

Research on the Strategic Choice of Technological Innovation and Technological Leapfrogging of Late-Developing Enterprises ---- Literature Review and Future Prospect

Xinyuan Miao

International Business School, Shaanxi Normal University, Xi'an 710119, China.

miaoxinyuanmxy@163.com

Abstract. Because of the existence of opportunity window and innovation predicament of the leader, it is possible for the late-developing enterprises to achieve technological leapfrogging. The choice of technological innovation strategy plays an important role in the process of realizing technological leapfrogging of the late-developing enterprises. On the basis of defining the three important concepts of late-developing enterprises, technological innovation strategy and technological leapfrogging, this paper combs the leapfrogging practices of Japan, Korea and China, and extracts four influencing factors accordingly. Finally, in summary of the above, this paper summarizes three aspects of current research, and puts forward the prospect of future research, which provides theoretical support and practical guidance for follow-up research and enterprise development.

Keywords: Late-developing enterprises; Technological innovation strategy; Technological leapfrogging.

1. Introduction

Innovation has become an important theme for the sustainable development of the world economy and society [1]. In order to achieve the goal of economic transformation and innovation-driven development successfully, enterprises must play their main role well [2]. Since the reform and opening 40 years ago, Chinese enterprises have made remarkable achievements in many fields, but they are still in the position of the late comers in many fields. How to draw lessons from successful experience and realize leapfrog development under the condition of both technology and market disadvantages has become an important challenge for China's late-developing enterprises.

For China's late-developing enterprises in emerging economies, the overall environment provides opportunities and realistic possibilities [3]. On the one hand, the technological changes brought about by global scientific and technological progress alleviate the weakness of their technological base and enable them to achieve technological level by introducing and applying the technology of leading enterprises. On the other hand, domestic market demand creation, resource support and national policy guarantee provide a more competitive starting point. Technological innovation is the main way for enterprises to achieve technological breakthroughs, and its strategic choice has a great impact on whether late-developing enterprises can achieve technological breakthroughs [4]. Therefore, from the perspective of strategic choice, this paper discusses the technological innovation strategy and technological leapfrogging of late-developing enterprises, and combs the important influencing factors. Finally, on the basis of summarizing the existing achievements, the future research directions are prospected.

2. Definition of Relevant Concepts

2.1 Late-developing Enterprises

The study of the late-comer can be traced back to the 1960s. Gerashchenko, an economic historian, first used the term *late-comer* in his comparative analysis of the 19th century European industrialized countries [5]. With the deepening of economic globalization and the rise of Asian economy, the research on the internationalization of late-developing enterprises is gradually launched. According to Hobday's definition, late-developing enterprises refer to those enterprises in developing countries that are facing technological and market disadvantages and are trying to compete internationally [6].

In recent years, many studies began to focus on the background of transition economy. Regarding the advantages and possibilities of technological leapfrogging of late-developing enterprises, the school of strategic management believes that late-developing enterprises may surpass the early-developing enterprises with less effort. Liu Lina believes that incumbent enterprises are trapped in the Icarus dilemma because of organizational inertia or temptation by previous vested gains. During the transformation of technological paradigm, it is the small enterprises that are easy to achieve disruptive innovation for these large enterprises.

2.2 Technological Innovation Strategy

For the definition of technological innovation strategy, scholars have different defining angles and emphases. There are three main types: technological innovation strategy refers to the decision-making that enterprises take technological development as the center, create more value and enhance competitive advantage for enterprises through different innovative ways, and explain the innovative behavior of enterprises. Technological innovation strategy is a positioning process for enterprises to carry out technological innovation, which explains the source of technological innovation behavior. Enterprises improve their performance and implement technological objectives by determining the degree and method of technological innovation. Technology innovation strategy determines the allocation and development direction of enterprise technology innovation resources. Later-developing enterprises are essentially different from leading enterprises in technological innovation: leading enterprises mainly take original innovation as the main body, while later-developing enterprises pay more attention to technological innovation in technological catch-up. The goal of technological leapfrogging is to get rid of the situation that technology is always backward and restricted by others. Among them, technology introduction and independent innovation are the two most basic and important ways.

2.3 Technological Leapfrogging

The concept of technological leapfrogging was first put forward by Soete, which means that technological backward enterprises can skip certain stages of the same technological track or realize the transition between technological tracks or even create a new technological paradigm through technology introduction, digestion, absorption and independent innovation. Keun Lee and Chaisung Lim argue that technological leapfrogging refers to the process and manner in which some late-developing enterprises overtake old technologies and their huge investments and catch up with leading enterprises. Regarding the division of mode and stage, Lee and Lim believe that there are three main modes of technological catch-up: path-following, path-jumping and path-creating. Li Xiaoli and Yu Bo divided it into three stages: technology accumulation, technology integration and technology leapfrogging. The research of scholars both at home and abroad shows that the implementation of technology innovation strategy is an important channel to improve enterprises' technological innovation ability and innovation performance. Li Xiaoli believes that in the early stage of catch-up, technology introduction strategy should be adopted, and in the late stage of catch-up, more "mature" post-enterprises should carry out independent innovation. Zhang Shilong's research on manufacturing industry shows that enterprises should choose appropriate innovation strategy according to their industry structure and competitive position and development stage.

3. Innovation Strategic Choices and Technological Leapfrogging Practice of Countries

3.1 Japan

Implementing the strategy of technology importation and imitation innovation is the main way for Japan to catch up with the economy and leapfrog the development of technology. Through this strategy, Japan has achieved rapid growth and development in a relatively short period of time, won the precious time in the process of modernization, and later came to the top, reached the world-class

level in applied technology, and accumulated rich experience in scientific and technological research. Television and steel are typical industries for Japanese late-developing enterprises to achieve leapfrog development. In the 1950s, the United States was an international leader in television technology. After Japan introduced transistor technology and black-and-white television technology from the United States, its television manufacturing technology developed rapidly. In only five years, the United States won 15% of the color TV market. In the early 1950s, Japan began to introduce foreign steel technology and develop its own steel industry. By 1955, Japan had been able to export steel production technology and provide technical guidance to some countries. Since 1974, Japan has exported more steel technology projects than imported ones.

3.2 Korea

Scholars from all over the world mainly focus on the semiconductor industry. Chen Dezhi and Chen Xiangtang believe that the technological leap of Korean semiconductor industry has undergone a strategic transformation process from enterprise-oriented, government-led cooperative development to enterprise-oriented independent development. Wang Jin and Jin Tinghao took Samsung as an example to analyze the evolution process of its innovation strategy. It has experienced the evolution process of technological innovation strategy of imitation innovation, cooperative innovation and strategic transcendence. In the development of Korean semiconductor industry, the government has played an important role. In the 1980s and 1990s, the Korean government formulated a joint development plan for VLSI technology, with the government-affiliated National Institute of Electronics as the main body. Samsung, Hyundai, LG and other large enterprises participated in the formation of a semiconductor research and development portfolio. In order to maintain and strengthen the competitive advantage continuously, the Korean government has implemented the "New Generation Semiconductor Basic Technology Development Project", which not only leads the international level in technology, but also trains a number of advanced technical talents.

3.3 China

The successful leapfrogging practice and research of China's late-developing enterprises focus on security and high-speed rail industry. Taking Haikangwei as an example, Wu Xiaobo tracked the implementation and development process of his innovation strategy in the past two decades. Haikang has grown from imitative learning to independent research and development, completed the transformation from second innovation to one innovation, and leaped to the top of the global security industry. High-speed rail is one of the few industries in China to achieve technological leapfrogging of complex product systems in a short time. Its rapid development has played a tremendous driving effect on the development of national economy and society. He Jun, Lv Tie, Huang Yanghua and Jiang Hong divide the technological process of China's high-speed railway into four stages. First, before 2004, the experimental exploratory stage with independent R&D as the main part; second, the technology introduction stage with independent innovation orientation from 2004 to 2008; third, the formation stage of design capability from 2008 to 2012; fourth, the construction stage of independent intellectual property rights and China's high-speed railway standards from 2012 to 2017, China began to change from *follower* to *leader*.

4. The Influencing Factors

As far as late-developing enterprises are concerned, from the choice of innovation strategy to the realization of leapfrog development, they are constrained by multiple factors, such as talent, capital, innovation ability, policy system, education investment, etc. Based on the literature review and keyword co-occurrence analysis, the following four important factors are summarized.

4.1 Government Policy

From the experience and process of technological catching-up and leapfrogging in the above countries, the government's policy guidance and support have played an important role. Lichtenberg

believes that the government not only determines the allocation of national scientific research resources, but also determines the speed and direction of technological progress. Mahmood and Rufin's research show that for developing countries, governments can promote national innovation through centralized economic and political control. Garrett-Jones' research shows that Australian state government policies have significantly promoted the development of the national innovation system and enterprise innovation activities. Focusing on China, government support has a significant positive impact on the level of industrial innovation in China. At present, although China's high-tech industry has begun to take shape, it is large but not strong, which requires the government to provide more support and protection in fiscal and taxation policy, patent protection and transformation of achievements, talent training environment, financing system and so on.

4.2 Technological Innovation Resources

Technological innovation resources are the carrier and foundation for enterprises to enhance their technological innovation capabilities. Enterprises are bound to rely on their own basic resources and innovation resources when carrying out technological innovation activities. Areas with abundant resources tend to squeeze out technological innovation. From the scarcity of resources and its impact on enterprise development, technological innovation resources can be divided into general resources and strategic resources. As an important source of heterogeneous resources, strategic resources can promote technological innovation. Enterprises with innovative resources which are difficult to imitate by competitors will cause information asymmetry between enterprises and competitors. This heterogeneous resource forms a kind of first-mover advantage of an enterprise, and consequently produces a sustainable competitive advantage.

4.3 Technological Innovation Capability

In the dynamic environment of realizing technological leapfrogging, technological innovation capability means that an enterprise has the comprehensive power of invention and innovation in a certain scientific and technological field. Technological innovation strategy and technological innovation capability can promote the realization of technological leapfrogging if they can keep dynamic adaptation and achieve balance and matching through identification and adjustment. From the perspective of technological evolution, technological innovation capability consists of three sub-capabilities: absorptive capability, integration capability and independent innovation capability. The overall improvement of technological innovation capability is based on the capability cycle, and the mutual promotion between sub-capabilities. Only when the process of digesting and absorbing technological knowledge completes the cycle, can the technological innovation capability of enterprises be improved as a whole, which is embodied in practice, and is the completion of an overall system.

4.4 Organizational Learning

The process of technological leapfrogging is a process of high risk and high uncertainty, especially in industries where Technological Paradigms change frequently. Many once brilliant enterprises have not crossed the "incumbent trap". In order to combat the inertia in the process of development, organizations need not only to acquire new technology through accumulated learning, but also to abandon the technology already mastered by forgetting learning. Initially, organizations need to foster a culture of learning promotion, incorporate organizational learning into daily practices to ensure that organizations can keep up with the pace of new development strategies. In implementation, the organization needs to build an infrastructure to support learning, set up incentive mechanism, encourage employees to boldly innovate on the basis of existing, so as to promote the landing of organizational innovation strategy.

5. Conclusions and Prospects

Based on the above analysis, the current research on technological innovation strategy selection and leapfrog development of late-developing enterprises mainly focuses on three aspects: the first aspect is the theoretical research on technological innovation strategy and technological leapfrogging of late-developing enterprises, which defines the concepts, divides the stages and explores the relationship between them. The second aspect is the practical research on the path and experience of Technological Catching-up in a particular country or market, mainly focusing on Asian countries, and some scholars have analyzed the process of technological catching-up and leapfrogging in Europe, the United States and other places. The third aspect is the analysis of influencing factors.

These three aspects of research work have been more adequate. This paper holds that future research can start from the following three aspects. After nearly twenty or thirty years of catch-up, a considerable part of China's post-development enterprises has achieved leaps and bounds. How to maintain and consolidate their leading position and prevent the emergence of new paradigms from falling into a new round of backwardness-catch-up trap is a problem worthy of study; and the past research mainly focused on typical cases. At the level of technological capability innovation of manufacturing enterprises, we can study the technological innovation system that integrates technology and business model in the Internet era in the future. Third, the urgent requirement of environmental problems and the proposal of green innovation concept make enterprises must take low-carbon concept into account in the process of development, and how to balance low-carbon innovation strategy. Economic benefits will become a difficult problem for later-developing enterprises in the future, and future research can also focus on this aspect.

References

- [1]. Mei Liang, Chen Jin, Yu Fangzhen. Innovation Evolution and Paradigm Transfer: Origin, Characteristics and Framework of Sustainable Transition Theory. *Research on Dialectics of Nature* Vol. 31 (2015) No. 10, p.36-40.
- [2]. Chen Jin, Yin Ximing, and Zhao Chuang. "High Additional Manufacturing: Overtaking the Catching-up Strategy of Manufacturing Innovation in China." *Technological Economy* Vol. 37 (2018) No. 08, p.1-10+19.
- [3]. Fu Yamen. How does a latecomer enterprise go from catching up to surpassing?--A longitudinal comparative analysis of two cases from the perspective of opportunity window. *Management World* Vol. 35 (2019) No. 02, p.151-167.
- [4]. Lei Xiaomiao, Li Yang. Technological Catching-up and Leaping-forward Development of High-tech Industries - Literature Review and Research Prospect. *Industrial Technology Economy* Vol. 38 (2019) No. 02,p.147-154.
- [5]. Timmermans, S. , and I. Tavory . "Theory Construction in Qualitative Research: From Grounded Theory to Abductive Analysis." *Sociological Theory* Vol.30 (2012) No.03, p.167-186.
- [6]. Franco, Mário, and J. Almeida . "Organisational learning and leadership styles in healthcare organisations." *Leadership & Organization Development Journal* Vol.32.(2011) No.08,p.782-806.