stronger industry-university relations due to sophisticated clinical trials requiring access to hospitals.
Co-evolution: Patent system with Science & industry

- Science, technology, law and firms’ strategies co-evolve.
- Antibiotic revolution helped create the modern patent-intensive pharmaceutical industry of today.
- Now, research is focused explicitly on getting patentable inventions to be produced exclusively by large vertically integrated firms.
- Patent law adapted in patentability requirements and duration.
- Academic institutions became less reluctant to be involved in patenting and licensing medical inventions
What is the health innovation of the future?

Percent of all patents granted (USPTO, 1980-2012)

- Medical technology
- Organic fine chemistry
- Biotechnology
- Pharmaceuticals

All medical

Percent of all patents granted (USPTO, 1980-2012)
The Best Things in Life are (Nearly) Free: Technology, Knowledge and Global Health

U. Casabonne & C. Kenny (2011):

- Health has improved more in the past 100 years than ever before, including in poorest countries.

- Largely a result of the development and spread of cheap, effective technologies (such as vaccines).

- Other national or institutional factors appear to be secondary.

- But it may take time: Historical trends suggest not to expect too much too quickly.
Thank you!

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