

R&D of Chinese Firms: Characteristics and Implications

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Innovation-Oriented Economic Growth

Recently, China is facing limitations in economic growth driven by the expansion of factor-inputs, which allowed China to achieve economy of scale, using its abundant labor and capital. Therefore, China now is seeking to change its paradigm of economic growth into an innovation-oriented one where knowledge increases economic productivity. As a result, investment in research and development (R&D) and patents have sharply risen. This would be a good time to assess the policies and strategies for R&D in China to draw up some meaningful implications.

This study contains Chinese government policies for R&D, current state of Chinese firms' R&D, characteristics of Chinese patents according to the new method of patent classification and Chinese firms' reverse-innovation and globalization strategies.

China's R&D and Science-Technology Policy

Chinese policies on science and technology formed the basis of "Deng Xiaoping Thought" after the era of reform and openness began.

In 1985 the “decision on the reform of science-technology system” presented a basic direction for reforming the science-technology system and policy. This led to more specific reforms of the science-technology system, and various policies have been implemented at each stage of market reform, in accordance with long-term strategy. Chinese government has since formulated a medium- and long-term science and technology policies for innovative nation building to achieve sustainable and harmonious economic growth. The government bodies and agencies are leading the way in implementing such policy, including diverse R&D promotion programs.

It is undeniable that these efforts produced remarkable improvements in China’s scientific-technical capacity in general, yet more time and greater enhancement are needed for self-sustained innovations. In the end, the extent of China’s science-technology development hinges on effective policy management and the government’s determination to improve its institutions. A desirable direction for China’s medium-long term science-technology policy would be to build up its market competition system, to expand investment to support R&D of private firms, and to establish networks and enhance the quality of education for the development of human capital.

R&D Activities of Chinese Firms

In the past, the role of firms as agents of innovation was underestimated in China. However, domestic entities, especially innovative firms and high-tech enterprises, have lately emerged as the main applicants of Chinese patents. This study features an empirical analysis of the relationship between Chinese R&D and productivity. The analysis finds that the increase in

trained personnel in high-tech industry R&D significantly contributes to the increase in the number of patents and productivity.

Invention Patentees in China

The changes in the environment for Chinese patents are described by examining the three revisions of patent laws, and a microanalysis on the patent distribution and patentees in order to assess the capacity and growth potential for Chinese innovation. China enacted its first patent law in 1985 and modified the patent-related systems by revising the patent laws three times by 2008. The first and second revisions were, to some extent, forced by external factors, such as the international pressure of intellectual property rights protection and the necessity for WTO entry. In contrast, the third revision was initiated by the internal need to enhance the level of patent right protection. There are certain limitations in effective intellectual property rights protection in China because of the remaining legislative and legal problems, but the application and registration of patents in China in real term is very active given such institutional circumstances.

The convergence of technical knowledge portfolios between Chinese domestic firms and multinational enterprises in China were identified in the analysis of patent statistics according to a reclassification of Chinese patents. Also, improvements in technical knowledge by Chinese domestic firms’ and the localization and adaptation by foreign companies to China are simultaneously in progress; the former being dominant over the latter. In addition, the proportion of Chinese domestic firms or the university/research institutions that has risen to within the top 10s of each 35 industrial technology areas has increased. The result implies that the Chinese

domestic firms have, for the most part, succeeded in catching up in terms of technological capacity.

Chief findings of the microanalysis on the main entities of invention patentees in China are as follows: first, Chinese domestic entities of invention patent applications increased conspicuously in the IT sector, including electronics and computers; facility hardware sector, including machinery, civil engineering, and measures/standards. Second, the top three petroleum firms, that is, the main state-owned enterprises (SOEs) directly controlled by the Chinese central government, possess considerable patent technology. Third, some foreign investor firms, including Taiwanese firms, are operating affiliated companies that have applied and registered invention patents in China. These companies are able to utilize the abundant engineering manpower in China and strengthen the protection of intellectual property rights of their affiliates regarding production processes, as well as products produced and sold in China. Fourth, in China, universities and research institutions are the main agencies that possess patents, especially in high-tech areas where industrialization has yet to kick into high gear, in addition to science-based industries where the application of primary research to industrialization is easily implemented; and general purpose technology areas such as measurement, controlling and analysis methodology, etc.

Internationalization Strategy of Chinese firms

The internationalization strategy of the five types of emerging multinational enterprises (MNEs), as described by Ramamurti, was

referred to in analyzing the innovation factors and reverse-innovation among Chinese firms, by classifying the Chinese R&D firms into five types. Also, case studies for each type were performed to assess the main contents and characteristics of technological innovation strategies of these firms.

Five Types of Chinese Firms

The first type is state-owned natural-resource vertical integrators that include most SOEs, which secure technological capacity by strategic integration to develop foreign resources. Large-scale support from the government allows these enterprises to rapidly catch up with the leading firms. The second type is local optimizers that engage in market-oriented innovations to develop the products to be optimized according to customers' needs in the local markets. It is very possible that these firms became familiar with reverse innovation by exporting products optimized for the local market to the developed countries. The third type is the low-cost partners that MNEs of developed countries utilize to reduce production costs. Reverse innovation can take place when MNEs receive the spillover effects of technological innovation from Chinese firms. The fourth type is global consolidators that attempt to carry out the strategic consolidation to enhance the technological capacity all the way to the international level. The strategy, of course, is to innovate through the process of technological catch-up by consolidation. This has potential to spread the results of innovation from interactions among consolidated enterprises in the domestic venue into the developed world. The fifth type is a global first-mover, which is the most typical reverse innovator. In this instance, independent of external effects, local Chinese firms achieve independ-

ent R&D outcomes and the results spread to the global level.

Implications of R&D by Chinese Firms

The implications of R&D by Chinese firms and measures in response are suggested as follows.

1. Chinese R&D policy

First, the main response measures for dealing with the Chinese R&D policies would be to promote the technological cooperation with focus on the seven strategic emerging industries, formulate strategies to cope with the growth of Chinese firms in the high-tech industries and support joint R&D by the small and medium enterprises' with Chinese companies. The technological cooperation with China should be reinforced in energy-saving, environmental-protection, biotechnology, and new energy areas that overlap with Korea's new growth engine industries. Also, it is imperative that specific and novel innovation strategies be established to minimize the impact of technological catch-up of China in high-tech industries, along with settlement solutions in case of patent disputes. The policies are needed for supporting SMEs that lack the capacity to establish R&D centers in China so that they may conduct joint R&D or take advantage of R&D centers established by conglomerates or government bodies.

2. Globalization of Chinese firms

Second, another measure that Korea can enact to counter the globalization of Chinese firms would be to set up strategies to develop the

technologies through Korean companies' affiliates in China. Just as many foreign firms, including Taiwanese firms, are applying and registering patents in China, Korean firms also need to create effective portfolios of local patents in China. Furthermore, we need to deal with various challenges from Chinese global firms in accordance with their types of firms: firms that achieve growth by taking country specific advantages (CSAs), catch-up through innovative progress, and self-innovation.

3. R&D cooperation

Third, policy measures related to R&D cooperation should, include strengthening R&D cooperation with universities and research institutions in China, establishment of R&D cooperation models between the governments, and providing directions for cooperation in technical standards. Cooperation should be concentrated in universities and research institutions that dominate in terms of the proportion of invention patents in high-tech areas where industrialization is still in its infancy, or in general purpose technologies. As for R&D cooperation between the governments, it might take the form of mutual funding frameworks as in the case between China and Germany and should be focused on core industries later on. Lastly, the cooperation in technological standard between Korea and China should continue in areas that the new technologies have been introduced and the industrialization has just begun. **KIEP**

Table 1. Reverse-innovation of Chinese firms

Strategy	R&D Policy	Innovation	Reverse-Innovation
Natural-resource vertical integrator	- Develop natural resources. - M&A	Influence of government	- Reverse innovations may begin with laggards rather than lead users
Local optimizer	- Internal factors	Market orientation	- Developed-country multinational firms develop platform for China market and re-export to develop country.
Low-cost partner	- Initial process innovation is very important. - Develop product innovation in the end.	Organizational control	- Multinational enterprise's investment enables Chinese local firms to innovate and get spillover effect from them.
Global consolidator	- Learning in catching-up	Organizational learning cooperation and alliance	- Chinese firms that are based on domestic innovation expand their market to advanced country.
Global first-mover	- Develop R&D by itself.	Entrepreneurship orientation, top management team	- Innovations may occur in China and trickle up to rich ones.