

## Shortage of High- Skilled Technical Personnel, FDI and Protection of Intellectual Property Rights in China

**Jingchao Dai**

**Lucong Wang**

PhD Candidate

School of Economics

Central University of Finance and Economics

Shahe Higher Education Park, Changping District

Beijing China

**Abstract:**

*This paper analyzes the shortage of China's high-skilled technical personnel from the perspective of intellectual property rights protection. From a macro perspective, it points out that enterprises often introduce advanced technologies from multinational enterprises through foreign direct investment (FDI). And then through the learning effect and spillover effect of foreign advanced technology, enterprises strengthen the internal training of highly skilled technical personnel. FDI will be affected by the intellectual property protection system, so the cultivation of high-skilled technical personnel by enterprises in this way will also be restricted by intellectual property protection. This paper also puts forward how to avoid the adverse effects of the intellectual property protection system in the internal training of high-skilled technical personnel.*

**Keywords:** High-skilled Technician; Intellectual Property Rights; FDI; China

**1. Introductions**

The technical level of national vocational qualification includes senior engineer technician and senior technician. These three types of talents all belong to high-skilled technical personnel, which are also called senior blue-collar. As shown in Table 1, in the 21 years from 1996 to 2015, 230 million people in China participated in vocational skill appraisal. Among them, the proportion of highly skilled technical personnel participating is one fifth, including 40 million senior engineers, 6.7 million technicians and 1.7 million senior technicians.

**Table 1 The Situation of China's High-skilled Technical Personnel Participating in Vocational Skill Appraisal and Assessment<sup>1</sup>**

Year	The Number of People Participating in the Vocational Skill Appraisal and Assessment (Ten Thousand)				
	Total	Senior Engineers	Technicians	Senior Technicians	Proportion of High-skilled Technicians
	23246.53	3979.26	666.69	168.95	20.7%
2015	1894.12	400.61	65.96	20.98	25.7%
2014	1854.00	393.08	65.44	27.51	26.2%
2013	1838.57	351.47	57.78	18.54	23.3%
2012	1830.55	347.66	50.31	17.58	22.7%
2016	1755.48	385.56	57.71	17.14	26.2%
2011	1745.93	309.85	42.82	9.88	20.8%
2010	1657.55	272.21	45.38	9.90	19.8%
2009	1492.08	212.60	54.42	11.00	18.6%
2008	1337.47	202.92	40.37	7.90	18.8%
2007	1223.14	190.77	44.27	6.96	19.8%
2006	1182.16	190.93	43.24	6.54	20.4%
2005	957.74	145.68	29.06	5.45	18.8%

<sup>1</sup> Data Source: China Labor Economy Database

2004	881.28	123.71	21.59	4.97	17.1%
2003	687.54	96.95	9.67	0.91	15.6%
2002	661.90	96.54	6.94	0.65	15.7%
2001	534.80	64.56	6.77	0.56	13.4%
2000	442.19	50.57	4.38	0.30	12.5%
1999	367.87	36.90	4.53	0.48	11.4%
1998	319.42	27.89	5.18	0.73	10.6%
1997	314.18	42.76	3.95	0.47	15.0%
1996	268.57	36.05	6.91	0.53	16.2%

As shown in Table 2, during the 21 years from 1996 to 2015, nearly 200 million people obtained occupational skill certification. Among them, the proportion of highly skilled technical personnel was 18.9%, including 31 million senior engineers, 4.4 million technicians and 1.2 million senior technicians.

**Table 2 The Situation of China's High-skilled Technical Personnel Obtaining Vocational Skills Certification<sup>2</sup>**

Year	The Number of People Obtaining Vocational Skills Certification (Ten Thousand)				
	Total	Senior Engineers	Technicians	Senior Technicians	Proportion of High-skilled Technicians
	19376.65	3095.28	440.66	117.74	18.9%
2015	1539.23	309.22	41.64	13.67	23.7%
2014	1554.28	311.77	42.90	19.43	24.1%
2013	1536.67	272.85	37.61	12.36	21.0%
2012	1548.78	276.06	33.62	13.09	20.8%
2016	1446.15	296.37	35.06	11.62	23.7%
2011	1482.05	246.43	28.68	7.17	19.0%
2010	1392.94	209.74	31.67	7.16	17.8%
2009	1232.01	151.64	33.66	8.13	15.7%
2008	1137.21	160.65	31.80	6.33	17.5%
2007	995.61	142.92	27.42	4.66	17.6%
2006	925.24	144.06	26.08	3.54	18.8%
2005	785.73	113.33	19.56	3.91	17.4%
2004	737.56	98.25	14.38	3.67	15.8%
2003	583.92	76.89	6.95	0.62	14.5%
2002	556.26	76.12	4.89	0.34	14.6%
2001	457.01	52.30	4.97	0.35	12.6%
2000	372.66	39.32	3.42	0.23	11.5%
1999	314.14	29.36	3.67	0.32	10.6%
1998	285.88	24.45	4.50	0.60	10.3%
1997	278.64	36.40	3.05	0.30	14.3%
1996	214.69	27.13	5.13	0.23	15.1%

Statistics from the Ministry of Human Resources and Social Security show that in 2017, 170 million skilled workers were employed in China, accounting for 20 percent of the total employment, of which more than 50 million were highly skilled technicians, accounting for far less than 10 percent of the total employment. In 2017, there were less than 2 million R&D personnel in large and medium-sized industrial enterprises, including 600,000 R&D personnel in high-tech industries. The situation of R&D personnel in China's large and medium-sized industrial enterprises and high-tech industries is shown in Table 3. In addition, in terms of market supply and demand, the recruitment ratio of Chinese skilled workers, that is, the number of jobs/job seekers, remains above 1.5:1, while that of senior technicians is as high as 2:1.<sup>3</sup>

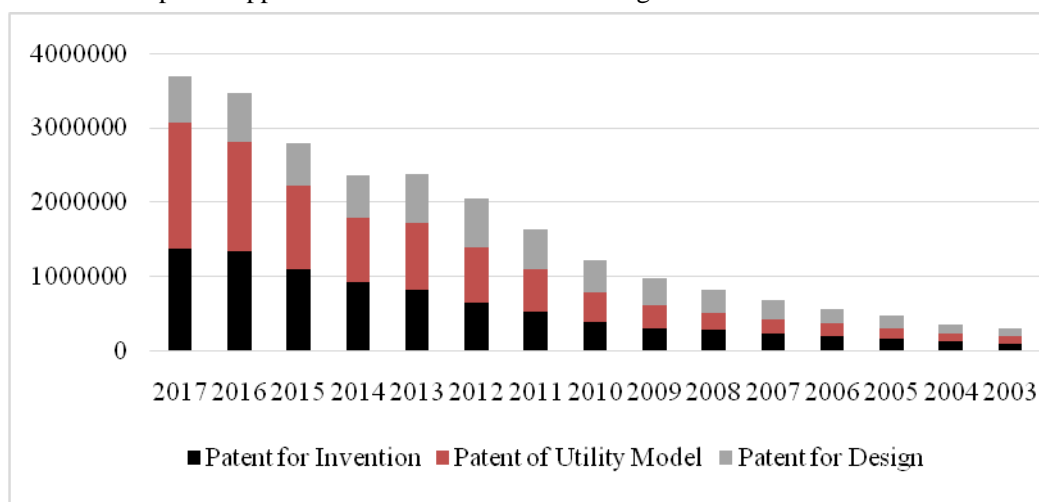
<sup>2</sup> Data Source: China Labor Economy Database

<sup>3</sup> Data source: Xinhua News Agency

**Table 3 The Number of R&D Personnel in Large and Medium-sized Industrial Enterprises and High-tech Industries (Full-time Equivalent)<sup>4</sup>**

Year	Large and Medium-sized Industrial Enterprises	High-tech Industries (Diameter Standard : Large and Medium-sized Industrial Enterprises)
2017	1931419	590300
2016	1964441	580200
2015	1985983	590000
2014	2037661.2	573000
2013	1976735.7	559000
2012	1818585	526000
2011	1587164.6	426700
2010	1369908.31	399100
2009	1158839	320000
2008	1014223.11	285100
2007	857649.74	248200
2006	695668.23	189000
2005	606376.22	173200
2004	438164.94	120800
2003	478066	127800

Therefore, the problems about the shortage of senior skilled workers, such as insufficient quantity, poor structure, team fault, contradiction between supply and demand, and so on, appear and have a growing tendency. Highly skilled technical personnel are not only simple manual laborers, but creators of knowledge labor. With the gradual strengthening of knowledge productivity, the intellectual property protection system has been established and improved to further protect the ownership of knowledge labor and stimulate the enthusiasm of enterprises and intellectual workers for continuous research and innovation. Intellectual property right is the right of the holder to enjoy the fruits of his intellectual labor. It is an intangible asset and has a time limit for protection. In working practices, highly skilled technical personnel also create knowledge and form intellectual property rights, especially patented technology. By the end of 2017, China had received nearly 3.7 million patent applications, of which nearly 1.4 million were for inventions, 1.7 million for utility models and more than 600,000 for designs. By the end of 2017, large and medium-sized industrial enterprises had applied for nearly 500,000 patents, including nearly 160,000 patents for high-tech industries. The acceptance of various patent applications in China is shown in Figure 1.

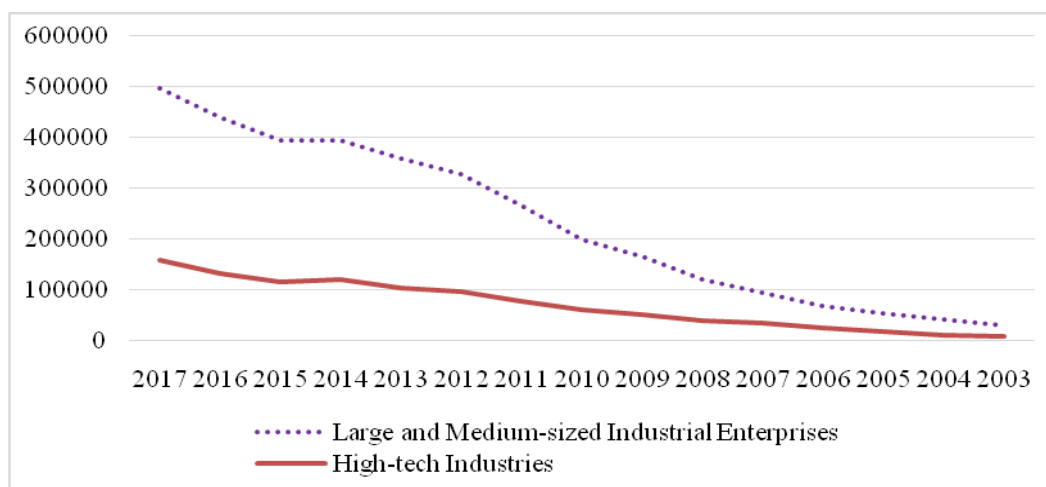


**Figure 1 The Acceptance of Various Patent Applications in China<sup>5</sup>**

<sup>4</sup> Data Source: National Bureau of Statistics

<sup>5</sup> Data Source: National Bureau of Statistics

And the patent applications of large and medium-sized industrial enterprises and high-tech industries are shown in Figure 2.



**Figure 2 Patent Applications of Large and Medium-sized Industrial Enterprises and High-tech Industries in China<sup>6</sup>**

## 2. Internal Training of High- skilled Technical Personnel in Enterprises

The shortage of senior technicians is mainly reflected in that with the continuous change of technology and equipment as well as the continuous improvement of business complexity, enterprises are increasingly short of professional composite technicians with high quality and high technology. They should be proficient in technology, participate in research and development, and do a good job after sales (Qin D.J. and Liu R.H.2015). Enterprises often introduce advanced technologies from multinational enterprises through foreign direct investment (FDI) (Chen G.H. and Guo T.,2008; Yao L.M. and Rao Y.,2009). And then through the learning effect and spillover effect of foreign advanced technology, enterprises strengthen the internal training of highly skilled technical personnel (Qin D.J. and Liu R.H.2015). As shown in Table 4 and Figure 3, the level of FDI and foreign technology import in China is increasing year by year. This means that domestic enterprises have more frequent links and closer technical exchanges with foreign enterprises, then have broader training space for highly skilled technical personnel.

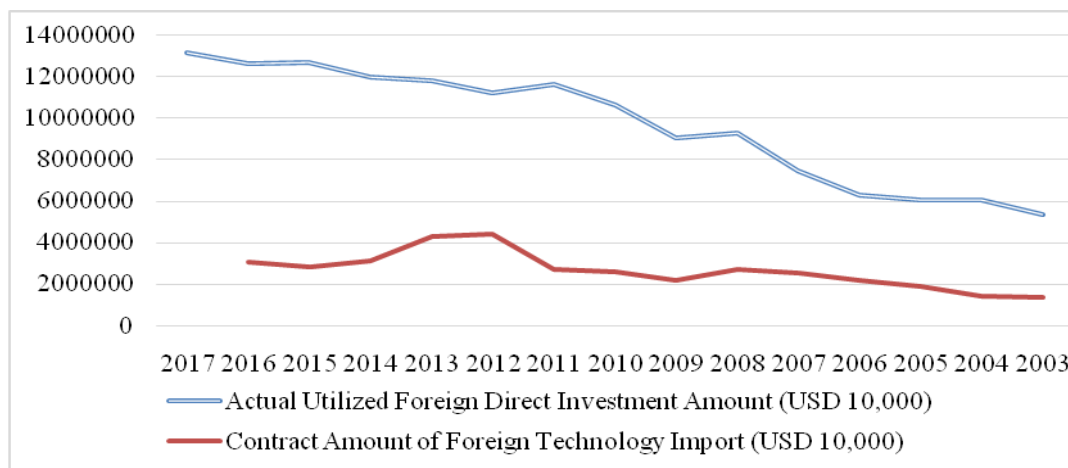
**Table 4 Situation of FDI and Foreign Technology Introduction<sup>7</sup>**

Year	Actual Utilized Foreign Direct Investment Amount (USD 10,000)	Contract Amount of Foreign Technology Import (USD 10,000)
2017	13,103,500	
2016	12,600,100	3,072,800
2015	12,626,700	2,815,388
2014	11,956,200	3,108,481
2013	11,758,600	4,336,413
2012	11,171,600	4,427,370
2011	11,601,100	2,696,812
2010	10,573,500	2,563,557
2009	9,003,300	2,157,179
2008	9,239,500	2,713,347
2007	7,476,800	2,541,535
2006	6,302,100	2,202,323
2005	6,032,500	1,904,303
2004	6,063,000	1,385,558
2003	5,350,500	1,345,121

<sup>6</sup> Data Source: National Bureau of Statistics

<sup>7</sup> Data Source: National Bureau of Statistics; China Science and Technology Database

In this way, through long-term cooperation and exchanges with leading multinational brands and enterprise, domestic companies can make full use of the opportunities of close cooperation and encourage skilled workers to absorb new knowledge and learn new skills, especially those tacit knowledge that is closely related to an individual's actual or practical experience and must be acquired through long face-to-face communication (Qin D.J. and Liu R.H.2015). So that the domestic enterprise high - skilled technical personnel master the world - class advanced technology. This will provide a more diverse and comprehensive promotion channels for highly skilled technical personnel. It is of great significance to increase job attraction, improve employee satisfaction, improve talent innovation and alleviate the shortage of high-skilled personnel. However, the internal training mode of enterprises can also be affected by the intellectual property protection system.



**Figure 3 Situation of FDI and Foreign Technology Introduction in China<sup>8</sup>**

### **3. The Influence of IPR Protection on Internal Training of High-skilled Technicians**

FDI, as the main channel for transnational cooperation and foreign technologies introduction, will be restricted and affected by the intellectual property protection system. The establishment and the strength of the intellectual property protection system have become the key factors for foreign enterprises to decide whether and how to make outbound investment. There are many domestic and foreign studies on the impact of intellectual property protection on a country's FDI inflow, but the research conclusions are not uniform.(Markus,1995;Maskus,1998; Fink and Braga,2001; Yang Q.F. and Han Y.,2006; Yu C.L. and Wang R.F.,2009) Among them, the argument that intellectual property protection has an inverted u-shaped relationship with FDI inflow has a strong comprehensive and realistic explanatory power, that is, appropriate intellectual property protection system is conducive to FDI inflow, but too strong intellectual property protection will hinder FDI inflow. Therefore, the strength of the intellectual property protection system will affect the flow direction and flow quantity of FDI, further affect the technology introduction level of domestic enterprises and the depth and breadth of contacts with foreign advanced enterprises or advanced technologies, and also affect the opportunities and channels for the internal promotion and training of enterprises' high-skilled technical personnel.

Of course, in addition to FDI, enterprises can also strengthen the contact and exchange with the world's advanced enterprises through other ways, and encourage senior technical personnel to learn, imitate and innovate. Regardless of the mean, the intellectual property protection system will have a similar impact to FDI. If the intellectual property rights cannot be effectively protected, leading transnational enterprises will carry out technology research with protective nature to protect intellectual property rights and safeguard their own interests. That means reducing the quantity and quality of transferred technology, reduces the willingness to export advanced technology, thus narrowing the channels of foreign technology introduction and reducing the opportunities to learn and imitate advanced technology for domestic companies. However, the over-strong intellectual property protection system is essentially protecting the market monopoly interests of the patentee or the multinational corporation. Then in turn, the intellectual property protection system is used to prohibit others from using the knowledge resources, thus hindering the technology dissemination and diffusion, and further inhibiting the introduction, absorption, transformation and application of foreign advanced technology by enterprises in developing countries and their highly skilled technical personnel.

<sup>8</sup> Data source: National Bureau of Statistics; China Science and Technology Database

As shown in Figure 4 and Figure 5, China is the world's factory, and the number of foreign patent applications is increasing day by day, but compared with the number of domestic patent applications in China and the number of foreign patent applications in other intellectual property powers, the gap is disproportionate and huge.

In this way, the intellectual property powers occupy the patent market of other countries in a large scale, which squeezes the patent application space of high-skilled technical personnel in other countries, thus hindering patent application or even making it difficult to go ahead. In addition, the foreign patentee may also obtain a monopoly position in the market by virtue of his or her patent, thus no longer following the patent-related principles such as locality or exhaustion of rights. The unreasonable refusal of legitimate domestic patent license requests, or the setting of unreasonable patent license fees, will lead to the infringement of the rights and interests of the domestic highly skilled technical personnel while grabbing excessive monopoly profits. (Yao L.M. and Rao Y.,2009)

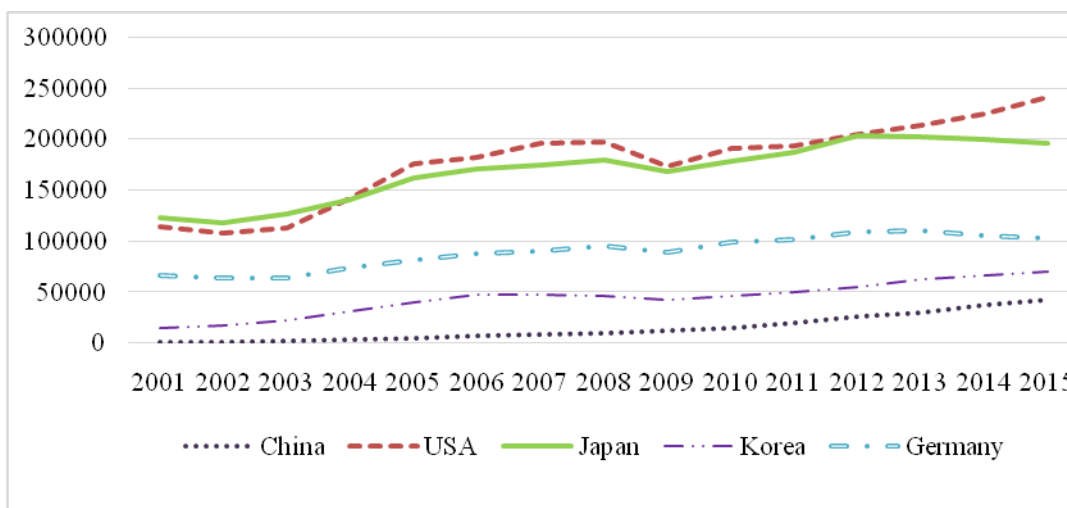


Figure 4 Number of Foreign Invention Patent Applications in the Five Countries<sup>9</sup>

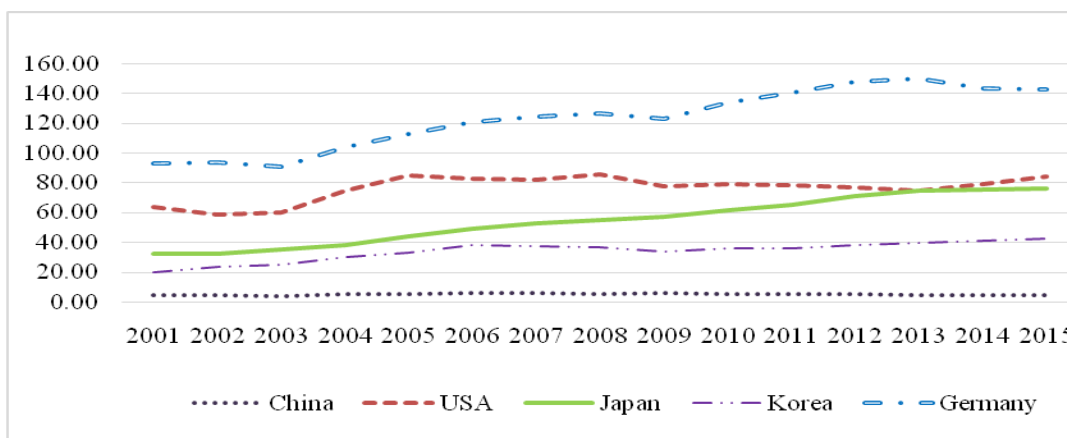


Figure 5 Number of Foreign Invention Patent Applications for Every 100 Domestic Invention Patent Applications in the Five Countries<sup>10</sup>

#### 4. How to Avoid the Adverse Effect of IPR Protection System

The influencing mechanism of intellectual property protection system on the cultivation of high-skilled technical personnel in enterprises is uncertain. Whether the system is reasonable is the standard of measurement. For enterprises, on the basis of respecting intellectual property rights, they should broaden the ways, methods and channels for

<sup>9</sup> Data Source: [http://www.sohu.com/a/160545472\\_221677](http://www.sohu.com/a/160545472_221677)

<sup>10</sup> Data Source: [http://www.sohu.com/a/160545472\\_221677](http://www.sohu.com/a/160545472_221677): German foreign patent applications include applications at the European Patent Office (EPO), so the number of domestic patent applications is lower than the number of foreign patent applications.

technical talents to learn, absorb, imitate and innovate advanced technologies, so as to avoid excessive reliance on transnational enterprises and technologies.

They should also rely on the enterprise's own strength to improve the internal training and incentive mechanism, constantly stimulate the creation and innovation potential of high-skilled technical personnel, and constantly improve the skill level and technical level of the enterprise's internal technical workers. In addition, enterprises or highly skilled technical personnel should appropriately shift their attention to overseas patent applications. At the same time, if technology introduction and innovation are infringed or hindered by intellectual property monopoly, such as being sued for unreasonable patent infringement, enterprises should face, respond and counterclaim actively. And also Identify unnecessary patent, duplicate patent or invalid patent, striving to protect their legitimate rights and interests.

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