Chapter 71
Is China Catching Up?
Health-Related Applications of Biotechnology

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ABSTRACT

The chapter examines whether Chinese health-related biotechnology is catching up with leaders in the field. The approach is inspired by Malerba's Sectoral System of Innovation and Production, complemented by Mathew's insight into strategies for latecomer firms. The results show that Chinese scientists are quickly catching up in the output of scientific publications. However, the basic research remains insufficient for the development of a sustainable, innovative industry. The industrial production of biotechnology-based manufacturing of drugs and medical devices is growing slower than their knowledge base. Most firms still manufacture under license or contract low-value "me too" generic pharmaceutical and biosimilar ingredients medicines. The intensity of R&D and patenting in China increased dramatically, especially in the foreign-invested firms but China's share of biotechnology patenting in the US, EPO and Japan are very low. In summary, Chinese biotechnology 'industry' is catching up with the West, but it has a long way to go.

INTRODUCTION

The emergence of biotechnology opened a window of opportunity for a few large emerging developing countries to catching up with the leaders in the field (Niosi and Reid, 2007). This paper focuses on the case of China's catching up in scientific research and principal biotechnology applications in life sciences, i.e. in the manufacturing of pharmaceuticals, medical equipment and instruments and in the associated services.

Modern or *new* biotechnology, is manipulation of the genetic structure of living organisms or parts thereof, for the production of goods and services. Biotechnology is an emerging science-based general purpose technology transcending many existing and future industries. The dedicated biotechnology firms employ highly specialized personnel, and their innovation activity is closely related to scientific

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research in public and academic institutions. The Government agencies provide the regulatory framework and funding of basic and applied research. In countries with a public, or public-private mixed health-care system like China, the government is intimately involved in administration and financing of health institutions with solvent demand for biological applications in medicine. Venture capital is often a crucial source of funds and business experience and mentoring in the early stage of innovating start-up companies competing and collaborating with the incumbent pharmaceutical firms.

Dependence on and Collaboration With Scientific Biotechnology Research

The knowledge-base of modern biotechnology are the scientific discoveries and continuing advances in several fields of biology, genetics and health sciences (Niosi, Hanel, & Reid, 2012; Tassey, 2007). Public scientific research institutes (SRIs) and universities, often in collaboration and partnerships with biotechnology-dedicated enterprises, are conducting the scientific research. The commercial applications of new biotechnology-based products, processes, and services are developed by the business sector, often in partnership with scientists from SRIs and academia. This clear-cut division of tasks has been the object of dramatic economic, institutional and scientific policy reforms in the post-Mao China.

Any effort of closing the gap between a latecomer country (or firm) and the forerunners in a science-based commercial activity such as biotechnology depends on the national scientific resources and their performance that is evolving within the national institutional and economic context. Taking into account the changes in the environment in which scientific and industrial organizations is of particular importance in a country that has changed as quickly and so much as China.

Commercial Applications of Biotechnology in Life Sciences

Except for the two founding companies of the biopharmaceutical industry[1], Genentech and Amgen, most other dedicated biotechnology firms in the U.S and Europe are small or medium size enterprises (SME). Their smaller size allows them to be more flexible and less risk-averse than the oversize conventional pharmaceutical majors. Thanks to their narrow focus on specific health issues, the research productivity of SME is often superior compared to large pharmaceutical firms. Owing to their complexity, discovering and developing biological production processes is very expensive. Despite their often very high price biological drugs are increasingly in demand because of addressing the previously untreatable health problems.

The global share of medicaments produced by biotechnological processes is estimated to have increased from 8% in 2001 to 18% in 2012 with sales of $169 billion (IMS Institute for Health Informatics, undated). At the same time, the conventional, chemical process-based manufacturers of brand-name medicines, were suffering huge losses[2] owing to the expiration of their patent protection, declining technological opportunities and rising research costs. To ward off the effects of the unsustainable cost and declining productivity of discovery of conventional chemical drugs, the leading pharmaceutical multinational companies PMCs use a combination of two main strategies:

1. Instead of building up own biotechnological capacity from the scratch, the large PMC are acquiring the new technology by strategic alliances, mergers with and acquisitions of dedicated small