Chapter 2
Bioinformatics: The Convergence between Biotechnology and ITC Impacts on the Productive Sector

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ABSTRACT

Bioinformatics is the methodological tool required to use the massive genomics databases being created on human, animal, bacterial and vegetal organisms. This paper retraces the development of bioinformatics as a new discipline and its diffusion into Latin America. It argues that governments in the region do not pay enough attention at this fast-growing new area of the set of biotech technologies stemming from the convergence between information and communication technology and biotechnologies, and in consequence, the region is falling increasingly behind the world leader (the United States), Japan and Western Europe.

WHAT IS BIOTECHNOLOGY?

Biotechnology is the use of living systems to make useful products and services. For several thousands years, human societies have used biotechnology in the production of food (beer, bread, yogurt), in agriculture (seed and cattle selection) and more recently in medicine (drug production such as antibiotics). Modern biotechnology, the transfer of genetic material from one living organism to another, appeared after the discovery of the double helix structure of the DNA by James Watson and Francis Crick in the early 1950s in the United Kingdom.

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An Innovation Cascade

Modern biotechnology is developing today in a process that the economics of complexity calls an "innovation cascade", a rapid series of scientific, organisational and technological changes that can profoundly modify or even establish a new industry (Lane, 2011). After Watson and Crick's landmark discovery, such a positive feedback mechanism was put in place. The original scientific discovery brought new technological novelties (i.e. genetic engineering), which in turn produced organisational novelties (the dedicated biotechnology firm, specialised venture capital companies, and industry-university liaison offices to manage the new intellectual property) and these innovations in turn facilitated the emergence of new scientific and technological novelty. This section provides a summary sketch of the process.

Genetic Engineering

The first major biotechnological landmark occurred in 1973 with the development of genetic engineering by Herbert W. Boyer at the University of California at San Francisco and Stanley N. Cohen at Stanford University. They showed that it was possible to transfer genetic material from one organism to another, thus creating genetically modified organisms (GMOs). In 1976, Boyer associated with a venture capitalist to create the world's first dedicated biotechnology company, Genentech (Kenney, 1986). This firm created a recombinant human protein in 1977 (somatostatin) and a second one in 1978 (insulin). In 1982, the Food and Drug Administration (FDA) approved this recombinant human insulin for sale. It was the first biopharmaceutical product ever on the market and the first product of modern biotechnology.

By 2012, over 150 new drugs produced through genetic engineering had been approved by the FDA. The first generation of these drugs includes different types of blood factors, erythropoietin, interferon, interleukin, and vaccines. They are used for the treatment of anaemia, leukaemia, hepatitis, cancer, and other diseases. Many of them have already lost patent protection and the new field of biosimilar drugs is now open for generic pharmaceutical companies. Even if the main producers of these biosimilar drugs are companies based in Germany, Israel and Switzerland (Merck Serono, Sandoz and TEVA), pharmaceutical firms based in Argentina, Canada, China, India and other countries are now producing and selling these products.

Genetically modified plants were tried originally in France and the United States in 1986. Yet, China was the first country to commercialise them, in 1992. The European Union and the United States both approved the first genetically engineered plants in 1994. The first GMOs were transgenic tobacco, tomato and a few other plants. But the application of modern biotechnology to plants took off in the late 1990s with the development of the main crops: canola, corn, cotton, soya beans, sugar beet, and