



Taiwan's pharmaceuticals: A failure of the sectoral system of innovation?



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ABSTRACT

The study investigates Taiwan's sectoral system of innovation in the pharmaceutical industry, which has failed to achieve international competitiveness, despite strong state support. Our investigations were designed and carried out in two stages. In the first stage, we developed a statistical method to measure the institutional drivers in Taiwan's pharmaceutical industry. This finding received strong support in our second stage of analysis, which involved the use of both: (1) inductive processes (through the use of interviews) and (2) deductive (i.e., mathematical) approaches to analyze the innovation performance in Taiwan's pharmaceutical industry. In particular, we compared patenting and publication activities in Taiwan versus those of India. The results of our study demonstrate that the intellectual property regime (i.e., patents and publications) is playing a critical role in linking actors and institutions and is highly associated with the effectiveness of the innovation system in the pharmaceutical sector.

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1. Introduction

The promotion of the pharmaceutical industry is one of the main priorities of Taiwan's industrial policy, as demonstrated in a series of legislation, including the implementation of cGMP (Current Good Manufacturing Practices) and PIC/S GMP (the highest standard, as per the European GMP criterion). Nevertheless, despite a considerable degree of state support (even more than that awarded to the information technology area, in which Taiwan appears to be one of the key leaders in the global market), our research question is why the performance of Taiwan's pharmaceutical industry is far inferior to that of the information technology (IT hereafter) sector, as both sectors operate in a dynamic high-tech environment and share a common national system of innovation?

In line with the view of technological regime and institutional paradigm, Jung and Lee (2010) and Park and Lee (2006) contend that "catch-up" in latecomer countries can only occur in

certain sectors, whose technological life cycles are shorter and more explicit, and more easily embedded in importing mechanisms. The pharmaceutical sector can be characterized as having a tacit body of knowledge, along with a longer technological life cycle, but despite these challenges, it is a successful sectoral system of innovation in India. Although Castellacci (2007) suggests that sectoral differences may be attributed to varying levels of productivity, the diverse innovation performance within countries engaged in "catch-up" still poses a challenge to the themes of innovation systems.

There are different types of system failures, for example, infrastructural failure, institutional failure, network failure, capability failure (Edquist, 1997; Malerba, 1997; Carlsson and Jacobsson, 1997; Smith, 1997), and transition and transformation failures (Weber and Rohracher, 2012; Jorgensen, 2012). Although the terminologies and definitions of the systemic failures are various, these works acknowledge the importance of clarifying imperfect systems and the difficulty in distinguishing the elements of one failure from the other. Moreover, the failure of some sectoral systems of innovation is linked with the success experienced by others, in that all the successful and failing systems are mutually influenced. In this respect, the clarification of the elements involved in the

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failure of a sectoral system of innovation is essential if a nation is to build its innovation system as a whole.

Using the framework of an innovation system, this study identifies the misalignments of Taiwan's pharmaceutical innovation system and also explores the role of intellectual property in this sector over the last three decades. Given the Indian pharmaceutical industry is a benchmark for emerging economies, we then extend the results of the Taiwanese case in a comparison with India.¹

The remainder of the paper is organized as follows. In Section 2, the evolution of the sectoral system of innovation is addressed, along with the use of patent data to investigate the development of Taiwan's pharmaceutical industry. In Section 3, we introduce two interactive statistical methods in order to clarify what drives Taiwan's pharmaceutical sector and the causal structure that is involved. In Section 4, the empirical results for the sectoral system of innovation in Taiwan's pharmaceutical industry are analyzed. Then we use six patent indicators and paper publication analysis to enable a comparison of innovation performance with the benchmark Indian case in Section 5. Conclusions are given in Section 6.

2. Literature review

National systems of innovation are important, but suffer from certain limitations in that a country may consist of many sectors both within its own territory and by virtue of cross-border interactions (Malerba, 2005). While a national innovation system is hard to be quantified, the sectoral system of innovation can be acted as a transition and measurable proxy due to its framework is broad, open, and flexible. In particular, the key characteristics of a sector, including its knowledge, its capabilities, its various types of actor, and its interactions and particular institutions, form the essential elements that can help to understand innovation activities in terms of their local, national, and global dimensions (Malerba and Mani, 2009). Indeed, the innovation process in a sector often is across different geographical boundaries. In particular, the catching-up countries often deliberate and operate intra-sectoral division of labor within and across a nation while linking with the global value chain. We therefore now discuss the complementary relationships that exist between national and sectoral systems of innovation.

2.1. National vs. sectoral systems of innovation

It was Freeman (1987) who first proposed the concept of a national innovation system (NIS) in his study of Japan's technological development. The NIS is defined as the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify, and diffuse new technologies. Later studies employed similar definitions to build on this idea (Lundvall, 1992; Nelson, 1993; Patel and Pavitt, 1994). The concept of NIS is now widely accepted as making an important contribution to our understanding of the differences in innovation performance between nations. Although the concept of NIS is generally recognized as comprising

a complex of functions and interactions between various actors and institutions (Liyanage, 1995; Smith, 1995; Hubner, 1996; OECD, 1999; Furman et al., 2002; Carlsson and Eliasson, 2003; Edquist and Hommen, 2008), it is bound by national boundaries and is difficult to examine quantitatively (Malerba and Mani, 2009).

As a complement to the NIS, the sectoral system of innovation acts as a transitional proxy that takes place across national borders and aims at providing a fuller understanding of sectoral dynamics, in terms of (a) patterns of change and (b) the factors that affect the performance and competitiveness of firms/countries. Many authors have considered what drives the building of a sectoral system of innovation. For example, the descriptions of sectoral systems of innovation by Malerba (2004, 2005) suggest that knowledge regimes, market structures, and the degree of embodied technological change in the sectors are the major variables at the sectoral level; Link and Bauer (1989), Vonortas (1997), and Sigurdson (1998) suggest that the onward division of labor in the global pharmaceutical sector has resulted from the various types of firms who have tended to enter into innovation networks to pursue strategic or economic goals; and Jorgensen (2012) demonstrates how different actors at all levels in the society navigate and perform strategic interventions to foster a sustainable system.

The international leaders in the global pharmaceutical industry generally pursue economizing industrial interactions, aiming at the sharing of the costs and risks involved in the highly uncertain development of a new drug. In contrast, small firms or technological latecomers generally have more strategic aims, targeting on the creation of new business opportunities via the development or acquisition of technological capabilities. The aim in these cases is to increase the absorptive capacity of firms, thereby affording them the potential to gain access to a wider range of technological options (Cohen and Levinthal 1989). However, the degree of spillover from these activities depends on the extent to which the development of sectoral systems of innovation is available to enable new opportunities to open up in markets and technologies (Dodgson et al., 2008; Malerba, 2005).

Castellacci (2007) further explains that sectoral differences in productivity are centered on five factors, namely appropriability conditions, levels of technological opportunity, levels of education and skill, the degree of openness to foreign competition, and the size of the market. This has been seen in the innovation system of Japan, where the establishment of new industries (e.g., software) appears to be more difficult than in the U.S. and Europe (Storz, 2008; OECD, 2006). Mani (2009) continues in the same vein by comparing innovation systems for India's pharmaceutical and telecommunication equipment industries. India's pharmaceutical industry is more innovative than its telecommunication equipment industry, but the latter has better market performance than the former. Mani (2009) suggests that the differences in market performance are in contrast to the efficiency of the structure of the respective sectoral systems of innovation.

Differences in sectoral systems of innovation, in developing countries in particular, stem from differences in learning behavior and capability, which in turn are constrained by the technology, knowledge base, and institutional context (Malerba and Mani, 2009). Park and Lee (2006) conducted an

¹ Due to the difficulty of data collection for India, this study is not able to make a comprehensive comparison for the sectoral systems of innovation between Taiwan and India.

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