

## **Technology Transfer in China: Panel evidence from Chinese Large- and Medium-size Manufacturing Enterprises**

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### **1. Introduction**

Since the adoption of the Chinese economic reform in 1978, China has experienced a miraculous economic development in the past three decades. During the transit period, China observed a dramatic structural change from agriculture to manufacturing and service industries, and meanwhile an ownership shift from state-owned enterprises (SOEs) to shareholding companies as well.

Against this backdrop, the advancement of science and technology is always put in a central stage by Chinese leaders. With the rapid growth of Chinese economy, Chinese manufacturing sectors has become an important venue for in-house R&D and technology transfer for catch-up.

In light of the catch-up effect theory, in any period, the economies of countries that start off poor generally grow faster than economies of countries that start off rich. China is also no exception in catch-up. Starting with a laggard industrial foundation, China imported a large number of foreign technologies from developed economies to improve its productivity and help develop technological abilities in manufacturing sectors.

Therefore, in the context aforementioned, this paper investigates the trends and determinants of foreign

technology transfer and domestic technology purchase respectively, and policy impacts on foreign technology transfer as well in this transit period. In addition, as large as China, it is also interesting to inspect the regional disparities of technology transfer activities existing among Chinese industrial bases.

### **2. Technology transfer in China**

Since 1979, China places an emphasis on importing production technologies. Technology transfer activities have entered most active period when reform and opening policy began to be adopted in China. A large amount of technology trades were conducted according to international technology trades rules. In 1990s, China accelerated its pace of technology transfer. In particular, under the guidance of State Development through Promoting Science Technology and Education (Ke Jiao Xing Guo) policy and Technology Innovation (Zi Zhu Chuang Xin) policy, Chinese manufacturing firms consolidated international technology communication and cooperation, extended the scope of imported foreign advanced technology, and hence facilitated technology and economy development.

In the past decade, there are some emerging trends in technology transfer activities in China. (1) Not only key

equipment and production line import, more alternative types appear in technology transfer, including patent technology license, technology license and technology consultation etc. Fig.1 represents the value of contracts by types of technology imports in the period from 2004 to 2007. (2) Diversified technology suppliers. The number of economies transferring technologies to China has developed into more than 60 countries and regions from a dozen only in the beginning. (3) Easing of regulations on technology transfer. (4) Diversified funding for technology import, including government loans, commercial loans, international financial organization loans and self-raising by firms. (5) The gradual soundness of rules and laws make technology transfer activities more standard and active in China.

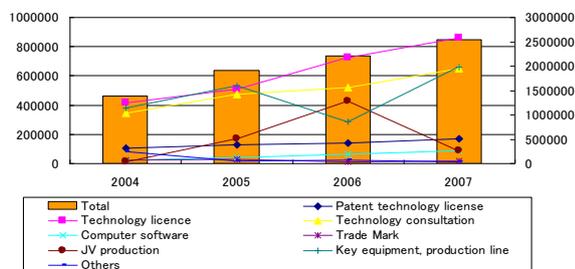


Fig.1

Regarding with domestic technology transfer, China also witnessed a steady development of its technology markets, as Fig.2 illustrates.

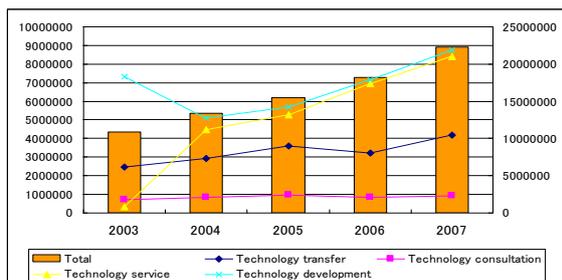


Fig.2

In terms of regulations, since the reform and opening policy implemented in the 1980s, the Chinese mainland area has maintained its technology import order mainly according to Regulations of the People’s Republic of China on Administration of Technology-Introduction Contracts, which basically speaking, was still an inadequate legal system, and laying a heavy constrain on technology import. However, in October, 2001, the Administrative Regulations on Technology Import and Export of the People’s Republic of China, a scientific and normative administrative system with the effective date of January 1, 2002, has come into shape through a loose-mixed-with-strict administrative mode of both permission and recordation in import of technology. The states encourages import of well-developed industrialize technology.

### 3. Data and trends in technology transfer

The dataset used in this paper is based on NBS’s Survey on Science and Technology Activities, an annual survey conducted for all large- and medium-sized enterprises (LMEs). The result of this survey is used as official S&T statistics in China, and the aggregated statistics are published annually as the Chinese S&T Statistical Yearbook.

Fig.3 shows the trends in number of firms engaging in foreign technology transfer (FT) and domestic technology transfer (DT) in the decade. The number of FT dropped sharply in the period from

2324 firms in 1995 to only 891 firms in 2005, while the number of DT slipped slightly, almost keeping on the same level as the beginning. Particularly, the number of firms engaging in DT surpassed those in FT for the first time in 2004, with 1309 firms versus 871 firms. It may illustrate that more and more Chinese firms opt for domestic channel to acquire technology.

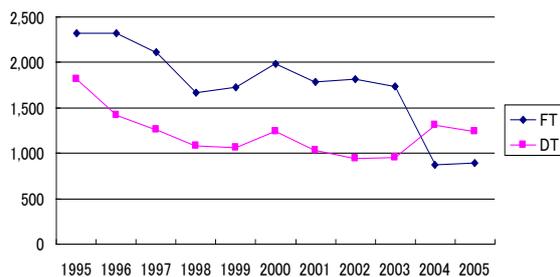


Fig.3

Fig.2 shows the trends in the mean value of amount invested in FT and DT by firms. While the mean value of FT and DT kept flat before 2000, the growth had become evident since then. Under the background of SOEs reform and easing of technology import regulations in China, technology transfer has been converged to a portion of active firms with high incentives and specific capability compared with the period in which firms conducted technology transfer passively in the central planning system.

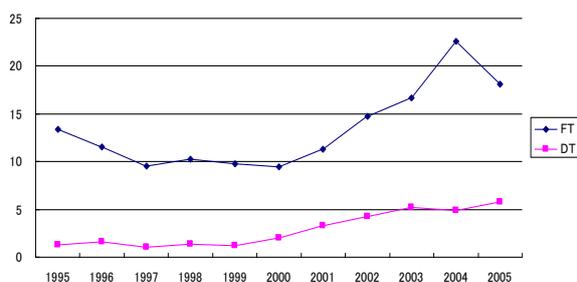


Fig.4

This may be attributed to SOEs

Ownership Reforms and on-going easing of the regulations on technology import in China. Ownership Reforms eliminated SOEs and Collective outliers carrying out an unreasonable rate in foreign technology transfer but with low performance. On the other hand, the regulation easing gave a portion of firms with high motivation and also specific capability more incentives to conduct foreign technology transfer more actively as supposed to the ear of central planning. Besides, foreign technology transfer activities in high-tech industries lagged behind both in the number of firms engaging and in the amount invested, compared with medium and low tech industries.

In terms of domestic technology transfer, there are upward trends in domestic technology transfer activities in China. Not only did the mean value of amount invested in domestic transfer increase gradually in the decade, but also in 2004 the number of firms engaging in domestic technology transfer surpassed that of firms conducting foreign technology transfer for the first time. Moreover, among firms conducting foreign technology transfer, more and more firms set out to acquire external technology from domestic counterparts, which could be validated from the perspective of both the number and the amount.

#### 4. Regression model

In order to further investigate factors behind the trends in foreign technology transfer, a regression analysis is

conducted. In this section, two types of gauge indicators are used as a dependent variable. One is a qualitative variable, whether a firm conducts foreign technology transfer (yes=1 and no=1). The other one is an intensity indicator, the ratio of foreign technology transfer amount to sales. The former variable shows what extent foreign technology transfer become popular in the target population, while the latter one represents how intensive a firm invests in foreign technology transfer. A list of independent variables is presented in Table 1. There are two motivations for the analysis. First, it is interesting to see whether foreign technology transfer is positively correlated with intramural R&D. The absorptive capacity hypothesis suggests positive relation between foreign technology transfers with in-house R&D, which boosts the firms' absorptive capacity. Besides, it also makes sense to investigate whether the level of absorptive capacity, with the ongoing easing of the regulations on technology import in China, has become a critical factor for firms to make decisions on foreign technology transfer, as opposed to the past central planning cases in which the government played an important role.

Table 1 Regression Model

Dependent Variable	Independent Variable	Definition
FT Qualitative (Probit: Yes:1 No:0)	lnemp	log of number of employees
	lncap	log of capital amount

FT Intensity (Tobit: FT/Sales)	lnrdin	log of R&D stock
	lnage	log of firm age
	stnew_r	ratio of NP to total S&T
	stuemp_r	ratio of undergraduate degree to total S&T staff
	rdbasic_r	ratio of basic and applied R&D to total R&D
	ownership dummies	dummy variable
	province dummies	dummy variable
	industry dummies	dummy variable

First, the positive relationships between R&D and foreign technology transfer are found both in qualitative variable and intensity variable regression all the years, verifying the complementary relation between the two. Hence, it can be concluded that absorptive capacity is important in deciding whether to conduct foreign technology transfer, and a firm with large scale R&D also tends to conduct technology transfer with heavy intensity. Besides, in terms of chronological comparison, the value of positive coefficients to the qualitative variable increases over time. Due to market-based economic reform and the gradual easing of the regulations on technology import in China, with government intervene becoming dim, the absorptive capacity factor has become more dominant and critical over time to firms planning to conduct foreign technology transfer. In terms of dummy variables of firm's ownership structure, some positive and

statistically significant coefficients are found in share holding companies, as expected. This finding suggests that market-based economic reforms improve incentive structure of innovation.

Regression analysis above, also including a large number of existing relevant studies, regards China as a whole to conduct empirical analysis. However, in a country as large and technologically heterogeneous as China, it is very interesting to put a closer eye to inspect the disparities among the regions. Consequently, an investigation on foreign technology transfer based on Chinese large four industrial bases is conducted, attempting to find out some different characteristics of foreign technology transfer activities among the four industrial bases.

Chinese large four industrial bases are made of northeast industrial base, capital industrial base, Yangzi Delta industrial base and Pearl Delta industrial base, located along the coastal area stretching from Northern China to Southern China.

By using the same model as above, regression analysis is conducted to further investigate the trends of foreign technology transfer activities in each region, and the differences existing among the four industrial bases. The same regression model as above is employed again but on a regional basis.

First, a complementary relationship in both qualitative and intensity regression between foreign technology transfer and in-house R&D is found only in Yangzi Delta area. Besides, in terms of dummy

variables of industry types, also in Yangzi Delta area, positive and statistically significant coefficients are found in high tech industries in 2003, as is expected. In addition, regarding with dummy variables of firms' ownership structure, positive and statistically significant coefficients are found in shareholding companies in Pearl Delta area. It may be translated that Pearl Delta area, a non-government economy booming region and not so deeply influenced by central planning system, has a better incentive structure of innovation through technology transfer.

In fact, neither complementary relationship nor significance in shareholding companies can be observed in Capital and Northeast area. It may be due to the shortage of market mechanisms in Northern China, where state-owned enterprises hold the majority and dominate the economic rules, which depict a stark comparison with Yangzi Delta and Pearl Delta area in Southern China, where on the contrary market-based economy is relatively easy to be accepted and executed.

In order to further investigate the factor behind the upward trend in domestic technology transfer activities, another regression analysis is conducted here. A simplified version of the previous model for foreign technology transfer is constructed, as Table 2 shows.

Table 2 Regression Model

Dependent Variable	Independent Variable	Definition

DT Qualitative	Inemp	log of number of employees
	Incap	log of capital amount
	Inrdin	log of R&D stock
DT Intensity	Inspl_pro_sctr_ex	log of R&D spillover
	year dummies	dummy variable
	ownership dummies	dummy variable

a positive and significant correlation between domestic technology transfer and inter-industry technology spillover is found in both qualitative and intensity regression, as expected. Hence, it comes to the conclusion that Chinese firms tend to acquire external technology within the close area and from different industries to complement their own technology. In addition, complementary relation between domestic technology transfer and R&D appears again, which represents that absorptive capacity is also important in conducting domestic technology transfer.

Based on the above regression result, it is interesting to further investigate domestic technology transfer activities in the perspective of industry. In order to inspect whether or not technology spillover effect still holds in high, medium and low industry, a regression analysis based on every industry type is conducted by means of the same model as above.

First, only high tech industry holds a positive and significant correlation between domestic technology transfer and inter-industry technology spillover, neither medium tech nor low tech industry. It may be translated that firms in high

tech industry are more actively engaging in domestic technology transfer activities. It is important for a high tech firm to acquire some technologies from medium or even low tech industry as a foundation to conduct further R&D or production in high tech industry.

## 5. Policy implications

First, the technological capability of firms is still relatively low in China. Therefore, it is critical to consider improving the technology level of Chinese firms so as to fill the technological gap between China and developed countries. On the other hand, the easing and flexibility on regulations are also very essential to buildup an efficient environment for foreign firms to transfer their technologies to China, and for Chinese counterparts to conduct technology transfer. Besides, the dynamism of foreign technology transfer in southern areas indicates that it is wise to further roll out the reform in northern China, where state-owned enterprises prevail. Last but not least, with the improvement of technological capability, domestic technology transfer is becoming an important alternative for Chinese firms to acquire external technologies. Hence, the establishment of a mature and healthy domestic technical market is set out to be indispensable for firms engaging in domestic technology transfer.

