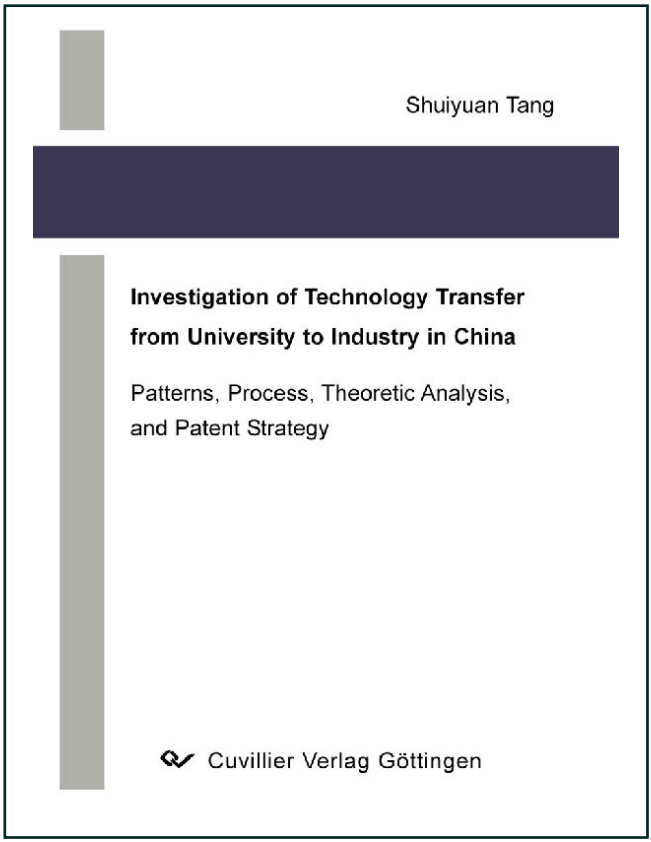
Shuiyuan Tang (Autor)

Investigation of Technology Transfer from University to Industry in China

Patterns, Process, Theoretic Analysis, and Patent Strategy



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1. Introduction

University technology transfer emerged in the mid-1800s in American universities,[1] referring to the movement of research results, primarily of intellectual property rights (IPRs) from university to industry. It has played important roles in economic growth and technological innovation in industry, both in developed and developing nations. It has become a part of technology policy in western countries, particularly in the United States of America recently.[2]

University technology transfer in China became well recognized by both industry and universities during the 1990s. Since the reform and opening up in 1980s, China has experienced long-term, high-speed economic growth and stable progress in science and technology development. Study of China's economic growth, technological development, and the relationship between the two is a hot topic both domestically and internationally. The economic growth creates a historical opportunity for China's universities to get well-equipped for research and development (R&D). In the last two decades, the Chinese government carried out a series of programs, including Project 211 in 1995 and Project 985[3] in 1998, to strengthen uni-

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[1] H. Norman Abramson, et al. Technology Transfer Systems in the United States and Germany. Washington, D.C.: National Academy Press, 1997, p96.

[2] Wei Lu. Intellectual Property Right System Challenge and Countermeasure. Beijing: Intellectual Property Publishing House, 2004, p173.

[3] Project 211 is the Chinese government's new endeavor aimed at strengthening about 100 universities and their key disciplinary areas as a national priority for the 21st century. The figure of 21 and 1 within 211 are from the abbreviation of the 21st century and approximate 100 universities respectively. Project 211 is an important measure taken by the Chinese government in its effort to facilitate the development of higher education in the context of the country's advancement in social and economic fields, primarily aiming at training high-level professional manpower to implement the national strategy for social and economic development. The project currently involves 106 universities. Project 985 is a constructive project for the founding of world-class universities in the 21st century conducted by the government of the People's Republic of China. It was initiated in May 1998 and currently involves 38 universities.

versity competence nationwide. China's universities have made considerable progress in R&D. They are credited to be the cradle of highly-qualified innovative talents, the frontier of R&D, and the important power of knowledge creation and technology transfer. As China's enterprises on the whole are commonly deficient in R&D compared to those of western countries, technology transfer from university to industry is an important channel of support for industrial innovation. Although a significant contribution to China's economic growth, this implicit force is often neglected in discussions of China's economic growth.

1.1 The Subjects

Science and technology (S&T) became the major driving force of economic growth early in the 20th century. According to the statistics from the World Bank, S&T contributed 49% to economic growth of the world from the 1950s to the 1970s. In some nations, this figure was as high as 60-70%. In the late 20th century, S&T contributed 60-80% to economic growth in developed countries, while in China the rate was 30.1%.[4]

The Chinese government realized the importance of S&T in contributing to economic growth in the early 1980s and has taken measures to improve China's S&T level. For example, the Chinese government has increased the S&T budget steadily during the last decade. The gross domestic expenditure on S&T (GEST) reached RMB 483.6 billion, about 6 times of that of 1995, 2.64% of gross domestic product (GDP) in 2005. The gross domestic expenditure on R&D (GERD) comprised more than half of the GEST. Table 1.1 and Figure 1.1 show expenditures on R&D and S&T from 1995 to 2005. According to the statistics compiled by the Ministry of Science and Technology of China, during the 10th Five-year plan (FYP, 2001-2005), the number of full-time personnel engaged in basic research in China rose from 78,800 in 2001 to 115,400 in 2005, a jump of 46.5%.

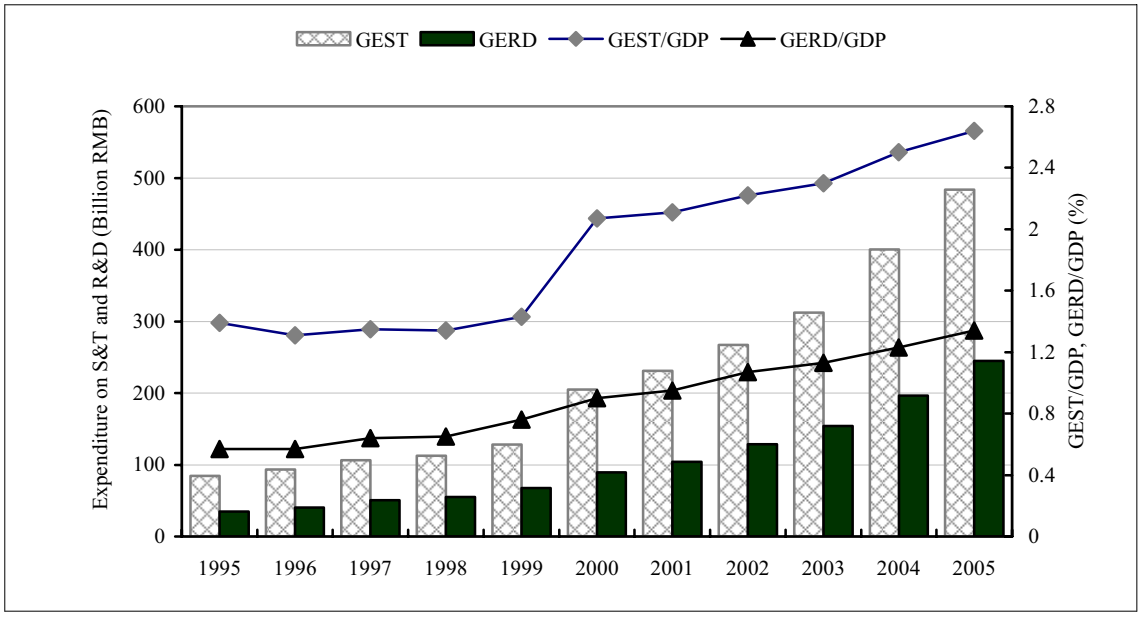
[4] Fangge Li, Senwan Shao. General introduction of industry-university cooperation. Chengdu: Sichuan University Press, 1995.

Table 1.1 China's expenditures on S&T and R&D during 1995-2005

Year	GEST (Billion RMB)	GEST/GDP (%)	GERD (Billion RMB)	GERD/GDP (%)
1995	84.7	1.39	34.9	0.57
1996	93.7	1.31	40.4	0.57
1997	106.6	1.35	50.9	0.64
1998	112.8	1.34	55.1	0.65
1999	128.5	1.43	67.9	0.76
2000	205.0	2.07	89.6	0.90
2001	231.3	2.11	104.2	0.95
2002	267.2	2.22	128.7	1.07
2003	312.2	2.30	154.0	1.13
2004	400.4	2.50	196.6	1.23
2005	483.6	2.64	245.0	1.34

Source: the Ministry of Science & Technology of China.

Figure 1.1 China's expenditures on S&T and R&D during 1995-2005



Source: the Ministry of Science & Technology of China.

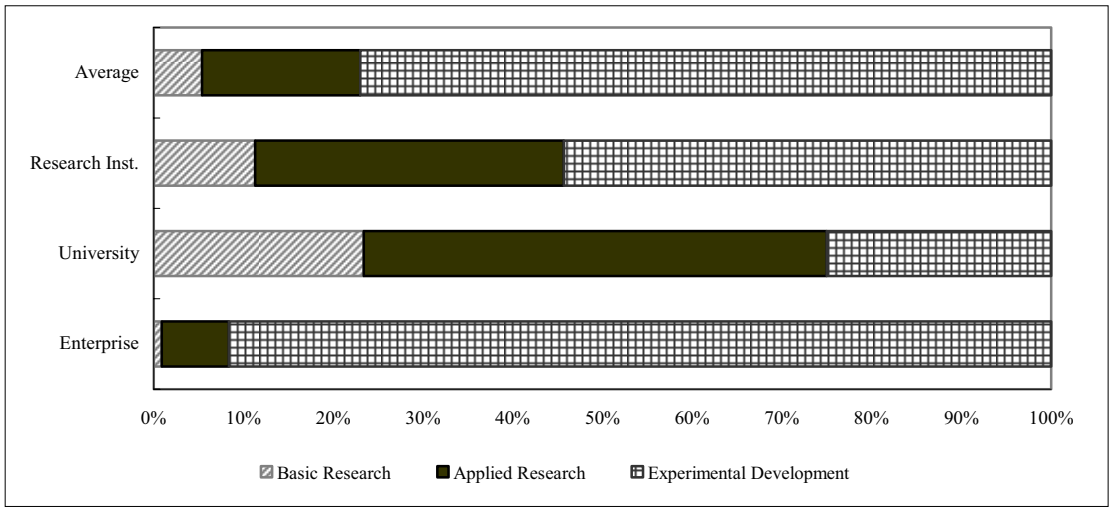
With the rapid increase of national R&D budget, China's universities experienced high-speed growth, particularly in R&D, during the last two decades. They have become a leading force in the development of national S&T, spearheading far ahead all other institutions in terms of scope and scale of R&D activities, R&D achievements and public reputations. In essence, a university becomes an academic institution to create, spread, and preserve knowledge, dedicating significantly in offering well-qualified talents and pursuing technology transfer. Linking technology with market, university technology transfer is not only a process of academic approach commercialization but also an academic process with characteristics of industrialization. It's a typical process of technology innovation in accordance with the theory of Joseph Alois Schumpeter[5], who defines technology innovation, in his book *Theory of Economic Development*, as the resetting of the production elements. There are five forms of innovation according to Schumpeter's theory, which are importing a new product, pioneering a new market, finding a new source of raw material, inventing a new manufacturing process, and adopting a new organizational form of enterprise.

As centralized, multi-disciplinary institutes with high-quality personnel, China's universities participate in a wide range of R&D programs, publicly and privately, producing a large number of patents and technological secrets which are vital for industrial competitiveness and technological progress. We will find in chapter 2 that applied research and experimental development make up more than 75% of total university R&D activities in terms of R&D funds (see Figure 1.2). Most of university R&D achievements result from applied research and experimental development. They may be commercialized by the universities themselves or by enterprises off

[5] Joseph Alois Schumpeter (1883–1950), Austrian-American economist. He was professor of economics at the University of Graz from 1911 to 1914 and at Bonn from 1925 to 1932, when he went to the United States. Thereafter, he was professor of economics at Harvard. He served (1919–20) as Austrian Minister of Finance. His major contributions to economics were the theory of the entrepreneur as the dynamic factor in fostering the business cycle and the theory of economic development of capitalism. His most important books are *Theory of Economic Development* (1911, in German *Theorie der wirtschaftlichen Entwicklung*; translated in 1934), *Business Cycles* (1939), *Capitalism, Socialism, and Democracy* (1942, 3d ed. 1950), and *History of Economic Analysis* (1954).

campus. Finally, university R&D achievements are transformed from technological secrets or patents in university laboratories or R&D centers to products or services in the market. Since the unexpected emergence of university-owned scientific and technological enterprises (S&T enterprises), such as Founder Group (Peking University), Tsinghua Tongfang Co. Ltd (Tsinghua University), Neusoft Group (Northeastern University) etc., China's universities have engaged in commercialization directly and contributed significantly to industry's progress in technology development and competitiveness. China's universities received recognition as the synonym for the most advanced technologies then. Technology transfer from university to industry in China is generally thought to be a major approach for revitalizing science, technology and the economy. In particular since 1998, the excellent performance of the publicly listed university-owned companies has made technology transfer from university to industry in China a hot topic in the media and the society both domestically and abroad, helping promoting the concept of university R&D and university technology transfer deeply in the hearts of Chinese people. Consequently, the university-owned S&T enterprise became the "bellwether" of high-tech and emerging technology industries in China.

Figure 1.2 Fractions of three R&D activities in China 2005



Source: the Ministry of Science & Technology of China.

As a result, technology transfer from university to industry has become a key characteristic of research universities.[6] The Ministry of Education of China proposes that technology transfer from university to industry be one of the three major tasks of a university, as equally important as teaching and scientific research. At present, thanks to the trend that many enterprises and investment companies are seeking scientific and technological cooperation with universities, technology transfer from university to industry in China has become increasingly a brisk business.

However, only a small part, merely 10-15%, of university R&D results have been commercialized or applied in China, indicating the difficulty of technology transfer from university to industry. In developed countries, the commercialization rate of university R&D results is about 30%, while the USA and Japan have reached 80% in some periods.[7] A report by the Ministry of Education of China showed that there were nearly 8,000 scientific and technological achievements made by China's universities each year, but only about 2,000 achievements were applied or commercialized. It indicates that technology transfer from university to industry still has immense potential of development in China.

Based on above discussion, we may conclude that technology transfer from university to industry in China is a very important factor for understanding China's long-term high-speed economic growth. Unfortunately, no book or dissertation has been published currently to provide a comprehensive approach to this topic. As analyzed in literature review that follows, only several treatises relating to China's university technology transfer are published with discussions on limited aspects of this topic. A comprehensive study on China's university technology transfer becomes now necessary and important to provide a panoramic picture of technology transfer from university to industry in China including the university R&D system, the basic patterns of technology transfer, the patenting system in China's uni-

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[6] Qinping Zhao. Taking Our Own Way to Research Universities. China Higher Education, 2003(15-16):4.

[7] Jingwen Gong. Innovation, the permanent topic of the S&T development in university. Science and technology Review , April 14, 2005.

versities, and technology transfer related IPRs protection. A comparative study of university technology transfer in China and Germany is particularly valuable for researchers in both China and Germany to understand each other with respect to university R&D system, university-industry relationship, and structure of university technology transfer.

1.2 Literature Review

There are many references to university technology transfer, including books, papers in journals and proceedings. A search in Elsevier ScienceDirect with term "technology transfer" within title or keywords yields 1828 articles, of which 52 articles are relate to university technology transfer with only 2 papers concerning China's university technology transfer. A search on Amazon revealed 116 books with the term of "university technology transfer" within the title, but unfortunately no book on China's university technology transfer in English.[8]

One of the 2 papers related to China's university technology transfer mentioned above presented a brief overview of technology transfer in China in 2000, introduced a conceptual framework that addressed major determinants of technology development and transfer in China.[9] The other paper has no discussion on China's university technology transfer. All books on university technology transfer have no words on China's university technology transfer. So, even though a large numbers of studies on university technology transfer were carried out in developed countries, mainly in the United States and Germany, no comprehensive research concerning China's university technology transfer has been undertaken internationally.

Many Chinese scholars are interested in study on technology transfer from university to industry and commercialization of university research results in China. Some of them give theoretical support and guidance to univer-

[8] Unless otherwise noted, the data quoted in this study refer to the year of 2007.

[9] Hong Liu, Yunzhong Jiang. Technology transfer from higher education institutions to industry in China: nature and implications. Technovation. Volume 21(3), March 2001, pp. 175-188.