

Co-evolution of Social Technology and Physical Technology: Chinese Hi-tech Industry

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Abstract Chinese Hi-tech industry has become the economic growth generator in China nowadays. Through the comparison of sector data and analysis on the change of government policy, we can see a co-evolution process of social technology and physical technology in the development of Chinese Hi-tech industry. The last thirty years development of Chinese High-tech industry since opening up is correlated to the development of technology, forms of business organization, public policies, and regulatory structures. The changing of development strategy on technology and institutional reform meet the requirement of the development of high-tech industry to some extent. But the development of Chinese High-tech industry shows a different trajectory compared with the path which developed country experienced. The coevolution path of social technological and physical technology in the catching up is from technology import, absorption to innovation, from Stated-owned to Joint Venture, from imitation to innovation, and from process innovation to product innovation which is different from the well-known industry life cycle theory which Abernathy and Utterback initially put forward in 1978. Therefore, A new ‘industrial life cycle model for catching-up’ was put forward in this paper.

Key words social technology, physical technology, Hi-tech industry

1 Introduction

The growth of economy roots in the interaction between institution and technology. Social technology as a definition to institution has been mentioned a lot in the recently papers of Nelson et al (2001, 2002, 2008). Sophisticated scholars have understood the important role of institution in supporting and molding efforts to advance technology. Most of the camps of economy theory such as Smith’s and Marx’s have referred to the relationship between institution and technology to some certain. Richard Nelson (2008, 2002) suggested that there would appear to be a real need and challenge to build an intellectual bridge helping economists to recognize better how institutions and institutional change relate to technological advance. In the normal flow of events, new social technologies, new “institutions”, often come into the picture as change in the mode of interaction- new ways of organizing work, new kinds of market, new laws , new forms of collective action—that are called for as the new technologies are brought into economic use. From the perspective of macroeconomic development and history, the Kondratieff cycles and Schumpeter thought of business cycle are the major contributions to understand the long term coevolution in technology and economy. More recently, Chris Freeman and Carlota Perez have made important contributions to the detailed characteristics of the long waves. Perez (2004) suggested that the long-term fluctuations that we called long waves are the results of successive couplings of two spheres of the system: the techno-economic on the one hand and social-institutional on the other hand. She also suggested that there are mechanisms inherent in the way technologies diffuse which results in technological revolutions or changes of paradigm every 50 or 60 years, leading to long-term patterns of continuity and discontinuity in the techno-economic sphere which require matching transformations at the socio-institutional level. For the short term, the coevolution between institution and technology could be understood by the industry life cycle theory. There have been many versions of Lifecycle theory since the economists Utterback and Abernathy first launched their theories of Industry Lifecycle in the 1975. But most of the theories are based on the research of the developed countries.

2 Coevolution of Physical Technology and Social Technology of Chinese High-tech Industry

2.1 Trajectory of the development of technological capability: from import, absorption to indigenous innovation and from process innovation to product innovation.

The path of the development of Chinese high-tech industry is a groping onward process. For most of the enterprises in China, the process of acquiring technological capability was from import,

absorption to indigenous innovation. This process also went with the institutional reform of from planed oriented to market oriented economy, from closing down to opening up, and from pure stated owned to joint venture and private enterprises. In this coevolution process, the technological capabilities of Chinese enterprises have been improved tremendous.

Table 1 Sales revenue of High-tech products

| | 1995 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|------|------|------|------|-------|-------|-------|-------|-------|-------|-------|
| Sales revenue from new products (100M Yuan) | 538 | 805 | 1207 | 1526 | 2484 | 2876 | 3416 | 4515 | 6099 | 6915 | 8249 |
| Sales revenue (100M Yuan) | 3917 | 5618 | 6580 | 7820 | 10034 | 12015 | 14614 | 20412 | 27846 | 33922 | 41585 |
| Percentage of New product (%) | 13.7 | 14.3 | 18.3 | 19.5 | 24.8 | 23.9 | 23.4 | 22.1 | 21.9 | 20.4 | 19.8 |

(Source of data : Chinese high-tech industry Statistical Yearbook 2002 , 2007)

If we look at the sales revenue of new high-tech product, we can see that that the sales revenue of new product increased sharply after 2000. The average increasing rate of the percentage of new product was 16% from 1995 to 1999 while it was 39% after 2000 (Table 1). During the process of technology import and absorption, the enterprises have very low capability of indigenous innovation on product. Therefore, most of the innovation should take place in the process of producing product to decrease the cost. While as long as the enterprises grow up and continuously owned the indigenous innovation capacity on product, the rate of new product will grow. Therefore, we can conjecture that the pattern of innovation of Chinese high-tech industry is from the process innovation to product innovation and is different from the Patterns of Industrial Innovation which Abernathy and Utterback put forward in 1978.

2.2 Coevolution of the institution and the technology of Chinese Hi-tech industry

The trajectory of technology import, absorption and innovation went with the institutional and organizational changes in the development of Chinese Hi-tech industry. The evolution of the institution in china basically evolved along there main threads which are the adjustment on the development strategy and the transformation from planed economy to market economy and the reform on the property right in the last 30 years. The policy and business structure kept on being adjusted to promote the industrial competitiveness and to improve the technology innovation capability of Chinese Hi-tech industry.

2.2.1 The evolution of government strategy on Chinese innovation system after the opening up

The development of the strategy on Chinese innovation system is an evolutionary process and is from a specific plan to a widespread setting up of innovative country. We can observe 4 stages of the development of the strategy.

The first phase is from 1978 to 1985. After the opening up, Deng Xiaoping put forward that Science and technology are primary productive forces in 1978. The second phase is from 1986 to 1994. Chinese reform on the S&T system started after 1985. Since 1985, a series of plan including Xinghuo Plan, 863 Plan, Huoju Plan, Pandeng Plan, Major research project plan and Promoting major research project plan were initiated to promote the development of some technology and 53 Hi-tech development zones were set up. The third Phase is from 1995-2005. In 1995, Jiang Zeming put forward 'The Strategy of Revitalizing China through Science and Education' on the national science and technology conference. In the May of 1998, a leading small group (LSG) on technology and education was found which indicated that China strengthened the overall direction and coordination on the development of S&T on a higher level. During this phase, the government led central planning S&T system was turning into a new system which was more related with the development of economy. The last phase is after 2006. In the February of 2006, Chinese government put forward building an innovation-oriented country in the medium-and long-term national science and technology development planning framework (2006-2020). This framework indicated that the Chinese government was trying to transfer the Chinese economy growth from resource-driven to innovation-driven.

2.2.2 The industrial policy on Chinese Hi-tech industry

In the different stages of the development of Chinese Hi-tech industry, Chinese government initiated a variety of policies to adapt to the changing of the industry. The process could be classified into three different groups. The first group is the policy on the Hi-tech industrial distribution since the

beginning of 1990s. Chinese industrial distribution policy has been implemented since the early 1990s and it is the earliest high-tech industrial policy. It focuses on the development of industrial clusters through setting up Hi-tech development zones and regulating high-tech industrial distribution. Since the publishing of the “Preferential Tax Policy on Hi-tech industry development zones” in 1991, Chinese government has established a series of policy to promote the development of Hi-tech development zones. The second group is the policy on the Hi-tech industrial organization after 1997. The most influential high-tech industry organization policy in China is the 10th Five-Year Plan (1997) which encourages the formation of large enterprise through reorganization, mergers and acquisitions. At the same time, government started to support the technology development of key industries and key enterprises by the forms of bond and funds. The last group is the High-tech industrial structure policy since 2002. In 2002, the Chinese state economic and trade commission, the Ministry of Finance, the Ministry of Science and Technology, and the State Administration of Taxation jointly issued the "national high-tech industrial policy" to promote the 7 selected priority high-tech industries. This policy included technology development policy, financial policy, export promoting policies, property rights policies, and training policies.

2.2.3 The changes of the forms of business organization and technology acquiring

Since the opening up of China in the 1980s, joint venture and private enterprises has been getting prosperously which was correlated to the government policy of property right reform and ‘market for technology’. The development of joint ventures in China is a double-edged sword. The rapid development of foreign investment enterprise stimulated the changes of the management methodology of domestic firm and promotes the development of technology. But the domestic market has lost a lot and leave very small room for domestic firm to grow up in the furious competition.

The proportion of the export of high-tech product of State owned and stated controlled enterprises (SOE and SCE) kept on decreasing after 1999, while the proportion of the export of Foreign invested enterprises(FIE, including joint venture(JV), foreign(F) and cooperative enterprises(CE)) kept on increasing. The value added of foreign invested enterprises is 646.57Billon Yuan in 2006 and the foreign invested enterprises have become the main body of the Chinese High-tech industry. Different ownerships of enterprises also have different paths of technology acquirement (Figure 1).

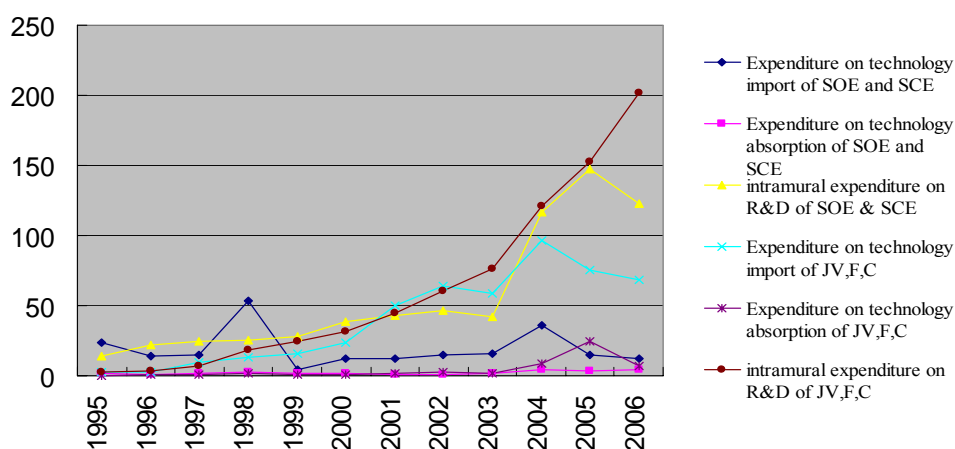


Figure 1 The Expenditures on Technology by ownership

Source of data : Chinese high-tech industry Statistical Yearbook (2002 , 2007)

2.2.4 The government promoted big firms and technology innovation

The correlation between innovation capability and size of firms is an old industry paradigm. A lot of countries try to acquire technological innovation capability by supporting big firms. The Chinese government’ policy on prior developing big firms which was put forward in the 15th CPC national congress in 1997 has affected the development of Chinese high-tech industry a lot. The industrial concentrations of Chinese Hi-tech industry after 2003 were increasing and the number of big high-tech enterprises decreased sharply from 1170 in 2002 to 266 in 2003 which was correlated to the government industrial structure policy of prior developing big firms.

3 Conclusion

The development of Chinese high-tech industry is a Coevolutionary process of technology and institution. In the past 30 years since the Chinese opening-up, the industrial policy, Innovation strategy, industrial organization, and enterprise' scale have changed a lot. The Chinese high-tech industrial policy is continuously adjusted to meet the evolution of technology innovation capability and to promote the development of Chinese Hi-tech industry. The competitiveness of Chinese high-tech industry interacts with the development of society, technology, economy, market, and other complicated background.

For most of the Chinese High-tech enterprises, the paths of the development of them were different with those countries where the first generation product or invention came into being, mostly developed countries. The well-known industry life cycle theory which Abernathy and Utterback put forward in 1978 is not suitable to the development process of the catching up of developing countries. The path of the development of Chinese high-tech industry is from process innovation to product innovation but not from product innovation to process innovation. The development of the Chinese High-tech industry is correlated with the evolution of government policy, strategy, ownership of enterprises, and technological innovation. Through the above analysis, we conjecture that the catching-up of Chinese Hi-tech industry might be the following phases (Figure 2). 'The Industry life cycle for Catching-up' might be good frameworks to understand the industrial catching-up process of developing countries.

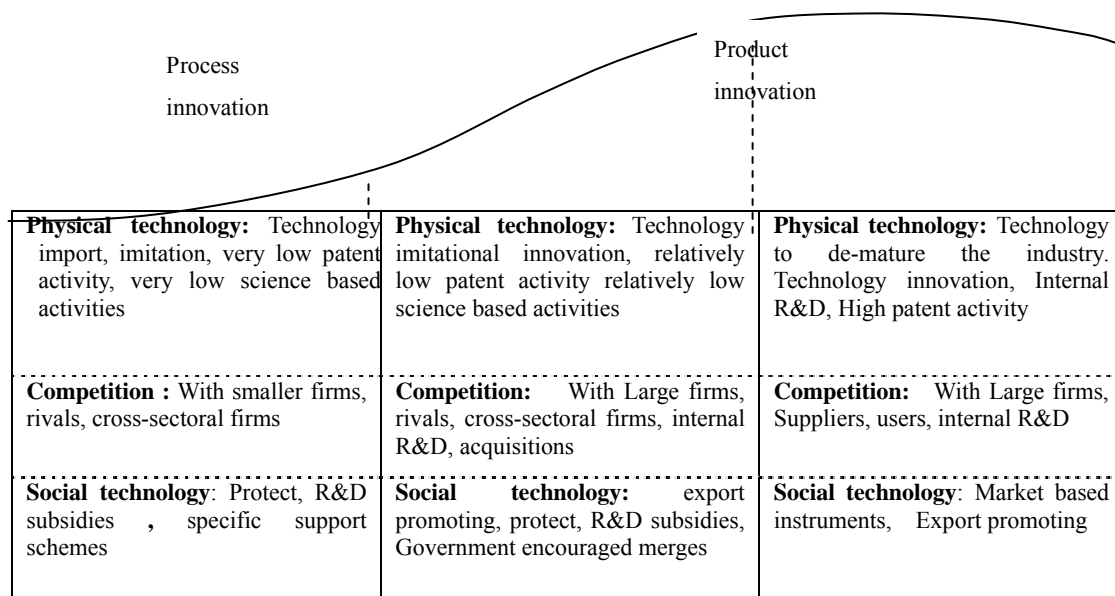


Figure 2 Industry life cycle for Catching-up

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