The Yellow Book on Science and Technology Vol. 12

CHINA SCIENCE AND TECHNOLOGY INDICATORS

2014

MINISTRY OF SCIENCE AND TECHNOLOGY OF THE PEOPLE'S REPUBLIC OF CHINA

科学技术文献出版社
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This book is the 12th volume in the biennially-released *China Science and Technology Indicator*, i.e. the Yellow Book on Science and Technology, published by the Ministry of Science and Technology of China.

The report has, on the basis of China's national Science and Technology (hereafter referred to as S&T) statistics and relevant economic and social statistics, presented a systematic analysis and evaluation of China's S&T human resources, R&D expenditures, S&T output, S&T activities carried out by major entities (enterprises, higher education institutions and government research institutes), high-technology industries, the overall scale and structural distribution of regional S&T development from the start of the National Twelfth Five-Year Plan on Economic and Social Development. The report has reflected the main characteristics of China's S&T activities.

With the help of richly and solidly collected S&T development data and information, the report has made itself a reliable evidence and data source not only suitable for studying China's S&T status quo, strength, achievements and development tendency but also desirable for the macro management and decision making process. It could also serve as a fine reference book for S&T professionals and school teachers and students.

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Preface

Science and Technology (hereafter referred to as "S&T") indicators represent quantitative means through which people can observe or measure S&T activities. S&T indicators can accurately reflect the status of S&T development and its roles and impacts on social and economic development. S&T indicators act as the basic evidences in decision-making process and the important instruments in evaluating the effects of S&T policies. Almost all nations and international organizations have been paying more and more attention to S&T indicators and using them as the basic tools of scientific decision making and policy analysis.

Since the 1990s, the Ministry of Science and Technology of China has, together with other governmental departments under the State Councils and relevant institutions, compiled and published series of reports as a government publication on China's S&T indicators in the form of S&T Yellow Book. *China Science and Technology Indicators 2014, or No.12 Yellow Book on Science and Technology*, is the 12^{th} volume in the series.

This issue has made full use of the scientific statistics data and relevant economic and social statistics data until the end of 2013, mainly reflecting the basic S&T development status since the release of *the National Plan for Long and Medium-Term Scientific and Technological Development (2006—2020)* and *the National Scientific and Technological Development Plan (2011—2015)*. It unveils major characteristics of China's S&T activities in the course of supporting the economic and social transformation and reflects historical process of strengthening China's capacity of indigenous innovation and developing an innovative country.

As one of the serial reports, this volume is consistent with the structures and indicators system applied in the previous volumes. The report has presented a systematic analysis and evaluation on China's S&T human resources, R&D expenditures, S&T activity output, S&T activities carried out by major entities (enterprises, higher education institutions and government research institutes), high-technology industries, overall scale and structural distribution of regional S&T development in the recent decade, especially during the 12^{th} Five-Year Plan period. At the same time, this volume has made some updates. First, it underscored the analysis of the trend of S&T indicators and the comparison with historic data. Through the analysis and comparison, it reviewed China's S&T development history and the process of developing an innovative country in recent years, and tried to analyze the trend and rule of S&T development from a longer-term perspective. Second, this report continued to emphasize on international comparison. Some representative and comparative S&T indicators have been used in the report to compare China with some important developed countries, emerging industrialized countries and developing countries so as to reflect the national characteristics of China's S&T and China's position in the world. Third, this report has made some necessary adjustments of the structure. Due to the lack of data on Chinese citizens' scientific awareness, the report does not include the chapter of "Citizen's Understanding and Attitude to S&T". To facilitate readers' understanding of the report, some columns of background information and relevant knowledge were inserted when necessary. Because of the limitation in statistic data collection and application, the report, unless otherwise noted, does not contain the data on Hong Kong Special Administrative Region (SAR), Macao SAR and Taiwan regions. The Editorial Board of *China Science and Technology Indicators 2014* acknowledges its gratitude to the guidance and assistance provided by authorities, experts and scholars of many government agencies and institutions including Ministry of Science and Technology, Chinese Association for Science and Technology, Chinese Academy of Sciences, National Natural Science Foundation, State Administration of Foreign Exchange, Ministry of Education, National Bureau of Statistics, State Intellectual Property Office, the National Development and Reform Commission, Ministry of Finance, Ministry of Commerce, Commission of Science Technology and Industry for National Defense. The Board also appreciates comments or suggestions, if any, from readers.

Editorial Board
China Science and Technology Indicators 2014

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Executive Summary

Conclusion of the year 2013 witnessed implementation of the Twelfth Five-year National Plan for Scientific and Technological Development (2011—2015) past the half way, and China's economic, social and S&T development has entered a new stage. Based on the latest S&T, economic and social statistics, *the China Science and Technology Indicators 2014* made a comprehensive analysis of China's S&T development and its role in advancing economic growth and social progress in recent years, especially since the start of the Twelfth Five-year Plan period.

1. S&T investments continued to increase and R&D expenditure leap into the forefront of the world

Human resources in S&T (HRST) are a leading force and strategic resources to advance the national strategy of developing an innovation-driven economy. China's efforts to develop higher education and bolster S&T investments have ensured steady growth in the total HRST. In 2013, China's total HRST reached 71.05 million, up by 5.4% or 3.62 million year on year. 29.43 million people had received university or higher education by 2013, up by 7.2% year on year, more than any other country on the planet. The quality of China's HRST has kept improving. There were 522 HRST per 10,000 people in 2013, up from 197 in 2000.

In 2013, China's R&D personnel reached 5.02 million, including 287,000 doctorates (5.7%), 661,000 masters (13.2%), and 1.39 million undergraduates (27.7%). In terms of full-time equivalent, the total amount of R&D personnel was 3.53 million person-years. The total amount of R&D researchers was 1.48 million person-years, accounting for 42% of the total amount of R&D personnel. For every 10,000 employed people, there were 45.9 person-years of R&D personnel, up by 8.4% or 3.6 person-years from 2012. For every 10,000 employed people, there were 19.3 person-years of R&D researchers.

Enterprises are the principal participants of R&D activities in China. Among China's total R&D personnel in 2013, 77.6% came from enterprises, 10.3% from research institutes, 9.2% from higher education institutions and 2.9% from other types of institutions. R&D talents at research institutes and higher education institutions have continued to increase, but represented a decreasing percentage of the total R&D personnel. R&D personnel working at enterprises have kept going up, with 89% of the newly increased R&D talents in 2013, or 255,000 person-years, going to work at enterprises.

College graduates are a primary source of HRST in China. In 2013 domestic universities and colleges recruited 11.77 million on total, including 5.66 million undergraduates and 6.11 million junior college students. Besides, 611,000 postgraduates were recruited, including 70,000 doctoral candidates and 541,000 master degree candidates. China's gross enrollment rate of higher education had jumped from 19.2% in 2005 to 34.5% in 2013, but that was still a low level compared to advanced nations and emerging economies. In 2013 there were 37.10 million students in Chinese universities and colleges, including 19.78 million undergraduates and 17.32 million junior college students, making China the world's largest scale in higher education market.

College graduates specializing in natural sciences, engineering and technology are a primary source of future scientists and engineers. 2.08 million undergraduates of natural sciences, engineering and technology graduated in 2013, 5.9% more than that of the previous year, a little higher than a 5.3% rise in the number of graduates in all disciplines. 302,000 people obtained master or doctorate degree in natural sciences, engineering and technology, including 39,000 doctorates (13.0%) and 263,000 masters (87.0%), up by 3.9% year-on-year and accounting for 57.1% of all postgraduates that year .

Returned overseas Chinese talents are also an important source of HRST in China. 414,000 Chinese talents returned home in 2013 after pursuing study at foreign countries, 295,000 more than that in 2005,witnessing an average annual growth rate of 16.9% since 2005. Favorable economic conditions and improving climate for innovation and entrepreneurship have been attracting more and more overseas Chinese talents to go back to work or start a new business in China. The growth rate of returned overseas talents has apparently accelerated since 2007. There were 354,000 overseas Chinese talents going back home in 2013, 10.1 times more than that in 2005, with an average annual growth rate of 33.5%. 85.4% of Chinese students who studied abroad have eventually returned home, a record figure.

In contrast to the obvious trend of slowing growth in R&D expenditure worldwide, China has witnessed a rapid increase in R&D expenditure in recent years that was faster than any other country. China's R&D expenditure hit 1.18 trillion yuan in 2013, a year on year increase of 12.5% (calculated on comparable prices). China's R&D intensity (the ratio of R&D expenditure to GDP) hit 2.01% in 2013. It's the first time that it exceeded 2% and higher than the average ratio in the EU. Increased R&D spending have laid a solid foundation for China to accelerate economic restructure and upgrading, to promote transformation of economic development pattern and to develop an economic model driven by innovation.

Asia, America and Europe have been running neck and neck in R&D expenditure. According to statistics on 39 countries and regions collected by the OECD and data provided by Brazil and India, the global R&D expenditure was estimated to be 1.4 trillion dollars in 2013, and the US, China, Japan, Germany, France, Korea, the UK, Australia, Canada and Italy were the top 10 R&D spenders. The US was the biggest R&D spender, accounting for 31.6% of the total R&D expenditure worldwide. China's 2013 R&D expenditure was 191.2 billion dollars (calculated according to the average exchange rate in 2013), representing 13.2% of the global spending, edging ahead of Japan as the second biggest R&D spender. Japan and Germany were in the third and fourth places respectively. The top four countries each spent more than 100 billion dollars in R&D, and collectively they accounted for 64.2% of the global R&D spending in the year.

In a breakdown of China's 2013 R&D expenditure, basic research funding was 55.5 billion yuan (4.7%), applied research spending 126.91 billion yuan (10.7%), and experimental development expenditure 1 trillion yuan (84.6%). Among the world's largest R&D spenders, China's investment in scientific research (including basic research and applied research) was the least concerning a share of R&D expenditure. That percentage was 15.4% in 2013, versus at least 35% at developed countries and emerging industrialized countries. In China, scientific research activities are primarily carried out in higher education institutions and research institutes. At higher education institutions, 87.4% of their R&D expenditure went to scientific research, compared to 42.0% in research institutes. For enterprises, 97.2% of their R&D budgets were spent on experimental development and 2.8% went to scientific research. China's labor cost has been on the rise in recent years. The average labor cost for R&D personnel has increased from 63,000 yuan per person-year in 2009 to 89,000 yuan in 2013, but still far lower than that of the developed world.

Since the 12th Five-year Plan was launched (2011), the Chinese government has stepped up funding support to basic research, strategic high technologies research and public-interest research. Government funding to R&D projects hit 250.06 billion yuan in 2013, up by 50% from 2010. Despite a rapid increase in R&D funding from the government, its share in the overall R&D expenditure has dropped to 21.1% in 2013 from 33.4% in 2000, because R&D spending from enterprises was growing at a faster pace during the period. Government funds are mainly used to finance national S&T programs undertaken by government-affiliated research institutes and some research-oriented universities. In a breakdown of R&D funds appropriated by the government in 2013, 59.2% went to research institutes, 20.7% to higher education institutions, 16.4% to enterprises and 3.7% to other units.

2. S&T output posted significant gains with improving quantity and quality of S&T achievements

Sustained increases in S&T funding have led to a sharp output growth in S&T activities, measured in the form of papers and patents, making China front rank in the world in terms of the scale and quality of S&T output.

In the recent decade China has continued to enhance the international competitiveness of its scientific research, with SCI papers maintaining a steady growth. China churned out 232,000 S&T papers in 2013, up from 57,000 in 2004, with an average annual growth rate of 16.8% during the period. China has been the world's second largest producer of S&T papers for five straight years, with the US dominating the top spot. Among China's SCI papers released in 2013, 52.7% were dedicated to basic researches and 26.7% focused on industrial technologies. Compared to the prior year, SCI papers recorded positive growth at all disciplines but space science. Chemistry-related papers increased 15.5% year on year, representing the biggest proportion of all SCI papers. 20.6% of the world's chemistry papers released in 2013 were contributed by China, up by 18.8% a year before. Biology & biochemistry, pharmacy & toxicology, and agricultural science reported sharp increases in SCI papers thanks to lower base numbers, rising by 90.8%, 63.2% and 59.9% from the previous year, respectively.

Between 2004 and 2014 (as of September 2014), Chinese scientists and researchers issued 288,000 chemistry papers collected by SCI, much more than papers written in other disciplines. SCI papers in four other subjects (physics, engineering technology, materials science and clinical medicine) accumulated over 100,000 during the ten-year period. Accumulated number of Chinese-authored SCI papers in nine disciplines made up more than 10% of the world's total. Among them, the proportion was more than 20% for papers in materials science and chemistry, and more than 15% for papers in mathematics, physics and engineering technology.

As China issues more and more academic papers, they stand a higher chance to be cited. China's S&T personnel published a total of 1.37 million SCI papers between 2004 and 2014, with combined citations of 10.37 million, putting China at the fourth place in the world by SCI citations, up by one spot from the prior year's statistics. A Chinese-authored paper was cited 7.57 times on average, up by 9.4% from 6.92 times in the prior year's statistics, narrowing the gap with the world average of 11.05 citations per SCI paper. Among the 19 countries that published more than 200,000 SCI papers, 12 had more citations than the world average, and China was in the 15th place in terms of average citations per SCI paper.

The numbers of China's SCI papers and citations in the field of materials science and chemistry was in the front rank in the world, but it's an unneglectable fact that the average citations of all papers in China were only 68.5% of the world average, and there is a noticeable gap between different disciplines in terms of citations. Among the 10 disciplines with citations higher than 68.5% of the world average, two, namely mathematics and engineering technology, recorded citations of 90% of the world average. Three disciplines - materials science, agricultural science and botany & zoology-recorded citations higher than 80% of the world average. SCI papers of biomedicine discipline, including molecular biology & genetics, immunology, microbiology, neuroscience and behavioral science, had the lowest citations of roughly 50% of the world average.

56,000 papers in China (excluding Hong Kong and Macau) collected by the SCI in 2013 were produced from international cooperation, up by 19.0% from 2012 and taking up 24.3% of all papers published by China. 66.1% of these papers, or 37,000, were published with Chinese researchers as the first authors, and joint authors came from 138 countries and regions, involving joint authors from the US, Australia, the UK, Canada, Japan and Germany as the top six countries. For SCI papers produced in 2013 with international cooperation, biology, chemistry, physics, clinical medicine, materials science and computer technology were the top six disciplines where the Chinese were the first authors.

China's intellectual property strategy has produced remarkable outcome. China's ability to develop independent innovations and technologies has seen a steady and swift improvement, and that ability has been demonstrated by a widening edge in the number of domestic patent applications and grants over overseas ones. 85.4% of China's invention patent applications in 2013 were filed by domestic applicants, up by 3.4 percentage points from the preceding year. Foreign applicants filed 120,000 invention patent applications in China, up by 2.3% year on year, registering a slower growth than the prior year. Domestic invention patent grants have maintained strong growth over the years and expanded the lead since domestic patent grants outnumbered foreign patent grants for the first time in 2009. Domestic and foreign invention patent grants slipped in 2013, but the share of domestic grants rose by 2.9 percentage points year on year to 69.1%. Foreign invention patent applications and grants were increasingly concentrated to a few countries. From 2001 to 2013, entities from Japan, the US, Korea and Germany have remained the top four foreign patent applicants in China, accounting for approximately 80% of the total patent applications filed by foreign entities. In terms of granted patents in 2013, Japan (22,609), the US (16,674), Germany (6,589) and korea (4,271) were the top four source countries of applicants, taking up 78.2% of the total patents granted to foreign entities.

Patent applications and grants to enterprises have been steadily increasing in recent years, and took up more than 60% of all patent applications and grants in each of the past six years, suggesting enterprises have strengthened their roles as the principal participants of technological innovations. In 2013 domestic applications of patents filed by enterprises jumped by 34.8% year on year to 427 thousand, representing 74.7% of all domestic patent applications. Nine of the top 10 applicants of domestic invention patents were Chinese-funded companies. Enterprises were granted 79 thousand patents, up by 1.0% from 2012 and accounting for 62.6% of all granted patents. Among the top 10 enterprises obtaining the most invention patents, 6 were Chinese ones, and the top 3 spots were dominated by Chinese companies.

By the end of 2013, China's total patents in force added up to 4.2 million, including 24.6% in invention patents, 46.2% in utility model patents and 29.2% in design patents. Divided by nationality of patent holders, 3.64 million patents were held by domestic entities and 559 thousand by foreign entities, up by 21.0% and 11.1% year on year, respectively. Domestic invention patents in force totaled 586 thousand, up by 23.9% year on year and accounting for 56.7% of the total invention patents in force, but the figure took up only 16.1% of all domestic patents in force, lower than the share of 80.0% at foreign countries. China had 4 invention patents per 10,000 people by 2013, up by 0.8 from the preceding year and achieved the goal set by the *National Outline of the 12th Five-year Plan* ahead of schedule.

Among the domestic invention patents in force, 352 thousand patents, or 59.9%, were held by enterprises; 116 thousand patents, or 19.8%, were held by colleges and universities. The top three corporate holders of invention patents in force were all Chinese-funded enterprises-Huawei Technologies Co., Ltd, ZTE Corporation and China Petroleum & Chemical Corporation. They had dominated the top three spots for four consecutive years.

The average lifespan of a domestic invention patent was 5.9 years in 2013, compared to 9.2 years for a foreign invention patent awarded in China. 46.8% of domestic invention patents survived more than five years and 6.7% survived more than ten years. In contrast, 89.4% of foreign invention patents survived more than five years and 29.5% survived more than ten years.

PCT applications worldwide increased by 5.1% year on year to 205 thousand in 2013. Among the top 10 applicant countries, China, US and Sweden posted double-digit growth in PCT applications, while Germany and the UK recorded negative growth. Mexico, Israel, Brazil and South Africa reported substantial growth rates of 22.0%, 17.1%, 12.2% and 11.5%, respectively. China's PCT applications rose by 15.5% in 2013 to 22 thousand. The number allowed China to edge out Germany to be the third largest PCT applicant in the world.

According to OECD statistics for 41 countries and regions with triadic patent families, the global total of triadic patent families added up to 51 thousand by 2012, among which Japan held 15 thousand triadic patent families and the US held 14 thousand, and they accounted for a combined 57.0% of the global total, down from 59.5% in 2010 statistics. China had held 1,851 triadic patent families by 2012, up by 11.6% year on year and taking up only 3.6% of the global total. China moved up one spot to be in the 6th place in triadic patent families.

3. Cooperation among industrial enterprises, universities, and research institutes produced fresh progress and innovation output made new breakthrough

China has been accelerating the pace of building a national innovation system, and technological innovations initiated by enterprises have been making substantial progress. R&D personnel working at enterprises reached 2.74 million person-years in 2013, 5.7 times of the talent resources in 2000. Measured by full-time equivalent, the proportion of R&D personnel hired by enterprises increased from 52.1% in 2000 to 77.6% in 2013. R&D expenditure by enterprises amounted to 907.58 billion yuan in 2013, equivalent to 16.9 times of the R&D spending in 2000. The share of corporate R&D expenditure to China's total R&D spending rose from 60.0% in 2000 to 76.6% in 2013. Calculated by comparable prices, corporate R&D expenditure grew at an average annual rate of 20% during the period.

Industrial enterprises are principal participants of technological innovations in China and they are also primary force to advance the country's technological innovations. 55,000 industrial enterprises in China carried out R&D activities in 2013, up by 7,628 from 2012 and 3.2 times of that in 2000. The number (55,000) accounted for 14.8% of all industrial enterprises, up by 4.2 percentage points from 2000. 43,000 industrial enterprises set up R&D institutes, 4,191 more than that in 2012 and representing 11.6% of all industrial enterprises, up by 5.6 percentage points from 2004. Industrial enterprises hired 2.388 million R&D employees, nearly quadrupled from 2000, with a total R&D spending of 594.15 billion yuan, an average annual growth rate of 17.2% since 2000.

In terms of full-time equivalent, the amount of R&D personnel at industrial enterprises in 2013 reached 2.494 million person-years, 5.7 times of that in 2000. 32.7% of that amount, or 815,000 person-years, were R&D researchers. A typical industrial enterprise had 6.74 person-years of R&D personnel on average. Industrial enterprises spent 831.84 billion yuan in R&D programs, 17.0 times of that in 2000. R&D spending at industrial enterprises increased at an annual growth rate of 19.2% from 2000 to 2013. Industrial enterprises have begun to step up R&D spending since the beginning of the 11th Five-year Plan period (2006—2010), and R&D expenditure rose to 0.80% of their business revenue in 2013. Continued increase in R&D investments has been providing robust support for industrial enterprises to pursue technological innovations.

Patent applications filed by China's industrial enterprises increased rapidly and reached 561,000 in 2013, implying an average annual growth rate of 26.6% since 2000. Accordingly, applications of invention patents also rose quickly. Such applications filed by industrial enterprises were fewer than 10,000 in 2000, and spiked to 205,000 in 2013, averaging an annual growth rate of 28.4% and accounting for 36.6% of the total patent applications. In the corresponding period, the number of invention patents in force held by industrial enterprises jumped from 15,000 to 335,000, implying an average annual growth rate of 26.8%.

R&D project cooperation is an important means of collaboration among industrial enterprises, universities, and research institutes. Industrial enterprises launched 235,000 R&D projects in

2013, and independently carried out 77.8% of them, or 183,000 projects, and cooperated with partners to work on the remainder of the projects. A total of 2.68 million people worked on the R&D projects with a total spending of 705.42 billion yuan, and 24.2% of the R&D workforce were assigned to develop joint projects funded by 25.4% of the entire R&D expenditure. 21,000 R&D projects, or 40.1% of the total, were jointly undertaken by industrial enterprises and universities, and 20.4% were co-studied with independent domestic research institutes.

Higher education institutions are important bases to cultivate innovative talents and a primary source to generate original innovations in the field of basic scientific research and frontier technologies. China had 2,491 higher education institutions as of 2013, up by 939, or more than 60%, from that in 2003. 1,170 institutions were permitted to confer bachelor degrees and 1,321 institutions allowed to confer college degrees. 113 institutions were directly managed by the central government, 1,661 by local governments and 717 were run by private entities.

R&D personnel and funding at China's higher education institutions have seen a steady increase in recent years, but its proportion in the national total has kept falling as a result of faster growth in R&D investments by enterprises. In terms of full-time equivalent, the amount of R&D personnel at higher education institutions reached 325,000 person-years in 2013, implying an average annual growth rate of 5.6% since 2003, and the proportion to national total shrank from 17.3% in 2003 to 9.2% in 2013. R&D expenditure appropriated to higher education institutions amounted to 85.67 billion yuan in 2013, growing at an average annual rate of 10.0% since 2003, and the share to national total dropped from 10.5% in 2003 to 7.2% in 2013.

R&D programs initiated by higher education institutions are primarily funded by government and secondly by enterprises. In a breakdown of the source of R&D funding to higher education institutions in 2013, 51.69 billion yuan (60.3%) was contributed by government, 28.93 billion yuan (33.8%) came from enterprises and 5.06 billion yuan (5.9%) from other entities and foreign sources. According to the 2013 R&D spending structure at higher education institutions, biggest share of 44.13 billion yuan went to applied research, 30.76 billion yuan to basic research, and 10.78 billion yuan to experimental development, up by 30.9%, 71.0% and 34.2% from 2010, respectively. The shares of basic research funding and applied research spending higher education institutions to the national total have been on the rise. The share of basic research spending jumped to 55.4% in 2013 from 37.5% in 2003, 17.9 percentage points higher, while the share of applied research expenditure rose from 28.8% to 34.8% in the period, 6 percentage points higher.

The output of S&T activities carried out by universities and colleges has seen sustained growth. Chinese universities and colleges churned out 161,000 SCI papers in 2013, up by 133,000 or nearly six times that of in 2003. Universities and colleges have continued to play a leading role in scientific research, and produced 83.7% of all SCI papers published by China in 2013. That ratio has stayed above 80% for a long period of time. Patent applications filed by universities and colleges registered a dramatic increase, from 10,000 in 2003 to 168,000 in 2013, implying an average annual growth rate of 32.2%. Invention patent applications surged from 7,704 in 2003 to 99,000 in 2013, indicating an average annual growth rate of 29.0%. Granted patents spiked as well, from 3,416 to 85,000, growing at an average annual rate of 37.9%. Granted invention patents jumped from 1,730 to 33,000, translating into an average annual growth rate of 34.3%. In the period, however, the proportion of invention patent applications and grants had been on the decline, down from 75.1% and 50.6% in 2003 to 58.8% and 39.2% in 2013 respectively. The proportion to the national total of patent applications from and grants to universities and colleges had been rising slowly year by year, and reached 7.5% and 6.9% in 2013 respectively.

Government-backed research institutes are independent organizations affiliated to the departments of the State Council and local governments. They are an integral part of China's innovation system and a principal force to carry out basic, strategic and public-interest researches. There were 568,000 S&T personnel working at 3,651 government-backed research institutes in 2013, including 409,000 R&D personnel. In terms of full-time equivalent, the amount of R&D personnel reached 364,000 person-years. R&D workforce at government-backed research institutes had been expanding at an average annual rate of 6.8% since 2005, and the proportion of R&D personnel to S&T personnel increased from 52.9% in 2005 to 72.1% in 2013. Despite the expanding pool of R&D personnel at the government-backed research institutes, they took up a shrinking share of the national total of R&D personnel, down from 15.8% in 2005 to 10.3% in 2013.

R&D funding at the research institutes amounted to 178.14 billion yuan in 2013, and 90.2% of the money went to research institutes directly managed by the central government. Calculated on the current prices, R&D expenditure in research institutes logged an average annual growth rate of 16.8% from 2005 to 2013, but its share in the national total had kept falling, from more than 20% in 2005 to about 15% in 2011, and that share has basically remained flat in the recent three years.

Government subsidies have long been a primary source of funding to R&D programs launched by research institutes. Government subsidies increased from 42.47 billion yuan in 2005 to 148.12 billion yuan in 2013. Government contribution has stayed at more than 80% over the years. In 2013, 3.4% of the R&D funding came from enterprises, 13.1% from other entities and less than 0.5% from foreign sources.

Per capita R&D funding at research institutes rose from 239,000 yuan/person-year in 2005 to

490,000 yuan/person-year in 2013, indicating an average annual growth rate of 9.4%. Labor cost takes up roughly 20% of the R&D expenditure in China's research institutes, while capital expenditure generally accounts for more than 20%. That's exactly on the contrary to the R&D spending structure of government-backed research institutes at developed countries.

From the perspective of education background, among the R&D personnel at research institutes, 63,000 people (15.4%) held doctorate degrees and 127,000 (31.0%) held master degrees. The number of R&D personnel with highly-educated background has kept increasing over the years, and their share to the total R&D personnel rose from 35.9% in 2009 to 46.4% in 2013. R&D personnel at research institutes affiliated to central governments generally have higher academic degrees than their counterparts at local research institutes. National-level research institutes had 320,000 R&D personnel in 2013, including 54,000 (16.8%) with doctorate degrees and 100,000 (31.7%) with master degrees. Local-level research institutes had 89,000 R&D personnel, including 10.3% with doctorate degrees and 28.8% with master degrees. More than 85% of R&D personnel with doctorate degrees were working at national-level research institutes.

Chinese research institutes have been intensifying funding to basic research over the years, with an average annual growth rate of 18.2% since 2005, compared to a respective growth rate of 14.6% and 17.8% in funding for applied research and experimental development. When it came to the proportion of funding to the three categories of research activities, experimental development snapped up the biggest share of 58%, versus 12.4% for basic research and 29.5% for applied research. In terms of full-time equivalent, the amount of R&D personnel dedicated to basic research, applied research and experimental development reached 61,000 person-years, 130,000 person-years and 173,000 person-years, respectively, indicating an average annual growth rate of 10.2%, 5.7% and 6.6% accordingly.

R&D projects undertaken by research institutes were mostly completed on their own. In 2013 they independently completed 68,000 R&D projects, or 81.5% of the total, partnered with domestic institutes to finish 7,742 projects (8.8%), worked together with domestic enterprises on 2,826 projects (2.8%). 3,262 R&D projects (2.5%) were jointly carried out with domestic universities and colleges, while only 1.3% of the total projects were completed with the help of foreign-funded entities (including foreign institutes and wholly foreign-owned enterprises registered in China).

China's research institutes issued 60,000 S&T papers at domestic journals in 2013, up by 8.1% year on year, and 24,000 SCI papers, basically flat with the preceding year. They filed 53,000 patent applications in 2013, implying an average annual growth rate of 23.4% since 2005. 37,000 or 69.0% of the total were invention patent applications, growing 23.3% annually during the period. 25,000 patents were granted in 2013, indicating an average annual growth rate of 21.3% since 2005; 12,000, or 49.4% of the total granted patents, were invention patents, translating into an average annual growth rate of 21.7% since 2005. The contract value of technologies sold by China's research institutes increased by 24.3% year on year, to 50.1 billion yuan in 2013, accounting for 6.7% of the total value of technology transactions in the country. The research institutes collected 400 million yuan of revenues by transferring or licensing 2,644 patents. They also drafted 4,368 national or industry standards in the year 2013, including 3,300 (75.6%) by national research institutes and 1,068 (24.4%) by local research institutes.

4. Strength of industrial innovation continued to improve, high technology industry achieved remarkable success

China's S&T investments have begun to pay off after years of efforts, and they have provided a strong boost to the high technology industry and raised its profile and influence on the international market. According to statistics from the US *National Science Board Science & Engineering Indicators 2014*, China's high technology industry was the world's second largest after the US, producing 23.9% of the total added-value of the global high technology industry. According to the *World Development Indicators 2014* released by the World Bank, China was the largest exporter of high technology products and services in 2012 with a share of 23.6% at the global high technology market. China's high technology export had kept growing in recent years. High technology export took up 26.3% of China's manufacturing products export in 2012, 8.7 percentage points higher than the world average and also higher than the ratio at developed countries like the US, the UK, France, Japan and Germany.

Domestic-funded high technology enterprises have kept gaining ground in China. Domestic-funded enterprises contributed 43.2% of the sector's business revenue in 2013, up by 13.6 percentage points from 2008; while contribution from foreign-funded enterprises decreased to 56.8% from 70.4% in 2008. Foreign-funded enterprises continued to dominate the industries of electronic computer & office equipment as well as electronic & communication equipment, contributing 90% and 61.8% business revenue of the two industries in 2013, respectively; aerospace & plane-making industry was largely controlled by domestic-funded enterprises with 82.9% business revenue of the industry in 2013.

China's high technology industry has been ratcheting up R&D spending. Large and medium-sized high technology enterprises spent 173.44 billion yuan in R&D in 2013, taking up 27.1% of the R&D expenditure by large and medium-sized manufacturing enterprises, and 0.8 percentage point higher than the previous year. The intensity of R&D expenditure for the high technology industry, measured as a share of sales revenue, rose to 1.89%. Among the branch industries of high technology, aerospace & plane-making had the highest R&D intensity of 7.62%, while the electronic computer & office equipment had the lowest intensity of 0.62%. Generally speaking, the intensity of R&D expenditure at China's high technology industry is still relatively low, and the intensity at different branch industries varies sharply.

The high technology industry has continued to see rapid growth of revenue in new product sales. New product sales revenue topped 1 trillion yuan in 2007, exceeded 2 trillion yuan in 2011 and approached 3 trillion yuan in 2013, rising by 19.5% from the year before. At large and medium-sized high technology enterprises, new product sales revenue accounted for 31.7% of main business revenue in 2013, up by 7.7 percentage points from 2005, suggesting continually strengthening innovation capabilities of the high technology industry.

The total value of China's imported and exported high technology products climbed to 1.22 trillion dollars in 2013. Exports increased by 9.8% year on year to 660.3 billion dollars and imports rose by 10.1% to 558.2 billion dollars. Among China's high technology exports, computer and communication products were the biggest export with a combined export value of 439.09 billion dollars, accounting for 66.5% of the value of China's total export of high technology products; electronic products were the second biggest export with an aggregate export value of 136.79 billion dollars, accounting for 20.7%.

In 2013 nine provincial high-tech zones were approved by the State Council to be upgraded, bringing the total number of national high-tech zones to 114. Above 520,000 enterprises were registered at the national high-tech zones. Based on statistics collected from 71,180 of these enterprises, 1,186 listed on the stock market, and 356 listed on the New Third Board. 21,795 enterprises or 30.6% of enterprises registered at the national high-tech zones were recognized as high-tech enterprises, taking up 39.9% of all high-tech enterprises in China. 31,457 enterprises at the national high-tech zones, or 44.2% of the total were technology-intensive, including 10,934 (15.4%) high-tech manufacturing enterprises and 20,523 (28.8%) high-tech service enterprises. The figures showed high-tech service enterprises had outnumbered high-tech manufacturing enterprises.

National high-tech zones have been providing powerful support to China's economic growth and regional economic development. In 2013 enterprises operating at national high-tech zones posted total business revenue of 20 trillion yuan, total industrial output of 15.1 trillion yuan, total net profit of 1.2 trillion yuan, and they paid 1.1 trillion yuan in taxes and earned foreign exchanges equivalent to 413.33 billion dollars through exports. Excluding the nine high-tech zones upgraded to national zones in 2013, the other zones posted a year-on-year growth rate of 17.8%, 14.9%, 19.1%, 13.7% and 8.3% in gross business revenue, total industrial output, net profit, tax and foreign exchange earnings respectively. The total industrial output of all national high-tech zones reached 6.3 trillion yuan in 2013, taking up 11.1% of China's gross domestic product. 35 zones churned out industrial output that was more than 20% of total industrial output of the cities. The gross foreign exchange earnings generated by all national high-tech zones accounted for 18.7% of China's total export value.

Enterprises operating at national high-tech zones launched 277,000 S&T projects in 2013, filed 139,000 invention patent applications, accounting for 16.8% of China's total applications. They were granted 51,000 invention patents, accounting for 24.5% of all patents granted in the year. Enterprises operating at national high-tech zones held a total of 188,000 invention patents in force, with every 10,000 staff holding 128.7 patents, 9.6 times of the national average.

In recent years China's high-tech enterprises have made steady progress in enhancing their innovation capabilities and competitiveness. By the end of 2013, there had been 59,613 certified high-tech enterprises, up by 21.0% year on year, among which 16.3% were large and medium-sized enterprises and 83.7% were small, medium and micro-sized businesses. 2,288 high-tech firms, or 4.2% of the total, had listed on the stock market.

In 2013 China's high-tech enterprises posted a gross business revenue of nearly 20 trillion yuan, a gross industry output value of 17.5 trillion yuan, and net profit of 1.3 trillion yuan, paid 927.74 billion yuan of taxes and levies, and earned foreign exchanges equivalent to 491.58 billion dollars, up by 15.6%, 15.0%, 17.7%, 10.7% and 6.7% year on year, respectively. High-tech enterprises contributed 22.2% of China's total export value. Their average operating income margin was 6.6% and return on net assets was 9.2% in 2013, both higher than the year before.

China had 1,468 technology business incubators by 2013, up by 18.5% year on year. These business incubators were served and managed by 26,700 people and ran a total incubation area of 53.793 million square meters, up by 22.9% year on year. 78,000 businesses were still being incubated in the year, up by 10.6% from the year before. Among the 1,468 technology business incubators, 456 or 31% of the total, were based in the national high-tech zones. 850 business incubators, or 57.9% of the total, were run like an enterprise.

78,000 businesses were being incubated by technology business incubators in 2013, including 9,482 started by returned overseas students. The incubated businesses were concentrated in such high technology sectors as electronic information, advanced manufacturing, new materials, new energy & energy efficiency management, biomedicine & medical instruments as well as environmental protection.

By the end of 2013, about 52,000 enterprises had become strong enough to exit the technology business incubators, among which 6,969 exited in 2013. In the same year, 2,395 incubated enterprises posted business revenue of more than 10 million yuan, 166 were acquired and 46 got listed on the stock market. On the whole, more than 200 incubated enterprises have been listed on the stock market after exit. A total of 41,000 enterprises, or 78.8% of all enterprises exiting technology business incubators, were successfully incubated by national incubators.

China had 1,408 venture investment institutions by 2013, up by 225 or 19.0% year on year. Among them were 1,095 venture investment enterprises (funds), up by 153 or 9.5% year on year, and 313 venture investment management enterprises, up by 72 or 29.9% year on year.

In 2013 China's venture investment institutions invested in 1,501 projects, flat with the year before, with a total investment volume of 27.9 billion yuan, down by 11.1% year on year. The average investment in a project was 18.585 million yuan. By the end of 2013, China's venture investment institutions had invested in 12,000 projects, up by 1,037 or 9.3% year on year, with a total investment of 263.41 billion yuan, up by 11.8% year on year.

China's venture investments in high-tech projects increased in 2013, but investors preferred to pour the money into small businesses in the early development stage. Venture investors injected 10.9 billion yuan in 590 high-tech projects in 2013, down by 26.3% and 9.5% year on year respectively. An average project received 18.47 million in venture investment. By the end of 2013, China's venture investment institutions made a combined 130.21 billion yuan investment in 6,779 high-tech projects, accounting for 49.4% of their total venture investments and 55.8% of all projects they invested.

Chapter 1 Human Resources in Science and Technology

Human resources in Science and Technology (HRST) refer to the human resources that are actually or potentially engaged in systematic work for the production, advancement, diffusion and application of scientific and technological knowledge, which include labor forces that are either actually engaged in or qualified for carrying out S&T activities. HRST are the leading force and strategic resources for the building of an innovative country. This chapter aims to address the current status of the utilization and cultivation of HRST in China from three perspectives, i.e. overview of HRST, R&D personnel and source of HRST, and demonstrate China's international standing in HRST and its gap with leading nations through comparison with international standards.

Section 1 Overview of Human Resources in Science and Technology

This section aims to present the general picture of China's HRST through the analysis of the stock of HRST and technical personnel in S&T in China.

1. The Stock of HRST

The stock of HRST in China refers to the sum of the stock of graduates holding a junior college or above diploma or degree in S&T and the number of labor forces actually engaged in S&T activities without such a diploma (or degree). The stock of HRST is a reflection of the current status of HRST and potential input of S&T personnel in China in the future.

China is already a major country of HRST. Since 2000, the stock of HRST has maintained steady increase, reaching 71.05 million in 2013, 5.4% higher than the previous year. Of all HRST, 29.43 million held a bachelor or above degree, up by 7.2% year-on-year. From 2000 to 2013, the stock of HRST rose by 2.8 times, registering an average annual growth of 8.4% on the whole, and 8.7% for human resources with a bachelor or above degree (Fig. 1-1). In recent years, as the focus of higher education shifts from quantity to quality, growth in the stock of HRST has relatively slowed.

The S&T literacy of the Chinese population continues to rise. From 2000 to 2013, the number of

HRST per 10,000 persons increased from 197 to 522, representing an average growth of 7.8% per year.

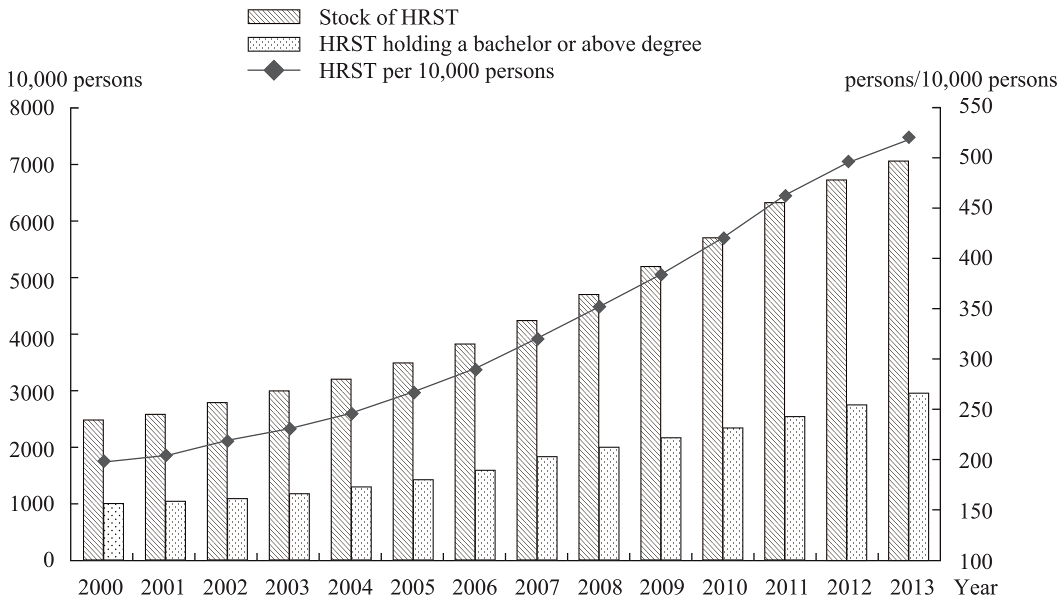

Fig. 1-1 Stock of HRST in China (2000—2013)

See Appendix table 1-1.

China Science and Technology Indicators 2014

The stock of HRST with a bachelor or above degree in China has exceeded that of the United States. According to *the Science and Engineering Indicators 2014* of the US, the total volume of US labor forces with a university degree in science and engineering① rose from 17.2 million in 2008 to 21.9 million in 2010, representing an average growth of 8.4% per year.

2. Technical personnel in S&T in state-owned and collective-owned enterprises and institutions

Technical personnel, which include 17 categories②, refer to the employees of public institutions and enterprises who have completed the second or higher education or obtained junior or senior professional title. Technical personnel in S&T consist of five categories of technical personnel,

① Equivalent to the stock of HRST with a bachelor or above degree in China.

② The 17 categories of specialized technical personnel includes engineering technical personnel, agricultural technical personnel, scientific researcher, health technical personnel, teaching personnel, economic personnel, accountancy personnel, statistical personnel, translating personnel, library and archiving personnel, journalism and publishing personnel, lawyers and notarial personnel, broadcasting personnel, craftwork personnel, physical education personnel, art personnel and political work personnel.

namely, engineering, agriculture scientific researcher, health care and teaching. The number of technical personnel in S&T in publicly-owned enterprises and institutions reflects the amount of HRST developed and utilized by public economic units.

In 2013, the number of technical personnel in S&T in China's public economic units reached 24.39 million①, up by 11% over 2000, representing an average annual growth of 1.4% (Fig. 1-2). The number of Technical personnel in S&T per 10,000 employees reflects the scientific literacy of the employed labor forces. Before 2008, the number of technical personnel in S&T per 10,000 employees had maintained rapid growth, up by 45% from 2000 to 2008, or 4.8% per year. After 2008, growth has somewhat slowed, reaching 4,639 persons in 2013, with an average annual growth of only 0.1%.

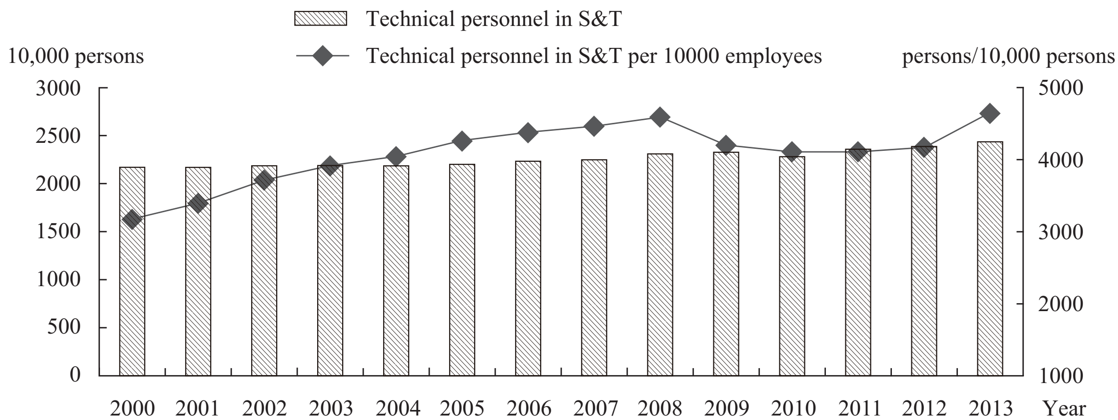

Fig. 1-2 Technical personnel in S&T in state-owned and collective-owned enterprises and institutions (2000—2013)

See Appendix table 1-2.

China Science and Technology Indicators 2014

In 2013, among the five categories of technical personnel in S&T in China's public economic units, there were 12.81 million teaching staff, accounting for 52.5% of the total; 6.14 million engineering technicians, 25.2% of the total; 4.28 million health technicians, 17.5% of the total; 733,000 agricultural technicians, 3.0% of the total; and 432,000 scientific researchers, 1.8% of the total. Of the five categories of technical personnel in S&T, the number of scientific researchers saw the largest increase during the eight years from 2005 to 2013, up by 121,000 persons or 4.2% per year; the number of engineering technicians increased by 1.35 million, or 3.1% per year; the number of health technicians increased by 695,000 or 2.2% per year; the

① The statistical subject before 2008 (included) is "state-owned enterprises and institutions", which does not include collective-owned enterprises and institutions.

number of agricultural technicians increased by 28,000 or 0.5% per year. The growth in the number of teaching staff was the slowest, up by only 0.2% per year (Fig. 1-3).

Since 2005, there has been a constant change in the distribution of technical personnel among different economic units in China. Between 2005 and 2013, the compound annual growth rate (CAGR) of the number of college graduates or above, in both stock (11.1%) and increment (6.8%), far outpaced that of the total technical personnel in S&T (1.3%) and t in the other 12 categories (0.6%) in public economic units. In 2013, the stock of college graduates or above increased by 71.35 million over 2005, while the total volume of technical personnel in S&T in public economic sectors during the same period only went up by 2.41 million, which shows that a significant number of graduates of China's higher education institutions have been employed by private economic units.

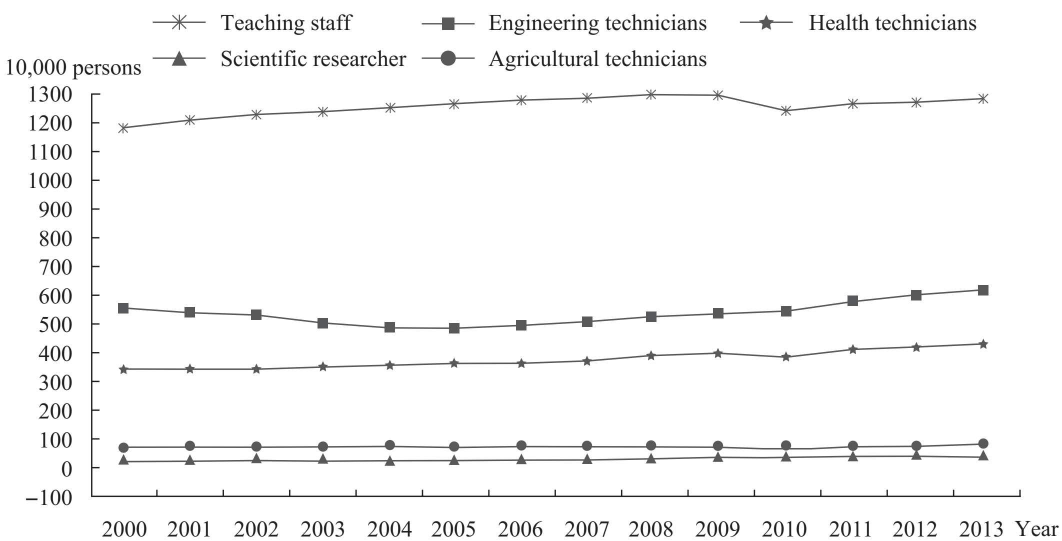

Fig. 1-3 Total numbers of the five categories of technical personnel in S&T in public economic units (2000—2013)

See Appendix table 1-2.

China Science and Technology Indicators 2014

Section 2 Research and Development Personnel

Research and development (R&D) refers to creative and systematic work carried out in the S&T field for the purpose of increasing the stock of knowledge and creating new applications of available knowledge. R&D personnel refer to those directly engaged in R&D activities as well as those providing direct services such as R&D managers, administrator and clerical staff. The quantity and quality of R&D personnel is one of the key indicators of a country's innovation capability. Using the total volume and distribution of R&D personnel as the main indicators, this section aims to present the picture of China's labor power in R&D activities and its comparison with international standards.

1. Total R&D personnel

The total R&D personnel in China has maintained high-speed growth. In 2013, the total number of R&D personnel reached 5.02 million persons in terms of headcount in China, up by 8.7% over 2012, including 287,000 PhDs, 661,000 masters and 1.388 million bachelors, accounting for 5.7%, 13.2% and 27.7% of the total respectively.

According to full-time equivalent (FTE)[①], the total R&D personnel in China was 3.53 million person-year in 2013, up by 8.8% over the previous year (Fig. 1-4). Between 2000 and 2013, the total R&D personnel in China increased by 2.44 million person-year, or 22.3% per year.

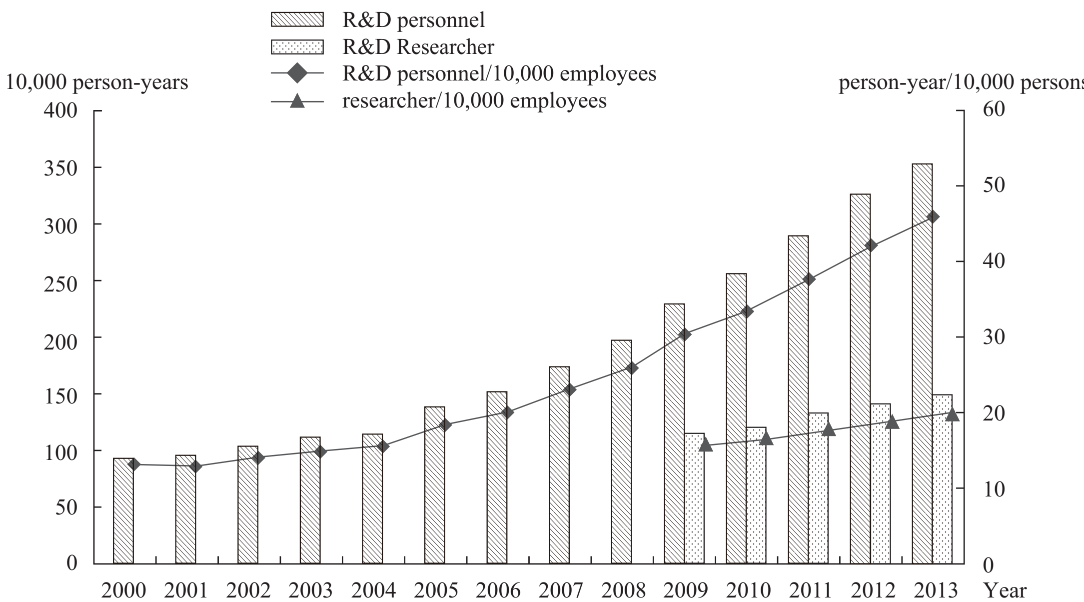

Fig. 1-4 Total volume and input intensity of R&D personnel (2000—2013)

See Appendix table 1-1.

China Science and Technology Indicators 2014

In recent years, there has been an accelerated growth of labor powers in R&D activities in China. From 2006 to 2013, the total R&D personnel increased by 2.03 million person-year,

① Full-time equivalent is the sum of the number of full-time persons and the number of non-full-time persons discounted by workloads. Full-time persons refer to those that spend 90% or more of their work time of the entire year on R&D activities.

representing an average annual growth of 19.3%. From 2000 to 2006, the total R&D personnel increased by 0.58 million person-year, up by 8.5% per year.

Researchers in R&D activities refer to professionals that are engaged in the conceptualization or creation of new knowledge, products, processes, methods and systems as well as senior managers of R&D projects. In the actual S&T statistics, they refer to R&D personnel with an intermediate or above professional title or doctorate. The proportion of researchers to R&D personnel reflects the competence of the R&D labor power and the quality of R&D activities. In 2013, the number of researchers in China reached 1.48 million person-years, up by 5.7% over 2012, accounting for 42.0% of all the R&D personnel.

The number of R&D personnel (or researcher) per 10,000 total employment is an important indicator for measuring the input intensity of a country's labor power in R&D activities and reflecting the overall quality of a country's human resources in S&T. The number of R&D personnel per 10,000 total employment has been on an upward trajectory since 2000, totaling 45.9 person-year in 2013, up by 3.6 person-year or 8.4% over the previous year, 3.6 times that of 2000, representing a 10.3% average annual growth during the 13-year period (Fig. 1-4).

In 2013, the number of researcher per 10,000 total employment reached 19.3 person-year, up by 4.1 person-year or 27% over 2009, representing a 6.8% increase per year, 5.5 percentage points lower than that of the R&D personnel per 10,000 total employment in the same period.

2. R&D personnel by performing sectors

Enterprises, research institutions and higher education institutions are the three major performing sectors of R&D activities in China. In terms of the distribution of R&D personnel among the three sectors, enterprises are still the primary entity for carrying out R&D activities in China. In 2013, 77.6% of the R&D personnel were from enterprises, 10.3% from research institutions, 9.2% from higher education institutions, and 2.9% from other public institutions (Table 1-1). The total volume of R&D personnel from enterprises continues to rise and its share in the total also steadily increases. In 2013, the proportion of R&D personnel from enterprises rose by 1 percentage point over the previous year. In terms of absolute volume, R&D personnel from enterprises increased by 255,000 person-years, accounting for 89% of the increment (286,000 person-years) of total R&D personnel in the country. The number of R&D personnel from research institutions and higher education institutions also increases annually, yet its share in the total is decreasing, down by 0.3 and 0.5 percentage point respectively in 2013 from the previous year.

Table 1-1 R&D personnel by performance sectors (2005—2013)

Year	Total		Research institutions		Higher education institutions		Enterprises		Others*	
	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%
2005	136.5	100	21.5	15.8	22.7	16.6	88.3	64.7	3.9	2.9
2006	150.2	100	23.2	15.4	24.3	16.1	98.8	65.7	4.0	2.7
2007	173.6	100	25.6	14.7	25.4	14.6	118.7	68.4	4.0	2.3
2008	196.5	100	26.0	13.2	26.7	13.6	139.6	71.0	4.3	2.2
2009	229.1	100	27.7	12.1	27.5	12.0	164.8	71.9	9.1	4.0
2010	255.4	100	29.3	11.5	29.0	11.3	187.4	73.4	9.7	3.8
2011	288.3	100	31.6	11.0	29.9	10.4	216.9	75.2	9.9	3.4
2012	324.7	100	34.4	10.6	31.4	9.7	248.6	76.5	10.3	3.2
2013	353.3	100	36.4	10.3	32.5	9.2	274.1	77.6	10.4	2.9

* Others refer to government-affiliated public institutions that are engaged in S&T activities yet cannot be defined as research institutions

See Appendix table 1-1

China Science and Technology Indicators 2014

3. R&D personnel by types of activity

R&D activities can be divided into three types according to the nature of such activities, namely, basic research, applied research and experimental development. Basic research refers to experimental or theoretical work undertaken for the purpose of acquiring new knowledge of the underlying foundation of phenomena and observable facts (revealing the nature of objects and the rules of their operations, acquiring new discoveries or establishing new theories),without any particular application or use in view. Applied research refers to original investigation conducted for the purpose of acquiring new knowledge aimed at a specific aim or objective. Experimental development refers to the systematic work carried out with the knowledge acquired through basic research, applied research and/or practical experience for the purpose of producing new products, materials and equipments, installing new processes, systems and services, or making substantive improvement to what have been produced or installed.

In 2013, of all the R&D personnel in China, 223,000 person-years were engaged in basic research, or 6.3% of the total; 396,000 person-year in applied research, 11.2% of the total; and 2.91 million person-year in experimental development, or 82.5% of the total (Fig. 1-5).

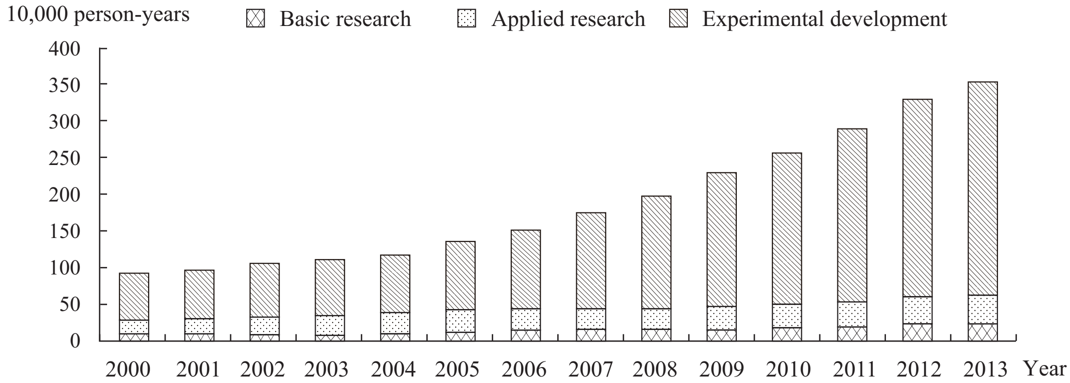

Fig. 1-5 R&D personnel by activities (2000—2013)

See Appendix table 1-1.

China Science and Technology Indicators 2014

From 2005 to 2013, the number of scientific research personnel (basic research personnel plus applied research personnel) increased from 412,000 person-year to 619,000 person-year, up by 5.2% per year. The number of experimental development personnel rose by 1.96 million person-years, or 15.0% per year. The proportion of basic research personnel and applied research personnel experienced a steady decline, from 8.4% and 21.8% in 2005 down to 6.3% and 11.2% in 2013 respectively.

As shown by the distribution of R&D personnel in the three types of activities, research institutions, higher education institutions and enterprises each play a different role. Table 1-2 shows: 1)The majority part of basic research personnel in China work in higher education institutions. In 2013, basic research personnel from higher education institutions accounted for the largest share in the total, 65.7%; research institutions accounted for 27.3% of the total, while only 1.3% was from enterprises. 2)Applied research personnel were mostly from higher education institutions and research institutions, which together accounted for 73% of the total. 3)Experimental development personnel were mostly from enterprises and became increasingly concentrated. The proportion of experimental development personnel from enterprises rose from 70.7% in 2000 to 92% in 2013.

Table 1-2 R&D personnel in China both by activities and performance sectors (2013)

Unit / Type	Total		Research institution		Higher education institution		Enterprise		Research institution	
	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%
Total	353.28	100	36.37	10.3	32.49	9.2	274.06	77.6	10.36	2.9
Basic research	22.32	100	6.09	27.3	14.66	65.7	0.29	1.3	1.28	5.7

continued from table 1-2

Type \ Unit	Total		Research institution		Higher education institution		Enterprise		Research institution	
	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%	10,000 person-year	%
Applied research	39.56	100	12.97	32.8	15.91	40.2	5.56	14.1	5.12	12.9
Experimental development	291.40	100	17.32	5.9	1.92	0.7	268.21	92.0	3.96	1. 4

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Year Book on Science and Technology 2014.*

See Appendix table 1-1.

China Science and Technology Indicators 2014

As shown in the types of R&D activity conducted in different performing sectors, research institutions, higher education institutions and enterprises each have their special features in terms of the R&D human resources in the three types of R&D activities. Higher education institutions are mainly focused on scientific research (applied research and basic research). Since 2000, their R&D personnel in scientific research activities have been growing in both absolute and relative terms. In 2013, the share of their R&D personnel in scientific research activities hit a record high of 94.2% of their total. Enterprises, on the other hand, continue to focus on experimental development, with their share of total R&D personnel reaching 97.8% in 2013. The number of R&D personnel in scientific research is relatively stable for research institutions, the share of which has been kept at around 52% in recent years.

4. International comparison of R&D personnel

The international comparison of the total number and input intensity (number of R&D personnel per 10,000 total employment) of R&D personnel shows China's gap with world leaders in the input of R&D personnel as well as its international status in R&D capability.

1) Total number and input intensity of R&D personnel

In 2013, the total R&D personnel in China reached 3.53 million person-years, and the number of researcher totaled 1.48 million person-years, both of which rank the first in the world (see Table 1-3).

Measured by the indicator of input intensity, despite the rapid growth in recent years, China is still lagging behind in the world. In 2013, the number of R&D personnel per 10,000 total employments stood at 45.9 person-years in China, lower than all the developed countries and russia. In terms of number of researcher per 10,000 total employments, China also ranked lower than most of the countries with over 100,000 person-years of R&D personnel. The number of researcher per 10,000 total employment in those countries like the Korea, Japan, France, the UK and the US remained at least four times as large as that of China (Table 1-3).

Table 1-3 Countries with over 100,000 person-years of R&D personnel

Country	Year	R&D personnel (10,000 person-years)	R&D personnel per 10,000 total employment (person-year)	Researcher (10,000 person-year)	Researcher per 10,000 total employment (person-year)
China	2013	353.3	45.9	148.4	19.3
Japan	2013	86.6	133.5	66.0	101.9
Russia	2013	82.7	115.8	44.1	61.7
Germany	2013	60.5	140.3	36.1	85.4
France	2012	41.2	152.1	25.9	95.6
Korea	2012	39.6	160.4	31.6	127.9
UK	2013	36.2	120.9	25.9	86.6
Italy	2013	25.3	104.0	11.8	48.5
Canada	2012	22.4	125.4	15.7	87.7
Spain	2013	20.4	113.4	12.4	68.9
Australia	2008	13.8	126.1	9.3	85.0
Netherlands	2013	12.1	139.7	7.2	83.1
Turkey	2013	11.3	44.3	8.9	34.9
US	2011	—	—	125.3	88.1

See Appendix table 1-3.

China Science and Technology Indicators 2014

Between 2005 and 2013, the total R&D personnel in China increased by 12.6% per year, faster than other countries. Countries with relatively faster growth in the number of R&D personnel include Turkey, Korea, Portugal, Slovenia, Argentina and Hungary. Most of them, except the Korea, are countries with smaller R&D activities. Between 2005 and 2013, Turkey's average annual growth reached 10.9%, while Portugal, Slovenia and Hungary increased by 8.1%, 6.8% and 6.4% per year respectively. In the case of the Korea and Argentina, their number of R&D personnel increased by 9.1% and 6.8% per year respectively between 2005 and 2013. On the other hand, most of the developed countries with relatively larger R&D activities experienced slow or even negative growth in the number of R&D personnel. Between 2005 and 2013, the total number of R&D personnel in Japan dropped by 0.4% per year. In the case of the UK, the annual growth is only 1.4% since 2005, and for Germany and France, the number is 3.1% and 2.4% respectively. In Finland, the number of R&D personnel has experienced negative growth in recent years, down by 0.9% per year. The total number of R&D personnel in Russia fell by 10.1% during the same period.

2) International comparison of R&D personnel by performing sectors

R&D personnel by performing sectors reflect the differentiated features of the innovation systems of various countries. Based on these differentiated features, the world's major countries can be divided into the following three categories:

Category 1 countries are those with relatively strong R&D capability in the business sector. China and the Korea are the two countries where enterprises account for the largest proportion in the total number of R&D personnel, i.e. 77.6% (2013) and 71.1% (2012) respectively, followed by the US and Japan. Most OECD member states, such as Canada, Germany, France and Finland, also have over 50% of their R&D personnel coming from the business sector (Table 1-4).

Table 1-4 International comparison of R&D personnel by performance sectors

%

Country	Year	Enterprise	Higher education institution	Research institution	Others
China	2013	77.6	9.2	10.3	2.9
Korea	2012	71.1	19.5	8.3	1.1
US*	2011	68.1	—	—	—
Japan	2013	67.5	24.0	7.1	1.4
Germany	2013	62.0	21.8	16.2	0.0
France	2012	59.9	26.5	12.1	1.5
Canada	2012	59.0	31.8	8.5	0.6
Finland	2012	57.3	29.9	11.8	1.0
Turkey	2013	51.7	37.7	10.6	—
Russia	2013	51.3	14.4	34.1	0.2
Singapore	2012	51.2	41.2	7.6	—
Slovakia	2013	21.1	58.1	20.6	0.2
Greece	2013	16.7	54.1	28.3	0.9
Portugal	2013	33.1	51.2	4.4	11.3
New Zealand	2011	37.3	48.7	14.0	—
UK	2013	45.8	47.9	4.7	1.7
South Africa	2012	32.3	44.5	21.0	2.2
Poland	2013	32.3	44.2	23.3	0.2
Spain	2013	43.7	36.8	19.3	0.2
Romania	2013	31.7	30.7	37.2	0.4
Argentina	2012	12.3	37.8	48.0	1.9

* refer to the data of researcher.

See Appendix table 1-4

Category 2 countries are those with relatively strong R&D capability in higher education institutions. Countries that fall in this category include Slovakia, Greece, Portugal, New Zealand, the UK, Australia, South Africa and Poland. Of these countries, Slovakia, Greece and Portugal all have more than 50% of their R&D personnel coming from higher education institutions. For other countries, such as New Zealand, the UK, Australia and South Africa, the proportion of R&D personnel from higher education institutions also exceeds 44%.

Category 3 countries are those with relatively strong R&D capability in research institutions. Argentina and Romania both belong to this category. The R&D personnel from research institutions account for as much as 48% of the total in Argentina.

Section 3 Cultivation of Human Resources in Science and Technology

The cultivation of human resources in S&T depends mainly on higher education. Graduates of higher education institutions (HEI) in the S&T field are the primary source of HRST in China. This section analyzes China's progress in the development of higher education and cultivation of HRST in recent years, with a focus on the education of undergraduate and postgraduate students and overseas Chinese students in the S&T field.

1. The development of higher education

In the last ten years, the development of higher education has decelerated and low-speed growth has become the new normal in China. In 2013, China enrolled 11.76 million new undergraduate students in normal courses and short-cycle courses (including the students of regular HEIs, adult HEIs and web-based HEIs), up by 4.2% year-on-year, among which 5.66 million were undergraduate students in normal courses and 6.107 million in short-cycle courses; There were 611,000 new postgraduate students (excluding part-time PhD and master students) (Fig. 1-6), up by 3.7% year-on-year, including 70,000 PhD students and 541,000 master students. The gross enrollment rate of higher education in China was raised from 19.2% in 2005 to 34.5% in 2013. The number of on-campus undergraduates reached 37.10 million in 2013, including 19.78 million undergraduate students in normal courses, making China the largest country in higher education.

In the beginning of the 21st century, higher education institutions in China substantially expanded their enrollment. Since 2004, the expansion in enrollment has moderated and entered a stage of steady development. Between 2010 and 2013, the average annual growth rate of new entrants of PhD students, master students, undergraduate students in normal courses and undergraduate students in short-cycle courses was 3.4%, 4.5%, 4.8% and 3.9% respectively.

Compared to the average annual growth rate between 2005 and 2010 (3.1%, 8.9%, 6.9% and 4.6% respectively), except for a modest increase of new entrants of PhD students, the growth speed in other categories have all dropped by a notable margin (Fig. 1-6). This has resulted in a lower growth rate of the number of graduates in recent years than previous years.

Between 2010 and 2013, the average annual growth rate of university graduates in normal courses and short-cycle courses was 4.5%, and that of postgraduates was 10.2%, both of which were significantly lower than the growth rate in the 11th Five-Year Plan period (13.8% and 15.1%). In 2013, China produced 10.68 million university graduates (including the graduates of regular HEIs, adult HEIs, web-based HEIs and self-taught higher education examinations), among which 5.10 million were in normal courses and 5.34 million in short-cycle courses. During the same period, China also produced 514,000 postgraduates, including 53,000 PhDs and 461,000 masters. Every year, HEIs provide over 10 million skilled labor forces for China.

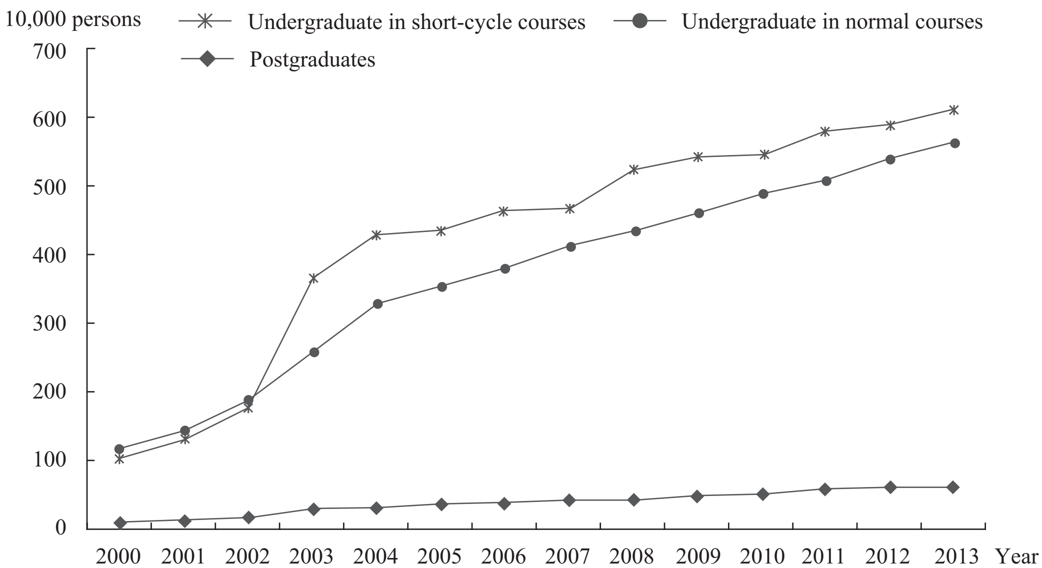

Fig. 1-6 The total number of higher education enrollment in China (2000—2013)

See Appendix table 1-5.

China Science and Technology Indicators 2014

2. Undergraduates in natural science and engineering technologies in normal courses

Undergraduates in natural science and engineering technologies in normal course are the main source of scientists and engineers. Traditionally, cultivating students in the field of natural science and engineering technologies has been a focus of China's higher education. The proportion of undergraduates in the field of natural science and engineering technologies normally exceeds 50%. In 2000, the Fig.1-7 was 59.6% higher than that of developed western countries. Since 2000, as the market demand for university graduates becomes increasingly diversified, the proportion of undergraduates in the field of natural science and engineering technologies has gradually dropped, down to 50.2% in 2004, which was more or less the same as graduates majoring in social sciences and humanities. In 2007, it hit a record low of 43.6%. After that, the proportion of students enrolled in the field of natural science and engineering technologies showed a slow growth and climbed back to 45.8% in 2013 (Fig. 1-7).

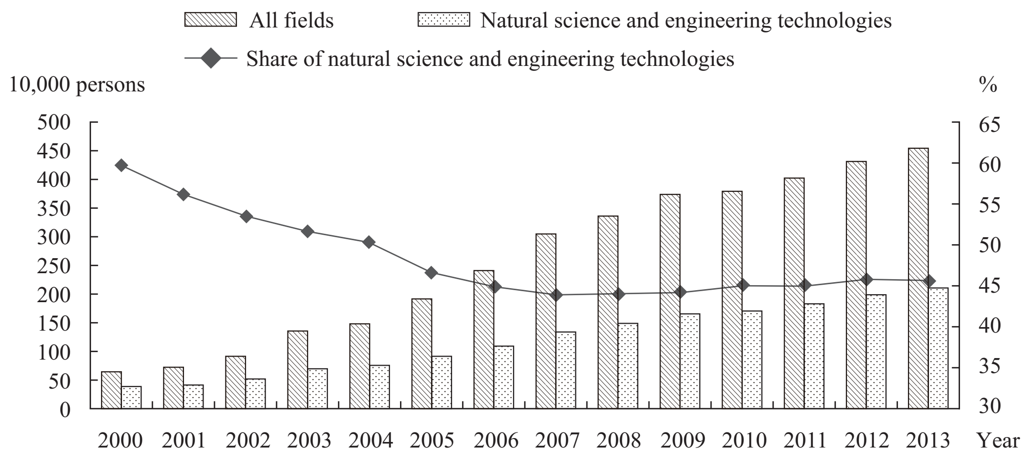

Fig. 1-7 The number and share of graduates in t natural science and engineering technologies in normal course (2000—2013)

See Appendix table 1-5.

China Science and Technology Indicators 2014

The graduates of higher education institutions in the field of natural science and engineering technologies have provided a large number of S&T labor forces for China's economic development. In 2013, the number of undergraduates in the field of natural science and engineering technologies totaled 2.09 million, up by 5.9% over the previous year, slightly higher than the growth rate of all undergraduates (5.3%).

Following the expanded enrollment of higher education institutions in 1998, the number of Chinese undergraduates in the field of natural science and engineering technologies has experienced rapid growth, and the gap in growth speed has widened among different disciplines (Fig. 1-8). The number of graduates majored in engineering has traditionally been the highest, reached 1.34 million in 2013. The number of graduates in medicine exceeded that of science for the first time in 2012, and reached 390,000 in 2013. In recent years, the number of graduates in science has spiraled downward, reaching 280,000 in 2013. The number of graduates in agriculture hit a record high of 75,000 in 2013. Since 2005, growth speed in the number of graduates has slowed for all disciplines, from double digit to single digit.

Between 2005 and 2010, the average annual growth reached 12.8% for undergraduates of engineering science, 21.4% for medical science, 11.9% for science and 12.1% for agricultural science. Between 2010 and 2013, the average annual growth fell to 9.4% for undergraduates in engineering science, 11.7% for medical science, -4.3% for science and 5.2% for agricultural science. In 2013, of all the undergraduates in the field of natural science and engineering technologies, those majoring in engineering science still accounted for the largest share, 64.2%. The proportion of undergraduates majoring in science and medical science was 13.4% and 18.7% respectively, while the proportion of agricultural science was the lowest, 3.6%.

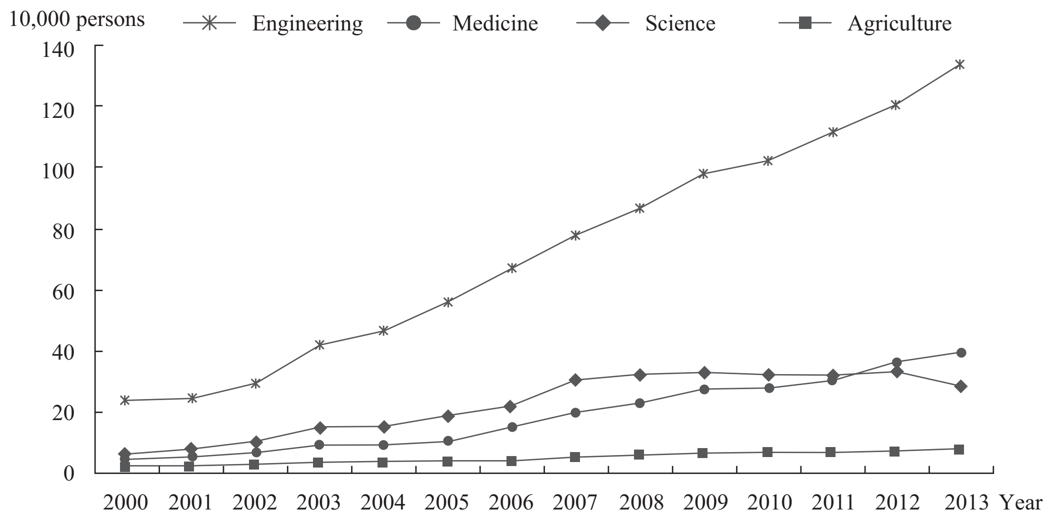

Fig. 1-8 The number of graduates in natural science and engineering technologies in normal courses by discipline (2000—2013)

See Appendix table 1-5.

China Science and Tecnology Indicators 2014

3. Postgraduates in natural science and engineering technologies

Postgraduates in China are awarded doctor & master degrees by higher education institutions and government research institutions, with the former accounting for more than 90% of the total. In 2013, the number of graduates with doctor & master degrees in natural science and engineering technologies reached 302,000, up by 3.9% year-on-year, accounting for 57.1% of all the postgraduates of the year. Among all the postgraduates in natural science and engineering technologies, 50,000 or 16.5% of the total majored in science; 176,000 or 58.3% of the total majored in engineering science, while those majoring in agricultural science and medical science totaled 17,000 and 59,000 respectively, accounting for 5.8% and 19.4% of the total. The number of PhDs and masters were 39,000 and 263,000 respectively, accounting for 13.0% and 87.0% of the total.

In 2013, China enrolled 367,000 postgraduate students in the field of natural science and engineering technologies, accounting for 60.1% of the total. Compared to 2010, the number of postgraduate students in science rose by 3.1%, which was the lowest. The increase of students in engineering science and agricultural science was 41.4% and 57.2% respectively. The postgraduate students in medical science saw the largest increase of 66.0%. Of all the postgraduate students in natural science and engineering technologies, those majoring in engineering science accounted for the largest share, 59.1%, while the proportion for science was 16.4%, both of which were 0.1 percentage point lower than the previous year. The proportion for agricultural science was 6.4%, up by 0.4 percentage point, and 18.1% for medical science, down by 0.3 percentage point (Table 1-5). The increased enrollment of postgraduate students in agricultural and medical sciences during the 12th Five-Year Plan period shows that academic disciplines related to people's livelihood are increasingly considered to be paid more attention.

Table 1-5 The number of postgraduate-entrants in natural science and engineering technologies by discipline (2005—2013)

10,000 persons

Year	Total number of postgraduate-entrants	Natural science and engineering technologies	Science	Engineering	Agriculture	Medicine
2005	36.48	22.87	4.52	13.13	1.39	3.83
2006	39.79	24.96	4.77	14.48	1.48	4.22
2007	41.86	25.76	5.14	14.63	1.57	4.42
2008	44.64	27.17	5.55	15.55	1.33	4.74
2009	51.10	27.75	5.93	15.87	1.48	4.47
2010	53.82	26.70	5.84	15.37	1.49	4.01
2011	56.02	33.37	5.77	19.51	2.01	6.08
2012	58.97	35.33	5.81	20.92	2.11	6.49
2013	61.14	36.75	6.02	21.73	2.34	6.65

See Appendix table 1-5.

China Science and Technology Indicators 2014

4. Overseas Chinese students

Overseas Chinese students are an important source of HRST in China. Against the backdrop of rapid economic growth and continuous increase in household income, the number of overseas Chinese students has maintained high-speed growth since 2005. In 2013, the number of overseas Chinese students totaled 414,000, 295,000 higher than 2005, marking an average growth of

16.9% per year.

China's sound economic performance and ever improving environment for innovation and entrepreneurship have attracted more and more overseas students to find jobs or start up their own business back in China. In particular, since 2007, growth in the number of returned overseas students has picked up speed, reaching 354,000 in 2013, 29.5% higher than the previous year and 10.1 times that of 2005, achieving an average growth of 33.5% per year. The ratio of returned overseas students to all the Chinese students studying abroad climbed to a record high of 85.4% in 2013 (Fig. 1-9).

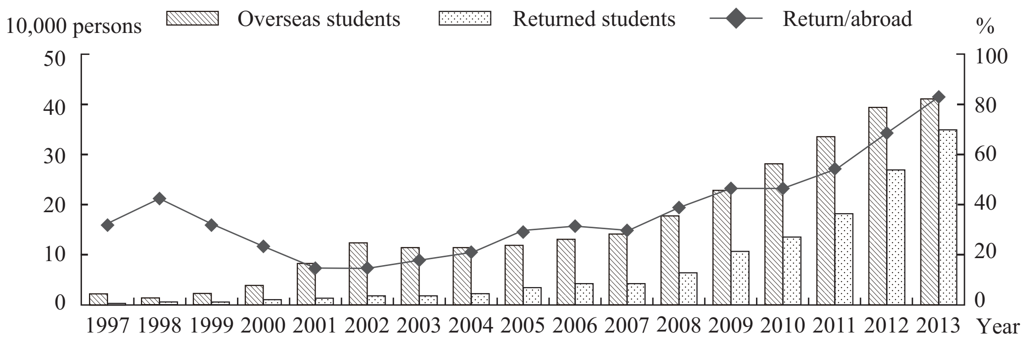

Fig. 1-9 Overseas and returned Chinese students (1997—2013)

See Appendix table 1-6.

China Science and Technology Indicators 2014

Developed western countries are the preferred destinations for Chinese students studying abroad. The number of Chinese students studying in the universities of US, UK and Japan has increased rapidly over recent years. Chinese students are now the largest foreign student community in the universities of many developed western countries.

The number of Chinese students studying in the US universities and colleges has notably increased. In 2012, the total number of Chinese students studying in the US universities (including undergraduate and postgraduate students) reached 190,000, up by 29.8% year-on-year. Since 2009, China has been the largest source of foreign students for US universities, with its proportion rising from 17.5% in 2009 to 29.9% in 2012. Meanwhile, the number of Chinese high school students choosing to study in US universities also reached 93,000 in 2012, 40.8% higher than the previous year. The proportion of undergraduate and junior college students in all the Chinese students studying in the US rose from 34.0% in 2009 to 45.0% in 2012, almost on a par with that of PhD and master students. In 2012, the number of Chinese postgraduate students in the US totaled 97,000, up by 20.8% year-on-year. In terms of disciplines, most of the Chinese postgraduate students studying in the US choose science and engineering (S&E)

as their major. Despite a moderate decline in recent years, they still accounted for 61.0% of the total in 2012. The number of undergraduate students in Non-S&E accounted for 65.5% of the total. In 2012, of all the foreign students in the US, China ranked the first in the total number of both undergraduate and postgraduate students (Table 1-6).

Table 1-6 Top three countries in US by number of overseas students

person

Country	All fields			Science and engineering			Non-science and engineering		
	Undergraduates	Postgraduates	Total	Undergraduates	Postgraduates	Total	Undergraduates	Postgraduates	Total
China	92700	97350	190050	31980	59430	91410	60720	37920	98640
India	10930	51310	62240	5740	39480	45220	5190	11830	17020
Korea	40670	21200	61870	11360	7810	19170	29310	13390	42700

Source: National Science Board, Science and Engineering Indicators 2014.

China Science and Technology Indicators 2014

The number of Chinese students studying in Japanese universities is only next to that of the US. In 2012, the total number of Chinese students studying in Japan reached 76,000, up by 3,000 over 2010, accounting for 62.5% of all the foreign students in Japanese universities. Of all the Chinese students in Japan, 51,000 were undergraduate students and 25,000 were postgraduate students. The proportion of Chinese undergraduate students in science and engineering to the total was 65.1%, and 55.5% for postgraduate students. Between 2008 and 2012, the number of Chinese students studying in Japan rose by 5.5% per year on the whole, while 4.4% for undergraduate students and 8.0% for postgraduate students (Table 1-7).

Table 1-7 Number of Chinese students studying in Japanese universities (2008, 2010, 2012)

Person

Year	Type	All fields	Science and engineering	Non-science and engineering
2008	Undergraduates	42936	27546	15390
	Postgraduates	18545	10343	8202
	Total	61481	37889	23592
2010	Undergraduates	49838	31862	17976
	Postgraduates	23617	13061	10556
	Total	73455	44923	28532
2012	Undergraduates	50976	33189	17787
	Postgraduates	25219	13987	11232
	Total	76195	47176	29019

Source: National Science Board, Science and Engineering Indicators 2014.

China Science and Technology Indicators 2014

In recent years, the number of Chinese students in science and engineering in UK universities has steadily increased. The number of Chinese undergraduate students in science and engineering in the UK universities rose from 7,700 in 2007 to 11,090 in 2012, up by 7.6% per year. The number of PhD and master students rose from 9,850 in 2007 to 13,455 in 2012, up by 6.4% per year (Table 1-8). The number of Chinese postgraduate students in the UK is slightly higher than that of undergraduate students.

Table 1-8 Number of Chinese students in S&E in UK universities (2007, 2009, 2011, 2012)

person

Year	Total	Undergraduates	PhD and Masters
2007	17550	7700	9850
2009	16930	7990	8940
2011	21620	10260	11360
2012	24545	11090	13455

Source: National Science Board, Science and Engineering Indicators 2014.

China Science and Technology Indicators 2014

Chapter 2 Research and Development Expenditure

Research and development expenditure, or R&D expenditure, refers to all the expenses actually spent on R&D activities. Based on the figures of domestic, international R&D and economic statistics, this chapter includes an analysis of the total volume, input intensity, structural pattern and trend of R&D expenditures in China, evaluation of the international status of China's R&D activities and its gap with developed countries, and a brief introduction to China's fiscal spending on science and technology and the implementation of the country's S&T development programs.

Section 1 Research and Development Expenditure

R&D expenditure refers to the total expenses spent on the R&D activities carried out inside a country, including the expenditures of R&D activities supported by foreign funds, but it does not include the expenditures of R&D activities supported by domestic funds in foreign countries. R&D expenditure is an important indicator to measure the scale of R&D activities and evaluate the technological strength and innovation capability of a country.

1. R&D expenditure

As the Chinese economy transiting from high-speed growth to the new normal of medium-high-speed growth, the rapid rise in R&D expenditure has given a strong boost to the innovation activities of the society. In 2013, China's R&D expenditure totaled 1,184.66 billion yuan, up by 12.5% year-on-year at constant price (Fig. 2-1).

Between 2001 and 2013, China's R&D expenditure expanded by 22.5% per year on average terms, which is 1.5 times that of the GDP growth during the same period at 15.0% per year.

2. Input intensity of R&D expenditure

The input intensity of R&D expenditure refers to the ratio of R&D expenditure to GDP. It is a key indicator to measure the input of R&D expenditure and to evaluate a country's model of economic growth. In 2013, the input intensity of R&D expenditure in China continued to rise and exceeded the 2% threshold for the first time, reaching 2.01%, higher than the average level of the EU countries (Fig. 2-2).

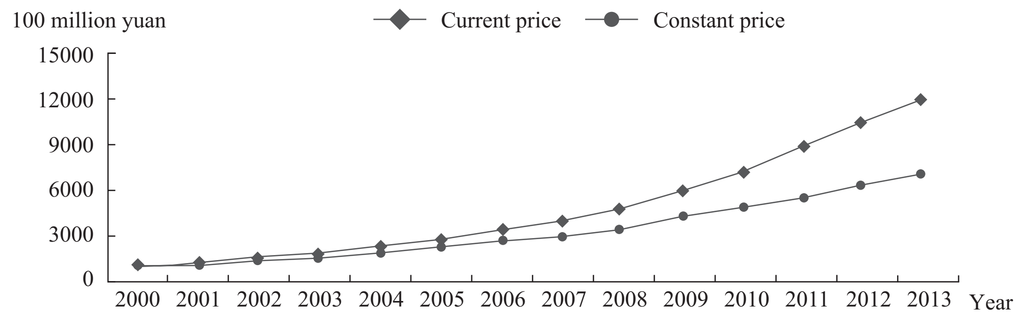

Fig. 2-1 Trend of R&D expenditures in China (2000—2013)

Note: constant price calculated based on GDP deflator.

See Appendix table 2-1.

China Science and Technology Indicators 2014

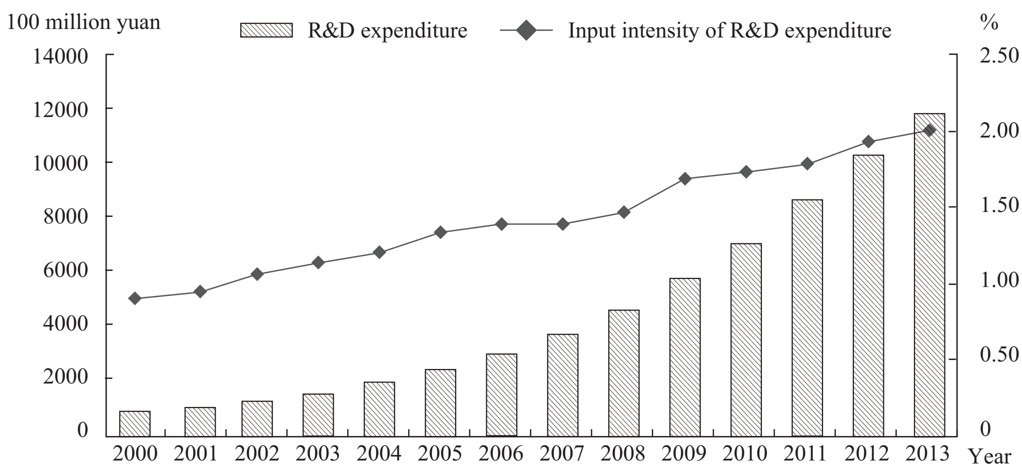

Fig. 2-2 Trend of China's R&D expenditure and input intensity (2000—2013)

See Appendix table 2-1.

China Science and Technology Indicators 2014

3. International comparison of R&D expenditure

According to the OECD statistics of 39 countries (regions) and the statistics of Brazil and India, the global R&D expenditure stood at around 1.4 trillion US dollars in 2013. The US, China, Japan, Germany, France, the Korea, the UK, Australia, Canada and Italy are the top ten spenders on R&D. Among them, the R&D expenditures of US, China, Japan and Germany all exceeded 100 billion US dollars, accounting for 64.2% of the world total. In 2013, the R&D expenditure of the US totaled 457 billion US dollars, 31.6% of the world total, ranking the first in the world. China's R&D expenditure, 191.2 billion US dollars, accounted for 13.2% of the world total, replacing Japan as the second in the world. Japan ranked the third with an R&D expenditure of 170.9 billion US dollars. Germany, spending 109.5 billion US dollars on R&D, came the fourth (Fig. 2-3).

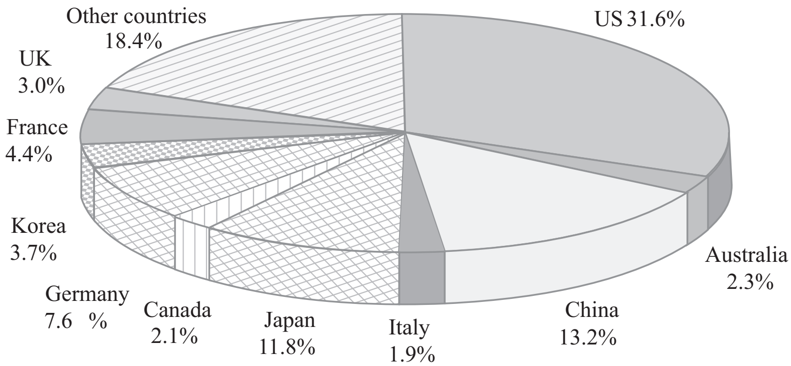

Fig. 2-3 Distribution of R&D expenditure in 41 countries (regions)

Source: OECD, Main Science and Technology Indicators 2014-2.

See Appendix table 2-5.

China Science and Technology Indicators 2014

Among the top ten spenders on R&D, China and the Korea recorded the highest growth between 2011 and 2013, up by 14.1% and 8.1% respectively. The R&D expenditures of the US, Japan, Germany and France continued to expand at a rate of 1.5%, 3.1%, 2.7% and 1.2% respectively. The UK, Canada and Italy saw negative growth in R&D expenditure, down by 2.6% for Canada (Table 2-1).

Table 2-1 Top ten spenders on R&D (2011—2013)

1 million USD, %

Country \ Year	2011	2012	2013	Average growth
China	134443	163148	191205	14.1
US	429143	453544	456977	1.5
Japan	199795	199066	170910	3.1
Germany	104956	101650	109515	2.7
France	62710	59809	62616	1.2
Korea	45016	49225	54163	8.1
UK	43868	42660	43528	−0.8

continued from table 2-1

Year / Country	2011	2012	2013	Average growth
Australia	31665	—	—	—
Canada	31818	31331	29858	−2.6
Italy	27539	26343	26824	−0.5

Note: average growth calculated based on GDP deflator in local currency

Source: OECD, *Main Science and Technology Indicators 2014-2*

See Appendix table 2-5

China Science and Technology Indicators 2014

For developed countries and emerging industrialized countries known for their innovation capability in the world, the input intensity of R&D expenditure is normally over 2%. According to the latest statistics, Israel, the Korea, Japan, Finland, Sweden and Denmark all have their input intensity of R&D expenditure over 3%, while in countries like the US, Germany and France, the Fig. 2-4 is also above 2%. China's input intensity was 2.01% in 2013, which was higher than the average level of some developed countries such as the UK, Italy and Canada and the 28 EU states, but still lower than the average 2.4% of OECD states, and lagging far behind developed countries like the US, Japan and Germany (Fig. 2-4).

Among the BRICS countries, China's input intensity of R&D expenditure is the highest, as compared to Brazil (1.16%), Russia (1.12%), India (0.88%) and South Africa (0.76%).

Section 2 Structure of Research and Development Expenditure

The structure of R&D expenditure mainly concerns its distribution in various R&D activities like basic research, applied research and experimental development, distribution in various performing organizations like enterprises, research institutions, universities, colleges and other agencies, as well as distribution and trend of changes according to the purposes of spending such as labor remunerations, other routine expenditures, instrument and equipment procurement fees, land and building procurement and construction fees.

1. Distribution of R&D expenditures according to types of activities

In 2013, China spent 55.5 billion yuan on basic research, 126.91 billion yuan on applied research, and 1,002.25 billion yuan on experimental development, accounting for 4.7%, 10.7% and 84.6% respectively of the total R&D expenditure (Fig. 2-5).

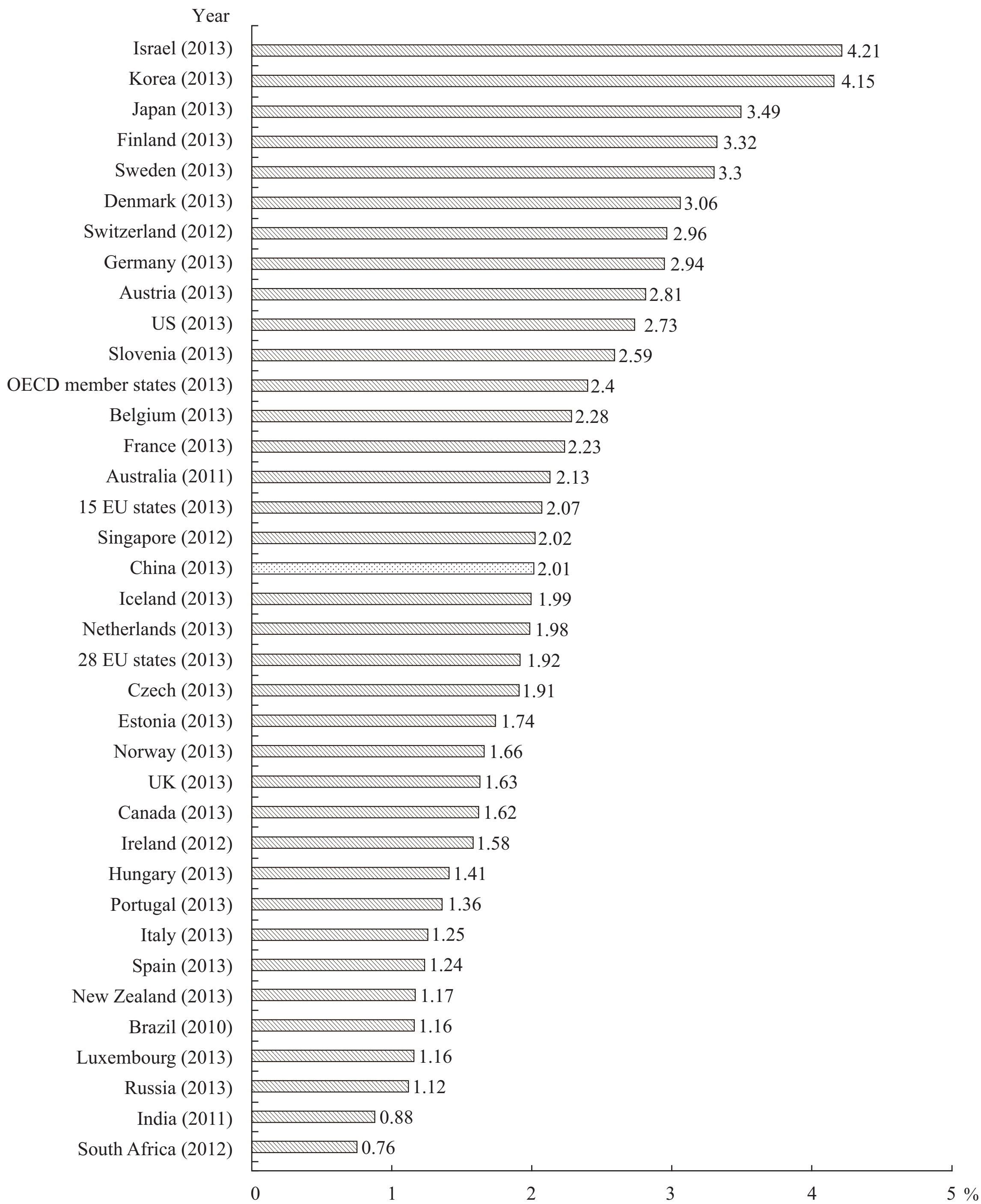

Fig. 2-4 Input intensity of R&D expenditure in certain countries and regions

Source: OECD, Main Science and Technology Indicators 2014-2.

See Appendix table 2-7.

Since 2007, the expenditure for basic research has steadily expanded, and its share in the total has been kept at 4.6% ～ 4.8%. The proportion of expenditure for applied research has been on the decline, hitting a record low of 10.7% in 2013. The share of experimental development in R&D expenditure has stayed above 82%.

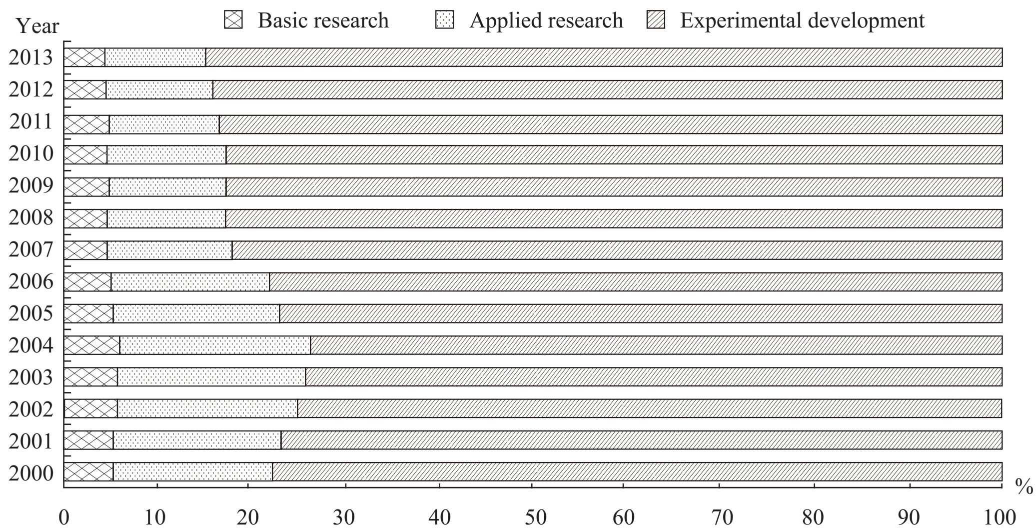

Fig. 2-5 Distribution of R&D expenditure according to types of activities (2000—2013)

See Appendix table 2-2.

China Science and Technology Indicators 2014

Compared to some countries, the share of scientific research (including basic research and applied research) in the total R&D expenditure is relatively low in China. In 2013, China spent 15.4% of its R&D expenditure on scientific research, while the Fig. 2-6 for most of the developed countries and emerging industrialized countries exceeded 35%, such as over 60% for France, and 35.1% and 37.1% respectively for Japan and the Korea (Fig. 2-6). This shows that China should not only increase its R&D expenditure faster, but also improve the structure of R&D expenditure, investing more in basic research and applied research, in order to enhance the capability for original innovation in science and technology.

The distribution of the R&D expenditure in different types of activities for various performing organizations shows the features of their R&D activities. In 2013, the ratio of basic research, applied research and experimental development is roughly 1∶3∶6 for research institutions, with 12.5% of the funds spent on basic research, 29.5% on applied research and 58.0% on experimental development. For universities and colleges, the ratio of the three activities is 3∶4∶1, with 87.4% on scientific research and 12.6% on experimental development. The R&D activities of enterprises are concentrated in experimental development, accounting for 97.2% of their total expenditures.

And the proportion of applied research and basic research in the expenditure is 2.7% and 0.1% respectively (Table 2-2).

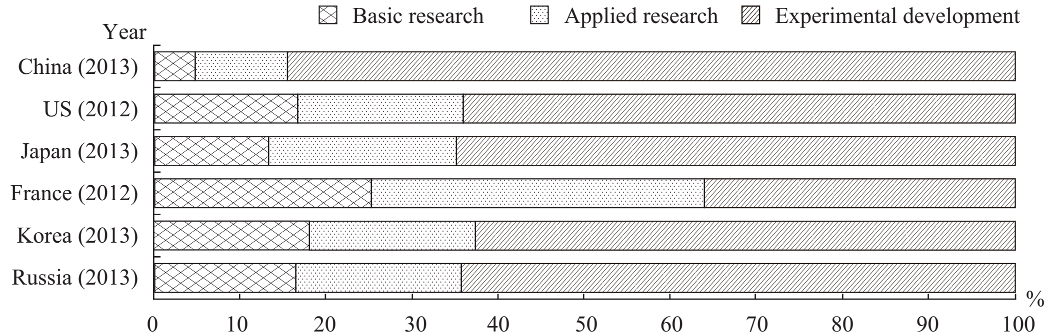

Fig. 2-6 Distribution of R&D expenditure according to types of activities in certain countries

See Appendix table 2-9.

China Science and Technology Indicators 2014

Table 2-2 Distribution of R&D expenditure according to types of activities and performing organizations (2013)

		Total		Basic research		Applied research		Experimental development	
		100 million yuan	%	100 million yuan	%	100 million yuan	%	100 million yuan	%
Nationwide	100 million yuan	11846.6	100.0	555.0	100.0	1269.1	100.0	10022.5	100.0
	%	100.0		4.7		10.7		84.6	
Enterprise	100 million yuan	9075.8	76.6	8.6	1.5	249.2	19.6	8818.0	88.0
	%	100.0		0.1		2.7		97.2	
Research institution	100 million yuan	1781.4	15.0	221.6	39.9	525.8	41.4	1034.0	10.3
	%	100.0		12.5		29.5		58.0	
Universities and colleges	100 million yuan	856.7	7.2	307.6	55.4	441.3	34.8	107.8	1.1
	%	100.0		35.9		51.5		12.6	
Other organizations	100 million yuan	132.7	1.1	17.7	3.1	52.8	4.2	62.7	0.6
	%	100.0		12.9		39.8		47.3	

See Appendix table 2-3.

China Science and Technology Indicators 2014

As shown in the distribution of R&D activities in different performing organizations, basic research is concentrated in universities and colleges. Since 2006, they have been the largest spender on basic research, while the proportion of research institutions has also been on the rise. In 2013, among all the expenditures on basic research, 55.4% came from universities and colleges, 39.9% from research institutions, and only 1.5% from enterprises. In terms of the expenditure on applied research, research institutions, universities and colleges universities and colleges and enterprises each accounted for 41.4%, 34.8% and 19.6% of the total. Experimental development activities are mainly carried out by enterprises, which represent 88.0% of the expenditure on experimental development.

2. Distribution of R&D expenditure according to performing organizations

In 2013, the R&D spending of enterprises, research institutions, universities and colleges totaled 907.58 billion yuan, 178.14 billion yuan and 85.67 billion yuan respectively, accounting for 76.6%, 15.0% and 7.2% of the total (Table 2-2). At constant price, the 2013 R&D expenditure of enterprises, research institutions and universities and colleges rose by 13.2%, 12.5% and 7.3% respectively over 2012 (Table 2-3).

Table 2-3 Growth speed of the R&D expenditures of different performing organizations at constant price (2004—2013)

%

Organization \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Nationwide	19.5	19.9	18.0	14.5	15.4	25.8	13.8	13.8	15.7	12.5
Enterprise	28.0	22.6	22.7	16.5	17.0	25.7	14.1	17.3	16.3	13.2
Research institution	1.2	14.4	6.4	12.4	9.4	22.9	11.4	1.9	15.7	12.5
Higher learning institution	15.8	16.1	9.9	5.4	15.0	20.1	19.3	6.7	10.6	7.3
Other organizations	1.8	1.6	13.4	−2.7	18.8	172.0	−2.3	11.0	10.3	2.4

Note: calculated based on GDP deflator

See Appendix table 2-2.

China Science and Technology Indicators 2014

Since 2000, there has been a notable change in the distribution pattern of R&D expenditures across various performing organizations in China. In 2013, the share of enterprises in the total R&D expenditure reached 76.6%, 16.6 percentage points higher than that of 2000. The share of research institutions, 15.0%, was down by some 13.8 percentage points compared to 2000. The share of higher learning institutions, 7.2%, also dropped by 1.4 percentage points over that of 2000 (Fig. 2-7).

In terms of international comparison, the share of enterprises in China's R&D expenditure, which reached 76.6% in 2013, has already surpassed that of Japan. Meanwhile, the share of research institutions is larger, while the share of universities and colleges is relatively small. The difference between countries in the relative proportion of the R&D expenditures of research institutions, universities and colleges is mainly impacted by the way their science and technology system established. Most developed countries in the west have a long history of developing universities and colleges and the tradition of promoting scientific research. Therefore, in these countries, the R&D expenditure of universities and colleges is often larger than that of research institutions. On the other side, research institutions in China and Russia both witnessed robust development under the planned economy. Although these research institutions have been reformed over the years, they still occupy an important position in the country's scientific research system. In 2013, research institutions, universities colleges each contributed to 15.0% and 7.2% of China's R&D expenditure (Fig. 2-8).

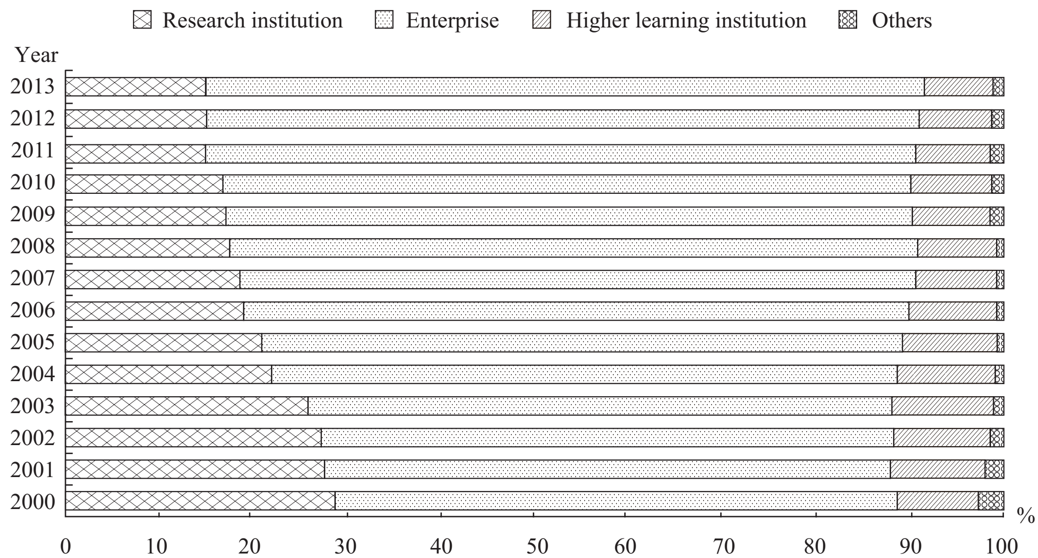

Fig. 2-7 Distribution of R&D expenditure according to performing organizations (2000—2013)

See Appendix table 2-2.

China Science and Technology Indicators 2014

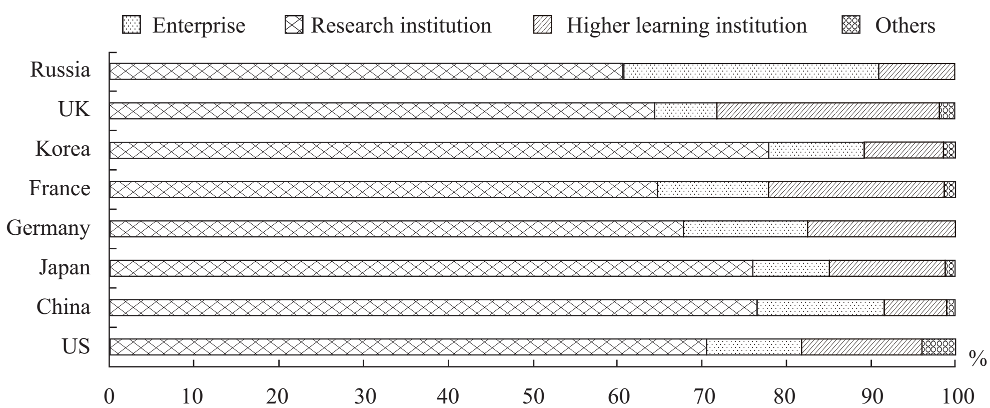

Fig. 2-8 Distribution of R&D expenditure according to performing organizations in certain countries (2013)

See Appendix table 2-8.

China Science and Technology Indicators 2014

3. R&D expenditure according to the purposes of spending

According to the purposes of spending, R&D expenditure can be divided into such categories as labor fees, other routine expenses, instrument and equipment procurement fees, and other capital expenses. Other routine expenses refer to all the actual purchase expenses required for carrying out R&D activities, including raw material fees, utility fees, processing and testing fees, equipment usage fees, travel allowances, house rental fees, etc. With the reform of China's compensation system and the establishment of various kinds of social insurance schemes, the statistics of labor remunerations in China now include not just remunerations paid in cash and in kind, but also contributions to entitlement programs such as medical services, housing and transportation allowances and insurance.

Concerning China's R&D expenditure in 2013, 26.7% were spent on labor remuneration, 59.2% on other routine expenses, 11.9% on instrument and equipment procurement fees, and 2.2% on other capital expenses. In recent years, China's labor costs have steadily increased, with the per capita labor remuneration of R&D personnel rising from 63,000 yuan/person-year in 2009 to 89,000 yuan/person-year in 2013. Higher labor remuneration for the R&D personnel can help attract more S&T human resources to take part in R&D activities (Table 2-4).

Table 2-4 Distribution of R&D expenditure according to purposes of spending (2009—2013)

Year	R&D expenditure (%)	Labor remuneration (%)	Other routine expenses (%)	Instrument and equipment procurement fees (%)	Other capital expenses (%)	Per capita labor remuneration of R&D personnel (10,000 yuan/ person-year)
2009	100.0	24.7	59.2	12.9	3.2	6.3
2010	100.0	23.6	60.3	13.2	2.9	6.5
2011	100.0	24.2	60.2	13.2	2.3	7.3
2012	100.0	25.7	59.8	12.1	2.3	8.1
2013	100.0	26.7	59.2	11.9	2.2	8.9

Source: National Statistics Bureau and the Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2010—2014*.

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Despite rising labor remuneration of the R&D personnel, China is still a country with relatively low R&D labor costs, and labor remuneration only accounts for a small proportion of the R&D expenditure. In the case of Japan and the Korea, the proportion of labor costs in the R&D expenditure is generally about 40%, while the Fig. for France and Russia is normally above 55%.

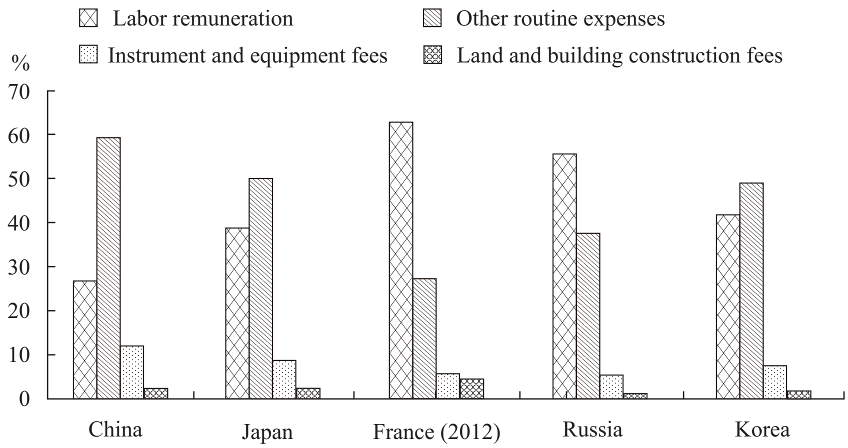

Fig. 2-9 Proportion of labor costs in the R&D expenditure of certain countries (2013)

See Appendix table 2-10.

Section 3 Origin and Destination of R&D Expenditure

This section analyzes the source of China's R&D funds, including government funds, enterprise funds, overseas funds and other funds, as well as the utilization of funds by enterprises, research institutions, universities and colleges and other organizations.

1. Source of R&D funds

China's R&D funds totaled 1,184.66 billion yuan in 2013, including 250.06 billion yuan from the government, 21.1% of the total; 883.77 billion yuan from enterprises, 74.6% of the total, 10.59 billion yuan from overseas, 0.9% of the total; and 40.25 billion yuan from other sources, 3.4% of the total (Fig. 2-10). These figures show that enterprises are the primary source of R&D funds in China.

Following the implementation of the *Outline of the National Medium- and Long-term Program for Science and Technology Development (2006—2020)*, the Chinese government has increased its spending on basic research, national defense and strategic high technology research and research for public benefits. In 2013, the government spending on R&D totaled 250.06 billion yuan, which was 1.5 times than that of 2010. Despite the rapid increase in government-sourced R&D expenditure, its share in the total R&D expenditure dropped from 33.4% in 2000 to 21.1% in 2013.

Internationally, the proportion of government-sourced R&D funds is under 25% in Japan and the Korea, while the Fig 2-11. for the US, Germany and the UK is between 25% and 30%, France around 35% and Russia up to 60% (Fig. 2-11).

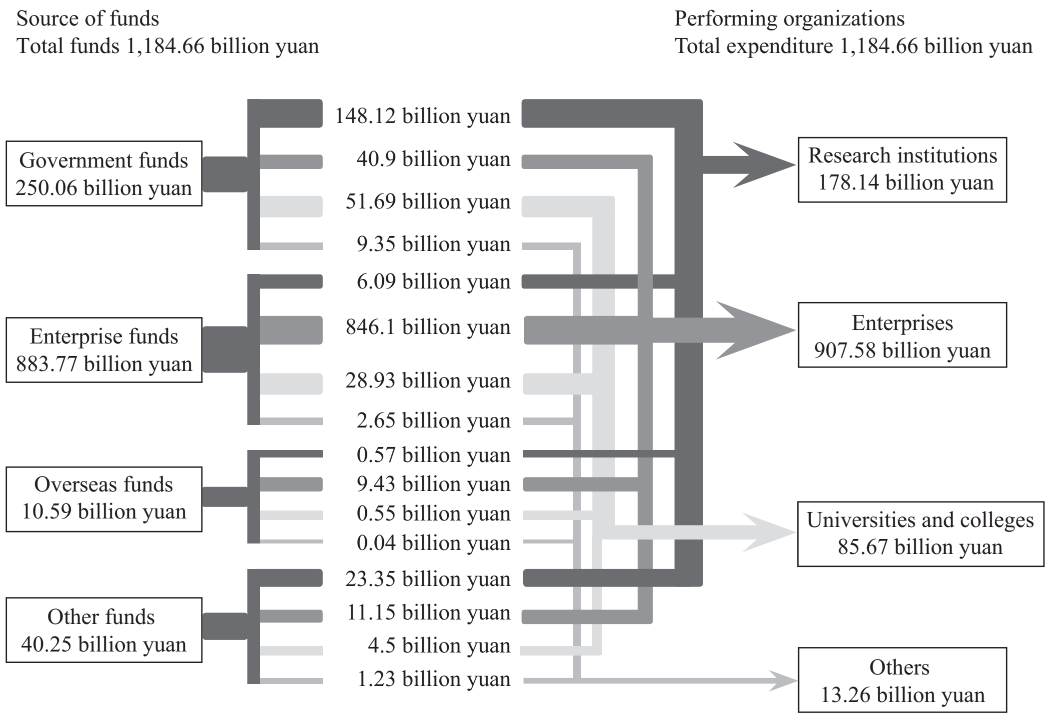

Fig. 2-10 Origin and destination of R&D funds (2013)

See Appendix table 2-3.

China Science and Technology Indicators 2014

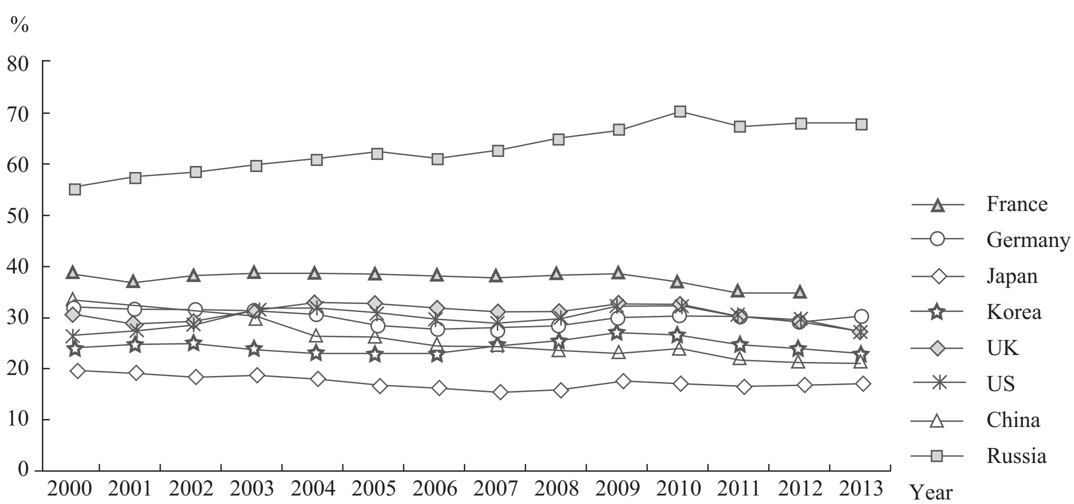

Fig. 2-11 Proportion of government-sourced R&D funds in certain countries (2000—2013)

Source: OECD, Main Science and Technology Indicators 2014-2

China Science and Technology Indicators 2014

2. Destination of R&D funds

The main destinations of China's R&D funds include enterprises, research institutions, universities, colleges and other organizations. Government funds are mainly spent on centrally-affiliated research institutions commissioned for the implementation of national science and technology programs and some research-based universities. In 2013, government-sourced R&D funds totaled 250.06 billion yuan, of which 59.2% went to research institutions, 20.7% to universities and colleges, 16.4% to enterprises and 3.7% to other organizations.

Enterprises are both the main performers and major investors in China's R&D activities. Among the 883.77 billion yuan of R&D funds sourced from enterprises in 2013, 846.1 billion yuan were used by enterprises, accounting for 95.7% of the total, and only less than 5.0% of the funds went to universities and colleges, research institutions and other organizations.

Overseas-sourced R&D funds mainly went to enterprises, accounting for 89.0% of the total, while the remaining 11.0% of the funds were received by universities and colleges, research institutions and other organizations.

Section 4 Government Spending on Science and Technology

Government spending on science and technology refers to the direct funding support provided by central and local governments for S&T activities. The funds provided are not just used to support R&D activities, but also to support public S&T activities on such subjects as earthquake, environmental protection and scientific knowledge dissemination, and to promote the commercialization of S&T outcomes. This section will focus on the fiscal expenditure of the government spending on science and technology and the allocation of central government funds under the national S&T programs.

1. Fiscal expenditure on science and technology

Fiscal expenditure on science and technology mainly includes the funds for S&T management, basic research, applied research, technology research and development, S&T conditions and services, social science, S&T dissemination, S&T exchanges, cooperation and other S&T funds under the item of S&T expenditure, as well as S&T funds under other items of functional expenditure. The funds for S&T management include the funds of governments at various levels for managing S&T affairs; the funds for basic research and applied research include the operational funds of the institutions engaged in basic research, and applied research, and the funds in support of key basic research programs, natural science foundations, key laboratories and matching facilities, major science projects, public research programs and research of high technologies. The funds for technology research and development include the funds for the research and development of applied technologies and industrial technologies as well as the funds in support of the conversion and dissemination of S&T outcomes. The "S&T expenditures under other items of expenditures" of the central government include SME innovation fund, special fund for industrial transformation and upgrading, and the S&T funds under the item of education. The "S&T expenditures under other items of expenditure" of the local government mainly include the funds for the demonstration and dissemination of agricultural, forestry and aquatic technologies.

In 2013, the fiscal expenditure on science and technology totaled 618.49 billion yuan, up by 10.4% year-on-year, and its proportion in the overall fiscal expenditure reached 4.4%, slightly lower than the previous year (Fig. 2-12). Of all the fiscal expenditure on science and technology, 508.43 billion yuan was spent under the item of S&T expenditure, accounting for 82.2% of the total; 110.06 billion yuan spent under other items of expenditure, 17.8% of the total (Table 2-5).

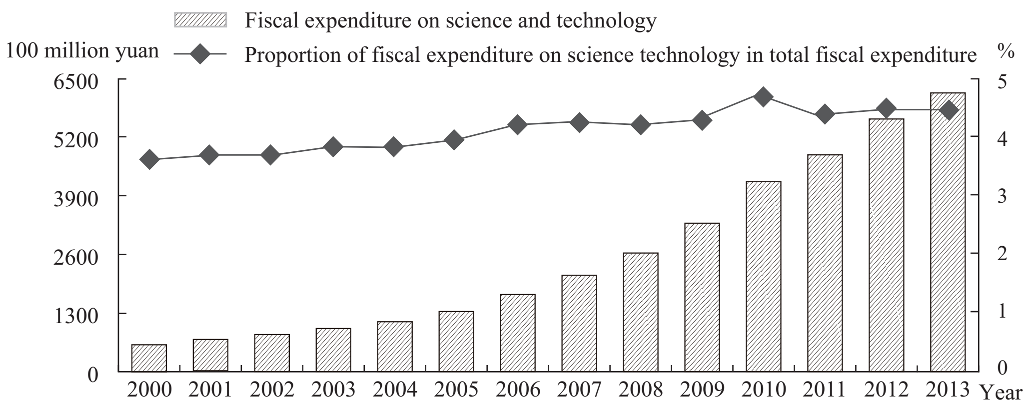

Fig. 2-12 Fiscal expenditure on science and technology and its proportion in total fiscal expenditure (2000—2013)

Note: Statistical subjects are now different from pre-2006 period following the reform of classification of government revenue in 2007.

See Appendix table 2-4.

China Science and Technology Indicators 2014

Table 2-5 Fiscal expenditure on science and technology classified according to functions

100 million yuan

Category	2013			2012		
	Nationwide	Central	Local	Nationwide	Central	Local
Fiscal expenditure on S&T	6184.9	2728.5	3456.4	5600.1	2613.6	2986.5
# S&T expenditure	5084.3	2369.0	2715.3	4452.6	2210.4	2242.2

continued from table 2-5

Category	2013			2012		
	Nationwide	Central	Local	Nationwide	Central	Local
S&T expenditure under other items of expenditure	1100.6	359.5	741.1	1147.5	403.2	744.3

Source: National Statistics Bureau, *China Statistical Year Book (2013, 2014)* ; National Statistics Bureau and the Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology (2013, 2014)* .

China Science and Technology Indicators 2014

Fiscal expenditure on science and technology includes the expenditures of both central and local governments. In 2013, the fiscal expenditure on science and technology of the central government totaled 272.85 billion yuan, accounting for 13.3% of its total fiscal expenditure, down by 0.9 percentage points from the 2011 level of 14.2%. In 2013, the central government accounted for 44.1% of the total fiscal expenditure on science and technology (Table 2-6).

In 2013, the fiscal expenditure on science and technology of local governments totaled 345.64 billion yuan, accounting for 2.9% of their total fiscal expenditure, the highest in the last three years. In 2013, local governments accounted for 55.9% of the total fiscal expenditure on science and technology.

Table 2-6 Fiscal expenditure on science and technology of central and local governments and their shares in central and local fiscal expenditure (2000—2013)

Year	Fiscal expenditure on science and technology (100 million yuan)		Fiscal expenditure on science and technology as a share of total fiscal expenditure (%)	
	Central	Local	Central	Local
2000	349.6	226.0	6.3	2.2
2001	444.3	258.9	7.7	2.0
2002	511.2	305.0	7.6	2.0
2003	609.9	335.6	8.2	2.0
2004	692.4	402.9	8.8	2.0
2005	807.8	527.1	9.2	2.1
2006	1009.7	678.8	10.1	2.2
2007	1044.1	1091.6	9.1	2.9
2008	1287.2	1323.8	9.7	2.7
2009	1653.3	1623.5	10.8	2.7
2010	2052.5	2144.2	12.8	2.9
2011	2343.3	2453.7	14.2	2.7
2012	2613.6	2986.5	13.9	2.8
2013	2728.5	3456.4	13.3	2.9

See Appendix table 2-4.

China Science and Technology Indicators 2014

2. Central government funds provided under national S&T programs

As the central government increases its funding support for science and technology, national S&T programs are now playing an increasingly important role in promoting the development of science and technology. The national S&T programs implemented during the "12th Five-Year Plan" period mainly include National Major S&T Projects, National Key Basic Research Program ("973" program, including major scientific research plan), National High-tech Research and Development Program ("863" program), national S&T supporting programs, Major International S&T Cooperation Programs, policy guiding programs, building of major S&T innovation bases and other programs.

The National Major S&T Projects refer to major strategic products, key generic technologies and major projects achieved within a fixed time frame through core technology breakthroughs and resource integration for the purpose of realizing the development goals of the country. They are the top priority in China's S&T agenda. In 2013, the central government provided 13.69 billion yuan to support National Major S&T Projects. Between 2006 and 2013, the central government funds allocated under National Major S&T Projects exceeded 80 billion yuan①.

Driven by the major development needs of the country, the "973" program is a basic research program with strategic, forward-looking, overarching and catalytic importance to the future development and S&T progress of China. Its main task is to provide solutions to the major scientific issues concerning China's economic development, social progress, state security and S&T development, to produce a group of original innovations with major impact on the mainstream science in the world, to provide the scientific foundation for the country's sustainable economic and social development and source of innovation for the development of high and new technologies, and to enhance China's ability to pursue independent innovation in basic research. In 2013, the central government allocated 4.06 billion yuan under the "973" program, including 2.83 billion yuan in support of the nine basic research programs of major strategic needs in the country, i.e. agricultural science, energy science, information science, resource and environment science, health science, material science, manufacturing and engineering science, interdisciplinary science and major frontier science (Fig. 2-13); 1.23 billion yuan for the six major scientific research programs, i.e. nanotechnology, quantum control, protein, development and reproduction, stem cell and global change (Fig. 2-14).

The implementation of the "863" program has highlighted its features as a strategic, forward-looking and frontier program. It gained a number of major S&T outcomes with international competitiveness in key sectors. It has notably enhanced China's indigenous innovation capability

① The data of key national S&T special programs is provided by the Ministry of Finance.

in high-tech fields and provided a strong boost to the industrialization of high technologies and the development of high-tech industries. In 2013, the central government allocated 5.2 billion yuan under the "863" program, which mainly supported scientific research in ten priority areas, i.e. information technology, biological and medical technology, new material technology, advanced manufacturing technology, advanced energy technology, resource and environment technology, marine technology, modern agricultural technology, modern transportation technology and remote sensing (Fig. 2-15).

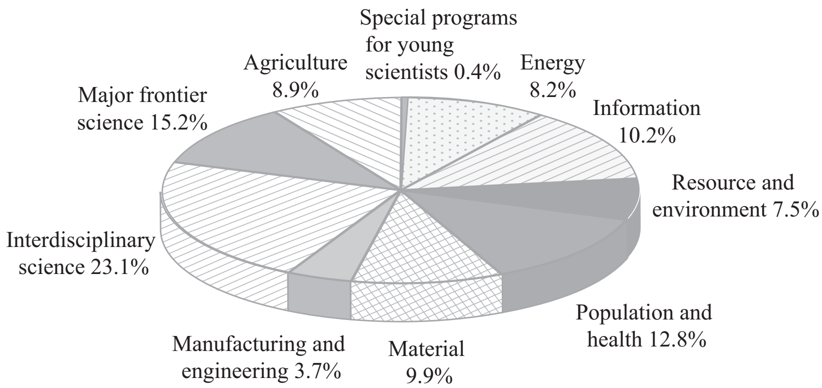

Fig. 2-13 Distribution of central government funds under the "973" program according to technological sectors (2013)

Source: Ministry of Science and Technology, *Annual Report of National Science and Technology Programs 2014.*

China Science and Technology Indicators 2014

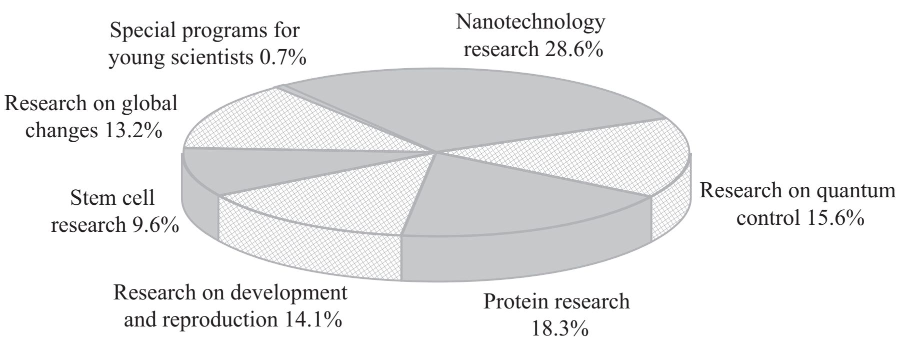

Fig. 2-14 Distribution of the funds of key national scientific research programs according to sectors (2013)

Source: Ministry of Science and Technology, *Annual Report of National Science and Technology Programs 2014.*

China Science and Technology Indicators 2014

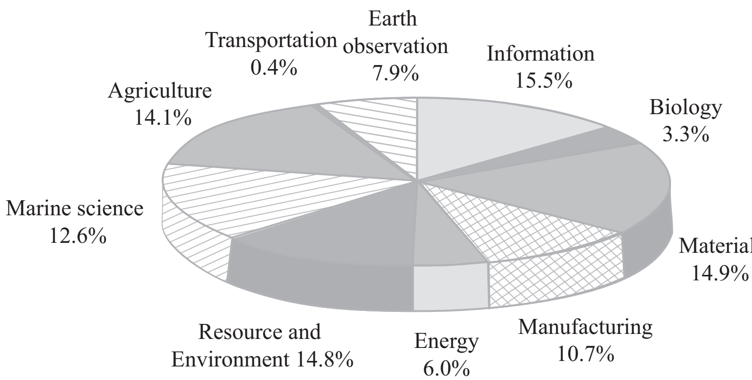

Fig. 2-15 Distribution of central government funds under the "863" program according to technological sectors (2013)

Source: *Ministry of Science and Technology, Annual Report of National Science and Technology Programs 2014.*

China Science and Technology Indicators 2014

The national S&T supporting programs are launched for the purpose of implementing the *Outline of the National Medium- and Long-term Program for Science and Technology Development (2006—2020)*, serving the country's needs of economic and social development, and dealing with the major S&T issues in the economy and society. In 2013, the central government allocated 6.13 billion yuan under national S&T supporting programs, which mainly addressed the key issues and generic technologies concerning energy, resources, environment, agriculture, material, manufacturing, transportation, information and modern service industries, population and health, urbanization and urban development, public security and other social programs. The break-down of funds is as follows: 0.26 billion yuan for energy, or 4.2% of the total; 0.26 billion yuan for resources, or 4.2% of the total; 0.42 billion yuan for environment, or 6.9% of the total; 1.12 billion yuan for agriculture, or 18.3% of the total; 0.57 billion yuan for material, or 9.3% of the total; 0.34 billion yuan for manufacturing, or 5.6% of the total; 0.38 billion yuan for transportation, or 6.2% of the total; 1.34 billion yuan for information and modern service industries, or 21.9% of the total; 0.58 billion yuan for population and health, or 9.5% of the total; 0.46 billion yuan for urbanization and urban development, or 7.5% of the total; 0.44 billion yuan for public security and other social programs, or 7.1% of the total.

In 2013, the central government funds totaled 0.75 billion yuan, 0.61 billion yuan, 3.26 billion yuan and 8.79 billion yuan respectively in support of international S&T cooperation programs, policy guiding programs, building of major S&T innovation bases and other programs. The policy guiding programs include the Torch program, the Spark program, the National program on key new products and the National soft science program, which respectively received 0.21 billion yuan, 0.19 billion yuan, 0.19 billion yuan and 0.03 billion yuan of funds from the central government in 2013. The key S&T innovation bases include key state laboratories, the national science & technology infrastructure and the national key engineering center, which respectively received 2.89 billion yuan, 0.27 billion yuan and 0.1 billion yuan of funds from the central government in 2013. Other programs mainly include the innovation fund for technology-based SMEs, the special fund for the technology research and development of scientific research institutions, the fund for the commercialization of S&T outcomes in agriculture, the action plan for supporting county development with science and technology, the program on S&T infrastructure (including the program on innovation in methodology), the national special research program on magnetic fusion power, the national program on major scientific instrument and equipment, and the science and technology program for public wellbeing, which respectively received 5.12 billion yuan, 0.3 billion yuan, 0.5 billion yuan, 0.5 billion yuan, 0.24 billion yuan, 0.42 billion yuan, 1.04 billion yuan and 0.27 billion yuan of funds from the central government in 2013.

Chapter 3 Output of Science and Technology Activities

The output of science and technology activities refers to various kinds of outcome produced in the course of scientific research and technological innovation, mainly in the form of S&T papers and patents. S&T papers embody outcome of creating knowledge, and mainly serve as an indicator of the output of scientific research. Patents generally serve as an indicator of the output of technological innovation, and reflect the outcome of technology invention.

Section 1 Science and Technology Papers

S&T papers, as an important means of S&T activities, reflect a country's S&T output from basic research and applied research, and indicate a country's S&T capabilities and international competitiveness. Based on statistics gathered from the SCI database, the section analyzes SCI papers, internationally-coauthored papers and the output of S&T articles per research investment. When China's output of SCI papers is compard with that of other countries, papers contributed by researchers from Hong Kong and Macau is included. When the number of SCI papers is divided according to academic disciplines, institutions and geographic regions, only SCI papers with the first authors coming from mainland China is counted. When internationally-coauthored papers are analyzed, papers published by authors from mainland China are counted.

1. Science citation index papers

Three retrieval systems, namely Science Citation Index (SCI), Engineering Index (EI), and Conference Proceedings Citation Index-Science (CPCI-S, formerly known as ISTP), have been adopted to collect statistics on international S&T papers for many years. SCI mainly reflects facts of basic scientific research. EI primarily presents scientific researches of engineering technology. CPCI-S is an important supplement to journals and relevant literature, recording a majority of proceedings of scientific conferences published all over the world. This section only analyzes SCI papers because of the overlapping between SCI and EI papers. Moreover, the indicator of SCI papers is a general standard in international comparison.

(1) Total volume of SCI papers and its distribution

The volume of SCI papers produced by China has seen a steady increase as China has strengthened the competitiveness of its scientific researches on the international academic community. China churned out 232,000 S&T papers in 2013, up by 175,000 from 2004, translating into an annual average growth rate of 16.8% in the period. China has been the world's second largest producer of S&T papers for five straight years, with the US dominating the top spot. The UK, Germany and Japan were also among the top five producers of academic papers. 5.4% of SCI papers published worldwide in 2004 came from China, and the figure increased to 13.5% in 2013 (Fig. 3-1).

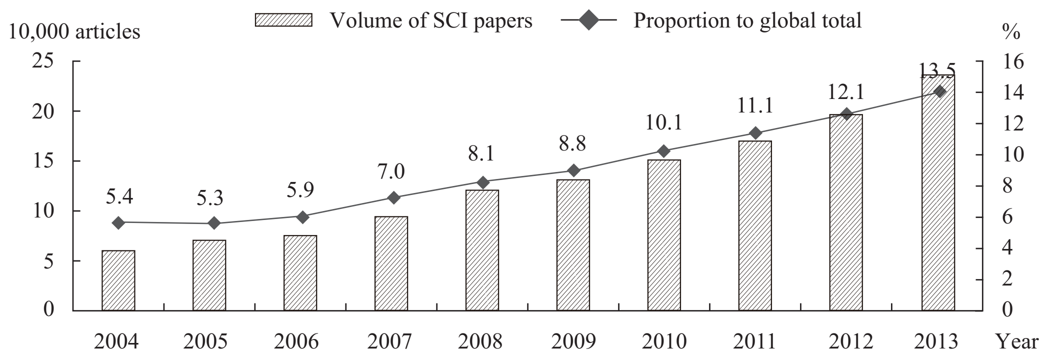

Fig. 3-1 Volume of Chinese-authored SCI papers and its proportion to the global total (2004—2013)

See Appendix table 3-1.

China Science and Technology Indicators 2014

Among China's SCI papers issued in 2013, 102,000 papers, or 52.7% of the total were dedicated to basic disciplines, down by 1 percentage point year on year. 52,000 papers, or 26.7% of the total, focused on industrial technologies, up by 0.6 percentage point year on year. SCI papers in all academic disciplines recorded positive growth in almost all but a few years in the 2004—2013 period. The volume of papers in the industries of farming, forestry, animal husbandry, and fishery registered the fastest annual growth rate of 29.9% thanks to low base numbers, and the proportion of papers in the industries rose by 1.4 percentage points in the period. Volume of foundamental-discipline papers recorded a slower annual growth rate of 14.9% and the proportion slumped by 11.7 percentage points (Fig. 3-2). Papers related to industrial technologies logged an average annual growth rate of 17.7%, and the proportion hit a ten-year high of 28.4% in 2011 before slipping to the 2004 level in the next two years.

Between 2004 and September 2014, Chinese scientists and researchers issued 288,000 chemistry papers collected by SCI, much more than papers in other disciplines. SCI papers in four other disciplines exceeded 100,000 in the ten-year period, including physics (186,000), engineering technologies (148,000), materials science (147,000) and clinical medicine (125,000). There were nine disciplines in which Chinese-authored SCI papers took up more than 10% of the world's total. Among them, the proportion was more than 20% for papers in materials science and chemistry, and more than 15% for papers in mathematics, physics and engineering technology. Compared to the prior year, SCI papers recorded positive growth at all disciplines but space science. Chemistry-related papers increased by 15.5% year on year, representing the biggest proportion of all SCI papers. 20.6% of the world's chemistry papers released in 2013 were contributed by China, up from 18.8% a year before. Biology & biochemistry, pharmacy & toxicology, and agricultural science reported sharp increases in SCI papers thanks to lower base numbers, rising by 90.8%, 63.2% and 59.9% from the previous year, respectively (Table 3-1).

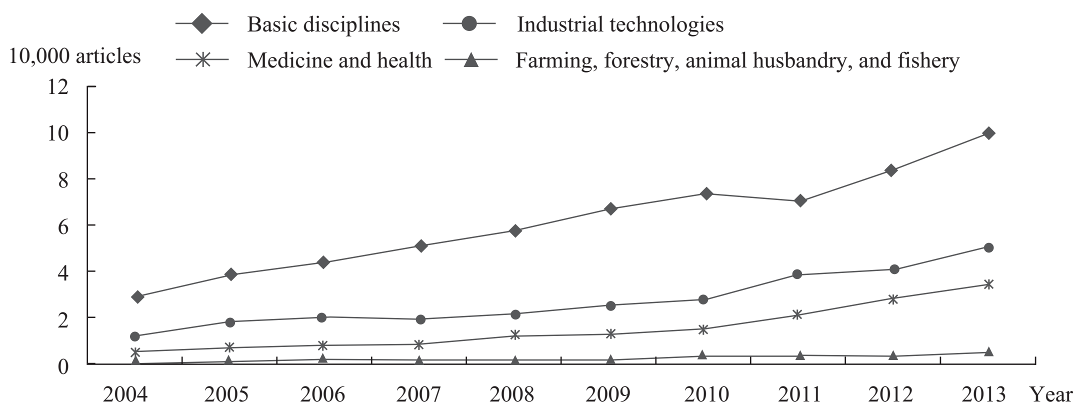

Fig. 3-2 Breakdown of China's SCI papers by academic disciplines (2001—2013)

See Appendix table 3-2.

China Science and Technology Indicators 2014

Table 3-1 International status of Chinese-authored SCI papers in major disciplines (January 2004— September 2014)

Discipline	Article statistics		Citation statistics				Average citation per SCI paper	
	Number of articles	Percentage (%)	Times	Percentage (%)	World ranking	Change in ranking	Times	Percentage to world average (%)
Materials science	146649	24.5	1066365	20.16	2	—	7.27	0.82
Chemistry	287718	20.56	2708970	16.07	2	—	9.42	0.78
Mathematics	61298	17.53	222482	16.75	2	—	3.63	0.96
Physics	185552	17.11	1395813	12.83	3	—	7.52	0.75
Engineering technology	147852	15.61	765678	14.68	2	—	5.18	0.94
Computer science	45220	13.99	160075	10.05	2	—	3.54	0.72
Earth sciences	44644	12.54	366897	9.78	5	—	8.22	0.78

continued from table 3-1

Discipline	Article statistics		Citation statistics				Average citation per SCI paper	
	Number of articles	Percentage (%)	Times	Percentage (%)	World ranking	Change in ranking	Times	Percentage to world average (%)
Environment and ecology	35761	10.53	298929	7.45	5	↑ 1	8.35	0.71
Pharmacology and toxicology	33351	10.43	267141	6.92	5	—	8.01	0.66
Comprehensive disciplines	2468	9.66	42868	4.93	8	↓ 1	17.37	0.51
Biology and biochemistry	87962	9.14	540835	5.28	7	—	9.33	0.58
Molecular biology and genetics	32301	8.68	363562	3.98	9	↑ 1	11.26	0.46
Microbiology	14523	8.56	114525	4.53	7	↑ 1	7.89	0.53
Agricultural science	27823	8.38	185341	7.48	3	—	6.66	0.89
Botany and zoology	44590	7.16	303508	5.79	8	—	6.81	0.81
Space science	9448	7.15	93530	4.36	13	↑ 1	9.9	0.61
Clinical medicine	124961	5.59	958861	3.48	10	↑ 3	7.67	0.62
Immunology	12070	5.55	119828	2.9	12	↑ 1	9.93	0.52
Neurology and behavioral science	23002	5.21	200195	2.64	12	↑ 1	8.7	0.51
Psychiatry and psychology	6682	2.11	51917	1.43	15	—	7.77	0.68

Source: Institute of Scientific and Technical Information of China (ISTIC).

China Science and Technology Indicators 2014

(2) Citations to SCI papers

Scientists cite a paper as a recognition of the research work done by peers. The collection of these citations provides an effective means measuring the quality and influence of articles. Articles have lagging and accumulating effects. The accumulation of SCI papers in the past 10 years has led to a substantial increase in the citations of Chinese-authored articles in recent years.

Between 2004 and September 2014, Chinese scientists and researchers published 1.37 million pieces of articles, retaining the second place in the world, rising by 19.8% from the previous statistics in 2013. These articles recorded a combined 10.37 million citations, putting China at the fourth place in the world by SCI citations, up by one spot from the prior statistics. An average Chinese-authored paper was cited 7.57 times, up by 9.4% from 6.92 times in the prior statistics, further narrowing the gap with the world average of 11.05 times of citations per SCI paper. The average citation per article is decided by a couple of factors such as the number of published articles, the language of articles and so on. Therefore, the application of this indicator must have a certain premise, that is, it is meaningful to compare the academic influence of a country with countries having the similar output scale. If a country publishes a limited number of articles and they have relatively higher citations, the country would lead in the world by average citations per article. Among the 19 countries that published more than 200,000 SCI papers, 12 had more citations than the world average, and China was in the 15th place. The average citations per SCI paper are higher than the world average of 15 times at Switzerland, Netherlands, the US, the UK and Sweden (Table 3-2).

Table 3-2 Number of SCI articles of major countries (regions) and their citations (2004—2014)

Country/region	SCI papers		Total citations		Average citation per article	
	Number of articles	Ranking	Times	Ranking	Times	Ranking
US	3454354	1	57289094	1	16.58	3
Germany	900112	3	13124606	2	14.58	6
UK	805373	4	13036332	3	16.19	4
China	1369834	2	10370132	4	7.57	15
Japan	804677	5	8935485	5	11.1	12
France	637957	6	8748589	6	13.71	8
Canada	543312	7	7844494	7	14.44	7
Italy	521511	8	6840041	8	13.12	9
Netherlands	308982	13	5296751	9	17.14	2
Spain	439049	9	5166842	10	11.77	11
Australia	395956	11	5162098	11	13.04	10
Switzerland	222232	17	4095298	12	18.43	1
Sweden	206650	19	3257936	13	15.77	5
Korea	389181	12	3186917	14	8.19	14
India	399674	10	2766683	15	6.92	17
Brazil	297729	14	2071836	16	6.96	16
Taiwan province	233450	16	1943644	17	8.33	13
Russia	281458	15	1537138	18	5.46	19
Turkey	207446	18	1273366	19	6.14	18

Source: Institute of Scientific and Technical Information of China (ISTIC).

China Science and Technology Indicators 2014

As seen from Table 3-2, in terms of the citations of articles, Chinese-authored SCI articles in some disciplines have produced extensive influence on the international academic community. Between 2004 and 2014, China had 7 disciplines ranking top 10 worldwide, including materials science (1.066 million citations, 2^{nd}), chemistry (2.709 million citations, 2^{nd}), mathematics (222,000 citations, 2^{nd}), engineering technology (766,000 citations, 2^{nd}) and computer science (160,000 citations, 2^{nd}), taking up 20.2%, 16.1%, 16.8%, 14.7% and 10.1% of the worldwide total of the respective disciplines. Physics and agricultural science recorded 1.396 million and 185,000 citations, accounting for 12.8% and 7.5% of the worldwide total respectively and snapping up the third place, the same as the year before.

The numbers of China's SCI papers and citations in the field of materials science and chemistry were among the highest in the world, but it's an unignorable fact that the average citations of all Chinese papers were only 68.5% of the world average[①], and there is a sizable gap between different disciplines in terms of citations. Among the 10 disciplines with citations higher than 68.5% of the world average, two disciplines, namely mathematics and engineering technology, recorded citations of 90% of the world average. Three disciplines-materials science, agricultural science and botany & zoology-recorded citations higher than 80% of the world average. SCI papers of biopharmaceutical disciplines, including molecular biology & genetics, immunology, microbiology, neuroscience and behavioral science, had the lowest citations of roughly 50% of the world average.

2. Internationally co-authored articles

Publishing articles at international journals or introducing their own research at international conferences makes more and more Chinese researchers known by international academia, so that some researchers have opportunities to enter international academic organizations and play important roles. Moreover, it would widen the horizon of Chinese researchers and expand the scope of international collaboration.

Based on statistics gathered by SCI database, 56,076 Chinese papers (excluding Hong Kong and Macau) collected by the SCI in 2013 were produced from international cooperation, up by 19.0% from 2012 and taking up 24.3% of all papers published by China. 66.1% of these papers, or 37,082, were published with Chinese researchers as the first authors, and joint authors came from 138 countries and regions, with the most of joint authors from the US, Australia, the UK, Canada, Japan and Germany, accounting for 75.3% of the total internationally-coauthored papers with Chinese as the first authors. Chinese authors participated in 18,994 internationally-coauthored papers along with counterparts from 105 countries and regions, with the most

① Globally speaking, the citations per article are skewed, and therefore the world average is a bit higher than the median level.

partners from the US, Germany, Japan, the UK, Australia and Canada, accounting for 95.8% of the total internationally-coauthored papers with Chinese as joint authors (Fig. 3-3).

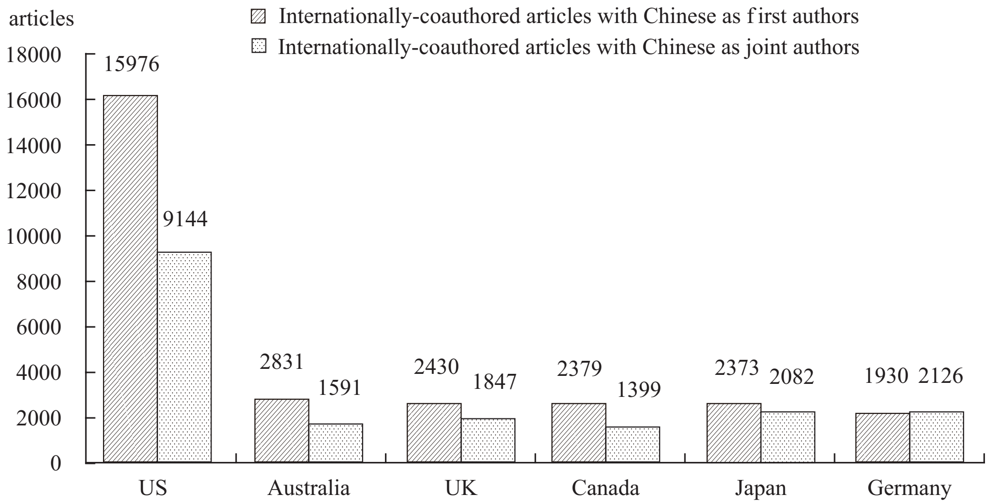

Fig. 3-3 Major countries of internationally-coauthored papers with Chinese as first authors and joint authors (2013)

Source: Institute of Scientific and Technical Information of China (ISTIC), *Chinese S&T Papers Statistics and Analysis 2013.*

China Science and Technology Indicators 2014

For SCI papers produced in 2013 from international cooperation, biology, chemistry, physics, clinical medicine, materials science and computer technology (Table 3-3) were the top 6 disciplines where the Chinese were the first authors. Biology (2,693 papers), clinical medicine (2,587 papers), physics (2,296 papers), chemistry (2,231 papers), basic medicine (1,485 papers) and materials science (1,025 papers) were the top 6 disciplines of internationally-coauthored papers where the Chinese were the joint authors.

Table 3-3 Top 6 disciplines of internationally-coauthored papers with Chinese as first authors (2013)

Discipline	Number of internationally-coauthored papers	Percentage to total papers in a discipline (%)
Biology	4736	22.02
Chemistry	4387	12.12
Physics	3785	15.48
Clinical medicine	3722	19.99
Materials science	2542	15.62
Computer technology	2341	35.13

Source: Institute of Scientific and Technical Information of China (ISTIC), *Chinese S&T Papers Statistics and Analysis 2013.*

China Science and Technology Indicators 2014

Column 3-1 EI, CPCI-S and Scopus

Engineering Index (EI), founded in 1884, is the famous engineering and technical search tools published by Engineering Information Inc (Now known as Elsevier). EI collects over 5,100 journals and more than 2,000 kinds of proceedings reports in engineering and technical field worldwide, the data of which from more than 50 countries and regions, covering disciplines like chemical engineering, mechanics, civil engineering, electronics & electrical, materials, bioengineering and etc. About 22% of the data are conference papers including keywords and abstract, and 90% are English literatures. EI database collected 566,000 journals and papers in 2013, up by 27.2% from 2012, including 164,000 from China, up by 31.6% from 2012. China accounted for 28.9% of the total journals and papers collected by EI in 2013, more than any other country.

Conference Proceedings Citation Index-Science (CPCI-S) is another paper search tool edited and published by Institute for Scientific Information (ISI) (Now Thomson Reuters Corporation), which was founded in 1978. CPCI-S collects a variety of important conference papers around the world, including the internationally famous institute conferences, first-class meetings, as well as important scientific magazine conferences. Conference papers are an important part of academic papers, in which many innovative ideas, concepts or experiments often appear firstly. So CPCI-S becomes an important supplement to academic journals. CPCI-S reports 80% ～ 90% of the important conferences worldwide and collects conference papers covering natural science, agricultural science, medicine, engineering technology and etc. CPCI-S database collected 400,000 papers in 2013, up by 10.7% from 2012, including 69,000 from China, down by 11.6% from 2012. China accounted for 17.1% of the total papers collected by CPCI-S in 2013, taking the second place in the world.

Scopus is the world's largest abstract and citation database of peer-reviewed literature. Launched by Elsevier in late 2004, Scopus covers a broad range of literatures, references and indexes in science, technology and medicine, and collects more than 19,500 journals from over 5,000 publishing houses worldwide, such as Elsevier, Kluwer, Institution of Electrical Engineers, John Wiley, Springer, Nature, Science and etc. Scopus collected 2.567 million S&T articles worldwide in 2013, including 401,000 from China, or 15.6% of the total, the second most in the world. The US, China, the UK, Germany and France are also on the top five lists.

3. Output of S&T articles per research investment

S&T articles are an important output of scientific research activities (including basic research and applied research). The output of articles per research investment can reflect the output efficiency of scientific research activities to some extent. Given the fact that output of scientific research activities has some time lag, according to international practice, the output of scientific research activities in a year is measured by the number of S&T articles published two years later[①].

Between 2000 and 2011, the output efficiency of SCI papers fell in the initial years, and then picked up before falling again. 215.2 SCI papers were churned out in 2008 for per 100 million yuan of research funding in China. The figure slipped in the following years before rising to 215.5 papers in 2011, up by 10.8% from 2010. The output of SCI papers by scientists and researchers has seen a steady rise in the period, and reached 3,529.3 papers per 10,000 person-years, up by 160% from 2010 (Fig. 3-4).

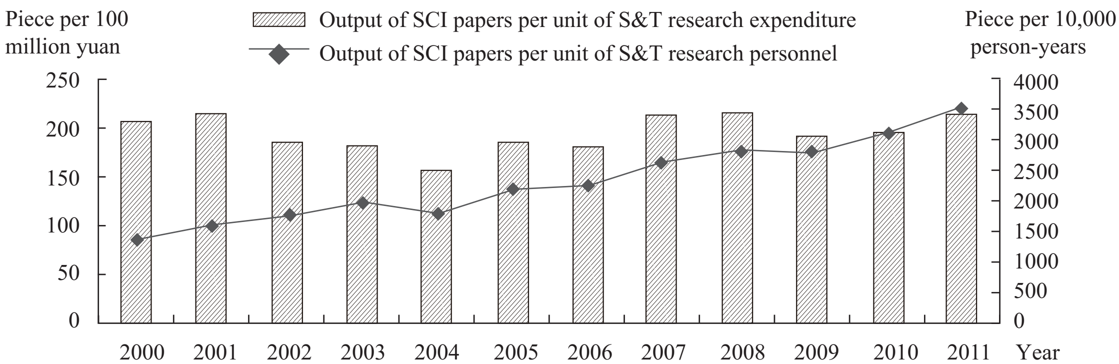

Fig. 3-4 Output of SCI papers per unit of S&T research input in China (2000—2011)

See Appendix table 3-3.

China Science and Technology Indicators 2014

Measured by the output of SCI articles from the same amount of scientific research expenditure, China is not only higher than big R&D spenders like the US, Japan, France and the UK, but higher than emerging countries like Korea and Russia. Calculated by current prices, China churned out 865.7 SCI papers in 2011 for every US$100 million spent on scientific research. The UK is an efficient paper producer in the developed world, and it produced 480.9 SCI papers, 55.6% of China's output, for the same amount of spending in scientific research in 2011. In the same year, Korea and Russia published 330.2 and 427.3 papers, or 38.1% and 49.4% of China's output, respectively.

Column 3-2 Introduction of prestigious international academic journals

A journal with the highest impact factor in a specific academic discipline is generally considered the most influential journal in the world. Seven international journals (*Nature, Science, Cell, Chem Rev, New England J Med, Lancet, JAMA-JAM MED ASSOC*) were cited more than 100,000 times in 2013 and their impact factors

① For example, output per research funding in 2011 is calculated by the domestic S&T articles output in 2013/research funding in 2011.

all exceed 30. The seven journals published a total of 11,396 papers in 2013, including 385, or 3.3%, authored by researchers from China, ranking the 7th place. China would have been in the 6th place with 233 papers if only literatures of article and review were counted.

Nature, Science and *Cell* are internationally recognized as the most prestigious journals in the field of science and technology. Articles at the three journals are of the highest academic quality because they have to be repeatedly reviewed and edited by world-famous experts before they are published. The three journals published 5,806 papers in 2013, down by 183 from 2012. China was the world's the 6th largest contributor with 226 papers, or 3.9% of the total. In 2012 China published 187 papers and was in the 9th place. The US was the biggest contributor with 2,535 papers, taking up 43.7% of the total, followed by the UK, Germany, France and Canada. China would have been in the 5th place, moving up by one spot from the prior year, with 166 papers when only literatures of article and review were counted.

Section 2 Invention Patents

Patents refer to a monopolistic intellectual property that the law assigns to the inventor with the aim of protecting, encouraging inventions and promoting S&T advancement and economic development. Patented technologies, when are commercialized, can bring economic returns to the inventor either an institution or an individual, and enhance market competitiveness and bring social effect of stimulating technology innovations. Patent indicators are important indicators to evaluate S&T strength, compare S&T outcome and evaluate market competitiveness worldwide. Patent indicators are always used as a standard to measure S&T innovation and indigenous innovation capability. They are also important foundations to analyze the status of patents, evaluate the innovation capability and foresee future S&T progress and economic development.

1. Volume of applications and grants of invention patents

Any invention granted with patent right must possess novelty, inventiveness and practical applicability. Unlike the application for utility model patents and design patents, which requires only preliminary examination, the application for invention patent has to go through the examination as to substance, during which the criteria for judging the inventiveness of invention patents applications is higher than utility model patent applications. Therefore, with more S&T contents, invention patents can reflect the capabilities of technological development and indigenous competitiveness of a country, a region or an enterprise, accordingly being an important indicator measuring S&T output and international comparison.

(1) Applications and grants of invention patents

Domestic applications of invention patents have continued to increase rapidly and the lead-over from foreign applications have widened constantly since 2003, when domestic applications of invention patents began to outnumber foreign applications (Fig. 3-5). In 2013, the proportion of domestic applications of invention patents to the total invention patent applications reached 85.4%, up by 3.4 percentage points from the previous year. It indicates that China's intellectual property strategy has brought remarkable effect, and capabilities of indigenous innovation and technological development level have improved steadily and rapidly. In 2013 foreign applications of invention patents added up to 120,000, indicating a slower growth of 2.3% from the previous year.

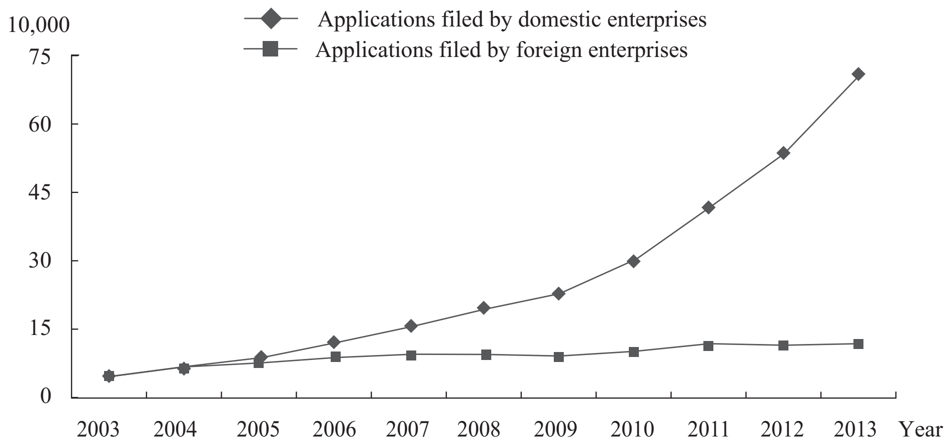

Fig. 3-5 Applications of domestic and foreign invention patents (2003—2013)

See Appendix table 3-4.

China Science and Technology Indicators 2014

Grants of domestic invention patents have been rising at a rapid pace through 2013, and the lead-over grants from foreign invention patents has expanded since grants of domestic invention patents outnumbered those of foreign patents in 2009. Grants of both domestic and foreign invention patents slipped in 2013, but the proportion of grants of domestic invention patents continued to rise to 69.1%, up by 2.9 percentage points from the previous year (Fig. 3-6).

2. Breakdown of applications and grants of foreign invention patents by country

As China continues to open the market and strengthen the protection of intellectual property, many foreign countries, especially developed ones, have intensified efforts to protect their companies' technological innovations in China.

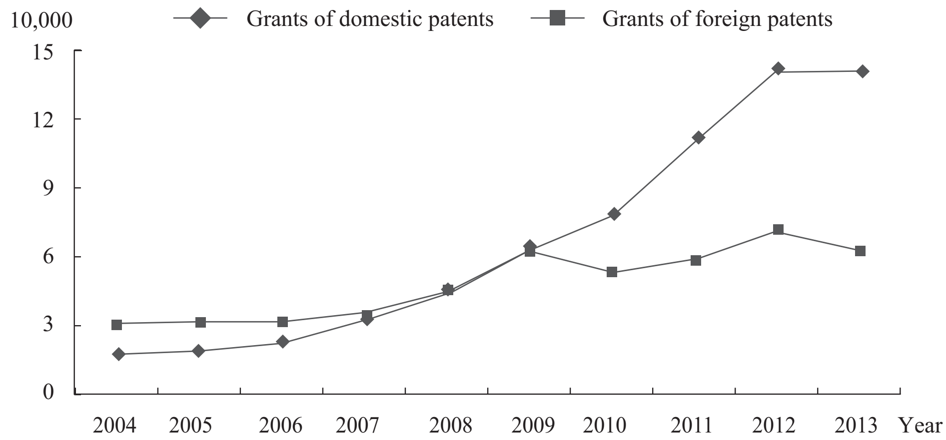

Fig. 3-6 Grants of domestic and foreign invention patents (2004—2013)

See Appendix table 3-4.

China Science and Technology Indicators 2014

The distribution of applications and grants of foreign invention patents shows obvious concentration trends. From 2001 to 2013, entities from Japan, the US, Korea and Germany have dominated the top four foreign patent applicants in China, accounting for approximately 80% of the total patent applications filed by foreign entities. Japan and the US have always ranked the first and second among foreign applicants for invention patent applications in China. In 2013, applications from Japan and the US amounted to 41 thousand and 30 thousand respectively, accounting for a combined 59.2% of the total invention patent applications filed by foreign entities (Fig. 3-7).

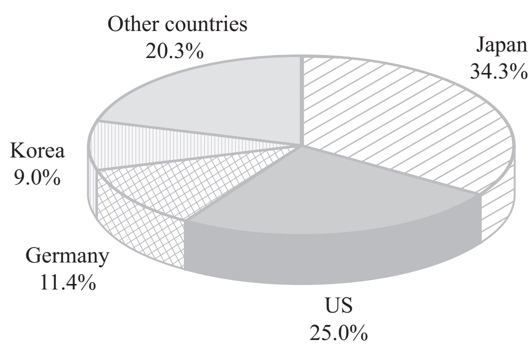

Fig. 3-7 Breakdown of applications of foreign invention patents by country (2013)

See Appendix table 3-5.

China Science and Technology Indicators 2014

Applicants of invention patent grants are also highly concentrated to a few countries. In 2013, Japan (22,609), the US (16,674), Germany (6,589) and Korea (4,271) were the top four source countries of invention patent applicants, taking up 78.2% of the total patents granted to foreign entities. Japan and the US snapped up a combined share of 61.2% (Fig. 3-8).

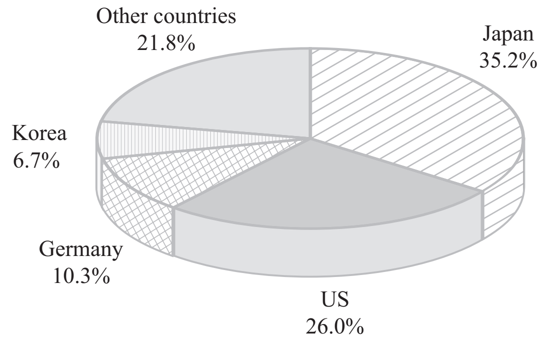

Fig. 3-8 Breakdown of grants of foreign invention patents by country (2013)

See Appendix table 3-6.

China Science and Technology Indicators 2014

2. Distribution of applications and grants of invention patents by nature of applications

Guided by China's strategy of transforming the model of economic development, enterprises are actively playing their roles as principal participants of innovations. They have kept strengthening innovation capabilities and are leading applicants of domestic service invention patents. In 2013 enterprises in China filed 427 thousand domestic invention patent applications, up by 34.8% from the preceding year and accounting for 74.7% of the total. Other institutions also reported substantial increases in invention patent applications. Applications filed by universities and colleges, research institutes and organizations reached 99 thousand, 37 thousand and 9,438 in 2013, up by 30.2%, 23.9% and 38.7% year on year, respectively.

Among the top ten domestic enterprises filing the most invention patent applications in 2013, nine were domestic-funded enterprises. State Grid Corporation of China rose to the top place for the first time with 7,182 applications. Huawei Technologies came in the second with 5,012 applications, up by 18.5% year on year. The top 10 lists of foreign applicants of invention patent applications were dominated by Japanese and American enterprises (Table 3-4).

Among the domestic service invention patents granted in 2013, enterprises were granted 79 thousand patents, compared to 33 thousand to colleges and universities, 12 thousand to research institutes and 1,828 to organizations, up by 1.0%, down by 1.5%, up by 9.2% and down by 18.2% year on year respectively. Service invention patents granted to enterprises accounted for 62.6% of the total grants in 2013.

Table 3-4 Top 10 domestic and foreign enterprises with the most invention patent applications (2013)

	Enterprise name	Nature of enterprise	Applications
Domestic	State Grid Corporation of China	Domestic-funded	7182
	Huawei Technologies Co., Ltd.	Domestic-funded	5012
	China Petroleum & Chemical Corporation	Domestic-funded	3701
	Tencent Technology (Shenzhen) Co., Ltd.	Domestic-funded	2002
	Ocean's King Lighting Science & Technology Co., Ltd.	Domestic-funded	1983
	ZTE Corporation	Domestic-funded	1948
	Shenzhen Hongfujin Precision Industry Co., Ltd.	Foreign-owned	1897
	Lenovo (Beijing) Limited	Domestic-funded	1870
	China Nation Petroleum Corporation	Domestic-funded	1261
	BOE Technology Group Co., Ltd.	Domestic-funded	1173
	Enterprise name	Country	Applications
Foreign	Samsung Electronics Corporation	Korea	2276
	Panasonic Corporation	Japan	2009
	Sony Corporation	Japan	1810
	Robert Bosch GmbH	Germany	1775
	Canon, Inc.	Japan	1278
	Toyota Motor Corporation	Japan	1249
	International Business Machines Corporation	US	1186
	Qualcomm, Inc.	US	1166
	GM Global Technology Operations LLC	US	1123
	General Electric Company	US	1109

Source: State Intellectual Property Office.

China Science and Technology Indicators 2014

The statistics showed that the proportion of service invention patents granted to enterprises has been rising steadily and stayed above 60% since 2008 (Fig. 3-9), suggesting enterprises have continued to consolidate and strengthen their roles as principal participants of technological innovations in China.

Among the top 10 domestic enterprises granted the most invention patents in 2013, six were domestic-funded enterprises and they claimed the top 3 spots. Huawei Technologies Co., Ltd climbed to the top with 2,251 granted patents, followed by China Petroleum & Chemical Corporation with 1,627 and ZTE Corporation with 1,448. On the list of the top 10 foreign enterprises granted the most invention patents, Japan took a commanding lead with five Japanese enterprises on the list (Table 3-5).

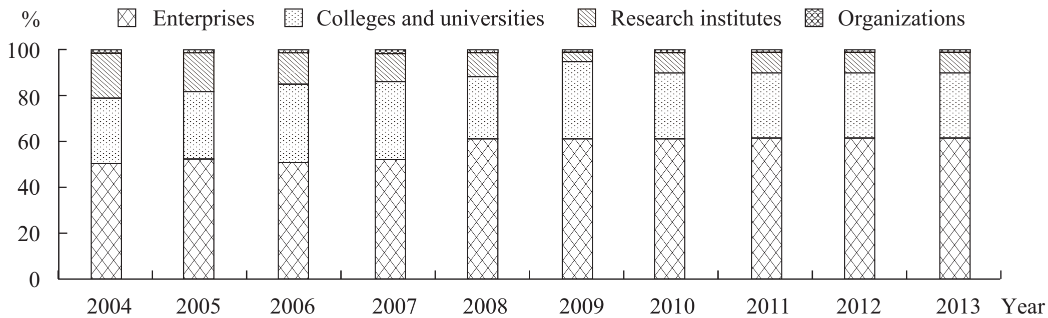

Fig. 3-9 Breakdown of domestic service invention patent grants by nature of applicants (2004—2013)

See Appendix table 3-7.

China Science and Technology Indicators 2014

Table 3-5 Top 10 domestic and foreign enterprises with the most invention patent grants (2013)

	Enterprise name	Nature of enterprise	Grants
Domestic	Huawei Technologies Co., Ltd.	Domestic-funded	2251
	China Petroleum & Chemical Corporation	Domestic-funded	1627
	ZTE Corporation	Domestic-funded	1448
	Shenzhen Hongfujin Precision Industry Co., Ltd.	Foreign-owned	932
	China Nation Petroleum Corporation	Domestic-funded	527
	Ocean's King Lighting Science & Technology Co., Ltd.	Domestic-funded	460
	Semiconductor Manufacturing International Corporation (Shanghai)	Foreign-owned	374
	BYD Company Limited	Domestic-funded	340
	AU Optronics Corporation	Foreign-owned	322
	Taiwan Semiconductor Manufacturing Company Limited	Foreign-owned	317
	Enterprise name	Country	Grants
Foreign	Panasonic Corporation	Japan	1189
	Qualcomm, Inc.	US	982
	Toyota Motor Corporation	Japan	805
	Samsung Electronics Corporation	Korea	802
	GM Global Technology Operations LLC	US	752
	Canon, Inc.	Japan	750
	LG Electronics, Inc.	Korea	685
	Royal Dutch Philips Electronics Ltd.	Netherlands	664
	Sony Corporation	Japan	641
	Sharp Corporation	Japan	636

Source: State Intellectual Property Office.

China Science and Technology Indicators 2014

3. Patents in force

Patents in force refer to the granted patents that are still effective. Holders of granted patents must pay annual fee to maintain their validity, and the validity period in most countries is 20 years from the date of patent application. According to China Patent Law, the validity of invention patent is 20 years, and 10 years for utility model patent and design patent. During the protection period, patent holders can decide the length of the protection term based on the cycle of technological development and the implementation of patent technologies. Patents with a long protection period are generally the ones that have high technological and economic value or core patents. Thus, patents in force are significant indicators to evaluate S&T innovation capabilities and market competitiveness of enterprises, regions and countries.

In 2013 the domestic invention patents in force amounted to 586 thousand, up by 23.9% year on year and accounting for 56.7% of the total invention patents in force. However, only 16.1% of the domestic patents in force were invention patents. In contrast, as much as 80.0% of foreign patents in force were invention patents, which numbered at 447 thousand.

Among the domestic invention patents in force in 2013, 352 thousand (59.9%) were held by enterprises, 116 thousand (19.8%) by colleges and universities, 67 thousand (11.4%) by individuals, 47 thousand (8.0%) by research institutes and 5,018 (0.9%) by government or non-profit organizations.

In 2013 the top three domestic holders of invention patents in force were all domestic-funded enterprises, namely Huawei Technologies Co., Ltd (19 thousand), ZTE Corporation (13 thousand) and China Petroleum & Chemical Corporation (6,416). The three have stayed on the top three spots for four consecutive years. The top three foreign holders of invention patents in force were Panasonic Corporation (13 thousand), Samsung Electronics Corporation (10 thousand) and Canon Inc (7,861).

The average lifespan of a domestic invention patent was 5.9 years in 2013, compared to 9.2 years for a typical foreign invention patent awarded by China. 46.8% of domestic invention patents survived more than five years and 6.7% survived more than ten years. In contrast, 89.4% of foreign invention patents survived more than five years and 29.5% survived more than ten years.

4. International comparison of invention patent applications and grants

Patent is an important tool to protect inventors, and an effective means for enterprises to actively participate in international competition and successfully explore overseas markets. Through analyzing overseas invention patent applications and grants of Chinese applicants and comparing China's situation with other countries, the result can, to a great extent, reflect indigenous innovation capabilities and technological development in China.

(1) PCT applications

PCT applications worldwide increased by 5.1% year on year to 205 thousand in 2013. Among the top 10 applicant countries, China, the US and Sweden posted double-digit growth in PCT applications, while Germany and the UK recorded negative growth. Mexico, Israel, Brazil and South Africa reported substantial growth rates of 22.0%, 17.1%, 12.2% and 11.5%, respectively.

China's PCT applications rose by 15.5% in 2013 to 22 thousand, and the number allowed China to edge out Germany to be the third largest PCT applicant in the world (Fig. 3-10). With respect to the ranking of PCT applicants, ZTE Corporation slipped to the second place with 2,309 PCT applications, and Huawei Technologies Co., Ltd dropped one spot to the third place with 2,110 applications.

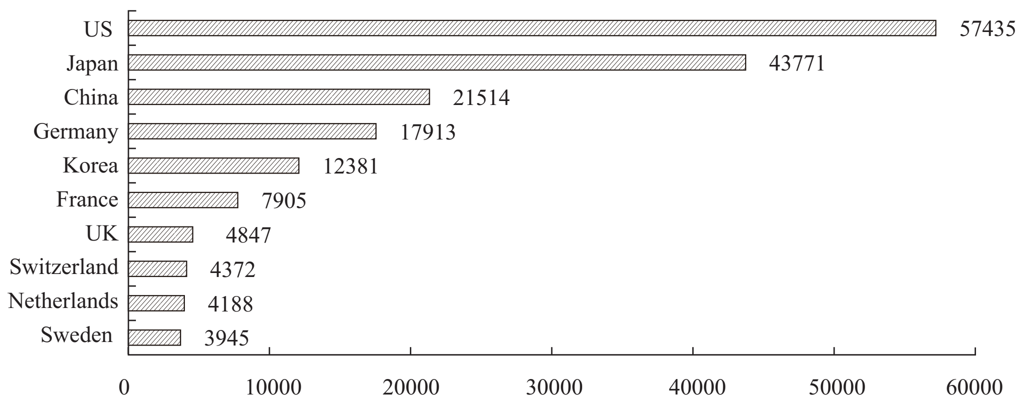

Fig. 3-10 Top 10 countries of PCT applications (2013)

See Appendix table 3-8.

China Science and Technology Indicators 2014

(2) Triadic patent families

Patent indicator is one of the most used indicators to evaluate S&T output of a country, region or institution, but it is a bias based on "Home Advantage" if the patent statistics of some certain country is adopted. In order to establish a statistical basis for patent appraisal with international comparability, the OECD put forward the concept of "Patent Families", which refers to a series of patents obtained and/or applications filed in different countries on the basis of a single invention. According to the OECD definition, a patent is a member of the triadic patent families if and only if it is filed at the European Patent Office (EPO), the Japan Patent Office (JPO) and the US Patent and Trademark Office (USPTO).

According to OECD statistics for 41 countries and regions with triadic patent families, the global total of triadic patent families added up to 51 thousand by 2012. The 34 OECD member countries held 49 thousand triadic patent families, taking up 95.0% of the total. The 28 EU member countries held 14 thousand triadic patent families, accounting for 27.3% of the total. Japan held 15 thousand triadic patent families and the US held 14,000, and they accounted for a combined 57.0% of the global total.

China had held 1,851 triadic patent families by 2012, up by 11.6% year on year and taking up 3.6% of the global total (Fig. 3-11). China moved up one spot to be in the 6th place.

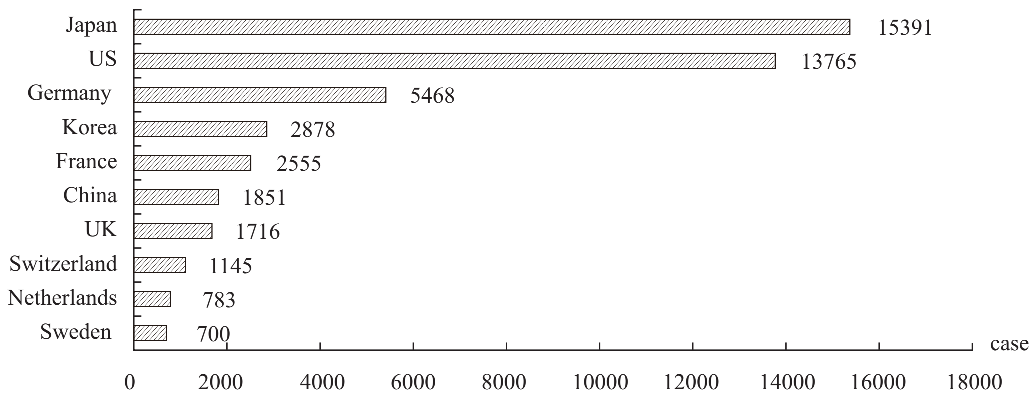

Fig. 3-11 Top 10 countries of triadic patent families (2012)

See Appendix table 3-9.

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Chapter 4 Research and Development Activities and Innovations of Enterprises

Enterprises are principal participants of technological innovations. Their innovation capabilities collectively determine a country's overall strength of innovation. As China advances the push into an innovation-driven economy, enterprise entities are playing an increasingly prominent role in the national innovation system. This chapter analyzes the R&D activities of Chinese enterprises, R&D activities in industrial enterprises, as well as technological innovations and technology acquisitions.

Section 1 Research and Development Activities of Enterprises

Research and Development activities are a core component of technological innovations carried out by enterprises. Manpower input and funding have a direct impact on the effect of R&D activities. The section makes a comprehensive analysis of R&D activities of Chinese enterprises from the aspect of R&D personnel, R&D funding and structure of the funding.

1. R&D personnel

R&D personnel are a pivotal force in an enterprise to practice indigenous innovations and play an important role in China's push for S&T innovations. As enterprises grow bigger and stronger, they are building a larger taskforce devoted to R&D missions. Chinese enterprises had a total workforce of 3.71 million dedicated to R&D activities in 2013, up by 10.3% from the year before. In terms of full-time equivalent, R&D personnel working at enterprises reached 2.74 million person-years in 2013, equivalent to 5.7 times of the talent resources in 2000. Measured by full-time equivalent, the proportion of R&D personnel at enterprises increased from 52.1% in 2000 to 77.6% in 2013 (Fig. 4-1).

The structure of R&D personnel at enterprises is characterized as follows:

First, R&D activities are mostly continuous and professional. In 2013, 66.7% of the R&D personnel were full-time staff.

Second, female staff took up a relatively small proportion of the R&D personnel. 767,000 people, or 20.7% of all R&D personnel at enterprises, were female, significantly lower than the ratio of female R&D staff at higher education institutions and research institutes.

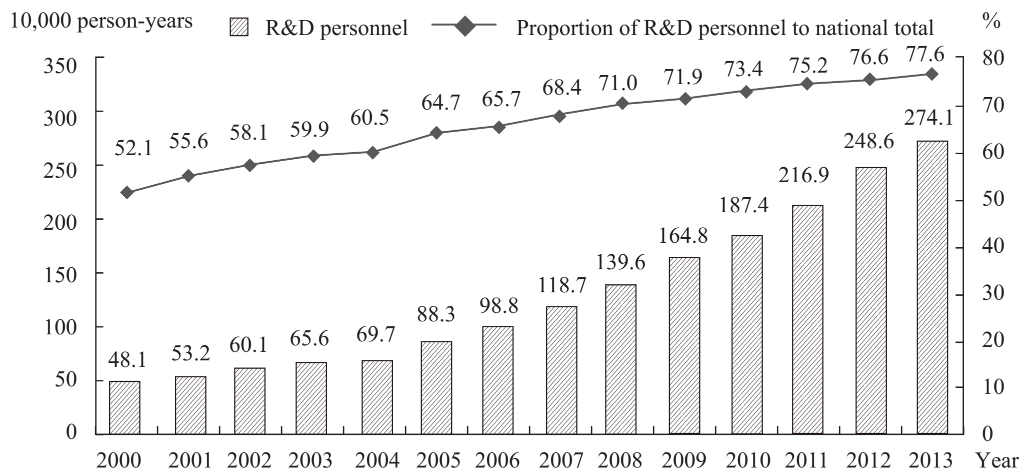

Fig. 4-1 Full-time equivalent amount of R&D personnel at enterprises and its proportion to national total (2000—2013)

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

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Third, R&D personnel at enterprises received much less education than their counterparts at research institutes and higher education institutions. At enterprises, 37,000 R&D staff, or 1.0%, held doctor degrees, and 7.4% held master or higher degrees. In comparison, 46.5% and 62.5% of staff at research institutes and higher education institutions held master or higher degrees (Table 4-1).

Table 4-1 Composition of R&D personnel at enterprises, research institutes and higher education institutions (2013)

Type of institutions	R&D researchers	Full-time personnel		Female		Doctor		Master		Undergraduate	
	10,000 persons	10,000 persons	%	10,000 persons	%	10,000 persons	%	10,000 persons	%	10,000 persons	%
Enterprise	371.2	247.3	66.6	76.7	20.7	3.7	1	23.9	6.4	99.2	26.7
Research institutes	40.9	32.9	80.5	13.4	32.7	6.3	15.4	12.7	31.1	14.7	36
Higher education institutions	71.5	29.4	41.1	27.7	38.7	17.9	25.1	26.7	37.4	22.1	31

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

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2. R&D expenditure

Over the years Chinese enterprises have kept stepping up spending in R&D activities. R&D expenditure in enterprises amounted to 907.58 billion yuan in 2013, equivalent to 16.9 times of the spending in 2000. The share of business enterprise R&D (BERD) expenditure to China's total R&D spending rose from 60.0% in 2000 to 76.6% in 2013 (Fig. 4-2). Calculated by comparable prices, BERD expenditure grew at an annual rate of 20% during the period.

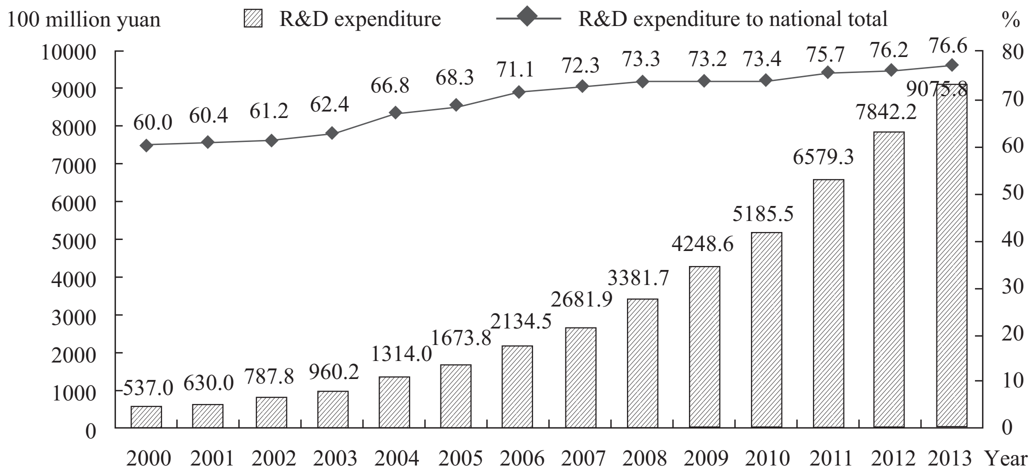

Fig. 4-2 Business Enterprise R&D (BERD) expenditure and its proportion to the national total (2000—2013)

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

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Classified by the type of R&D activities, a large majority of expenditure went to experimental development, and only a small portion was spent to fund basic research and applied research. In 2013 enterprises spent 860 million yuan in basic research and 24.92 billion yuan in applied research, and the two accounted for a combined 2.8% of total expenditure. Funding for basic research came at a marginal share of 0.1% (Table 4-2). Since 2010, the share of budget for basic research and applied research has been tight relative to the total BERD expenditure, hovering within a small range of 2.5% to 3.1%.

There is a great difference between China and developed countries in terms of the structure of R&D expenditure. Enterprises at developed countries earmark a large majority of their R&D spending to fund experimental development activities, but their investments in basic research and applied research are also substantial. More than 95% of R&D budget at Chinese enterprises goes to experimental development, compared to 50% ～ 80% at their counterparts in developed markets (Table 4-3). Less funding commitment to basic research and applied research indicates weaker capacity on indigenous innovations of China's industrial enterprises.

Table 4-2 Breakdown of BERD expenditure, by R&D activities (2010—2013)

Year	R&D expenditure	Basic research		Applied research		Experimental development	
	100 million yuan	100 million yuan	%	100 million yuan	%	100 million yuan	%
2010	5185.5	4.3	0.1	126.2	2.4	5054.9	97.5
2011	6579.3	7.3	0.1	191.0	2.9	6381.1	97.0
2012	7842.2	7.1	0.1	238.9	3.0	7596.3	96.9
2013	9075.8	8.6	0.1	249.2	2.7	8818.0	97.2

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2011—2014*.

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Table 4-3 Corporate R&D expenditure at major countries, by R&D activities

%

Type of R&D activities \ Country	China	US	Japan	UK	France	Italy	Korea	Russia
	2013	2012	2013	2012	2012	2012	2013	2013
Basic research	0.09	4.41	6.85	5.13	5.40	8.68	13.07	2.45
Applied research	2.75	16.03	18.55	41.71	42.59	51.21	17.08	12.47
Experimental development	97.15	79.57	74.37	50.16	52.01	40.10	69.85	8.51

Source: OECD, R&D Statistics 2015.

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Regarding the structure of R&D expenditure, regular spending has been basically stable at 88% of the BERD expenditure in recent years. Labor cost took up a rising share of the regular spending, up from 25.9% in 2011 to 29.0% in 2013. The share of capital expenditure has been roughly unchanged at 13% in the years. Capital expenditure was mainly used to buy equipment and instruments, which accounted for about 12% of the internal BERD expenditure (Table 4-4).

Table 4-4 Structure of BERD expenditure (2010—2013)

Year	Internal R&D expenditure	Regular expenditure				Capital expenditure			
		Labor cost		Other		Equipment and instruments		Other	
	100 million yuan	100 million yuan	%	100 million yuan	%	100 million yuan	%	100 million yuan	%
2010	5185.5	1326.3	25.6	3204.2	61.8	617.7	11.9	37.2	0.7
2011	6579.3	1703.1	25.9	4015.8	61.0	815.5	12.4	45.0	0.7
2012	7842.2	2175.1	27.7	4738.4	60.4	884.0	11.3	44.8	0.6
2013	9075.8	2631.6	29.0	5398.4	59.5	998.4	11.0	47.4	0.5

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2011—2014*.

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With respect to the source of R&D expenditure, much of the funding comes from enterprises themselves, while government contribution has stayed at a steady level. 846.1 billion yuan or 93.2% of the total internal BERD expenditure in 2013 came from enterprises themselves, up by 0.5 percentage point from 2010. Government funding amounted to 40.9 billion yuan in 2013, accounting for 4.5%. Government contribution has remained steady at around 4.5% in recent years (Fig. 4-3)

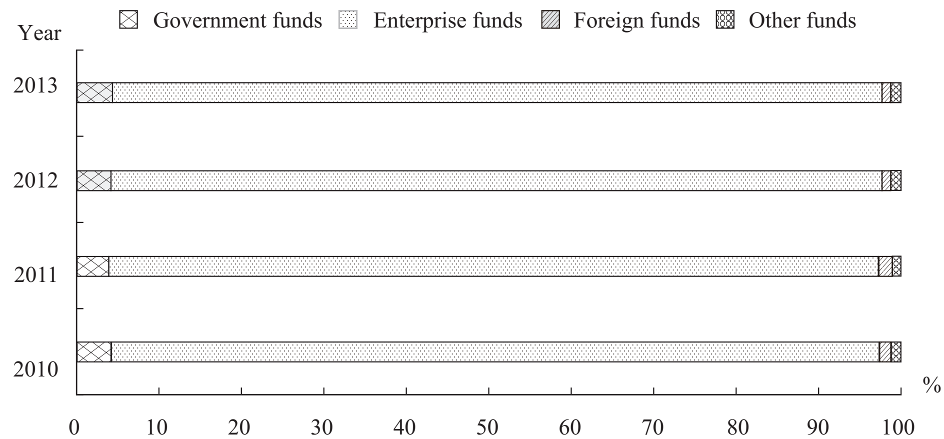

Fig. 4-3 Sources of corporate R&D expenditure (2010—2013)

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2011—2014.*

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Section 2 Research and Development Activities in Industrial Enterprises

Industrial enterprises are principal participants of technological innovations in China and primary force to develop an innovation-driven economy and build an innovation-oriented country. BERD activities, to a great extent, reflect the overall S&T strength and innovation capabilities of China's enterprises. In China, BERD activities are primarily undertaken by industrial enterprises above designated scale. The section analyzes R&D activities by this category of industrial enterprises[①].

① Unless otherwise specified, industrial enterprises mentioned in the chapter refer to industrial enterprises above designated size. Before 2011, China had collected statistics about R&D activities by such enterprises in 2000, 2004 and 2008. And in 2011, China lifted the threshold of industrial enterprises above designated size from 5 million yuan in annual revenue from principal business to 20 million yuan. There might be an issue of incommensurability when we compare R&D activities before and after 2011, but that issue should not pose a big problem because there were not many enterprises with annual revenue from principal business in the range of 5～20 million yuan that carried out R&D activities.

1. R&D institutes

R&D institutes of enterprises are organizational guarantee to carry out R&D activities. Setting up a R&D institute indicates an enterprise's R&D strategy is systematic, well-organized and institutionalized.

55,000 industrial enterprises in China carried out R&D activities in 2013, up by 7,628 from 2012 and 220% from 2000. The number (55,000) accounted for 14.8% of all industrial enterprises, up by 4.2 percentage points from 2000. 43,000 industrial enterprises set up R&D facilities, up by 4,191 from 2012 and representing 11.6% of all industrial enterprises, up by 5.6 percentage points from 2004 (Table 4-5).

Table 4-5　General information of enterprise S&T activities (2000—2013)

Indicator	2000	2004	2008	2009	2011	2012	2013
Industrial enterprises (Number)	—	276474	418880	429378	325753	343769	369741
Enterprises with R&D activities (Number)	17272	17075	27278	36387	37467	47204	54832
Proportion of enterprises with R&D activities (%)	10.6	6.2	6.2	8.5	11.5	13.7	14.8
Enterprises setting up R&D institutes (Number)	—	13906	22156	25391	25454	38864	43055
Proportion of enterprises setting up R&D institutes (%)	—	5.0	5.3	5.9	7.8	11.3	11.6

Source: National Office of R&D Census, *National Industrial Statistics on the 2000 R&D Census*, *China Economic Census Yearbook 2004, 2008*, *National Statistics on the 2009 R&D Census*, and National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2012—2014.*

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Industrial enterprises set up 52,000 R&D institutes in 2013, up by 230% from 2000. The number of corporate R&D facilities has been growing quickly since 2004, and the trend became even more apparent after 2011. Between 2000 and 2004, Chinese enterprises added about 500 R&D facilities every year, and the annual increase surged to 2,000 between 2004 and 2011. 14,617 R&D institutes were established in 2012, compared to 5,688 in 2013 (Table 4-6).

Industrial enterprises had 2.39 million R&D employees in 2013, nearly quadrupled from 2000. Among them were 296,000 doctor and master degree holders, accounting for 12.4% of the total R&D workforce, up by 6.6 percentage points from 2004.

R&D institutes at industrial enterprises spent 594.15 billion yuan in 2013, up by 12.6 times from 2000, translating into an average annual growth rate of 17.2% based on comparable prices (Table 4-6).

Table 4-6 R&D institutes established by industrial enterprises (2000—2013)

Indicator	2000	2004	2008	2009	2011	2012	2013
Corporate R&D institutes (Number)	15529	17555	26177	29879	31320	45937	51625
Staff number (10,000 persons)	60.1	64.4	130.4	155.0	181.6	226.8	238.8
Spending by corporate R&D institutes (100 million yuan)	435.8	841.6	2634.8	2983.6	3957.0	5233.4	5941.5

Source: Same as Table 4-5.

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2. R&D personnel

R&D personnel are a principal force at an enterprise to push technological innovations. In 2013 China's industrial enterprises had 3.38 million R&D employees, 4.8 times of that in 2000 and accounting for 3.5% of their total workforce. The full-time equivalent of R&D personnel reached 2.5 million person-years in 2013, 5.7 times of the talent resources in 2000 (Table 4-7). 32.7% of that amount, or 815,000 person-years, were R&D researchers. A typical industrial enterprise had 6.74 person-years of R&D personnel.

Table 4-7 Statistics about R&D personnel (2000—2013)

Year	R&D personnel (10,000 persons)	R&D personnel at large and medium-sized enterprises (10,000 persons)	Proportion (%)	Full-time equivalent of R&D personnel (10,000 person-years)	Full-time equivalent of R&D personnel at large and medium-sized enterprises (10,000 person-years)	Proportion (%)
2000	70.0	54.3	77.6	43.9	32.9	74.9
2004	81.2	65.4	80.5	54.2	43.8	80.8
2008	152.0	124.1	81.6	123.0	101.4	82.4
2009	191.4	151.9	79.4	144.7	115.9	80.1
2011	254.7	205.2	80.6	193.9	158.7	81.8
2012	305.1	243.5	79.8	224.6	181.9	81.0
2013	337.6	263.4	78.0	249.4	197.7	79.3

Source: Same as Table 4-5.

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R&D personnel at industrial enterprises are largely working at large and medium-sized enterprises, which had 2.64 million R&D employees in 2013, accounting for 78.0% of all R&D staff at industrial enterprises, down from 2011 and 2012. The full-time equivalent of R&D

personnel reached 1.98 million person-years, taking up by 79.3% of the total at all industrial enterprises, and that ratio has also kept falling in recent years.

3. R&D expenditure

(1) R&D expenditure and its intensity

China's industrial enterprises have begun to step up R&D spending since 2000. Industrial enterprises spent 831.84 billion yuan in R&D programs, 17.0 times of that in 2000. Based on comparable prices, R&D spending increased at an annual growth rate of 19.2% from 2000 to 2013. Continued increase in R&D investments has been providing robust support for industrial enterprises to pursue technological innovations.

Large and medium-sized industrial enterprises have always been a pivotal force to advance technological innovations in China's corporate sector. They spent 35.34 billion yuan in R&D activities in 2000, or 72.2% of R&D expenditure of all industrial enterprises, and the figures jumped to 674.41 billion yuan and 81.1% in 2013, 8.9 percentage points higher than that of 2000 (Fig. 4-4).

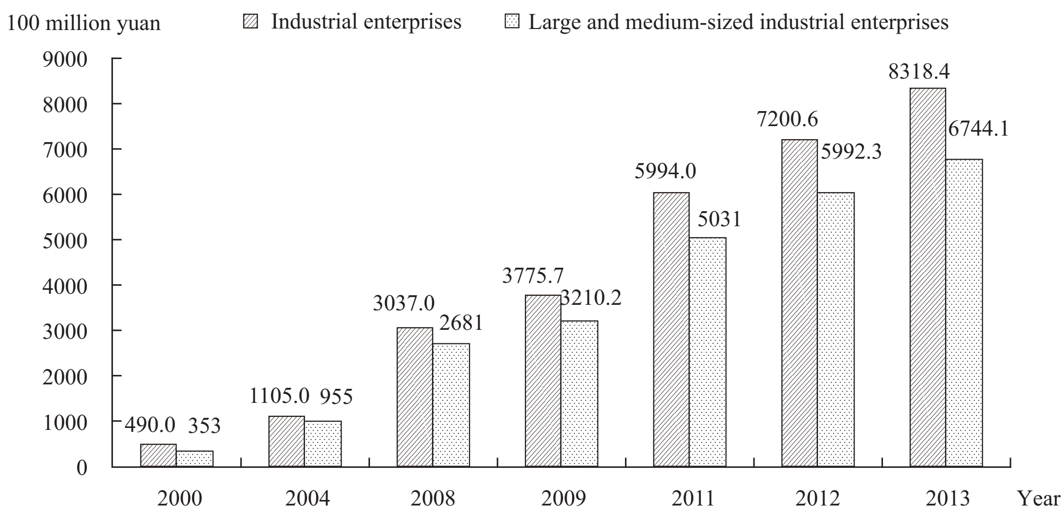

Fig. 4-4 R&D expenditure of industrial enterprises and large and medium-sized industrial enterprises (2000—2013)

Source: Same as Table 4-5.

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Intensity of R&D expenditure (measured by the proportion of R&D expenditure to revenue from principal business) is an important indicator of an enterprise's strength on indigenous innovation. The intensity for industrial enterprises has stayed at a low level in the 10th Five-year Plan period (2001—2005) and begun to trend up in the next five years. The intensity was 0.58% in 2000, slipped to 0.56% in 2004 and rose to 0.61% in 2008. It further climbed to 0.80% in 2013. A rising intensity suggests China's industrial enterprises have stepped up investments in indigenous innovations and attached growing importance to technological innovations.

Large and medium-sized industrial enterprises apparently have a higher intensity of R&D expenditure than that of industrial enterprises above designated size. Their gap had been expanding until 2009, and began to narrow after that and stabilized since 2011. The intensity was 1.01% for large and medium-sized industrial enterprises in 2013, 0.21 percentage point higher than that of industrial enterprises above designated size (Fig. 4-5).

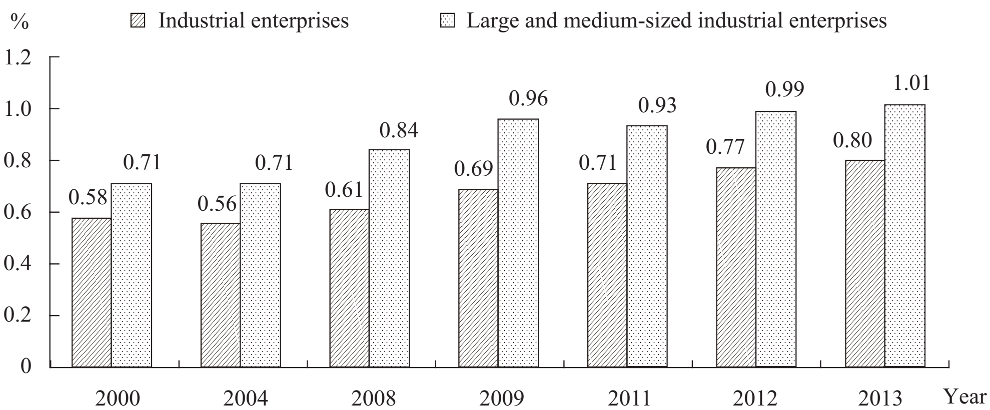

Fig. 4-5 Intensity of R&D expenditure of industrial enterprises (2000—2013)

Source: Same as Table 4-5.

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(2) Breakdown of R&D expenditure by category of R&D activities

R&D activities at China's industrial enterprises have long been dominated by experimental development, while funding for basic research and applied research has been very limited and kept falling since 2000. China's industrial enterprises spent 811.8 billion yuan to fund experimental development activities in 2013, representing 97.6% of the total R&D expenditure, while basic research and applied research took up a combined 2.4%, down by 0.1 percentage point from 2011 and by 5.1 percentage points from 2000 (Fig. 4-6).

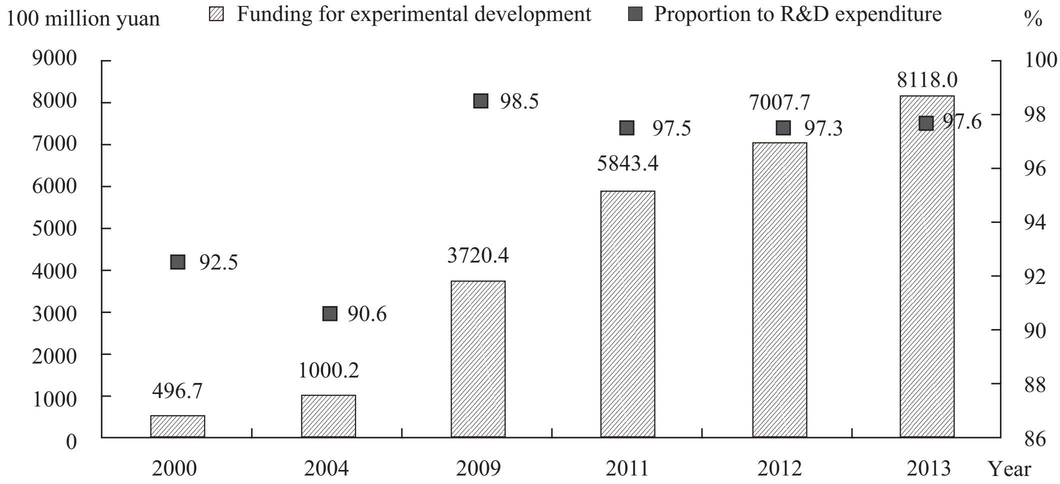

Fig. 4-6 Funding for experimental development at industrial enterprises (2000—2013)

Source: Same as Table 4-5.

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Section 3 Patents and Development of New Product in Industrial Enterprises

Filing patent applications to protect innovative ideas is not only an effective means adopted by enterprises to generate lucrative income from innovation, but a primary approach for them to enhance technological strength and market competitiveness. By sustained development of new products, enterprises can cater to the constantly changing market demands and explore new markets.

1. Patents

The number of patents an enterprise holds is an intuitional indicator of its innovation dynamism, and also an important sign of its technological strength and innovation capabilities. Particularly, the applications and grants of invention patents, which generally require more advanced technologies to be developed, are more convincing signs of technological strength and competitiveness of an enterprise.

(1) Patent applications

Patent applications filed by China's industrial enterprises increased rapidly, from 26,000 in 2000 to 561,000 in 2013, implying an average annual growth rate of 26.6%. Accordingly, applications of invention patents also rose quickly. Such applications filed by industrial enterprises were fewer than 10,000 in 2000, and spiked to 205,000 in 2013, averaging an annual growth rate of

28.4% and accounting for 36.6% of the total patent applications (Table 4-8).

Table 4-8 Patent applications filed by industrial enterprises (2000—2013)

Indicator	2000	2004	2008	2009	2011	2012	2013
Patent applications	26184	64569	173573	265808	386075	489945	560918
Invention patent applications	7970	20456	59254	92450	134843	176167	205146
Proportion of invention patent (%)	30.4	31.7	34.1	34.8	34.9	36.0	36.6

Source: Same as Table 4-5.

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(2) Invention patents in force

The number of invention patents in force held by industrial enterprises has registered strong growth since 2000, from 15,000 in 2000 to 335,000 in 2013, implying an average annual growth rate of 26.8%. Growth rate in 2013 was 21.0% from the prior year, down by 6.7 percentage points year on year.

2. New product development

As China has been making steady progress in recent years in the ongoing transition to develop an innovation-driven economy, industrial enterprises keep innovating their product lines and such products meet the market needs.

(1) Projects of new product development

China's industrial enterprises have accelerated the launch of projects on new product development since 2000. The number of such projects has jumped from 92,000 in 2000 to 358,000 in 2013, implying an average annual growth rate of 11.0%. Growth rate at foreign-funded enterprises was the fastest at 15.9%, followed by 12.2% at enterprises funded by investors from Hong Kong, Macau and Taiwan province, and 10.3% at Chinese-funded enterprises (Table 4-9).

Table 4-9 Breakdown of new product development projects by type of industrial enterprises (2000—2013)

Type of enterprise	2000	2004	2008	2009	2011	2012	2013
Total	91880	76176	184859	237754	266232	323448	358287
Chinese-funded enterprise	76840	62706	140645	181305	205080	247015	274397
Enterprises funded by investors from Hong Kong, Macau and Taiwan Province	7707	5404	17189	22261	25518	30947	34247
Foreign-funded enterprise	7333	8066	27025	34188	35634	45486	49643

Source: Same as Table 4-5.

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From the table we can see that Chinese-funded industrial enterprises are a dominant force in developing new product. In the seven years with data available, domestic enterprises accounted for more than 76% of all new product development projects at every year, although the proportion slipped between 2000 and 2013.

(2) Funding for new product development

Funding for new product development at China's industrial enterprises has kept rising over the years, from 52.9 billion yuan in 2000 to 924.7 billion yuan in 2013, 17.5 times more than that in 2000, indicating an average annual growth rate of 24.6%.

The intensity of new product development funding (measured by the proportion of the funding to revenue from principal business) is a primary indicator of funding commitment of an enterprise to new product development. The intensity has been trending up since 2000 and hit a record high of 0.89% in 2013 (Fig. 4-7).

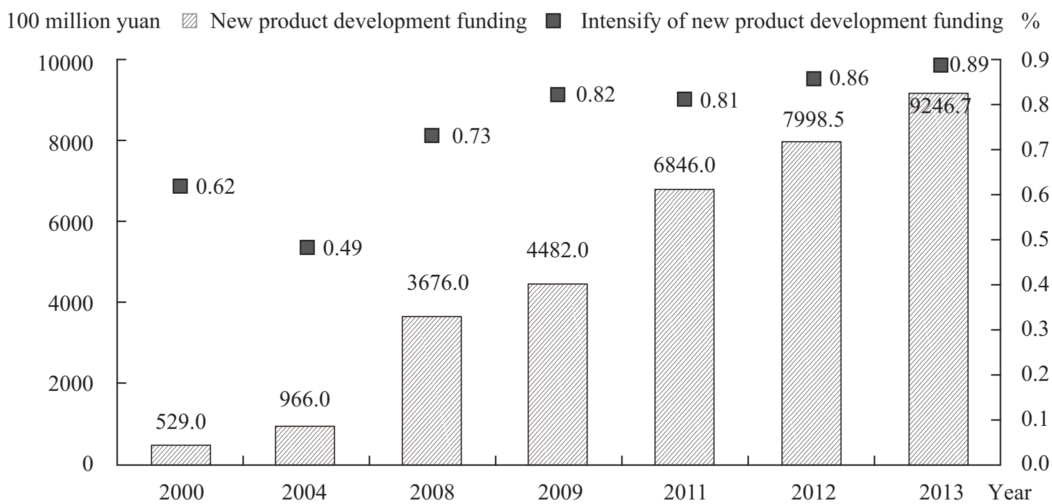

Fig. 4-7 New product development funding at industrial enterprises (2000—2013)

Source: Same as Table 4-5.

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(3) Sales revenue of new product

Thanks to the rapid growth in funding for new product development in recent years, China's industrial enterprises have made a great success in bringing more and more new products to the market. Revenue from new product sales was less than 100 million yuan in 2000, and hit 1.28 billion yuan in 2013, implying an average annual growth rate of 22.3%. The strong growth fully demonstrated the remarkable results produced by new product development.

The share of new product sales (proportion of new product sales revenue to total sales revenue) is an important indicator of output of an enterprise yield from technological innovations. The share of new product sales at industrial enterprises has been edging up over the years, from 11.0% in 2000 to 12.4% in 2013.

Section 4 Cooperation among Industrial Enterprises, Universities, and Research Institutes and Technology Acquisition

Against the backdrop of economic globalization, enterprises can make full use of all resources at its disposal to pursue technological innovations. Cooperation with universities and research institutes as well as technology acquisitions are important means to optimize allocation of S&T resources and facilitate technological innovations, not only an effective solution to address the issue on lacking indigenous innovation capabilities of enterprises, but also helpful to push universities and research institutes to commercialize their technological achievements.

1. External funding for R&D activities

External funding for R&D activities refers to money spent by enterprises to commission other institutions or collaborate with them to carry out R&D activities. External funding to fund R&D efforts made by research institutes and universities is a crucial indicator of the cooperation among industrial enterprises, universities, and research institutes. In 2013 industrial enterprises spent 42.32 billion yuan to fund external R&D activities, with 40.3% of the money going to research institutes and 20.6% to universities.

Among the ten industries receiving the most external R&D funding, pharmaceutical, electricity & thermo power generation and supply, and chemical materials & chemical product poured 71.3%, 55.2% and 53.4% of their external R&D funding into research institutes respectively; computer, communication and electronic equipment manufacturing, auto manufacturing, electrical machinery and device manufacturing, railroad, ship, aviation and other transport equipment manufacturing put a majority of their external R&D funding to institutes other than research institutes and universities; coal mining and dressing industry funneled 48.6% and 39.7% of their external R&D funding to research institutes and universities; general equipment manufacturing, ferrous metal smelting and rolling more evenly distributed their funding to research institutes, universities and other institutes (Table 4-10).

2. R&D project cooperation

R&D project cooperation is an important means of collaboration among industrial enterprises, universities and research institutes. By analyzing R&D projects launched by industrial enterprises and their R&D collaboration with other institutions, a brief picture of their cooperation with universities and research institutes unveiled. The analysis is only focused on R&D projects with funding above a certain amount of money①.

Table 4-10 Ten industries receiving the most external R&D funding (2013)

Industry	External R&D funding		Proportion of funding to research institutes (%)	Proportion of funding to universities (%)	Proportion of funding to other institutes (%)
	Total (100 million yuan)	Proportion (%)			
Auto manufacturing	73.1	17.3	35.2	10.9	53.9
Computer, communication and electronic equipment manufacturing	56.8	13.4	23.5	8.8	67.7
Railroad, ship, aviation and other transport equipment manufacturing	42.7	10.1	35	13	52
Pharmaceutical	40.8	9.6	71.3	17.3	11.4
Electrical machinery and device manufacturing	26.4	6.2	26.7	20.2	53
Chemical materials & chemical product	20.4	4.8	53.4	33.1	13.5
General equipment manufacturing	19.3	4.6	37.6	23.5	38.9
Ferrous metal smelting and rolling	16.1	3.8	35.7	34.4	29.9
Coal mining and dressing	15.5	3.7	48.6	39.7	11.7
Electricity & thermo power generation and supply	13.6	3.2	55.2	19.2	25.6

Source: National Bureau of Statistics & Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

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Industrial enterprises launched 235,000 R&D projects in 2013, and independently carried out 77.8% of them, or 183,000 projects, and cooperated with partners to work on the remainder of the projects. A total of 2.68 million people worked on the R&D projects with a total spending of 705.42 billion yuan, and 24.2% of the R&D workforce were assigned to develop joint projects funded by 25.4% of the entire R&D expenditure.

21,000 R&D projects, or 40.1% of the total, were jointly undertaken by industrial enterprises and universities, and 20.4%, 19.3%, 5.7% and 2.4% of the projects were co-studied with independent domestic research institutes, other enterprises registered in China, foreign-funded institutes and exclusively foreign-owned enterprises registered in China respectively. In addition, 12.1% R&D projects were jointly explored by other means. Industrial enterprises have

① R&D projects with funding above a certain amount of money means project funding is at least 100,000 yuan.

strengthened R&D cooperation with domestic universities in recent years, with the proportion of projects they co-studied rising from 26.1% in 2000 to 40.1% in 2013, while the share of projects carried out in partnership with other enterprises registered in China has dropped by 10.7 percentage points in the period (Fig. 4-8).

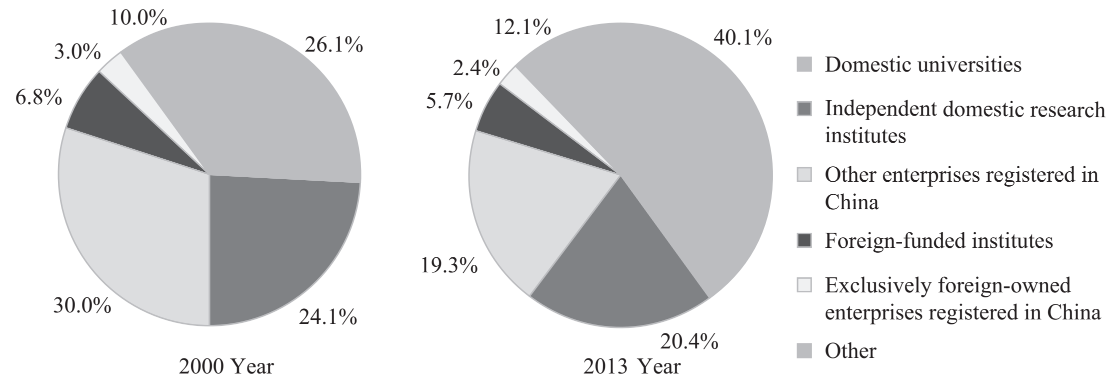

Fig. 4-8 Breakdown of R&D projects launched by industrial enterprises with different partners (2000, 2013)

Source: National Office of R&D Census, *National Industrial Statistics on the 2000 R&D Census*, National Bureau of Statistics and National Development and Reform Commission, *Statistical Yearbook on Science and Technology Activities of Industrial Enterprises 2014*.

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3. Technology acquisition

With the deepening globalization process and the thriving technology trade market, in addition to technological innovations pursued on its own, enterprises can also seek to acquire technologies to strengthen themselves. If acquiring an advanced technology costs less than developing it, it should be a preferred option for an enterprise to swiftly narrow its technological gap with competitors and strengthen its innovation capabilities. According to technology sources, enterprises can either introduce foreign technologies or purchase domestic technologies.

(1) Technology introduction

In light of lacking strong indigenous innovation capacities at most of China's industrial enterprises, introducing foreign technologies is seen as an important means to enhance their technological capabilities. Changes of the spending in technology introduction, to some extent, reflect the trend. Chinese industrial enterprises' spending in technology introduction has gone up in the years after 2000 and started to fall in later years. They spent 30.49 billion yuan in technology introduction in 2000, and the expenditure rose to 46.69 billion yuan in 2008 and dropped to 44.9 billion yuan in 2011. The figure further decreased to 39.39 billion yuan in

2013. The spending in technology introduction, as a share to the total R&D expenditure of enterprises, has kept dropping in the period, from 62.3% in 2000 to 15.2% in 2008 and 4.7% in 2013 (Fig. 4-9). These numbers suggest China's industrial enterprises are increasingly relying on independent research, development and innovations, instead of foreign technologies, to beef up their technological capabilities.

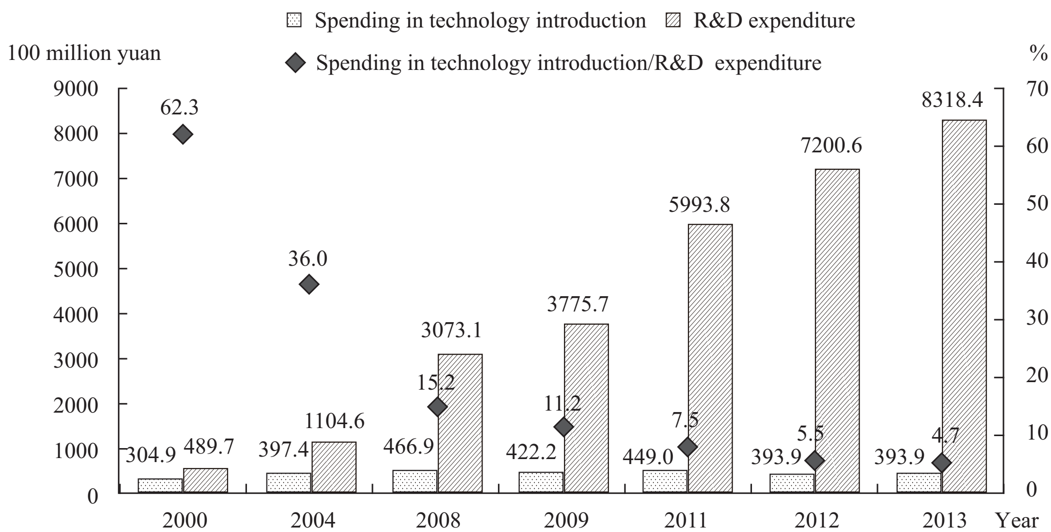

Fig. 4-9 Industrial enterprises' spending in technology introduction (2000—2013)

Source: Same as Table 4-5.

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(2) Technology digestion & absorption

Enterprise expenditure in technology digestion & absorption indicates how much money an enterprise spends in learning, imitating and innovating imported foreign technologies. The expenditure and its proportion to enterprise spending in technology introduction have gone up in the years after 2000 and started to fall in later years. Expenditure in technology digestion & absorption amounted to 2.28 billion yuan in 2000, and surged to 20.22 billion yuan in 2011 before declining to 15.06 billion yuan in 2013; its proportion to spending in technology introduction jumped from 7.5% in 2000 to 45.0% in 2011 before dropping to 38.2% in 2013 (Fig. 4-10). For Chinese-funded enterprises, the proportion spiked from 7.6% in 2000 to 61.3% in 2013.

(3) Purchase domestic technologies

As Chinese researchers produce more and more S&T achievements and the domestic technology trade market develops, China's industrial enterprises are ratcheting up spending to buy domestic technologies. The spending has increased from 3.45 billion yuan in 2000 to 21.44 billion yuan in 2013. In the same period, the spending, as a share of the money spent to introduce foreign technologies, spiked from 11.3% to 54.4% (Fig. 4-11). As China's industrial enterprises continue to strengthen their capabilities in exploring technological innovations and the domestic technology trade market further improves, they will increasingly shift to domestic technologies as a primary means to obtain external technologies.

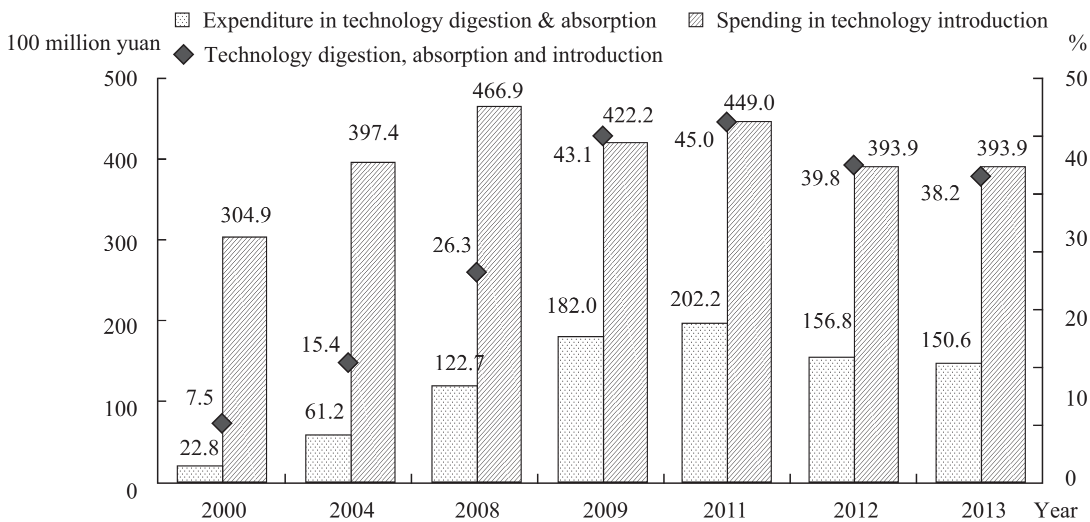

Fig. 4-10 Industrial enterprises' spending in technology introduction, digestion and absorption (2000—2013)

Source: Same as Table 4-5.

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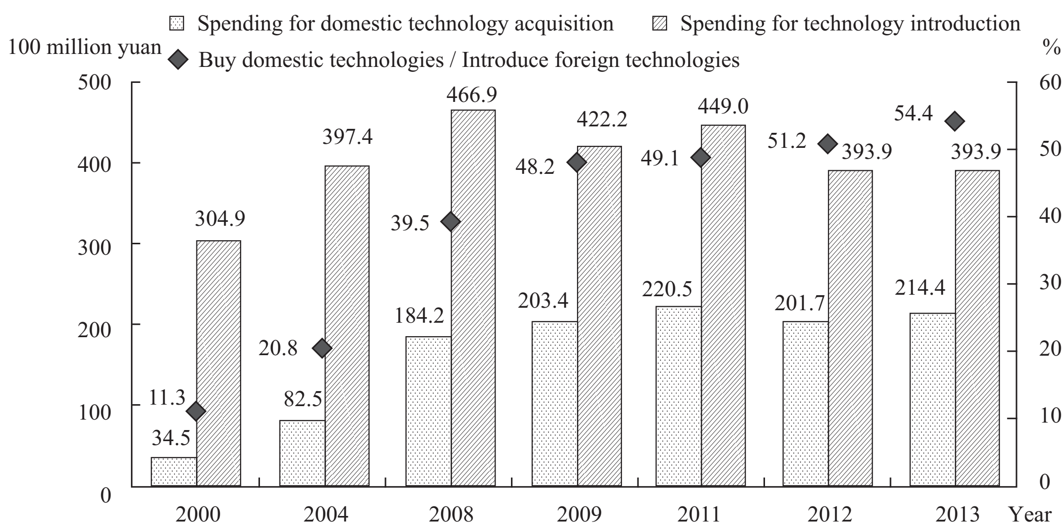

Fig. 4-11 Industrial enterprises' spending for domestic technology acquisition (2000—2013)

Source: Same as Table 4-5.

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Chapter 5 Science and Technology Activities in Higher Education Institutions

Higher education institutions, as important forces in China's research and experimental development activities, are playing an irreplaceable role in providing innovation resources like knowledge, technology, talents and information for society. Based on data and overview of regular colleges and universities, this chapter introduces the R&D institutions, personnel and expenditure, S&T output and achievements of higher education institutions, and analyzes the performance of such institutions by multiple levels and types.

Section 1 Overview of Higher Education Institutions

With higher education being increasingly popularized, the number of higher education institutions (hereafter referred to as HEIs) in China has, after several years of fast growth, basically stabilized. The continued and stable increase of teachers and postgraduate students has laid an important foundation for conducting R&D activities by HEIs.

1. The number of higher education institutions

From 2003 to 2013, with the demand for higher education increasing and expanded enrollment policy being implemented, China's HEIs have been increasing every year. In 2013, the number of HEIs was 2,491, an increase of 939 or over 60% from 2003. Before 2004, HEIs increased at least 10% annually, and after that, gradually stabilized. In 2008, over 300 independent colleges were transformed into private undergraduate colleges, thus causing the marked increase of HEIs. Thereafter, such average annual growth rate stabilized to no more than 5% (Fig. 5-1).

By the level of school, the number of undergraduate colleges and universities was 1,170 in 2013 and that of junior colleges was 1,321. By the affiliation of school, 113 were affiliated with the central government, 1,661 with local governments and 717 were run privately.

2. The number of full-time teachers and postgraduate students

Full-time teachers are the major group of R&D activities in HEIs; some postgraduate students participate in the R&D activities of HEIs under the instruction of tutors and play important roles, thus becoming important R&D forces and main sources of future R&D personnel.

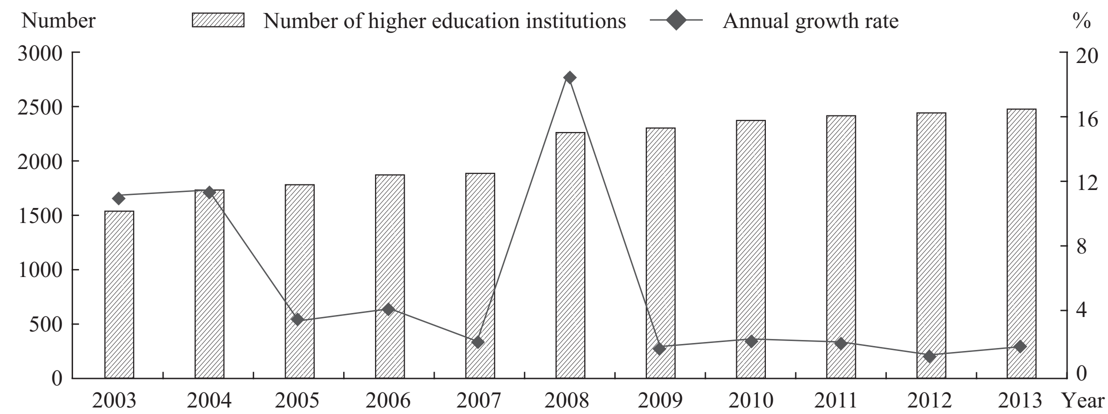

Fig. 5-1 The number and increase of higher education institutions (2003—2013)

See Appendix table 5-1.

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2.1 The number of full-time teachers

In 2013, the number of full-time teachers in China's HEIs totaled 1.497 million, an increase of 4.0% from the previous year. From 2003 to 2013, the enrollment of HEIs gradually stabilized and the number of full-time teachers kept growing, though at a slower rate (Fig. 5-2).

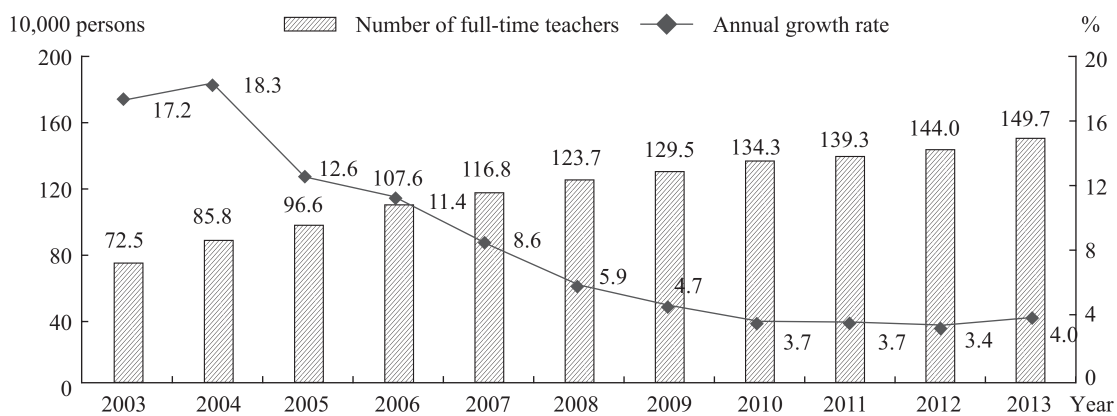

Fig. 5-2 The number of full-time teachers in higher education institutions (2003—2013)

Source: Department of Development Planning, Ministry of Education, *China Statistical Yearbook on Education 2003—2013.*

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From professional title, among China's full-time teachers in 2013, 614,000 or 41.0% had a senior title; 597,000 or 39.9% had an intermediate title; 204,000 or 13.6% had a junior title; 82,000 or 5.5% had no title. From education background, 285,000 or 19.0% had a doctor's degree; 536,000 or 35.8% had a master's degree; 655,000 or 43.8% had a bachelor's degree; 21,000 or 1.4% had a junior college degree or below.

3. The number of postgraduate students at school

In 2013, the number of postgraduate students in HEIs was 1.75 million, an increase of 4.2% from the previous year. From 2003 to 2013, with the enrollment increase of HEIs slowing down, such rapid growth gradually also slowed down.

From 2003 to 2005, the average annual increase of postgraduate students at school was above 25%. From 2006 to 2013, this rate decreased to 7.5% (Fig. 5-3).

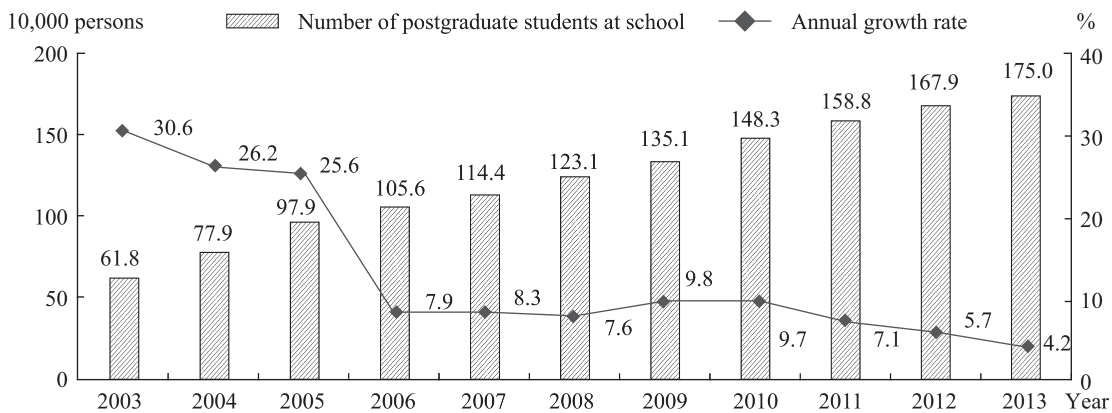

Fig. 5-3 The number of postgraduate students at school (2003—2013)

Source: Department of Development Planning, Ministry of Education, *China Statistical Yearbook on Education 2003—2013.*

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Section 2 R&D Institutions and Personnel in Higher Education Institutions

Over the past decade, R&D institutions and personnel in China's HEIs have been increasing steadily and their structure has been continuously optimized. Compared with developed countries, China has a larger number of R&D personnel based on HEIs, but their proportion in total national R&D personnel is smaller.

1. The number of R&D institutions

Various R&D institutions, as an integral part of the S&T innovation system of HEIs, are an important carrier of knowledge innovation and innovation talent cultivation. From 2003 to 2013, the number of R&D institutions in China's HEIs has been increasing from 3,145 in 2003 to 9,842 in 2013. And 2010 saw the highest year-on-year increase of 35.4% (Fig. 5-4).

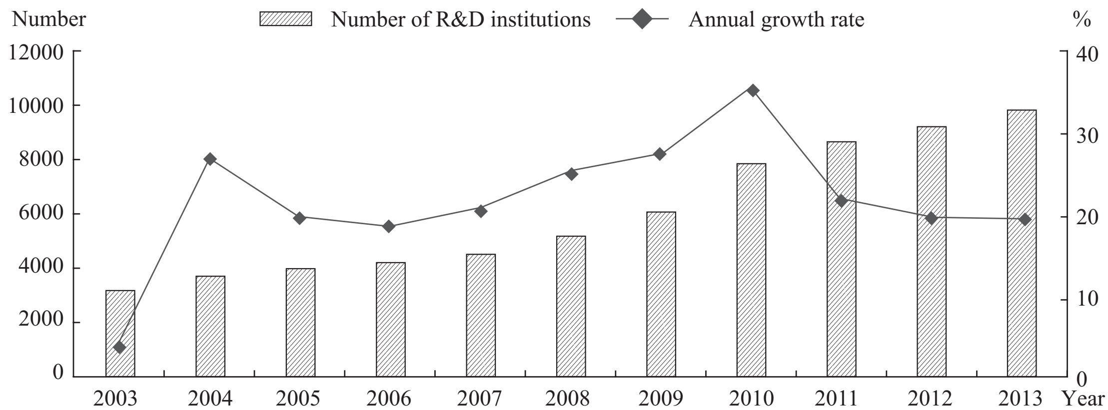

Fig. 5-4 The number of R&D institutions in higher education institutions (2003—2013)

See Appendix table 5-1.

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2. The scale of R&D personnel

2.1 R&D personnel

In recent years, R&D personnel in China's HEIs have been growing steadily and reached 715,000 in 2013, an increase of 122,000 or 6.4% from 2010. This number accounted for 14.3% of the national total, down by 2.6% from 2010. The structure of R&D personnel in HEIs has two features. First, the number of female R&D personnel and their proportion in total R&D personnel in HEIs are both increasing steadily. In 2013, HEIs had 277,000 female R&D personnel, up by 23,000 from 2010; they accounted for 38.7% in total R&D personnel in HEIs, up by 3.6% from 2010 and 6% higher than those in GRIs (government research institutes), which was only 2.8% in 2010; they accounted for 22.2% in total national female R&D personnel, down by 1.2% from 2010.

Second, R&D personnel in HEIs have higher education level. In 2013, 447,000 R&D personnel in HEIs held a master or doctoral degree, an increase of 32.1% from 2010; they accounted for 62.5% of total R&D personnel in HEIs, up by 5.5% from 2010 and 16% higher than that in GRIs; 25.1% of R&D personnel in HEIs held a doctoral degree, and 37.4% a master's degree, up by 3.4% and 2.1% respectively.

2.2 Full-time equivalents of R&D personnel

In 2013, the full-time equivalents of R&D personnel in HEIs were 325,000 person-years. From 2003 to 2013, the full-time equivalents of R&D personnel in HEIs were increasing steadily with an average annual increase of 5.6%, but their proportion in the full-time equivalents of total national R&D personnel was falling gradually, from 17.3% in 2003 to 9.2% in 2013 (Fig. 5-5).

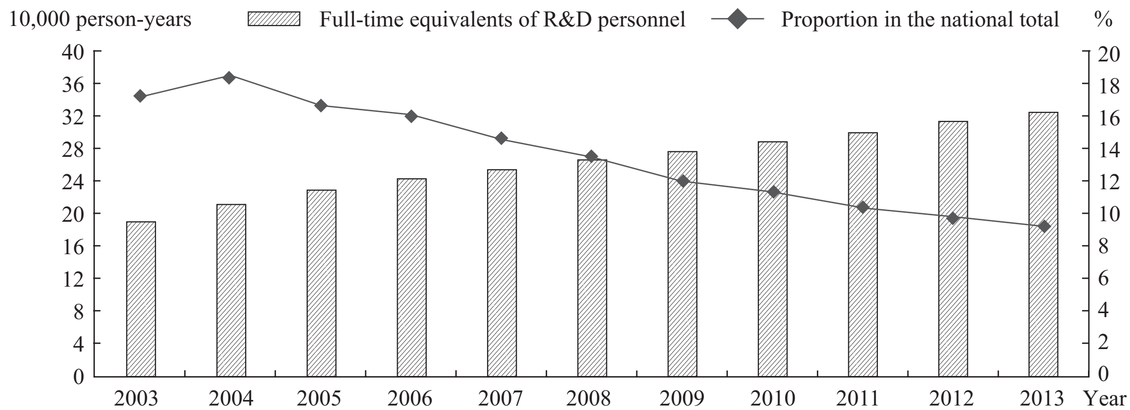

Fig. 5-5 R&D personnel in higher education institutions and their proportion in the national total (2003—2013)

See Appendix table 5-1.

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From the perspective of natural sciences and engineering technology and by the standard of school, R&D personnel in "211 Project" universities and universities jointly built by provinces and ministries accounted for 43.8% in 2013, other undergraduate colleges and universities 54.3% and junior colleges 1.9%. By the affiliation of school, R&D personnel in HEIs affiliated to the central government accounted for 36.1%, while those affiliated to local governments 63.9%.

3. International comparison of R&D personnel

From a global perspective, China's R&D personnel in HEIs have an obvious advantage for a large number, but their proportion in total national R&D personnel lags far behind that of developed countries. In 2013, China's R&D personnel in HEIs were 325,000 person-years, those in Japan 208,000 person-years, and those in the UK, Germany, Russia and France between 100,000 and 180,000 person-years. From the proportion of R&D personnel in HEIs of total national R&D personnel, the proportion in the UK was 47.9% in 2013, both Switzerland (2012) and Canada (2012) 30%, and France, Netherlands, Sweden, Germany and Japan above 20%. But the proportion in China was only 9.2%, lagging far behind from other developed countries (Fig. 5-6).

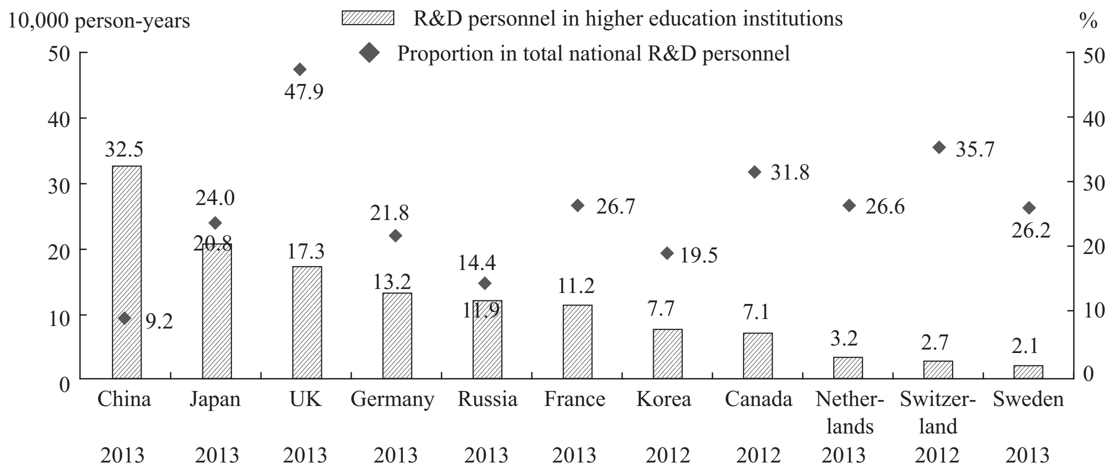

Fig. 5-6 The full-time equivalents of R&D personnel in higher education institutions of some countries and their proportion in total national R&D personnel

Source: OECD, *Main Science and Technology Indicators*, *2014-2*.

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The proportion of R&D research personnel in total R&D personnel indicates the rationality of the structure of R&D personnel. In 2013, China's HEIs had 273,000 person-years of R&D research personnel, accounting for 83.9% of total R&D personnel in HEIs. The proportion in the UK was 88.6%, Australia 87.6% (2010), Sweden 77.5%, Germany 76.3% and Japan 65.7%. This indicates that the number of research personnel in HEIs and their proportion in total R&D personnel in China have some advantages (Fig. 5-7).

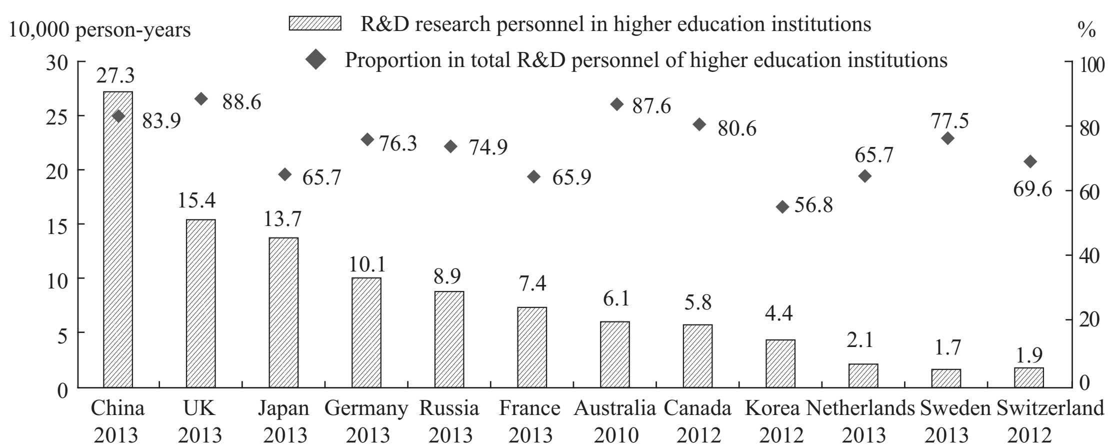

Fig. 5-7 Research personnel in higher education institutions of some countries and their proportion in R&D personnel of higher education institutions

Source: OECD, *Main Science and Technology Indicators*, *2014-2*.

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Section 3 R&D Expenditure of Higher Education Institutions

R&D expenditure is an important guarantee for conducting S&T innovation activities in HEIs and the material foundation for enhancing R&D level. Thus, increasing the input of R&D expenditure for HEIs and enhancing the utilization efficiency of such expenditure is significant for accelerating the building of an innovation-driven country.

1. R&D expenditure

In 2013, the R&D expenditure of HEIs was 85.67 billion yuan, an increase of 7.61 billion yuan from the previous year. From 2003 to 2013, the R&D expenditure of China's HEIs was increasing steadily, with an average annual growth of 10.0%. In this period, the proportion of this expenditure in the national total gradually decreased from 10.5% in 2003 to 7.2% in 2013 (Fig. 5-8).

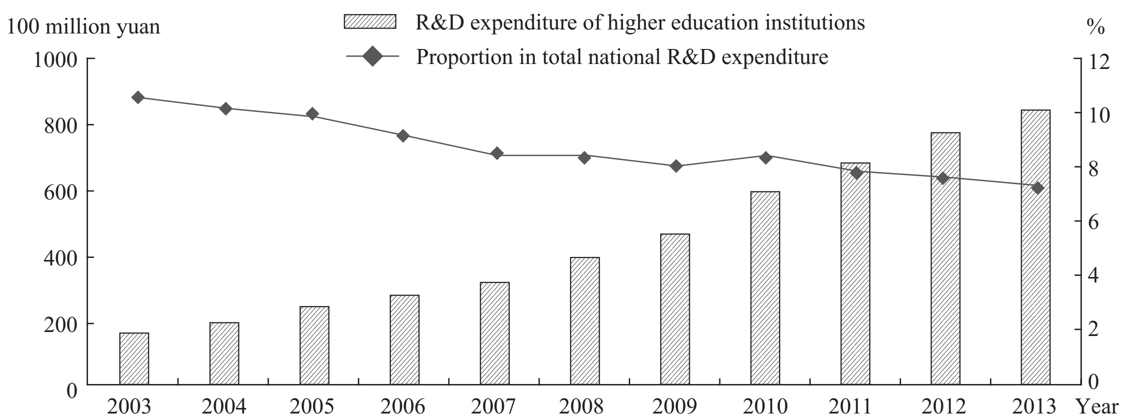

Fig. 5-8 R&D expenditure of higher education institutions and its proportion in total national R&D expenditure (2003—2013)

See Appendix table 5-1.

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In 2013, the per capita expenditure of R&D personnel in HEIs reached 264,000 yuan per person-year, an increase of 178,000 yuan per person-year from 2003. From 2003 to 2013, the growth of per capita expenditure of R&D personnel in HEIs had a significant fluctuation; calculated at comparable prices, the growth rate of 2009 was the highest over the past ten years. In last three years, the per capita expenditure of R&D personnel has been steady and was 3.7% in 2013 (Fig. 5-9).

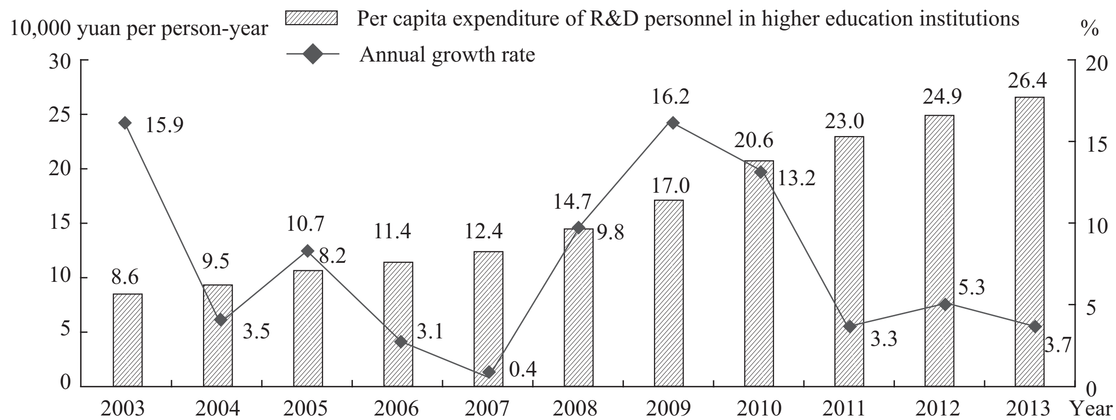

Fig. 5-9 Per-capita expenditure of R&D personnel in higher education institutions (2003—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology (2004—2014).*

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2. The structure of R&D expenditure

In 2013, among the R&D expenditure of HEIs, the expenditure for applied research was the largest, 44.13 billion yuan, an increase of 30.9% from 2010; the expenditure for basic research was 30.76 billion yuan, an increase of 71.0% from 2010; the expenditure for experimental development was 10.78 billion yuan, an increase of 34.2% from 2010. From 2003 to 2013, the proportion of basic research expenditure in the total R&D expenditure of HEIs increased significantly, from 20.3% in 2003 to 35.9% in 2013; the proportion of applied research expenditure maintained between 50% and 55%; the proportion of experimental development was decreasing year by year, from 24.5% in 2003 to 12.6% in 2013 (Fig. 5-10).

From 2003 to 2013, the proportion of R&D expenditure of HEIs in total national R&D expenditure decreased gradually. During this period, the shares of basic research expenditure and applied research expenditure of HEIs in total national basic research expenditure and applied research expenditure were both on the rise, with the former increasing more, from 37.5% in 2003 to 55.4% in 2013. The proportion of applied research expenditure increased by 6.0%, from 28.8% in 2003 to 34.8% in 2013. The proportion of experimental development expenditure was declining from 3.5% in 2003 to 1.1% in 2013 (Fig. 5-11).

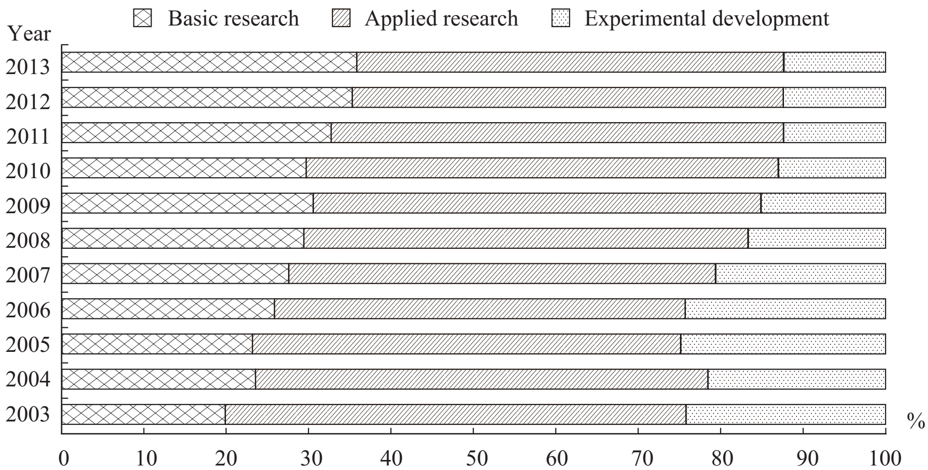

Fig. 5-10 The distribution of R&D expenditure of higher education institutions by the type of activity (2003—2013)

See Appendix table 5-1.

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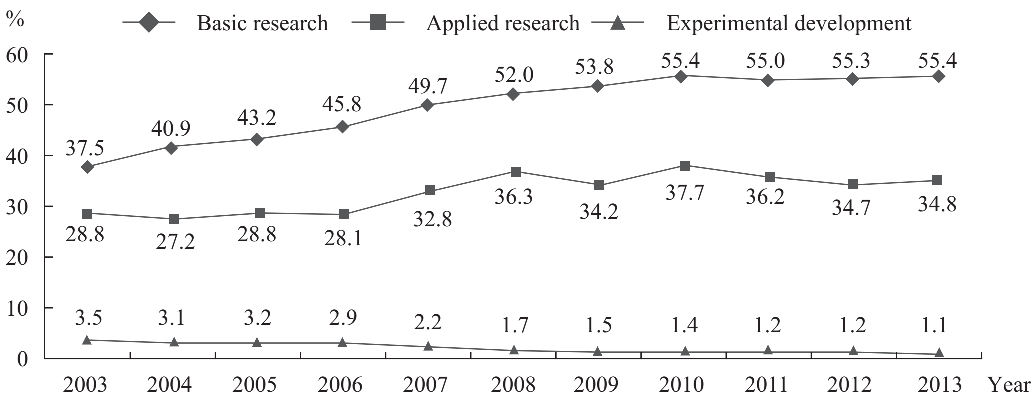

Fig. 5-11 Proportion of R&D expenditure of higher education institutions in the national total (2003—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology (2004—2014)*.

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3. The sources of R&D expenditure

Governmental funds are the main source of R&D expenditure of HEIs and mainly used for the exploratory research of natural phenomena and social development. In 2013, among the R&D expenditure of HEIs, 51.69 billion yuan was from governmental funds and accounted for 60.3%, an increase of 4.28 billion yuan from the previous year; 28.93 billion yuan was from enterprise funds, accounting for 33.8%; 5.06 billion yuan was from other funds and foreign funds, accounting for 5.9%. From 2003 to 2013, the proportion of R&D expenditure of HEIs from governmental funds maintained above 50% and was on the rise, increasing from 54% in 2003 to 60.3% in 2013. That from enterprises maintained around 35% (Fig. 5-12).

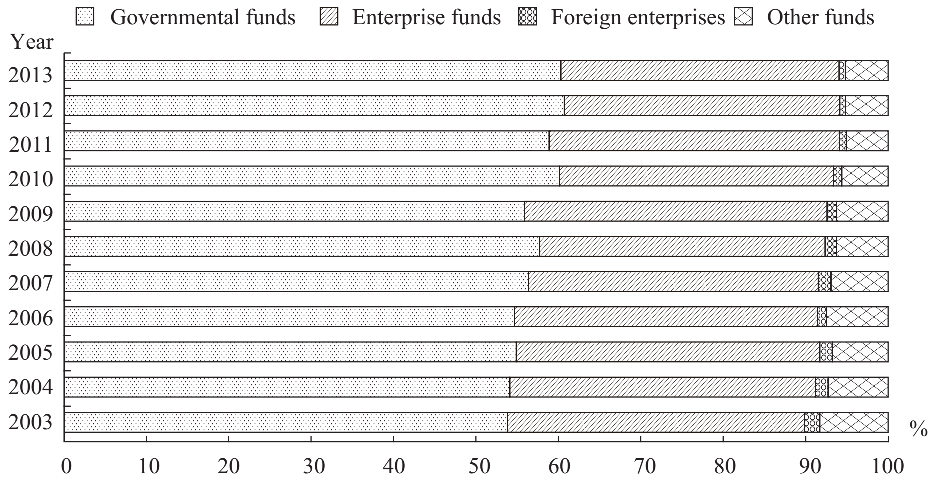

Fig. 5-12 The sources of R&D expenditure of higher education institutions (2003—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology (2004—2014)*

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4. International comparison of R&D expenditure input

From the total R&D expenditure input of various countries, the input of China in 2013 lagged far behind that of the US which was USD 62.58 billion (2012), but surpassed that of some developed countries like Italy and Netherlands and was close to that of France and Canada. Countries whose R&D expenditure of HEIs surpassed that of China also included Japan and Germany, which had USD 23.01 billion and USD 19.16 billion respectively.

The proportion of R&D expenditure of HEIs in total national R&D expenditure indicates the extent of concern that countries put on R&D activities of HEIs. In 2013, the R&D expenditure of HEIs accounted for 7.2% of the national total, while this proportion of developed countries was generally above 10%, that of France, the UK, Italy and Sweden maintained between 20% and 30%, and that of Canada and Netherlands was even above 30%. The proportion of the Korea and Russia was relatively low and around 9% (Fig. 5-13).

On the whole, the research conducted by HEIs in various countries was mainly basic research and applied research. Yet due to differences in research system, the R&D expenditure of HEIs differed in countries by the type of activity. The proportion of basic research expenditure in the US, Italy, Japan and France was relatively high and above 55%, and that of France was as high as 82.9%. The applied research expenditure of China and the UK was relatively high and above 50%. Russia and the Korea had a relatively high proportion of experimental development expenditure, which was 24.4% and 29.2% respectively (Fig. 5-14).

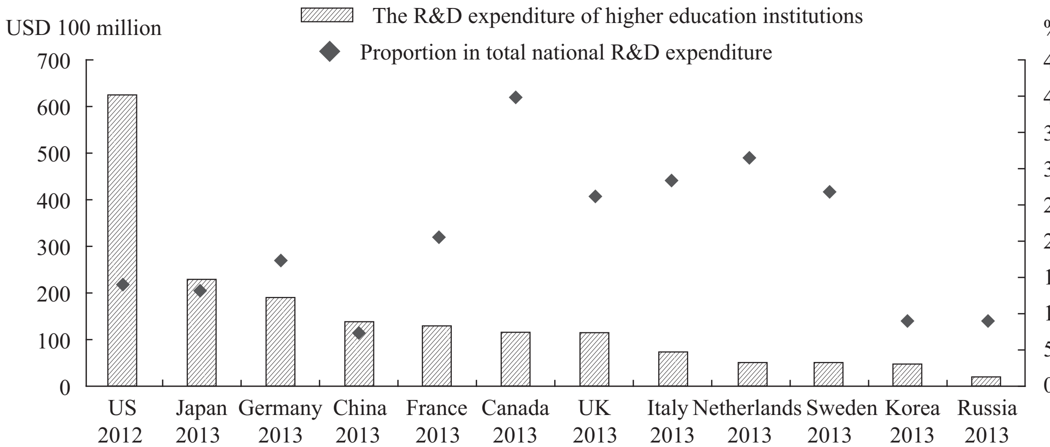

Fig. 5-13 The R&D expenditure of higher education institutions of some countries and its proportion in total national R&D expenditure

See Appendix table 5-2.

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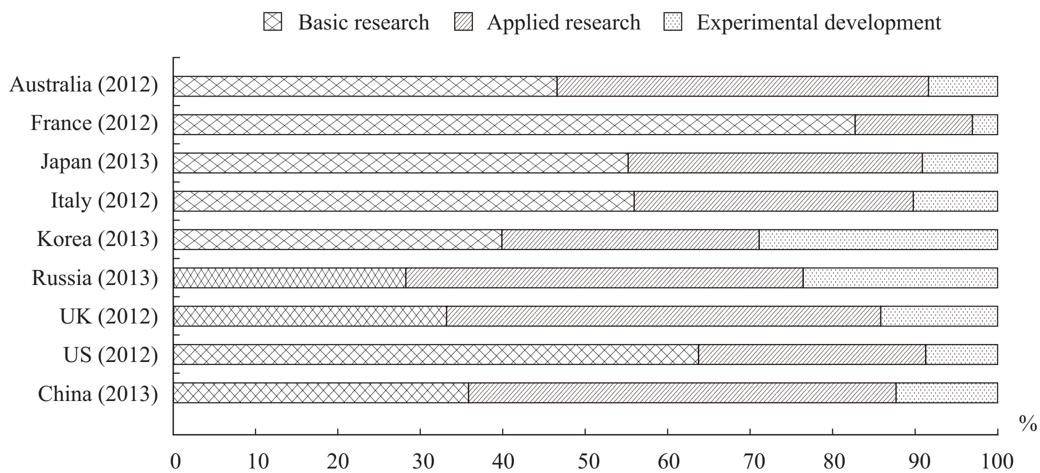

Fig. 5-14 The distribution of R&D expenditure of higher education institutions in some countries

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology (2014)*; OECD, R&D Statistics 2015.

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The ratio of R&D expenditure in HEIs to GDP can indicate the intensity of R&D expenditure in

HEIs. In 2013, the R&D expenditure intensity of Chinese HEIs was 0.15%, 0.03% higher than that of 2003 and slightly higher than that of Russia (0.10%). The R&D expenditure intensity of HEIs in the UK, France, the US, Japan and other developed countries was above 0.40% on the whole (Fig. 5-15).

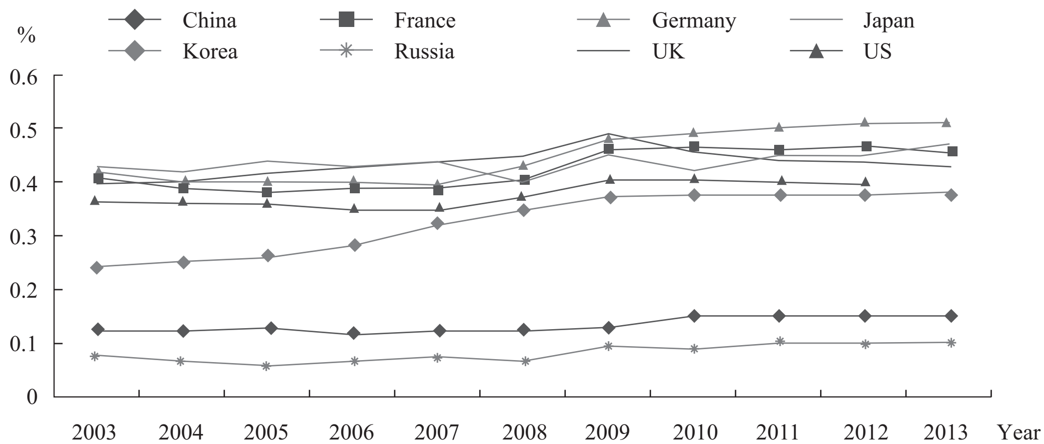

Fig. 5-15 The intensity of R&D expenditure of higher education institutions in some countries (2003—2013)

See Appendix table 5-3.

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Section 4 Output and Achievement of Commercialization of S&T Activities at Higher Education Institutions

In recent years, the S&T papers, patents and other S&T activities in HEIs have been increasing steadily and the transfer and commercialization of S&T achievements accelerating, thus providing a strong support for the restructuring and upgrading of China's industries.

1. S&T papers

From 2003 to 2013, the number of SCI papers in HEIs has been on the rise. In 2013, this number reached 161,000, an increase of 133,000 or almost 6 times from that of 2003. The dominant role of HEIs in science and research fields has been stable. The proportion of SCI papers of HEIs in the national total has long maintained above 80% and reached 83.7% in 2013 (Fig. 5-16).

2. patents

With S&T personnel's awareness of protecting intellectual property increasing generally and R&D personnel's enthusiasm for innovation being further inspired, the number of patents applied by HEIs has increased markedly from 10,000 in 2003 to 168,000 in 2013, with an average annual growth of 32.2%. Among them, invention patents applied increased from 7,704 to 99,000, with an average annual growth of 29.0%. Since 2003, the proportion of patents applied by HEIs in the national total has been growing slowly, and was 7.5% in 2013, still below 10%. From 2003 to 2013, the proportion of invention patents applied in total patents applied by HEIs was declining from 75.1% in 2003 to 58.8% in 2013 (Fig. 5-17).

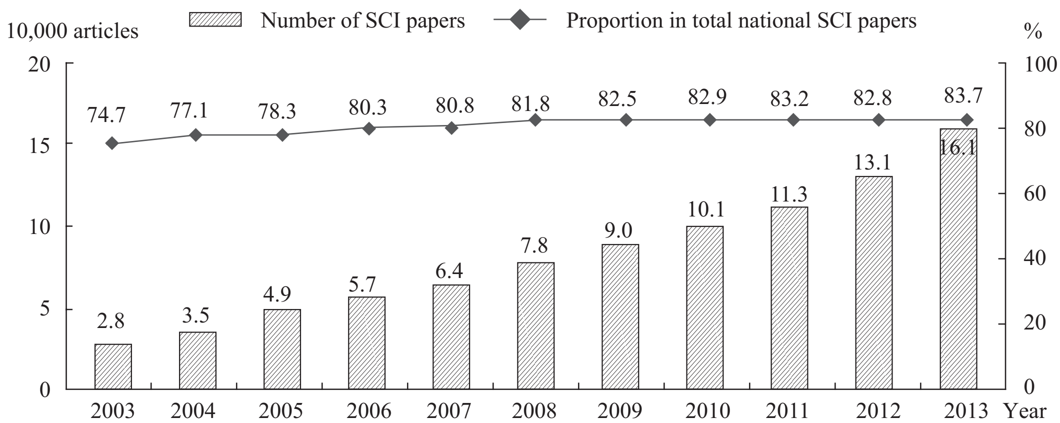

Fig. 5-16 The number of SCI papers in higher education institutions and their proportion in the national total (2003—2013)

Source: Institute of Scientific and Technical Information of China, *Chinese S&T Papers Statistics and Analysis (2003—2013)*.

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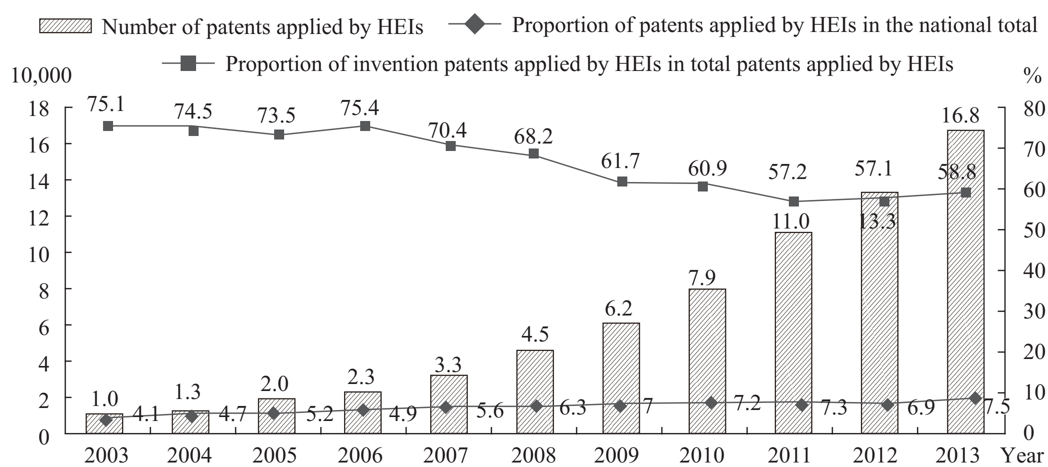

Fig. 5-17 The number of patents applied by higher education institutions and their proportion in the national total (2003—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2004—2014*.

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From 2003 to 2013, the patents granted of HEIs have been increasing, from 3,416 in 2003 to 85,000 in 2013, with an average annual growth of 37.9%. Among them, invention patents granted increased from 1,730 to 33,000, with an average annual growth of 34.3%. Since 2003, the proportion of patents granted of HEIs in the national total has been increasing. In 2013, this proportion reached 6.9%, up from 4.6% in 2003. In recent years, the proportion of invention patents granted in the total patents granted of HEIs has been declining. In 2013, this proportion was only 39.2%, down from 50.6% in 2003 (Fig. 5-18).

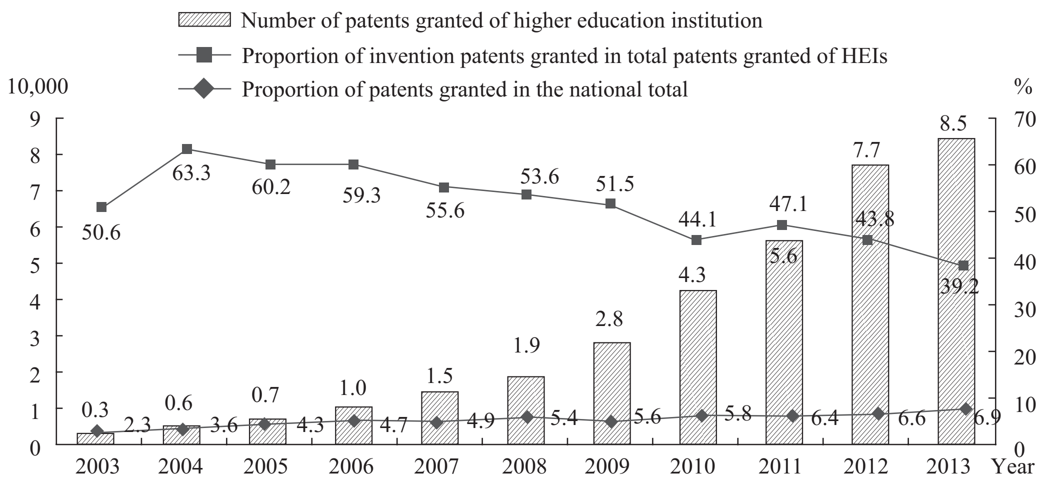

Fig. 5-18 The number of patents granted of higher education institutions and their proportion in the national total (2003—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2004—2014.*

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Chapter 6 Science and Technology Activities in Government Research Institutes

Government research institutes are independent research institutes (Hereafter referred to as "research institutes") affiliated to the ministries and departments of the State Council and local governments. They are an integral part of China's innovation system and the major sector to carry out basic, strategic and public-interest researches. The chapter analyzes the basic facts about S&T activities carried out by research institutes in 2013 from four perspectives, including overview of research institutes, R&D personnel, R&D expenditure, and output and achievement transfer of S&T activities.

Section 1 Overview of Research Institutes

In recent years, the number of research institutes has been decreasing, while the R&D personnel, R&D expenditure and per capita R&D expenditure have kept increasing.

1. Number of research institutes

China had 3,651 research institutes by 2013, including 711 affiliated to the central government and 2,940 affiliated to local governments. Between 2005 and 2013, the total number of research institutes decreased by 250, because the increase in the number of central research institutes was much less than offset by the heavy reduction in the number of local research institutes (Table 6-1).

Table 6-1 Number of research institutes (2005—2013)

Year	Number of total research institutes	Central research institutes	Local research institutes
2005	3901	679	3222
2006	3803	673	3130
2007	3775	674	3101
2008	3727	678	3049
2009	3707	691	3016
2010	3696	686	3010
2011	3673	686	2987
2012	3674	710	2964
2013	3651	711	2940

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

2. S&T personnel

There were 568 thousand S&T personnel working at China's research institutes in 2013, in which there were 409 thousand R&D personnel and 134 thousand female R&D personnel . In terms of full-time equivalent, the amount of R&D personnel reached 329 thousand person-years.

R&D personnel at research institutes have been expanding since 2005, and registered an average annual growth rate of 6.8% through 2013. R&D personnel have accounted for a rising proportion of S&T personnel, up from 52.9% in 2005 to 72.1% in 2013 (Fig. 6-1).

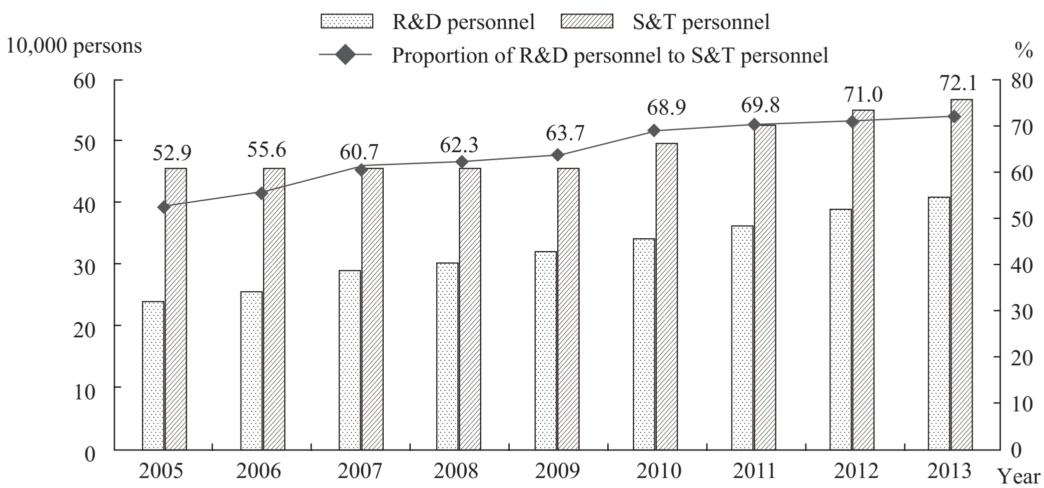

Fig. 6-1 S&T personnel and R&D personnel at research institutes (2005—2013)

See Appendix table 6-1.

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3. R&D expenditure

R&D expenditure at research institutes amounted to 178.14 billion yuan in 2013, and 90.2% was performed by central government affiliated research institutes, much more than local government affiliated research institutes. Calculated on the basis of current prices, R&D expenditure of research institutes logged an average annual growth rate of 16.8% from 2005 to 2013.

The proportion of R&D expenditure at research institutes to the national total had kept falling, from more than 20% in 2005 to about 15% in 2011, and remained stable since then (Fig. 6-2)

Per capita R&D expenditure at research institutes rose from 239 thousand yuan in 2005 to 490 thousand yuan in 2013, indicating an average annual growth rate of 9.4%, wherein Growth rate quickened to more than 12% between 2008 and 2010.

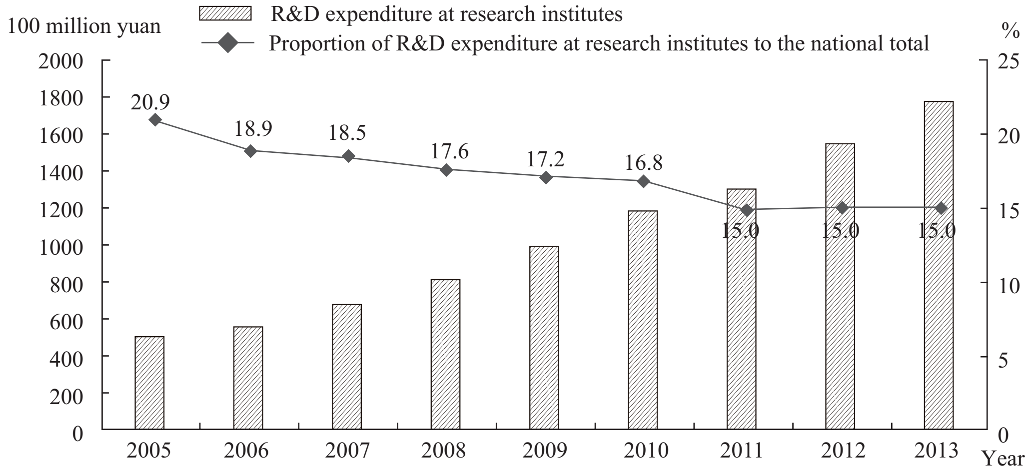

Fig. 6-2 R&D expenditure at research institutes and its proportion to the national total (2005—2013)

See Appendix table 6-2.

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Labor cost takes up roughly 20% of the R&D expenditure in China's research institutes, lower than some developed countries, while capital expenditure generally accounts for more than 20%. According to OECD statistics, labor cost represented more than 40% of the R&D expenditure in German and French research institutes between 2005 and 2013, compared to 20% ～ 40% in Japan and Korea. For the American research institutes, capital expenditure has always took up less than 5% of their total R&D expenditure (Fig. 6-3, 6-4).

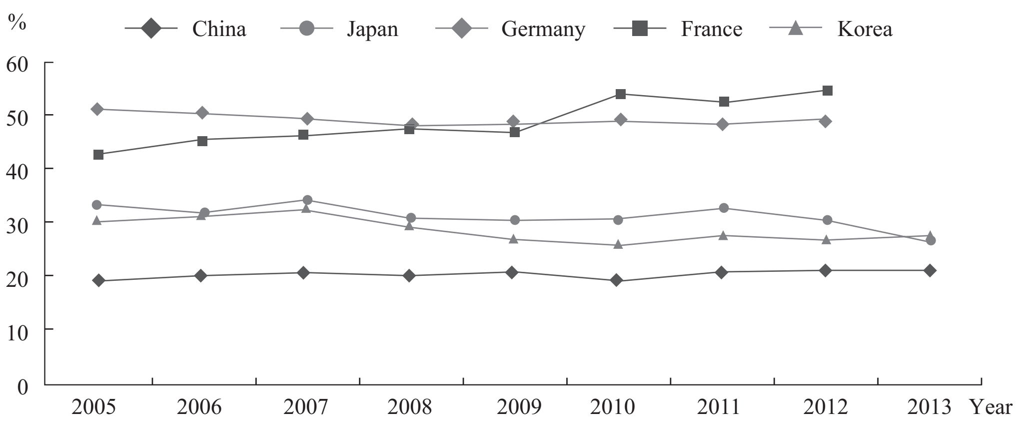

Fig. 6-3 Proportion of labor cost to R&D expenditure at major countries' research institutes (2005—2013)

Source: OECD, R&D Statistics 2015.

China Science and Technology Indicators 2014

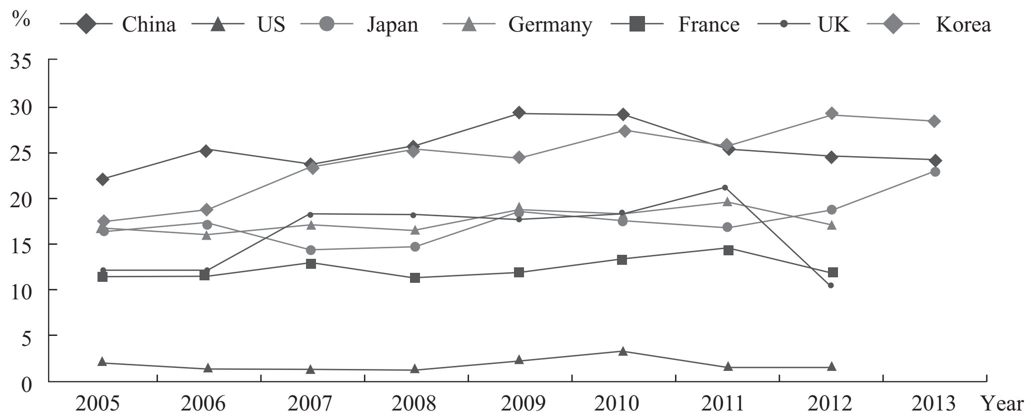

Fig. 6-4 Proportion of capital expenditure to R&D expenditure at major countries' research institutes (2005—2013)

Source: OECD, R&D Statistics 2015.

China Science and Technology Indicators 2014

Section 2 Research and Development Personnel at Research Institutes

The number of R&D personnel at research institutes rose in 2013 from the year before, but its proportion to the national total continued to decline. The share of R&D personnel with higher academic degrees kept going up.

1. Scale of R&D personnel

In terms of full-time equivalent, the total amount of R&D personnel at research institutes added up to 364 thousand person-years. Specifically, the amount of R&D personnel dedicated to basic research, applied research and experimental development reached 61 thousand person-years, 130 thousand person-years and 173 thousand person-years, respectively, indicating an average annual growth rate of 10.2%, 5.7% and 6.6% (Fig. 6-5).

R&D personnel at research institutes continued to go up, but its proportion to the national total of R&D personnel kept falling from 15.8% in 2005 to 10.3% in 2013. The drop accelerated between 2007 and 2009 and had moderated after that (Fig. 6-6).

2. Structure of educational background

Among the R&D personnel at research institutes, 63 thousand people (15.4%) held doctor degrees and 127 thousand (31.1%) held master degrees. R&D personnel with master degrees or higher have kept increasing between 2009 and 2013 (Fig. 6-7).

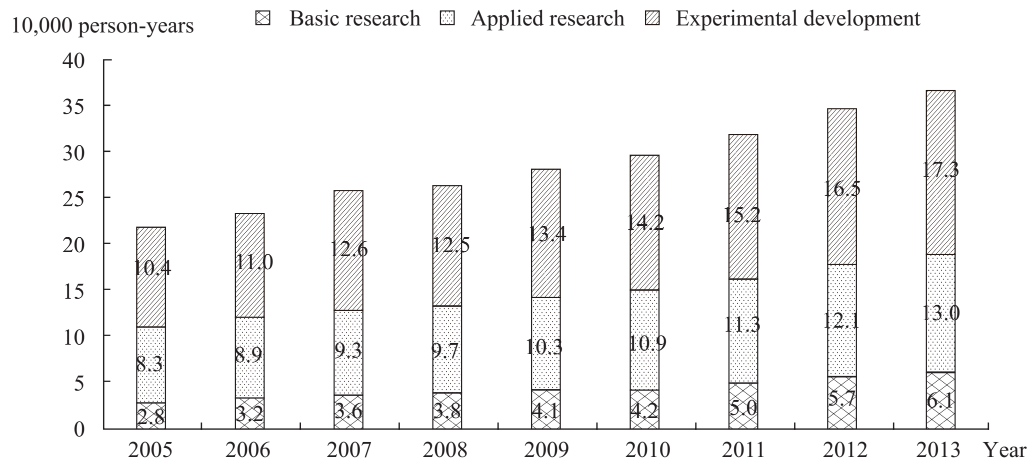

Fig. 6-5 R&D personnel at research institutes by type of activity (2005—2013)

See Appendix table 6-1.

China Science and Technology Indicators 2014

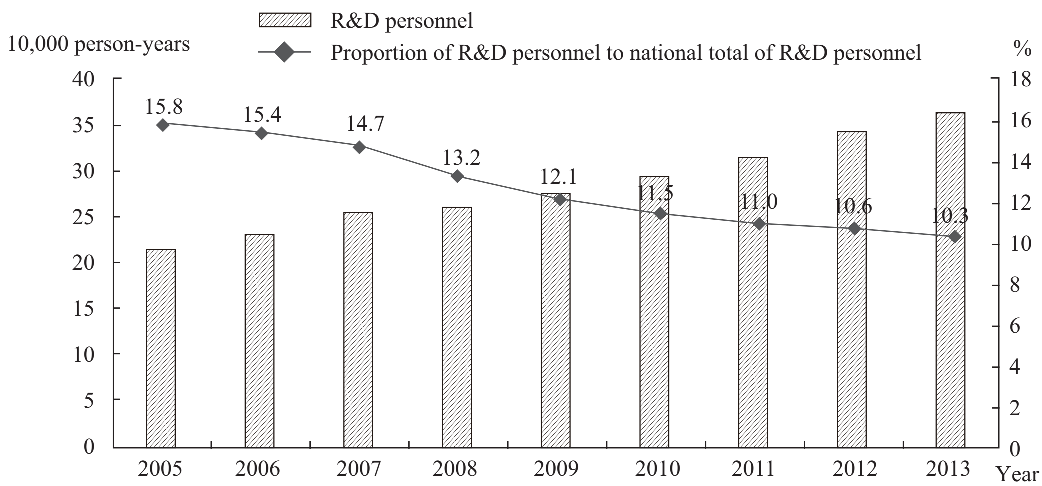

Fig. 6-6 Proportion of R&D personnel at research institutes to national total (2005—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

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Central research institutes had 320 thousand R&D personnel in 2013, including 54 thousand (16.8%) with doctor degrees and 100 thousand (31.7%) with master degrees. Local research institutes had 89 thousand R&D personnel, including 9,086 (10.3%) with doctor degrees and 25.5 thousand (28.8%) with master degrees. More than 85% of R&D personnel with doctor degrees were working at central research institutes (Table 6-2).

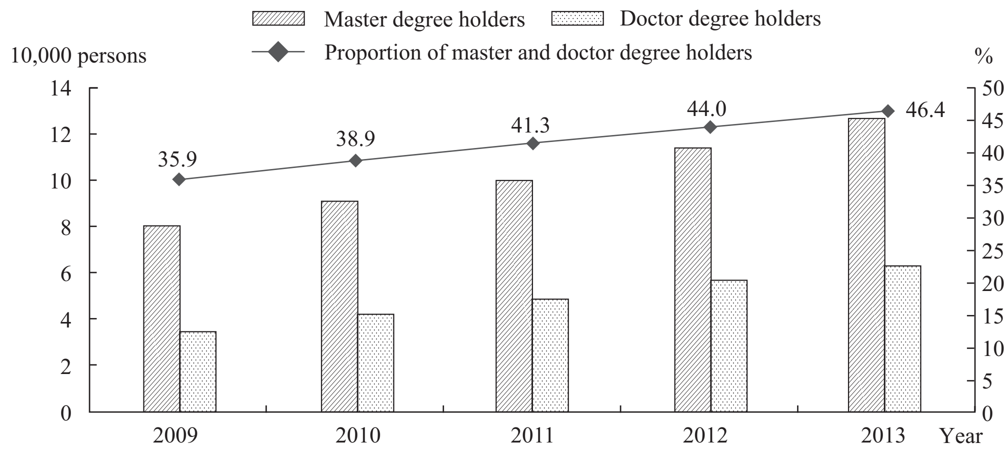

Fig. 6-7 Structure of educational background of R&D personnel at research institutes (2009—2013)

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2010—2014*.

China Science and Technology Indicators 2014

Table 6-2 Structure of educational background of R&D personnel by affiliation of research institutes (2013)

Item	R&D personnel	R&D personnel with doctor degrees	R&D personnel with master degrees
Total	409032	62907	127070
Central research institutes	320498	53821	101613
Local research institutes	88534	9086	25457

Source: National Bureau of Statistics, Ministry of Science and Technology. *China Statistical Yearbook on Science and Technology 2014*.

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From the perspective of academic disciplines, talents studying engineering and technology occupied the biggest share of 58.8% of the R&D personnel at research institutes, followed by 18.2% for natural science and 12.8% for agricultural science. Researchers dedicated to medical science and humanity & social sciences accounted for the smallest portion of 6.2% and 4.1% of the R&D personnel. 35.5% of doctorates are specialized in natural science, followed by 22.6% for humanity & social sciences and 16.1% for medical science. Agricultural science and engineering & technology science had the lowest proportions of doctorates at 12.8% and 9.1% (Table 6-3).

Table 6-3 Structure of educational background of R&D personnel by academic discipline (2013)

Academic discipline	R&D personnel	R&D personnel with doctor degrees	R&D personnel with master degrees
Natural science	74391	26394	21138
Agricultural science	52240	6692	14148
Medical science	25338	4086	7312
Engineering & technology science	240333	21951	79572
Humanity & social sciences	16730	3784	4900

Source: National Bureau of Statistics, Ministry of Science and Technology. *China Statistical Yearbook on Science and Technology 2014*.

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Section 3 Research and Development Expenditure at Research Institutes

In recent years, government appropriations have been a primary source of funding to research institutes. Funding to basic research has been growing at the fastest pace, but an overwhelming majority of R&D expenditure has flowed to fund experimental development.

1. Sources of R&D expenditure

Government funding has long been a primary source of R&D spending by research institutes. Government subsidies increased from 42.47 billion yuan in 2005 to 148.12 billion yuan in 2013. Government contribution has stayed above 80% over the years (Fig. 6-8). 3.4% of the R&D funding came from enterprises, 13.1% from other entities and less than 0.5% from foreign sources.

Enterprise contribution to R&D spending by research institutes has been small and has never exceeded 4% of their total R&D expenditure since 2005 although the amount of such contributions has ballooned from 1.76 billion yuan in 2005 to 6.09 billion yuan in 2013.

According to OECD statistics, R&D expenditure of Chinese research institutes, as a share of the national total, has kept falling from 20.9% in 2005 to 15.0% in 2013, but still higher than their counterparts in countries like the US, the UK, Germany, France, Japan and the Korea (Fig. 6-9).

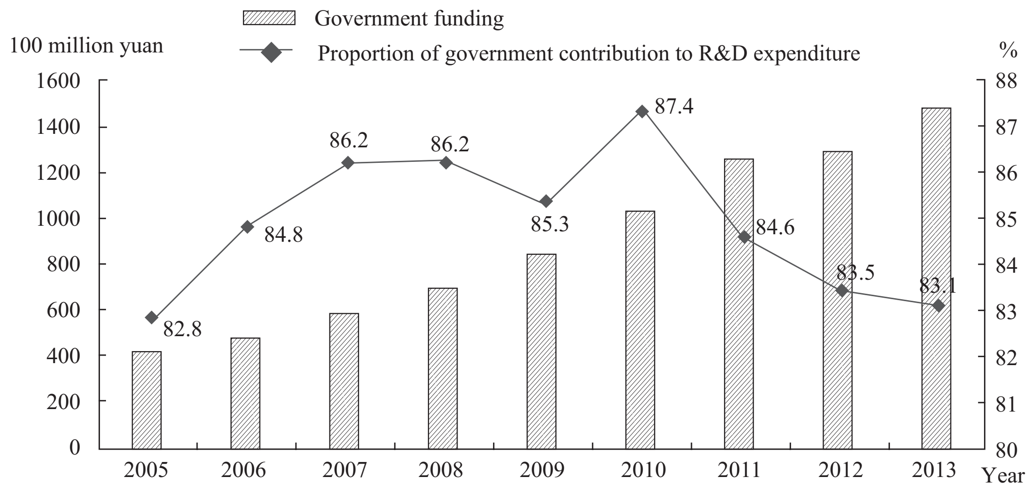

Fig. 6-8 Amount and proportion of government contribution to R&D expenditure of research institutes

Source: National Bureau of Statistics, Ministry of Science and Technology. *China Statistical Yearbook on Science and Technology 2014*.

China Science and Technology Indicators 2014

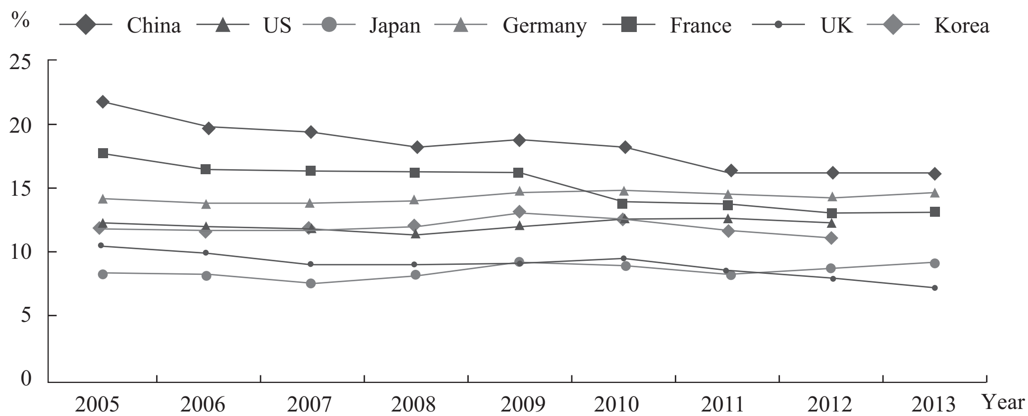

Fig. 6-9 Proportion R&D expenditure of research institutes to national total at major countries (2001—2013)

Source: OECD, *Main Science and Technology Indicators 2014-2*.

China Science and Technology Indicators 2014

2. Structure of R&D expenditure

Along with the rapid growth of R&D expenditure since 2005, research institutes have registered an average annual growth rate of respectively 18.2%, 14.6% and 17.8% in funding to basic research, applied research and experimental development through 2013. In terms of the proportion of funding to the three categories of research activities, experimental development snapped up the biggest share of 58%, versus 12.4% for basic research and 29.5% for applied research (Table 6-4).

Table 6-4 Breakdown of R&D expenditure of research institutes by category of research activities (2005—2013)

Year	Basic research		Applied research		Experimental development	
	100 million yuan	%	100 million yuan	%	100 million yuan	%
2005	58.0	11.3	176.3	34.4	278.7	54.3
2006	67.9	12.0	196.2	34.6	303.2	53.4
2007	74.7	10.9	227.1	33.0	386.1	56.1
2008	92.7	11.4	271.3	33.4	447.2	55.1
2009	110.6	11.1	350.9	35.2	534.4	53.7
2010	129.9	10.9	387.6	32.7	668.9	56.4
2011	160.2	12.3	417.2	31.9	729.3	55.8
2012	197.9	12.8	469.3	30.3	881.7	56.9
2013	221.6	12.4	525.8	29.5	1034.0	58.0

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

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Engineering & technology disciplines were the biggest recipients of R&D expenditure at research institutes, snapping up 71.6% of the total, followed by natural science with 16.3%. Agricultural science, medical science, humanity & social sciences received a smaller share of 6.6%, 3.5% and 2.0% respectively (Fig. 6-10).

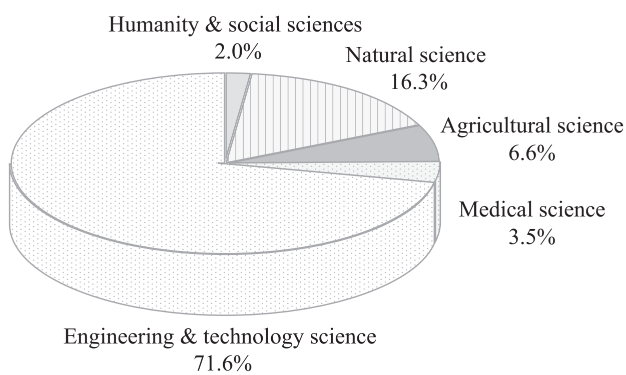

Fig. 6-10 Breakdown of R&D expenditure of research institutes by academic disciplines (2013)

Source: *National Bureau of Statistics, Ministry of Science and Technology, China Statistical Yearbook on Science and Technology 2014.*

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3. R&D projects

R&D project is an important form of R&D activities. In 2013, research institutes spent 122.17 billion yuan in 85,069 R&D projects with a total labor input of 327 thousand person-years, up by 13.3%, 7.2% and 5.4% year on year respectively. R&D project number, personnel input and funding have kept growing quickly since 2005, registering an average annual growth rate of 10.2%, 8.1% and 16.8% respectively (Table 6-5).

Table 6-5 Statistics about research institutes' R&D projects (2005—2013)

Year	R&D project number	Full-time equivalent of personnel input (10,000 person-years)	R&D project funding (100 million yuan)
2005	39072	17.6	353.5
2006	42262	20.2	365.4
2007	49453	22.2	451.7
2008	54900	22.9	537.7
2009	61135	23.7	579.8
2010	67050	25.4	681.5
2011	70967	27.3	807.1
2012	79343	31.1	1078.3
2013	85069	32.7	1221.7

See Appendix table 6-3.

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Central research institutes play a leading role in conducting R&D projects. They accounted for 65.4% of the total R&D projects, 80.4% of the personnel input and 93.4% of the funding.

Among the 62 first-level disciplines, the top 10 recipients of R&D project funding are aviation and aerospace technology, electronics & communication and automatic control technology, engineering & technology science, nuclear science, earth sciences, agricultural science, physics, biology, materials science, and chemistry (Fig. 6-11).

With respect to the source of project funding, 77.8% of R&D project funding of research institutes in 2013 came from the central government, 4.8% from local governments, 2.6% from enterprises, 3.3% from research institutes themselves and 0.5% from foreign sources (Fig. 6-12).

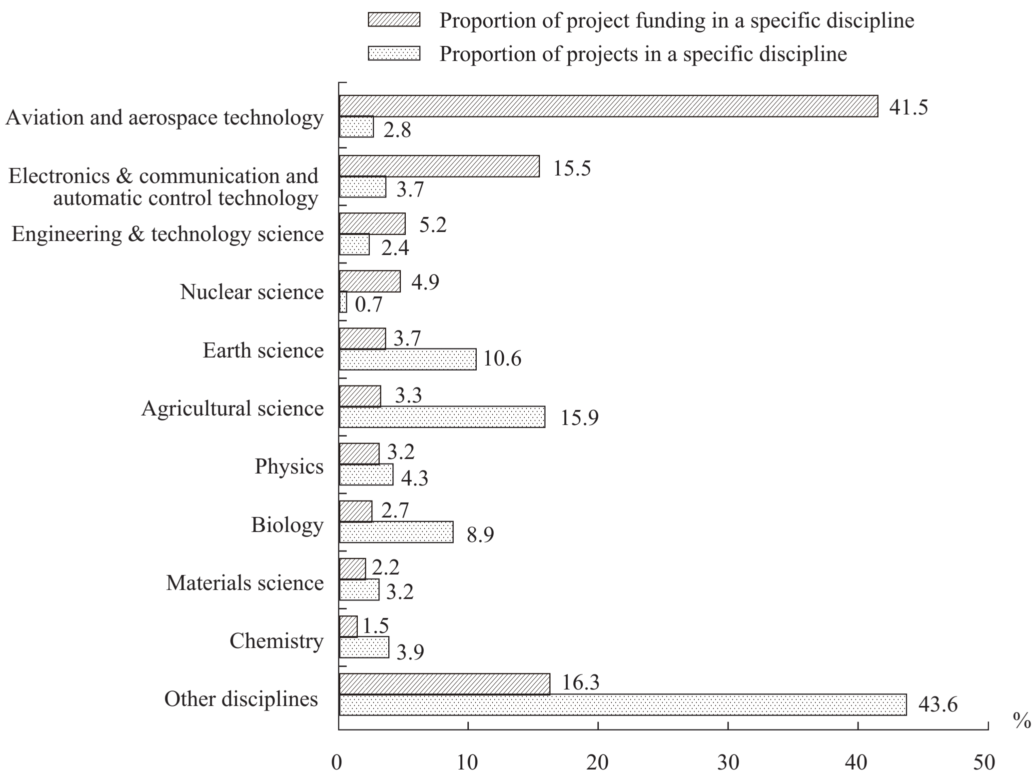

Fig. 6-11 Breakdown of R&D expenditure of research institutes by academic disciplines (2013)

Source: *National Bureau of Statistics, Ministry of Science and Technology, China Statistical Yearbook on Science and Technology 2014.*

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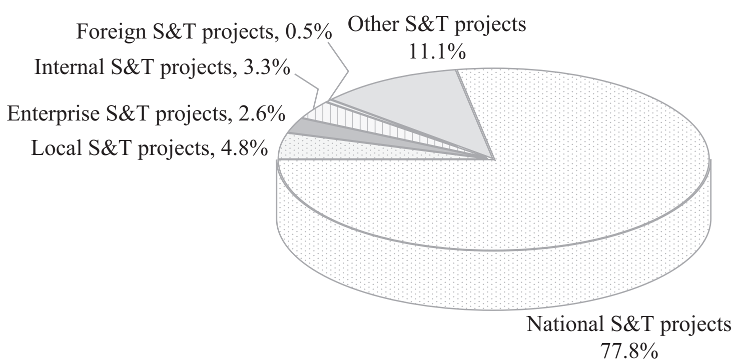

Fig. 6-12 Source of R&D project funding of research institutes (2013)

Source: *National Bureau of Statistics, Ministry of Science and Technology, China Statistical Yearbook on Science and Technology 2014.*

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4. Form of cooperation in R&D projects

R&D projects undertaken by research institutes were mostly completed on their own. In 2013 they independently completed 68 thousand R&D projects, or 80.0% of the total, partnered with domestic institutes to finish 7,742 projects (9.1%), worked together with domestic enterprises on 2,826 projects (3.3%). 3,262 R&D projects (3.8%) were jointly carried out with domestic universities and colleges, while only 1.3% of the total projects were completed with the help of foreign-funded entities (including foreign institutes and wholly foreign-owned enterprises registered in China) (Table 6-6).

Table 6-6 Partners of research institutes in R&D projects (2013)

Cooperation partner	Number of R&D projects	Personnel (Person-year)	Expenditure (10,000 yuan)
Foreign institutes	1046	2427	62707
Domestic colleges and universities	3262	11875	310052
Domestic independent government research institutes	7742	30561	1070762
Wholly foreign-owned enterprises registered in China	51	123	2408
Other enterprises registered in China	2826	8839	343822
No partner	68090	260333	9951699
Other partners	2052	13310	475196

Source: *National Bureau of Statistics, Ministry of Science and Technology, China Statistical Yearbook on Science and Technology 2014.*

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Section 4 Output and Achievement Transfer of Science and Technology Activities

S&T papers and patents are significant output produced by research institutes in knowledge innovation and original innovation. As China keeps increasing investments in science and technology, research institutes have witnessed growth in the number of S&T papers, patent applications and grants and the value of technology transactions in domestic technical markets[①].

① In the section, data about papers and patents were separately cited from *the Chinese S&T Papers Statistics and Analysis* published by the Institute of Scientific and Technical Information of China and *the Patent Statistical Yearbook* released by the State Intellectual Property Office, and data about the structure of papers and patents were cited from the National Bureau of Statistics and the Ministry of Science and Technology *China Statistical Yearbook on Science and Technology.*

1. S&T papers

China's research institutes issued some 60 thousand S&T papers at domestic journals in 2013, up by 8.1% year on year, and published 24 thousand SCI papers, basically flat with the preceding year (Fig. 6-13).

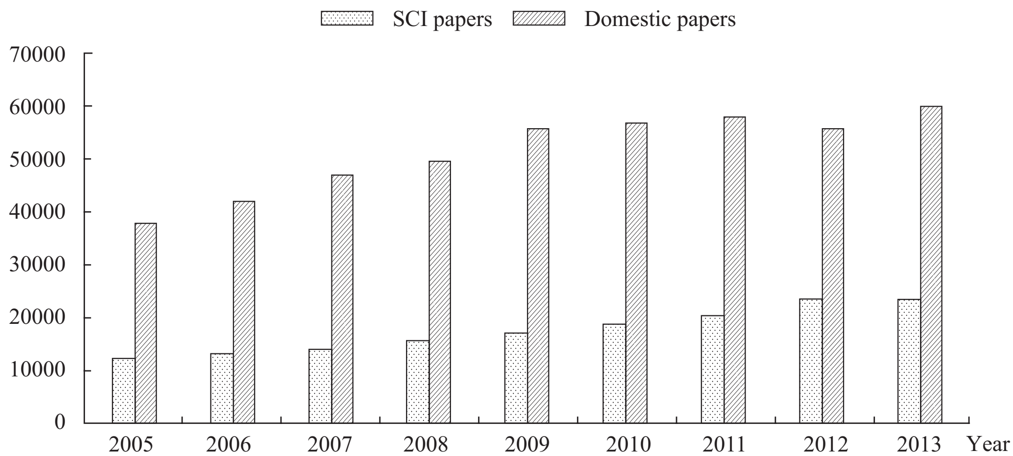

Fig. 6-13 SCI papers and domestic papers issued by research institutes (2005—2013)

See Appendix table 6-4.

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Among the academic disciplines, engineering & technology science accounted for the biggest share (32.9%) of S&T papers published by research institutes, followed by natural science (21.3%), agricultural science (19.3%), humanity & social sciences (14.7%) and medical science (11.8%). Among the S&T papers published at foreign journals, papers of natural science snapped up the biggest share (46.2%), followed by engineering & technology science (31.3%), medical science (about 10%), agricultural science (about 10%) and humanity & social sciences (1.3%) (Table 6-7).

Table 6-7 Breakdown of S&T papers issued by research institutes by academic disciplines (2013)

%

Discipline	S&T papers	Papers published at foreign journals
Natural science	21.3	46.2
Agricultural science	19.3	10.6
Medical science	11.8	10.8
Engineering and technology science	32.9	31.1
Humanity and social sciences	14.7	1.3

2. Patents

China's research institutes filed 53 thousand patent applications in 2013, implying an average annual growth rate of 23.4% since 2005, and 37 thousand, or 69.0% of the total were invention patent applications, growing by 23.3% annually in the period. They were granted 25 thousand patents in 2013, indicating an average annual growth rate of 21.3% since 2005; 12 thousand, or 49.4% of the total granted patents, were invention patents, translating into an average annual growth rate of 21.7% since 2005 (Fig. 6-14).

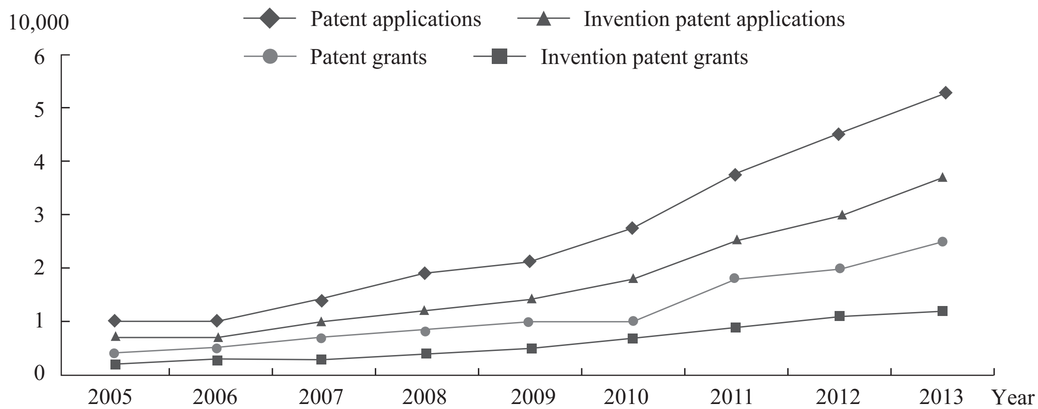

Fig. 6-14 patent applications and grants in research institutes (2005—2013)

See Appendix table 6-4.

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Invention patent applications snapped up the biggest share of all patent applications filed by research institutes, accounting for 65.4% to 69.3% since 2005, followed by the applications of utility model patents, taking up roughly 40% of the total in recent years, while design patent applications have been at a relatively low number of no more than 10% of the total patent applications.

With respect to the authorization of different patent categories, invention patent secured the highest proportion of 45% ～ 60% from 2005 to 2013, followed by 35% ～ 50% for utility model patents. Design patent grants had the smallest proportion among the three patent categories. Grants of design patents and utility model patents logged an average annual growth rate of 28% between 2005 and 2013, higher than that of invention patent grants.

Statistical data showed central research institutes accounted for 84.2% of all patent applications filed by China's research institutes in 2013, including 80% in invention patent applications, while 62.8% of applications filed by local research institutes involved invention patents. 87.1%

of invention patent applications filed by research institutes in 2013 came from central research institutes.

Speaking from different academic disciplines, engineering & technology science accounted for the biggest share of patent applications at 63.7%, followed by natural science (19.1%) and agricultural science (14.3%), medical science (2.5%) and humanity & social sciences (0.5%) (Table 6-8).

Table 6-8 Breakdown of patent applications of research institutes by academic disciplines (2013)

%

Academic discipline	Patent application	Invention patent application
Natural science	19.1	21.9
Agricultural science	14.3	11.9
Medical science	2.5	2.5
Engineering & technology science	63.7	63.4
Humanity & social sciences	0.5	0.3

Source: *National Bureau of Statistics, Ministry of Science and Technology, China Statistical Yearbook on Science and Technology 2014.*

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3. Transfer of technological achievements

Transfer of patent proprietary is an important means for research institutes to commercialize their technological achievements. In 2013, research institutes sold or licensed 2,644 patents and received a total revenue of 400 million yuan. Among them, central research institutes sold or licensed 2,454 patents and brought in 360 million yuan of revenue.

In terms of academic disciplines, patents in the field of engineering & technology science and natural science recorded the biggest volume in patent transfer and licensing, accounting for 58.6% and 32.6% of the total number of transactions, and 52.8% and 25.2% of the total value of transactions respectively. Patents in the field of medical science were the most valuable, with an average patent transaction bringing in 934 thousand (Table 6-9).

China's research institutes signed 33 thousand contracts in 2013 as technology sellers. The number of patent transactions with research institutes as sellers and its proportion in the national total have fallen sharply since 2009, and the proportion declined to 11.23% in 2013 (Fig. 6-15).

Table 6-9 Patent trading and licensing of research institutes by academic disciplines (2013)

Academic discipline	Volume of patent transfer and licensing	Revenue of patent transfer and licensing (10,000 yuan)	Average licensing revenue per patent (10,000 yuan)
Natural science	863	9986	11.6
Agricultural science	176	3603	20.5
Medical science	55	5138	93.4
Engineering & technology science	1549	20949	13.5
Humanity & social sciences	1	5	5

Source: *China Statistical Yearbook on Science and Technology 2014* by National Bureau of Statistics, Ministry of Science and Technology.

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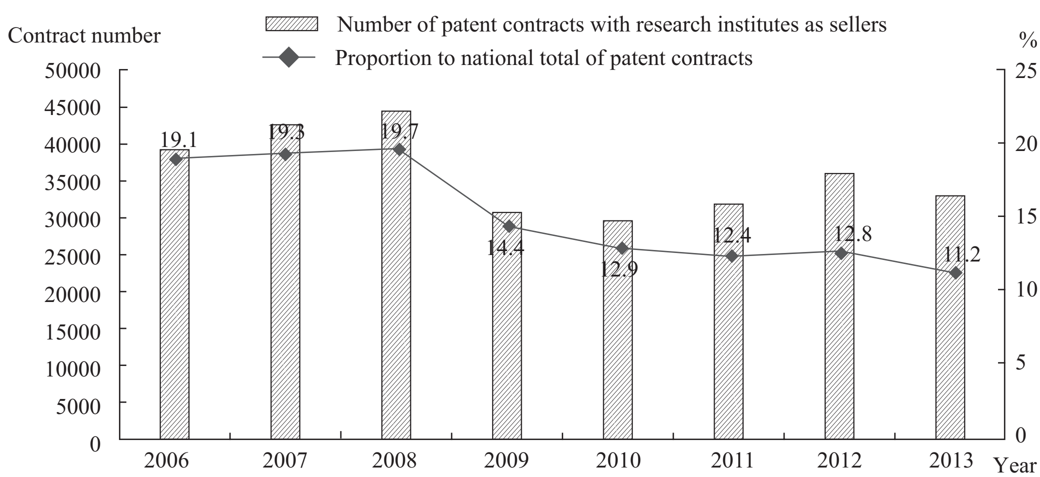

Fig. 6-15 Number of patent contracts signed by research institutes and its proportion to national total (2006—2013)

See Appendix table 6-4.

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In the technology market, the value of patent transactions with research institutes as sellers has kept increasing and risen by 24.3% year on year to 50.1 billion yuan in 2013, accounting for 6.7% of the total value of national patent transactions (Fig. 6-16).

China's research institutes drafted 4,368 national or industry standards in 2013, including 3,300 (75.6%) by central research institutes and 1,068 (24.4%) by local research institutes, which is one third of that at central level. 3,030 standards, or 69.4% of the total, involved engineering & technology science, followed by 828 standards (19%) in the field of agricultural science, 6.3% for medical science, 3.2% for humanity & social sciences and 2.1% for natural science (Fig. 6-17).

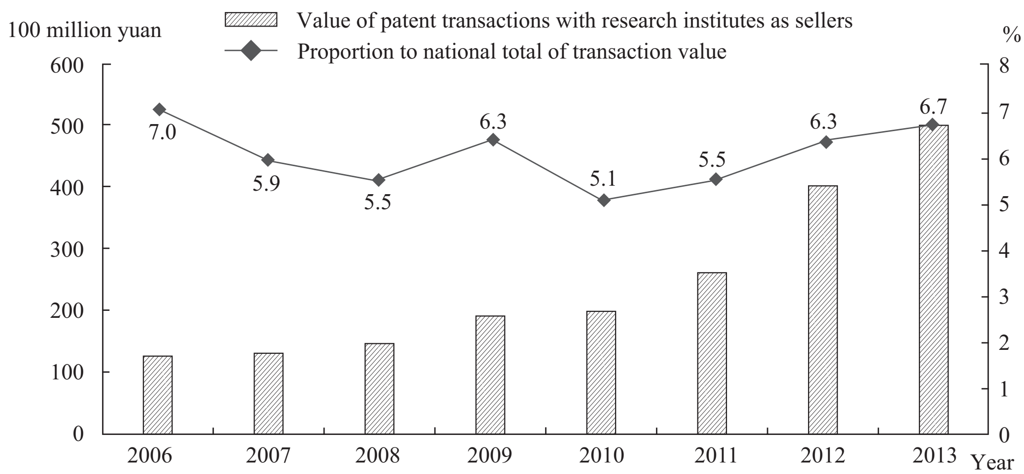

Fig. 6-16 Value of technology transactions of research institutes and its proportion to national total (2006—2013)

See Appendix table 6-4.

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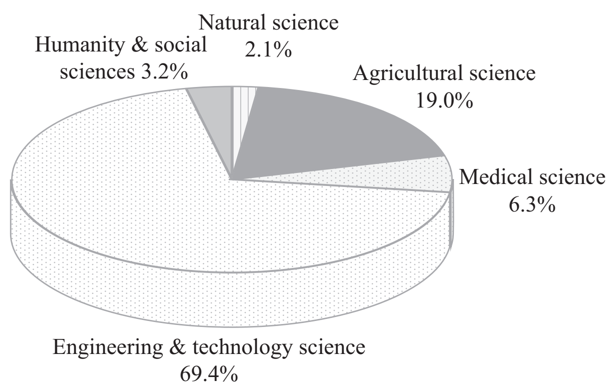

Fig. 6-17 Breakdown of national and industry standards drafted by research institutes by academic disciplines (2013)

Source: *National Bureau of Statistics, Ministry of Science and Technology, China Statistical Yearbook on Science and Technology 2014.*

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Chapter 7 Development of High-Technology Industry

High-technology industry is of critical importance to accelerating industrial restructuring and shifting economic growth model as well as increasing the contribution of science and technology to economic development. This chapter analyzes the status and features of China's hi-tech industry from the perspectives of hi-tech industry, imports and exports of hi-tech products, National High-Tech Industrial Development Zone (NHTIDZ) and venture capital.

Section 1 High-Technology Industry

According to the classification standard of high-technology industry published by the OECD in 2001, five manufacturing industries, namely aircraft and spacecraft, electronic and telecommunication equipment, computer and office equipment, medical equipment and meters and pharmaceuticals have been classified as high-technology industries in China. This section analyzes the overall scale and technological innovation capacity of China's high-technology industry and evaluates its position and performance globally based on international comparisons.

1. Overall scale of the high-technology industry

In 2013, the revenue from principal business of China's high-technology industry reached 11.6 trillion yuan, with a year-over-year increase of 11%[①]. Since 2003, China's high-technology industry has kept expanding but with overall declining growth rate, which hit the lowest level in a decade of 4% in 2008 before rebounded (Fig. 7-1)

The growth rate of the five branch industries varies a lot. During the past five years, pharmaceuticals experienced the fastest growth in its revenue from principal business, with an average annual growth rate of 18%; the manufacturers of medical equipment and meters are second to the best performer with a growth rate of 17.6%; the computer and office equipment grew only by 3.0%, the lowest among the five.

① The growth rate indicators in this section are calculated at the constant price of the year of 2000, while all other data is calculated at the current price.

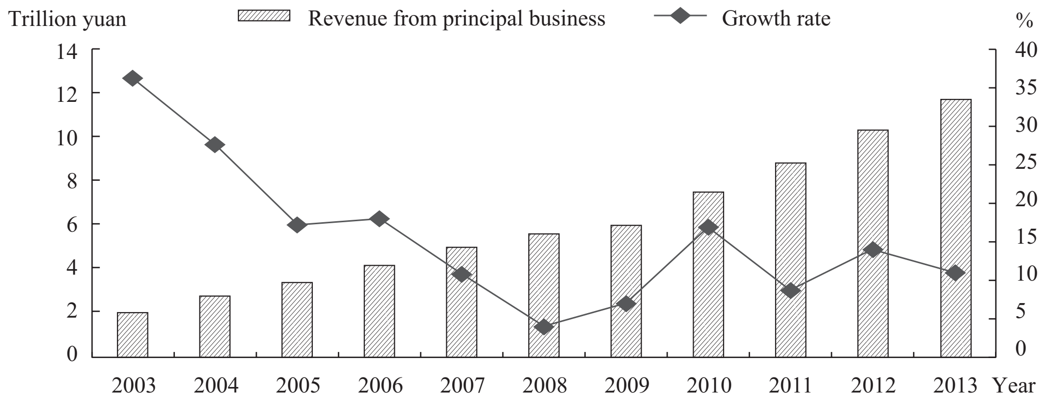

Fig. 7-1 Revenue from principal business and annual growth rate of high-technology industry (2003—2013)

See Appendix table 7-1.

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Due to the distinct variation of revenue from principal business growth rate of the five branch industries, the industrial structure of the high-technology industry is constantly evolving. During the past five years, the share of pharmaceuticals increased at the fastest pace. In 2013, the revenue from principal business of the pharmaceuticals accounted for 17.7% of the total, with an increase of 4.4 percentage points on the level of 2008; the electronic and telecommunication equipment took up over half of the total, with a share standing at 52.3%, up by 3.1 percentage points compared with 2008; the share of computer and office equipment declined to 20% in 2013, 9.6 percentage points down from 2008; the medical equipment and meters as well as aircraft and spacecraft respectively accounted for 7.6% and 2.5%, with a rise of 1.8 percentage points and 0.4 percentage point respectively (Fig. 7-2).

With the continued expansion of high-technology industry, China is enjoying a higher status in the global high-technology industry. According to the statistics published by the US in *Science and Engineering Indicators 2014*, China's value added in high-technology industry merely took up 7.9% of the world's total. But the share surpassed that of Japan in 2007 and reached 23.9% in 2012, ranking the second only next to the US (Fig.7-3). China's high-technology exports also kept growing. According the *World Development Indicators 2014* released by the World Bank, China's high-technology exports took up 23.6% of the world total in 2012, ranking the first globally.

2. High-technology industry development by ownership

With higher indigenous innovation capacity, domestic-invested enterprises are taking up an even larger share in high-technology industry. In 2013, the revenue from principal business of domestic-invested enterprises accounted for 43.2% of the total, 13.6 percentage points higher than that of 2008. But the foreign-invested enterprises, which have long been the major player in China's high-technology industry, dropped to 56.8% in 2013 down from 70.4% in 2008 (Fig. 7-4).

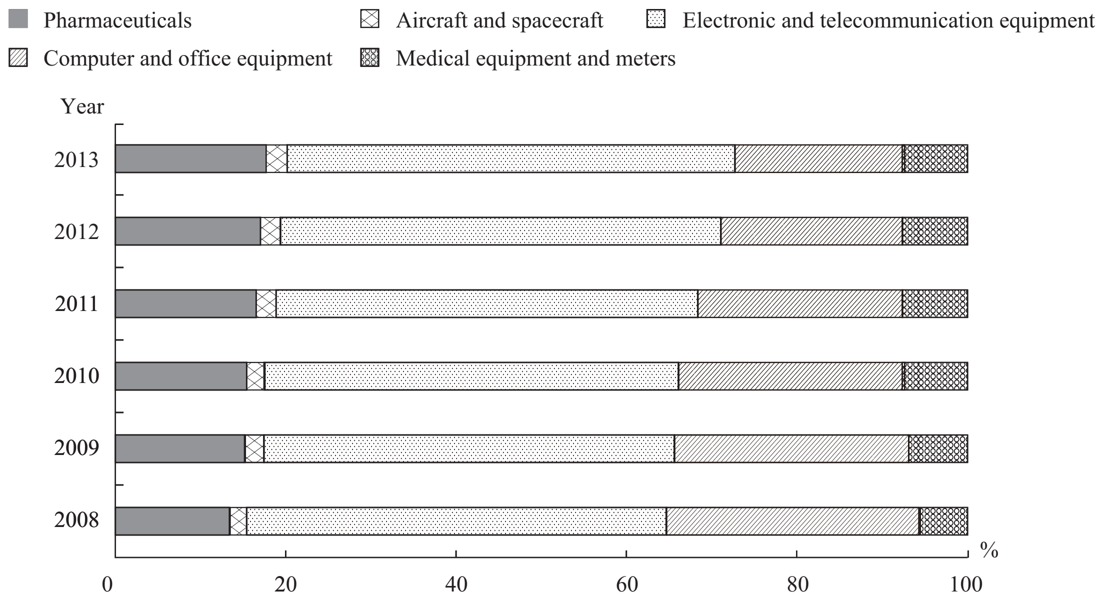

Fig. 7-2 Shares of revenue from principal business of branch industries (2008—1013)

See Appendix table 7-1.

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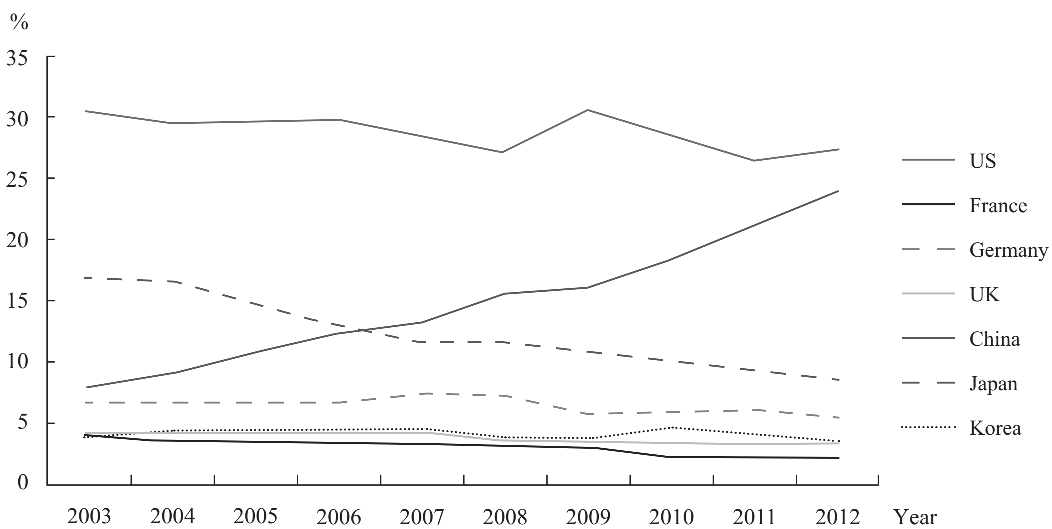

Fig. 7-3 Shares of global high-technology industry value-added of selected countries (2003—2012)

Source: *National Science Board, Science and Engineering Indicator 2014*.

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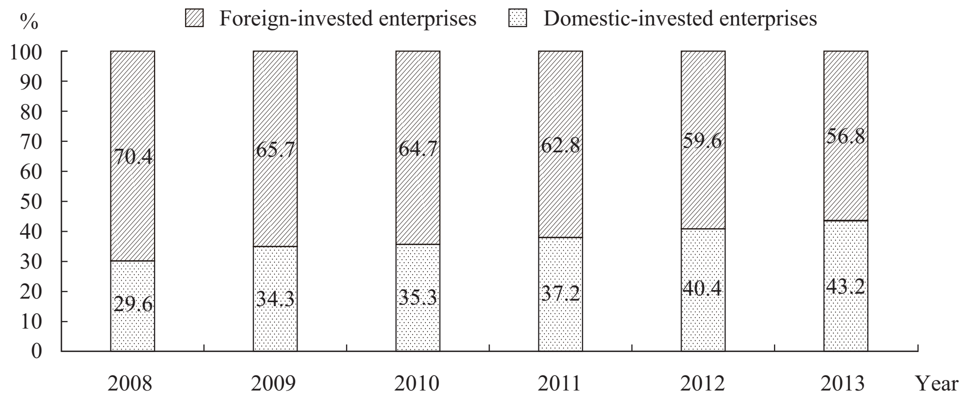

Fig. 7-4 Enterprises distribution in high-technology industry by ownership (2008—2013)

Source: National Bureau of Statistics, etc., *China Statistics Yearbook on High Technology Industry 2014*.

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In the five branch industries, foreign-invested enterprises boasted an overwhelming share of 90% in computers and office equipment and a satisfying share of 61.8% in electronic and telecommunication equipment in 2013. However, in aircraft and spacecraft manufacturing, domestic-invested enterprises were the main forces, with a share of 82.9% in 2013.

3. High-technology industry and manufacturing

High-technology industry, as a critical component of manufacturing, not only fosters new momentum for the growth of manufacturing and creates jobs, but also drives the technological upgrading and restructuring of the manufacturing industry as a whole. Since the reform and opening up, high-technology industry has gradually become an indispensable player in China's manufacturing industry and a key influencer in the international high-technology product markets. With the nation's intensive efforts to rejuvenate the traditional industries, the share of the high-technology industry declined year by year since 2003 and hit the bottom of 12% in 2011, the lowest level in a decade. Then the share rebounded slightly and reached 12.8% in 2013 (Fig.7-5).

With ever increasing share, China's high-technology industry has greatly optimized the structure of manufacturing exports. Compared with major developed countries, the proportion of China's high-technology exports in the total of manufacturing sustained at a high level. According to the World Bank, China's high-technology industry accounted for 26.3% of all manufacturing exports, 8.7 percentage points higher than the world average and also higher than such developed economies as the US, the UK, France, Japan and Germany (Fig. 7-6).

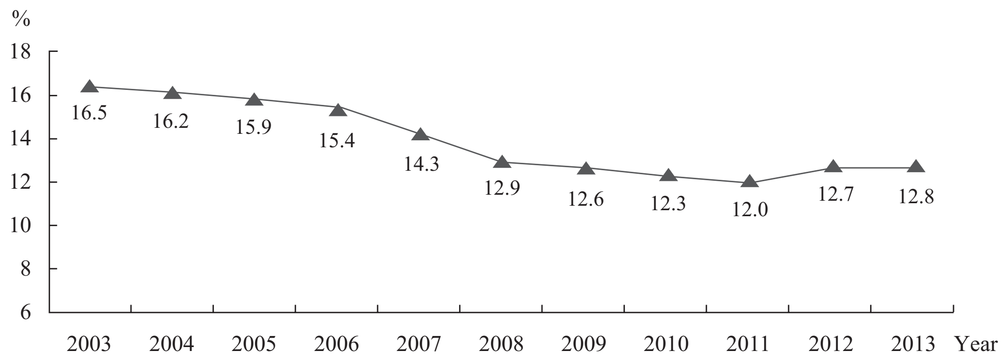

Fig. 7-5 Share of high-technology industry's revenue from principal business in manufacturing (2003—2013)

See Appendix table 7-1.

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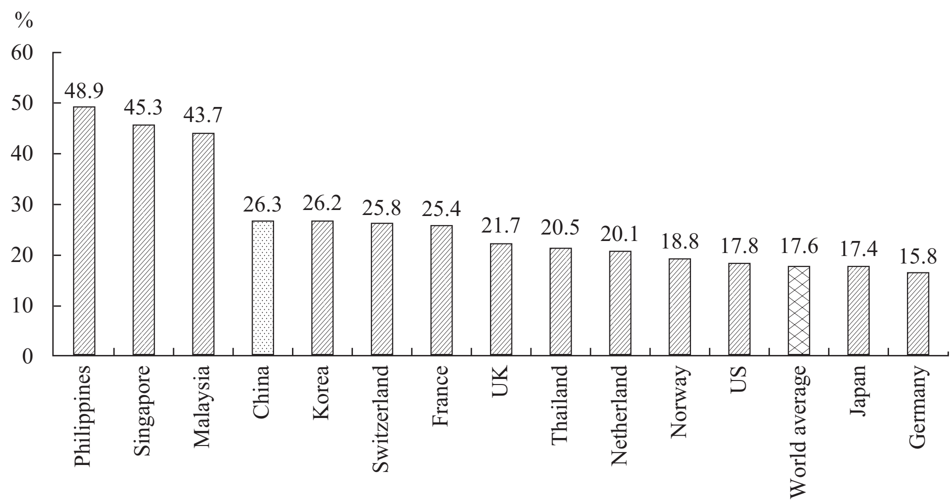

Fig. 7-6 Share of high-technology industry in manufacturing of selected countries, (2012)

Source: World Bank, World Development Indicators 2014.

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4. Technological innovation in High-technology Industry

High-technology industry stands out from manufacturing with its vitality and creativity. And technological innovation is the fundamental motive for its sustainable growth. This part analyzes the technological innovation activities of large and medium-sized high-technology enterprises by examining their R&D, as well as introduction and adsorption of technologies.

4.1 R&D activities

The intensity of R&D expenditure (the ratio of R&D expenditure to revenue from principal business of the industry) is a critical indicator reflecting the indigenous R&D capability of the industry. Recent years witnessed the sustained growth of the expenditure of Chinese high-technology industry on R&D. In 2013, the expenditure on R&D of large and medium-sized high-technology enterprises reached 173.44 billion yuan, accounting for 27.1% of the total R&D expenditure of large and medium-sized manufacturers, with a year-over-year increase of 0.8 percentage points. Meanwhile, the intensity of R&D expenditure① in high-technology industry continued to grow, on the basis of 2010, to 1.89%. The R&D intensity of aircraft and spacecraft manufacturing ranked the top, reaching 7.62%. But in the computers and office equipment branch, it has the highest output yet the lowest expenditure of merely 0.62%. Overall, the R&D expenditure of China's high-technology industry is relatively low with distinct variation across different branch industries.

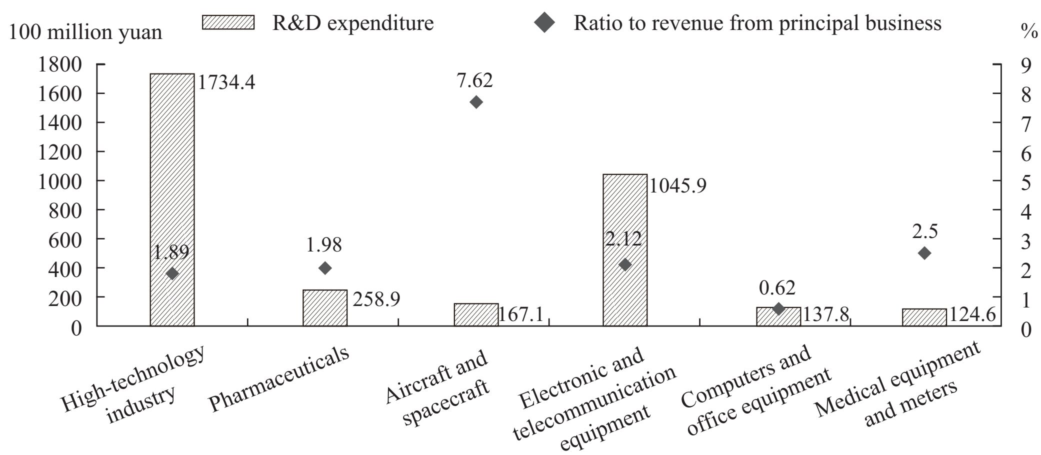

Fig. 7-7 R&D expenditure of high-technology industry and its ratio to revenue from principal business (2013)

See Appendix table 7-2.

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4.2 Introduction and absorption of technology

Introducing technology from abroad for digestion and absorption is an important means to upgrade technology capability for developing countries. In the process of developing high-technology industry, China has brought in a large number of foreign technologies. Many high-technology enterprises, through the absorption of imported technologies, have equipped themselves with high technological competence and gradually acquired indigenous innovation

① Data refers to that of large and medium-sized enterprises.

capability. The expenditure of large and medium-sized high-technology enterprises on the introduction of foreign technologies reached historic high of 13.09 billion yuan in 2007. Since then, it declined year by year and plunged to 5.32 billion yuan in 2013, the lowest level in a decade. On the other hand, as domestic institutions gained strength in R&D, more and more enterprises purchased domestic technologies for upgrading. As a result, the expenditure on purchasing domestic technologies grew year by year from 950 million yuan in 2005 to 3.13 billion yuan in 2013.

4.3 Performance of technology innovation

Invention patents and new products represent the main technology and innovation achievements for high-technology industry. By effectively analyzing the number of invention patent owned by enterprises and sales revenue of new products. The performance of technology innovation of high-technology industry, to some extent, unveiled.

Invention patent is an important indicator to measure the degree of technological innovation and indigenous innovation capability. The number of patents in force filed by enterprises serves as a critical indicator of their technology output. With the increase of R&D expenditure, the number of patents in force filed by enterprises also grew by a large margin. In 2003, only 3,356 patents in force were filed by China's large and medium-sized high-technology enterprises. In 2007, the number exceeded 10,000, reaching 13,000. In 2013, this number surpassed 100,000, reaching 116,000. (Fig. 7-8)

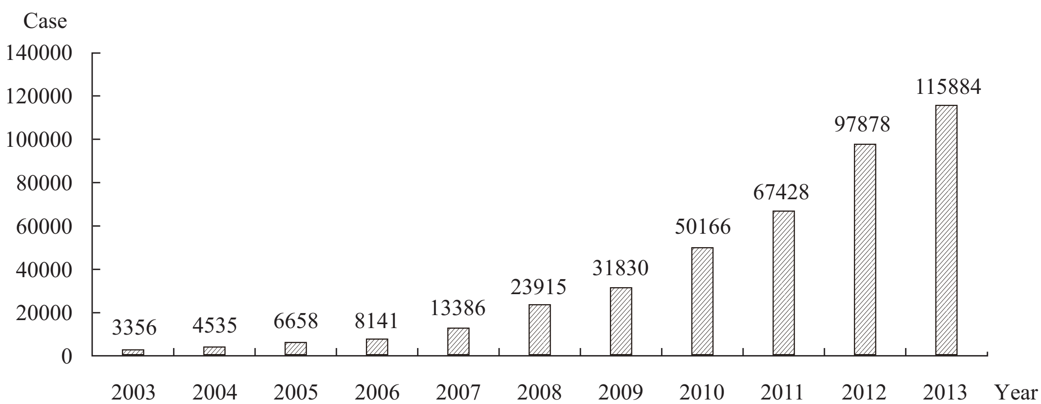

Fig. 7-8 Invention patents in force owned by large and medium-sized high-technology enterprises

See Appendix table 7-2.

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The sales revenue of new products in China's high-technology industry has long sustained rapid growth for many years. In 2003, the sales revenue of new high-technology products totaled 451.5 billion yuan. This number exceeded 1 trillion yuan in 2007 and 2 trillion yuan in 2011.

In 2013, the number reached almost 3 trillion yuan, with a substantial year-over-year increase of 19.5%. In the decade between 2003 and 2013, the sales grew by 14.7% on average. Share of new product sales (the ratio of new product sales to the total) measures the effectiveness of technological innovation. In 2013, share of new product sales of large and medium-sized high-technology enterprises reached 31.7%, 7.7 percentage points higher than that in 2005, reflecting the ever rising innovation capability of Chinese high-technology industry.

Section 2　High-Technology Products

Compared with other manufactured goods, high-technology products feature high R&D expenditure and high value added. High-technology products are defined in China with reference to the US catalogue of advanced-technology products (ATP) trade. By studying the trading statistics of high-technology products, this section analyzes the general situation of high-technology products trade, technology distribution by field and trade partners.

1. General situation of high-technology product imports and exports

In 2013, the trade of China's high-technology products continued to grow, reaching USD 1.22 trillion. Among them, the exports reached USD 660.3 billion, with an increase of 9.8% from the year before; and the imports stood at USD 558.2 billion, up by 10.1% from the year before. Internationally, due to the sluggish investment demand in developed countries such as US and Europe and developing countries as well, China's high-technology product trade is yet faced with further downward pressure (Fig. 7-9, 7-10).

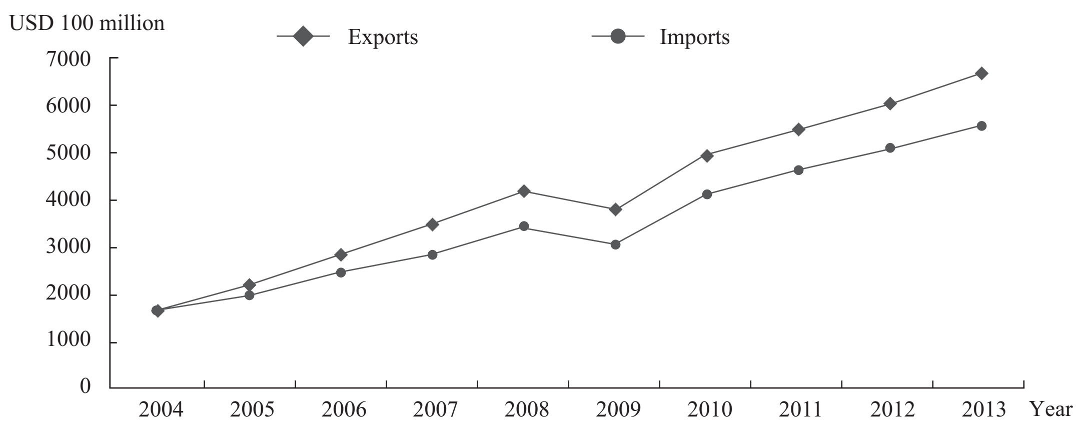

Fig. 7-9　Imports and exports of China's high-technology products (2004—2013)

See Appendix table 7-3

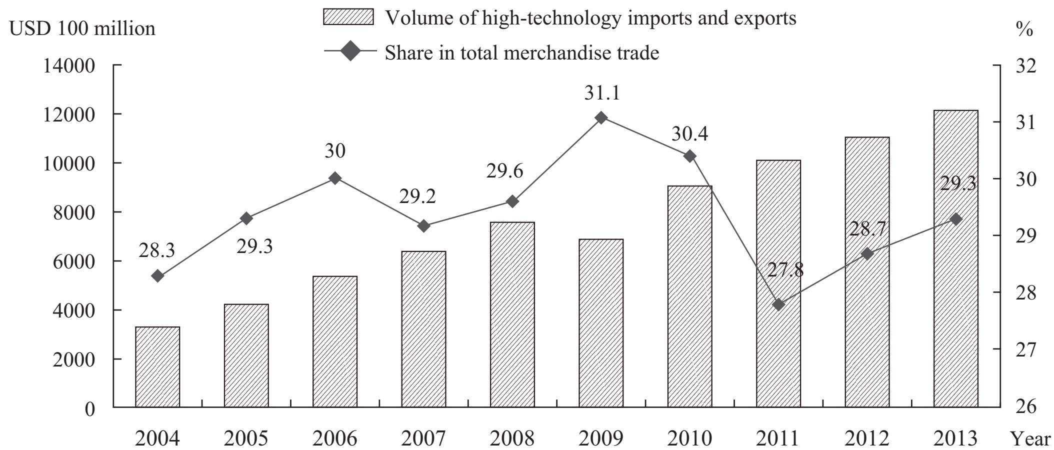

Fig. 7-10 Volume and high-technology imports and exports & its share in total merchandise trade（2004—2013）

Source: General Administration of Customs, Import and export statistics.

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2. Distribution of high-technology product trade by technology fields

In terms of distribution by fields, computers, communication equipment and electronics remained the major drivers for high-technology product exports in 2013. In all the fields, computers and communications sustained the dominant position, with exports of USD 439.09 billion, which took up 66.5% of the total high-technology product exports; electronics ranked the second with an export amount of USD 136.79 billion and a share of 20.7%.

In 2013, in terms of the distribution of imported high-technology products by fields, electronics ranked the top with total imports of USD 279.96 billion, accounting for 50.2% of the total high-technology imports. Computers and telecommunications ranked in the second place with a total import amount of USD 127.42 billion and a share of 22.8%. On the whole, trade of electronic technology grew at a substantially faster pace than other high-technology products.

3. Major trade partners of import and export of high-technology products

In terms of the exports of high-technology products, Hong Kong, US and EU were the major export destinations, accounting for respectively 32.0%, 17.9% and 12.2% of the market share. In the field with the largest amount of exports-computer and telecommunication, Hong Kong, US, and EU altogether took up 66.0%. Hong Kong was the largest market for electronics exports, accounting for 59% of the total.

In terms of the imports of high-technology products, Taiwan remained the largest source of imports, with a share of 19.3% and followed by Korea with a share of 17.7%. Recent years witnessed the dramatic decline of imports from Japan, which took up only 8.5% of the total, even lower than 8.7% of the US electronic technology was the field greeting the largest amount of imports, with Taiwan, Korea and Malaysia as the top three sources, which respectively accounted for 28.9%, 19.5% and 11.5% of the total. The branch industry of aircraft and spacecraft, featuring relatively small amounts of imports, mainly imported from the US and EU, with share of 55.6% and 35.8% respectively (Fig. 7-11).

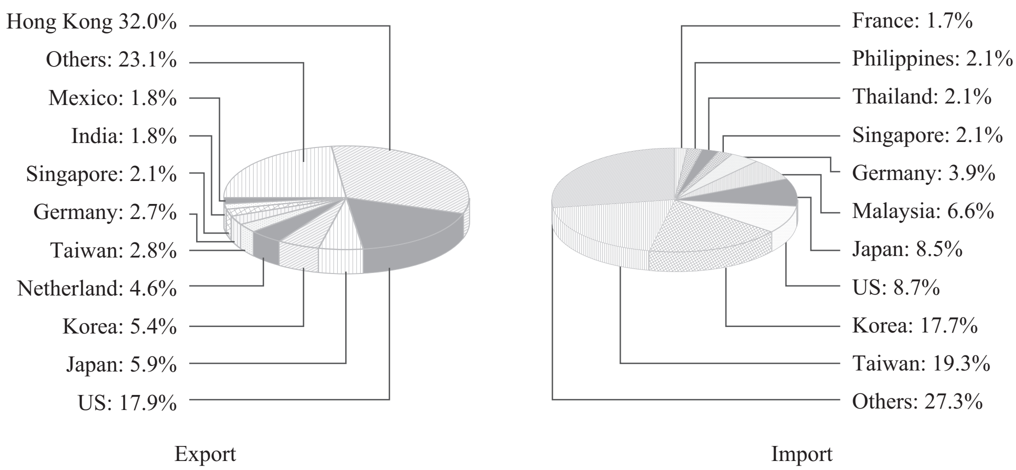

Fig. 7-11 Imports and exports of high-technology products by major countries and regions (2013)

Source: General Administration of Customs, Import and Export Statistics.

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4. Export patterns and business types for high-technology products

4.1 Export patterns of high-technology products

High-technology product exports are conducted in three ways including feeding processing trade, processing and assembling trade and general trade. The processing trade represented by processing with supplied materials, processing with supplied samples, assembling supplied parts and compensation trade has long took up over 70% of the trade of high-technology products. But since 2010, the proportion has gradually fallen to 61% in 2013. Meanwhile, the trade volume gained from general trade has risen sharply and reached a share of 16.8% in 2013(Fig. 7-12).

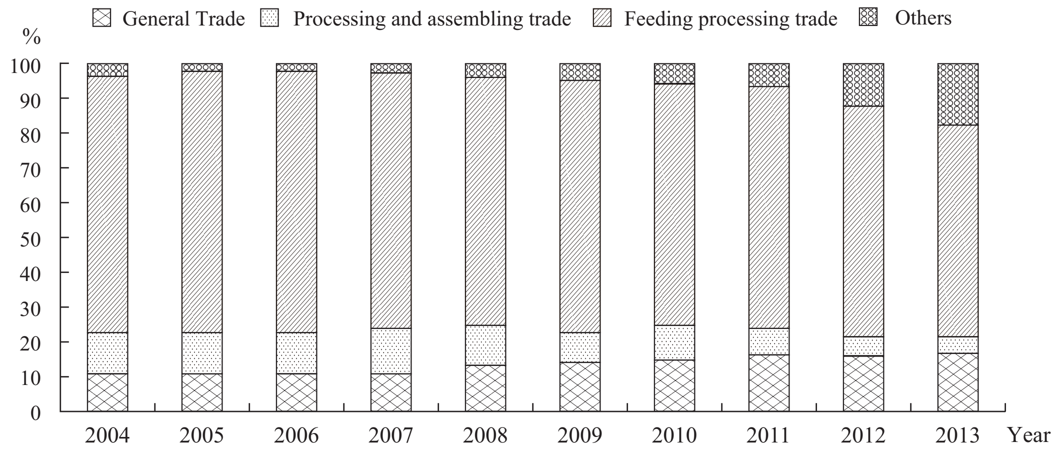

Fig. 7-12 Exports of high-technology products by trade patterns (2004—2013)

Source: General Administration of Customs, Import and Export Statistics.

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4.2 Business types for high-technology exports

The years after 2011 witnessed the continuous declining of the share of wholly foreign-funded enterprises in high-technology exports and gradual climbing of the proportion of private enterprises. In 2013, despite the overwhelmingly dominant share of 54.7%, the share of wholly foreign-funded enterprises in high-technology exports went down by 6 percentage points compared the year before. Meanwhile, other business types represented by private enterprises increased their share by 5.3 percentage points (Fig. 7-13).

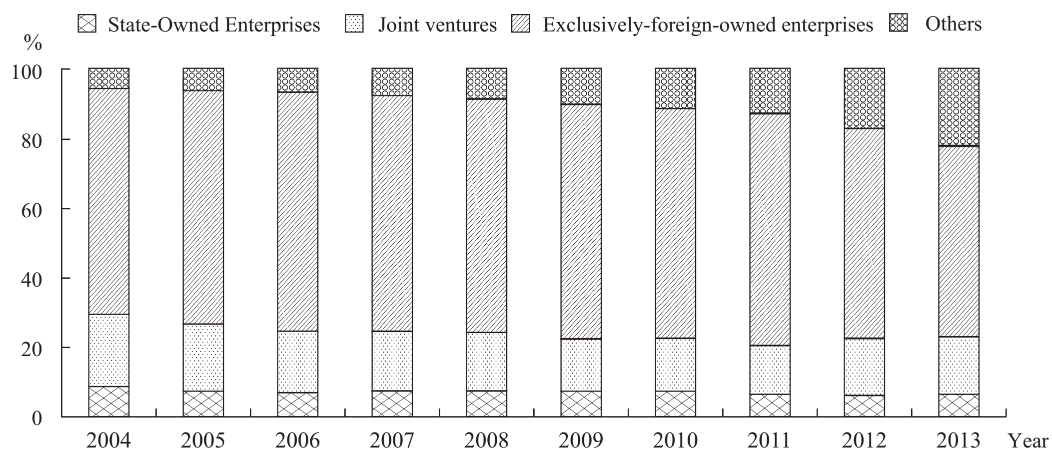

Fig. 7-13 Export volumes of high-technology products by business types (2004—2013)

Source: General Administration of Customs, Import and Export Statistics.

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Section 3　National High-Technology Industrial Development Zones

Building National High-Technology Industrial Development Zones (NHTIDZs) is a major strategic measure dedicated to materializing the initiative of "developing high technology and realizing industrialized growth". This section provided brief introduction to the development of NHTIDZs, high-technology enterprises and high-technology business incubators.

1. National high-technology industrial development zones (NHTIDZs)

1.1　Economic development of NHTIDZs

In 2013, 9 provincial-level high-technology zones got approved by the State Council. A total number of 114 NHTIDZs housed over 520,000 registered enterprises. Among 71,180 surveyed enterprises, 1,186 were listed on stock exchanges and another 356 were listed on China's New Third Board; 21,795 of them represented high-technology enterprise; 4 of them boasted business revenue exceeding 100 billion yuan, an increase of 2 compared with the year before; 319 of them earned revenue over 10 billion yuan, an increase of 57 compared with last year; 2715 of them made more than one billion yuan, accounting for 3.8% of the total number of enterprises and the share grew by 0.3 percentage point compared with 2012; 15,710 of them, which accounted for 22.1% of the total number, scored revenue of over 100 million yuan, showing an increased share of 1.6 percentage points compared with last year.

1.1.1　Economic development

The year of 2013 witnessed the total income of 20.0 trillion yuan, gross industrial output value of 15.1 trillion yuan, net profit of 1.2 trillion yuan, tax of 1.1 trillion yuan and foreign exchange earned from export of 413.33 billion yuan for NHTIDZs. With 9 new entrants in 2013 excluded, the numbers grew year over year respectively by 17.8%, 14.9%, 19.1%, 13.7% and 8.3%.

In 2013, the gross product output value created by NHTIDZs reached 6.3 trillion yuan, which was 11.1% of China's GDP. 35 NHTIDZs took up over 20% of GDP of the city where they resided respectively. The foreign exchange earned from export by NHTIDZs accounted for 18.7% of national export volume. Compared with the previous year, the proportion of all indicators showed an upward trend. The scale economic output of the NHTIDZs has provided robust support for national and regional economic growth.

1.1.2　Industrial structure

NHTIDZs have in the development process emphasized on enhancing innovation capacity, promoting the close interaction between technology and economy, and improving the indigenous capability of enterprises, so as to upgrade economy and transform economic growth model. In 2013, the average profit margin for enterprises residing in NHTIDZs reached 6.23%, with net profit per capita of 85,000 yuan. Among them, 26 enterprises boasted net profit per capita over 100,000 yuan.

In 2013, 31,457 enterprises in NHTIDZs represented high-technology industry (manufacturing) and high-technology service industry, accounting for 44.2% of all the enterprises. Among them, 10,934 were high-technology manufacturers, taking up 15.4% of the total; and 20,523 belonged to high-technology service industry, taking up 28.8% of the total. The number of high-technology service enterprises has already surpassed that of the high-technology manufacturers.

1.2 Innovation performance of NHTIDZs

1.2.1 Environment for innovation

In 2013, 49 NHTIDZs, over 40% of the total, were credited by the State Intellectual Property Office (SIPO) of China as pilot parks. By the end of 2013, NHTIDZs have attracted a large number of research institutions, including 578 universities of all kinds, 2,048 research institutes, 995 postdoctoral research stations, 563 of which were ones. Various laboratory centers have been established, including 411 national key laboratories, 577 research institutes for industrial technology, 100 national engineering laboratories, 117 national engineering research centers and 264 national engineering research centers. A variety of industrial promotion agencies have also been built, including 897 high-technology business incubators.

1.2.2 Resources for innovation

By the end of 2013, there were altogether 1,266 human resources service agencies in NHTIDZs. The enterprises in NHTIDZs employed a total of 14.602 million persons, among whom 486,000 were that year's college graduates, which played an active role of creating jobs and maintaining social stability.

In 2013, the total financial appropriation for NHTIDZs reached 49.51 billion yuan, taking up 12.4% of NHTIDZs' total expenditure. The R&D expenditure of NHTIDZs enterprises amounted to 348.88 billion yuan, which was 38.2% of the national total. Among them, 105 NHTIDZs enterprises spent 342.36 billion yuan on R&D, with a year-over-year increase of 24.5%. The intensity of R&D expenditure was 5.53%, 2.6 times higher than the national average.

In 2013, 21,795 high-technology enterprises resided in NHTIDZs, taking up 39.9% of high-technology enterprises nationwide and 30.6% of all the enterprises in NHTIDZs. Regarding the major economic indicators, high-technology enterprises take up over 40% of the total, with faster growth rate in all indicators than the average level. The contribution of high-technology enterprises to the NHTIDZs continued to grow.

1.2.3 Outcomes of innovation

In 2013, NHTIDZs enterprises participated in 277,000 S&T programs. The patent filed in the same year reached 289,000 pieces, among which 139,000 pieces were invention patent, taking up 16.8% of the national total invention patent. The patent granted in 2013 totaled 166,000 pieces, among which 51,000 pieces were invention patent, accounting for 24.5% of all invention patent that got granted. NHTIDZs enterprises owned 544,000 pieces of valid patent, of which 188,000 were valid invention patent. Valid invention patent owned by per 10,000 practitioners reached 128.7, which is 9.6 times more than that of the national average.

2. High-technology enterprises in NHTIDZs

High-technology enterprises, as a solid foundation for developing high-technology industry, have been the robust driving force for restructuring the industry and upgrading national competitiveness. In recent years, high-technology enterprises have made constant efforts to seek development through technological innovation. As a result, the enterprises as a whole have steadily improved their innovation capability and competitive edges as well as played a positive role in promoting the growth of China’s strategic emerging industry and shifting economic growth model.

2.1 Numbers of high-technology enterprises

By the end of 2013, there were 59,613 high-technology enterprises nationwide, up by 21.0% compared with the previous year. 65.6% of them were concentrated in six provinces and municipalities including Beijing, Guangdong, Jiangsu, Shanghai, Zhejiang and Shandong.

Among 54,683 high-technology enterprises surveyed in 2013, 2,288 were listed, taking up 4.2%. In terms of the scale, 16.3% of the high-technology enterprises belonged to the large-scale camp while the rest 83.7% were medium, small and micro-sized enterprises, which were split into medium-sized enterprises of 56.5%, small-sized enterprises of 21.6% and micro-sized enterprises of 5.7%. In terms of revenue, 21,368 high-technology enterprises earned over 100 million yuan, accounting for 39.1%; 24,687 enterprises, that was 45.1% of the total, fell into the category with revenue between 10 million to 100 million yuan; 3839 enterprises, standing for 7.0% of the total, earned between 5 million and 10 million yuan, and 4,789 enterprises, representing 8.8% of the total, earned less than 5 million yuan.

In 2013, a total of 21,795 high-technology enterprises resided in NHTIDZs, taking up 39.9% of all the high-technology enterprises nationwide and 30.6% of all the enterprises in NHTIDZs.

32,888 enterprises, or 60.1% of the total high-technology enterprises, were established outside the NHTIDZs.

2.2 Economic scale

With ever rising number of high-technology enterprises, they also delivered better performance in major economic indicators. For high-technology enterprises in 2013, the business revenue amounted to near 20 trillion yuan, up by 15.6% compared with the previous year; the gross industrial output value reached 17.5 trillion yuan, with a year-over-year growth of 15.0% year-on-year; the net profit totaled 1.3 trillion yuan, with an increase of 17.7% compared with the previous year; the actual tax paid reached 927.74 billion yuan, increasing by 10.7% year-on-year; the foreign exchange earned in export was USD 491.58 billion, up by 6.7% year-on-year. The high-technology enterprises earned 22.2% of total foreign exchange in export in 2013. High-technology enterprises' operating profit margin of 6.6% and Rate of return on net assets of 9.2% both went up on the previous year's level (Table 7-1).

Table 7-1 Major economic indicators for high-technology enterprises (2012, 2013)

Indicators	2012	2013	Growth rate in 2013(%)
Number	45313	54683	20.7
Gross revenue (100 million yuan)	167744	193837.4	15.6
Gross industrial output value(100 million yuan)	152235	175106.4	15.0
Net profit (100 million yuan)	10892	12825.2	17.7
Actual tax paid (100 million yuan)	8378	9277.4	10.7
Foreign exchange earned from export (USD 100 million)	4608	4915.8	6.7

Source: Torch High Technology Industry Development Center, Ministry of Science and Technology, *China Torch Statistical Yearbook 2014*.

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2.3 Human resources

In 2013, 18.1 million persons were employed by high-technology enterprises, which increased by 11.7% compared with the previous year. Employees with junior college and above degrees reached 8.93 million, accounting for 49.3% of the total, up by 0.5 percentage point year-on-year. Among all the employees, 70,000 of them are with doctor degree, 694,000 with master degree and 84,000 having pursued advanced studies overseas.

2.4 S&T input

In 2013, high-technology enterprises spent 881.84 billion yuan on science and technology research activities, among which the expenditure on R&D reached 540.1 billion yuan, up by 25.7% year-on-year and accounting for 59.5% of the national total.

2.5 S&T output

In 2013, high-technology enterprises filed 491,000 patents, among which 217,000 were invention patents, taking up 26.3% of the national total. For all these filed, 348,000 patents were granted, including 85,000 invention patents, which was 40.9% of the national total. The patents in force owned by high-technology enterprises reached 1.15 million, including 341,000 valid invention patents. The invention patents owned by per 10,000 persons in high-technology enterprises reached 188.7, 14 times more than that of the national average. In 2013, high-technology enterprises earned 7.5 trillion yuan from the sales of new products, accounting for 45.2% of the total sales revenue.

3. S&T business incubators

S&T business incubators are agencies that nurture and help high-technology SMEs by providing services. With the attention and support from central government, departments under the State Council and local governments at all levels, China S&T business incubators have achieved sound growth. Currently, S&T business incubators serve as important platform for high-technology SMEs to start-up businesses.

3.1 Number and scale

In 2013, China had altogether 1,468 S&T business incubators, with a year-over-year growth of 18.5%. The incubators covered a total area of 53.79 million square meters, up by 22.9% on the level of 2012. 26,700 people were employed in the service and management teams of incubators. A total of 78,000 enterprises were incubated in 2013, increasing by 10.6% of the previous year. Among 1468 incubators, 456 resided in NHTIDZs, taking up 31% of all incubators. 850 incubators, which took up 57.9% of the total, were operating as enterprises, showing that more social forces were contributing to the development of incubators.

3.2 Incubated enterprises

In 2013, 78,000 enterprises were incubated, 9482 of them were founded by students returning from overseas study. Incubated enterprises mainly concentrated in such high-technology industries as electronic information, advanced manufacturing, new materials, new energy, high efficiency and energy saving, biological pharmaceuticals and medical apparatus and instruments and environmental protection.

3.3 Graduated enterprises

By the end of 2013, about 52,000 incubated enterprises have graduated. The year 2013 alone witnessed 6,969 graduates. In 2013, 2,395 enterprises earned revenues over 10 million yuan; 166 were acquired and merged; 46 were listed on stock exchanges. A total of over 200 enterprises went public through Initial Public Offerings (IPOs).

3.4 National-level incubators

In 2013, national-level incubators reached 504, with 69 new entrants. National-level incubators took up 34.3% of the total. 231 national-level incubators, or 45.8% of the total, were operated within NHTIDZs. A total of 46,900 enterprises were nurtured in national-level incubators, accounting for 60% of all incubated enterprises. A total of 41,000 enterprises have graduated from NHTIDZs incubators, taking up 78.8% of all graduates.

Section 4 Venture Capital Investment

Venture Capital (VC) investment provides critical financial support to high-technology enterprises, especially for the establishment and growth of high-technology SMEs. Based on the statistics gained from joint annual survey on VC investment by the Ministry of Science and Technology, the Ministry of Commerce and the National Development Bank, this section analyzed the status of VC investment and its operational features.

1. General situation of venture capital investment

In 2013, the number of China's venture capital institutions reached 1408, growing by 19.0% year-on-year with 225 new entrants. Among them, venture capital enterprises (funds) totaled 1,095, with an increase of 9.5% year-on-year with 153 new entrants, while venture capital management enterprises amounted to 313, up by 29.9% year-on-year with 72 new entrants (Fig. 7-14).

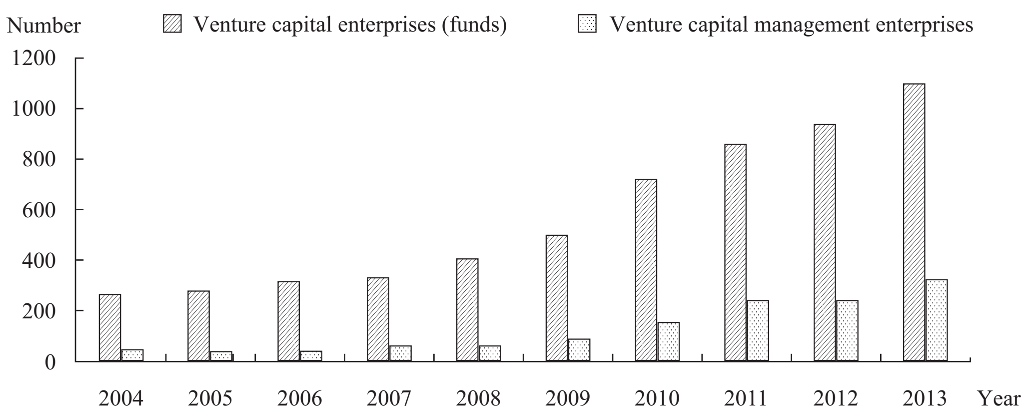

Fig. 7-14 Change of the number of China's venture capital institutions (2004—2013)

Source: Chinese Academy of Science and Technology for Development, *Venture Capital Development in China 2014*.

In 2013, all the known Chinese venture capital institutions invested in 1,501 projects, maintaining roughly the same level as the previous year. The investment totaled 27.9 billion yuan, down by 11.1% with an average investment volume of 18.59 million yuan for each project. The institutions that invested in high-technology enterprises numbered 590, down by 9.5% compared with the previous year. The venture capital investment in high-technology enterprises totaled 10.9 billion yuan, down by 26.3% year-on-year, with average investment for each project of 18.469 million yuan.

In terms of the structure of sources of China's venture capital, unlisted companies, which contributed 42.8% of the total capital, remained dominant players in 2013. Their contribution increased by 8.8 percentage points compared with the previous year. Government and solely-state-owned enterprises jointly contributed 29.2%, lower by 11.4 percentage points compared with 2012 (Fig. 7-15).

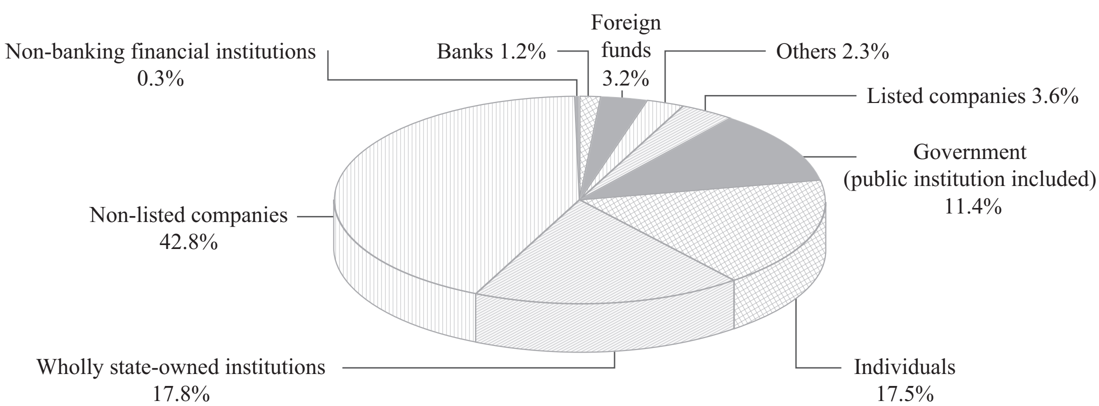

Fig. 7-15 Sources of China's venture capital (2013)

See appendix table 7-10.

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2. Venture capital investments

By the end of 2013, China's venture capital institutions have invested in 12,000 projects, adding 1,037 projects on the level of 2012. The accumulated investment reached 263.41 billion yuan, up by 11.8% compared with that of 2012 (Table. 7-2).

Table. 7-2 Accumulated investment of China's venture capital (2010—2013)

Indicators	2010	2011	2012	2013
Number of accumulated investment projects	8693	9978	11112	12149
Accumulated investment (100 million yuan)	1491.3	2036.6	2355.1	2634.1

Source: Chinese Academy of Science and Technology for Development, *Venture Capital Development in China 2014*.

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In 2013, China's venture capital investment shifted towards the earlier stages. Seedling enterprises attracted 12.2% of the total investment in 18.4% of projects. There were substantial increase in both the share of investment amount and projects for fledging enterprises. As to the rounds of investment, first round investment and subsequent investment took up 77.5% and 22.5% respectively, featuring the dominance of the first round investment and constant rising of subsequent investment.

In 2013, a total of 66 Chinese enterprises were listed on domestic and foreign stock exchanges, much lower than 356 of 2011 and 154 of 2012. 27 enterprises among them received venture capital investment. According to exit channels, the share of IPO exits declined for the first time since 2008, which was mainly impacted by the suspension of IPO in 2013. Meanwhile, the merger & acquisition (M&A) market grew prosperously in 2013, with 26.3% of M & A exits (Table. 7-3).

In 2013, the exit performance deteriorated for the industry as a whole. IPO exits experienced continuous decline in earnings, which was merely 4.48 times more than that of the average book returns. But the return rates on M & A exits rose to 24.09%. Besides, with sharp increase in the return rates on repurchase and liquidation, venture capital institutions were better positioned in project management.

Table. 7-3 Distribution of China's VC investment by channels of exits (2007—2013)

%

Channels of Exits / Year	Go public	M & A	Repurchase	Liquidate	Others
2007	24.2	29.0	27.4	5.6	13.7
2008	22.7	23.2	34.8	9.2	10.1
2009	25.3	33.0	35.3	6.3	—
2010	29.8	28.6	32.8	6.9	1.9
2011	29.4	30.0	32.3	3.2	5.1
2012	29.4	18.9	45.0	6.7	—
2013	24.3	26.3	44.8	4.6	—

Source: Chinese Academy of Science and Technology for Development, *Venture Capital Development in China* 2014.

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3. Venture capital investment and high-technology enterprises

Since venture capital provides financing for the growth of high-technology enterprises, its own development to a large extent drives the growth of high-technology enterprises. In 2013, venture capital institutions invested more in projects of high-technology enterprises, but the average intensity dropped, pivoting towards smaller-scale and earlier-stage enterprises. In 2013, 590 enterprises invested in high-technology projects, with a year-over-year decrease of 9.5%. The investment totaled 10.9 billion yuan, falling by 26.3% year-over-year, with average investment of 18.469 million yuan for each project.

By the end of 2013, China's venture capital institutions invested in 6,779 high-technology projects, which took up 55.8% of all projects. The accumulated investment in high-technology enterprises reached 130.21 billion yuan, taking up 49.4% of the total amount (Fig. 7-4).

Table. 7-4 China's VC investment in high-technology enterprises and projects (2010—2013)

Types	2010	2011	2012	2013
Number of invested high-technology enterprises / projects	5160	5940	6404	6779
Amount of investment in high-technology enterprises / projects (100 million yuan)	808.8	1038.6	1193.1	1302.1

Source: Chinese Academy of Science and Technology for Development, *Venture Capital Development in China* 2014.

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In 2013, China's venture capital investment were concentrated in five industries including pharmaceuticals and healthcare, new materials, new energy and high-efficiency-energy-saving technologies, finance and insurance and traditional manufacturing, accounting for 36.9% of the total investment. Projects receiving venture investment were concentrated in finance and insurance, pharmaceuticals and healthcare, new energy and high-efficiency-energy-saving technologies as well as new materials. On the whole, China's venture investment was less concentrated in certain industries, shifting away from traditional manufacturing and towards emerging industries such as pharmaceuticals and healthcare and Internet finance, but new energy, high-efficient-energy-saving technologies and new materials remained hotspot for investors. Judging from the trend, with the rise of mobile internet and massive opportunities it brings about, investment in the internet/IT service will grow rapidly. Pharmaceuticals and healthcare/biotechnology, with strong counter-cyclical nature, also unfold relatively high value for investment.

Chapter 8 Regional Science and Technology Indicators

Regional S&T progress is important to implementing innovation-driven development strategy and developing national innovation system. Due to uneven economic and social development, regional S&T development in China has great disparities and the major regional S&T indicators also show different features. This chapter analyzes the S&T activities of 31 regions (provinces, autonomous regions, municipalities directly under the Central Government) in China in 2013 based on the regional distribution of major S&T indicators and regional S&T distribution features.

Section 1 Regional Distribution of Major S&T Indicators

The analysis of regional major S&T indicators is helpful to understand the development and changing trend of regional S&T. This section analyzes, based on the regional level, the distribution features of S&T expenditure, S&T activity output and industrial innovation capability indexes of China in 2013, and the regional structural features of some important indicators.

1 General features of regional distribution of major S&T indicators

From the aspects of R&D personnel, R&D expenditure, S&T papers, patents output and hi-technology industry, the most prominent feature of China's S&T resources is unbalanced regional distribution.

1.1 R&D personnel

1.1.1 Full-time equivalents of R&D personnel

In 2013, the full-time equivalents of R&D personnel in China were 3.533 million person-years. Based on the regional scale of R&D personnel, from large to small, the 31 regions of China are divided into 4 categories in general. The first group had R&D personnel over 100,000 person-years, accounting for 79.4% of the national total, including 13 developed regions like Guangdong, Jiangsu and Zhejiang provinces. The second group had R&D personnel between

60,000 to 100,000 person-years, accounting for 9.6% of the national total, including Liaoning, Shaanxi, Hebei and Heilongjiang province. The third group had R&D personnel between 30,000 and 60,000, which included Chongqing municipal city and other 5 regions. The fourth group had R&D personnel less than 30,000 person-years, including Inner Mongolia autonomous region and other 7 regions (Fig. 8-1).

1.1.2 Full-time equivalents of R&D personnel per 10,000 employees

In 2013, the full-time equivalents of R&D personnel per 10,000 employees were 45.9 person-years. Based on the intensity of R&D personnel input, from strong to weak, 31 regions of China could be divided into 4 categories. The indicator value of the 1st group was over 100 person-years, including 3 municipalities, i.e. Tianjin, Beijing and Shanghai. The 2nd group was between 50 and 100 person-years, including Jiangsu, Guangdong, Zhejiang and Fujian province. The 3rd group was between 25 and 50 person-years, including Shandong province and other 10 regions. The 4th group was below 25 person-years, including Ningxia and autonomous region other 12 regions (Fig. 8-1).

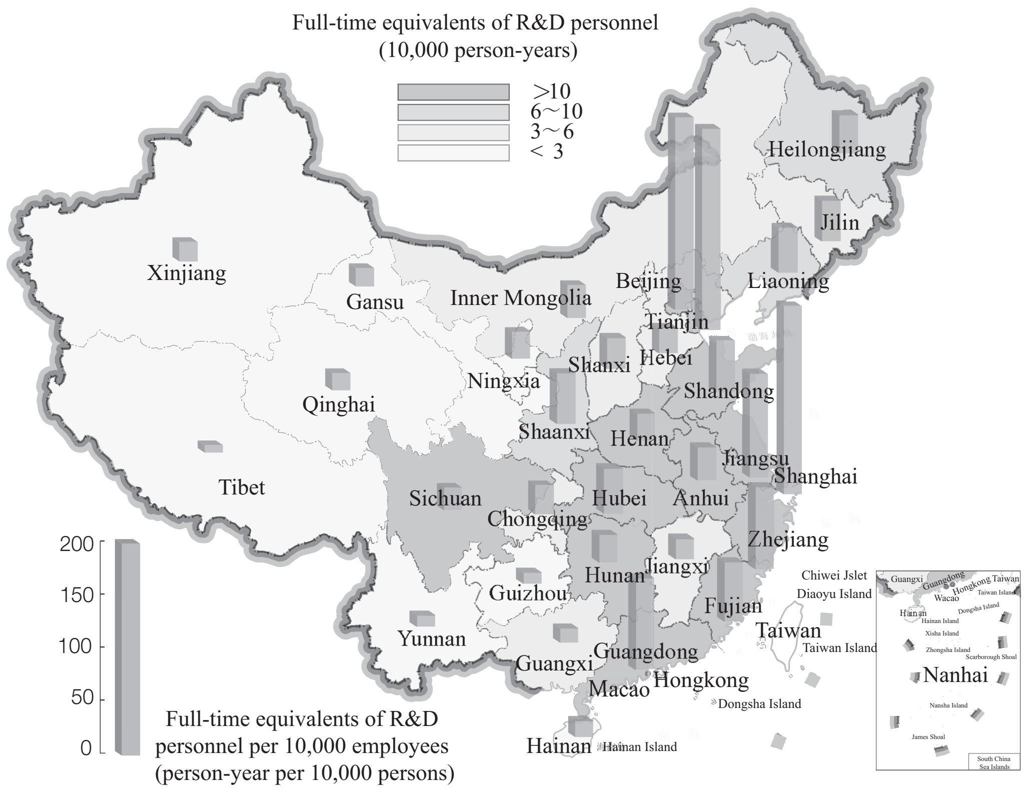

Fig. 8-1 Regional distribution of R&D personnel (2013)

See Appendix tables 8-1, 8-13.

1.2 R&D expenditure

1.2.1 Total R&D expenditure

In 2013, the total R&D expenditure of China reached 1.18466 trillion yuan. The 31 regions of China can be divided into 4 categories from more or less based on the R&D expenditure. The R&D expenditure of the 1st group was over 40 billion yuan, including Jiangsu, Guangdong, Beijing and other 6 provinces and municipal cities. The 2nd group was between 20 and 40 billion yuan, including Sichuan, Henan, Anhui and other 4 provinces and cities. The total R&D expenditure of the 16 regions above totaled 1,057.91 billion yuan, accounting for 89.3% of the national total. The R&D expenditure of the 3rd group was between 10 and 20 billion yuan, including Chongqing municipal city and other 6 regions. The R&D expenditure of the 4th group was below 10 billion yuan, including Yunnan province and other 7 regions (Fig. 8-2).

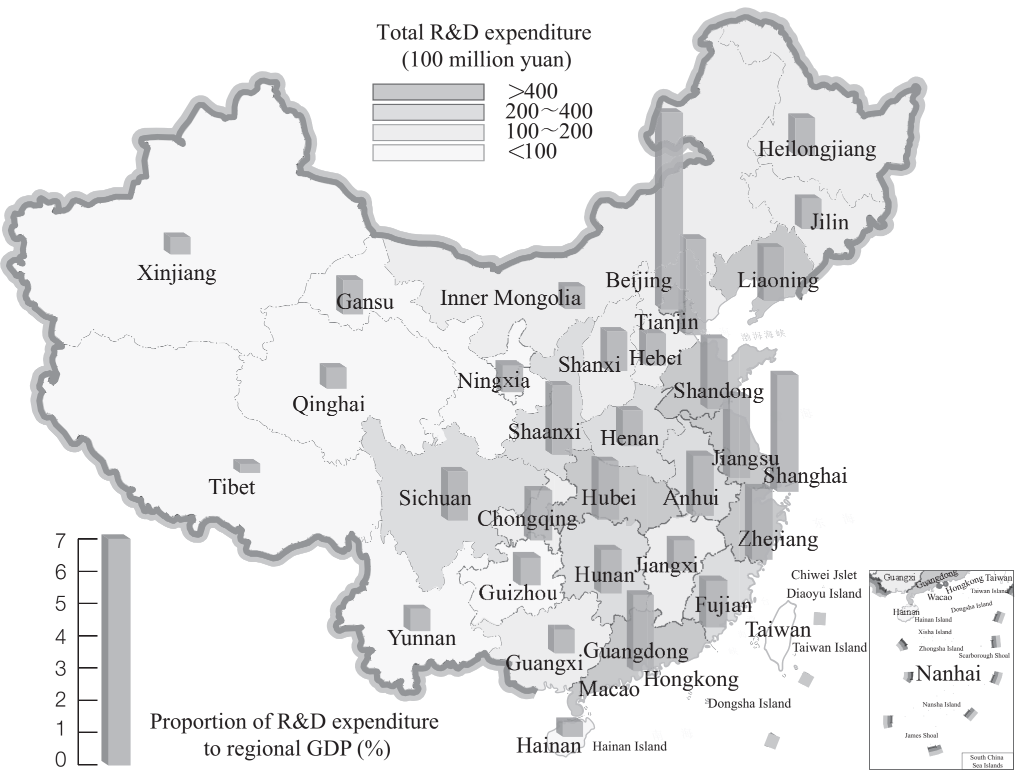

Fig. 8-2 Regional distribution of R&D expenditure (2013)

See Appendix tables 8-1, 8-13.

China Science and Technology Indicators 2014

1.2.2 Proportion of R&D expenditure to regional GDP

In 2013, the proportion of R&D expenditure to GDP of China reached 2.01%. The 31 regions of

China can be divided into 4 categories based on the proportion of R&D expenditure to regional GDP. The 1st group of the intensity of R&D expenditure input reached above 2.0%, including 8 regions like Beijing, Shanghai and Tianjin. That 2nd group was between 1.5% and 2.0%, including Anhui, Hubei, Liaoning and Sichuan province. That 3rd group was between 1.0% and 1.5%, including Fujian province and other 7 regions. That 4th group was below 1.0%, including Hebei province and other 10 regions (Fig. 8-2).

1.3 S&T papers

1.3.1 Total volume of domestic S&T papers

In 2013, the number of domestic S&T papers published reached 511,000. Based on the regional distribution of authors of S&T papers, the regions of China can be divided into 4 categories. The total volume of S&T papers in the 1st group, which only includes Beijing, was over 50,000. The 2nd group had domestic S&T papers between 20,000 and 50,000, including Jiangsu, Guangdong, Shanghai and other 5 provinces and municipalities. The total number of domestic S&T papers of the above 9 regions reached 305,000, accounting for 59.7% of the national total. The 3rd group had between 10,000 and 20,000, including Liaoning province and other 8 regions. Regions with domestic S&T papers fewer than 10,000 belonged to the 4th group, including Fujian province and other 12 regions (Fig. 8-3).

1.3.2 Total volume of SCI papers

In 2013, the total volume of SCI papers in China reached 193,000. Based on the regional distribution of authors of SCI papers, the 31 regions of China can be divided into 4 categories. The first group had SCI papers over 10,000, including Beijing, Jiangsu, Shanghai, Guangdong and Zhejiang. The number of SCI papers in these 5 regions totaled 95,000 and accounted for 49.2% of the national total. Hubei, Shaanxi, Shandong and other 7 regions belonged to the 2nd group with SCI papers between 5000 and 10,000, and the total volume of these 10 regions was 71,000, accounting for 36.8% of the national total. The 3rd group had SCI papers between 2000 and 5000, including Chongqing and other 4 regions. Yunnan and other 10 regions belonged to the 4th group with SCI papers under 2000 (Fig. 8-3).

1.4 Invention patents

1.4.1 Invention patent applications

In 2013, the number of domestic invention patent applications in China reached 705,000. The 31 regions of China can be divided into 4 categories according to the regional invention patent application in general. The 1st group had invention patent applications over 20,000, including Jiangsu, Guangdong, Shandong and other 8 regions, and the number of invention patent applications in these 11 regions totaled 559,000, accounting for 79.2%. The 2nd group had invention patent applications between 10,000 and 20,000, including 6 such regions as Hubei, Henan, Guangxi, Chongqing, Hunan and Heilongjiang. The invention patent applications of Fujian and other 7 regions were between 3000 and 10,000, which were in the 3rd group. The 4th group had below 3000, including Xinjiang and other 5 regions (Fig. 8-4).

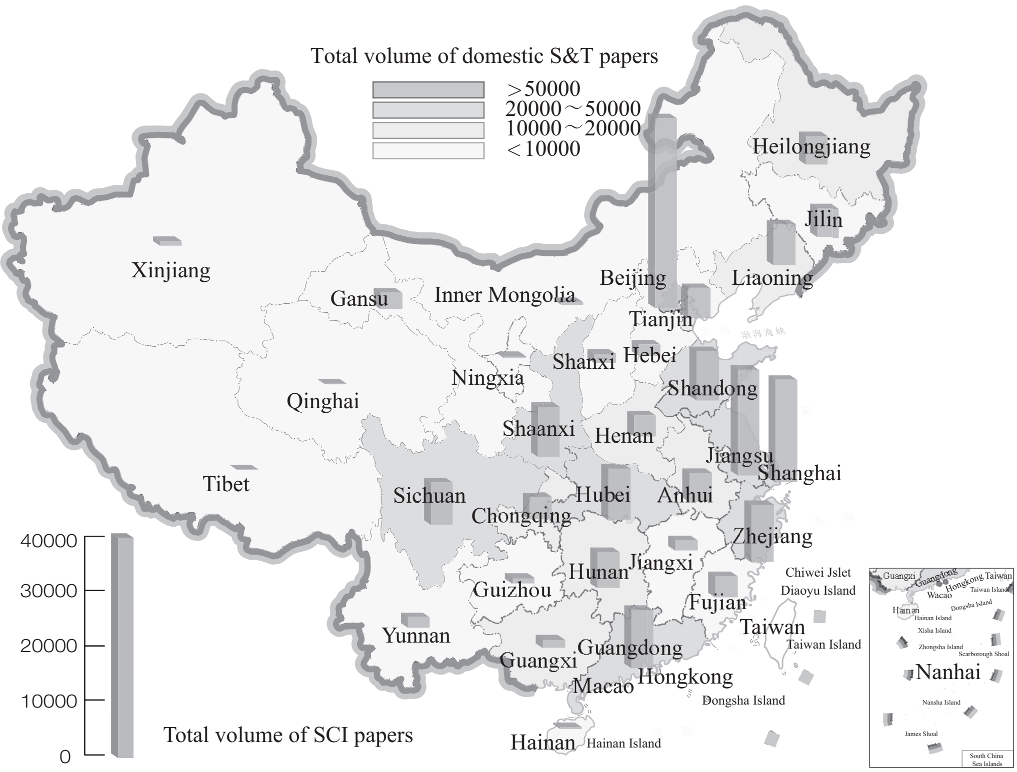

Fig. 8-3 Regional distribution of authors of S&T papers (2013)

See Appendix tables 8-2, 8-13.

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1.4.2 Invention patent grants

In 2013, the number of Chinese invention patents granted reached 144,000. The 31 regions of China can be divided into 4 categories according to the volume of invention patents granted by region. The 1st group had over 5000 of invention patents granted, including such 6 regions as Beijing, Guangdong, Jiangsu, Shanghai, Zhejiang and Shandong. The 2nd group was between 2000 and 5000 and included Sichuan, Anhui, Shaanxi and other 9 regions. The invention patents granted of the above 18 regions accounted for 89.6% of the national total. The 3rd group was between 1000 and 2000, including Jilin and other 3 regions. The 4th group was below 1000, including Jiangxi and other 8 regions (Fig. 8-4).

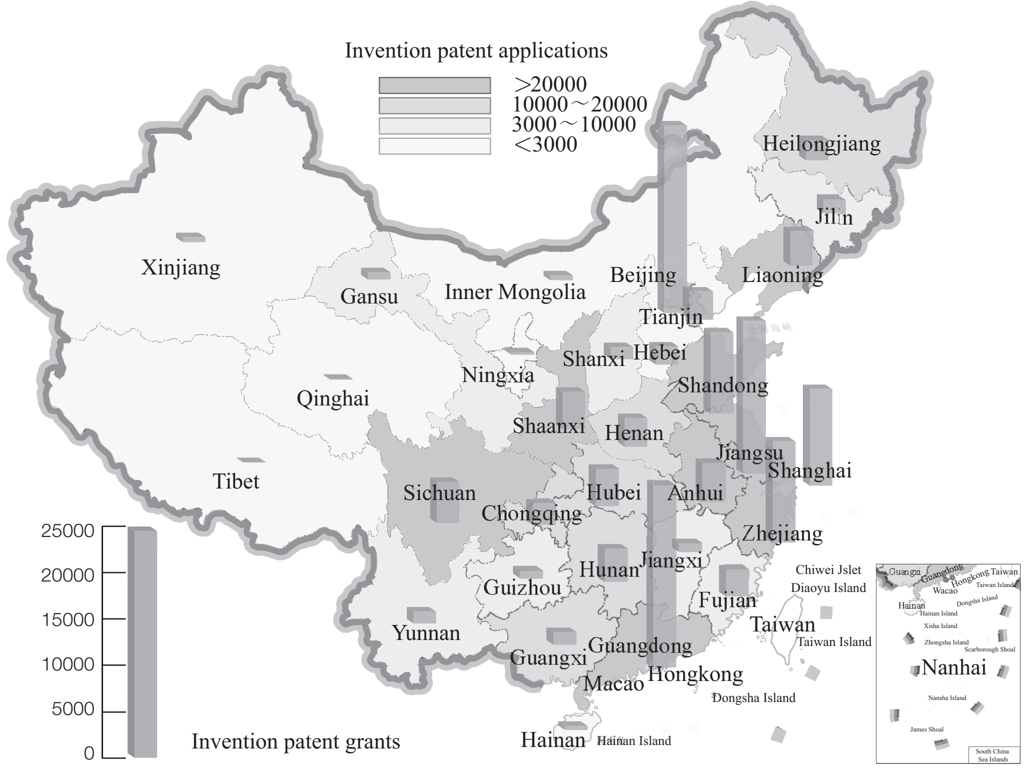

Fig. 8-4 Regional distribution of invention patents (2013)

See Appendix tables 8-4, 8-5.

China Science and Technology Indicators 2014

1.5 High-technology industry output

1.5.1 Total output value of high-technology industry

In 2013, the total output value of Chinese hi-tech industry totaled 8.72 trillion yuan. Based on the total output value of high-technology industry, from high to low, the 31 regions of China can be divided into 4 categories. The 1st group had over 1 trillion yuan, including Guangdong and Jiangsu province. The 2nd group had between 200 billion and 1 trillion yuan, including Shanghai, Zhejiang, Shandong and other 6 regions. The total output value of high-technology industry of the above 11 regions accounted for 80.8% of the national total. The 3rd group had between 50 billion and 200 billion yuan, including Liaoning and other 10 regions. The 4th group had below 50 billion yuan, including Guizhou and other 8 regions (Fig. 8-5).

1.5.2 Export of high-technology products

In 2013, export volume of China’s high-technology products reached USD 660.33 billion. The

31 regions of China can be divided into 4 categories according to the export volume of hi-technology products. The 1st group had an export of over USD 100 billion, including Guangdong and Jiangsu province. The 2nd group was between USD 50 billion and USD 100 billon, only including Shanghai municipal city. The export of the above 3 regions accounted for 71.6% of the national total. The 3rd group was between USD 10 billion and USD 50 billion, including Chongqing, Henan, Beijing and other 5 regions. The 4th group was below USD 10 billion, including Liaoning and other 19 regions (Fig. 8-5).

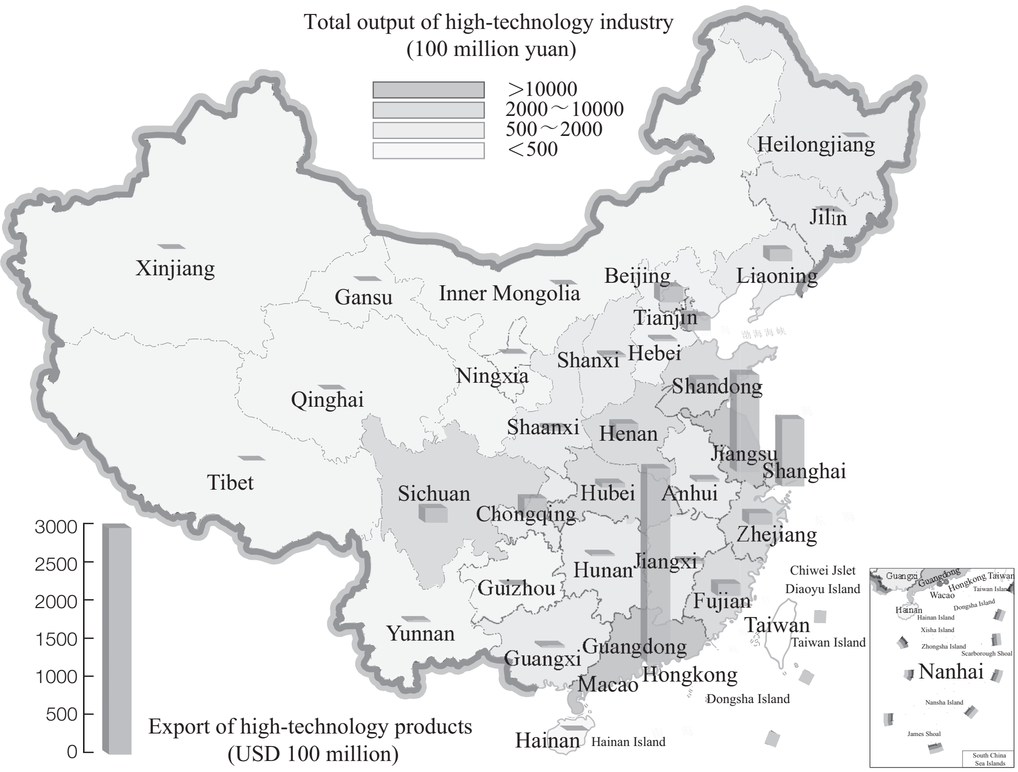

Fig. 8-5　Regional distribution of hi-technology industry (2013)

See Appendix tables 8-6, 8-7.

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2. Structural features of regional distribution of major S&T indicators

2.1 Structure of R&D input by sector of performance

2.1.1 R&D personnel input

In 2013, among the full-time equivalents of R&D personnel, those from research institutes accounted for 10.3% and from higher education institutions 9.2%, while those from enterprises and other institutions had the largest proportion, 80.5%. By region, there were 7 regions with the proportion of R&D personnel in research institutes above 20%, in which the top 3 was Beijing, Shaanxi and Tibet, 39.7%, 32.2% and 31.6% respectively. The full-time equivalents of R&D personnel in higher education institutions accounted for 10% to 20% in most regions; but Tibet, Guangxi, Jilin and Heilongjiang accounted for 32.7%, 26.3%, 24.7% and 24.0% respectively, all above 20%. The proportion of the full-time equivalents of R&D personnel in enterprises and other institutes was relatively high in all regions, in which 13 regions were over 80%, and the top 3 were Zhejiang, Guangdong and Fujian province, 94.9%, 94.3%, and 92.4% respectively (Fig. 8-6).

2.1.2 R&D expenditure

In 2013, in the 1.18466 trillion yuan of R&D expenditure in China, research institutes accounted for 15.0% and higher education institutions 7.2%, while enterprises and others accounted for 77.7%. By region, there were 4 regions with the proportion of R&D expenditure of research institutes over 1/3, which were Tibet, Beijing, Shaanxi and Sichuan, reaching 57.7%, 50.8%, 45.2% and 42.0% respectively. Regions with comparatively high proportion of R&D expenditure of higher education institutions to local total included Heilongjiang (22.1%), Jilin (16.8%) and others. In most regions, the R&D expenditure of enterprises and other institutes accounted for more than 50% of the total regional expenditure, in which Shandong was 93.8%, the highest (Fig. 8-7).

2.2 Disciplinary structure of S&T papers

2.2.1 Domestic S&T papers

In 2013, the volume of Chinese domestic S&T papers published reached 511,000. By discipline, medical science and industrial technology are the fields that witnessed the most volume of S&T papers published. In 2013, the S&T papers of the above-mentioned two fields accounted for 41.4% and 37.3% of the total respectively. In most regions, the S&T papers in medical science accounted for over 30%, and Guangxi had the highest proportion, 60.2%. The proportion of S&T papers in basic disciplines was relatively low in many regions, and 24 regions had a proportion of below 15%. Those with high proportion of S&T papers on industrial technology were mostly traditional industrial bases (Fig. 8-8).

2.2.2 SCI papers

The volume of SCI papers published totaled 193,000 in 2013. By discipline, basic disciplines and industrial technology enjoyed the most SCI papers published, which accounted for 52.7% and 26.7% of the total respectively. By region, SCI papers of basic disciplines accounted for more than 40% of the total SCI papers published in all regions of China, with 13 regions above 60%. Those with high proportion of SCI papers on industrial technology were mostly traditional industrial bases (Fig. 8-9).

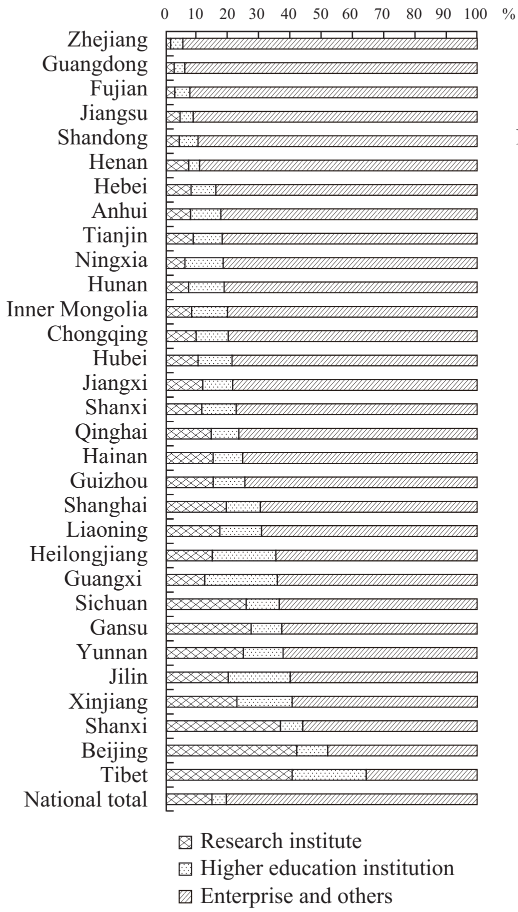

Fig. 8-6 R&D personnel input by sector of performance (2013)

See Appendix table 8-8.

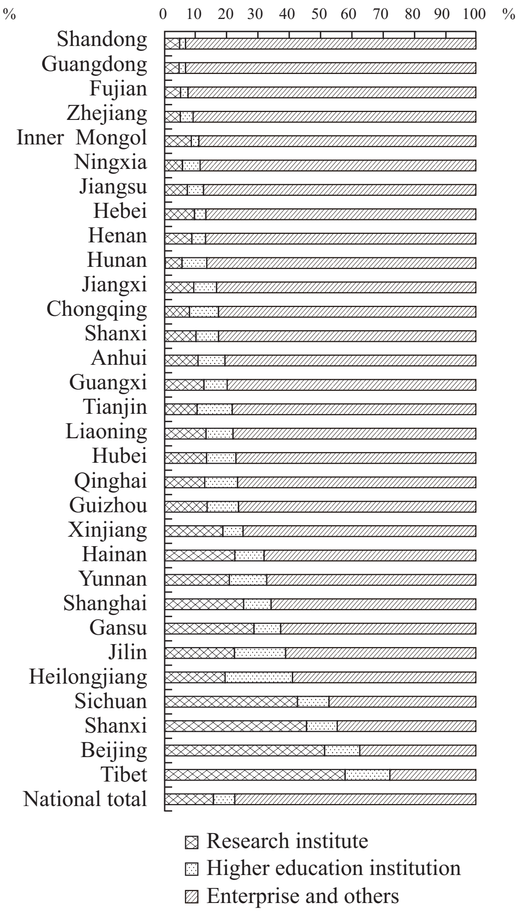

Fig. 8-7 R&D expenditure input by sector of performance (2013)

See Appendix table 8-9.

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2.3 Structure of domestic patents

2.3.1 Domestic patent applications

Among the 364,000 domestic patent applications in 2013, invention patent applications accounted for 31.5%, utility model patents 39.6% and industrial design patents 28.8%. By region, among patent applications, invention patents accounted for 20%～40% in most regions, the highest being 61.9% in Guangxi. Regions with utility model patents as the major type of patent applications included Hebei, Xinjiang, Tianjin, Henan, Hubei, Chongqing, Inner Mongolia and Heilongjiang, all above 50% (Fig. 8-10).

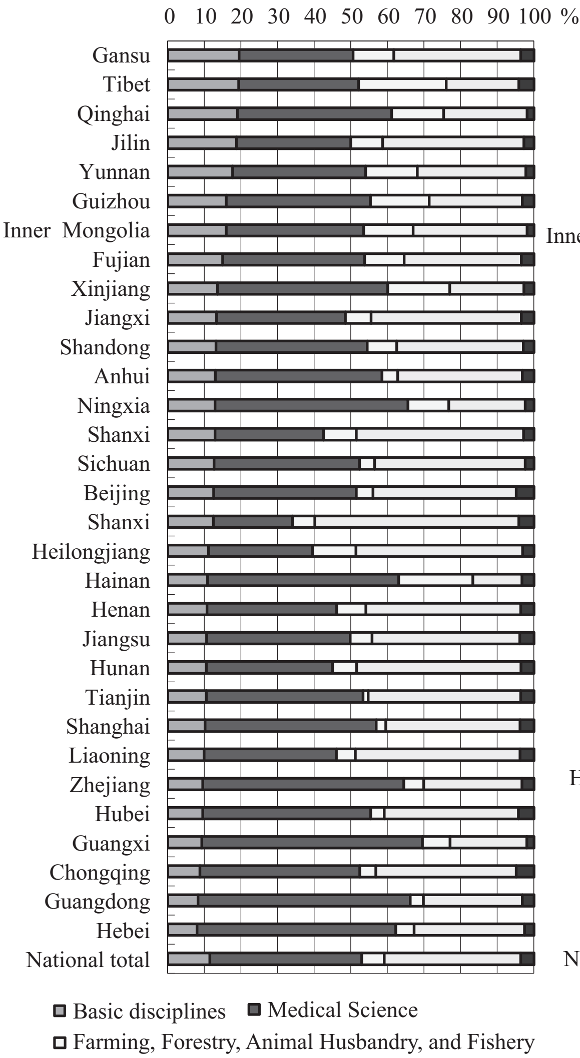

Fig. 8-8 The disciplinary structure of domestic S&T papers (2013)

See Appendix table 8-2.

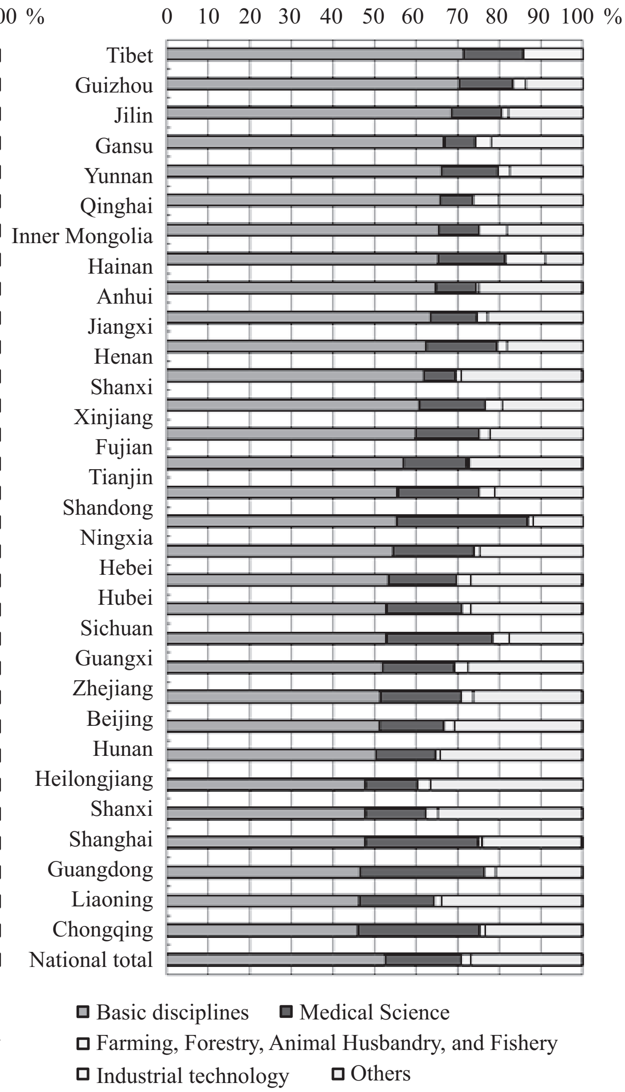

Fig. 8-9 The disciplinary structure of SCI papers (2013)

See Appendix table 8-3.

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2.3.2 Domestic patents granted

In 2013, China's domestic patents granted totaled 123,000, in which invention patents accounted for 11.7%, utility model patents 55.9% and industrial design patents 32.5%. From regional distribution, the proportion of invention patents in all patents granted was less than 30% in most regions. Regions where the proportion of utility model patents was over 50% are Shandong, Tianjin, Ningxia and other 24 regions (Fig. 8-11).

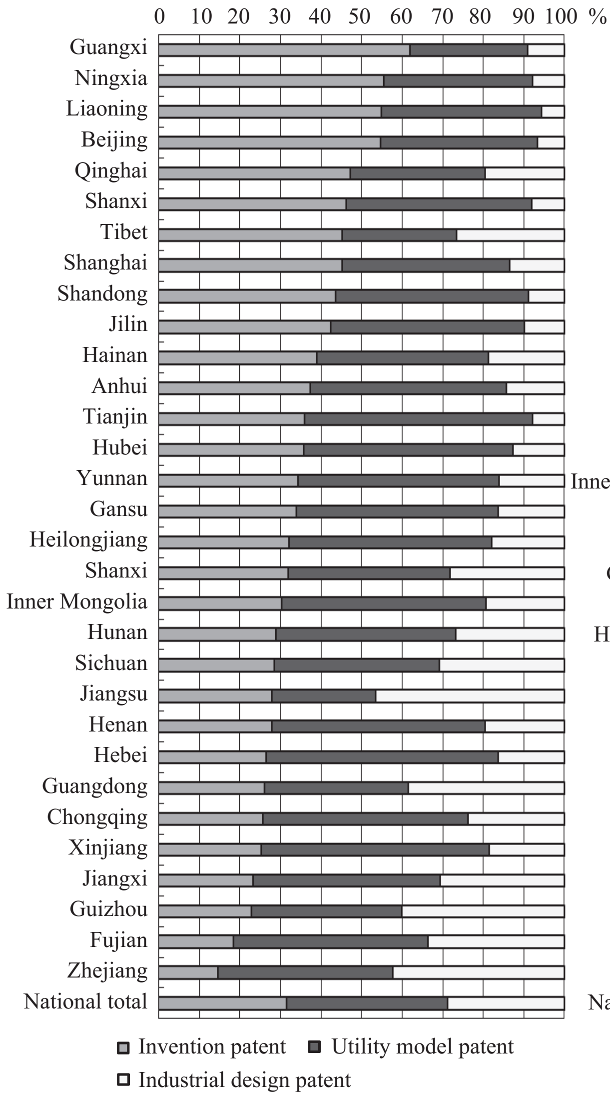

Fig. 8-10 Structure of domestic patent applications (2013).

See Appendix table 8-4.

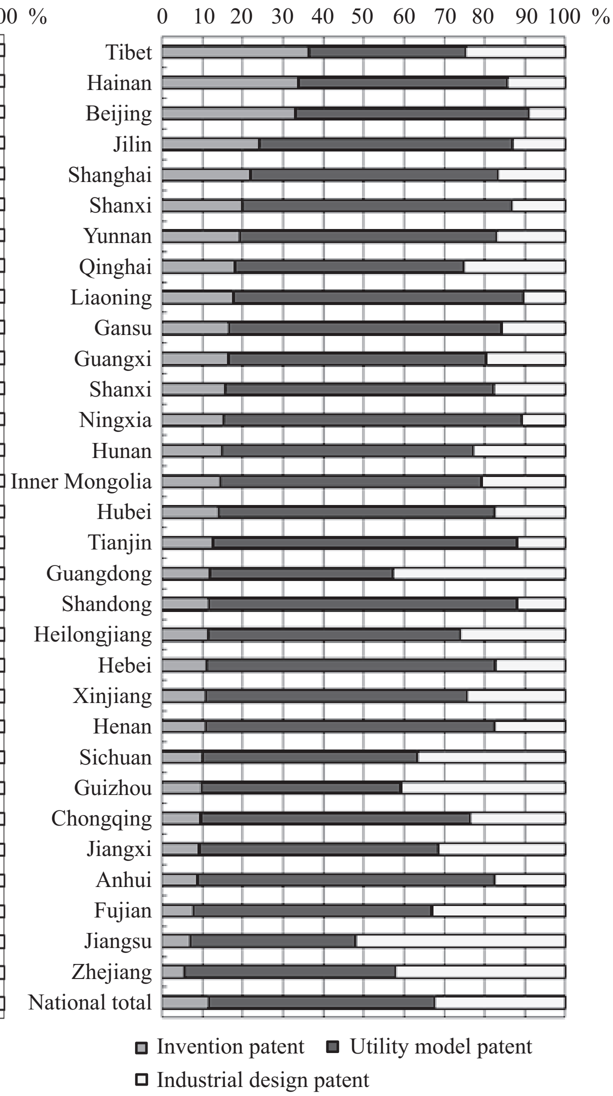

Fig. 8-11 Structure of domestic patents granted (2013)

See Appendix table 8-5.

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2.4 Industry structure of total output value of hi-technology industry

In 2013, in the total output value of hi-technology industry, which was 8.72 trillion yuan, the contribution of electronic and telecommunication equipment manufacturing was 51.1%, the highest. By region, the contribution of electronic and telecommunication equipment manufacturing in 8 regions was above 50%, and the top 3 regions were Guangdong, Fujian and Jiangsu province, with a contribution of 70.9%, 62.9% and 59.6% respectively (Fig. 8-12).

Fig. 8-12 Industry structure of total output value of hi-technology industry (2013)

See Appendix table 8-10.

2.5 Structure of technology field on export volume of high-technology products

In 2013, the export volume of high-technology products totaled USD 660.33 billion, in which the most contribution belonged to the computer and communication technology field of 66.5%, and that of other fields was lower. By region, the contribution of computer and communication technology fields was over 50% in 20 regions, in which the top 3 were Shanxi, Henan and Chongqing, with a contribution of 98.0%, 97.6%, 95.2% respectively (Fig. 8-13).

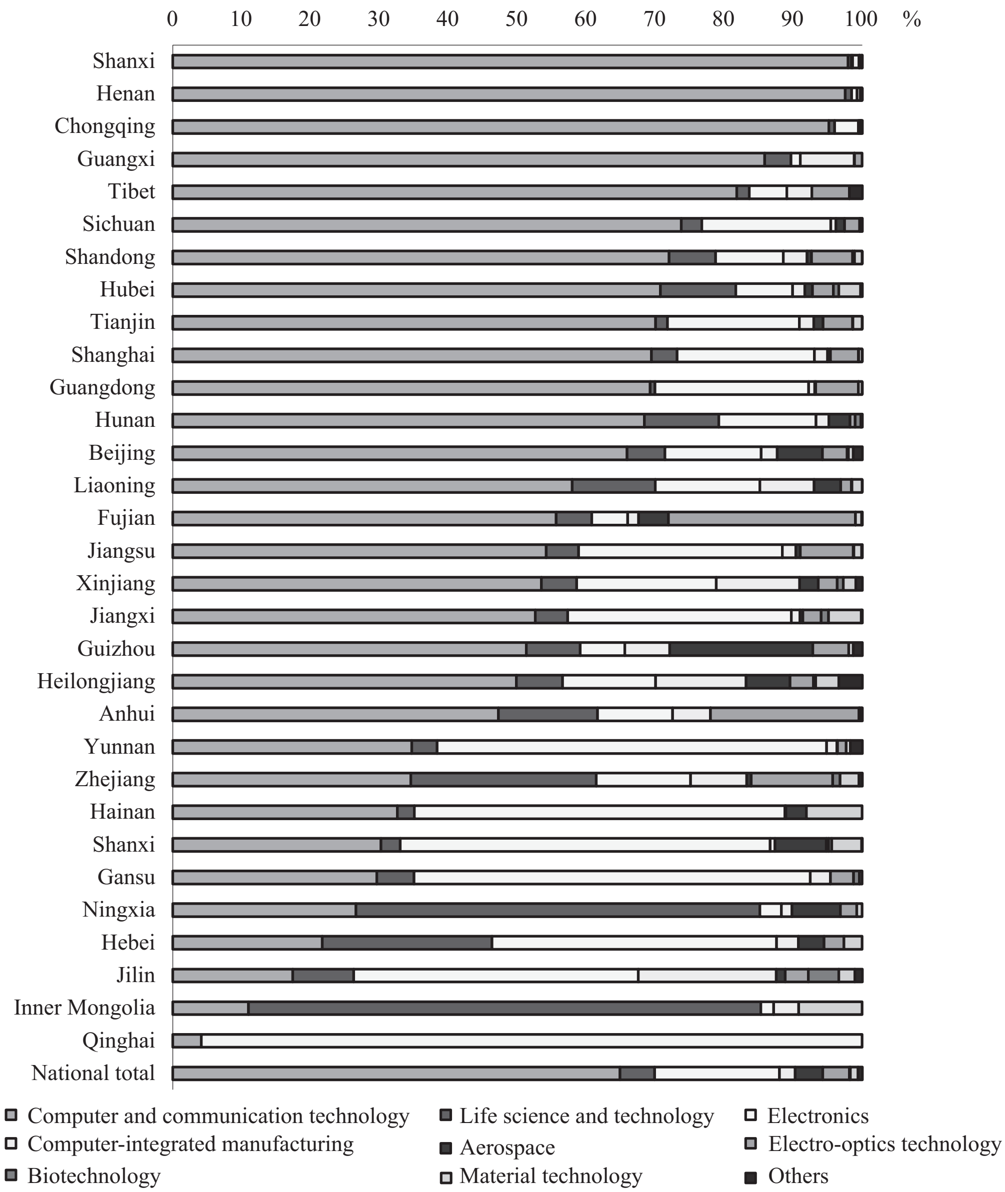

Fig. 8-13 Structure of technology field on export of high-technology products (2013)

See Appendix table 8-11.

Section 2 Distribution Features of Regional S&T

In recent years, the overall strategy for regional development of China has been implemented smoothly and boosted China's S&T and economic growth. To better observe the regional distribution of S&T in China, this section divides the 31 regions (provinces, autonomous regions, municipalities directly under the central government) into four regions, i.e. the Eastern Coastal Region, Northeastern Region, Middle Region and Western Region. This section selects 8 indicators① and applies the method of location quotient and radar chart to compare and analyze the four regions②.

Column 8-1 The concept of location quotient and its application in this section

Location quotient (also named as regional specialization ratio) is an analytical method frequently applied in the regional science research. It was firstly used to reflect the specialization level of a certain industrial sector in a region compared with the national level of this industry, so the industrial sectors with comparative advantages in the region could be discovered. According to the calculation of the location quotient of an industry in every region, the concentration feature of spatial distribution of an industry can also be found. This section uses the location quotient to analyze the comparative advantages of different regions in S&T development. Let T_{ij} be the value of S&T indicator j in region i, T_{0j} be the national average value of S&T indicator j, then, the location quotient (C_{ij}) of S&T indicator j in region i can be expressed as: $C_{ij}= T_{ij}/T_{0j}\times 100$. If $C_{ij} \leqslant 100$, it means the value of S&T indicator j in region i is not lower than or equal to the national average level; if $C_{ij} > 100$, it means the value of S&T indicator j in region i is higher than the national average level, with a certain comparative advantage.

1. S&T regional distribution

According to the analysis of the 8 indicators, the four regions, i.e. the eastern coastal region, northeastern region, middle region and western region have shown different features (Fig. 8-14). The general advantages of the eastern coastal region in S&T development were obvious: the

① The 8 indicators include "full-time equivalents of R&D personnel per 10,000 employees" "the proportion of R&D expenditure to regional GDP" "the proportion of local S&T appropriation to the local fiscal expenditure" "invention patents per 10,000 persons" "the number of SCI papers per 100,000persons" "the proportion of total value of high-technology industry output to total value of above-scale industry output" "the proportion of exports of hi-technology products to exports of commodities" and "the proportion of the value of signed contracts in technology market to regional GDP". For simplicity, the 8 indicators are called "R&D personnel" "R&D expenditure" "S&T appropriation" "invention patents", "SCI papers" "high-technology industry" "high-technology products" and "technology contracts" in the text.

② The Eastern Coastal Region includes Beijing, Tianjin, Hebei, Shandong, Shanghai, Jiangsu, Zhejiang, Fujian, Guangdong and Hainan; The Northeastern Region includes Liaoning, Jilin and Heilongjiang; The Middle Region includes Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; The Western Region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang.

location quotients of 8 indicators were all above the national average, and 4 indicators, i.e. “S&T appropriation” “invention patents” “SCI papers” and “R&D personnel”, were 168, 158, 189 and 158 respectively, 1.5 times of the national average. In the northeastern region, the location quotient of “SCI papers” was 117, higher than the national average; the location quotient of “high-technology products” in the western region was 139, higher than the national average; however, the 8 indicators of the middle region were all below national average levels.

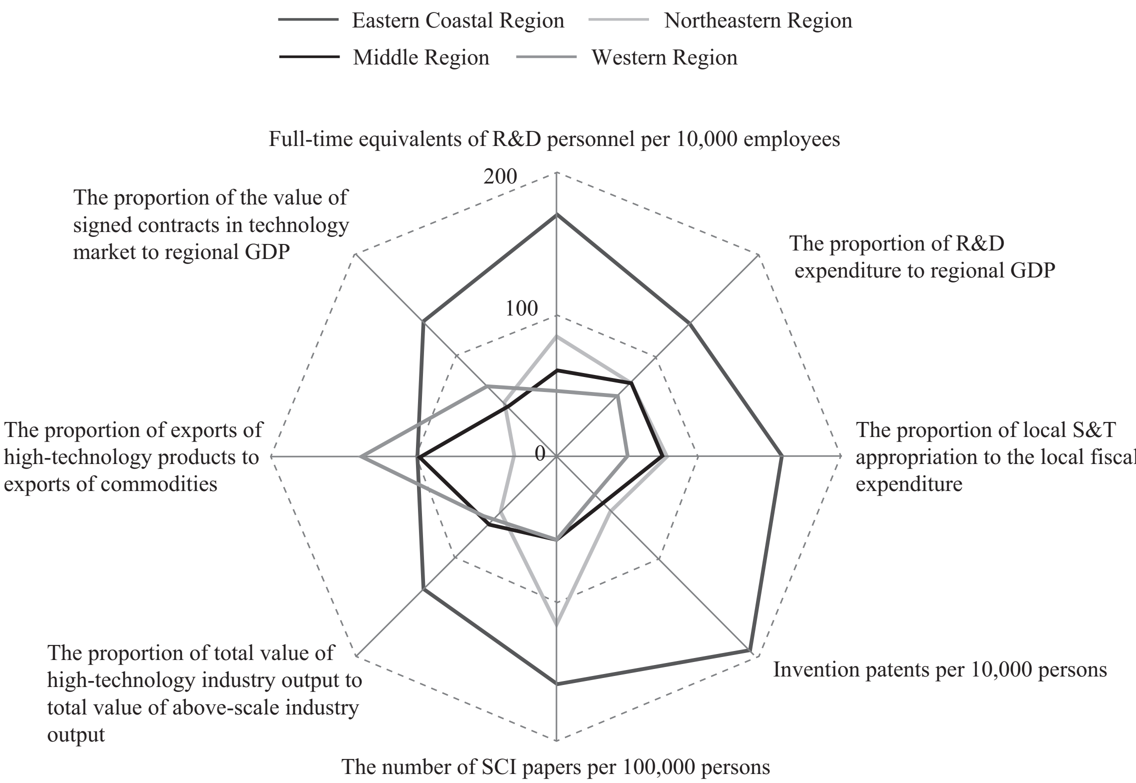

Fig. 8-14 S&T regional distribution (2013)

See Appendix table 8-12.

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The analysis of the 8 indicators shows that regions differ greatly in S&T development. From the indicator of “R&D personnel”, the location quotient of the eastern coastal region was 168, while that of Northeastern, Middle and Western Regions were 85, 62 and 45, respectively. From the indicator of “R&D expenditure”, the location quotient of the eastern coastal region was 131, while that of northeastern, middle and western regions were 71, 74 and 60, respectively. From the indicator of “S&T appropriation”, the location quotient of the eastern coastal region was 158, while that of northeastern, middle and western regions were 76, 75 and 49 respectively. From the indicator of “invention patents”, the location quotient of Eastern Coastal Region was

189, while that of Northeastern, Middle and Western Regions were 52, 43 and 36 respectively. From the indicator of “SCI papers”, the location quotients of Eastern Coastal and Northeastern Regions were 158 and 117 respectively, while those of Middle and Western Regions were 56 and 58 respectively. From the indicator of “technology contracts”, the location quotient of the Eastern Coastal Region was 132, while that of northeastern, middle and western Regions was only 48, 49 and 68 respectively. From the indicator of “high-technology industry”, the location quotient of the eastern coastal region was 132, while that of northeastern, middle and western regions was only 56, 66 and 62 respectively. From the indicator of “high-technology products”, the location quotients of eastern coastal and western regions were 100 and 139 respectively, while those of northeastern and middle regions were only 29 and 96 respectively.

2. The S&T distribution of the eastern coastal region

The S&T development level in 10 provinces and municipalities of the Eastern Coastal Region differs greatly and can be divided into 3 groups. The 1st group includes Beijing, Tianjin and Shanghai municipal cities; the 2nd group includes Jiangsu, Zhejiang, Guangdong and Shandong province; the 3rd group includes Fujian, Hebei and Hainan province.

All location quotients of Beijing were higher than the region’s average level; 2 indicators, “technology contracts” and “SCI papers”, were as high as 932 and 746 respectively. In Tianjin, 6 indicators were higher than the average; “R&D personnel” was 247, the highest; “invention patents” and “high-technology industry” were both 92, below the average. All 8 indicators of Shanghai were above the average level, in which the location quotients of “SCI papers” and “R&D personnel” were 351 and 230 respectively (Fig. 8-15).

In Jiangsu, 7 indicators were higher than the region’s average level, but the location quotient of “technology contracts” was only 57% of the average. In Zhejiang, the location quotients of “R&D personnel” “S&T appropriation” and “invention patents” were 100, 113 and 199 respectively, all higher than the average level; other 5 indicators were below the average level. In Guangdong, 5 indicators, “R&D personnel” “S&T appropriation” “invention patents” “high-technology industry” and “high-technology products” were 111, 114, 109, 195 and 117 respectively, all higher than the average level; the remaining 3 were below the average;. In Shandong, all 8 indicators were below the average level; the location quotient of “technology contracts” was only 21% of the average (Fig. 8-16).

The 8 indicators of Fujian, Hebei and Hainan were all below the region’s average level. Fujian performed better in “R&D personnel” and “high-technology industry”, which were 72% and 69% of the average level respectively. Hebei and Hainan lagged far behind in “technology contracts”, only 7% and 8% of the average level respectively (Fig. 8-17).

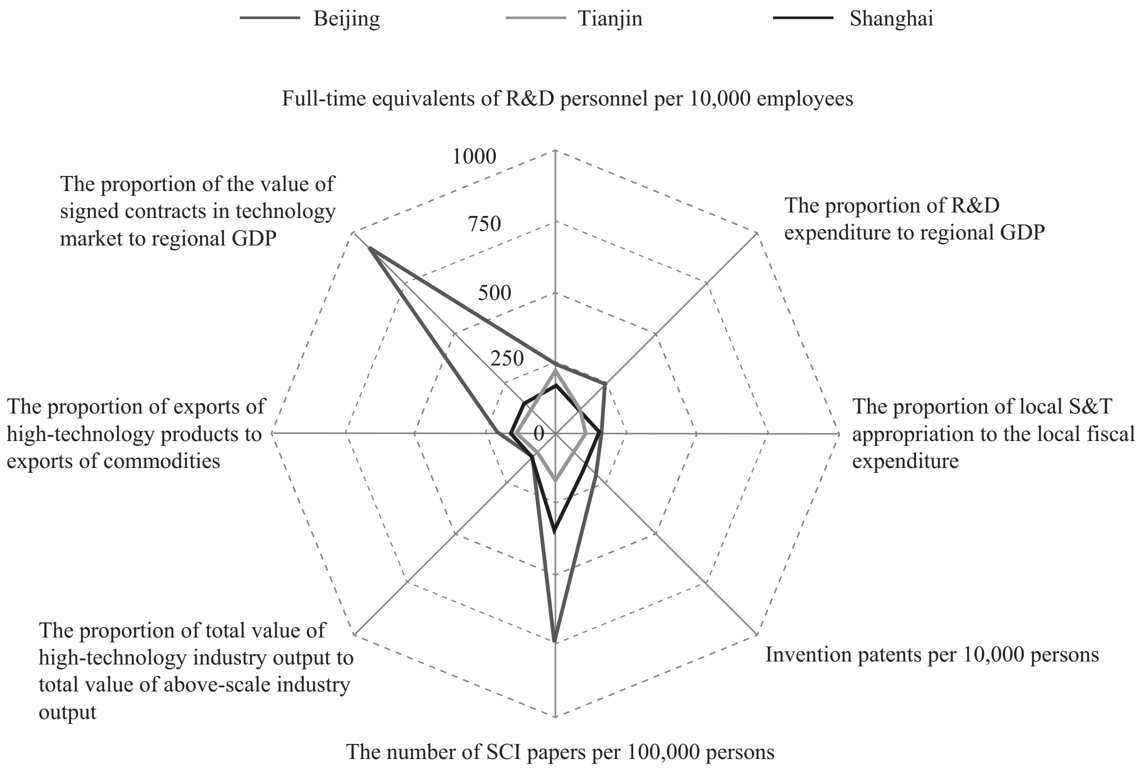

Fig. 8-15 S&T distribution of Beijing, Tianjin, and Shanghai (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

3. The S&T distribution of the northeastern region

The analysis of the 8 indicators in Northeastern Region indicates that the S&T development level in 3 provinces there was generally balanced. 7 indicators of Liaoning were higher than the average, among which the location quotients of “R&D expenditure” and “S&T appropriation” were 123 and 133 respectively; the location quotient of “hi-technology industry” was below the regional average. In Jilin, 2 indicators were higher than the average level; the location quotient of “high-technology industry” was 125, the highest; 6 indicators, i.e. “R&D personnel” “R&D expenditure” “invention patents” “high-technology products” and “technology contracts” were slightly lower than the average. In Heilongjiang, 2 indicators were above the average; the location quotient of “technology contracts” was 124, the highest; other 6 indicators, “R&D personnel” “R&D expenditure” “S&T appropriation” “SCI papers” “high-technology industry” and “hi-technology products” were all below the average (Fig. 8-18).

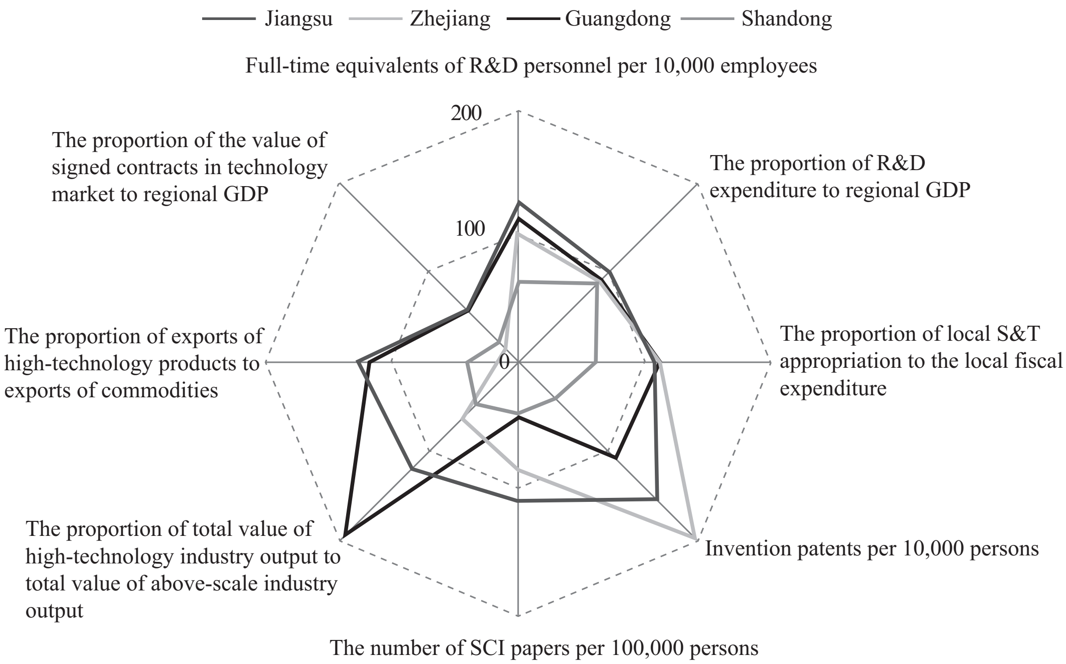

Fig. 8-16 S&T distribution of Jiangsu, Zhejiang, Guangdong, and Shandong (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

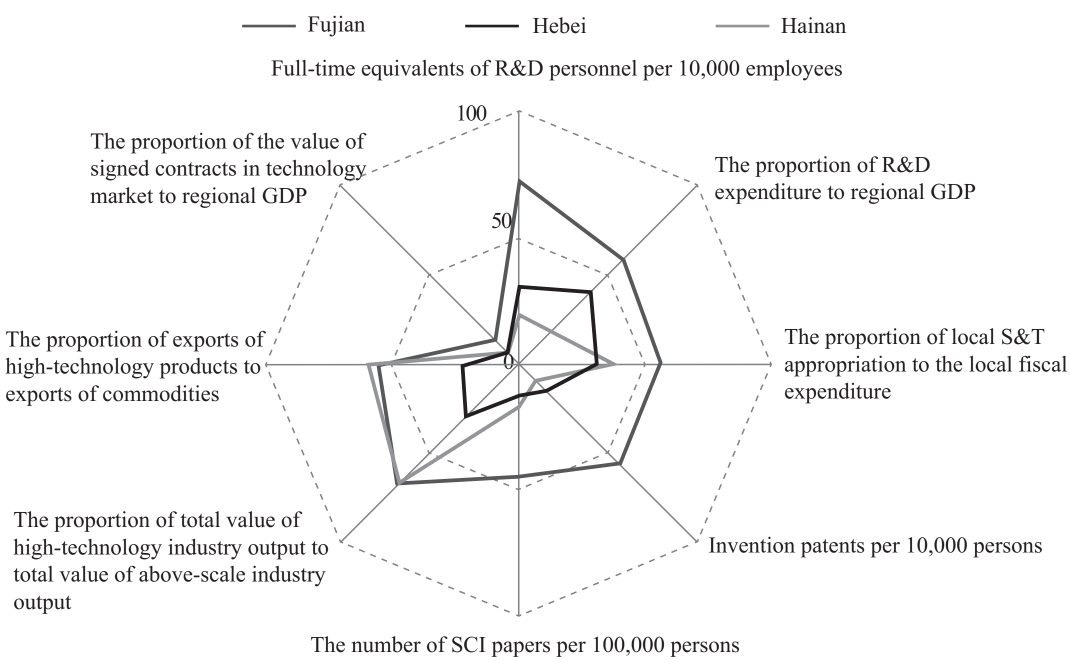

Fig. 8-17 S&T distribution of Fujian, Hebei, and Hainan (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

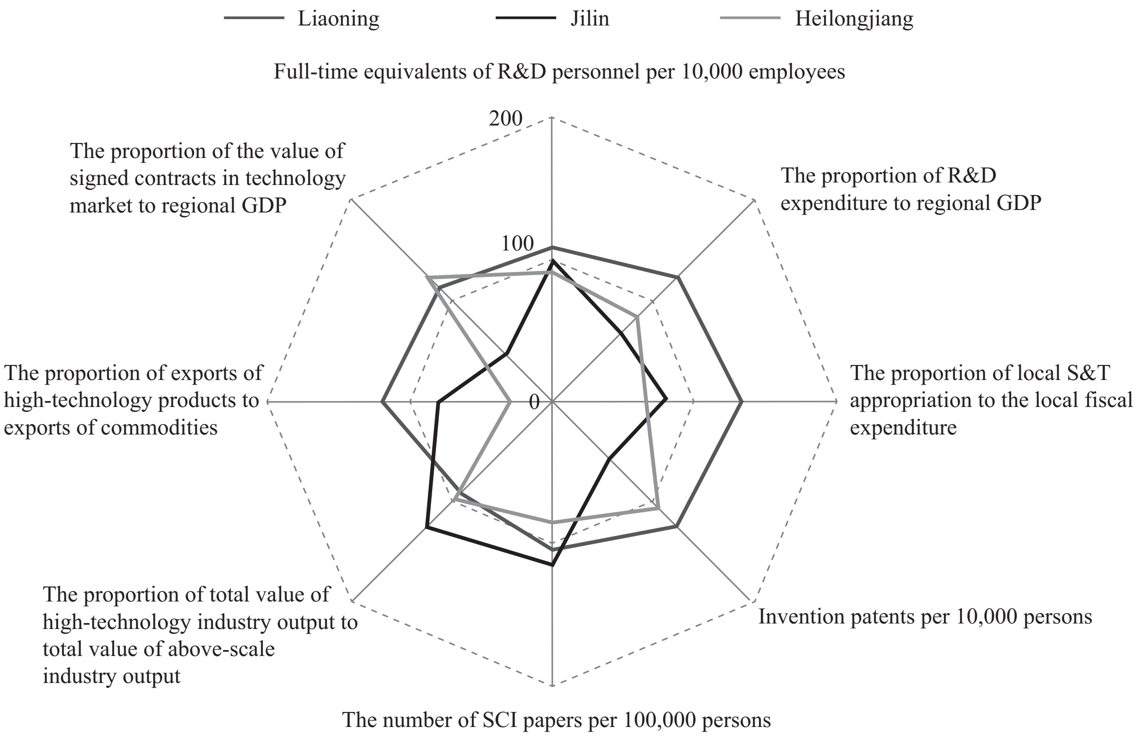

Fig. 8-18 S&T distribution of the northeastern region (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

4. The S&T distribution of the middle region

To clearly show differences, the 6 provinces of the middle region are divided into 2 groups. The 1st group includes Shanxi, Henan and Hubei. The 2nd group includes Hunan, Anhui and Jiangxi.

The location quotients of "R&D personnel" "S&T appropriation" and "high-technology products" in Shanxi were 103, 121 and 116 respectively, higher than the regional average level, while other 5 indicators were lower. In Henan, The location quotients of "high-technology industry" and "high-technology products" were 108 and 188 respectively, higher than the average level; other 6 indicators were lower. In Hubei, all indicators except for "high-tech products" were higher than the average level; the location quotients of "SCI papers" and "technology contracts" were 205% and 277% of the average level, respectively (Fig. 8-19).

In Hunan, the location quotient of "SCI papers" was above the average level; "R&D personnel" "R&D expenditure" "invention patents" and "high-technology products" were close to the average level; "S&T appropriation" "technology contracts" and "high-tech products" were lower than the average. In Anhui, the location quotients of "R&D personnel" "R&D expenditure" "S&T appropriation" "invention patents" "SCI papers" "high-technology industry" and "technology contracts" were all higher than the average level, in which "invention patents" was as high as 173; "hi-technology products" was lower than the average level. In Jiangxi, the location quotient of "hi-technology industry" was 160, above the regional level, while other 7 were lower (Fig. 8-20).

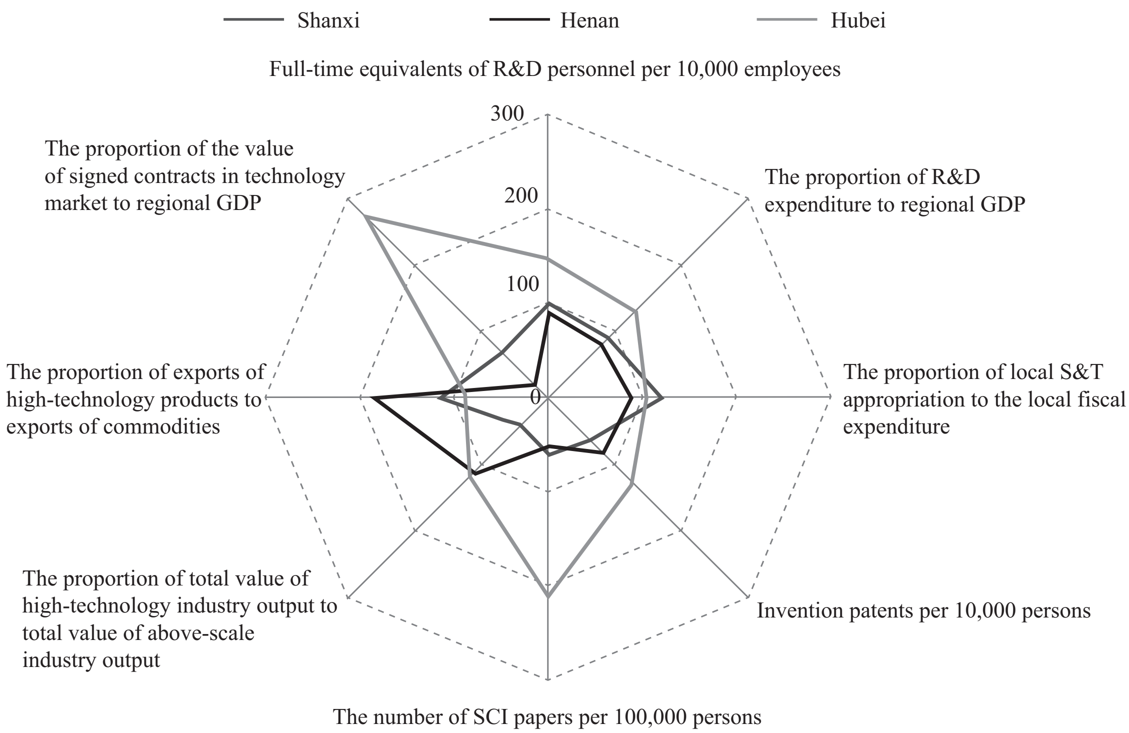

Fig. 8-19 S&T distribution of Shanxi, Henan, and Hubei (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

5. The S&T distribution of the western region

To clearly show differences, the provinces of the Western Region are divided into 4 groups: the 1st group includes Inner Mongolia, Shaanxi and Ningxia. The 2nd group includes Gansu, Qinghai and Xinjiang. The 3rd group includes Chongqing, Sichuan and Guizhou. And the 4th group includes Guangxi, Yunnan and Tibet.

In Inner Mongolia, the location quotient of "R&D personnel" was 152, higher than the average level, while other 7 indicators were lower. In Shaanxi, all indicators were close to the average level, except for "S&T appropriation", which was 94; the location quotients of "SCI papers" "technology contracts" "R&D personnel" "R&D personnel" and "invention patents" were 304, 415, 231, 189 and 154 respectively. In Ningxia, the location quotients of "R&D personnel" and "S&T appropriation" were 122 and 105 respectively, above the average level, while other 6 were lower (Fig. 8-21).

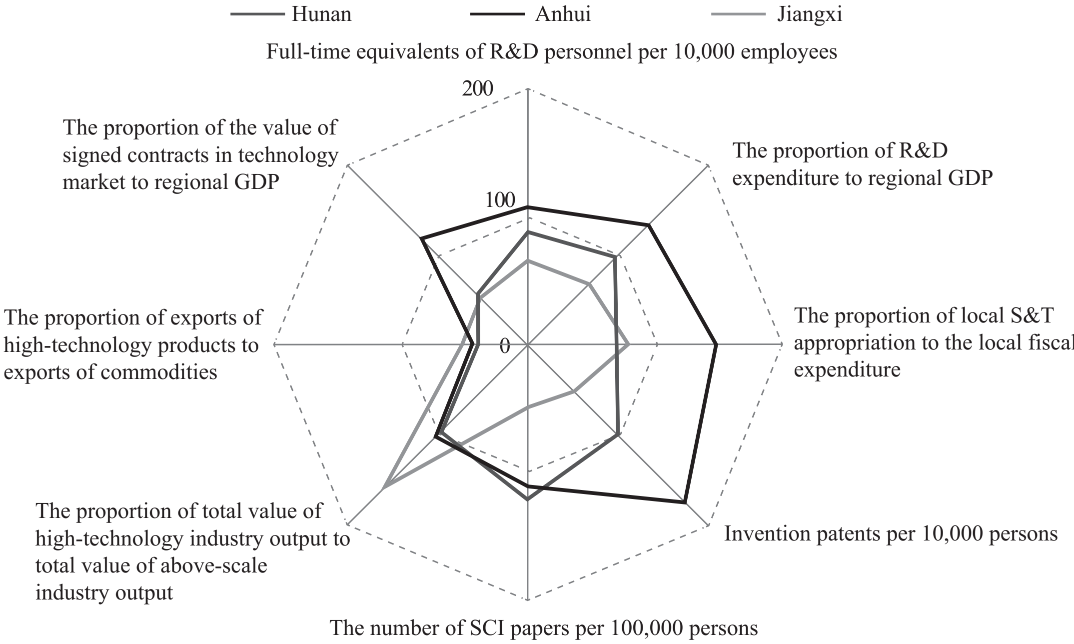

Fig. 8-20 S&T distribution of Hunan, Anhui, and Jiangxi (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

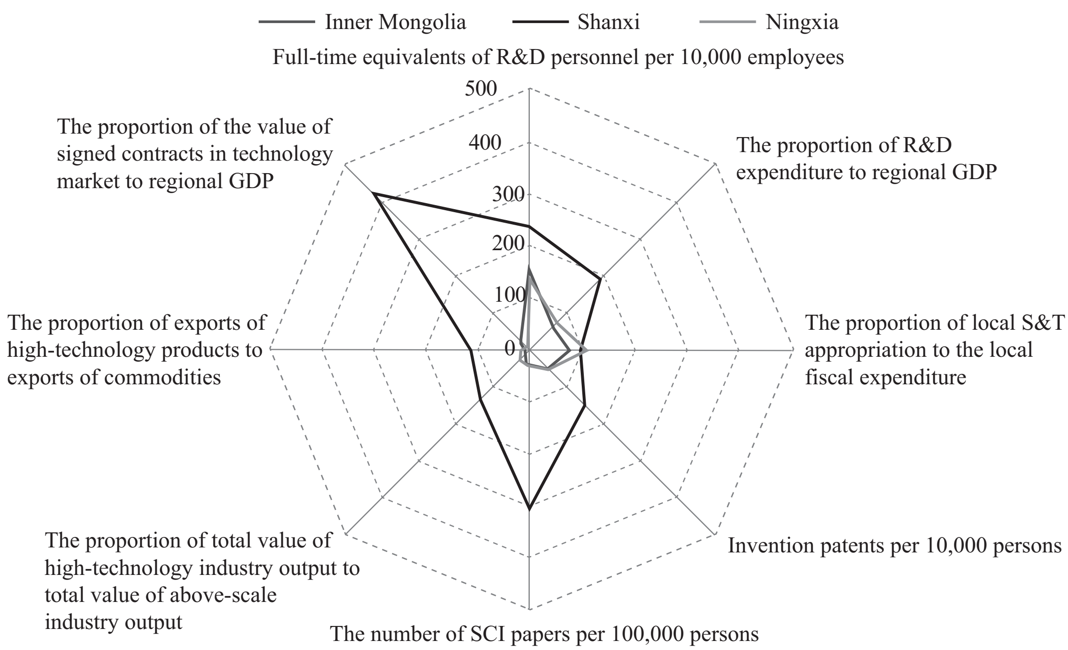

Fig. 8-21 S&T distribution of Inner Mongolia, Shaanxi, and Ningxia (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

In Gansu, the location quotients of “SCI papers” and “technology contracts” were 142 and 199 respectively, both above the region’s average level; “R&D expenditure” was close to the average; other 5 were all below the average. In Qinghai, the location quotient of “technology contracts” was 160, higher than the average; other 7 were all below the average. In Xinjiang, the location quotient of “R&D personnel” was close to the average level and that of “S&T appropriation” was 118, higher than the average; other 6 were below the average (Fig. 8-22).

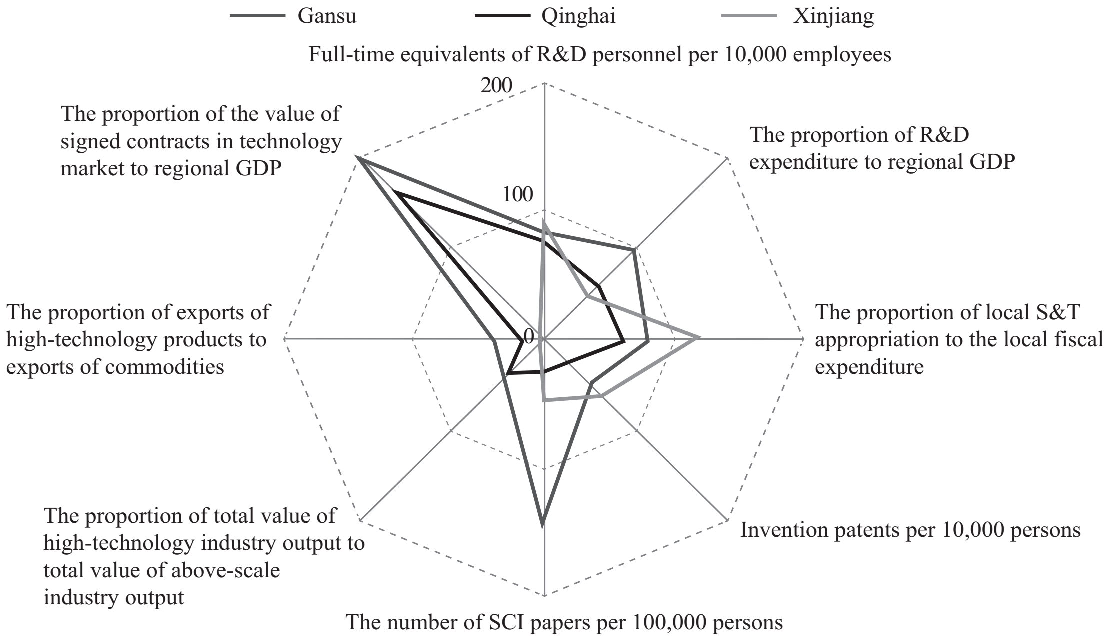

Fig. 8-22 S&T distribution of Gansu, Qinghai, and Xinjiang (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

In Chongqing, all indicators except for “technology contracts” were higher than the regional average level; the location quotients of “invention patents” “SCI papers” “hi-technology industry” and “hi-technology products” were 234, 168, 187 and 156 respectively, 1.5 times of the average. In Sichuan, all indicators were higher than the average except for “technology contracts”; the location quotients of “invention patents” and “hi-technology industry” were 155 and 212 respectively. In Guizhou, all indicators were lower than the average except for “S&T appropriation”, which was 101, slightly higher than the average (Fig. 8-23).

In Guangxi, the location quotient of “S&T appropriation” was 154, higher than the regional average level, while other 7 were lower. In Yunnan, the location quotient of “S&T appropriation” was 94, close to the average level; all other 7 were all lower. In Tibet, all indicators were lower than the average except for “technology contracts” whose data was missing (Fig. 8-24).

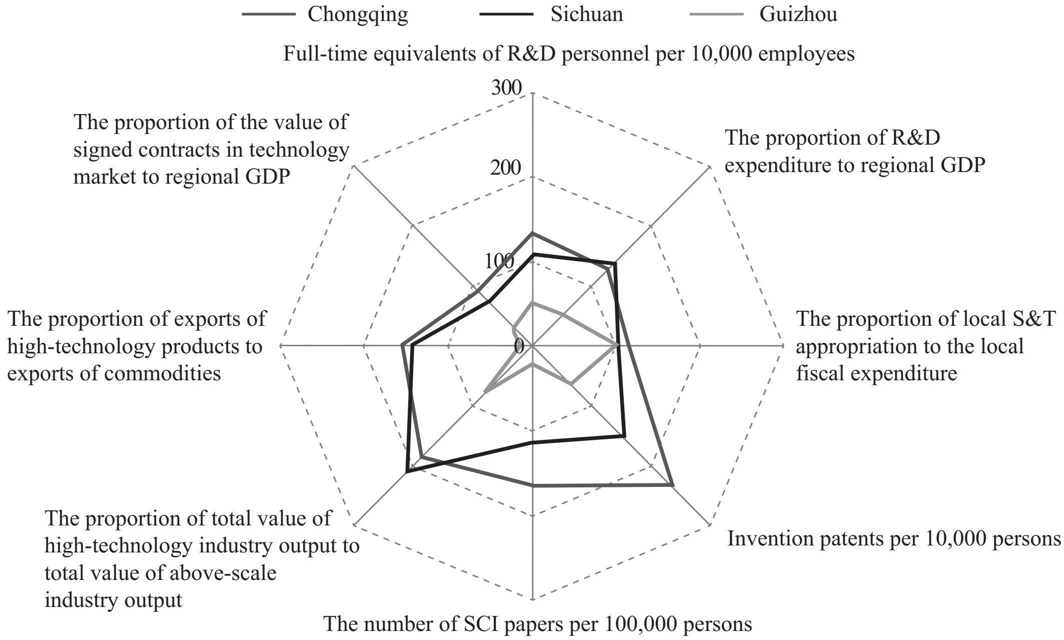

Fig. 8-23　S&T distribution of Chongqing, Sichuan, and Guizhou (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

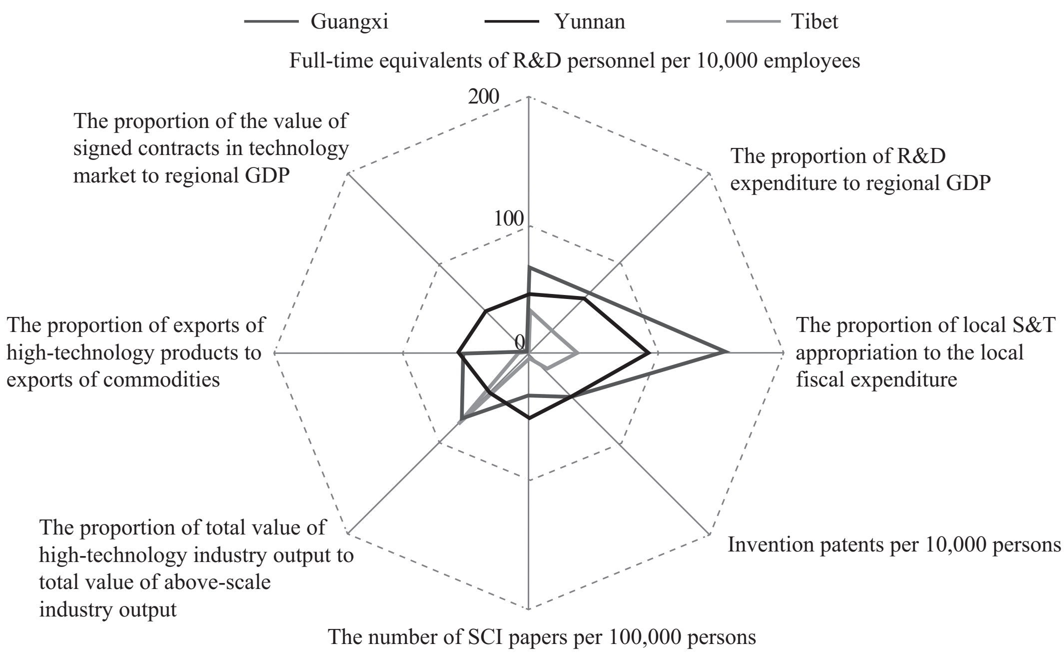

Fig. 8-24　S&T distribution of Guangxi, Yunnan, and Tibet (2013)

See Appendix tables 8-12, 8-13.

China Science and Technology Indicators 2014

Tables

Table 1-1 Overview of human resources in S&T (2004—2013)

Category \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Population at year-end (10,000 persons)	129988	130756	131448	132129	132802	133450	134091	134735	135404	136072
Number of Employed Persons at Year-end (10,000 persons)	74264	74647	74978	75321	75564	75828	76105	76420	76704	79300
The stock of graduates holding a junior college or above diploma (10,000 persons)[a]	4800	5400	6000	6780	7650	8570	9505	10510	11540	12610
Human resources in S&T (10,000 persons)[a]	3240	3510	3840	4200	4700	5190	5700	6300	6743	7105
#Number of persons holding a bachelor's degree or above (10,000 persons)	1320	1460	1620	1810	2020	2161	2353	2556	2745	2943
R&D personnel (10,000 person-years)	115.26	136.48	150.25	173.62	196.54	229.13	255.38	288.29	324.68	353.28
#Basic research	11.07	11.54	13.13	13.81	15.40	16.46	17.37	19.32	21.22	22.32
#Research institution	2.73	2.80	3.20	3.59	3.82	4.08	4.20	5.03	5.66	6.09
Higher education institution	7.49	7.75	8.97	9.45	10.90	11.27	12.00	12.93	14.01	14.66
Enterprise	0.57	0.73	0.68	0.50	0.36	0.17	0.16	0.22	0.23	0.29
Others	0.29	0.25	0.29	0.27	0.31	0.94	1.00	1.14	1.32	1.28
Applied research	27.86	29.71	29.97	28.6	28.94	31.53	33.56	35.28	38.38	39.56
#Research institution	8.08	8.33	8.98	9.33	9.74	10.29	10.91	11.33	12.14	12.97
Higher education institution	10.40	11.07	11.35	11.98	13.68	14.12	14.83	15.03	15.43	15.91
Enterprise	7.95	8.89	8.12	5.81	3.99	2.50	2.72	4.00	5.80	5.56
Others	1.43	1.41	1.53	1.47	1.53	4.62	5.10	4.91	5.01	5.12
Experimental development	76.33	95.23	107.14	131.21	152.2	181.14	204.46	233.73	265.09	291.40
#Research institution	9.52	10.39	11.02	12.63	12.45	13.35	14.24	15.20	16.55	17.32
Higher education institution	3.32	3.89	3.94	3.95	2.10	2.12	2.14	1.96	1.92	1.92
Enterprise	61.16	78.69	89.98	112.37	135.24	162.08	184.51	212.75	242.61	268.21
Others	2.32	2.26	2.20	2.26	2.40	3.59	3.57	3.81	4.02	3.96
#Research institution	20.33	21.53	23.19	25.55	26.01	27.72	29.35	31.57	34.35	36.37
Higher education institution	21.17	22.72	24.25	25.39	26.68	27.52	28.97	29.93	31.35	32.49
Enterprise	69.68	88.31	98.78	118.68	139.59	164.75	187.39	216.93	248.64	274.06
Others[b]	4.04	3.92	4.02	4	4.25	9.14	9.68	9.86	10.34	10.36

continued from table 1-1

Category \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
#Senior R&D personnel						115.23	121.08	131.81	140.40	148.40
#Research institution						17.25	18.21	19.99	21.78	23.59
Higher education institution						22.50	23.92	24.90	26.21	27.27
Enterprise						70.78	73.99	81.88	87.24	92.27
Others						4.70	4.96	5.04	10.34	10.36

a: Estimated based on education statistics.

b: Others refer to government-affiliated public institutions that are engaged in S&T activities yet cannot be defined as research institutions.

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2005—2014*; National Bureau of Statistics, *China Statistical Yearbook 2005—2014*; the Department of Development Planning of the Ministry of Education, *China Statistical Yearbook on Education 2005—2014*.

Table 1-2 Technical personnel in S&T in state-owned enterprises and institutions (2000—2013)

person

Year	Total	Sub-total	Engineering technician	Agro-technician	Health technician	Scientific research personnel	Teaching personnel
2000	28874159	21650807	5551098	670105	274506	3371966	11783132
2001	28477431	21698037	5316327	674644	265554	3390233	12051279
2002	28344158	21860024	5289166	666998	262692	3402326	12238842
2003	27745585	21739699	4992867	683437	275496	3441109	12346790
2004	27504073	21783019	4807869	704576	282002	3532282	12456290
2005	27567260	21978684	4791227	705720	311166	3581181	12589390
2006	27739287	22298171	4893672	701930	326728	3612091	12763750
2007	28014657	22545110	5017747	701481	349208	3640554	12836120
2008	28635696	23098880	5176798	715774	3888273	368655	12949380
2009	28879635	23211769	5310622	714720	3929037	388150	12869240
2010	28157323	22697107	5415126	688651	339676	3840124	12413530
2011	29186650	23569312	5715561	714489	403853	4107373	12628036
2012	29774237	23874234	5950025	711841	416231	4144889	12651248
2013	30259517	24389488	6140240	733474	432018	4276401	12807355

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2001—2014*.

Table 1-3 R&D personnel in selected countries/regions

Country/Region	Year	R&D personnel (10,000 person-years)	R&D personnel per 10,000 employees (10,000 person-years)	Researcher (10,000 person-years)	Researcher per 10,000 employees (10,000 person-years)
China	2013	353.28	45.9	148.40	19.3
Argentina	2012	7.19	41.1	5.16	29.5
Australia	2008	13.75	126.1	9.26	85.0
Austria	2012	6.49	153.4	3.94	93.1
Belgium	2012	6.47	142.1	4.38	96.2
Canada	2012	22.39	125.4	15.66	87.7
Taiwan province	2012	22.80	209.9	13.92	128.2
Czech	2012	6.03	119.1	3.32	65.6
Denmark	2012	5.87	213.5	4.09	149.0
Finland	2012	5.40	213.0	4.05	159.5
France	2012	41.20	152.1	25.91	95.6
Germany	2013	60.46	143.0	36.09	85.4
Greece	2013	4.21	108.5	2.77	71.4
Hungary	2013	3.82	93.3	2.50	61.2
Iceland	2011	0.32	193.8	0.23	134.9
Ireland	2012	2.25	122.4	1.57	85.6
Israel	2012	7.73	211.4	6.37	174.4
Italy	2013	25.26	104.0	11.80	48.5
Japan	2013	86.55	133.5	66.05	101.9
Korea	2012	39.60	160.4	31.56	127.9
Luxembourg	2013	0.50	129.4	0.26	67.6
Mexico	2011	—	—	4.61	9.8
Netherlands	2013	12.15	139.7	7.23	83.1
New Zealand	2011	2.36	106.6	1.63	73.6
Norway	2012	3.90	145.0	2.78	103.5
Poland	2013	9.38	60.6	7.15	46.2
Portugal	2013	4.79	107.7	4.33	97.4
Romania	2013	3.32	36.1	1.87	20.4
Russia	2013	82.67	115.8	44.06	61.7
Singapore	2012	3.95	117.5	3.41	101.7
Slovakia	2013	1.72	78.3	1.47	67.2
Slovenia	2013	1.52	164.8	0.87	94.2
South Africa	2012	3.51	24.3	2.14	14.8
Spain	2013	20.36	113.4	12.36	68.9
Sweden	2013	8.13	173.9	6.23	133.3
Switzerland	2012	7.55	158.0	3.59	75.3
Turkey	2013	11.30	44.3	8.91	34.9
UK	2013	36.21	120.9	25.93	86.6

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; OECD, *Main Science and Technology Indicators 2014-2*.

Table 1-4 R&D personnel in selected countries/regions, by performance sectors

10,000 person-years

Country/Region	Year	R&D personnel				
		Total	Enterprise	Higher education institution	Research institution	Others
China	2013	353.28	274.06	32.49	36.37	10.36
Argentina	2012	7.19	0.88	2.72	3.45	0.14
Austria	2012	6.49	4.46	1.71	0.27	0.04
Belgium	2012	6.47	3.62	2.29	0.52	0.04
Canada	2012	22.39	13.22	7.13	1.91	0.14
Taiwan Province	2012	22.80	16.55	3.61	2.52	0.11
Czech	2012	6.03	3.22	1.64	1.13	0.03
Denmark	2012	5.87	3.68	2.00	0.15	0.03
Finland	2012	5.40	3.10	1.61	0.64	0.05
France	2012	41.20	24.67	10.92	4.99	0.62
Germany	2013	60.46	37.50	13.18	9.78	—
Greece	2013	4.21	0.70	2.28	1.19	0.04
Hungary	2013	3.82	2.22	0.82	0.78	—
Iceland	2011	0.32	0.15	0.11	0.06	0.01
Ireland	2012	2.25	1.53	0.63	0.09	—
Israel	2012	7.73	6.47	1.11	0.09	0.06
Italy	2013	25.26	13.34	7.53	3.81	0.58
Japan	2013	86.55	58.39	20.78	6.15	1.24
Korea	2012	39.60	28.15	7.71	3.30	0.44
Luxembourg	2013	0.50	0.29	0.10	0.11	—
Netherlands	2013	12.15	7.71	3.23	1.21	—
New Zealand	2011	2.36	0.88	1.15	0.33	—
Norway	2012	3.90	1.94	1.29	0.68	—
Poland	2013	9.38	3.02	4.14	2.19	0.02
Portugal	2013	4.79	1.58	2.45	0.21	0.54
Romania	2013	3.32	1.05	1.02	1.23	0.01
Russia	2013	82.67	42.41	11.90	28.21	0.16
Singapore	2012	3.95	2.02	1.63	0.30	—
Slovakia	2013	1.72	0.36	1.00	0.35	—
Slovenia	2013	1.52	0.98	0.28	0.26	—
South Africa	2012	3.51	1.13	1.56	0.73	0.08
Spain	2013	20.36	8.89	7.49	3.93	0.04
Sweden	2013	8.13	5.64	2.13	0.32	0.03
Switzerland	2012	7.55	4.78	2.69	0.08	—
Turkey	2013	11.30	5.84	4.26	1.20	—
UK	2013	36.21	16.57	17.35	1.69	0.60

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; OECD, *Main Science and Technology Indicators 2014-2*.

Table 1-5 Undergraduates and postgraduates in regular higher education institutions (2001—2013)

person

Type \ Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Undergraduate													
Total graduates	567839	655763	929598	1196290	1465786	1726674	1995944	2256783	2455359	2587737	2796229	3038473	3199716
#Science	63517	72526	103409	134164	163076	194807	228090	251610	264494	268658	279101	294060	248790
Engineering	219563	252024	351537	442463	517225	575634	633744	704604	763635	813012	884542	964583	1058768
Agricultural	19005	22462	29758	34078	35419	36740	43270	45649	46847	48442	51148	53789	58752
Medicine	41468	47320	55927	81098	96011	107210	122815	139105	152392	162401	168582	178085	192344
Sub-total	343553	394332	540631	691803	811731	914391	1027919	1140968	1227368	1292513	1383373	1490517	1558654
Total Entrants	1381835	1587939	1825262	2099151	2363647	2530854	2820971	2970601	3261081	3512563	3566411	3740574	3814331
#Science	165609	191997	220157	247995	268061	279708	1462	312069	332874	344921	341487	344671	277254
Engineering	498984	543447	595398	669745	739668	798106	1194782	943738	1023678	1108832	1134270	1195234	1274915
Agricultural	37133	37513	41637	44379	45674	47312	49802	53332	58940	62322	60835	63974	68658
Medicine	97512	105815	119270	131218	147726	155242	192273	175221	202892	219549	217290	228294	238919
Sub-total	799238	878772	976462	1093337	1201129	1280368	1438319	1484360	1618384	1735624	1753882	1832173	1859746
Total Enrollments	4243744	5270845	6292089	7378436	8488188	9433395	10243030	11042207	11798511	12656132	134%577	14270888	14944353
#Science	480290	600480	723579	845784	959757	1041387	1100855	1152206	1201046	1251280	1287275	1314644	1076027
Engineering	1573665	1886996	2156584	2424903	2699776	2958802	3205516	3475740	3718959	3995779	4275808	4522917	4953334
Agricultural	126579	140868	151756	164514	174783	188067	197269	204809	213986	226030	235342	244261	259837
Medicine	361084	424401	496136	558369	627249	688777	736800	778706	830050	883847	942912	1006410	1064363
Sub-total	2541618	3052745	3528055	3993570	4461565	4877033	5240440	5611461	5964041	6356936	6741337	7088232	7353561
Postgraduate													
Total graduates	67809	80841	111091	150777	189728	255902	311839	344825	371273	383600	429994	486455	513626
#Science	8637	9866	13220	17540	22028	29137	35266	39444	41822	43654	47731	50266	49992
Engineering	24873	30078	41337	56074	72941	94516	114621	123226	130514	128678	145303	168434	176436
Agricultural	2136	2790	3849	5165	6038	8853	11297	12879	13425	14079	12845	16313	17464
Medicine	6992	8677	12207	16128	19405	26415	32453	37402	34629	35582	49039	56001	58550
Sub-total	42638	51411	70613	94907	120412	158921	193637	212951	220390	221993	254918	291014	302442
Total Entrants	165197	202611	268925	326286	364831	397925	418612	446422	510953	538177	560168	589673	611381
#Science	21286	26240	33969	41067	45193	47749	51389	55526	59279	58388	57688	58124	60202
Engineering	62958	79486	103212	120750	131345	144841	146318	155484	158703	153704	195082	209244	217338
Agricultural	5687	6521	9693	12110	13864	14841	15733	13259	14800	14874	20063	21080	23388
Medicine	16800	19815	26501	33012	38340	42200	44161	47412	44713	40067	60831	64868	66525
Sub-total	106731	132062	173375	206939	228742	249631	257601	271681	277495	267033	333664	353316	367453
Total Enrollments	393256	500980	651260	819896	978610	1104653	1195047	1283046	1404942	1538416	1645845	1719818	1793953
#Science	49614	63940	82125	102381	120510	134729	146146	157404	168908	177570	181072	180330	183997
Engineering	154508	197278	255754	318063	369738	412273	436352	461951	474170	490374	587587	616173	648218
Agricultural	13112	16475	22105	28930	36061	41442	45285	44914	45325	45273	56119	58893	63778
Medicine	38837	50000	63939	81859	100343	115901	128471	140030	128205	128916	181129	188666	196621
Sub-total	256071	327693	423923	531233	626652	704345	756254	804299	816608	842133	1005907	1044062	1092614

Source: Department of Development Planning of the Ministry of Education, *China Statistical Yearbook on Education 2002—2014*.

Table 1-6 Overseas Chinese students and returnes (1990—2013)

10,000 persons

Year	Overseas Chinese students	Returnes
1990	0.30	0.16
1991	0.29	0.21
1992	0.65	0.36
1993	1.07	0.51
1994	1.91	0.42
1995	2.04	0.58
1996	2.09	0.66
1997	2.24	0.71
1998	1.76	0.74
1999	2.37	0.77
2000	3.90	0.91
2001	8.40	1.22
2002	12.52	1.79
2003	11.73	2.02
2004	11.47	2.47
2005	11.85	3.50
2006	13.40	4.20
2007	14.40	4.40
2008	17.98	6.93
2009	22.93	10.83
2010	28.47	13.48
2011	33.97	18.62
2012	39.96	27.29
2013	41.39	35.35

Source: National Bureau of Statistics, *China Statistical Yearbook 1991—2014.*

Table 2-1 Input of R&D expenditure (2000—2013)

Year	R&D expenditure (100 million yuan)	GDP (100 million yuan)	Ratio (%)	Growth rate of R&D expenditure (%)
2000	895.7	99776.3	0.90	—
2001	1042.5	110270.4	0.95	14.05
2002	1287.6	121002.0	1.06	22.78
2003	1539.6	136564.6	1.13	16.57
2004	1966.3	160714.4	1.22	19.47
2005	2450.0	185895.8	1.32	19.90
2006	3003.1	217656.6	1.38	17.96
2007	3710.2	268019.4	1.38	14.54
2008	4616.0	316751.7	1.46	15.42
2009	5802.1	345629.2	1.68	25.81
2010	7062.6	408903.0	1.73	13.80
2011	8687.0	484123.5	1.79	13.76
2012	10298.4	534123.0	1.93	15.67
2013	11846.6	588018.8	2.01	12.51

Note: Calculated based on comparable price.
Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 2-2 R&D expenditure, by activities and performence sectors (2000—2013)

100 million yuan

Year	R&D expenditure	By types of activities			By performence sectors			
		Basic research	Applied research	Experimental development	Research institution	Enterprise	Higher education institution	Others
2000	895.7	46.7	151.9	697.0	258.0	537.0	76.7	24.0
2001	1042.5	55.6	184.9	802.0	288.5	630.0	102.4	21.6
2002	1287.6	73.8	246.7	967.2	351.3	787.8	130.5	18.0
2003	1539.6	87.7	311.4	1140.5	399.0	960.2	162.3	18.1
2004	1966.3	117.2	400.5	1448.7	431.7	1314.0	200.9	19.7
2005	2450.0	131.2	433.5	1885.2	513.1	1673.8	242.3	20.8
2006	3003.1	155.8	489.0	2358.4	567.3	2134.5	276.8	24.5
2007	3710.2	174.5	492.9	3042.8	687.9	2681.9	314.7	25.7
2008	4616.0	220.8	574.8	3820.4	811.3	3381.7	390.2	32.9
2009	5802.1	270.3	730.8	4801.3	995.9	4248.6	468.2	89.4
2010	7062.6	324.5	893.8	5844.3	1186.4	5185.5	597.3	93.4
2011	8687.0	411.8	1028.4	7246.8	1306.7	6579.3	688.9	112.1
2012	10298.4	498.8	1162.0	8637.6	1548.9	7842.2	780.6	126.7
2013	11846.6	555.0	1269.1	10022.5	1781.4	9075.8	856.7	132.6

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 2-3 Structure of R&D expenditure within performance sectors (2013)

100 million yuan

Expenditure on R&D		Total	Enterprise	Research institution	Higher education institution	Other organizations
		11846.6	9075.8	1781.4	856.7	132.6
By types of activities	Basic research	555.0	8.6	221.6	307.6	17.1
	Applied research	1269.1	249.2	525.8	441.3	52.8
	Experimental development	10022.5	8818.0	1034.0	107.8	62.7
By purposes of spending	Labor remunerations	3157.4	2631.6	344.5	125.6	55.7
	Other routine expenses	7016.4	5398.4	1000.6	568	49.4
	Instrument and equipment procurement fees	1411.2	998.4	258.6	133.4	20.8
	Other capital expenses	261.6	47.4	177.7	29.7	6.7
By sources of funds	Government funds	2500.6	409.0	1481.2	516.9	93.5
	Enterprise funds	8837.7	8461.0	60.9	289.3	26.5
	Overseas funds	105.9	94.3	5.7	5.5	0.4
	Other funds	402.5	111.5	233.5	45.0	12.3

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

Table 2-4 Fiscal expenditure on science and technology of central and local total governments and their shares in central and local fiscal expenditure (2000—2013)

Year	A. National fiscal expenditure (100 million yuan)			B. National fiscal expenditure on science and technology (100 million yuan)			B/A (%)		
	Nationwide	Central	Local	Nationwide	Central	Local	Nationwide	Central	Local
2000	15886.5	5519.9	10366.7	575.6	349.6	226.0	3.62	6.33	2.18
2001	18902.6	5768.0	13134.6	703.3	444.3	258.9	3.72	7.70	1.97
2002	22053.2	6771.7	15281.5	816.2	511.2	305.0	3.70	7.55	2.00
2003	24650.0	7420.1	17229.9	944.6	609.9	335.6	3.83	8.21	1.95
2004	28486.9	7894.1	20592.8	1095.3	692.4	402.9	3.84	8.77	1.96
2005	33930.3	8776.0	25154.3	1334.9	807.8	527.1	3.93	9.20	2.10
2006	40422.7	9991.4	30431.3	1688.5	1009.7	678.8	4.18	10.11	2.23
2007	49781.4	11442.1	38339.3	2135.7	1044.1	1091.6	4.29	9.13	2.85
2008	62592.7	13344.2	49248.5	2611.0	1287.2	1323.8	4.17	9.65	2.69
2009	76299.9	15255.8	61044.1	3276.8	1653.3	1623.5	4.29	10.84	2.66
2010	89874.2	15989.7	73884.4	4196.7	2052.5	2144.2	4.67	12.84	2.90
2011	109247.8	16514.1	92733.7	4797.0	2343.3	2453.7	4.39	14.19	2.65
2012	125953.0	18764.6	107188.3	5600.1	2613.6	2986.5	4.45	13.93	2.79
2013	140212.1	20471.8	119740.3	6184.9	2728.5	3456.4	4.41	13.33	2.89

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 2-5 R&D expenditure in certain countries/regions (2004—2013)

100 million dollars

Country/Region \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	237.6	299.0	376.6	487.7	664.3	849.3	1043.2	1344.4	1631.4	1912.0
Australia	117.4	—	164.0	—	237.4	—	283.6	326.6	—	—
Austria	65.2	74.3	79.3	94.0	110.6	103.9	106.8	115.1	114.5	120.5
Belgium	67.1	69.0	74.3	87.0	99.8	95.9	99.2	113.6	111.9	119.7
Canada	205.1	231.3	256.3	279.6	288.2	263.6	296.6	318.2	313.3	298.6
Czech	13.7	15.9	19.1	24.6	29.2	26.7	27.7	35.5	37.0	39.8
Denmark	60.8	63.3	68.0	80.3	98.0	98.1	93.9	101.3	97.4	102.7
Estonia	1.0	1.3	1.9	2.4	3.0	2.7	3.1	5.3	4.9	4.3
Finland	65.2	68.1	72.3	85.4	100.6	94.3	92.3	99.6	87.8	88.7
France	443.2	450.5	475.5	537.9	601.6	595.1	575.7	627.1	598.0	626.2
Germany	682.5	693.2	737.4	841.5	974.6	931.0	926.4	1049.6	1016.5	1095.1
Greece	12.7	14.3	15.3	18.4	23.5	20.6	17.9	19.3	17.2	18.9
Hungary	9.0	10.4	11.3	13.4	15.5	14.8	14.9	16.7	16.2	18.8
Iceland	—	4.5	5.0	5.5	4.5	3.4	—	3.7	—	3.1
Ireland	22.9	25.2	27.8	33.3	38.2	38.0	35.4	36.5	35.0	—
Israel	52.5	57.7	63.8	79.1	93.8	85.7	92.1	106.0	109.2	122.4
Italy	189.4	194.0	211.1	249.5	278.2	266.8	259.9	275.4	263.4	268.2
Japan	1458.8	1512.7	1485.3	1507.9	1681.2	1690.5	1788.2	1998.0	1990.7	1709.1
Korea	193.7	235.9	286.4	336.8	313.0	297.0	379.3	450.2	492.2	541.6
Luxembourg	5.6	5.9	7.1	8.1	9.1	8.6	7.8	8.3	6.5	6.9
Mexico	30.4	35.0	36.0	38.4	44.5	38.5	47.7	49.8	—	63.1
Netherlands	117.6	121.5	127.6	141.5	153.8	144.6	144.3	168.8	162.0	169.2
New Zealand	—	12.9	—	15.9	—	15.2	—	20.7	—	22.0
Norway	40.8	45.8	50.3	62.7	71.9	66.6	70.7	81.1	82.6	86.8
Poland	14.1	17.2	19.0	24.1	32.0	29.1	34.5	39.4	44.1	45.6
Portugal	13.8	14.9	19.9	27.0	37.9	38.5	36.5	35.7	29.8	30.8
Slovakia	2.2	2.4	2.7	3.4	4.5	4.2	5.5	6.5	7.5	8.1
Slovenia	4.7	5.1	6.1	6.9	9.0	9.1	9.9	12.4	11.9	12.4
Spain	111.1	126.8	148.2	182.6	215.3	202.6	193.2	197.2	172.1	173.3
Sweden	129.4	131.9	147.0	158.9	179.6	146.8	157.1	181.5	178.5	191.3
Switzerland	105.3	—	—	—	150.5	—	—	—	197.4	—
Turkey	20.3	28.5	30.8	46.7	53.0	52.2	61.7	66.6	72.7	77.8
UK	370.7	394.2	426.9	500.2	471.4	402.9	407.3	438.7	426.6	435.3
US	3056.4	3281.3	3533.3	3803.2	4072.4	4060.0	4096.0	4291.4	4535.4	4569.8
Argentina	6.7	8.4	10.6	13.3	17.2	18.4	22.9	29.0	35.3	36.5
Romania	2.9	4.1	5.6	8.9	11.8	7.7	7.6	9.1	8.3	7.4
Russia	68.0	81.6	106.2	145.1	173.4	153.1	172.3	207.8	226.9	235.5
Singapore	24.0	27.5	31.5	42.1	50.4	41.5	47.6	59.2	58.0	—
South Africa	18.6	22.2	24.4	26.4	25.5	24.7	27.7	30.6	29.1	—
Taiwan province	78.8	87.4	94.4	100.9	111.5	111.1	124.8	140.3	145.6	152.8

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; OECD, *Main Science and Technology Indicators 2014-2*.

Table 2-6 GDP of certain countries (2004—2013)

100 million dollars

Country \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	19417	22686	27298	35231	45585	50594	60397	74925	84616	94907
Australia	6783	7621	8186	9861	10553	10106	12914	15349	15748	15288
Austria	2999	3146	3343	3864	4276	3976	3897	4291	4076	4283
Belgium	3705	3869	4107	4723	5201	4858	4844	5282	4989	5248
Canada	10184	11642	13108	14579	15426	13708	16141	17887	18327	18390
Czech	1190	1360	1552	1888	2352	2057	2070	2273	2068	2088
Denmark	2512	2646	2830	3195	3526	3198	3198	3415	3223	3359
Estonia	121	140	170	222	242	197	195	228	227	249
Finland	1968	2044	2165	2554	2838	2515	2478	2737	2558	2673
France	21242	22036	23249	26630	29236	26937	26468	28627	26867	28064
Germany	28156	28576	29985	34355	37471	34128	34120	37521	35332	37303
Greece	2397	2477	2733	3187	3546	3298	2996	2888	2495	2422
Hungary	1032	1119	1142	1386	1566	1294	1296	1394	1268	1334
Iceland	137	168	171	214	176	128	133	147	142	153
Ireland	1930	2104	2305	2693	2737	2335	2184	2378	2220	2321
Israel	1340	1412	1522	1767	2139	2065	2329	2584	2572	2906
Italy	17992	18535	19434	22040	23920	21861	21266	22782	20918	21495
Japan	46558	45719	43568	43563	48492	50351	54954	59056	59378	48985
Korea	7649	8981	10118	11227	10022	9019	10945	12025	12228	13046
Luxembourg	342	370	418	492	550	501	521	590	563	601
Mexico	7700	8648	9653	10431	11013	8934	10499	11679	11816	12566
Netherlands	6461	6724	7194	8331	9313	8580	8364	8938	8231	8535
New Zealand	1015	1138	1102	1353	1305	1190	1435	1638	1715	1858
Norway	2644	3087	3454	4009	4619	3864	4285	4982	5097	5223
Poland	2535	3044	3433	4288	5302	4365	4767	5244	4962	5259
Portugal	1892	1973	2086	2402	2620	2437	2383	2449	2180	2273
Slovakia	431	489	570	767	961	886	890	975	927	977
Slovenia	345	363	396	481	556	502	480	513	463	480
Spain	10696	11572	12645	14793	16350	14990	14316	14946	13557	13930
Sweden	3817	3890	4200	4878	5140	4297	4884	5631	5439	5795
Switzerland	3935	4075	4292	4774	5516	5395	5812	6963	6661	6854
Turkey	3922	4830	5309	6471	7303	6146	7311	7748	7889	8221
UK	22981	24121	25828	29633	27919	23089	24079	25918	26149	26785
US	122749	130937	138559	144776	147186	144187	149644	155179	161632	167681
Argentina	1833	2229	2647	3319	4083	3805	4646	5604	6050	6121
Romania	762	997	1235	1715	2082	1674	1680	1854	1720	1921
Russia	5909	7640	9899	12997	16608	12226	15249	19048	20175	20968
Singapore	1142	1274	1478	1800	1922	1924	2364	2741	2869	2979
South Africa	2191	2471	2610	2862	2731	2842	3652	4039	3823	3506

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; OECD, *Main Science and Technology Indicators 2014-2*.

Table 2-7 Ratio of R&D expenditure (regional) to GDP (regional) in certain countries/regions (2004—2013)

%

Country/Region \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
China	1.22	1.32	1.38	1.38	1.46	1.68	1.73	1.79	1.93	2.01
Australia	1.73	—	2.00	—	2.25	—	2.20	2.13	—	—
Austria	2.17	2.38	2.37	2.43	2.59	2.61	2.74	2.68	2.81	2.81
Belgium	1.81	1.78	1.81	1.84	1.92	1.97	2.05	2.15	2.24	2.28
Canada	2.01	1.99	1.96	1.92	1.87	1.92	1.84	1.78	1.71	1.62
Czech	1.15	1.17	1.23	1.31	1.24	1.30	1.34	1.56	1.79	1.91
Denmark	2.42	2.39	2.40	2.51	2.78	3.07	2.94	2.97	3.02	3.06
Estonia	0.85	0.92	1.12	1.07	1.26	1.40	1.58	2.34	2.16	1.74
Finland	3.31	3.33	3.34	3.35	3.55	3.75	3.73	3.64	3.43	3.32
France	2.09	2.04	2.05	2.02	2.06	2.21	2.18	2.19	2.23	2.23
Germany	2.42	2.43	2.46	2.45	2.60	2.73	2.72	2.80	2.88	2.94
Greece	0.53	0.58	0.56	0.58	0.66	0.63	0.60	0.67	0.69	0.78
Hungary	0.87	0.93	0.99	0.97	0.99	1.14	1.15	1.20	1.27	1.41
Iceland	—	2.69	2.91	2.56	2.53	2.66	—	2.49	—	1.99
Ireland	1.18	1.20	1.21	1.24	1.39	1.63	1.62	1.53	1.58	—
Israel	3.92	4.09	4.19	4.48	4.39	4.15	3.96	4.10	4.25	4.21
Italy	1.05	1.05	1.09	1.13	1.16	1.22	1.22	1.21	1.26	1.25
Japan	3.13	3.31	3.41	3.46	3.47	3.36	3.25	3.38	3.35	3.49
Korea	2.53	2.63	2.83	3.00	3.12	3.29	3.47	3.74	4.03	4.15
Luxembourg	1.62	1.59	1.69	1.65	1.65	1.72	1.50	1.41	1.16	1.16
Mexico	0.39	0.40	0.37	0.37	0.40	0.43	0.45	0.43	—	0.50
Netherlands	1.82	1.81	1.77	1.70	1.65	1.69	1.72	1.89	1.97	1.98
New Zealand	—	1.13	—	1.17	—	1.28	—	1.27	—	1.17
Norway	1.55	1.48	1.46	1.56	1.56	1.72	1.65	1.63	1.62	1.66
Poland	0.56	0.57	0.55	0.56	0.60	0.67	0.72	0.75	0.89	0.87
Portugal	0.73	0.76	0.95	1.12	1.45	1.58	1.53	1.46	1.37	1.36
Slovakia	0.50	0.49	0.48	0.45	0.46	0.47	0.62	0.67	0.81	0.83
Slovenia	1.37	1.41	1.53	1.42	1.63	1.82	2.06	2.43	2.58	2.59
Spain	1.04	1.10	1.17	1.23	1.32	1.35	1.35	1.32	1.27	1.24
Sweden	3.39	3.39	3.50	3.26	3.50	3.42	3.22	3.22	3.28	3.30
Switzerland	2.68	—	—	—	2.73	—	—	—	2.96	—
Turkey	0.52	0.59	0.58	0.72	0.73	0.85	0.84	0.86	0.92	0.95
UK	1.61	1.63	1.65	1.69	1.69	1.75	1.69	1.69	1.63	1.63
US	2.49	2.51	2.55	2.63	2.77	2.82	2.74	2.77	2.81	2.73
Argentina	0.37	0.38	0.40	0.40	0.42	0.48	0.49	0.52	0.58	0.58
Romania	0.38	0.41	0.45	0.52	0.57	0.46	0.45	0.49	0.48	0.39
Russia	1.15	1.07	1.07	1.12	1.04	1.25	1.13	1.09	1.12	1.12
Singapore	2.10	2.16	2.13	2.34	2.62	2.16	2.01	2.16	2.02	—
South Africa	0.85	0.90	0.93	0.92	0.93	0.87	0.76	0.76	0.76	—
Taiwan province	2.32	2.39	2.51	2.57	2.78	2.94	2.91	3.01	3.06	3.12

Source: OECD, *Main Science and Technology Indicators 2014-2*.

Table 2-8 R&D funds of certain countries, by sources and performence sectors (2013)

Country/ Region	R&D funds (100 million dollars)	Sources (%)				Implementation organizations (%)			
		Enterprise	Government	Others	Overseas	Enterprise	Higher education institution	Research institution	Others
China	1912.05	74.60	21.11	3.40	0.89	76.61	7.23	16.16	—
Austria	120.48	47.36	36.76	0.43	15.44	68.78	25.59	5.14	0.49
Belgium	119.69	—	—	—	—	69.10	21.68	8.80	0.43
Canada	298.58	46.45	34.86	12.73	5.95	50.52	39.80	9.15	0.52
Czech	39.78	37.60	34.74	0.51	27.15	54.12	27.23	18.31	0.34
Denmark	102.65	59.78	29.27	3.78	7.18	65.43	31.77	2.39	0.40
Estonia	4.33	42.05	47.22	0.38	10.34	47.72	42.30	8.93	1.06
Finland	88.75	60.84	26.03	1.59	11.54	68.86	21.52	8.92	0.71
France	626.16	—	—	—	—	64.75	20.75	13.15	1.35
Germany	1095.15	65.21	29.78	0.35	4.37	66.91	18.00	15.09	—
Greece	18.94	30.28	52.27	3.46	13.98	33.34	37.43	27.98	1.25
Hungary	18.78	46.80	35.88	0.75	16.57	69.43	14.39	14.89	—
Iceland	3.06	38.77	36.57	5.37	19.28	53.40	32.65	12.65	1.30
Israel	122.42	—	—	—	—	82.74	14.07	2.13	1.05
Italy	268.25	—	—	—	—	53.98	28.21	14.92	2.88
Japan	1709.10	75.48	17.30	6.70	0.52	76.09	13.47	9.17	1.28
Korea	541.63	75.68	22.83	1.18	0.30	78.51	9.24	10.91	1.33
Luxembourg	6.95	20.46	—	1.63	—	61.38	15.32	23.30	—
Mexico	63.09	22.16	75.49	1.94	0.41	—	—	—	—
Netherlands	169.19	51.13	33.34	3.35	12.17	55.67	32.09	12.23	—
New Zealand	22.02	39.78	39.78	13.18	7.23	46.41	30.43	23.17	—
Norway	86.77	43.14	45.84	1.55	9.47	52.49	31.53	15.98	—
Poland	45.64	37.33	47.24	2.31	13.12	43.62	29.26	26.83	0.29
Portugal	30.83	—	—	—	—	47.57	37.84	5.79	8.80
Slovakia	8.11	40.19	38.90	2.94	17.97	46.26	33.10	20.48	0.15
Slovenia	12.41	63.85	26.87	0.37	8.91	76.53	10.42	13.01	0.04
Spain	173.30	46.30	41.63	4.71	7.36	53.08	28.03	18.72	0.17
Sweden	191.33	60.95	28.20	4.05	6.80	68.95	27.14	3.68	0.22
Turkey	77.78	48.87	26.55	23.74	0.83	47.49	42.09	10.42	—
UK	435.28	46.55	26.99	5.81	20.65	64.51	26.30	7.31	1.88
US	4569.77	60.85	27.75	6.95	4.45	70.58	14.15	11.17	4.10
Argentina	36.50	20.07	75.50	3.91	0.53	20.75	30.47	47.03	1.75
Romania	7.41	31.02	52.29	1.19	15.50	30.66	19.72	49.23	0.40
Russia	235.51	28.16	67.64	1.16	3.03	60.60	9.01	30.26	0.13
Taiwan province	152.80	75.45	23.45	1.03	0.06	75.50	10.77	13.41	0.32

Source: OECD, *Main Science and Technology Indicators 2014-2*.

Table 2-9 Distribution of R&D expenditure, by types of activities in certain countries

%

Country	Year	Basic research	Applied research	Experimental development
China	2013	4.7	10.7	84.6
Australia	2008	20.1	38.7	41.2
Austria	2011	19.4	35.8	44.8
Czech	2012	30.0	36.3	33.7
Denmark	2012	18.3	27.6	54.1
France	2012	25.0	38.7	36.3
Italy	2012	25.3	48.9	25.8
Japan	2013	13.2	21.9	64.9
Korea	2013	18.0	19.1	62.9
UK	2012	15.5	47.0	37.5
US	2012	16.5	19.2	64.3
Russia	2013	16.4	19.1	64.5

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*; OECD, *R&D Statistics 2015*.

Table 2-10 Distribution of R&D expenditure, by purposes of spending in certain countries

%

Country	Year	Labor remunerations	Other routine expenses	Instrument and equipment procurement fees	Land and building procurement and construction fees
China	2013	26.65	59.23	11.91	2.21
Japan	2013	38.78	50.03	8.72	2.47
Germany	2011	57.71	32.73	—	—
France	2012	62.83	27.29	5.58	4.29
Spain	2012	60.95	28.70	7.75	2.60
Italy	2012	63.37	28.98	—	—
Russia	2013	55.69	37.66	5.49	1.16
Korea	2013	41.7	48.93	7.54	1.83
Australia	2008	39.06	53.84	3.05	4.04

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; OECD, *R&D Statistics 2015*.

Table 3-1 China's S&T papers included in SCI (2002—2013)

Number

Year	Number of papers	Share in all SCI papers (%)	Ranking
2002	40758	4.18	6
2003	49788	4.48	6
2004	57377	5.43	5
2005	68226	5.25	5
2006	71184	5.87	5
2007	89147	7.03	3
2008	116677	8.12	2
2009	127532	8.84	2
2010	143769	10.12	2
2011	165818	11.08	2
2012	192761	12.08	2
2013	232070	13.47	2

Note: SCI is the acronym for *Science Citation Index*. Data for *2002—2007* include SCI papers with authors from mainland China only, while those for *2008—2013* include SCI papers with authors from both China mainland and Hong Kong and Macao.
Source: Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2004—2013*.

Table 3-2　Distribution of China's S&T papers included in SCI, by discipline and type of organizations (2004—2013)

Number

Category \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total	45351	63150	71351	79669	95506	108806	121530	136445	158615	192697
By discipline										
Basic discipline	29196	39022	44198	50829	57325	66760	74111	71061	85084	101516
Medicine	3809	5515	5641	8472	13055	13960	15501	22102	27987	34823
Farming, forestry, animal husbandry, and fishery	438	1109	1408	1396	2221	2175	3040	4111	4047	4612
Industrial technology	11846	17425	19675	18743	22533	25541	28600	38699	41450	51525
Others	62	79	429	229	372	370	278	472	47	221
By type of organizations										
Higher education institution	34947	49438	57286	64381	78079	89780	100772	113481	131356	161344
Research institution	9924	12632	13406	14284	15924	17169	18941	20685	23739	23734
Enterprise	119	203	134	208	359	359	342	433	633	692
Medical institution	285	458	406	702	1046	1373	1340	1687	2707	3588
Others	76	419	119	94	98	125	135	159	180	3339

Note: When analyzing the distribution of mainland China's S&T papers included in SCI by discipline and type of organizations, we only count SCI papers with the first authors coming from China mainland.

Source: Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2004—2013*.

Table 3-3 Efficiency of SCI papers to R&D funds in China (2000—2011)

Year	Output efficiency of R&D funds (piece per 100 million yuan)	Output efficiency of R&D personnel (piece per 10,000 person-years)
2000	205.20	1362.23
2001	211.31	1633.46
2002	183.82	1731.87
2003	180.05	1949.47
2004	154.86	1828.25
2005	184.74	2161.14
2006	179.97	2215.70
2007	213.17	2565.57
2008	215.16	2741.37
2009	190.91	2843.17
2010	194.47	3114.55
2011	215.45	3529.30

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2001—2012*; Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2002—2013*.

Table 3-4 Three kinds of patent applications and grants (2004—2013)

	Year	Applications				Grants			
		Total	Invention	Utility model	Design	Total	Invention	Utility model	Design
Sub-total	2004	353807	130133	112825	110849	190238	49360	70623	70255
	2005	476264	173327	139566	163371	214003	53305	79349	81349
	2006	573178	210490	161366	201322	268002	57786	107655	102561
	2007	693917	245161	181324	267432	351782	67948	150036	133798
	2008	828328	289838	225586	312904	411982	93706	176675	141601
	2009	976686	314573	310771	351342	581992	128489	203802	249701
	2010	1222286	391177	409836	421273	814825	135110	344472	335243
	2011	1633347	526412	585467	521468	960513	172113	408110	380290
	2012	2050649	652777	740290	657582	1255138	217105	571175	466858
	2013	2377061	825136	892362	659563	1313000	207688	692845	412467
Domestic	2004	278943	65786	111578	101579	151328	18241	70019	63068
	2005	383157	93485	138085	151587	171619	20705	78137	72777
	2006	470342	122318	159997	188027	223860	25077	106312	92471
	2007	586498	153060	179999	253439	301632	31945	148391	121296
	2008	717144	194579	223945	298620	352406	46590	175169	130647
	2009	877611	229096	308861	339654	501786	65391	202113	234282
	2010	1109428	293066	407238	409124	740620	79767	342256	318597
	2011	1504670	415829	581303	507538	883861	112347	405086	366428
	2012	1912151	535313	734437	642401	1163226	143847	566750	452629
	2013	2234560	704936	885226	644398	1228413	143535	686208	398670
Foreign	2004	74864	64347	1247	9270	38910	31119	604	7187
	2005	93107	79842	1481	11784	42384	32600	1212	8572
	2006	102836	88172	1369	13295	44142	32709	1343	10090
	2007	107419	92101	1325	13993	50150	36003	1645	12502
	2008	111184	95259	1641	14284	59576	47116	1506	10954
	2009	99075	85477	1910	11688	80206	63098	1689	15419
	2010	112858	98111	2598	12149	74205	55343	2216	16646
	2011	128677	110583	4164	13930	76652	59766	3024	13862
	2012	138498	117464	5853	15181	91912	73258	4425	14229
	2013	142501	120200	7136	15165	84587	64153	6637	13797

Source: State Intellectual Property Office, *Statistical Yearbook on Patent 2004—2013*.

Table 3-5 Applications of foreign invention patents by country (2004—2013)

Country \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total	64347	79842	88172	92101	95259	85477	98111	110583	117464	120200
Austria	206	260	263	346	379	357	475	598	664	811
Australia	499	546	562	617	609	525	608	621	657	641
Belgium	249	340	413	525	535	486	563	592	595	642
Brazil	50	61	69	80	74	73	117	130	107	115
Canada	555	665	756	817	896	807	940	1033	1111	1037
Switzerland	1455	1776	1932	2366	2337	2362	2644	2665	2924	3212
Germany	5182	6411	7502	8066	8686	8264	9867	11422	12659	13712
Denmark	310	379	438	520	631	584	734	781	732	840
Finland	720	752	898	973	979	902	1089	964	1069	1039
France	2098	2644	2954	2991	3170	3011	3506	3973	4315	4143
UK	1127	1331	1478	1628	1795	1624	1737	1876	1874	1849
Israel	238	220	307	379	440	330	450	532	532	530
India	121	198	172	146	184	122	168	202	248	279
Italy	852	1046	1163	1228	1194	998	1184	1245	1288	1318
Japan	25542	30976	32801	32870	33264	30293	33882	39231	42278	41193
Korea	5858	8131	9187	8467	8022	5907	7178	8129	8985	10866
Netherlands	2789	3735	3503	3481	3261	3089	2998	2999	2629	2546
Norway	148	142	163	218	187	192	235	234	234	237
Russia	54	46	72	66	85	91	111	120	139	152
Sweden	806	1015	1318	1527	1766	1653	1780	1730	1663	1795
UK	14562	18000	20536	22887	24527	21799	25380	28457	29510	29992
Others	438	552	1685	1903	2238	2008	2465	3049	3251	3251

Source: State Intellectual Property Office, *Statistical Yearbook on Patent 2004—2013*.

Table 3-6 Grants of foreign invention patents by country (2004—2013)

Country \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total	31119	32600	32709	36003	47116	63098	55343	59766	73258	64153
Austria	116	145	122	125	155	215	205	239	308	302
Australia	195	266	210	264	272	322	314	280	353	366
Belgium	108	116	126	142	184	229	249	328	461	410
Brazil	18	21	25	28	31	37	37	34	55	54
Canada	227	225	194	253	350	461	440	490	605	570
Switzerland	892	867	820	871	941	1245	1317	1471	1898	1745
Germany	2948	2894	2628	2913	3598	5034	4609	5442	7058	6589
Denmark	198	194	160	190	206	280	257	334	449	431
Finland	380	402	317	338	472	674	539	545	783	606
France	1285	1328	1181	1171	1388	2200	1926	2006	2632	2602
UK	590	638	600	599	698	825	734	857	1226	1047
Israel	95	68	60	105	143	161	125	151	197	243
India	24	38	49	62	82	81	51	58	95	99
Italy	326	388	389	458	512	757	719	793	898	830
Japan	12490	13883	15099	16174	21999	27897	23890	25387	28847	22609
Korea	2248	2509	2752	3127	4675	6476	5168	4882	5320	4271
Netherlands	1157	1179	1129	1214	1449	2128	1712	1817	2091	1862
Norway	82	62	67	77	80	139	97	109	151	153
Russia	33	37	31	24	35	49	46	49	59	41
Sweden	777	690	454	498	582	895	902	1020	1397	1158
US	6538	6160	5870	6891	8661	12158	10985	12334	16776	16674
Others	392	490	426	479	603	815	1021	1140	1599	1491

Source: State Intellectual Property Office, *Statistical Yearbook on Patent 2004—2013*.

Table 3-7 Domestic grants for inventions patents by service and non-service (2004—2013)

Year	Service invention					Non-service invention
		Universitiesand colleges	Scientific Research Institutes	Enterprises	Government agencies and organizations	
2004	12176	3484	2406	6128	158	6065
2005	14761	4453	2423	7712	173	5944
2006	18400	6198	2553	9433	216	6677
2007	24488	8214	3173	12851	250	7457
2008	36956	10266	3945	22493	252	9634
2009	52265	14391	5299	32160	415	13126
2010	66149	19036	6557	40049	507	13618
2011	95069	26616	9238	58364	851	17278
2012	125954	33821	11248	78651	2234	17893
2013	126860	33309	12284	79439	1828	16675

Source: State Intellectual Property Office, *Statistical Yearbook on Patent 2004—2013*.

Table 3-8 PCT applications in major countries (2004—2013)

Year / Country	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
US	43398	46884	51303	54062	51668	45658	45090	49210	51859	57435
Japan	20268	24870	27024	27743	28763	29810	32216	38864	43523	43771
China	1707	2503	3930	5455	6119	7896	12300	16398	18620	21514
Germany	15217	15987	16733	17825	18857	16793	17559	18847	18750	17913
Korea	3555	4689	5946	7064	7902	8040	9604	10357	11787	12381
France	5183	5747	6263	6566	7076	7218	7231	7406	7802	7905
UK	5035	5093	5096	5540	5479	5039	4892	4875	4917	4847
Switzerland	2897	3290	3614	3816	3778	3677	3761	4045	4222	4372
Netherlands	4283	4500	4545	4421	4361	4420	4011	3511	4077	4188
Sweden	2851	2885	3333	3654	4135	3567	3303	3476	3600	3945
Italy	2190	2349	2701	2949	2884	2653	2655	2686	2845	2868
Canada	2107	2318	2573	2844	2906	2509	2688	2914	2737	2845
Finland	1672	1893	1845	1994	2212	2123	2136	2075	2312	2095
Spain	822	1125	1202	1295	1391	1563	1769	1732	1704	1705
Israel	1227	1456	1593	1743	1902	1555	1475	1449	1374	1607
Australia	1835	2004	2000	2050	1938	1736	1769	1748	1710	1604
India	724	679	833	904	1073	960	1276	1323	1309	1320
Denmark	1049	1122	1158	1153	1357	1339	1156	1288	1408	1264
Austria	709	851	914	1009	951	1029	1144	1343	1319	1262
Russia	519	658	696	735	802	736	814	1009	1114	1191
Global total	122631	136750	149643	159933	163241	155404	164341	182437	195334	205264

Source: WIPO Statistics Database, December 2014.

Table 3-9 Triadic patent families in major countries (2003—2012)

Country \ Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Japan	17905	18694	17697	17926	17518	15234	14502	15245	15607	15391
US	16828	17258	17434	15537	13931	13857	13559	12805	13229	13765
Germany	6745	6998	7141	6532	5807	5472	5560	5350	5409	5468
Korea	2194	2570	2749	2348	1982	1828	2104	2453	2660	2878
France	2757	2966	3049	2882	2781	2887	2716	2465	2599	2555
China	356	402	519	562	693	823	1296	1408	1658	1851
UK	2199	2093	2166	2096	1796	1697	1721	1680	1690	1716
Sweden	1041	1099	1084	1149	1008	995	967	1057	1092	1145
Netherlands	1986	1972	1760	1476	1065	1126	1050	818	803	783
Switzerland	757	804	969	885	962	837	797	636	669	700
Italy	899	972	965	823	728	758	736	698	687	696
Canada	672	736	714	666	679	687	678	549	549	556
Belgium	463	566	542	477	429	455	478	476	493	490
Austria	346	353	408	354	377	342	367	390	420	456
Israel	362	419	501	421	350	367	375	351	368	391
Denmark	312	370	390	316	316	344	257	297	304	311
Australia	495	523	481	364	346	316	351	302	298	294
Finland	350	396	390	294	259	253	224	225	233	244
Spain	207	292	293	268	257	267	254	232	248	244
Norway	126	135	141	123	105	88	129	114	115	119

Source: OECD, *Main Science and Technology Indicators 2014-2*.

Table 4-1 **Personnel engaged in R&D activities in above-scale industrial enterprises (2013)**

Category	R&D personnel (person)	Female	Researcher	Full-time personnel	Full-time equivalent of R&D personnel (person-year)	Researcher
Total	3375912	698435	1095573	2233774	2493958	814984
By status of registration						
Domestic funded enterprise	2564162	526153	916430	1671775	1865328	677370
Enterprise with funds from Hong Kong, Macao and Taiwan province	352698	78973	76234	244680	274173	58294
Foreign funded enterprise	459052	93309	102909	317319	354457	79320
By region						
Beijing	79368	21304	25229	66790	58036	18766
Tianjin	93313	20165	28545	55185	68175	20475
Hebei	94021	23446	41213	57922	65049	27411
Shanxi	46544	8958	24387	27736	34024	17236
Inner Mongolia	32210	8299	16264	18479	26990	14371
Liaoning	95912	19909	42248	57939	59090	25738
Jilin	32841	9185	15416	15729	23709	11473
Heilongjiang	51198	11992	29841	33317	37296	21879
Shanghai	116806	25798	35019	82873	92136	27777
Jiangsu	510930	103785	128010	339701	393942	99469
Zhejiang	337155	70337	71441	219898	263507	56443
Anhui	127627	22017	38477	78412	86000	26120
Fujian	130227	30679	31396	87313	100200	23922
Jiangxi	46599	9468	17735	27378	29519	11287
Shandong	326793	73472	109583	229530	227403	78442
Henan	168212	31757	61833	104983	125091	46472
Hubei	128952	28257	48938	86389	85826	33747
Hunan	99002	18072	41541	66537	73558	29786
Guangdong	530551	92562	158230	376921	426330	135809
Guangxi	30205	5757	9725	17134	20700	7005
Hainan	4678	1497	988	3116	2882	549
Chongqing	53781	11309	19217	37936	36605	13544
Sichuan	92424	16291	34438	56924	58148	20954
Guizhou	20026	5249	7579	12095	16049	6327
Yunnan	20323	3602	7745	9751	11811	4426
Tibet	228	45	68	74	81	18
Shannxi	67210	17037	31811	41025	45809	22801
Gansu	17565	3270	9739	11470	12472	6807

continued from table 4-1

Category	R&D personnel (person)	Female	Researcher	Full-time personnel	Full-time equivalent of R&D personnel (person-year)	Researcher
Qinghai	2940	530	1257	1100	2039	831
Ningxia	8638	2006	2749	4180	4817	1566
Xinjiang	9633	2380	4911	5937	6668	3533

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology*; National Bureau of Statistics and National Development and Reform Commission, *Statistics Yearbook on Science and Technology Activities of Industrial Enterprises 2014*.

Table 4-2 R&D expenditure, input intensity of R&D expenditure, and labor productivity of industrial enterprises among industries (2013)

Industry	R&D expenditure (10,000 yuan)	Input intensity of R&D expenditure (%)	Labor productivity (10,000 yuan/ person)
Total	83184005	0.80	106.1
Mining	2926383	0.43	82.4
Mining and washing of coal	1565542	0.48	62.2
Extraction of petroleum and natural gas	806879	0.70	149.5
Mining and processing of ferrous metal ores	77399	0.08	138.7
Mining and processing of non-ferrous metal ores	217517	0.35	111.9
Mining and processing of non-metal ores	71520	0.15	91.0
Manufacture	79598052	0.88	105.6
Processing of food from agricultural products	920658	0.29	143.8
Manufacture of foods	626131	0.53	92.3
Manufacture of liquor, beverages and refined tea	693436	0.54	97.1
Manufacture of tobacco	159702	0.27	418.3
Textile	1360233	0.44	74.2
Manufacture of textile, wearing apparel and accessories	289534	0.36	42.7
Manufacture of leather, fur, feather and related products and footwear	154417	0.27	42.6
Processing of timber, manufacture of wood, bamboo, rattan, palm and straw products	144700	0.23	87.0
Manufacture of furniture	90341	0.34	57.3
Manufacture of paper and paper products	558877	0.68	91.9
Printing and reproduction of recording media	190130	0.51	65.2
Manufacture of articles for culture, education, arts and crafts, sport and entertainment activities	136993	0.38	58.0
Processing of petroleum, coking and processing of nuclear fuel	625447	0.22	433.6
Manufacture of raw chemical materials and chemical products	4699215	0.86	154.9
Manufacture of medicines	2112462	1.70	98.2
Manufacture of chemical fibers	587560	0.95	145.4
Manufacture of rubber and plastic products	631281	0.72	83.2
Manufacture of non-metallic mineral products	726377	0.41	91.4
Smelting and pressing of ferrous metals	1397206	0.83	182.9
Smelting and pressing of non-ferrous metals	5126475	0.64	230.3
Manufacture of metal products	1901947	0.69	89.3
Manufacture of general purpose machinery	1112914	1.26	91.5
Manufacture of special purpose machinery	4066679	1.57	92.9
Manufacture of automobiles	3656608	1.14	140.1

continued from table 4-2

Industry	R&D expenditure (10,000 yuan)	Input intensity of R&D expenditure (%)	Labor productivity (10,000 yuan/ person)
Manufacture of railways, ships, aircrafts and spacecraft and other transport equipment	7852546	2.27	87.3
Manufacture of electrical machinery and apparatus	6240088	1.32	98.8
Manufacture of computers, communication and other electronic equipment	9410520	1.59	89.5
Manufacture of instruments and meters	1208653	1.97	72.4
Other manufacture	242662	0.62	56.4
Comprehensive utilization of waste resources	29273	0.28	194.3
Repair service of metal products, machinery and equipment	45747	0.85	54.3
Production and supply of electric power, gas and water	659570	0.11	172.3
Production and supply of electric power and heat power	584488	0.10	190.7
Production and supply of gas	35789	0.09	169.7
Production and supply of water	39293	0.26	37.9

Note: 1. Input intensity of R&D expenditure refers to the proportion of R&D expenditure to main business revenue; 2. Labor productivity refers to the proportion of main business revenue to number of employees at year-end.

Source: National Bureau of Statistics and National Development and Reform Commission, *Statistics Yearbook on Science and Technology Activities of Industrial Enterprises 2014*.

Table 4-3 Structure of source of funds of industrial enterprises among industries (2013)

10,000 yuan

Industry	Government funds	Enterprise funds	Overseas funds	Other funds
Total	3597485	78217423	475736	893361
Mining	102302	2618624	8	17923
Mining and washing of coal	21169	1530073	—	14299
Extraction of petroleum and natural gas	67790	738121	8	960
Mining and processing of ferrous metal ores	2580	74802	—	18
Mining and processing of non-ferrous metal ores	8034	207165	—	2319
Mining and processing of non-metal ores	2730	68463	—	328
Manufacture	3463277	74697528	475527	865955
Processing of food from agricultural products	58010	1645980	1260	24577
Manufacture of foods	30999	916722	2115	35466
Manufacture of liquor, beverages and refined tea	28259	788620	4575	5976
Manufacture of tobacco	438	207216	—	13402
Textile	36192	1524587	2144	21954
Manufacture of textile, wearing apparel and accessories	8902	673683	901	9385
Manufacture of leather, fur, feather and related products and footwear	3566	324797	1260	9300
Processing of timber, manufacture of wood, bamboo, rattan, palm and straw products	9562.8	256991	280	4748
Manufacture of furniture	1421	219859	864	2506
Manufacture of paper and paper products	10163	865040	—	2714
Printing and reproduction of recording media	2844	296500	116	4429
Manufacture of articles for culture, education, arts and crafts, sport and entertainment activities	12030	478568	1332	3950
Processing of petroleum, coking and processing of nuclear fuel	20356	862975	5457	4407
Manufacture of raw chemical materials and chemical products	175158	6302923	51351	74296
Manufacture of medicines	204243	3223942	11818	36550
Manufacture of chemical fibers	10362	651238	495	5802
Manufacture of rubber and plastic products	38167	1924219	3189	29002
Manufacture of non-metallic mineral products	72631	2048797	3321	25580
Smelting and pressing of ferrous metals	43287	6270718	3242	13127
Smelting and pressing of non-ferrous metals	96386	2850507	5178	59010
Manufacture of metal products	104177	2161644	3298	31047

continued from table 4-3

Industry	Government funds	Enterprise funds	Overseas funds	Other funds
Manufacture of general purpose machinery	279486	5084825	33781	80840
Manufacture of special purpose machinery	254489	4795848	17858	54969
Manufacture of automobiles	212692	6453359	99642	36544
Manufacture of railways, ships, aircrafts and spacecraft and other transport equipment	818017	2800024	26013	76879
Manufacture of electrical machinery and apparatus	241941	7793616	62398	55941
Manufacture of computers, communication and other electronic equipment	568565	11721311	116351	118781
Manufacture of instruments and meters	102897	1356354	17288	16351
Other manufacture	15750	121570	—	7942
Repair service of metal products, machinery and equipment	2287	75099	—	481
Production and supply of electric power, gas and water	13030	639063	202	7276
Production and supply of electric power and heat power	9153	568773	202	6360
Production and supply of gas	633	34667	—	489
Production and supply of water	3244	35622	—	427

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 4-4 Basic information on S&T activities in above-scale industrial enterprises (2000, 2004, 2009, and 2011—2013)

Category \ Year	2000	2004	2009	2011	2012	2013
Number of enterprises having R&D activities (unit)	17272	17075	36387	37467	47204	54832
Percentage of enterprises having R&D activities to total number of enterprises (%)	10.6	6.2	8.5	11.5	13.7	14.8
Full-time equivalent of R&D personnel (10,000 person-years)	43.9	54.2	144.7	193.9	224.6	249.4
Expenditure on R&D (100 million yuan)	489.7	1104.5	3775.7	5993.8	7200.6	8318.4
Input intensity of R&D expenditure (%)	0.58	0.56	0.69	0.71	0.77	0.80
Number of R&D projects (item)	65289	53641	194400	232158	287524	322567
Expenditure on R&D projects (100 million yuan)	417.6	921.2	3185.9	5052.0	6230.6	7294.5
Number of R&D institutions (unit)	15529	17555	29879	31320	45937	51625
Number of R&D personnel (10,000 persons)	60.1	64.4	155.0	181.6	226.8	238.8
Expenditure on R&D (100 million yuan)	435.8	841.6	2983.6	3957.0	5233.4	5941.5
Number of new products (unit)	91880	76176	237754	266232	323448	358287
Expenditure on new product development (100 million yuan)	529.5	965.7	4482.0	6845.9	7998.5	9246.7
Sales revenue of new products (100 million yuan)	9369.5	22808.6	65838.2	100582.7	110529.8	128460.7
# Export of new products	1728.4	5312.2	11572.5	20223.1	21894.2	22853.5
Number of patent applications (piece)	26184	64569	265808	386075	489945	560918
# Invention patents	7970	20456	92450	134843	176167	205146
Number of valid invention patents (piece)	15333	30315	118245	201089	277196	335401
Expenditure for acquisition of foreign technology (100 million yuan)	304.9	397.4	422.2	449.0	393.9	393.9
Expenditure for assimilation of technology (100 million yuan)	22.8	61.2	182.0	202.2	156.8	150.6
Expenditure for purchase of domestic technology (100 million yuan)	34.5	82.5	203.4	220.5	201.7	214.4
Expenditure for technical renovation (100 million yuan)	1291.5	2953.5	4344.7	4293.7	4161.8	4072.1

Source: *National Office of R&D Census, National Industrial Statistics on the 2000 R&D Census*; National Bureau of Statistics, *China Yearbook on Economic Census 2004*; *National Bureau of Statistics, National Statistics on the 2009 R&D Census*; National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2012—2014.*

Table 4-5 Basic information on S&T activities in medium and large-sized industrial enterprises (2000, 2005—2013)

Category \ Year	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of enterprises having R&D activities (unit)	7116	6874	7838	8954	10027	12434	12889	15709	18847	20408
Proportion of enterprises having R&D activities to total number of enterprises (%)	32.68	24.06	24.01	24.70	24.87	30.48	28.31	26.01	29.76	31.15
Full-time equivalent of R&D personnel (10,000 person-years)	32.9	60.6	69.6	85.8	101.4	115.9	137	158.7	181.9	197.7
Expenditure on R&D (100 million yuan)	353.4	1250.3	1630.2	2112.5	2681.3	3210.2	4015.4	5030.7	5992.3	6744.1
Input intensity of R&D expenditure (%)	0.71	0.76	0.77	0.81	0.84	0.96	1.82	1.73	0.99	1.01
Expenditure on R&D projects (100 million yuan)	309.5	1142.3	1491.0	1967.6	2520.9	2696.4	3446.2	4233.4	5180.5	5914.5
Number of R&D institutions (unit)	7639	9352	10464	11847	13241	15217	16717	16451	22326	23347
Number of R&D personnel (10,000 persons)	44.0	64.3	75.8	88.3	107.5	128.0	148.5	149.4	183.0	187.4
Expenditure on R&D (100 million yuan)	334.7	1018.3	1335.1	1791.8	2336.3	2625.1	3276.9	3454.3	4471.0	4983.6
Number of new products (unit)	55953	81033	100760	112369	121358	152770	159637	176044	210730	222508
Expenditure on new product development (100 million yuan)	388.9	1457.2	1862.9	2453.3	3095.8	3654.6	4420.7	5697.2	6571.8	7440.6
Sales revenue of new products (100 million yuan)	7641	24097	31233	40976	51292	57978	72863.9	88650.3	98192.2	112561.9
# Export of new products	1270.6	5538.9	7335.2	9922.4	13210.7	10678.7	14773.7	18956.6	20565.2	21293.2
Number of patent applications (piece)	11819	55271	69009	95905	122076	166762	198890	265612	327119	359791
# Invention patents	2792	18292	25685	36074	43773	63011	72523	97822	124695	139723
Number of valid invention patents (piece)	6394	22971	29176	43652	55723	81592	113074	146469	204636	244175
Expenditure for acquisition of foreign technology (100 million yuan)	245.4	296.8	320.4	452.5	440.4	394.6	386.1	421	377.9	373.6
Expenditure for assimilation of technology (100 million yuan)	18.2	69.4	81.9	106.6	106.4	163.8	165.2	178.2	145.7	138.1
Expenditure for purchase of domestic technology (100 million yuan)	26.4	83.4	87.4	129.6	166.2	174.7	221.4	203	178.1	189.5
Expenditure for technical renovation (100 million yuan)	1132.6	2792.9	3019.6	3650.0	4167.2	3671.4	3638.5	3677.8	3669.0	3495.0

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2001—2014*.

Table 4-6　Basic information on S&T activities in above-scale industrial enterprises, by registration type (2013)

Type	Total	Domestic funded enterprise	Enterprise with funds from Hong Kong, Macao and Taiwan	Foreign funded enterprise
Number of enterprises (unit)	369741	312378	26451	30912
Number of enterprises with R&D institutions (unit)	43055	34165	3910	4980
Number of enterprises having R&D activities (unit)	54832	43564	5115	6153
Number of R&D institutions in enterprises (unit)	51625	41257	4627	5741
Number of employees at year-end (10,000 persons)	9791.5	7255.4	1206.3	1329.8
Total assets (100 million yuan)	867062.6	678595.5	72891.1	115575.9
Main business revenue (100 million yuan)	1037289.3	794267.0	88774.1	154248.3
New products (100 million yuan)	128460.7	83742.2	14021.7	30696.9
Gross profits (100 million yuan)	68321.7	52518.7	5456.9	10346.1
R&D personnel (person)	3375912	2564162	352698	459052
Expenditure on R&D (100 million yuan)	8318.4	6303.3	772.2	1242.9
Government funds (100 million yuan)	359.7	320.3	19.1	20.4
Enterprise funds (100 million yuan)	7821.7	5904.9	741.0	1175.9
Overseas funds (100 million yuan)	47.6	11.1	6.1	30.3
Other funds (100 million yuan)	89.3	67.0	6.1	16.3

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 4-7 Patent information in above-scale industrial enterprises (2013)

Industry	Patent applications		Invention patents in force
		# Invention patents	
Total	560918	205146	335401
Mining and washing of coal	2857	708	835
Extraction of petroleum and natural gas	2628	888	1198
Mining and processing of ferrous metal ores	588	255	540
Mining and processing of non-ferrous metal ores	254	85	140
Mining and processing of non-metal ores	387	179	221
Processing of food from agricultural products	7344	3090	3221
Manufacture of foods	5421	2147	3105
Manufacture of liquor, beverages and refined tea	3863	937	1538
Manufacture of tobacco	2634	965	1168
Textile	11457	2220	2587
Manufacture of textile, wearing apparel and accessories	6347	946	1977
Manufacture of leather, fur, feather and related products and footwear	3538	604	712
Processing of timber, manufacture of wood, bamboo, rattan, palm and straw products	2603	687	1011
Manufacture of furniture	4826	593	880
Manufacture of paper and paper products	3278	1122	1282
Printing and reproduction of recording media	2867	882	1404
Manufacture of articles for culture, education, arts and crafts, sport and entertainment activities	10885	1331	3355
Processing of petroleum, coking and processing of nuclear fuel	1600	814	1710
Manufacture of raw chemical materials and chemical products	27165	14883	22005
Manufacture of medicines	17124	10475	19558
Manufacture of chemical fibers	3177	1090	1288
Manufacture of rubber and plastic products	15427	4168	6086
Manufacture of non-metallic mineral products	15369	4932	8941
Smelting and pressing of ferrous metals	13874	5767	7018
Smelting and pressing of non-ferrous metals	9022	3464	6753
Manufacture of metal products	18318	5152	9656
Manufacture of general purpose machinery	49305	14292	23994
Manufacture of special purpose machinery	53037	17528	28145
Manufacture of automobiles	38237	9041	14106
Manufacture of railways, ships, aircrafts and spacecraft and other transport equipment	19140	5897	9461
Manufacture of electrical machinery and apparatus	78154	25283	38601

continued from table 4-7

Industry	Patent applications		Invention patents in force
		# Invention patents	
Manufacture of computers, communication and other electronic equipment	88960	50516	97994
Manufacture of instruments and meters	19507	5950	9236
Other manufacture	1751	630	933
Repair service of metal products, machinery and equipment	697	192	264
Production and supply of electric power and heat power	17537	6742	3602
Production and supply of gas	84	22	49
Production and supply of water	294	102	138

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 4-8 R&D projects with annual revenues above designated amount in above-scale industrial enterprises, by cooperation form (2013)

Cooperation form	Number of R&D projects		Number of personnel for R&D projects		Expenditure on R&D projects	
	item	%	person	%	10,000 yuan	%
Total	234584	100	2677980	100	70542352	100
Accomplished independently	182575	77.8	2030164	75.8	52658979	74.7
Accomplished through cooperation with domestic higher education institutions	20857	8.9	264711	9.9	6825622	9.7
Accomplished through cooperation with domestic independent research institutions	10626	4.5	135159	5.0	3699874	5.2
Accomplished through cooperation with wholly foreign-owned enterprises registered in China	1230	0.5	16820	0.6	595138	0.8
Accomplished through cooperation with other enterprises registered in China	10062	4.3	120000	4.5	3349902	4.7
Accomplished through cooperation with overseas organizations	2953	1.3	43747	1.6	1786396	2.5
Others	6281	2.7	67379	2.6	1626442	2.4

Source: National Bureau of Statistics and National Development and Reform Commission, *Statistics Yearbook on Science and Technology Activities of Industrial Enterprises 2014*.

Table 4-9 Introduction, assimilation and absorption of technologies, and purchase of domestic technologies in above-scale industrial enterprises (2000, 2004, 2009, and 2011—2013)

Category	2000	2004	2009	2011	2012	2013
Expenditure on introduction of foreign technologies (100 million yuan)	304.9	397.4	422.2	449.0	393.9	393.9
Expenditure on R&D (100 million yuan)	489.7	1104.5	3775.7	5993.8	7200.6	8318.4
Expenditure on introduction, assimilation and absorption of technologies (100 million yuan)	22.8	61.2	182.0	202.2	156.8	150.6
Expenditure on purchase of domestic technologies (100 million yuan)	34.5	82.5	203.4	220.5	201.7	214.4
Proportion of expenditure on introduction of technologies to that on R&D (%)	62.3	36.0	11.2	7.5	5.5	4.7
Proportion of expenditure on assimilation and absorption to that on introduction of technologies (%)	7.5	15.4	43.1	45.0	39.8	38.2
Proportion of expenditure on purchase of domestic technologies to that on introduction of technology (%)	11.3	20.8	48.2	49.1	51.2	54.4

Source: *National Office of R&D Census, National Industrial Statistics on the 2000 R&D Census*; National Bureau of Statistics, *China Yearbook on Economic Census 2004*; *National Bureau of Statistics, National Statistics on the 2009 R&D Census*; National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2012—2014.*

Table 5-1 Overview of S&T activities in higher education institutions (2003—2013)

Indicator	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of schools (unit)	1552	1731	1792	1867	1908	2263	2305	2358	2409	2442	2491
Number of R&D institutions (unit)	3145	3681	3936	4154	4502	5159	6082	7833	8630	9225	9842
R&D personnel (10,000 persons)	—	—	38.7	42.1	44.8	47.8	50.9	59.4	63.2	67.8	71.5
Full-time equivalent of R&D personnel (10,000 person-years)	18.9	21.2	22.7	24.2	25.4	26.6	27.5	29.0	29.9	31.4	32.5
R&D expenditure (100 million yuan)	162.3	200.9	242.3	276.8	314.7	390.2	468.2	597.3	688.8	780.6	856.7
# Basic research	32.9	47.9	56.7	71.4	86.8	114.8	145.5	179.9	226.7	275.7	307.6
Applied research	89.7	108.8	125.0	137.3	161.8	208.9	250.0	337.0	372.4	402.7	441.3
Experimental development	39.7	44.2	60.6	68.2	66.1	66.5	72.6	80.3	89.8	102.2	107.8
# Government funds	87.7	108.8	133.1	151.5	177.7	225.5	262.2	358.8	405.1	474.1	516.9
Enterprise funds	58.3	74.6	88.9	101.2	110.3	134.9	171.7	198.5	242.9	260.5	289.3
Overseas funds	3.0	2.6	4.0	3.8	4.8	4.8	4.8	5.4	6.0	6.0	5.5
Other funds	13.4	15.0	16.3	20.3	21.9	24.9	29.5	34.5	34.8	40.0	45.1

Source: National Bureau of Statistics and Ministry of Science and Technology
China Statistical Yearbook on Science and Technology 2004—2014

Table 5-2　R&D expenditure of higher education institutions in certain countries (2013)

Country	Domestic R&D expenditure(100 million domestic currency)	R&D expenditure of higher education institutions (100 million domestic currency)	R&D expenditure of higher education institutions (USD 100 million)	Proportion of R&D expenditure of higher education institutions to national total (%)
China	11846.6	856.7	138.3	7.2
US (2012)	4535.4	627.2	627.2	13.8
France	471.6	97.9	129.9	20.7
Germany	824.8	144.3	191.6	17.5
Japan	166800.7	22461.1	230.1	13.5
Korea	5930090.0	548030.0	50.1	9.2
Italy	202.0	57.0	75.7	28.2
Sweden	1246.4	338.3	51.9	27.1
UK	278.4	73.2	114.5	26.3
Canada	307.5	122.4	118.8	39.8
Netherlands	127.4	40.5	53.8	31.8
Denmark	576.5	183.2	32.6	31.8
Russia	7498.0	675.3	21.2	9.0

Source: OECD *Main Science and Technology Indicators 2014-2.*

Table 5-3　Proportion of R&D expenditure of higher education institutions to GDP in certain countries (2003—2013)

%

Country	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
UK	0.40	0.40	0.42	0.43	0.44	0.45	0.49	0.46	0.44	0.44	0.43
US	0.36	0.36	0.36	0.35	0.35	0.37	0.40	0.40	0.40	0.39	—
Netherlands	0.62	0.60	0.63	0.60	0.59	0.63	0.68	0.70	0.62	0.62	0.63
Finland	0.63	0.66	0.63	0.63	0.62	0.61	0.71	0.76	0.73	0.74	0.71
France	0.41	0.39	0.38	0.39	0.39	0.41	0.46	0.47	0.46	0.47	0.46
Germany	0.42	0.40	0.40	0.40	0.39	0.43	0.48	0.49	0.50	0.51	0.51
Japan	0.43	0.42	0.44	0.43	0.44	0.40	0.45	0.42	0.45	0.45	0.47
Korea	0.24	0.25	0.26	0.28	0.32	0.35	0.37	0.38	0.38	0.38	0.38
Argentina	0.09	0.09	0.10	0.11	0.12	0.12	0.15	0.15	0.16	0.18	—
Russia	0.08	0.06	0.06	0.07	0.07	0.07	0.09	0.09	0.10	0.10	0.10
China	0.12	0.12	0.13	0.12	0.12	0.12	0.13	0.15	0.15	0.15	0.15

Source: OECD *Main Science and Technology Indicators 2014-2.*

Table 5-4 Papers, patents and technical market transactions in higher education institutions (2003—2013)

Indicators	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SCI papers	28463	34947	49438	57286	64381	78079	89775	100772	113481	131356	161344
Domestic papers	181902	214710	234609	243485	305787	317884	340630	343027	335907	337216	330605
# Basic discipline	35636	41983	44916	47227	45410	47403	52398	45141	43732	38157	42033
Medicine	56579	68404	74066	58657	101680	106382	116361	123660	123988	121808	118826
Farming, forestry, animal husbandry, and fishery	9500	11432	14218	17244	17692	33407	30232	26561	20352	20248	18927
Industrial technology	75538	85846	97351	113177	126283	129525	131832	135132	132250	141893	136353
Others	4649	7045	4058	7180	14722	1167	9807	12533	15585	15110	14466
Patent applications	10252	12997	19921	22950	32680	45145	61579	79332	110136	132648	167656
# Invention patents	7704	9683	14643	17312	23001	30808	37965	48294	63028	75688	98509
Patent grants	3416	5505	7399	10457	14773	19159	27947	43153	56484	77283	85038
# Invention patents	1730	3484	4453	6198	8214	10265	14391	19036	26616	33821	33309
Number of transactions in technical market(10,000 items)	—	—	—	2.2	2.8	3.0	3.3	4.2	5.0	5.8	6.4
Transaction value in technical market (100 million yuan)	—	—	—	76.0	103.0	118.3	135.1	196.7	248.8	294.0	329.5

Source: Institute of Scientific and Technical Information of China,*Statistics and analysis on China's S&T papers 2003—2013*; National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2004—2014.*

Table 6-1 Personnel in R&D institutes (2005—2013)

Indicator	2005	2006	2007	2008	2009	2010	2011	2012	2013
R&D personnel (10,000 persons)	24.1	25.7	29	30.4	32.3	34.2	36.2	38.8	40.9
Personnel engaged in S&T activities (10,000 persons)	45.6	46.2	47.8	48.8	50.7	49.6	51.9	54.7	56.8
Full-time equivalent of R&D personnel (10,000 person-years)	21.5	23.1	25.5	26.0	27.7	29.3	31.6	34.4	36.4
# Basic research	2.8	3.2	3.6	3.8	4.1	4.2	5.0	5.7	6.1
Applied research	8.3	8.9	9.3	9.7	10.3	10.9	11.3	12.1	13.0
Experimental development	10.4	11.0	12.6	12.5	13.4	14.2	15.2	16.5	17.3

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

Table 6-2 Funds in R&D institutes (2005—2013)

100 million yuan

Indicator	2005	2006	2007	2008	2009	2010	2011	2012	2013
Expenditure on R&D	513.1	567.3	687.9	811.3	996.0	1186.4	1306.7	1548.9	1781.4
# Basic research	58.0	67.9	74.7	92.7	110.6	129.9	160.2	197.9	221.6
Applied research	176.3	196.2	227.1	271.3	350.9	387.6	417.2	469.3	525.8
Experimental development	278.7	303.2	386.1	447.2	534.4	668.9	729.3	881.7	1034.0
# Government funds	424.7	481.2	592.9	699.7	849.5	1036.5	1106.1	1292.7	1481.2
Enterprise funds	17.6	17.3	26.2	28.2	29.8	34.2	39.9	47.4	60.9
Overseas funds	1.8	2.6	3.4	4.0	4.2	3.4	4.9	5.1	5.7
Other funds	68.1	66.1	65.3	79.3	112.4	112.2	155.8	203.8	233.5

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 6-3 Projects in R&D institutes (2005—2013)

Indicator	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number/Item of R&D projects/ subjects	39072	42262	49453	54900	61135	67050	70967	79343	85069
Full-time equivalent of personnel for R&D projects/ subjects (10,000 person-years)	17.6	20.2	22.2	22.9	23.7	25.4	27.3	31.1	32.7
Expenditure on R&D projects/ subjects (100 million yuan)	353.5	365.4	451.7	537.7	579.8	681.5	807.1	1078.3	1221.7

Source: National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 6-4 S&T output in R&D institutions (2005—2013)

Indicator	2005	2006	2007	2008	2009	2010	2011	2012	2013
SCI papers	12632	13406	14284	15924	17169	18941	20685	23739	23734
Domestic papers	38101	42354	47189	49906	56099	57022	58160	55656	60149
Patent appliations	9746	9878	14119	18612	21271	26962	37910	45119	53032
# Invention	6726	6845	9748	12435	14332	18254	25222	29518	36582
Utility model	2661	2691	3598	4724	6022	7474	10512	12786	14360
Design	359	342	773	1453	917	1234	2176	2815	2090
Patent grants	4192	5313	6558	8344	10269	14268	17777	19852	24878
# Invention	2423	2553	3173	3945	5299	6557	9238	11248	12284
Utility model	1599	2484	3101	4161	4503	7074	8016	7754	11319
Design	170	276	284	238	467	637	523	850	1275
Number/Item of transactions in technical market as seller	—	39249	42695	44477	30858	29673	31833	36140	33118
Transaction value in technical market as seller (10,000 yuan)	—	1276619	1313030	1472110	1913980	1990272	2614299	4029582	5010078

Source: Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2006—2014*; State Intellectual Property Office, *Statistical Yearbook on Patent 2005—2013*;
National Bureau of Statistics, Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

Table 7-1 Basic information on high technology industry (2003—2013)

Industry \ Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Manufacture											
Number of enterprises (unit)	181186	259374	251499	279282	313046	396950	405183	422532	301489	318772	343584
Gross output value at current price (100 million yuan)	127352	175287	217836	274572	353631	441358	479200	609558	733984	—	—
Added value (100 million yuan)	34089	45778	57232	72437	93977	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	4884	5667.34	5935	6347	6856	7732	7720	8391	8054	8395	8614
Main business revenue (100 million yuan)	124035	171837	213844	270478	347890	432760	471870	606300	729264	805662	909453
Total pre-tax profits(100 million yuan)	12119	10969	18441	23665	33855	40051	49736	69587	78806	84909	96953
High technology industry											
Number of enterprises (unit)	12322	17898	17527	19161	21517	25817	27218	28189	21682	24636	26894
Gross output value at current price (100 million yuan)	20556	27769	34367	41996	50461	25817	27218	74709	88434	—	—
Added value (100 million yuan)	5034	6341	8128	10056	11621	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	477	587	663	744	843	945	958	1092	1147	1269	1294
Main business revenue (100 million yuan)	20412	27846	33916	41585	49714	55729	59567	74483	87527	102284	116049
Total pre-tax profits(100 million yuan)	1465	1784	2090	2611	3353	4024	4660	6753	7814	9494	11117
Manufacture of aircrafts and spaceships											
Number of enterprises (unit)	148	177	167	173	181	217	220	237	224	304	318
Gross output value at current price (100 million yuan)	551	502	797	828	1024	1199.1	1353	1598	1913	—	—
Added value (100 million yuan)	141	149	209	241	292	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	34	27	30	30	30	31	33	34	35	36	34
Main business revenue (100 million yuan)	547	498	781	799	1006	1162	1323	1592	1934	2330	2853
Total pre-tax profits(100 million yuan)	28	26	44	61	76	92	113	107	140	182	184
Manufacture of computers and office equipment											
Number of enterprises (unit)	810	1374	1267	1293	1450	1695	1676	1642	1313	1387	1565
Gross output value at current price (100 million yuan)	5987	8692	10667	12511	14859	16493	16293	19823	21135	—	—
Added value (100 million yuan)	1022	1226	1824	2111	2273	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	59	83	101	122	143	165	163	181	195	198	191
Main business revenue (100 million yuan)	6306	9193	10722	12634	14887	16499	16432	19958	21164	22045	23214

continued from table 7-1

Industry \ Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total pre-tax profits(100 million yuan)	210	270	331	359	522	676	608	918	1018	1116	1148
Manufacture of electronics and communication equipment											
Number of enterprises (unit)	5166	8044	7781	8606	9963	12871	12831	13425	10220	12215	13465
Gross output value at current price (100 million yuan)	10217	14007	16867	21218	25088	28151	28947	35930	43559	—	—
Added value (100 million yuan)	2572	3366	4016	5118	5808	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	223	304	347	393	455	523	510	602	636	731	748
Main business revenue (100 million yuan)	9927	13819	16646	21069	24824	27410	28466	35984	43206	52799	60634
Total pre-tax profits(100 million yuan)	675	861	927	1270	1454	1616	1858	3019	3357	4287	5278
Manufacture of medical equipment, instruments and meters											
Number of enterprises (unit)	2135	3538	3341	3721	4175	4510	5684	5846	3999	4343	4707
Gross output value at current price (100 million yuan)	911	1327	1785	2421	3128	3369	4394	5617	6884	—	—
Added value (100 million yuan)	275	427	549	777	961	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	45	58	62	70	77	74	91	102	103	107	112
Main business revenue (100 million yuan)	880	1303	1752	2364	3030	3256	4259	5531	6739	7772	8864
Total pre-tax profits (100 million yuan)	105	148	202	279	374	399	563	753	925	1054	1191
Manufacture of medicines											
Number of enterprises (unit)	4063	4765	4971	5368	5748	6524	6807	7039	5926	6387	6839
Gross output value at current price (100 million yuan)	2890	3241	4250	5019	6362	7875	9443	11741	14942	—	—
Added value (100 million yuan)	1025	1173	1530	1808	2287	—	—	—	—	—	—
Annual average number of employees (10,000 persons)	115	114	123	130	137	151	160	173	179	197	209
Main business revenue (100 million yuan)	2751	3033	4020	4719	5967	7402	9087	11417	14484	17338	20484
Total pre-tax profits(100 million yuan)	447	480	584	643	928	1242	1518	1956	2375	2857	3316

Note: Data for 2006 and before are of all state-owned industrial enterprises, and non-state-owned industrial enterprises whose annual main business revenues were above 5 million yuan (included); data for 2007—2010 are of industrial enterprises whose annual main business revenues were above 5 million yuan (included); data for 2011 and after are of industrial enterprises whose annual main business revenues were above 20 million yuan (included).

Source: National Bureau of Statistics, the National Development and Reform Commission, and Ministry of Science and Technology, *China Statistics Yearbook on High Technology Industry 2014*.

Table 7-2 Major S&T indicators of high technology industry (2003—2013)

Industry \ Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Manufacture											
R&D personnel (10,000 person-years)	43.02	38.65	54.50	62.20	77.76	92.28	106.99	127.56	147.90	171.04	186.13
R&D expenditure (100 million yuan)	678.42	892.48	1184.52	1551.39	2009.56	2546.37	3012.94	3771.86	4753.75	5666.86	6407.34
Expenditure on technology introduction (100 million yuan)	394.74	354.48	288.49	302.46	434.64	411.87	383.69	377.25	397.04	370.05	365.92
Sales revenue from new products (100 million yuan)	14021.36	20259.95	23804.21	30876.90	40517.15	50287.42	57175.83	72310.12	87681.32	96939.94	111221.85
Number of valid invention patents (piece)	14654	17101	21870	28168	42455	54223	78884	109732	143397	199128	238501
High technology industry											
R&D personnel (10,000 person-years)	12.78	12.08	17.32	18.90	24.82	28.51	32.00	39.91	42.67	52.56	55.92
R&D expenditure (100 million yuan)	222.45	292.13	362.50	456.44	545.32	655.20	774.05	967.83	1237.81	1491.49	1734.37
Expenditure on technology introduction (100 million yuan)	93.54	111.90	84.82	78.58	130.9	84.29	64.42	68.78	62.18	73.31	53.21
Sales revenue from new products (100 million yuan)	4515.04	6099.00	6914.66	8248.86	10303.22	12879.47	12595.00	16364.76	20384.52	23765.32	29028.84
Number of valid invention patents (piece)	3356	4535	6658	8141	13386	23915	31830	50166	67428	97878	115884
Manufacture of aircrafts and spaceships											
R&D personnel (10,000 person-years)	2.82	2.40	2.99	2.74	2.72	1.93	2.30	2.82	2.95	3.79	4.44
R&D expenditure (100 million yuan)	22.26	25.25	27.80	33.34	42.59	51.99	65.78	92.84	143.56	158.68	167.15
Expenditure on technology introduction (100 million yuan)	7.58	3.35	3.04	3.68	2.19	0.70	2.67	6.49	2.11	0.97	1.63
Sales revenue from new products (100 million yuan)	215.11	212.48	337.35	305.04	379.13	472.98	272.17	472.16	498.03	601.83	716.15
Number of valid invention patents (piece)	141	73	192	228	270	400	565	700	1277	1770	2778
Manufacture of computers & office equipment											
R&D personnel (10,000 person-years)	1.24	1.36	1.75	2.46	2.97	3.11	3.54	6.85	4.57	5.86	5.50
R&D expenditure (100 million yuan)	25.75	39.60	43.45	72.93	81.82	80.90	98.87	117.57	151.33	158.07	137.84
Expenditure on technology introduction (100 million yuan)	17.43	2.20	11.47	9.89	18.99	2.69	5.64	3.66	0.86	2.41	1.97
Sales revenue from new products (100 million yuan)	954.96	1342.01	2070.09	2963.11	2814.74	4227.74	2253.12	4421.47	6738.85	6613.00	5653.46

continued from table 7-2

Industry \ Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Number of valid invention patents (piece)	271	711	473	1174	3210	3344	4192	7552	10532	14922	13302
Manufacture of electronics & communication equipment											
R&D personnel (10,000 person-years)	6.16	6.05	9.51	9.78	14.24	17.22	18.31	21.15	24.18	30.14	31.14
R&D expenditure (100 million yuan)	138.50	188.55	234.72	276.89	324.52	402.94	454.85	572.41	700.57	855.50	1045.91
Expenditure on technology introduction (100 million yuan)	59.53	100.01	66.50	60.54	104.42	71.84	48.03	47.47	47.85	56.36	36.26
Sales revenue from new products (100 million yuan)	2926.19	4026.43	3852.04	4173.48	6013.02	6759.08	8232.77	9071.49	10411.84	12904.34	18424.62
Number of valid invention patents (piece)	2100	2453	4268	3807	6532	15418	21298	33677	44448	64603	79689
Manufacture of medical equipment, instruments and meters											
R&D personnel (10,000 person-years)	0.81	0.88	1.11	1.38	1.81	2.23	2.74	3.56	4.11	4.58	5.42
R&D expenditure (100 million yuan)	8.27	10.55	16.59	20.70	30.51	40.29	54.93	62.39	86.08	104.35	124.60
Expenditure on technology introduction (100 million yuan)	1.62	0.55	0.23	1.25	2.26	4.51	3.85	6.32	5.93	8.39	8.28
Sales revenue from new products (100 million yuan)	115.00	129.31	185.82	237.31	383.65	470.77	588.62	724.12	910.49	1196.81	1243.77
Number of valid invention patents (piece)	385	396	591	967	892	1583	1864	2565	4644	6510	7320
Manufacture of medicines											
R&D personnel (10,000 person-years)	1.75	1.39	1.96	2.54	3.08	4.02	5.11	5.52	6.87	8.19	9.41
R&D expenditure (100 million yuan)	27.67	28.18	39.95	52.59	65.88	79.09	99.62	122.63	156.27	214.89	258.88
Expenditure on technology introduction (100 million yuan)	7.38	5.75	3.58	3.21	3.03	4.54	4.23	4.84	5.43	5.17	5.08
Sales revenue from new products (100 million yuan)	303.79	388.72	469.36	569.92	712.69	948.91	1248.32	1675.53	1825.31	2449.34	2990.83
Number of valid invention patents (piece)	459	902	1134	1965	2482	3170	3911	5672	6527	10073	12795

Note: The above data are of medium and large sized industrial enterprises.

Source: National Bureau of Statistics, the National Development and Reform Commission, and Ministry of Science and Technology, *China Statistics Yearbook on High Technology Industry 2014*.

Table 7-3 Import and export of high technology products (2003—2013)

Type	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total value of export (100 million dollars)	4382.3	5933.3	7620	9689.7	12186.4	14306.9	12016.1	15779	18986	20490	22100
#Finished industrial products (100 million dollars)	4035.6	5528.2	7129.6	9161.5	11564.7	13527.4	11384.8	14962.2	17980.5	19484	21027
Proportion to total value of export (%)	92.1	93.2	93.6	94.5	94.9	94.6	94.7	94.8	94.7	95.1	95.1
#High-technology products (100 million dollars)	1103.2	1653.6	2182.5	2814.5	3478.2	4156.1	3769.3	4923.8	5488	6011.7	6603
Proportion to total value of export (%)	25.2	27.9	28.6	29	28.5	29	31.2	31.2	28.9	29.3	29.9
Proportion to value of export of finished industrial products (%)	27.3	29.9	30.6	30.7	30.1	30.7	33.1	32.9	30.5	30.9	31.4
Total value of import (100 million dollars)	4127.6	5612.3	6601.2	7914.6	9559.5	11325.6	10059.2	11437.8	17434	18178	19503
#Finished industrial products (100 million dollars)	3400.5	4441.2	5124.1	6044.7	7128.4	7701.7	7161.2	9622.7	11390.8	11832	12927
Proportion to total value of import (%)	82.4	79.1	77.6	76.4	74.6	68	71.2	69	65.3	65.1	66.3
#High technology products (100 million dollars)	1193	1613.5	1977.1	2473	2869.8	3419.4	3098.5	4126.6	4632	5068.6	5582
Proportion to total value of import (%)	28.9	28.7	30	31.2	30	30.2	30.8	29.6	26.6	27.9	28.6
Proportion to value of import of finished industrial products (%)	35.1	36.3	38.6	40.9	40.3	44.4	43.3	42.9	40.7	42.8	43.2
Balance of export and import (100 million dollars)	255.3	321	1018.8	1775.1	2626.9	2981.3	1956.9	1815.1	1552.5	2312	2597
#Finished industrial products (100 million dollars)	635.1	1087	2005.5	3116.8	4436.3	5825.7	4223.6	5339.4	6589.7	7652	8100
#High technology products (100 million dollars)	-89.8	40.2	205.4	341.5	608.4	736.7	670.8	797.2	856	943.1	1021

Source: General Administration of Customs, Statistics of import and export of goods.

Table 7-4 Value of import and export of high technology products by field of technology (2011—2013)

100 million dollars

Field of technology	2011			2012			2013		
	Value of export	Value of import	Balance	Value of export	Value of import	Balance	Value of export	Value of import	Balance
Total	5488.3	4632.3	856	6011.7	5068.6	943.1	6603.3	5581.9	1021.4
Computer and communications technology	3929.4	1056.4	2873	4192.5	1224.7	2967.9	4390.9	1274.2	3116.7
Life science technology	178.4	158	20.4	209.3	194.1	15.2	225.8	219	6.7
Electronic technology	865.8	2139.8	−1274	1015.2	2384.1	−1368.8	1367.9	2799.6	−1431.7
Computer-integrated manufacturing technology	89.4	469.3	−379.9	98.6	362.9	−264.3	109.6	334.6	−224.9
Aerospace technology	46	190.2	−144.2	44.4	242.1	−197.7	51.1	301.9	−250.8
Optoelectronic technology	321.1	542	−220.9	395	585.4	−190.4	393.3	581.3	−188
Biotechnology	4.1	4.5	−0.4	4.7	4.8	−0.1	6.1	7.8	−1.7
Materials technology	47.2	59.3	−12.1	46.1	60.7	−14.6	51.6	53.5	−2
Other technologies	6.8	12.9	−6.1	5.9	10	−4	7.1	10.1	−3

Source: General Administration of Customs, Statistics of import and export of goods.

Table 7-5 Value of import and export of high technology products, by trade mode (2011—2013)

1 million dollars

Trade mode	2011			2012			2013		
	Value of export	Value of import	Balance	Value of export	Value of import	Balance	Value of export	Value of import	Balance
Total	548830	463225	85605	601173	506864	94309	660330	558193	102137
General trade	89849	122883	−33034	94483	123980	−29498	110728	135145	−24417
Supplies and gifts as aid given gratis between governments and by international organizations	104	9	95	196	10	186	171	10	161
Other overseas donations	1	242	−241	1	281	−279	1	1	—
Processing on order and assembling	39624	40554	−930	33900	33992	−92	28361	33878	−5517
Inward processing	382517	189411	193106	397817	201986	195831	403055	208922	194133
Consignment trade									
Small-scale border trade	499	2	497	576	2	574	1237	1	1236
Imported equipment for processing	—	565	−565	—	637	−637	—	736	−736
Exported goods for outsourced projects	729	—	729	819	—	819	1068	—	1068
Leasing	7	5458	−5451	6	6511	−6505	13	8077	−8064
Equipment and articles imported as investments by foreign funded enterprises	—	8322	−8322	—	5966	−5966	—	4704	−4704
Outward processing	1	1	0	32	41	−9	67	80	−13
Entry and exit goods in bonded warehouses	8263	17868	−9605	6567	15848	−9281	9099	19963	−10864
Warehousing and sailing goods in bonded areas	27132	73571	−46439	66606	111887	−45281	106260	142730	−36470
Imported equipment in export processing zones	—	3738	−3738	—	4867	−4867	—	3053	−3053
Others	102	601	−499	170	858	−688	269	865	−596

Source: General Administration of Customs, Statistics of import and export of goods.

Table 7-6 Value of import and export of high technology products, by type of enterprise (2011—2013)

1 million dollars

Type	2011			2012			2013		
	Value of export	Value of import	Balance	Value of export	Value of import	Balance	Value of export	Value of import	Balance
State-owned enterprises	31806	51372	−19567	34209	51021	−16812	37239	53608	−16369
Sino-foreign cooperative enterprises	5369	2047	3322	4948	2119	2829	5247	2402	2845
Sino-foreign joint-venture enterprises	79657	74835	4822	100959	92871	8088	115019	104512	10507
Wholly foreign-owned enterprises	367800	271846	95954	364676	270707	93970	361494	260636	100859
Collective-owned enterprises	12328	4131	8197	10709	3895	6814	10485	4118	6367
Private enterprises	51767	58633	−6866	85516	86009	−493	130712	132762	−2051
Other enterprises	104	361	−258	156	243	−87	134	154	−20

Source: General Administration of Customs, Statistics of import and export of goods.

Table 7-7 Information on import and export of high technology products in China with certain countries/ regions (2011—2013)

1 million dollars

Country/region	2011			2012			2013		
	Value of export	Value of import	Balance	Value of export	Value of import	Balance	Value of export	Value of import	Balance
US	105892	28971	76921	114367	32542	81826	117893	48331	69561
Hong Kong	135993	3316	132677	170147	2462	167686	211500	2090	209411
15 EU states	94734	43502	51232	86529	45507	41022	80880	47570	33310
Japan	33486	58545	−25059	36606	54968	−18362	38706	47539	−8834
Korea	25449	76903	−51454	31783	85787	−54004	35673	98578	−62905
Taiwan province	13361	73708	−60347	16425	84472	−68047	18362	107727	−89365
Australia	8146	373	7773	7944	402	7542	7508	305	7203

Source: General Administration of Customs, Statistics of import and export of goods.

Table 7-8 Major economic indicators of national high technology industrial development zones (2003—2013)

Year	Number of enterprises (unit)	Number of employees at year-end (10,000 persons)	Total income (100 million yuan)	Gross industrial output value (100 million yuan)	Net profits (100 million yuan)	Actual taxes paid (100 million yuan)	Exports (100 million dollars)
2003	32857	395.4	20938.7	17257.4	1129.4	990.0	510.2
2004	38565	448.4	27466.3	22638.9	1422.8	1239.6	823.8
2005	41990	521.2	34415.6	28957.6	1603.2	1615.8	1116.5
2006	45828	573.7	43320.0	35899.0	2128.5	1977.1	1361.0
2007	48472	650.2	54925.2	44376.9	3159.3	2614.1	1728.1
2008	52632	716.5	65985.7	52684.7	3304.2	3198.7	2015.2
2009	53692	810.5	78706.9	61151.4	4465.4	3994.6	2007.2
2010	55243	960.3	105917.3	84318.2	6855.4	5446.8	2648.0
2011	57033	1073.6	133425.1	105679.6	8484.2	6816.7	3180.6
2012	63926	1269.5	165689.9	128603.9	10243.2	9580.5	3760.4
2013	71180	1460.2	199648.9	151367.6	12443.6	11043.1	4133.3

Source: Ministry of Science & Technology, *China Torch Statistical Yearbook 2014* of Torch High Technology Industry Development Center.

Table 7-9 Overview of national high technology industrial development zones (2013)

Region	Number of enterprises (unit)	Number of employees (10,000 persons)	Total income (100 million yuan)	Gross industrial output value (100 million yuan)	Net profits (100 million yuan)	Actual taxes paid (100 million yuan)	Exports (100 million dollars)
Total	71180	1460.2	199648.9	151367.6	12443.6	11043.1	4133.3
Beijing Zhongguancun	15455	189.9	30497.4	7890.3	1908.2	1506.6	336.2
Tianjin Binhai New Area	3175	34.3	5674.4	3119.5	577.4	188.0	105.8
Shijiazhuang	608	10.2	1503.4	1002.7	91.2	74.4	11.3
Baoding	169	9.1	944.3	940.9	3.9	57.8	15.5
Tangshan	122	1.7	117.0	119.3	8.4	8.4	1.0
Yanjiao	181	2.9	485.7	406.4	18.7	26.2	1.0
Chengde	27	0.8	59.5	59.9	4.1	5.9	0.1
Taiyuan	1097	11.8	1604.8	1380.3	28.0	50.4	2.9
Baotou	517	11.8	1299.7	1320.5	116.6	74.9	19.8
Hohhot	29	6.5	533.0	151.5	32.7	29.7	—
Shenyang	783	14.8	1821.7	1471.5	119.3	88.8	21.3
Dalian	2035	20.5	2284.1	1650.4	159.3	112.1	65.2
Anshan	547	8.8	2069.2	1866.2	202.8	140.1	12.3
Yingkou	288	4.4	497.6	510.8	24.2	16.3	14.3
Liaoyang	32	3.5	838.9	639.8	31.7	64.6	16.5
Benxi	114	2.5	190.7	188.9	17.9	20.9	1.1
Fuxin	179	2.2	184.9	208.4	9.8	4.8	0.3
Changchun	729	16.1	4878.6	4635.7	443.6	620.4	5.5
Jilin	529	11.3	1099.9	1084.5	−18.5	94.5	2.9
Yanji	187	1.4	251.0	250.7	21.3	74.7	1.6
Changchun Jingyue	911	12.1	912.4	655.7	113.4	49.8	12.2
Tonghua	52	1.0	540.8	436.3	25.3	8.0	0.2
Harbin	310	16.3	1989.4	1531.9	70.4	146.1	12.9
Daqing	480	10.8	2072.9	1782.9	137.7	132.2	2.4
Qiqihar	43	2.6	230.2	200.4	11.7	8.7	5.0
Shanghai Zhangjiang	2806	72.2	11368.9	6665.8	728.9	595.7	312.8
Shanghai Zizhu	85	1.9	340.7	151.3	69.4	34.8	7.8
Nanjing	365	20.3	4310.9	4056.3	185.9	181.0	80.3
Changzhou	976	16.9	2146.7	2065.9	95.4	82.1	59.4
Wuxi	1234	34.3	2941.1	2894.0	121.6	108.2	186.4
Suzhou	1100	23.4	2825.8	2725.6	98.9	83.9	238.9
Taizhou	290	3.6	718.6	731.0	35.5	52.6	10.5

continued from table 7-9

Region	Number of enterprises (unit)	Number of employees (10,000 persons)	Total income (100 million yuan)	Gross industrial output value (100 million yuan)	Net profits (100 million yuan)	Actual taxes paid (100 million yuan)	Exports (100 million dollars)
Kunshan	892	28.8	2003.3	1987.0	69.7	80.1	60.4
Jiangyin	183	10.1	1778.7	1620.2	73.2	101.8	49.0
Wujin	333	8.9	658.3	676.0	54.9	27.0	16.1
Xuzhou	115	4.3	540.5	483.5	34.5	24.9	1.7
Nantong	368	8.5	1128.6	880.3	66.9	53.9	36.7
Hangzhou	1832	25.4	2798.7	1610.4	281.4	171.1	51.3
Ningbo	381	12.0	1938.0	1004.8	101.0	52.2	68.8
Shaoxing	208	3.8	210.4	206.6	6.6	9.1	7.5
Wenzhou	336	7.0	382.1	401.1	16.3	17.0	8.8
Quzhou	174	5.1	517.4	477.7	27.5	18.6	5.7
Hefei	530	15.6	2976.5	2693.4	310.9	360.3	65.8
Bengbu	268	5.4	622.8	654.2	37.3	40.6	7.0
Wuhu	190	4.3	646.4	681.9	30.7	22.8	6.5
Ma’anshan	125	3.0	624.0	517.0	20.6	17.2	4.7
Fuzhou	184	6.2	673.5	702.3	43.3	21.6	38.6
Xiamen	410	15.7	1985.3	1915.9	58.6	94.1	204.8
Quanzhou	190	6.7	440.6	579.0	33.2	17.6	7.1
Putian	113	5.2	354.2	358.1	10.9	3.8	1.2
Zhangzhou	161	4.9	321.4	324.5	18.6	10.2	11.1
Nanchang	370	10.9	1436.2	1332.8	49.2	132.2	19.8
Jingdezhen	145	5.7	750.7	756.8	22.4	32.8	8.8
Xinyu	153	4.1	563.7	552.8	22.8	17.1	6.8
Yingtan	93	2.2	393.0	388.7	11.1	15.2	0.4
Jinan	559	23.6	2831.1	2024.1	199.1	271.1	48.3
Qingdao	200	13.3	1970.6	1549.2	146.4	132.4	33.8
Zibo	450	11.9	2267.5	2152.7	119.8	193.5	27.1
Weifang	473	14.4	1964.7	1610.7	158.7	144.1	29.9
Weihai	221	10.3	1233.1	1220.1	89.4	72.4	45.2
Jining	442	16.7	2417.9	2264.9	125.9	94.2	18.0
Yantai	253	5.6	355.4	365.1	22.8	19.8	7.7
Linyi	355	6.6	889.0	880.5	57.5	35.5	9.7
Tai’an	318	7.1	500.3	465.4	33.0	28.1	3.8
Zhengzhou	755	17.5	3085.8	2689.5	175.0	153.7	11.2
Luoyang	708	11.0	1553.9	1243.2	117.7	98.8	10.2
Nanyang	164	4.4	256.0	253.1	18.7	10.6	3.4
Anyang	219	4.7	420.1	310.2	18.3	17.7	2.0

continued from table 7-9

Region	Number of enterprises (unit)	Number of employees (10,000 persons)	Total income (100 million yuan)	Gross industrial output value (100 million yuan)	Net profits (100 million yuan)	Actual taxes paid (100 million yuan)	Exports (100 million dollars)
Xinxiang	149	4.5	570.2	524.2	84.1	15.1	3.3
Wuhan	2883	41.9	6517.2	5086.2	394.7	320.9	104.7
Xiangyang	622	13.8	2068.8	2027.8	167.5	100.9	8.0
Yichang	301	11.0	1697.9	1760.5	76.7	43.5	9.6
Xiaogan	345	7.7	834.7	821.8	30.0	22.7	1.8
Jinmen	267	7.0	798.2	809.4	45.4	16.9	3.5
Changsha	846	21.5	3386.0	3207.2	226.0	164.8	24.7
Zhuzhou	215	10.7	1344.8	1422.3	72.0	73.3	11.2
Xiangtan	271	8.1	1160.0	1110.7	24.0	29.1	8.6
Yiyang	222	2.4	517.0	478.2	15.8	14.6	2.8
Hengyang	80	3.6	523.1	524.6	17.3	16.3	11.4
Guangzhou	2313	45.4	4680.2	3501.4	367.2	177.5	238.2
Shenzhen	1485	42.0	4656.0	4815.9	373.5	271.8	168.6
Zhuhai	469	18.6	1805.1	1735.4	129.2	96.4	120.8
Huizhou	313	17.2	2707.7	2504.3	86.1	108.6	218.7
Zhongshan	400	8.5	1648.8	1593.2	127.8	51.0	89.9
Foshan	612	28.8	3027.4	2953.7	209.9	105.9	116.6
Zhaoqing	149	4.4	718.3	728.2	15.2	16.3	7.4
Jiangmen	242	5.2	295.0	297.0	12.2	11.4	10.1
Dongguan	305	6.9	753.4	709.1	2.9	13.9	29.1
Nanning	662	13.7	1204.3	1044.9	72.7	49.6	14.1
Guilin	314	8.8	696.1	707.7	67.7	37.7	4.9
Liuzhou	194	8.4	1395.3	1342.9	54.0	72.5	8.3
Haikou	146	3.2	309.5	312.1	21.0	34.9	4.8
Chongqing	855	19.2	1762.2	1502.3	144.4	65.3	34.8
Chengdu	1626	27.2	4814.7	3662.4	461.0	253.2	164.9
Mianyang	110	11.3	909.2	1127.8	15.5	39.6	15.6
Zigong	102	3.2	373.7	381.7	18.1	21.4	8.0
Leshan	85	3.1	224.0	222.5	15.8	10.6	8.7
Guiyang	501	21.7	1908.5	1497.8	116.4	75.7	30.4
Kunming	286	6.7	1399.1	999.1	32.1	64.9	5.7
Yuxi	41	1.9	949.8	767.5	69.1	485.6	—
Xi’an	3368	32.3	6622.2	5157.7	440.0	480.0	78.8
Baoji	454	13.2	1463.4	1465.1	62.3	77.5	6.9
Yangling	144	1.6	138.8	96.1	4.1	4.9	0.2
Weinan	60	2.3	312.7	335.3	23.1	15.6	3.2

continued from table 7-9

Region	Number of enterprises (unit)	Number of employees (10,000 persons)	Total income (100 million yuan)	Gross industrial output value (100 million yuan)	Net profits (100 million yuan)	Actual taxes paid (100 million yuan)	Exports (100 million dollars)
Xianyang	64	1.4	420.5	386.7	13.0	64.2	1.1
Yulin	14	1.3	275.7	277.6	28.6	16.8	7.4
Lanzhou	600	15.6	1400.7	865.7	41.4	84.6	2.5
Baiyin	157	9.2	681.8	644.4	9.2	17.8	5.0
Qinghai	57	1.2	77.8	122.8	3.7	3.7	—
Yinchuan	59	0.9	133.6	134.7	12.4	1.2	3.0
Shizuishan	94	2.1	185.8	154.9	8.2	7.9	1.9
Urumqi	267	7.0	1107.0	516.1	21.4	22.2	31.4
Changji	87	1.1	218.5	202.5	19.2	7.0	0.4
Xinjiang Production and Construction Corps	18	1.6	229.8	199.0	13.1	2.2	0.2

Source: Ministry of Science & Technology, *China Torch Statistical Yearbook 2014 of Torch High Technology Industry Development Center.*

Table 7-10 Venture capital in China, by source of funds (2011—2013)

%

Source of funds \ Year	2011	2012	2013
Foreign funds	2.8	5.1	3.2
Unlisted companies	40.6	34	42.8
Government (including public institutions)	12.7	11.8	11.4
Solely funded state-owned investment organizations	20.5	18.8	17.8
Individual funds	13.7	18.9	17.5
Banks	0.2	0.6	1.2
Listed companies	2.3	4.6	3.6
Non-bank financial institutions	1.7	1.5	0.3
Others	5.5	4.7	2.2

Source: Chinese Academy of Science and Technology for Development, *Venture Capital Development in China 2012—2014*.

Table 8-1 Regional distribution of S&T resources (2013)

Region	Population(10,000 persons)	Personnel holding a junior college or above diploma(10,000 persons)	Employees(10,000 persons)	Full-time equivalent of R&D personnel(10,000 person-years)	R&D expenditure(100 million yuan)
Beijing	2114.8	83.4	1332.8	24.22	1185.05
Tianjin	1472.21	32.5	526.8	10.02	428.09
Hebei	7332.61	52.4	3833.6	8.95	281.86
Shanxi	3629.8	36.7	1684.2	4.90	154.98
Inner Mongolia	2497.61	23.9	1198.2	3.73	117.19
Liaoning	4390	84.2	2263.7	9.49	445.93
Jilin	2751.28	30.5	1263.0	4.80	119.69
Heilongjiang	3835.02	45.1	1763.4	6.27	164.78
Shanghai	2415.15	57.2	935.3	16.58	776.78
Jiangsu	7939.49	102.9	4786.0	46.62	1487.45
Zhejiang	5498	90.8	4034.9	31.10	817.27
Anhui	6029.8	50.9	3890.8	11.93	352.08
Fujian	3774	31.1	2206.3	12.25	314.06
Jiangxi	4522.15	39.3	2332.5	4.35	135.50
Shandong	9733.39	90.6	5719.5	27.93	1175.80
Henan	9413.35	70.0	6110.8	15.23	355.32
Hubei	5799	64.5	3152.2	13.31	446.20
Hunan	6690.6	52.8	4053.7	10.34	327.03
Guangdong	10644	81.1	5843.1	50.17	1443.45
Guangxi	4719	33.2	2979.1	4.07	107.68
Hainan	895.28	7.2	450.8	0.70	14.84
Chongqing	2970	26.3	1934.0	5.26	176.49
Sichuan	8107	80.3	5054.9	10.97	399.97
Guizhou	3502.22	29.4	2429.7	2.39	47.18
Yunnan	4686.6	33.6	2846.4	2.85	79.84
Xizang	312.04	0.7	177.0	0.12	2.30
Shaanxi	3764	42.1	1974.4	9.35	342.75
Gansu	2582.18	21.8	1448.3	2.50	66.92
Qinghai	577.79	6.7	297.5	0.48	13.75
Ningxia	654.19	6.8	329.7	0.82	20.90
Xinjiang	2264.3	26.4	862.4	1.58	45.46

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; National Bureau of Statistics,*China Statistical Yearbook 2014* .

Table 8-2 **Distribution of domestic S&T papers by region (2013)**

paper

Region	Domestic S&T papers	Basic discipline	Medicine	Farming, forestry, animal husbandry, and fishery	Industrial technology
Beijing	67557	8461	26330	3087	26406
Tianjin	13775	1448	5896	195	5731
Hebei	17341	1391	9412	858	5235
Shanxi	7149	922	2121	639	3265
Inner Mongolia	3829	612	1436	519	1189
Liaoning	19514	1937	7043	1017	8766
Jilin	8498	1597	2655	731	3281
Heilongjiang	12579	1406	3566	1496	5720
Shanghai	31210	3189	14581	813	11433
Jiangsu	48616	5174	19046	2898	19609
Zhejiang	24494	2348	13438	1340	6569
Anhui	13493	1749	6142	579	4595
Fujian	9000	1351	3490	971	2874
Jiangxi	6648	886	2338	469	2724
Shandong	23360	3079	9648	1882	8064
Henan	18843	2024	6666	1506	7970
Hubei	24623	2357	11288	918	9013
Hunan	15536	1639	5358	1020	6971
Guangdong	33787	2782	19589	1219	9132
Guangxi	10232	952	6164	773	2145
Hainan	2951	322	1538	598	396
Chongqing	13537	1191	5906	592	5195
Sichuan	23214	2945	9207	963	9533
Guizhou	5479	878	2155	880	1392
Yunnan	7860	1397	2849	1109	2327
Xizang	263	51	86	63	52
Shaanxi	28257	3519	6098	1727	15749
Gansu	8792	1717	2732	983	3038
Qinghai	1259	240	530	178	287
Ningxia	1998	258	1052	223	417
Xinjiang	7424	1009	3451	1254	1508

Source: Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2013.*

Table 8-3 Distribution of SCI papers by region (2013)

paper

Region	SCI papers	Basic discipline	Medicine	Farming, forestry, animal husbandry, and fishery	Industrial technology
Beijing	35284	18076	5439	915	10805
Tianjin	5646	3218	861	37	1520
Hebei	2122	1155	412	33	522
Shanxi	1699	1050	133	21	494
Inner Mongolia	539	353	52	36	98
Liaoning	7626	3529	1376	143	2567
Jilin	5209	3567	631	86	925
Heilongjiang	5320	2543	670	161	1943
Shanghai	18967	9050	5185	150	4512
Jiangsu	19471	10119	3373	616	5353
Zhejiang	10576	5435	2065	298	2771
Anhui	5254	3402	508	39	1301
Fujian	3816	2283	584	96	851
Jiangxi	1772	1125	198	45	403
Shandong	9045	5018	1786	340	1897
Henan	3909	2437	673	90	708
Hubei	9455	5035	1553	332	2525
Hunan	6548	3289	950	73	2230
Guangdong	10667	4955	3200	290	2208
Guangxi	1399	738	358	57	246
Hainan	334	218	54	32	30
Chongqing	4076	1870	1199	51	951
Sichuan	7887	4166	1435	164	2117
Guizhou	611	429	80	18	84
Yunnan	1944	1285	263	55	341
Xizang	7	5	1	1	—
Shaanxi	9358	4469	1358	274	3250
Gansu	3006	2003	230	113	659
Qinghai	114	75	9	7	23
Ningxia	152	84	48	2	18
Xinjiang	869	528	137	37	167

Source: Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2013*.

Table 8-4 Distribution of patent applications by region (2013)

Region	Patent applications	Invention	Utility model	Design
Beijing	123336	67554	47586	8196
Tianjin	60915	21946	34134	4835
Hebei	27619	7329	15781	4509
Shanxi	18859	6025	7527	5307
Inner Mongolia	6388	1935	3213	1240
Liaoning	45996	25292	18077	2627
Jilin	10751	4549	5141	1061
Heilongjiang	32264	10338	16118	5808
Shanghai	86450	39157	35584	11709
Jiangsu	504500	141259	128898	234343
Zhejiang	294014	42744	127122	124148
Anhui	93353	34857	45148	13348
Fujian	53701	9884	25769	18048
Jiangxi	16938	3931	7818	5189
Shandong	155170	67642	73862	13666
Henan	55920	15580	29420	10920
Hubei	50816	18189	26163	6464
Hunan	41336	11938	18327	11071
Guangdong	264265	68990	93592	101683
Guangxi	23251	14382	6755	2114
Hainan	2359	921	994	444
Chongqing	49036	12562	24865	11609
Sichuan	82453	23510	33488	25455
Guizhou	17405	3988	6456	6961
Yunnan	11512	3961	5705	1846
Xizang	203	92	57	54
Shaanxi	57287	26487	26157	4643
Gansu	10976	3735	5453	1788
Qinghai	1099	520	364	215
Ningxia	3230	1792	1187	251
Xinjiang	8224	2081	4620	1523

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 8-5 Distribution of patent grants by region (2013)

Region	Patent grants	Invention	Utility model	Design
Beijing	62671	20695	36301	5675
Tianjin	24856	3141	18759	2956
Hebei	18186	2008	13038	3140
Shanxi	8565	1332	5708	1525
Inner Mongolia	3836	549	2494	793
Liaoning	21656	3830	15582	2244
Jilin	6219	1496	3914	809
Heilongjiang	19819	2238	12435	5146
Shanghai	48680	10644	29859	8177
Jiangsu	239645	16790	98246	124609
Zhejiang	202350	11139	106238	84973
Anhui	48849	4241	36003	8605
Fujian	37511	2941	22152	12418
Jiangxi	9970	923	5913	3134
Shandong	76976	8913	58938	9125
Henan	29482	3173	21153	5156
Hubei	28760	4052	19655	5053
Hunan	24392	3613	15205	5574
Guangdong	170430	20084	77503	72843
Guangxi	7884	1295	5044	1545
Hainan	1331	449	691	191
Chongqing	24828	2360	16623	5845
Sichuan	46171	4566	24730	16875
Guizhou	7915	776	3916	3223
Yunnan	6804	1312	4322	1170
Xizang	121	44	47	30
Shaanxi	20836	4133	13936	2767
Gansu	4737	785	3205	747
Qinghai	502	91	285	126
Ningxia	1211	184	899	128
Xinjiang	4998	540	3244	1214

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 8-6 Output value of high technology industry and gross output value of above-scale industrial enterprises by region (2013)

Region	Output of high technology industry (100 million yuan)	Output of above-scale industrial enterprises (100 million yuan)	Share of output of high technology industry in that of above-scale industrial enterprises (%)
Beijing	4229.78	31398.28	13.47
Tianjin	2739.80	22059.41	12.42
Hebei	1460.11	36040.17	4.05
Shanxi	766.53	28058.27	2.73
Inner Mongolia	358.21	23141.71	1.55
Liaoning	1986.45	37989.29	5.23
Jilin	1095.97	15257.9	7.18
Heilongjiang	791.27	14059.17	5.63
Shanghai	5195.33	33538.26	15.49
Jiangsu	15200.34	92081.69	16.51
Zhejiang	5060.05	59633.11	8.49
Anhui	1728.12	25168.07	6.87
Fujian	2302.04	24671.06	9.33
Jiangxi	1480.00	13640.12	10.85
Shandong	5050.84	78881.06	6.40
Henan	3064.71	42021.92	7.29
Hubei	2407.59	30131.82	7.99
Hunan	1240.77	19031.64	6.52
Guangdong	20513.06	77943.52	26.32
Guangxi	592.16	13063.37	4.53
Hainan	215.47	2328.02	9.26
Chongqing	1570.37	13135.92	11.95
Sichuan	4712.26	34729.16	13.57
Guizhou	492.68	9703.64	5.08
Yunnan	434.48	15344.41	2.83
Xizang	26.51	548.63	4.83
Shaanxi	1945.87	22443.11	8.67
Gansu	278.55	10159.43	2.74
Qinghai	104.45	4597.68	2.27
Ningxia	85.80	5588.03	1.54
Xinjiang	48.38	14238.01	0.34

Source: National Bureau of Statistics and National Development and Reform Commission and Ministry of Science and Technology, *China Statistics Yearbook on High Technology Industry 2014*; National Bureau of Statistics,*China Statistical Yearbook 2014*.

Table 8-7 Value of export of high technology products and its share in value of export of goods by region (2013)

Region	Value of export of high technology products(100 million dollars)	Value of export of goods (100 million dollars)	Share of value of export of high technology products in that of goods (%)
Beijing	203.54	332.21	61.27
Tianjin	192.89	489.30	39.42
Hebei	28.11	408.44	6.88
Shanxi	32.28	97.49	33.11
Inner Mongolia	1.10	52.56	2.09
Liaoning	54.30	534.08	10.17
Jilin	3.86	56.99	6.77
Heilongjiang	2.96	122.39	2.41
Shanghai	887.10	1887.86	46.99
Jiangsu	1279.65	3338.04	38.34
Zhejiang	142.76	2624.14	5.44
Anhui	28.26	224.60	12.58
Fujian	155.27	943.14	16.46
Jiangxi	34.42	233.01	14.77
Shandong	173.94	1415.46	12.29
Henan	207.26	385.78	53.73
Hubei	52.09	209.86	24.82
Hunan	16.60	144.03	11.53
Guangdong	2564.31	7317.63	35.04
Guangxi	19.42	93.96	20.67
Hainan	5.71	31.73	17.98
Chongqing	248.36	382.11	65.00
Sichuan	192.17	327.60	58.66
Guizhou	1.54	32.09	4.80
Yunnan	20.19	87.69	23.02
Xizang	0.56	20.49	2.73
Shaanxi	47.39	102.24	46.35
Gansu	2.42	14.29	16.93
Qinghai	0.24	3.51	6.97
Ningxia	1.29	17.99	7.15
Xinjiang	3.31	159.33	2.08

Source: National Bureau of Statistics and General Administration of Customs, *China Statistical Yearbook 2014*.

Table 8-8 Distribution of R&D personnel by performing sectors by region (2013)

10,000 person-years

Region	Total	Research institutions	Higher education institutions	Enterprise and others
Beijing	24.22	9.62	2.95	11.65
Tianjin	10.02	0.86	0.95	8.21
Hebei	8.95	0.75	0.70	7.50
Shanxi	4.90	0.57	0.54	3.79
Inner Mongolia	3.73	0.31	0.42	3.00
Liaoning	9.49	1.26	1.65	6.58
Jilin	4.80	0.73	1.18	2.89
Heilongjiang	6.27	0.71	1.50	4.06
Shanghai	16.58	2.87	2.16	11.55
Jiangsu	46.62	2.14	1.99	42.49
Zhejiang	31.10	0.51	1.06	29.53
Anhui	11.93	0.97	1.11	9.85
Fujian	12.25	0.33	0.59	11.33
Jiangxi	4.35	0.51	0.42	3.42
Shandong	27.93	1.13	1.73	25.07
Henan	15.23	1.11	0.50	13.62
Hubei	13.31	1.39	1.41	10.51
Hunan	10.34	0.76	1.17	8.41
Guangdong	50.17	1.15	1.71	47.31
Guangxi	4.07	0.38	1.07	2.62
Hainan	0.70	0.11	0.06	0.53
Chongqing	5.26	0.51	0.53	4.22
Sichuan	10.97	2.62	1.36	6.99
Guizhou	2.39	0.28	0.32	1.79
Yunnan	2.85	0.62	0.45	1.78
Xizang	0.12	0.04	0.04	0.04
Shaanxi	9.35	3.01	1.08	5.26
Gansu	2.50	0.65	0.28	1.57
Qinghai	0.48	0.07	0.04	0.37
Ningxia	0.82	0.05	0.10	0.67
Xinjiang	1.58	0.32	0.32	0.94

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*.

Table 8-9 Distribution of R&D expenditure by performing sectors by region (2013)

100 million yuan

Region	Total	Research institutions	Higher education institutions	Enterprise and others
Beijing	1185.05	602.39	136.65	446.01
Tianjin	428.09	41.62	50.82	335.65
Hebei	281.86	25.99	10.20	245.67
Shanxi	154.98	14.47	12.30	128.21
Inner Mongolia	117.19	8.76	3.96	104.47
Liaoning	445.93	56.46	41.36	348.11
Jilin	119.69	26.10	20.10	73.49
Heilongjiang	164.78	30.80	36.34	97.64
Shanghai	776.78	192.54	71.50	512.74
Jiangsu	1487.45	101.88	80.74	1304.83
Zhejiang	817.27	24.17	47.28	745.82
Anhui	352.08	36.46	29.94	285.68
Fujian	314.06	10.78	11.08	292.2
Jiangxi	135.5	12.27	9.51	113.72
Shandong	1175.8	39.78	33.42	1102.6
Henan	355.32	30.00	15.91	309.41
Hubei	446.2	57.09	44.64	344.47
Hunan	327.03	16.83	26.20	284
Guangdong	1443.45	44.80	45.83	1352.82
Guangxi	107.68	12.96	8.28	86.44
Hainan	14.84	3.24	1.48	10.12
Chongqing	176.49	12.78	17.53	146.18
Sichuan	399.97	167.93	42.88	189.16
Guizhou	47.18	6.21	4.88	36.09
Yunnan	79.84	19.05	6.93	53.86
Xizang	2.3	1.33	0.34	0.63
Shaanxi	342.75	154.87	34.66	153.22
Gansu	66.92	18.88	5.88	42.16
Qinghai	13.75	1.68	1.50	10.57
Ningxia	20.9	1.04	1.29	18.57
Xinjiang	45.46	8.23	3.26	33.97

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014.*

Table 8-10 Gross output value of high technology industry according to industry by region (2013)

100 million yuan

Region	Total	Manufacture of medicines	Manufacture of aircrafts and spaceships	Manufacture of electronics and communication equipment	Manufacture of computers and office equipment	Manufacture of medical equipment, instruments and meters
Beijing	4229.78	946.48	279.84	1831.63	589.47	582.36
Tianjin	2739.80	685.10	584.92	1266.91	108.63	94.24
Hebei	1460.11	843.47	50.48	438.33	13.94	113.89
Shanxi	766.53	270.74	31.22	392.94	10.69	60.95
Inner Mongolia	358.21	263.25	17.09	69.43	1.26	7.18
Liaoning	1986.45	551.68	386.38	720.58	77.63	250.18
Jilin	1095.97	952.07	—	78.03	14.16	51.72
Heilongjiang	791.27	447.99	205.42	81.15	14.47	42.25
Shanghai	5195.33	787.48	193.63	2382.33	1391.21	440.67
Jiangsu	15200.34	1860.39	279.78	9053.67	1625.31	2381.19
Zhejiang	5060.05	1398.37	6.83	2673.00	124.96	856.89
Anhui	1728.12	415.81	22.99	998.20	150.59	140.53
Fujian	2302.04	229.37	55.81	1447.81	490.51	78.54
Jiangxi	1480.00	437.81	408.51	473.24	52.44	108.01
Shandong	5050.84	2565.29	24.07	1469.48	547.78	444.23
Henan	3064.71	920.94	93.88	1704.51	65.95	279.43
Hubei	2407.59	765.49	89.43	1354.54	56.35	141.78
Hunan	1240.77	374.22	110.70	534.47	61.49	159.89
Guangdong	20513.06	1585.81	234.74	14543.46	3362.21	786.84
Guangxi	592.16	262.47	11.17	183.82	103.91	30.80
Hainan	215.47	190.21	—	22.67	—	2.59
Chongqing	1570.37	386.90	5.21	205.39	818.28	154.59
Sichuan	4712.26	895.57	437.54	1955.88	1313.24	110.03
Guizhou	492.68	251.10	200.42	24.00	0.22	16.93
Yunnan	434.48	351.22	0.41	31.23	27.50	24.12
Xizang	26.51	26.51	—	—	—	—
Shaanxi	1945.87	315.52	923.94	472.47	1.61	232.33
Gansu	278.55	155.05	20.65	91.19	—	11.67
Qinghai	104.45	93.03	—	9.55	—	1.86
Ningxia	85.80	77.48	—	—	—	8.33
Xinjiang	48.38	44.76	—	0.36	—	3.26

Source: National Bureau of Statistics, National Development and Reform Commission, and Ministry of Science and Technology, *China Statistics Yearbook on High Technology Industry 2014.*

Table 8-11 Value of exports of high technology products by technology field by region (2013)

1 million USD

Region	Total	Computer and communications technology	Life science	Electronic technology	Computer-integrated manufacturing technology	Aerospace technology	Optoelectronic technology	Biotechnology	Materials technology
Beijing	20353.77	13416	1120	2839	476	1330	729	41	145
Tianjin	19288.81	13514	328	3688	410	258	831	7	253
Hebei	2810.85	609	692	1160	89	105	81	—	74
Shanxi	3228.23	3162	16	6	30	1	1	—	10
Inner Mongolia	109.78	12	81	2	4	—	—	—	10
Liaoning	5430.09	3147	653	824	428	209	83	7	77
Jilin	385.67	67	34	159	77	5	13	17	9
Heilongjiang	295.54	148	20	40	39	19	10	1	10
Shanghai	88710.47	61608	3310	17667	1687	388	3554	57	413
Jiangsu	127965.27	69322	6007	37811	2539	829	9800	119	1436
Zhejiang	14276.03	4930	3843	1949	1167	93	1683	153	393
Anhui	2826.39	1335	406	308	155	1	609	2	7
Fujian	15526.60	8636	804	807	249	670	4215	1	134
Jiangxi	3442.08	1812	162	1116	43	15	91	37	164
Shandong	17393.50	12521	1173	1713	599	116	1034	45	187
Henan	20726.18	20223	187	170	89	5	13	1	34
Hubei	5209.05	3686	570	429	92	58	158	41	165
Hunan	1660.23	1135	179	234	31	51	12	14	1
Guangdong	256430.88	177595	1806	57165	2277	291	15865	15	1312
Guangxi	1942.25	1668	74	26	152	1	21	—	—
Hainan	570.55	186	14	307	1	17	—	—	46
Chongqing	24836.26	23642	201	855	52	3	40	1	8
Sichuan	19217.26	14178	574	3592	146	242	414	20	40
Guizhou	154.02	79	12	10	10	32	8	—	1
Yunnan	2018.95	700	74	1140	30	2	25	—	13
Xizang	55.94	45	1	3	2	—	3	—	—
Shaanxi	4739.02	1432	132	2541	35	352	16	21	206
Gansu	241.94	71	13	138	7	—	8	2	1
Qinghai	24.46	1	—	23	—	—	—	—	—
Ningxia	128.64	34	75	4	2	9	3	—	1
Xinjiang	330.89	177	17	67	40	9	9	3	6

Source: General Administration of Customs.

Table 8-12 Major S&T indicators by region (2013)

Type \ Region	National	Northeastern	Eastern coastal	Central	Western
Full-time equivalents of R&D personnel per 10,000 employees (person-year per 10,000 persons)	45.89	38.86	77.03	28.30	20.49
The proportion of R&D expenditure to regional GDP (%)	2.01	1.34	2.46	1.39	1.13
The proportion of local S&T appropriation to the local financial expenditure (%)	2.27	1.72	3.58	1.69	1.10
Invention patents per 10,000 persons (piece per 10,000 persons)	26.72	13.79	50.39	11.45	9.54
The number of SCI papers per 100,000 persons (piece)	14.16	16.54	22.37	7.94	8.18
The proportion of total value of high technology industry output to total value of above-scale industry output (%)	10.25	5.76	13.51	6.76	6.39
The proportion of exports of high technology products to commodities (%)	29.89	8.57	29.98	28.65	41.58
The proportion of the value of signed contracts in technology market to regional GDP (%)	1.19	0.57	1.57	0.58	0.80

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; National Bureau of Statistics and the National Development and Reform Commission, and Ministry of Science and Technology, *China Statistics Yearbook on High Technology Industry 2014*; Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2013*; and General Administration of Customs.

Table 8-13 Major S&T indicators by administrative area (2013)

Region	Full-time equivalents of R&D personnel per 10,000 employees (person-year per 10,000 persons)	The proportion of R&D expenditure to regional GDP (%)	The proportion of local S&T appropriation to the local financial expenditure (%)	Invention patents per 10,000 persons (piece per 10,000 persons)	The number of SCI papers per 100,000 persons (piece)	The proportion of total value of high technology industry output to total value of above-scale industry output (%)	The proportion of exports of high technology products to commodities (%)	The proportion of the value of signed contracts in technology market to regional GDP (%)
Beijing	181.71	6.08	5.62	103.67	166.84	13.47	61.27	14.62
Tianjin	190.26	2.98	3.64	46.56	38.35	12.42	39.42	1.92
Hebei	23.36	1.00	1.13	7.47	2.89	4.05	6.88	0.11
Shanxi	29.12	1.23	2.05	6.90	4.68	2.73	33.11	0.42
Inner Mongolia	31.11	0.70	0.86	4.57	2.16	1.55	2.09	0.23
Liaoning	41.92	1.65	2.29	16.89	17.37	5.23	10.17	0.64
Jilin	38.01	0.92	1.36	7.97	18.93	7.18	6.77	0.27
Heilongjiang	35.53	1.15	1.15	14.42	13.87	5.63	2.41	0.71
Shanghai	177.22	3.60	5.69	80.53	78.53	15.49	46.99	2.46
Jiangsu	97.40	2.51	3.88	77.68	24.52	16.51	38.34	0.89
Zhejiang	77.09	2.18	4.06	100.52	19.24	8.49	5.44	0.22
Anhui	30.67	1.85	2.52	19.85	8.71	6.87	12.58	0.69
Fujian	55.54	1.44	1.98	28.42	10.11	9.33	16.46	0.21
Jiangxi	18.65	0.94	1.33	5.76	3.92	10.85	14.77	0.30
Shandong	48.84	2.15	2.23	21.27	9.29	6.40	12.29	0.33
Henan	24.92	1.11	1.43	8.97	4.15	7.29	53.73	0.13
Hubei	42.21	1.81	1.77	14.21	16.30	7.99	24.82	1.61
Hunan	25.51	1.33	1.18	11.29	9.79	6.52	11.53	0.32
Guangdong	85.86	2.32	4.10	55.11	10.02	26.32	35.04	0.85
Guangxi	13.65	0.75	1.69	4.67	2.96	4.53	20.67	0.05
Hainan	15.44	0.47	1.37	4.41	3.73	9.26	17.98	0.12
Chongqing	27.20	1.39	1.26	22.29	13.72	11.95	65.00	0.71
Sichuan	21.70	1.52	1.12	14.74	9.73	13.57	58.66	0.57
Guizhou	9.83	0.59	1.11	6.23	1.74	5.08	4.80	0.23
Yunnan	10.01	0.68	1.04	4.66	4.15	2.83	23.02	0.36

continued from table 8-13

Region	Full-time equivalents of R&D personnel per 10,000 employees (person-year per 10,000 persons)	The proportion of R&D expenditure to regional GDP (%)	The proportion of local S&T appropriation to the local financial expenditure (%)	Invention patents per 10,000 persons (piece per 10,000 persons)	The number of SCI papers per 100,000 persons (piece)	The proportion of total value of high technology industry output to total value of above-scale industry output (%)	The proportion of exports of high technology products to commodities (%)	The proportion of the value of signed contracts in technology market to regional GDP (%)
Xizang	6.79	0.29	0.41	1.69	0.22	4.83	2.73	—
Shaanxi	47.35	2.14	1.04	14.69	24.86	8.67	46.35	3.32
Gansu	17.29	1.07	0.86	4.82	11.64	2.74	16.93	1.60
Qinghai	16.03	0.65	0.68	2.75	1.97	2.27	6.97	1.28
Ningxia	24.97	0.81	1.16	5.01	2.32	1.54	7.15	0.06
Xinjiang	18.35	0.54	1.30	6.00	3.84	0.34	2.08	0.04

Source: National Bureau of Statistics and Ministry of Science and Technology, *China Statistical Yearbook on Science and Technology 2014*; National Bureau of Statistics, National Development and Reform Commission, and Ministry of Science and Technology,*China Statistics Yearbook on High Technology Industry 2014*; Institute of Scientific and Technical Information of China, *Statistics and analysis on China's S&T papers 2013*; and General Administration of Customs.

Explanatory Notes to Major Statistic Indicators

Science and Technology Activities refer to organized and systemic activities that are in close relation to the production, development, transmission and application of science and technology knowledge in fields like natural science, engineering technology, medical science, agricultural science, social sciences and the humanities. Science and technology activities are divided into three types, i.e. research and development activities, application activities of research and development achievements, and science and technology service activities.

Research and Development Activities, or briefly R&D activities, refer to systemic and innovative activities conducted in the science and technology field to increase the aggregate of knowledge and create new applications for such knowledge. R&D activities include basic research, applied research and experimental development, with the former two called "science and research activities".

Basic Research refers to experimental or theoretic work conducted to acquire new knowledge about the fundamental principles of phenomena and observable facts (and reveal the essence of things and law of motion and obtain new findings and theories). It does not aim for any special or specific application or utilization. The main form of its achievements is science papers and works.

Applied Research refers to innovative research conducted to acquire new knowledge, but mainly aims for a certain special purpose or target. Applied research is a new (theoretic) method or way of identifying the possible uses of basic research fruits or realizing the predetermined target of exploration. The main form of its achievements is science papers, works, theoretic models or invention patents.

Experimental Development refers to systemic work conducted, based on existing knowledge acquired from basic research, applied research and practical experience, to produce new products, materials and devices, develop new processes, systems and services, and make substantial improvements to them. The main form of its achievements is patents, proprietary technology (know-how), product prototypes with the basic characteristics of new products, or original prototypes with the basic features of new devices. In the field of social sciences, experimental development refers to a process that turns knowledge acquired from basic research and applied research into a feasible plan (including demonstration projects for examination and evaluation). In contrast, the humanities domain has no experimental development activities.

Science and Technology (S&T) Personnel refer to those who are directly engaged in science and technology activities, manage science and technology activities, or provide direct services for such activities,excluding personnel whose aggregate working hours in science and technology activities accounts for 10% and below their annual working hours.

a. Personnel directly engaged in science and technology activities include research personnel, engineering technology personnel, skilled workers and other personnel in the research rooms, laboratories, technology development centers and pilot plants (bases) of governmental research institutions, higher education institutions, enterprises of various types and public institutions; personnel who do not work in above institutions but are included in science and technology projects (subjects); postgraduate students engaged in paper design.

b. Personnel who manage and provide direct services for science and technology activities include heads of science and technology work in governmental research institutions, higher education institutions, enterprises of various types and public institutions; and personnel engaged in planning, administration, human resources, finance, material supply, equipment maintenance and library and information management for science and technology activities, but excludes those who provide indirect services like security guard, health care providers, drivers, canteen stuff, boilers, plumbers, cleaners and those providing catering services.

Research and Development (R&D) Personnel refer to personnel engaged in the research, management and supporting work of R&D projects (subjects), including members of projects (subjects), management personnel and auxiliary personnel who provide direct services. By the amount of annual working hours, R&D personnel consist of full-time personnel and part-time personnel. Full-time personnel refer to those whose working hours in R&D activities account for 90% and above of their total annual working hours; part-time personnel refer to those whose annual working hours in R&D activities account for 10% (including 10%) to 90% (not including 90%) of their total annual working hours. Part-time personnel converted to full-time equivalents refer to all part-time personnel are converted to full-time personnel by actual working time. For instance, if annual working hours of 3 part-time persons in R&D activities are 20%, 30% and 70% of the total respectively, their full-time equivalents are 0.2+0.3+0.7=1.2 person years. The number of R&D personnel by full-time equivalents, refers to the sum of full-time persons and part-time persons converted to full-time equivalents by workload. For instance, if there are 2 full-time persons and 3 part-time persons (whose annual working hours in R&D activities are 20%, 30% and 70% of the total respectively), the full-time equivalents are 2+0.2+0.3+0.7=3.2 person-years.

Senior R&D Personnel refer to personnel engaged in the conception or innovation of new knowledge, products, processes, methods and systems, and senior management personnel in

R&D projects (subjects) or institutions. Senior R&D personnel usually have an intermediate professional title or a doctoral degree. Doctoral candidates engaged in R&D activities are regarded as senior R&D personnel.

Fiscal Expenditures on Science and Technology Activities refer to funds directly earmarked by various governmental departments for science and technology activities. Before 2007, fiscal expenditures on science and technology activities included expenses on Three Science and Technology Items (trial-production of new products, intermediate tests and subsidies for key S&T projects), expenses on science operation, expenses on science and research infrastructure, and other S&T expenses in the operating expenses of other departments. Since 2007, fiscal expenditures on science and technology activities have included expenses on S&T management, basic research, applied research, technology research and development, S&T conditions and services, social sciences, S&T popularization, S&T exchanges and cooperation and others under the item of "Science and Technology Expenses". They also include expenses on science and technology under other items.

Internal Expenditures on R&D Activities refer to the actual expenditures of institutions on R&D activities (basic research, applied research, and experimental development). These expenditures include direct expenditures on R&D projects (subjects) and indirect expenditures on R&D management and services, R&D-related infrastructure, outsourcing and processing. They do not include expenditures on production activities, loan repayment and expenses paid to entrusted institutions that jointly or independently undertake R&D activities.

Governmental Research Institutions refer to research institutions above the county level, including those in fields like natural sciences, technology, social sciences, the humanities, and S&T information and literature.

The Number of Projects (Subjects) refers to the number of ongoing science and technology projects (subjects) approved in the present year or previous year, including those completed or announced aborted in the same year but excluding those outsourced by entrusted institutions.

Full-Time Equivalents of Subjects (Projects) Personnel refer to the sum of various personnel who have participated in subjects (projects) in a year, calculated based on the method of full-time equivalents. Method of statistics: convert the part-time personnel of subjects (projects) to full-time equivalents and then add the number of full-time personnel.

Internal Expenditures on Projects (Subjects) refer to the actual expenditures of investigated institutions on the research, trial and production of projects (subjects). They include service charge, other daily expenses, cost of purchase or construction of fixed assets, and outsourcing and processing fees, and do not include expenditures paid to entrusted institutions for independently or jointly undertaking projects (subjects).

S&T Papers refer to original science and research fruits published in academic journals and should meet three conditions: research fruits published for the first time; the conclusions and experiments of the author able to be repeated and verified by his peers; able to be applied by the science and technology community.

The Patent is an abbreviation for the patent right and refers to the exclusive right of ownership by the inventors or designers for a creation or an invention, granted by the patent office after due process of examination and assessment and approval in accordance with the Patent Law. Patents have three types, i.e. inventions, utility models and industrial designs. Inventions refer to new technical proposals to products or methods or their modifications. Patented utility models refer to new and practical technical proposals on the shape and structure of products or the combination of both. Industrial designs refer to aesthetic and industrially applicable new designs for the shape, pattern and color of products or their combinations.

Domestic Patent Application and Overseas Patent Application are two types of patent applications based on the identity of the applicant (legal person or natural person). Patent applications from Mainland China, Hong Kong, Macau and Taiwan are regarded as domestic applications, and others are overseas applications.

Service Inventions and Non-Service Inventions. Invention patents can be divided into service inventions and non-service inventions based on the patent application right and ownership of patent right. Service inventions refer to inventions and creations made in the implementation of one's appointed tasks or by using the material conditions of an institution of one's own, and their patent application right and ownership of patent right belongs to the institution. They include inventions and creations made in the implementation of one's appointed work; inventions and creations made other than the implementation of one's appointed tasks; inventions and creations made within one year after resignation, retirement or transfer of work and related with former appointed work or assigned tasks. Non-service inventions refer to inventions and creations made beyond one's appointed work and the right of patent application belongs to the inventor or creator. After the application's approval, the inventor or designer becomes the patentee.

Triadic Patent families. A patent is a member of the triadic patent families if and only if it is filed at the European Patent Office(EPO), the Japan Patent Office(JPO) and the US Patent and Trademark Office(USPTO).

High-Tech Industries refer to intelligence- and technology-intensive industries. China's hi-tech industries include aircraft manufacturing, electronics and communication equipment manufacturing, computer and office equipment manufacturing, pharmaceutical industry, medical equipment and meter manufacturing.

High-Tech Products. In accordance with *the Import and Export Catalogue of Chinese High and New Technology Products* identified by Ministry of Science and Technology and former Ministry of Foreign Trade and Economic Cooperation, high-tech products include 9 classifications of products, namely, computer and communication technology, life sciences, electronic technology, computer integrated manufacturing system, aeronautics and astronautics technology, photoelectric technology, biotechnology, materials technology and others.

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