National Innovation Index Report 2018

Chinese Academy of Science and Technology for Development

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National Innovation Index Report 2018

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Foreword

Improving indigenous innovation capability and building an innovation-driven country is a strategic goal set forth in China's *National Program for Long- and Medium-Term Scientific and Technological Development (2006–2020)*. The Chinese Academy of Science and Technology for Development began working on the national innovation index research in 2006 in order to track and assess China's progress in building an innovation-driven country. With the support and assistance from the Ministry of Science and Technology and its related departments and bureaus, related public institutions, and experts from various sectors, the *National Innovation Index Report* has been published annually since 2011. The *National Innovation Index Report 2018* is the 8th release.

The *National Innovation Index Report,* as one of the reports of the "national innovation survey system" series prepared in accordance with the *Work Plan to Establish a National Innovation Survey System* of the Ministry of Science and Technology, is a state-level innovation capacity evaluation report. Drawing upon domestic and international theories and methods of evaluation of national competitiveness and innovation capacity, it is based on an indicator matrix comprising five pillars, i.e. innovation resources, knowledge creation, enterprise innovation, innovation performance, and innovation environment. This report is still framed around the same indicator system structure as previous releases, which consists of 5 first-level indicators and 30 second-level indicators. The 30 second-level indicators include 20 quantitative indicators which highlight innovation scale, quality and efficiency

and international competitiveness while maintaining a balance between large and small countries, and 10 qualitative indicators which reflect the innovation environment.

This report continues to feature 40 countries with active science, technology and innovation (STI) activities (whose combined R&D expenditure accounts for more than 95% of the world's total), and continues to use the commonly adopted benchmarking method worldwide to calculate the national innovation index. All data are obtained from databases and publications of governments or international organizations and are internationally comparable and authoritative. It calculates the innovation index scores of the 40 countries based on statistical data in 2016 (unless otherwise indicated, the data of indicator are in 2016, and data for China excluded that of Hong Kong, Macao and Taiwan) and compare them with their performances in the previous release.

In today's world, a country's prosperity and sustainable development is mainly dependent on the development and accumulation of its national innovation capacity, rather than on the size of population or availability of natural resources. In the face of the opportunities and challenges accompanying science and technology development and the evolution of the international political and economic landscape, countries are increasing investment in technology and innovation to strengthen their innovation capacity. Against the backdrop of global competition, China ranks the 17th in the national innovation index with a higher overall index score, further narrowing its gap with advanced countries.

The report to the 19th CPC National Congress expressly put forward the strategic task of "accelerating the construction of innovative country". The establishment of the national innovation survey system will create favorable conditions for improving the innovation evaluation indicator system and advancing national innovation capability monitoring and evaluation. The effort to evaluate China's comprehensive innovation capability, track its innovation capability development and analyze the gap with leading innovation-driven countries requires continuous exploration and in-depth research. We sincerely hope that the

annual *National Innovation Index Report* will provide the public with a window through which to examine and understand China's innovation capacity development. We will continue to draw upon the valuable opinions of experts and scholars to continuously improve the national innovation index and witness the historical process of China becoming an innovation-driven country.

Editorial Committee of
National Innovation Index Report 2018

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National Innovation Index Report 2018

Part I

China's Innovation Through the Lens of Data

I. China's Progress in Key Indicators

Since the promulgation of the *National Program for Long- and Medium-Term Scientific and Technological Development (2006–2020)*, China has made steady progress in its innovation capacity. China's investment in innovation resources has been steadily increasing. China's R&D expenditure has ranked the second for four consecutive years in the world, with its R&D intensity reaching 2.11%, overtaking the 15-member EU for the first time, and its total R&D personnel has also ranked the first globally for many years. China's knowledge creation capacity has improved remarkably. China's SCI papers published ranked the second in the world, and its resident invention patent applications and grants maintained their No. 1 spot. Science and technology contributed a significantly increasing share to economic development. The transfer of science and technology achievement had a rapid growth and the industry structure was continously optimized.

With the implementation of the innovation-driven development strategy, China's strong innovation capacity becomes increasingly prominent. Driven by strong progress in relevant indicators including investment in innovation resources, output of science and technology activities, transfer of science and technology achievement, and growth of knowledge-intensive industries, technological innovation has played a steadily increasing role in supporting and leading China's social and economic development. Indeed, China has ascended to a new level in its effort of building an innovative country.

(I) Steadily Increased Investment in Innovation Resources

Sufficient innovation resources are crucial to ramping up a country's innovation capacity. As key innovation resources, R&D expenditure and R&D personnel reflect the intensity of innovation activity. In recent years, China has increased investment in innovative resources and maintained a high level of R&D expenditure and R&D personnel.

1. China ranked the second in R&D expenditure for the fourth consecutive year

The global (referring to the 40 countries included in this study, the same below) total R&D expenditure reached USD1.47 trillion, up 2.5%[①] from a year earlier. North America, Asia and Europe[②] had the most active R&D activity in the world (Figure 1-1), representing 36.8%, 33.7% and 25.8%, respectively, of the global R&D expenditure. North America was down 7.2 percentage points, Europe down 0.6 percentage point, and Asia up 6.4 percentage points from 2000.

① Growth data calculated on a constant price basis.

② Asian countries: China, Japan, Korea, Singapore, India, Israel and Turkey; European countries: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, the Netherlands, Norway, Poland, Portugal, Romania, Italy, Luxembourg, the Russian Federation, Slovak Republic, Slovenia, Spain, Sweden, Switzerland and the United Kingdom; North American countries: the United States, Canada and Mexico; South American countries: Argentina and Brazil; Oceanian countries: Australia and New Zealand; African country: South Africa.

China's R&D expenditure reached USD235.94 billion, ranking the second for the fourth consecutive year accounting for 16.1% of the global R&D expenditure (Figure 1-2). The United States held the leading position globally in R&D expenditure of USD511.1 billion, which was 34.8% of the global total, and 2.2 times China's. Japan ranked the third with USD155.45 billion, or 10.6% of the global total.

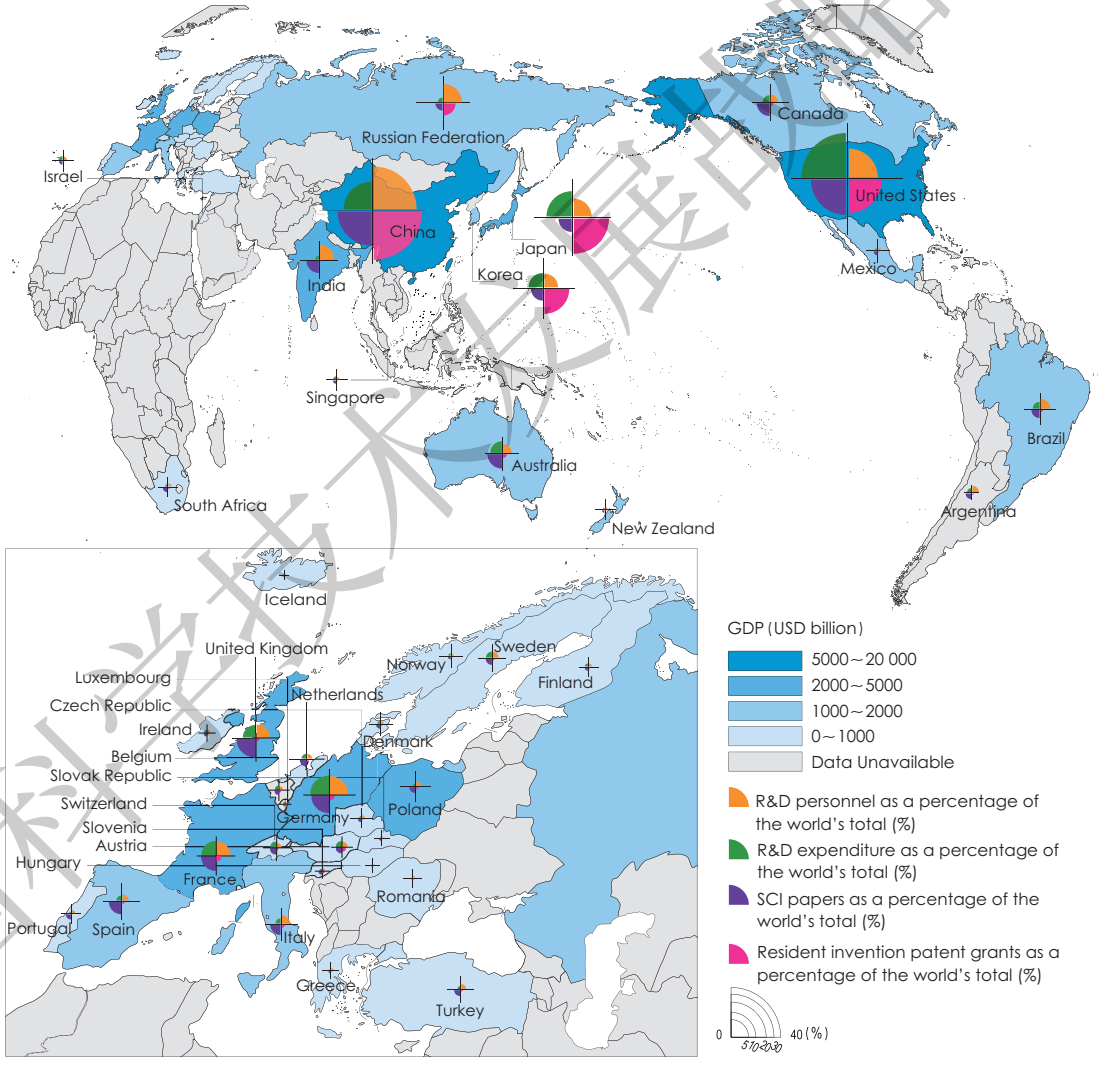


Figure 1-1 The world distribution of GDP, R&D personnel, R&D expenditure, SCI papers and resident invention patents

With the rapid rise of emerging economies and developing countries, global R&D expenditure has been significantly less concentrated among developed countries. The total R&D expenditure of the G7, which comprises the seven largest advanced economies in the world, as a percentage of the global R&D expenditure, was down 20.6 percentage points from 2000. In contrast, the combined R&D expenditure of the BRICS countries increased from 3.8% in 2000 to 19.8% in 2016.

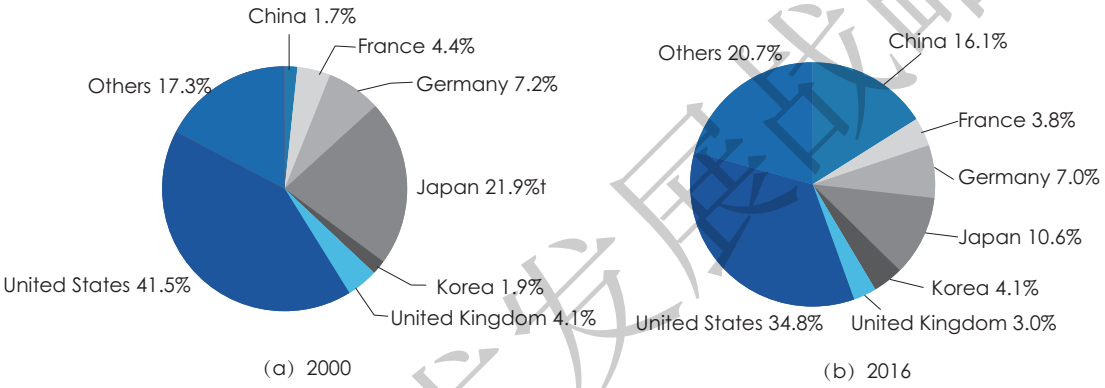


Figure 1-2 Percentage of R&D expenditure in the world's total of select countries

2. China led the world in R&D expenditure growth

Since the beginning of the 21st century, the global R&D expenditure has maintained an upward trend overall, posting an average annual growth of 3.2% between 2000 and 2016. China posted the fastest average annual growth of R&D expenditure among the 40 countries with 15.5%. Emerging countries have shown a robust R&D expenditure growth, with countries such as Korea (8.3%), India (6.6%) and the Russian Federation (4.2%) posting a growth higher than the world average, while developed countries such as the United States (2.1%), Japan (1.3%) and the United Kingdom (2.0%) have experienced a growth lower than the world average.

Due to the impact of the international financial crisis and the European debt crisis, the R&D expenditure growth of developed countries including the United States, Japan and the

United Kingdom reached the bottom in 2009 and 2012. After that, the United States and the United Kingdom have come back to the upward track, but Japan's R&D expenditure has continued to slow down due to the weak economic growth and even posted a negative growth in recent two years. Korea has always emphasized R&D and maintained a high level of R&D expenditure, but its R&D expenditure growth has gradually slowed down as well in the past two years. India's R&D expenditure growth was in low tide between 2010 and 2013 and has quickly recovered after that. China's R&D expenditure growth has gradually slowed down after reaching the peak in 2009 but is still higher than the growth of other countries (Figure 1-3).

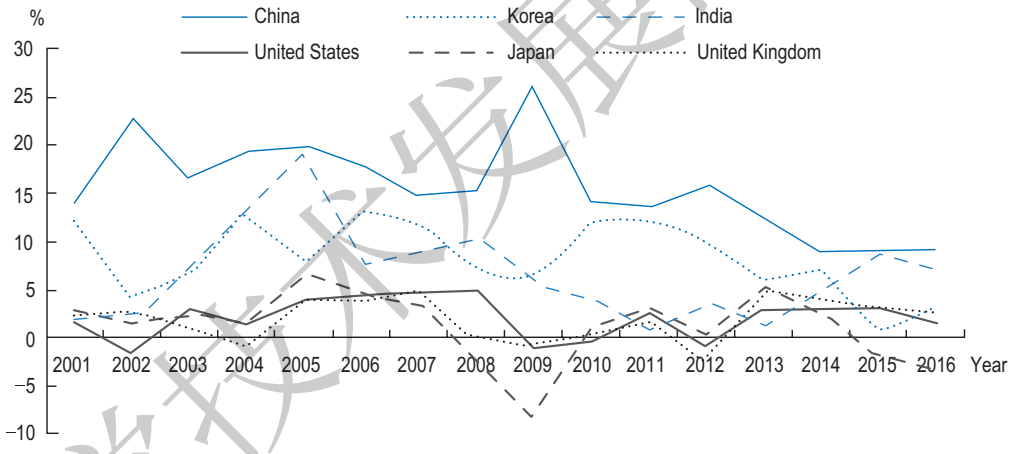


Figure 1-3 R&D expenditure growth of selected countries (On constant price basis)

3. China's R&D intensity steadily increased

In recent years, major developed countries have attached great importance to the role of science, technology and innovation and maintained a high level of their R&D intensity (R&D/GDP). Japan's R&D intensity has stayed at approximately 3% for many years, versus more than 2.5% for the United States; Korea has experienced a rapid growth of R&D intensity, posting more than 4% in recent five years. Although China's R&D intensity is still behind that of developed countries, it has maintained a strong growth momentum, reaching 2.11% in

2016, overtaking the average level of the EU-15 countries for the first time (2.09%) (Figure 1-4). Domestically, China had eight provinces and municipalities whose R&D intensity exceeded 2%, with Beijing's reaching 5.96% and Shanghai's reaching 3.82%.

According to the research data, it took China 13 years to raise its R&D intensity from 1.0% to 2.0%, being on par with Japan, slower than the United States (7 years) and faster than other developed countries such as Australia (22 years), Austria (20 years) and Denmark (17 years). The quick rise of China's R&D intensity marks a profound change in China's investment structure where innovation has become a key driver of economic growth.

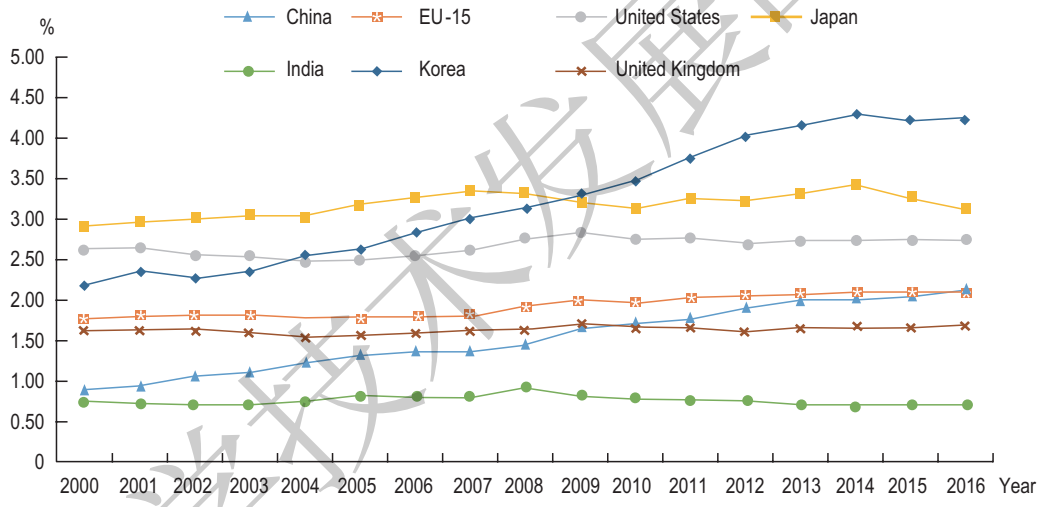


Figure 1-4 R&D intensity of selected countries and regions

4. China consistently led the world in R&D personnel

The number of global R&D personnel has maintained a rapid growth and reached 12.5 million person-years, representing a growth of 73.5% from 2000. In terms of their global distribution, R&D personnel are significantly concentrated in Asia and Europe, which account for 47.7% and 30.3%, respectively, of the global total. Since 2000, most countries, with the exception of a few countries such as Finland, Japan, Romania and the Russian

Federation, have seen a steady growth of R&D personnel, especially emerging economies represented by China and Korea which recorded an average annual growth rate of 9.4% and 7.6%, respectively, significantly higher than the global average growth rate of 3.5%.

China's R&D personnel reached 3.88 million person-years, or 31.0% of the global total, leading the world for the 10th consecutive year. Japan and the Russian Federation, both rich in R&D human resources with more than 800 thousand R&D person-years, saw a steady fall of their share in the global total, to 7.0% and 6.4%, respectively.

Concomitant with the increasing R&D activity of emerging economies has been a significant change in the global distribution of R&D personnel. Compared to 2000 when the total R&D personnel in the BRICS countries accounted for only 32.5% of the global total, the proportion increased to 44.5% in 2016. Meanwhile, the share of developed countries in global R&D personnel has been steadily decreasing, to 37.7% from 50.4% for the G7 countries, lower than the share of the BRICS countries.

(II) Significant Improvement of Knowledge Creation Capacity

Knowledge creation capacity reflects a country's R&D capacity, inventiveness and innovation activity. Internationally published scientific papers (SCI papers) and invention patent applications and grants are key measures of a country's knowledge creation capacity. In recent years, China's output of SCI papers and patents has steadily increased, showing its significantly increased knowledge creation capacity.

1. The impact of China's SCI papers steadily increased[①]

The global SCI papers have kept rising, reaching 1.97 million, 2.2 times the number in 2000. The top three countries in the number of SCI papers continued to be the United States, China and the United Kingdom, respectively, which have kept their positions for many years. The

① Data source: Clarivate Analytics. Statistics have all authors included. Document types: Article and Review.

United States retained its top spot with 407 thousand SCI papers, accounting for 20.7% of the global total. China contributed 308 thousand SCI papers, or 15.7% of the global total, 2.6 times the United Kingdom's.

Since 2000, countries have achieved a varying degree of growth of their SCI papers, with emerging countries like China, Korea, Brazil and India significantly outshining their developed counterparts. Between 2000 and 2016, China posted a 15.7% average annual growth of SCI papers, outstripping other countries by a big margin. Korea, Brazil and India also outperformed the global average annual growth of SCI papers (4.9%) with 10.5%, 10.0% and 9.3%, respectively. In contrast, the United States, Germany, the United Kingdom and Japan had their growth of SCI papers slowed to 2.6%, 3.0%, 3.0% and 0.4%, respectively, with their SCI papers as a percentage of the global total being on a downward trend (Figure 1-5).

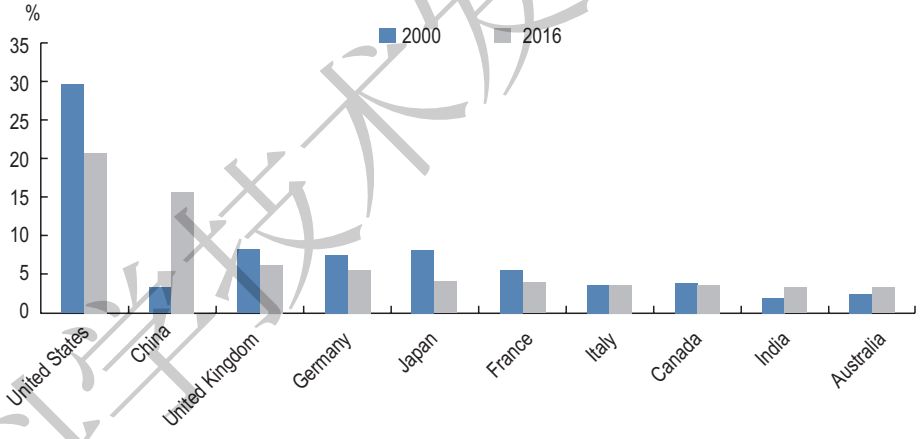


Figure 1-5 SCI papers as a percentage of the global total by country

2. China led the world in invention patent applications and grants[①]

Global invention patents are largely concentrated in four countries—China, the United

① The data of China's resident invention patent applications and grants are inclusive of the data of Hong Kong, Macao and Taiwan.

States, Japan and Korea, which combine to account for approximately 90.0% of the global total. In terms of resident invention patent applications, China continued to lead the world with 1.2 million, or 57.3% of the global total, followed by the United States in the second place (14.1%) and Japan in the third place (12.4%). In terms of resident invention patent grants, China remained in the first place with 302 thousand or 39.5% of the global total, followed by Japan with 21.0% and the United States with 18.8%.

Since 2000, the growth of global invention patent applications and grants have both experienced a slowdown with fluctuations, with some countries experiencing negative growth. Against this backdrop, China maintained a strong performance by posting an average annual growth of 27.3% and 27.5% of resident invention patent applications and grants. Between 2000 and 2016, China contributed 91.4% and 61.9%, respectively, of the global increase of resident invention patent applications and grants. Meanwhile, Japan was on a downward path in its resident invention patent applications, which decreased 29.3% in 2016 from 2000, and it experienced a decline of resident invention patent grants between 2014 and 2015, though the number slightly rebounded in 2016 by posting an increase of 43.1% from the level of 2000 (Figure 1-6).

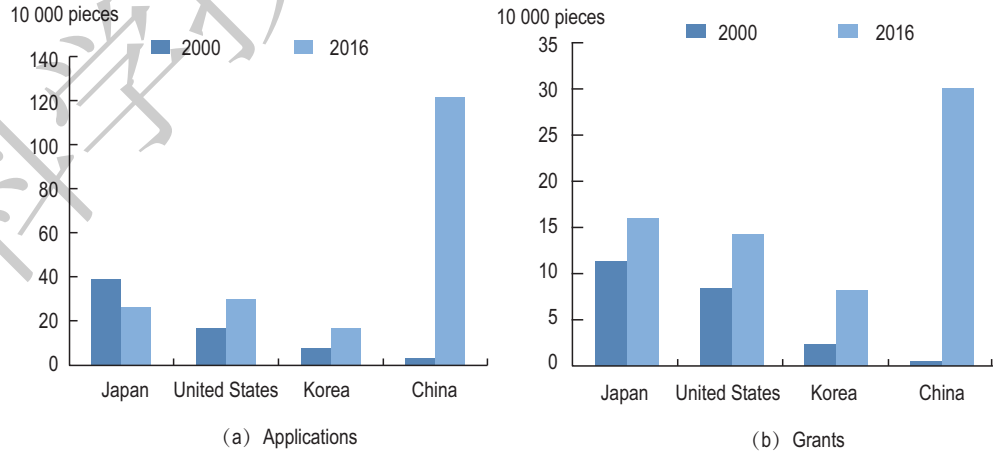


Figure 1-6 Number of resident invention patent applications and grants

While China led the world in resident invention patent applications and grants, it was still significantly behind Korea and Japan in invention patent intensity. In terms of invention patent applications, Korea had 31.9 per ten thousand population, versus 20.5 for Japan, 9.1 for the United States, and 8.7 for China. In terms of invention patent grants, Korea had 16.1 per ten thousand population, versus 12.6 for Japan, 4.4 for the United States, and 2.1 for China.

(III) Increasingly Prominent Contribution of Innovation to Economic Development

Since the reform and opening up, China has maintained a rapid economic growth and become the world's second largest economy. Strong economic growth has ensured China's ability to invest in innovation resources and drive innovation. Innovation has played an increasing role in supporting and leading China's economic and social development and provided an inexhaustible source of economic growth. As the Chinese economy shifts its focus from high-speed growth to high-quality growth, innovation will play an even greater role in supporting its economic development.

1. Transfer of technology achievement yielded fruitful results

The transfer of technology achievement is an important basis for science and technology to promote economic development. The technology market is a bridge and tie connecting R&D and production and an important facilitator of technology achievement transfer. China's technology market has played an increasingly significant role in promoting optimal allocation of domestic S&T resources, accelerating knowledge flow and technology transfer, and facilitating the integration of technology and economy. In 2016, China's technology market saw an unprecedented boom with as many as 320 thousand technology contracts closed, up 39.6% from 2010, and their combined turnover rose to RMB 1.14 trillion, up 192.0% from 2010.

2. Industry structure was continuously optimized

Innovation has played a crucial role in advancing China's supply-side structural reform.

Knowledge-intensive industries which gather high-tech equipment and advanced specialists provide a strong support for the country's supply-side structural reform and industrial upgrading. Knowledge-intensive industries include high-tech industries and knowledge-intensive services. In 2015, the added value of China's knowledge-intensive industries accounted for 19.0% of the global total, double that in 2010, and up 2.7 percentage points from the previous year. High-tech industries are a strategic pillar of the national economy and have achieved a rapid growth in recent years. China's high-tech industries reached RMB15 trillion in revenue from principal business in 2016, double that in 2010, which accounted for 14.7% of revenue from principal business of the manufacturing sector. China's high-tech exports as a percentage of its manufacture exports reached 25.0%.

II. China's Innovation Capacity in the Global Context

The global innovation landscape remained stable on the whole, with the United States, Asia and Europe increasingly asserting themselves as the three giants. Developing countries generally fell behind in the national innovation index(NII). China kept its 17th position from the previous year in the overall NII rankings. China further improved in innovation resources investment and knowledge creation capacity, with its innovation capacity leading other developing countries by a big margin. In comparison with top countries in innovation such as the United States, Japan, Korea and Switzerland, China remained relatively low in NII score, but was catching up. As the Chinese economy transitions from a phase of rapid growth to a stage of high-quality development, China's innovation-driven development should make full use of both technological innovation and institutional reform to accelerate improvement in innovation quality and innovation efficiency in order to support and serve the building of an innovative country.

R&D and innovation have become key tools adopted by major countries to foster new drivers of economic growth. With a global economy still lingering at low levels of growth, global R&D expenditure and innovation activity have been well on track of stable growth. The R&D activity of developed countries has basically returned to the level before the financial crisis, and emerging economies represented by China are quickly catching up. The globalization of innovation has become a rising trend. As indicated by its NII score and ranking movement in recent years, China has performed strongly in innovation-driven development and has been moving ahead steadily to rank among innovative countries.

(I) The Global Innovation Landscape Dominated by Asia, Europe and the United States Became Clearer

The national innovation index is a comprehensive index measuring a country's science, technology and innovation competitiveness. The 40 countries included in this report, distributed across six continents, represent the countries with the largest R&D expenditures in the world. Based on the comparison of the results of previous editions of the *National Innovation Index Report*, the 40 countries can be divided into three groups. Group 1 are the top 15 countries in the ranking, mainly developed countries in Europe and America, which are generally recognized as innovative countries. Group 2 are those ranked from the 16th to the 30th, consisting of other developed countries and a few emerging economies, which face the most intense competition. China ranked towards the top of this group. Group 3 are those ranking after the 30th, mostly developing countries (Figure 2-1).

Overall, the results of this study show that the global innovation landscape remained largely stable. Compared to the previous year, there were less countries moving across groups. Countries in Group 1 included one in America (the United States), four in Asia (Japan, Korea, Israel and Singapore), and ten in Europe (Switzerland, Germany, Denmark, Sweden, Finland, the United Kingdom, the Netherlands, France, Austria and Ireland). Among them, there was only Ireland, which moved up one place from the 16th to enter Group 1, replacing

Norway which fell one place to the 16th into Group 2. For movements between Group 2 and Group 3, Greece made its way from Group 3 to Group 2 by improving one spot from the 31st to the 30th, and Turkey moved the other way round by falling four places to the 34th. All other movements were slight movements within their respective groups (Table 2-1).

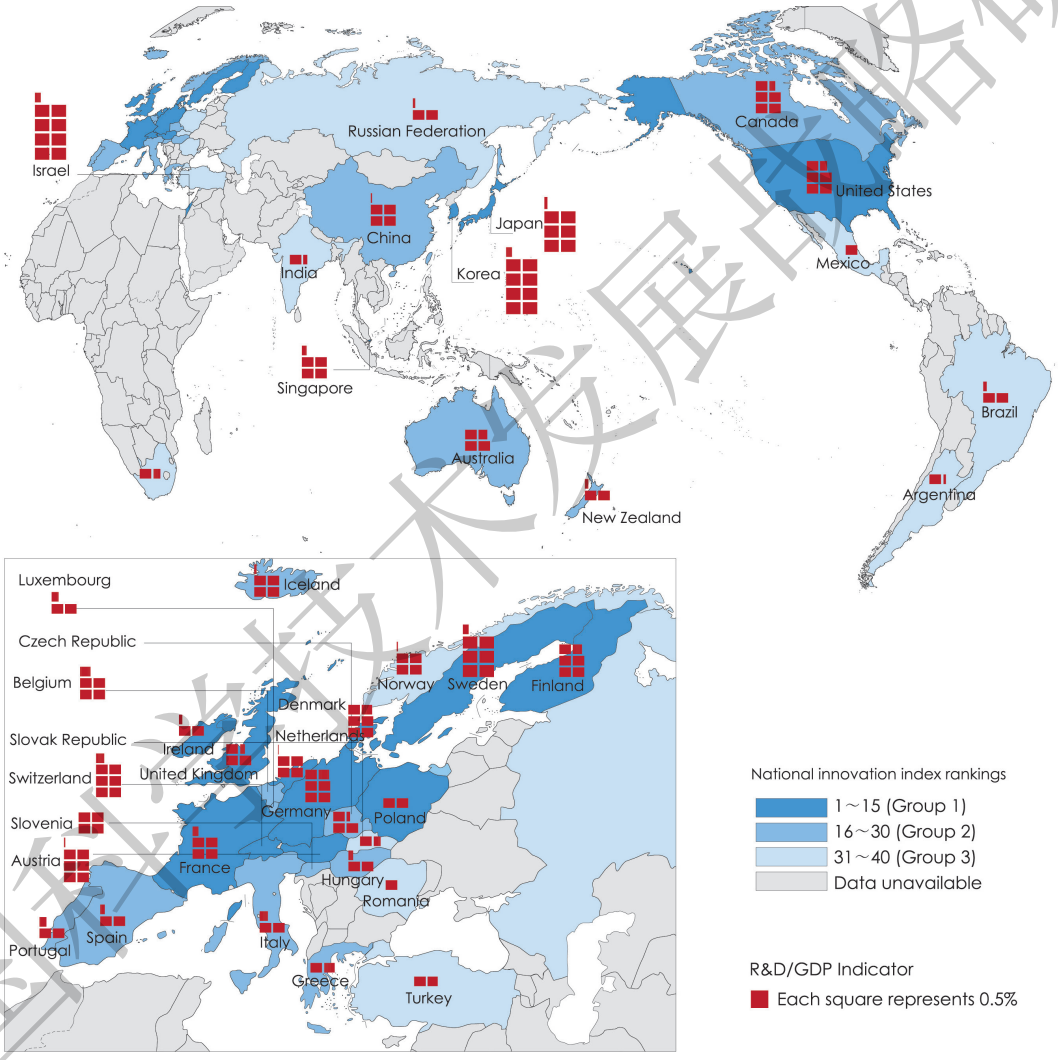


Figure 2-1 Innovation capability of countries

Table 2-1 National innovation index rankings by group of countries

Rank	Group 1	Rank movement	Rank	Group 2	Rank movement	Rank	Group 3	Rank movement
1	United States	0	16	Norway	–1	31	Poland	1
2	Japan	0	17	China	0	32	Romania	2
3	Switzerland	0	18	Iceland	3	33	Russian Federation	0
4	Korea	0	19	Belgium	–1	34	Turkey	–4
5	Germany	2	20	Luxembourg	0	35	Slovak Republic	0
6	Denmark	–1	21	Australia	–2	36	South Africa	0
7	Sweden	–1	22	New Zealand	0	37	Mexico	0
8	Israel	5	23	Slovenia	1	38	India	0
9	Singapore	0	24	Canada	–1	39	Brazil	0
10	Finland	1	25	Italy	0	40	Argentina	0
11	United Kingdom	–1	26	Spain	0			
12	Netherlands	–4	27	Czech Republic	0			
13	France	–1	28	Portugal	0			
14	Austria	0	29	Hungary	0			
15	Ireland	1	30	Greece	1			

In the NII rankings, the United States had advantages across the board and figured toweringly in the world. It continued to rank the first in the overall NII rankings by ranking within the top three in five first-level indicators and the first in innovation resources. Europe was a strong performer as a region in innovation capacity, having ten countries in Group 1 and dominating Group 2 as well. Among European countries, Switzerland improved by two places in enterprise innovation and kept its third position in the overall rankings; Germany and Finland ranked the 5th and the 10th, increasing two places and one place respectively; Scandinavian countries i.e. Denmark and Sweden ranked the 6th and the 7th, respectively; and the United Kingdom dropped one place in innovation resources and nine places in

knowledge creation, with its overall NII ranking falling one place to the 11th. Major Asian countries performed strongly. Japan and Korea, supported by their outstanding scores in enterprise innovation and knowledge creation, ranked the 2nd and the 4th, respectively; Israel ranked the 3rd in innovation resources and the 4th in enterprise innovation and improved in knowledge creation by five places to the 33rd, with its overall NII ranking rising to the 8th; Singapore, which ranked the 4th in innovation performance and the 1st in innovation environment, came in the 9th place in the overall rankings; China improved by three places in innovation resources and one place in knowledge creation and further improved in innovation environment, with its overall NII ranking coming in the 17th place; India, though ranked low at the 38th in the overall rankings, progressed remarkably in innovation, benefiting from its rapid economic growth in recent years.

(II) China Performed Prominently as a Developing Country

China kept its 17th position in the overall NII rankings, being the only developing country to rank among the top 20. While China's GDP per capita stood at USD 8123, only higher than that of India and South Africa among the 40 countries in this report, its NII score was close to European countries' with a GDP per capita of approximately USD 50 000 (Figure 2-2). In other words, China's innovation capacity substantially surpassed that of other countries at a comparative level of economic development.

A country's NII score is closely related to its stage of economic development. As shown in Figure 2-2, there is a remarkable positive correlation between the index score and GDP per capita: countries with a higher GDP per capita tend to have a higher index score. Most countries fall within the stripe between the two dashed lines in Figure 2-2, which represents the normal pattern of the development of countries. Only a few countries are located above the stripe, including the United States, Japan, Korea and China. One thing in common with these countries is that their governments all attach great importance to the role of science, technology and innovation in national development. The United States implements a strategy

designed to ensure its comprehensive global leadership in science and technology; Japan focuses on technology and intellectual property rights as the foundation of its national development; and Korea maintains a high R&D intensity and supports a greater role of large corporations in making breakthroughs in specific areas.

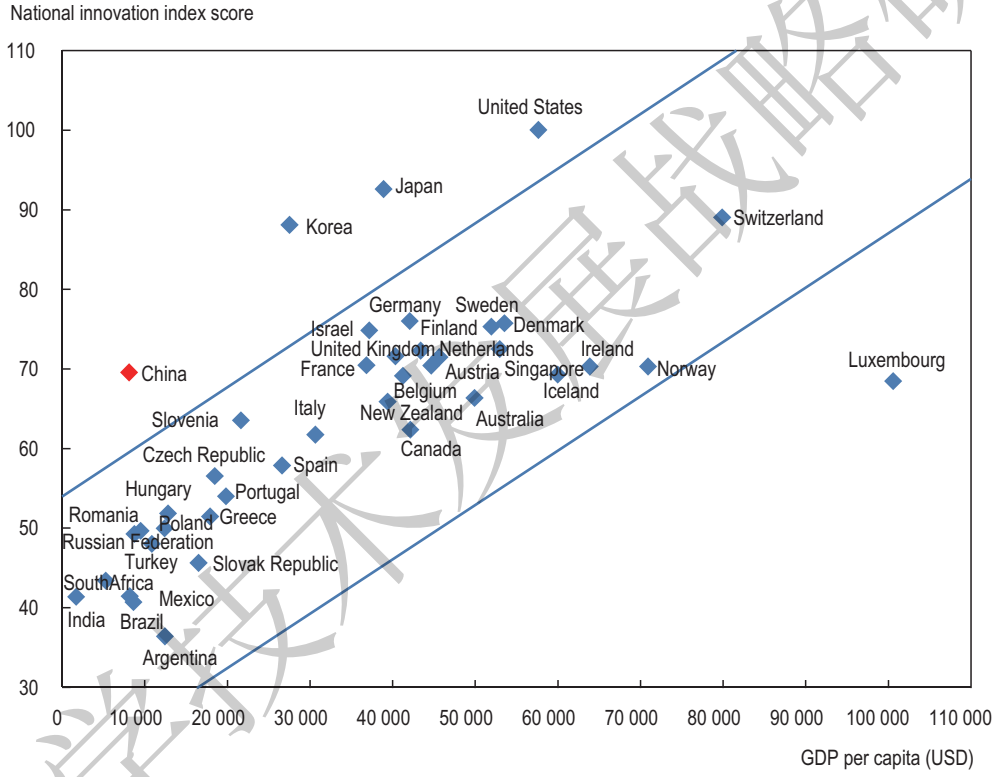


Figure 2-2 GDP per capita and national innovation index score

International organizations such as the World Bank and the International Monetary Fund generally use GDP per capita as the main criterion to determine the stage of development of countries. Analysis of GDP per capita data puts China together with Brazil, Romania, Mexico and the Russian Federation in terms of the stage of development (Table 2-2). As shown in the table, although China is behind the rest four countries in GDP per capita, China is far ahead of them in R&D intensity and innovation output, with all the four

countries falling in Group 3 and progressing very slowly. China is the only country in the group to have a R&D intensity of more than 2%, with its R&D expenditure being more than five times the combined R&D expenditure of the four countries and its invention patents in force being approximately seven times those of the four countries combined, though it is behind Mexico and the Russian Federation in the efficiency of output of papers and patents. China is in a leading position in the overall NII rankings among Group 2 countries.

Table 2-2 Comparison of China and comparable countries in key indicators and their NII rankings

	GDP per capita (USD)	R&D intensity (%)	S&T papers per ten thousand researchers	Invention patents in force per ten thousand population (Pieces)	High-technology exports as a percentage of manufacture exports (%)	NII ranking
China	8123	2.11	1820	8.0	25.0	17
Mexico	8209	0.50	4868	0.2	15.3	37
Brazil	8650	1.28	2575	0.1	13.4	39
Russian Federation	8748	1.10	843	10.6	10.7	33
Romania	9520	0.48	4441	0.6	8.5	32

The BRICS countries, as representatives of emerging market countries, have received a lot of attention from the international community. With the exception of China, all the rest of the BRICS members ranked behind the 30th. The Russian Federation ranked the 33rd, leading Group 3 countries. South Africa, India and Brazil ranked towards the bottom of Group 3 at the 36th, the 38th and the 39th, respectively.

China led the BRICS countries in all the five first-level indicators—innovation resources, knowledge creation, enterprise innovation, innovation performance and innovation environment. In innovation resources, China's score was 0.6 ahead of the Russian Federation, compared with 1.7 behind the latter in the previous year, mainly thanks to China's steadily

increasing R&D expenditure, but China was still somewhat behind the Russian Federation in R&D personnel intensity, higher education gross enrollment ratio and informatization. In knowledge creation, China ranked the 7th with a score of 51.2, outclassing South Africa in the 20th place by 10.3. In enterprise innovation, China ranked the 11th with a score of 59.7, further expanding its strength, with the Russian Federation, the second-ranked among the BRICS countries, taking the 23rd place in the indicator with 41.1. In innovation performance, China ranked the 18th with a score of 55.9, leading Brazil in the 29th place by 20.2 with a clear comparative edge. In innovation environment, China rose to the 16th with its score improving by 2.6 to 85.0, and India, which ranked the second among the BRICS countries, ranked the 21st among all countries in the study with a score of 82.1 (Figure 2-3).

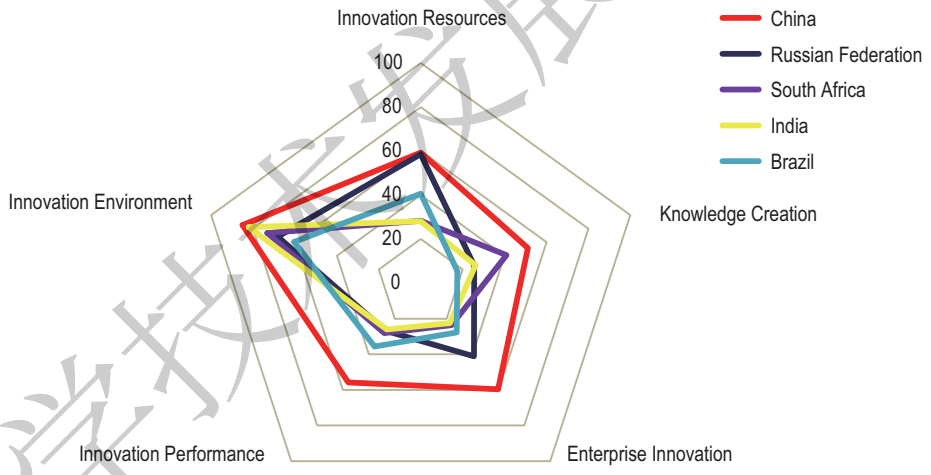


Figure 2-3 Comparison of BRICS countries in first-level indicators

Overall, China has the fastest progress among developing countries with steadily increasing R&D expenditure and a world-leading position in R&D personnel and scientific output such as patents and papers, but in terms of its performance in key economic and innovation indicators, it shows typical characteristics of a developing country. China needs to keep a moderately fast growth of innovation resources and gradually transition from factor-

driven to innovation-driven development to support its leapfrog development in the future.

(III) China's Development Potential Benefited from Improved Innovation Quality and Efficiency

China progressed hugely in innovation capacity. As shown in Figure 2-4, China's NII ranking moved up from the 38th in 2000 to the 17th. In spite of some fluctuations in the process, the overall trajectory was upward. Since 2009, in particular, China has not been seriously affected by the weak global economic conditions, showing a steady improvement in its overall innovation capacity. China's NII score, standing at 69.5, was 0.8~2.8 behind countries that ranking between the 10th and the 15th such as the United Kingdom, France and Ireland. In overall score, China was behind Norway in the 16th place by a thin margin of only 0.8. Therefore, judging from China's NII score and development trend, its innovation capacity improvement outlook looks highly optimistic.

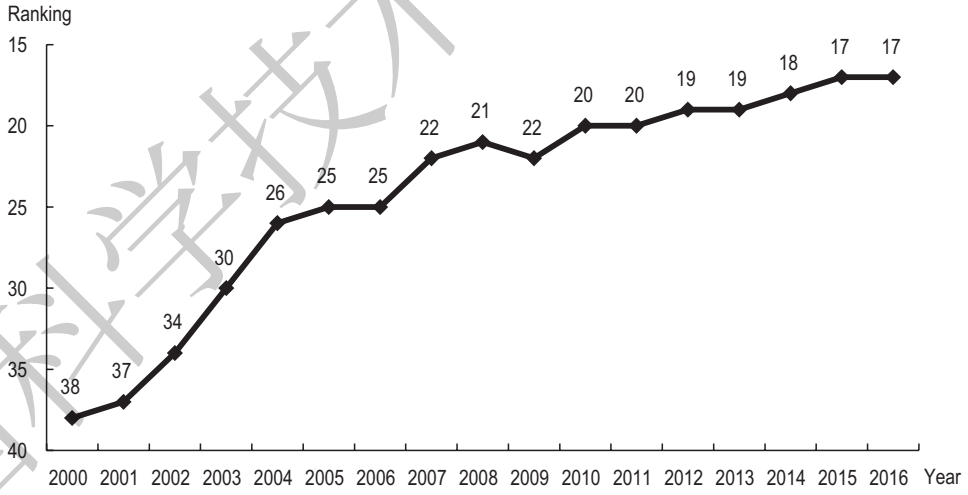


Figure 2-4 China's NII rankings

China had a varying degree of progress in five first-level indicators of the NII. The most

impressive progress of China since 2005 is in the indicator of knowledge creation, driven by the rapid growth of scientific output such as published scientific papers and patents, with its ranking in this indicator jumping by a whopping 30 places from the 37th in 2005 to the 7th in 2016, underscoring China's significantly increasing influence in the international R&D landscape. In the innovation performance indicator, China improved by 11 places to the 18th in 2016, thanks to China's substantial growth of intellectual properties and its rapidly developing knowledge-intensive industries. In enterprise innovation, China ranked the 11th, up 6 places from 2005, reflecting the steady improvement of Chinese enterprises' innovation capacity and international competitiveness. In innovation environment, China moved up from the 27th to the 16th. Innovation resources was the indicator where China made the slowest progress with its ranking staying at around the 30th during the 11th Five-year Plan period—bottoming at the 33rd in the 2007–2008—before making into the top 30 during the 12th Five-year Plan period and reaching the 25th in 2016 with an improvement of five places from 2012. This has something to do with China's population and economic size, because it is inherently difficult for a country like China to grow in an intensity indicator measured with population and economic size as the denominator. In this indicator, there will be a lot of work to do for China in a long run (Table 2-3).

Table 2-3 China's rankings in first-level indicators of NII

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment	NII ranking
2005	31	37	17	29	27	25
2006	32	34	17	28	28	25
2007	33	34	14	28	27	22
2008	33	33	12	25	23	21
2009	31	32	18	24	16	22
2010	30	29	15	18	18	20
2011	30	24	15	14	19	20
2012	30	18	15	14	14	19

Continued

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment	NII ranking
2013	29	19	13	11	13	19
2014	27	12	12	11	19	18
2015	28	8	11	12	20	17
2016	25	7	11	18	16	17

In comparison with leading innovative countries such as the United States, Japan and Korea, China scored relatively low in the NII rankings and was significantly behind due to a weak foundation and inadequate accumulation of innovation resources. In the four first-level indicators other than innovation environment, China was far behind the United States, Japan and Korea which were top-ranked in those indicators with a full score of 100[①] (Figure 2-5). Specifically, China scored below 60 in innovation resources, knowledge creation, enterprise innovation and innovation performance at 59.2, 51.2, 59.7 and 55.9, respectively. Compared to its scores in the previous release, China declined only in innovation performance due to a difficult global economic situation; it improved by 1.8, 6.6 and 1.9, respectively, in innovation resources, knowledge creation and enterprise innovation, further narrowing its gap with the top-ranked United States, Japan and Korea in the respective indicators, and by 2.6 points in innovation environment, becoming closer to Singapore. The movement of China's NII scores indicates both that China had a significant gap with the top-ranked United States, Japan and Korea in first-level indicators and that China was on a stable upward track in innovation capacity and set to further close its gap with the benchmark countries.

① In benchmarking calculation, the top-scoring country in an indicator among the 40 countries gets a full score of 100.

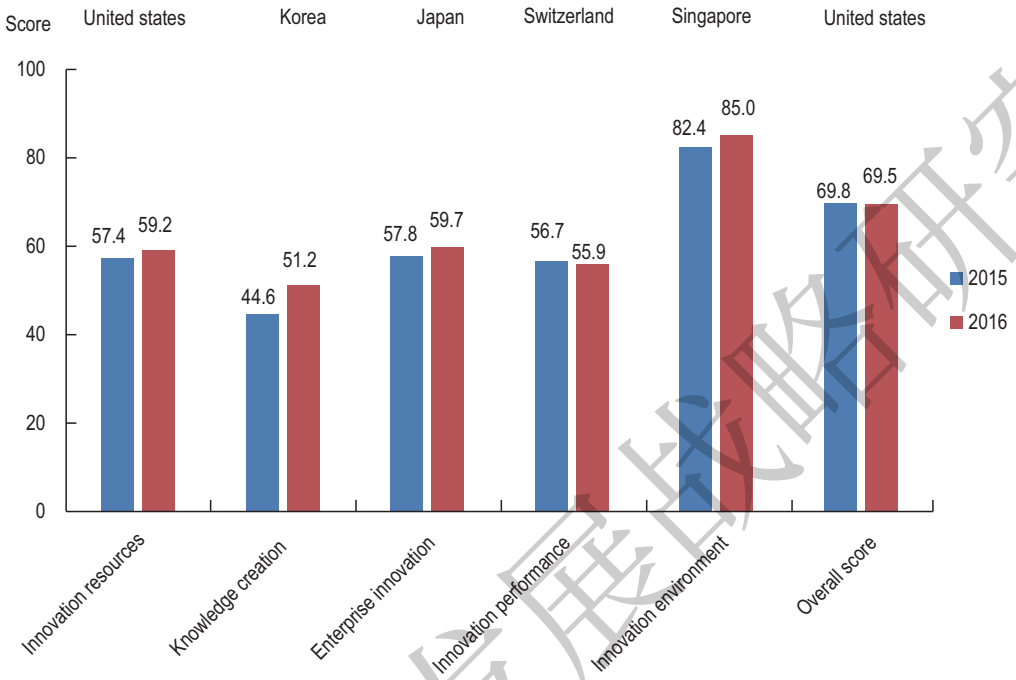


Figure 2-5 China's indicator and index scores compared to top-ranked countries

The potential of China's innovation capacity improvement comes from the improvement of its innovation quality. In recent years, China's R&D expenditure has maintained a fast growth, surpassing Japan to become the world's second largest country in R&D expenditure in 2013, with its R&D expenditure increasing from less than 10% of the United States' in 2005 to approximately 46% in 2016, and quickly closing the gap with the United States in papers and invention patents as well. Qualitative change arises from quantitative change. With the improvement of quality and the influence of innovation input and output, China's advantage in the scale of innovation will gradually play out and gradually close the gap between China and developed countries in innovation capacity to reshape the international innovation landscape.

The potential of China's innovation capability improvement comes from the increase of its innovation efficiency. China's advantage in innovation capability building lies in its huge

scale of innovation activities, and the future development potential will mainly depend on the improvement of innovation efficiency. Due to China's population size and development stage, its scores in indicators calculated on a per capita basis such as efficiency of scientific output, labor productivity, and economic output per unit of energy use, were lower than that of not only the OECD countries but even countries like Brazil and South Africa. China's performance in these measures of innovation efficiency and quality points to the direction of China's future innovation capability building. Going forward, China needs to step up its efforts to advance digitalization and increase the level of education to promote the transition of its human resources advantage from low-cost workers to high-caliber specialists and create more dividend in terms of talent and digitalization for its innovation capacity improvement.

The growth potential of China's innovation capacity comes from the innovation vitality released by the country's comprehensive deepening of reforms. In recent years, China has pushed ahead with its government system reform and achieved key breakthroughs with major measures. They include: 1) strengthening coordination of innovation resources with the focus on basic research and frontier research to optimize the national strategic research force and the overall design of the national innovation system; 2) deepening the project review, talent evaluation and institution evaluation reforms and further strengthening research integrity and ethics to create a comprehensive innovation service system; 3) stepping up performance-oriented incentives to promote research result transformation; 4) streamlining administration and delegating government powers and introducing policies that offer financing support for small- and micro-sized enterprises and tax incentives for high-tech enterprises and their innovation activities to unleash the potential of "mass entrepreneurship and innovation"; and 5) summarizing in a timely way experience from innovation and reform pilot programs in different regions and promoting relevant advanced practices to effectively drive the comprehensive implementation of the national innovation-driven development strategy.

To sum up, China's innovation activity is still in a stage of rapid growth. China needs to maintain the steady growth of R&D expenditure, give full scope to the advantages and

potential of its domestic market, push ahead with its research system reform, and steer and support the innovation transition towards high-quality development in order to continuously increase innovation performance and productivity and accelerate the pace of building an innovative country.

III. Assessment on National Innovation Index Indicators

In the innovation resources sub-index, China ranked the 25th with a score of 59.2, up three places from the previous year. Among the five second-level indicators, China made into the top 15 in two indicators and kept its places in four. Asian developed countries were high-ranked with Korea, Israel, Japan and Singapore staying in Group 1. The BRICS countries generally ranked low in innovation resources.

China ranked the 7th in the knowledge creation sub-index with a score of 51.2, up 1 place from the previous year, which was the only one of the five sub-indexes where China ranked among the top 10. Among the five second-level indicators, China's ranking improved in three and remained unchanged in two. China was high-ranked in three indicators relating to patents and low-ranked in two indicators relating to papers. Among Asian countries, Korea, Japan and China were prominent performers. The BRICS countries showed a pattern of polarization.

China kept its 11th place from the previous year in the enterprise innovation sub-index with a score of 59.7. It performed well in five second-level indicators, making into Group 1 in four indicators. In the indicator of PCT applications per ten thousand researchers in business enterprises, China took the 22nd place, up 5 places from the previous year. Asian countries performed prominently in Group 1, with Japan, Korea and Israel ranking among the top five.

China ranked the 18th in the innovation performance sub-index with a score of 55.9, down 6 places from the previous year. Among the five second-level indicators, China ranked among the top 15 in three and near-bottom-ranked in two, especially in the labor productivity indicator where it ranked the 2nd to last. High-ranked countries on the NII generally had a balanced performance in second-level indicators. Among the BRICS countries, Brazil made into Group 2 for the first time.

China had the highest score in the innovation environment sub-index among the five sub-indexes, with a score of 85.0, which put it in the 16th position on this sub-index, up 4 places. It entered the top ten in four of the ten second-level indicators with a gradient distribution in ranks in other indicators, including six improved over the previous year. Asian countries performed well on the NII as a whole. Among the BRICS countries, only the Russian Federation and Brazil were in Group 3.

(I) Significant Progress in Innovation Resources Input

Innovation resources, which cover a country's input in innovation activities and its reserve of human resources for innovation and allocation of innovation resources, provide the fundamental guarantee for a country to conduct innovation activities on a continuous basis. The sub-index of innovation resources consists of five second-level indicators, i.e. R&D expenditure intensity, R&D personnel intensity, higher education gross enrollment ratio, networked readiness and R&D expenditure as a percentage of the world. This sub-index measures a country's ability to allocate innovation resources in terms of manpower, funding and material supplies.

1. China improved by three places and Group 1 remained stable

In the innovation resources sub-index, China ranked the 25th with a score of 59.2, up three positions from the previous year (Figure 3-1). Among the five second-level indicators measuring innovation resources, China improved only in R&D expenditure intensity where it moved up 3 places to the 14th, and kept its positions from the previous year in the rest four indicators.

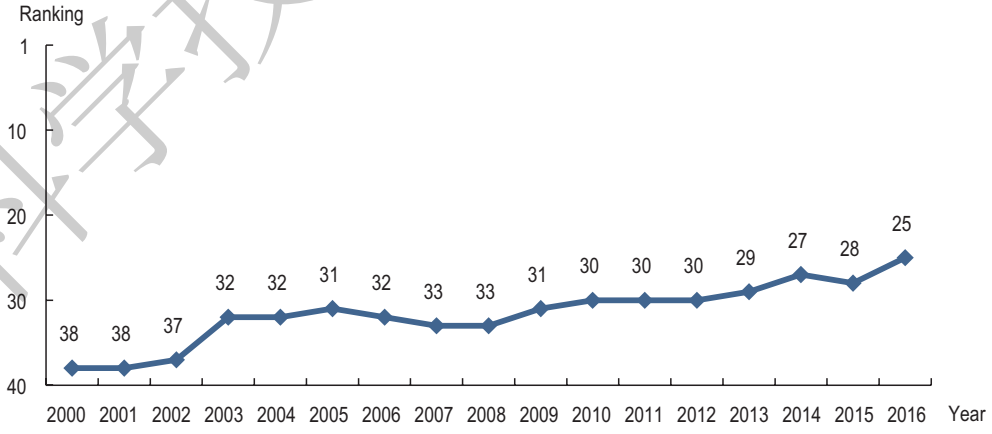


Figure 3-1 China's rankings in the innovation resources sub-index

The top 15 countries in the innovation resources sub-index were the United States,

Korea, Israel, Denmark, Finland, Switzerland, Sweden, Japan, Austria, Germany, Iceland, Norway, the Netherlands, Singapore and Belgium, respectively. Compared to the previous year, Belgium was the only new face among the top 15, which replaced Australia to make into Group 1.

2. China ranked high in R&D expenditure intensity and low in R&D personnel intensity

Among the five second-level indicators, China made into the top 15 internationally in two indicators in 2016 by keeping its 2nd place in R&D expenditure as a percentage of the world and improving by 3 places to the 14th in R&D expenditure as a percentage of GDP. China kept its places unchanged at below the 30th in three other indicators. China ranked the 33rd in both total R&D personnel per ten thousand population and networked readiness index and the 36th in higher education gross enrollment ratio (Figure 3-2).

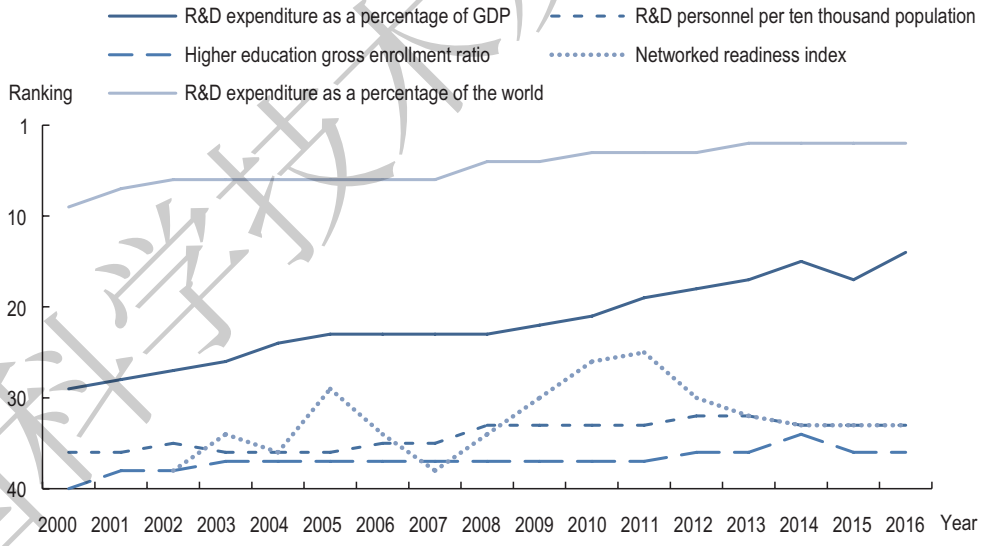


Figure 3-2 China's rankings in indicators of the innovation resources sub-index

China underperformed and ranked among Group 2 countries in innovation resources

compared to its performance in the other four first-level indicators. This was mainly due to the serious imbalance of its performance in the second-level indicators of innovation resources. In R&D expenditure, China has been high-ranked for more than ten years and firmly secured No. 2. China has been on a stable upward trajectory and in the upper middle class globally in R&D expenditure in recent years. China was in a world-leading position in the scale of R&D resources and personnel, but underperformed in higher education gross enrollment ratio and R&D personnel intensity, falling behind in the rankings worldwide without much improvement. In addition, its ranking in networked readiness index was subject to significant fluctuations and basically stayed beyond the 30th over the past years.

3. Developed Asian countries ranked in the top echelon and the BRICS countries trailed behind overall

Among the six Asian countries on the NII, Korea, Israel, Japan and Singapore were in Group 1 in the innovation resources sub-index, with the first three countries ranking among the top 10. China was in Group 2. India in the 40th place in this sub-index was at the bottom of Group 3. Historically, China and Korea have shown a remarkable upward trajectory in innovation resources since 2000, with their ranking jumping from the 38th and the 10th, respectively, in 2000 to the 25th and the 2nd, while Singapore's ranking fell 6 places to the 14th from the 8th. Japan, Israel and India were stable in their positions in this sub-index.

The BRICS countries were low-ranked overall in innovation resources input, staying near the bottom among the 40 major countries. The Russian Federation ranked the 27th in innovation resources, Brazil the 36th, South Africa the 39th and India the 40th.

(II) Slight Improvement in Knowledge Creation

Performance in knowledge creation is a direct manifestation of a country's innovation capacity and indicative of its scientific output and overall S&T strength. In this report, the knowledge creation sub-index uses five second-level indicators, including S&T papers

citations per million R&D expenditure in academic institutions, S&T papers per ten thousand researchers, patents in force as a percentage of the world, invention patent applications per million population, and invention patent grants per 100 million US dollars of GDP, to measure the countries' level of knowledge creation and application.

1. China climbed up one position and Group 1 countries had slight position movements

China ranked the 7th in the knowledge creation sub-index with a score of 51.2, up one position from the previous year (Figure 3-3). Among the five second-level indicators of knowledge creation, China's ranking improved in three and remained unchanged in two. China improved by one position in three indicators, i.e. S&T papers per ten thousand researchers, invention patent applications per million population and invention patent grants per 100 million US dollars of GDP, where it ranked the 36th, the 4th and the 3rd, respectively. It retained its positions from the previous year in S&T papers citations per million R&D expenditure in academic institutions at the 30th and patents in force as a percentage of the world at the 3rd.

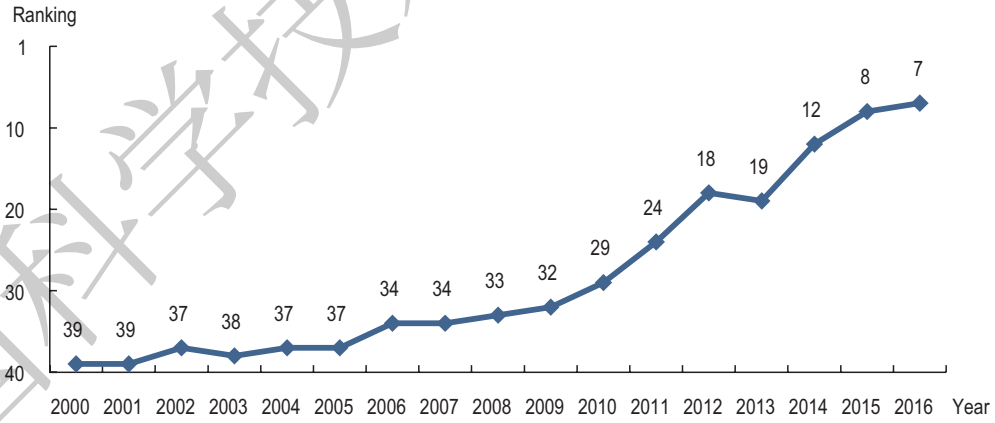


Figure 3-3 China's rankings in the knowledge creation sub-index

The top 15 countries in knowledge creation were Korea, Japan, the United States, Slovenia, Italy, Iceland, China, Switzerland, Hungary, Romania, New Zealand, Australia, the

Netherlands, Spain and the United Kingdom, respectively. Iceland and Romania were new faces in Group 1, replacing Belgium and South Africa. Other countries with the exception of Korea which retained its top position all had movement in their ranking positions.

2. China led the world in patent output with paper output efficiency leaving room for improvement

The five second-level indicators of knowledge creation mainly reflect the scale and efficiency of paper and patent output. China was high-ranked in three indicators relating to patents and low-ranked in two indicators relating to papers. It ranked the 3rd in patents in force as a percentage of the world, the 4th in invention patent applications per million population and the 3rd in invention patent grants per 100 million US dollars of GDP. China ranked the 30th in S&T papers citations per million R&D expenditure in academic institutions and the 36th in S&T papers per ten thousand researchers, pointing to a lot of room for improvement in paper output efficiency and overall influence (Figure 3-4).

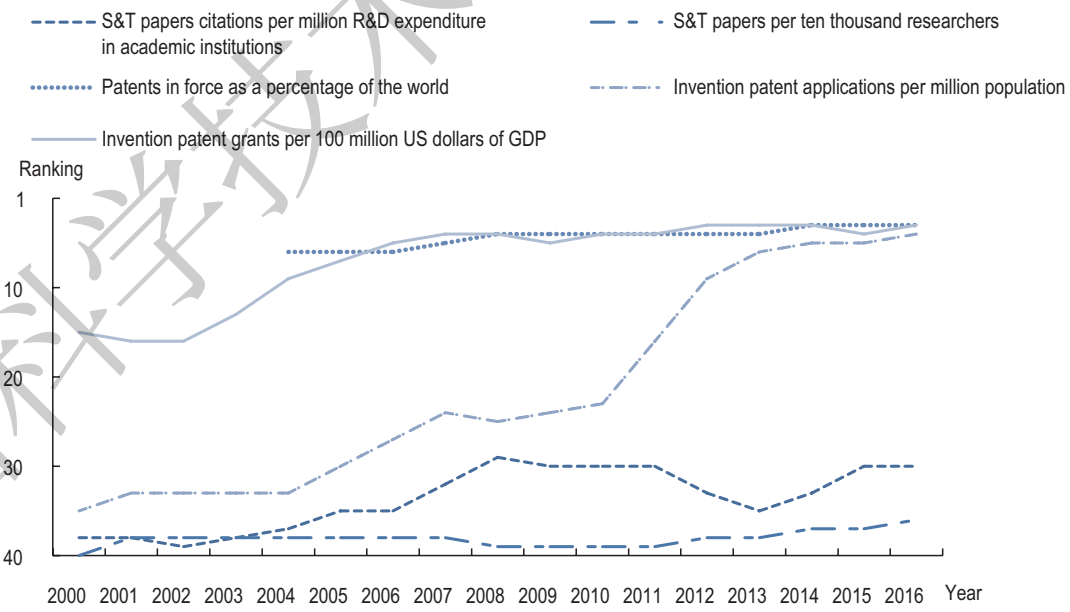


Figure 3-4 China's rankings in indicators of the knowledge creation sub-index

China achieved varying degrees of improvement from 2000 in all the five second-level indicators. Improvement was slow in S&T papers citations per million R&D expenditure in academic institutions and S&T papers per ten thousand researchers, with an increase of only eight places and four places, respectively. Improvement in invention patent grants per 100 million US dollars of GDP was significant by going up 12 places. The greatest improvement was in invention patent applications per million population, with the position jumping up from the 35th in 2000 to the 4th in 2016.

3. China, Japan and Korea led Asian countries and the BRICS countries polarized

Among Asian countries, Korea, Japan and China were high-ranked in the knowledge creation sub-index at the 1st, the 2nd and the 7th place, respectively. Singapore, Israel and India were low-ranked at the 31st, the 33rd and the 36th, respectively. With the exception of invention patent applications per million population which ranked the 6th, Singapore was behind the 20th in all other indicators of knowledge creation. Israel failed to enter Group 1 in any of the five second-level indicators, especially in S&T papers per ten thousand researchers which ranked the 35th, leading to its low ranking in knowledge innovation. Among these countries, China achieved the greatest improvement by moving up 32 places from the 39th in 2000 to the 7th in 2016.

China was the only outperformer among the BRICS countries and the only BRICS country to enter Group 1. South Africa was in Group 2 at the 20th. India, the Russian Federation and Brazil consistently ranked in the bottom ten, coming in the 36th, the 37th and the 39th place, respectively, in 2016.

(III) Stable Performance in Enterprise Innovation

Enterprises are the main actors of innovation and feature importantly in the national innovation system. The scale and quality of a country's enterprise innovation represents,

to a large extent, its national innovation capacity and level. This report measures enterprise innovation activity from a country perspective using five indicators—triadic patent families as a percentage of the world, business enterprise R&D expenditure as a percentage of value added, PCT applications per ten thousand researchers in business enterprises, technology independence, and business enterprise researchers as a percentage of total researchers.

1. China retained its position and countries in Group 1 remained stable

China kept its 11th place in the enterprise innovation sub-index with a score of 59.7 (Figure 3-5). China improved slightly in three of the five second-level indicators of enterprise innovation, i.e. triadic patent families as a percentage of the world, business enterprises expenditure on R&D as a percentage of value added and PCT applications per ten thousand researchers in business enterprises. It kept its position from last year in business enterprise researchers as a percentage of total researchers and fell six places in technology independence.

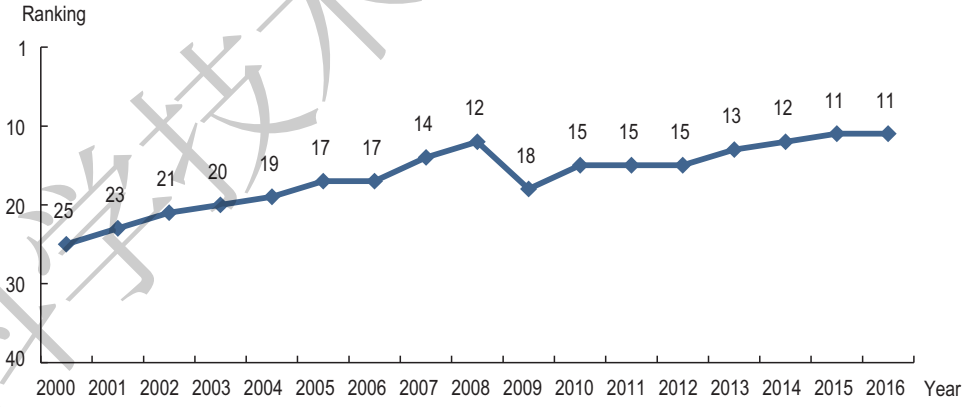


Figure 3-5 China's rankings in the enterprise innovation sub-index

The top 15 countries in the enterprise innovation sub-index were Japan, the United States, Korea, Israel, Germany, Sweden, Switzerland, France, Austria, Finland, China, Denmark, Luxembourg, Belgium and Slovenia. Most of them kept their positions from

the previous year, with Belgium being the only new face in the top 15 in place of the Netherlands. France dropped three places to the 8th.

2. China performed strongly in all second-level indicators with an impressive improvement in PCT applications efficiency

China was a strong performer in the enterprise innovation sub-index, having been steadily moving up since 2010 when it entered Group 1. China's rankings in the five second-level indicators were overall balanced. With the exception of PCT applications per ten thousand researchers in business enterprises where it ranked the 22nd, China was in Group 1 in all the rest four indicators by ranking the 4th in triadic patent families as a percentage of the world, the 15th in business enterprises expenditure on R&D as a percentage of value added, the 12th in technology independence and the 7th in business enterprise researchers as a percentage of total researchers (Figure 3-6).

In terms of the degree of improvement over the previous year, China had the biggest improvement in the indicator of PCT applications per ten thousand researchers in business enterprises by going up five places from 2016, but its ranking in the indicator was still behind its rankings in the other second-level indicators. Indeed, the indicator was the only second-level indicator of enterprise innovation where China was in Group 2. It shows that while China ranked the 3rd for the fourth consecutive year in total PCT applications, it still relatively fell behind in PCT applications in terms of output efficiency.

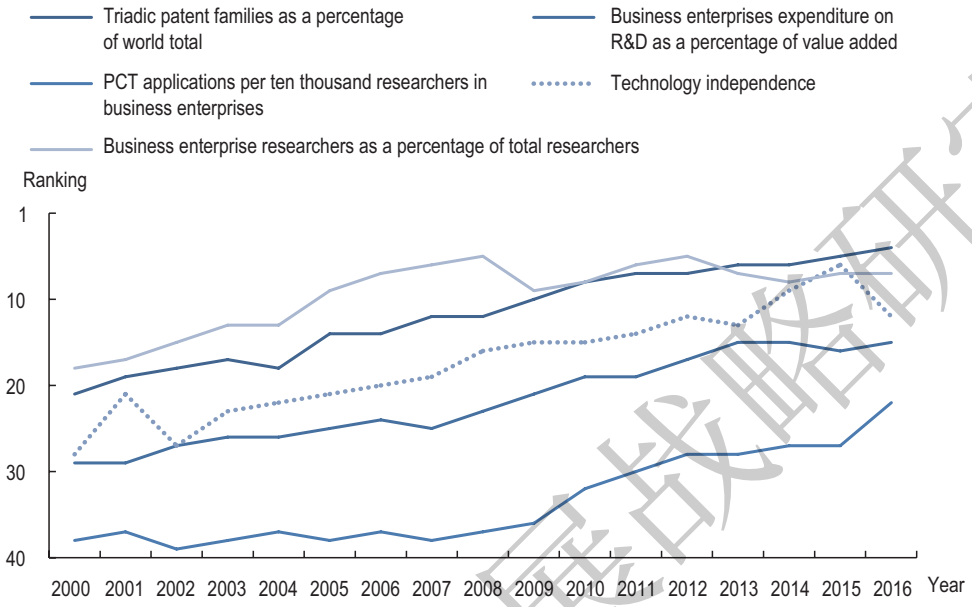


Figure 3-6 China's rankings in indicators of the enterprise innovation sub-index

3. Asian countries performed saliently and BRICS countries diverged in performance

Among the top 15 countries in the enterprise innovation sub-index, Asian countries had the best performance. Japan, Korea and Israel not only were high-ranked at the 1st, the 3rd and the 4th respectively in the sub-index but performed saliently in its five second-level indicators as well. Japan was the only country that made into top five in all five second-level indicators. Korea was in top ten in four second-level indicators and in top five in three. Israel ranked the 1st in two second-level indicators.

The BRICS countries diverged in their performance in the enterprise innovation sub-index, where China stayed in Group 1, the Russian Federation was in Group 2 at the 23rd, and Brazil, South Africa and India were low-ranked at the 37th, the 38th and the 39th, respectively. However, Brazil ranked the 7th in business enterprises expenditure on R&D as a percentage of value added and South Africa ranked the 11th in PCT applications per ten thousand researchers in business enterprises.

(IV) Stable Performance in Innovation Performance with a Slight Decline

Innovation performance epitomizes the effectiveness and impact of a country's innovation activity. The innovation performance sub-index consists of five second-level indicators, including labor productivity, GDP per unit of energy use, value added of knowledge-intensive services as a percentage of GDP, high-technology exports as a percentage of manufacture exports, and value added of knowledge-intensive industries as a percentage of the world, which measure and evaluate the output of innovation activities and their contribution to economic development, which are used to measure and assess innovation activity's output and contribution to economic growth.

1. China's ranking declined and three countries fell out of Group 1

China fell 6 places from the previous year to the 18th in the innovation performance sub-index with a score of 55.9 (Figure 3-7). However, it held exactly the same positions as in the previous year in all the five second-level indicators. This was mainly because while China's values for the five second-level indicators remained unchanged from the previous year, other countries improved to varying degrees, leading to lower scores for China in those indicators and to China's lower ranking in the innovation performance sub-index, which fell out of Group 1 into Group 2.

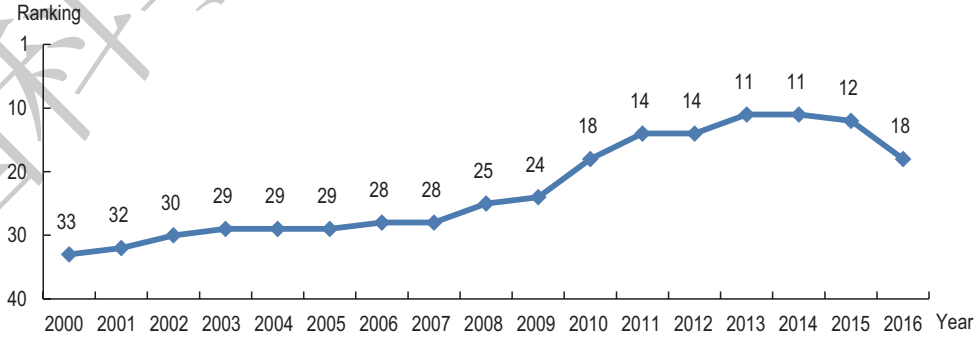


Figure 3-7 China's rankings in the innovation performance sub-index

The top 15 countries in the innovation performance sub-index were Switzerland, the United States, Ireland, Singapore, the United Kingdom, Denmark, Norway, Australia, France, Luxembourg, the Netherlands, Sweden, Belgium, Japan and Iceland. With the exception of the Netherlands, Belgium and Iceland, the other countries remained in Group 1 in the previous year as well.

2. Performance polarized in second-level indicators and China's economic transformation faced challenges

China ranked in top 15 in three of the five second-level indicators of innovation performance and near the bottom in two other indicators (Table 3-1). In spite of China's gradual improvement in labor productivity and GDP per unit of energy use since 2000, the progress has been insignificant, with its ranking remaining in the bottom five. It has always ranked at the second to last in labor productivity since 2000 and the 36th in GDP per unit of energy use since 2010. China has improved quickly in value added of knowledge-intensive services as a percentage of GDP and has stayed at the 12th in Group 1 since 2015. China performed prominently in high-technology exports as a percentage of manufacture exports and value added of knowledge-intensive industries as a percentage of the world and basically stayed in Group 1. Between 2009 and 2014, in particular, it ranked in top five in the two indicators. China's ranking in high-technology exports as a percentage of manufacture exports fell back in 2015 and has stayed there since then. This indicates that China's innovation performance remained mainly driven by the scale of its high-technology industries and high-technology output and under a huge pressure in transforming its mode of economic development and upgrading its industries.

Table 3-1 China's rankings in indicators of the innovation performance sub-index

Year	Labor productivity	GDP per unit of energy use	Value added of knowledge-intensive services as a percentage of GDP	High-technology exports as a percentage of manufacture exports	Value added of knowledge-intensive industries as a percentage of world total
2000	39	37	35	16	8
2001	39	35	35	14	7
2002	39	36	35	10	7
2003	39	38	35	6	7
2004	39	39	34	6	7
2005	39	39	34	6	6
2006	39	40	34	6	5
2007	39	40	34	6	5
2008	39	38	35	6	3
2009	39	37	34	4	3
2010	39	36	30	3	3
2011	39	36	29	3	2
2012	39	36	23	2	2
2013	39	36	20	2	2
2014	39	36	20	3	2
2015	39	36	12	6	2
2016	39	36	12	6	2

3. Leading countries showed a balanced performance in the second-level indicators and Brazil entered Group 2

The top nine countries in the innovation performance sub-index showed a balanced performance in the second-level indicators. Switzerland, the United States, Ireland and the United Kingdom had the best performance, each having two indicators where they ranked in top ten. The other countries each had two indicators where they ranked in top ten and none of them had any indicator where they were beyond the 30th.

The BRICS countries other than China were rather low-ranked, with Brazil coming at the 29th, South Africa the 37th, the Russian Federation the 38th and India the 39th. In terms of their performance in the second-level indicators, value added of knowledge-intensive industries as a percentage of the world was the only indicator where the Russian Federation, Brazil and India got into Group 1.

(V) Performance in Innovation Environment Bottoming out

A country's innovation environment provides an important basis and guarantee to improve its innovation capacity. The innovation environment sub-index consists of ten second-level indicators: intellectual property protection, burden of government regulation, macroeconomic environment, local availability of specialized training services, effectiveness of anti-monopoly policy, venture capital availability, pay and productivity, state of cluster development, university-industry collaboration in R&D and government procurement of advanced technology products. These indicators and data are all cited from the *Global Competitiveness Reports* released by the World Economic Forum over the years.

1. China improved by four places and Japan fell out of Group 1

China had a score of 85.0 in the innovation environment sub-index, its highest score among the five sub-indexes, and its ranking, after two years of decline, rallied back and improved from the 20th in the previous year to the 16th (Figure 3-8). China's performance in the innovation environment sub-index had been in a state of fluctuation since 2005. Between 2005 and 2009, its ranking gradually edged up with slight fluctuation and reached the 16th in 2009 before falling to the 19th in the subsequent years and then improved to the 13th in 2013, only to fall to the seven-year low of the 20th in 2015. Among the ten second-level indicators, China's ranking improved in six and declined in three.

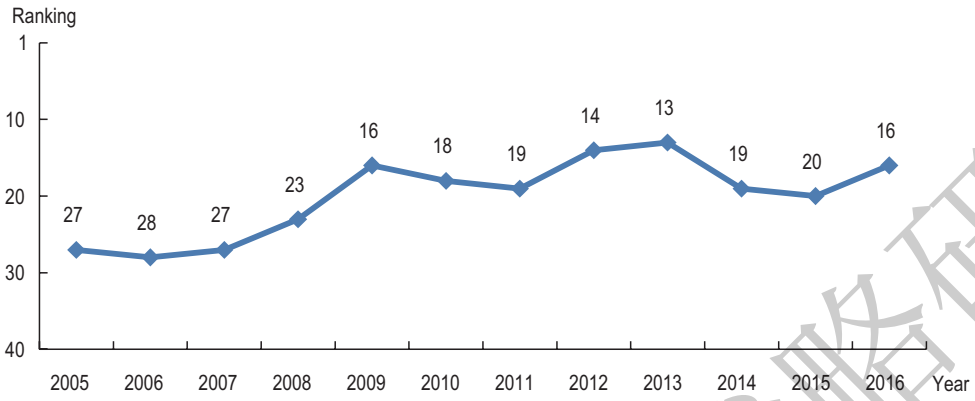


Figure 3-8 China's rankings in the innovation environment sub-index

Among the 40 countries, the top 15 countries in the innovation environment sub-index were Singapore, the United States, Switzerland, Germany, Finland, the Netherlands, Sweden, Luxembourg, Norway, the United Kingdom, New Zealand, Israel, Denmark, Ireland and Belgium. Denmark was the only new face in top 15, replacing Japan which fell to the 18th from the 15th in the previous year.

2. China improved in most second-level indicators, especially in intellectual property protection

China made into top 15 in four second-level indicators of innovation environment: burden of government regulation, macroeconomic environment, venture capital availability and government procurement of advanced technology products. Specifically, China fell five places from the previous year to the 11th in macroeconomic environment, an all-time low, and moved up two places in burden of government regulation and venture capital availability. It was relatively low-ranked in intellectual property protection and local availability of specialized training services, of which it jumped up five places in the former after two years of decline and moved up one place in the latter (Table 3-2).

Table 3-2 China's rankings in indicators of the innovation environment sub-index

Indicator	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Intellectual property protection	35	30	21	28	28	27	25	32	33	28
Burden of government regulation	10	6	5	7	6	3	6	9	9	7
Macroeconomic environment	2	5	1	5	4	3	4	4	6	11
Local availability of specialized training services	28	29	32	30	33	30	33	34	33	32
Effectiveness of anti-monopoly policy	36	34	28	28	28	27	22	24	21	22
Venture capital availability	33	28	12	11	12	8	5	11	9	7
Pay and productivity	7	5	12	9	28	5	9	18	20	17
State of cluster development	18	15	12	12	16	18	18	18	16	19
University-industry collaboration in R&D	22	20	22	24	26	25	25	25	23	22
Government procurement of advanced technology products	16	12	6	8	8	3	4	4	6	6

3. China had the biggest progress in innovation environment and Asian countries performed well on the whole

Asian countries performed rather well in innovation environment on the whole. Singapore and Israel were in Group 1 at the 1st and the 12th, respectively; China, Japan, India and Korea were in Group 2 at the 16th, the 18th, the 21st and the 23rd, respectively.

In innovation environment, China, India and South Africa were in Group 2 and the Russian Federation and Brazil in Group 3. South Africa, the Russian Federation and Brazil ranked the 26th, the 33rd and the 38th, respectively. The Russian Federation improved by two places from the previous year, while India and Brazil kept their positions and South Africa fell one place.

IV. China's Innovation Capacity Development and Evolution

Historically, China's national innovation capacity has been steadily increasing, but it still faces a huge challenge to enter Group 1. Between 2000 and 2016, China has been on a clear upward trend in innovation resources, knowledge creation, enterprise innovation and innovation performance, posing an average annual growth rate of 10.0% in innovation resources, 15.2% in knowledge creation, 16.9% in enterprise innovation and 10.5% in innovation performance, in addition to improvement in six of the ten indicators of innovation environment.

China has been steadily progressing, at different levels of development, in all the 12 indicators specified in the 13th Five-Year STI Development Plan (Hereinafter referred to as "Plan"). In 2017, China rose to the second place in the international ranking in S&T paper citations, meeting the Plan target three years in advance. Remarkable progress has been made in some other indicators. The Plan targets in operating revenue of high-tech enterprises and R&D expenditure of industrial enterprises above designated size as a percentage of revenue from principal business were both more than 80% completed. The Plan targets in PCT patent applications and resident invention patents in force per ten thousand population were 67.2% and 61.4% completed, respectively. Stable improvement was achieved in several indicators. The targets in value-added of knowledge-intensive services as a percentage of GDP and MFP contribution to economic growth were 53.3% and 53.2% completed, respectively. Scientific literacy rose to 8.47% in 2018, representing a 59.7% completion of the Plan target in this indicator. The growth was slower than expected in some indicators. The Plan target in R&D expenditure as a percentage of GDP was 15.9% completed. The targets in R&D personnel per ten thousand employees, turnover of the national technology contracts and international ranking in the national innovation index were all approximately 30% completed.

(I) China's Movement in the National Innovation Index

1. The basic pattern of China's movement in the NII

In today's world, competition in core innovation factors is becoming increasingly intense, with developed countries emphasizing innovation capacity buildup to maintain their leading positions and emerging economies scaling up investment in innovation in a bid to catch up with and surpass developed countries by way of overtaking on the corners. Since the new century, China has substantially stepped up investment in innovation resources, accompanied by a quick improvement in knowledge creation and application, enterprise innovation, innovation performance, and innovation environment. The movement of NII shows its closing gap with innovative countries in innovation capacity.

Since 2000, China has undergone three five-year plan periods. Examining China's performance in the NII on a "five-year plan" basis can provide a better picture of China's innovation capacity development. The 16 years after 2000 have seen China steadily increase its innovation capacity on a trajectory of exponential growth overall. This is clear based on a comparison of China's performance in the NII in the three five-year periods, as revealed by its scores in 2000, 2005 and 2010. According to data, China's NII score increased by 55% from 2000 to reach 155 in 2005 (Figure 4-1). With the promulgation and implementation of the *National Program for Long- and Medium-Term Scientific and Technological Development (2006–2020)* and related measures, China's score improvement accelerated with a 76% growth (Figure 4-2) in the 11th Five-Year Plan period. During the 12th Five-Year Plan period, China's NII score maintained a strong momentum of growth on the basis of the high levels by growing 55% (Figure 4-3). The score reached 167 in 2016, representing an increase of 67% from 2010. With the steady improvement of its innovation capacity, China is getting increasingly closer to Group 1. China has entered the decisive stage in its drive to build an innovative country.

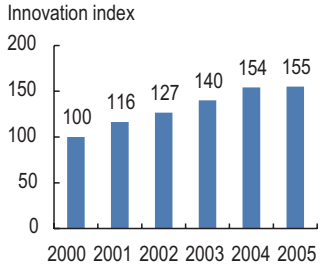


Figure 4-1 China's rankings in the national innovation index during the 10th Five-Year Plan period

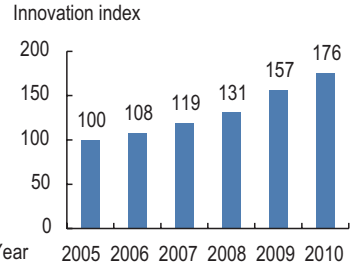


Figure 4-2 China's rankings in the national innovation index during the 11th Five-Year Plan period

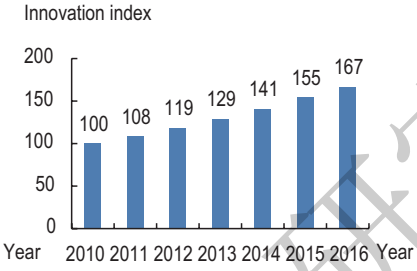


Figure 4-3 China's rankings in the national innovation index during the 12th Five-Year Plan period

2. Factors underlying China's movement in the NII

Except for the innovation environment sub-index where it progressed slowly with slight fluctuation, China has been steadily improving in the rest sub-indexes including innovation resources, knowledge creation, enterprise innovation and innovation performance, especially in enterprise innovation which achieved the fastest growth and reached 1219 in 2016, approximately 12 times that in 2000 (Table 4-1).

Table 4-1 China's scores in first-level indicators of NII

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment
2000	100	100	100	100	
2001	113	105	137	110	
2002	127	110	151	118	
2003	143	122	170	126	
2004	155	133	188	141	
2005	150	150	223	154	100
2006	163	169	257	171	98
2007	200	197	307	197	102
2008	220	211	352	233	108
2009	257	262	521	257	115
2010	282	300	603	295	112

Continued

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment
2011	309	366	656	339	109
2012	346	445	776	379	112
2013	380	549	845	419	112
2014	418	665	960	450	111
2015	451	801	1111	491	113
2016	456	957	1219	493	113

Capital, human resources and information resources are essential to innovation activity. Between 2000 and 2016, China's investment in innovation resources maintained a strong growth, with the average growth of 10.0% in the innovation resources sub-index during the period. The past 16 years saw China's R&D expenditure increase 17 times, which as a percentage of the global total jumped from 1.7% in 2000 to 16.1% in 2016. China's R&D expenditure as a percentage of GDP increased from 0.9% to 2.11%, higher than the average of the 15-member EU. China's human resources in innovation grew significantly as well, with its R&D personnel per ten thousand population increasing from 7.3 to 28.1 person-years. Its higher education gross enrollment ratio jumped from 7.7% to 42.7%. The rapid increase of investment in innovation resources, which is the foundation for improving the national innovation capacity, has provided a basic support for China's economic and industrial transformation.

S&T papers and patents are outcomes of knowledge generation activity and a direct output of innovation activity. Between 2000 and 2016, China's R&D strength improved quickly, achieving an average annual growth of 15.2% in the score of knowledge creation sub-index. The period saw China's S&T papers per ten thousand researchers increase by 3.2 times. China's invention patents grants per 100 million US dollars of GDP in 2016 were 3.6 times the number in 2000. The improvement in knowledge creation and conversion has provided a strong support for China's innovation activity and significantly boosted its original innovation capacity.

Given enterprises as the main actors of technological innovation, enterprise innovation is a core factor determining a country's innovation capacity. The "mass entrepreneurship and innovation" and other related policies have helped to boost China's enterprise innovation capacity quickly. Between 2000 and 2016, China's score in the enterprise innovation sub-index posted an average annual growth of 16.9%, representing the fastest growth among the five sub-indexes. China's triadic patent families as a percentage of the world increased from less than 0.2% in 2000 to 5.6% in 2015. China's PCT applications per ten thousand researchers in business enterprises increased from 22.0 to 411.1 pieces in 2016, representing an increase of 18.7 times. As Chinese enterprises become increasingly conscious of intellectual property protection and compete with their international counterparts, there will be an even stronger improvement in Chinese enterprises' innovation capacity.

Innovation performance is measured by the extent to which innovation promotes economic development, industrial structure optimization and social progress, which is the goal of innovation activity. Historically, China's innovation performance maintained a steady upward trend, recording an average annual growth of 10.5% in the innovation performance sub-index from 2000 to 2016. China's labor productivity increased from USD 2 thousand per person to USD 14 thousand per person in the same period. And its GDP per unit of energy use increased 2.4 times from USD 1.0 per kg of oil equivalent to USD 3.6 per kg of oil equivalent. Compared to other first-level indicators, innovation performance has a certain time lag. With the continuous accumulation of innovation resources and the steady improvement of enterprise innovation capacity, China's innovation performance still has a significant potential of improvement.

Innovation environment is where innovation activity takes place. Since the promulgation and implementation of the *National Program for Long- and Medium-Term Scientific and Technological Development*, China's innovation environment has improved greatly. Compared to 2005, China improved to varying degrees in seven of the ten indicators of innovation environment in 2015, posting the greatest improvement in venture capital

availability, and it slightly declined in two indicators and remained at the same level in one indicator. With the accelerated implementation of a slew of new policies supporting innovation and entrepreneurship, China's innovation environment is set to improve further.

The national innovation index has been included in China's 13th Five-Year STI Development Plan. The Plan states explicitly that efforts will be made to substantially increase China's scientific and technological strength and innovation capacity, make giant strides in innovation-driven development and place China in the top 15 countries in the national innovation index by 2020. China's advantage in innovation lies in its huge scale of innovation factors, and its future development potential will mainly depend on the improvement of innovation quality and efficiency. Efforts which should be made during the 13th Five-Year plan period include: 1) unwaveringly stepping up input of innovation resources while paying more attention to the intensity, structure and efficiency; 2) further increasing knowledge creation to provide a solid foundation for the improving of original innovation capacity; 3) continuing to leverage the role of science and technology in leading economic development, substantially improving enterprises' technological innovation capacity, developing high-tech industries, strategic emerging industries and knowledge-intensive services, and supporting economic transformation and industrial restructuring with science, technology and innovation; 4) highlighting the contribution of innovation to economic development and social progress and relying on innovation to break energy, resource and environmental constraints facing economic and social development to steadily improve innovation performance; and 5) strengthening the market economy system, promoting free competition, strengthening the legal environment including intellectual property protection, facilitating university-industry collaboration in R&D, and fostering a policy, legal and technological service environment that is favorable to innovation.

(II) Progress and Prospect of Indicator Targets in China's 13th Five-Year STI Development Plan

1. Analysis of progress in indicator targets

The 13th Five-Year Plan period is the crucial stage of China's effort to build a moderately prosperous society in all respects and innovation-driven country, and a key period which will see the comprehensive deepening of the national science and technology system and the thorough implementation of the innovation-driven development strategy. To accelerate strategic guidance, highlight innovation-driven development, and further emphasize innovation quality and innovation capacity building, China's 13th Five-Year STI Development Plan sets forth targets in 12 indicators of innovation, such as national innovation capacity, investment in innovation resources, output of innovation activity, structural adjustment for innovation-driven development, and environment of innovation and entrepreneurship (Table 4-2).

Table 4-2 Indicators and targets in China's 13th Five-Year STI Development Plan

	Indicator	2015	2017	2020 Indicator target
1	National innovation capacity ranking	18	17	15
2	MFP contribution to economic growth (%)	55.3	57.8	60
3	R&D expenditure as a percentage of GDP (%)	2.06	2.13	2.5
4	R&D personnel per ten thousand employees (Person-years)	48.5	52.0	60
5	Operating revenue of high-technology enterprises (RMB trillion)	22.2	31.8	34
6	Value-added of knowledge-intensive services as a percentage of GDP (%)	15.5	17.9*	20
7	R&D expenditure of enterprises above designated size as a percentage of revenue from principal business (%)	0.9	1.06	1.1
8	International ranking in S&T paper citations	4	2	2
9	PCT patent applications (10 000)	3.05	5.1	Doubled
10	Invention patents in force per ten thousand population(Pieces)	6.3	9.8	12
11	Turnover of national technology contracts (RMB 100 million)	9835	13 424	20 000
12	Scientific literacy (%)	6.2	8.47	10

Note: Value-added of knowledge-intensive services as a percentage of GDP in 2017 is forecasts; 8.47% is the data of scientific literacy in 2018.

According to the expected trend of normal development, all indicator targets should have been 40% completed in 2017, the second year of the 13th Five-Year Plan period. An analysis of the progress in the indicators has the following findings.

Firstly, the target in one indicator, i.e. output of papers, has been completed ahead of time. In 2017, China rose to the second place in its international ranking in S&T paper citations, meeting the Plan target three years in advance.

Secondly, far-stronger-than-expected growth has been registered in four indicators, including patent output and other indicators reflecting enterprises' innovation expenditure and innovation capacity. Since the implementation of the *Action Plan for the Further Implementation of the National Intellectual Property Strategy (2014–2020)*, China has made a rapid improvement in international competitiveness and strength of patent output by posting more than 50 thousand PCT patent applications and 9.8 resident invention patents per ten thousand population in 2017, representing 67.2% and 61.4% completion of the Plan targets, respectively. With the opening of the National Conference on Science, Technology and Innovation and the roll-out of the *Outline of the National Strategy of Innovation-Driven Development*, the implementation of the innovation-driven development strategy has picked up speed, accompanied by the rapid growth of enterprises' R&D expenditure and innovation capacity. R&D expenditure of industrial enterprises above designated size as a percentage of revenue from principal business increased from 0.9% in 2015 to 1.06% in 2017, completing the Plan target by 80%. Operating revenue of high-technology enterprises increased from RMB 22.2 trillion in 2015 to RMB 31.8 trillion in 2017, representing 81.4% completion of the Plan target.

Thirdly, stable growth has been achieved in three indicators reflecting industrial structure optimization, role of science and technology in supporting economic transformation, and innovation environment. Science and technology played a greater role in supporting economic transformation with value added of knowledge-intensive services as a percentage of GDP increasing from 15.5% in 2015 to 17.9% in 2017 to complete the Plan target by

53.3%. MFP contribution to economic growth rose to 57.8%, representing an improvement of 2.5 percentage points from 2015. Innovation environment continued to improve, with scientific literacy increasing from 6.2% in 2015 to 8.47% in 2018 to complete the Plan target by 59.7%.

Finally, the growth was slower than expected in four indicators, including R&D intensity and general indicators reflecting the transformation of R&D results and innovation-driven country building. China's R&D expenditure as a percentage of GDP reached 2.13% in 2017, up 0.07 percentage point from 2015, completing only 15.9% of the Plan target, representing the smallest progress among the 12 indicators. The number of R&D personnel per ten thousand employees reached 52 person-years, up 7.2% from 2015, completing only 30.4% of the Plan target. Turnover of the national technology contract reached RMB 1342.4 billion in 2017, up 36.5% from 2015, completing the Plan target by 35.3%. China's national innovation capacity ranking reached the 17th in 2017, up 1 place from 2015, completing the Plan target by 33.3%.

2. Outlook on accomplishment of Plan targets

Since the onset of the 13th Five-Year Plan period, China has made giant strides in science, technology and innovation development. In the indicator of international ranking in S&T paper citations, in particular, it not only has completed the Plan target ahead of time but is moving to even higher levels. The following section is an outlook on the progress of the Plan targets not yet accomplished.

Firstly, five Plan targets are expected to be accomplished ahead of time. In operating revenue of high-tech enterprises and R&D expenditure of industrial enterprises above designated size as a percentage of revenue from principal business, targets have been more than 80% completed. Operating revenue of high-tech enterprises has maintained an average annual growth of approximately 20% since 2015 and is expected to reach RMB 34 trillion in 2018 to overachieve the Plan target. Since the onset of the 13th Five-Year Plan period, China has placed a greater emphasis on economic and industrial transformation and the

quality of economic development, leading to increasing government and enterprise focus on innovation, with enterprise R&D expenditure increasing from 8.2% in 2015 to 11.6% in 2016 and 12.5% in 2017. Based on the growth trajectory of enterprise R&D expenditure in recent two years, R&D expenditure of industrial enterprises above designated size as a percentage of revenue from principal business is expected to grow 0.08% annually in the coming several years and reach the Plan target at the end of 2018. The Plan targets in PCT patent applications and resident invention patents in force per ten thousand population are 67.2% and 61.4% completed, respectively. Based on their average annual growth of 29.3% and 24.7%, respectively, over the recent two years, the Plan targets in these two indicators are expected to be achieved in 2018. In addition, China's knowledge-intensive services have seen excellent development since 2010, with value-added of knowledge-intensive services as a percentage of GDP having posted an average annual growth of 17.5% and expected, based on this growth trend, to meet the Plan target in 2019.

Secondly, the Plan targets in two indicators, namely turnover of the technology contract and scientific literacy, are expected to be achieved at the end of the 13th Five-Year Plan period. With the accelerated implementation of the mass entrepreneurship and innovation policy and the steady improvement of the entrepreneurship and innovation environment, transformation of R&D results will be brought to greater fruition. For the turnover of the national technology contract to meet the Plan target of RMB 2 trillion in 2020, it needs to maintain an average annual growth of 14.2%, lower than the average annual growth of 16.8% during the first two years of the 13th Five-Year Plan period. Therefore, the Plan target will be achieved as planned. China's national scientific literacy in 2018 is 2.27 percentage points higher than that in 2015. Based on this growth rate, it will exceed 10% in 2020, meeting the Plan target as planned.

Thirdly, significant challenges are expected for the accomplishment of two indicators, namely R&D expenditure as a percentage of GDP and R&D personnel per ten thousand employees. Recent years have seen China's R&D expenditure growth rate decline

significantly, which fell below 20% in 2012 and went down all the way to below 10% in 2014. If the growth rate in the coming several years maintains the average level of the recent two years, the indicator will reach 2.25% in 2020, being still some way from the Plan target. Suppose that China's GDP growth maintains its rate achieved in the recent two years in the coming three years, and then the national total R&D expenditure will need to exceed RMB 2.5 trillion for it to account for 2.5% of GDP in 2020 or, in other words, maintain an average annual growth of more than 12%, far higher than the average annual growth of 8.6% in the recent two years. Therefore, it will require a lot of efforts to accomplish the Plan target in R&D expenditure as a percentage of GDP. Due to the slowdown of R&D personnel growth, the growth rate of R&D personnel per ten thousand employees has decreased from 7.6% during the 12th Five-Year Plan period to 3.0% in the recent two years. Based on the growth rate in the recent two years, the indicator will reach 57.7 person-years in 2020, being 2.3 person-years less than the Plan target.

Finally, uncertainty is expected for the accomplishment of two indicators, i.e. MFP contribution to economic growth and international ranking in the national innovation index. China's MFP contribution to economic growth reached 57.8% in 2017, close to the Plan target of 60%. The indicator is a composite indicator measuring the contribution of technological advancements to economic growth, which has to do with the economic cycle and the inherent pace of technological development. As a relative indicator, it is subject to factors including economic growth, fixed asset growth, intangible asset growth and labor growth. Therefore, the accomplishment of the Plan target for this indicator will face a certain uncertainty. China needs to further transform its pattern of economic development, reduce the reliance of economic growth on investment, and make innovation the core driving force of economic development, transformation and upgrading. China currently stays in the most competitive Group 2 in the national innovation index. All countries have had a full realization of the important role played by innovation in improving economic strength and competitiveness. China's upward movement in the rankings is determined not only by its own innovation capacity improvement but also the movements of other countries in the rankings.

Therefore, China still needs to make unrelenting efforts to achieve the goal of ranking in the top 15 in the NII and become an innovation-driven country by 2020. In the second half of the 13th Five-Year Plan period, China should remain relentlessly committed to increasing investment in innovation resources while paying more attention to the intensity and structure of investment; further substantially improve knowledge innovation and enterprise innovation capacity and rely on innovation to breaking through the energy, resource and environmental constraints of economic and social development to make steady progress in innovation performance; and create a favorable policy, legal and economic environment for innovation.

National Innovation Index Report 2018

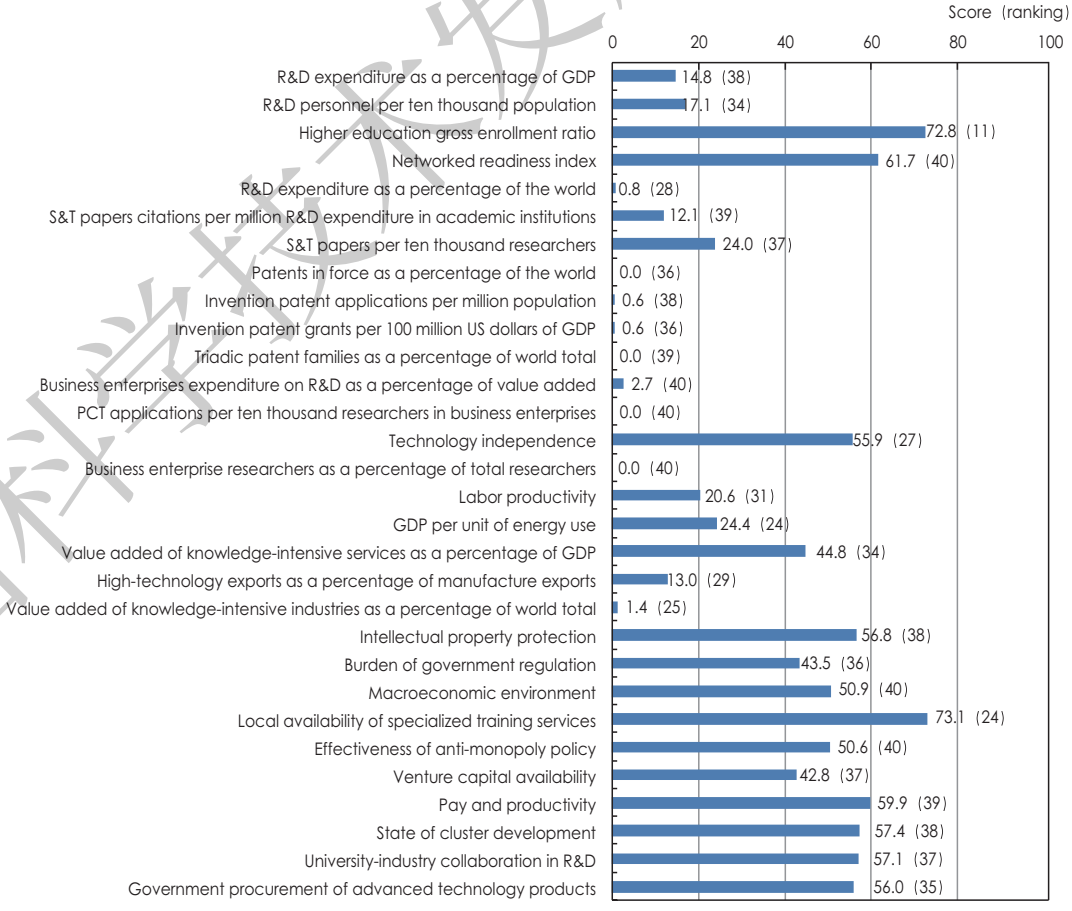
Part II

Country Analysis

Argentina

As a South American country, Argentina has a population of 43.85 million and a territory of approximately 2.78 million square kilometers with a GDP of USD 545.5 billion and GDP per capita of USD 12 440 in 2016 and is an upper-middle income country. It records USD 6.7 per kg of oil equivalent in GDP per unit of energy use, USD 4.0 billion in R&D expenditure, 0.6% in R&D intensity, 9205 in SCI indexed papers, 46 in PCT applications, and 8.8% in high-technology exports as a percentage of manufacture exports.

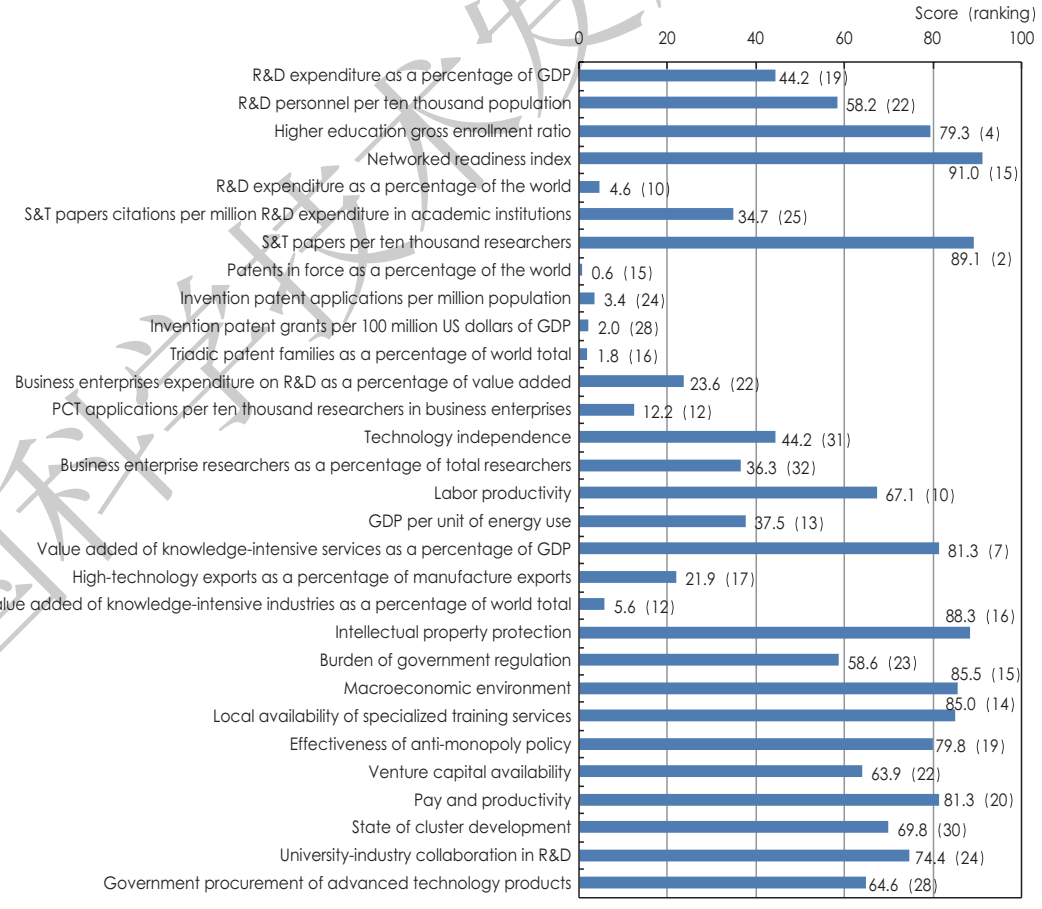
Argentina keeps its 40th position from the previous year in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 35th in innovation resources, drops 3 places to the 40th in knowledge creation, stays at the 40th in enterprise innovation, goes down 1 place to the 35th in innovation performance, and retains its 39th position in innovation environment.



Australia

As an Oceanian country, Australia has a population of 24.13 million and a territory of approximately 7.62 million square kilometers with a GDP of USD 1.20 trillion and GDP per capita of USD 49 928 in 2016 and is a high-income country. It records USD 10.3 per kg of oil equivalent in GDP per unit of energy use, USD 23.4 billion in R&D expenditure, 1.9% in R&D intensity, 65 thousand in SCI indexed papers, 1835 in PCT applications, and 14.8% in high-technology exports as a percentage of manufacture exports.

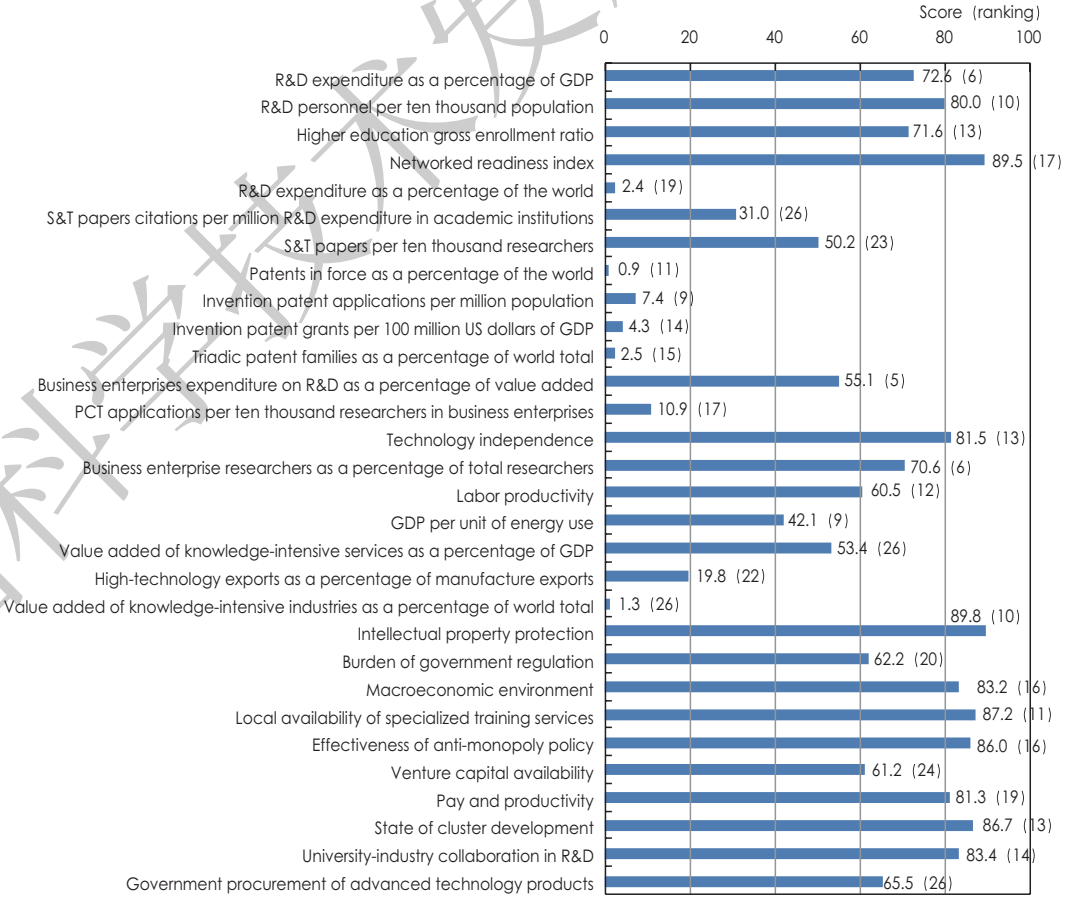
Australia drops 2 notches from the previous year to the 21st in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 16th in innovation resources, 3 places to the 12th in knowledge creation and 4 places to the 32nd in enterprise innovation and moves up 5 places to the 8th in innovation performance and 1 place to the 22nd in innovation environment.



Austria

As a European country, Austria has a population of 8.75 million and a territory of approximately 84 thousand square kilometers with a GDP of USD 390.8 billion and GDP per capita of USD 44 676 in 2016 and is a high-income country. It records USD 11.5 per kg of oil equivalent in GDP per unit of energy use, USD 12.1 billion in R&D expenditure, 3.1% in R&D intensity, 16 thousand in SCI indexed papers, 1422 in PCT applications, and 13.4% in high-technology exports as a percentage of manufacture exports.

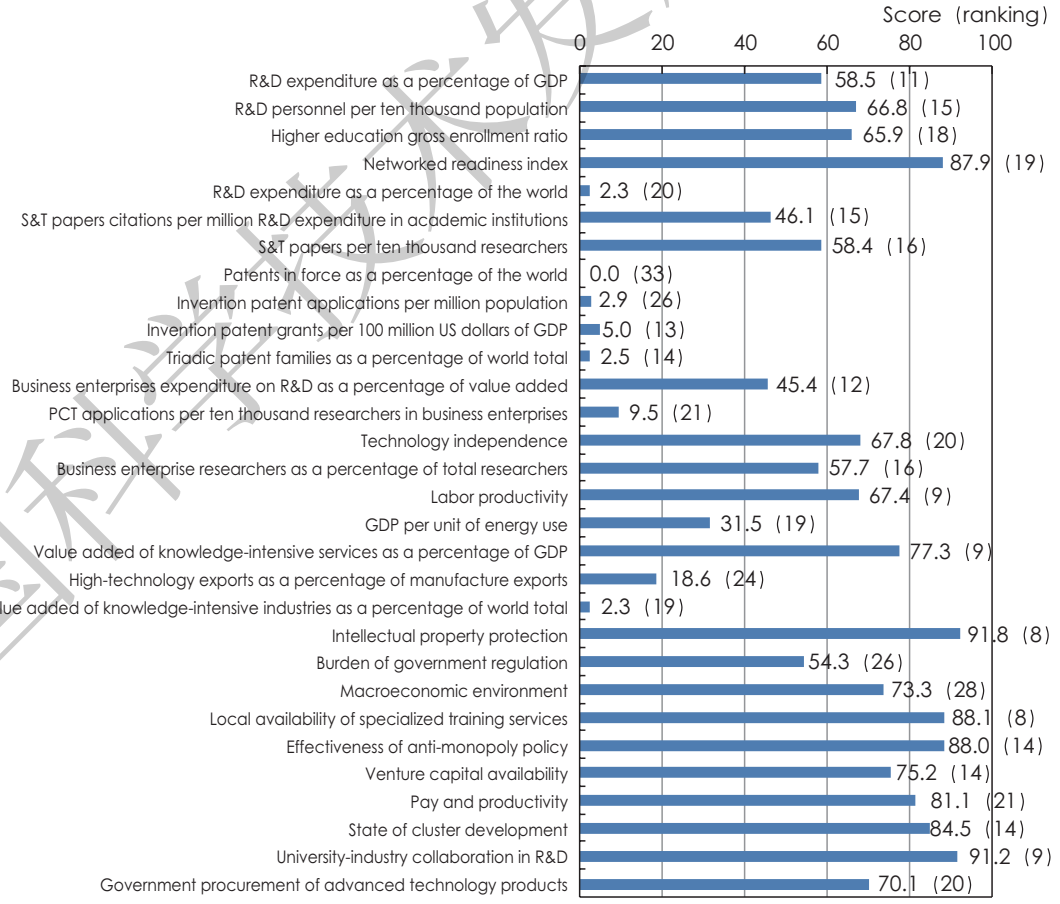
Austria keeps its 14th position from the previous year in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 9th in innovation resources and 5 places to the 32nd in knowledge creation, stays at the 9th in enterprise innovation, and drops 2 places to the 20th in innovation performance and 2 places to the 20th in innovation environment.



Belgium

As a European country, Belgium has a population of 11.35 million and a territory of approximately 31 thousand square kilometers with a GDP of USD 468.0 billion and GDP per capita of USD 41 236 in 2016 and is a high-income country. It records USD 8.6 per kg of oil equivalent in GDP per unit of energy use, USD 11.6 billion in R&D expenditure, 2.5% in R&D intensity, 23 thousand in SCI indexed papers, 1219 in PCT applications, and 12.5% in high-technology exports as a percentage of manufacture exports.

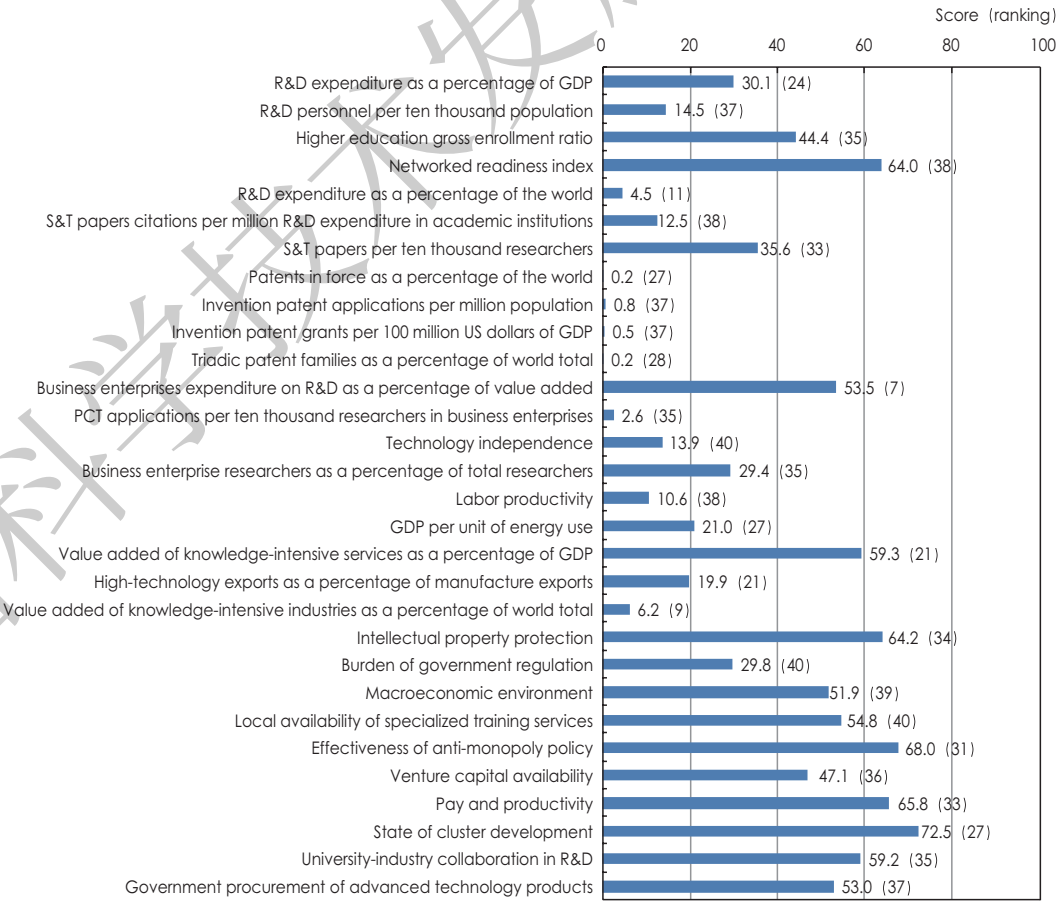
Belgium drops 1 place from the previous year to the 19th in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 15th in innovation resources, drops 11 places to the 22nd in knowledge creation, improves by 2 places to the 14th in enterprise innovation and 6 places to the 13th in innovation performance, and moves down 1 place to the 15th in innovation environment.



Brazil

As a South American country, Brazil has a population of approximately 208 million and a territory of approximately 8.52 million square kilometers with a GDP of USD 1.80 trillion and GDP per capita of USD 8650 in 2016 and is an upper-middle income country. It records USD 5.8 per kg of oil equivalent in GDP per unit of energy use, USD 23.0 billion in R&D expenditure, 1.3% in R&D intensity, 46 thousand in SCI indexed papers, 567 in PCT applications, and 13.5% in high-technology exports as a percentage of manufacture exports.

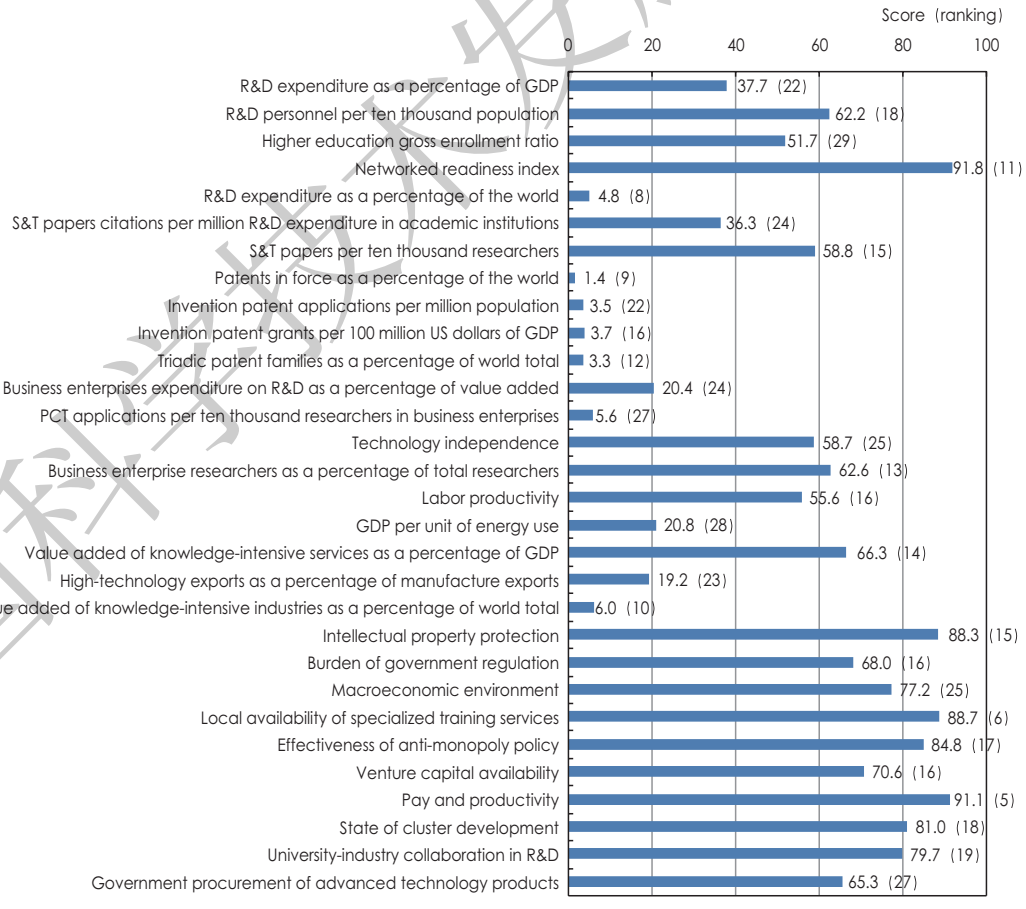
Brazil keeps its 39th position from the previous year in the national innovation index. Among the five first-level indicators, it keeps its 36th place in innovation resources and 39th place in knowledge creation, improves by 1 place to the 37th in enterprise innovation and 3 places to the 29th in innovation performance, and stays at the 38th in innovation environment.



Canada

As a North American country, Canada has a population of 36.29 million and a territory of approximately 9.98 million square kilometers with a GDP of USD 1.53 trillion and GDP per capita of USD 42 158 in 2016 and is a high-income country. It records USD 5.7 per kg of oil equivalent in GDP per unit of energy use, USD 24.6 billion in R&D expenditure, 1.6% in R&D intensity, 69 thousand in SCI indexed papers, 2336 in PCT applications, and 12.9% in high-technology exports as a percentage of manufacture exports.

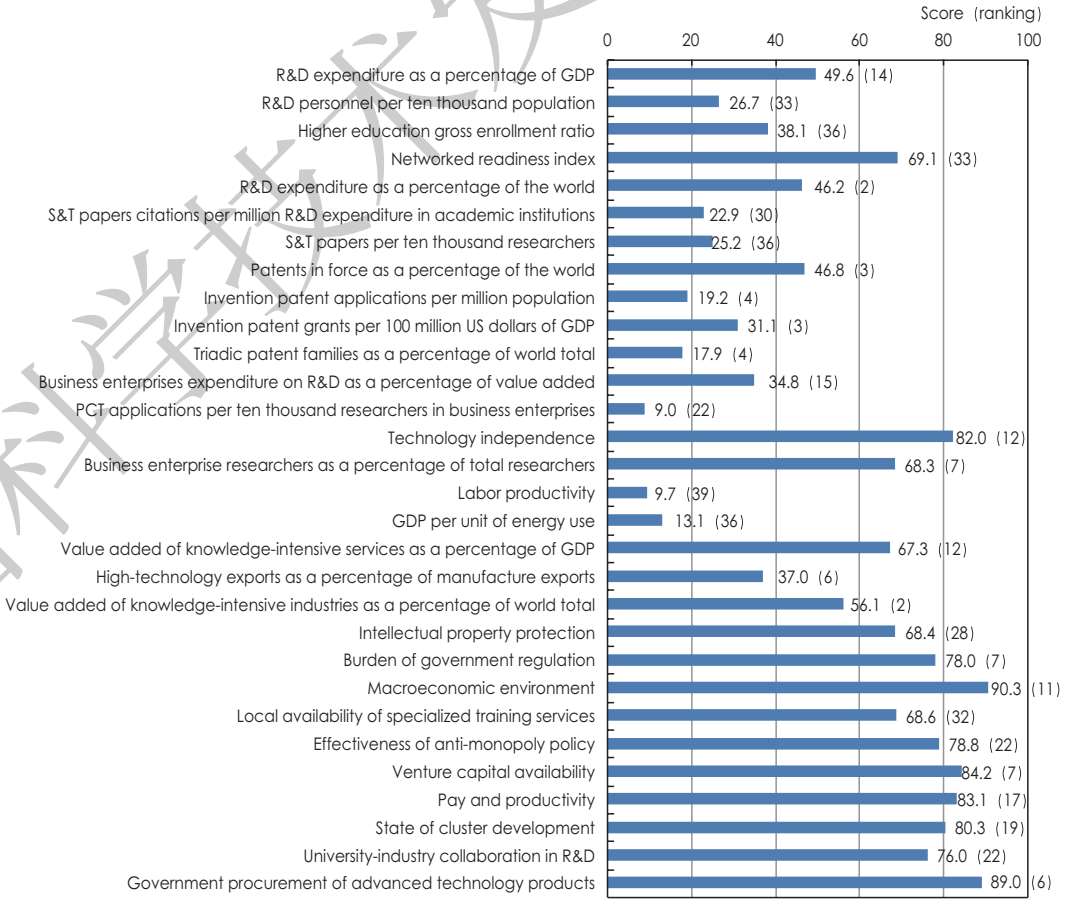
Canada drops 2 places from the previous year to the 24th in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 22nd in innovation resources and 6 places to the 28th in knowledge creation, stays at the 21st in enterprise innovation, drops 1 place to the 22nd in innovation performance, and improves by 2 places to the 17th in innovation environment.



China

As an Asian country, China has a population of approximately 1.4 billion and a territory of approximately 9.63 million square kilometers with a GDP of USD 11.20 trillion and GDP per capita of USD 8123 in 2016 and is an upper-middle income country. It records USD 3.6 per kg of oil equivalent in GDP per unit of energy use, USD 235.9 billion in R&D expenditure, next only to the United States in the second place in the world, 2.1% in R&D intensity, 308 thousand in SCI indexed papers, 43 094 in PCT applications, and 25.0% in high-technology exports as a percentage of manufacture exports.

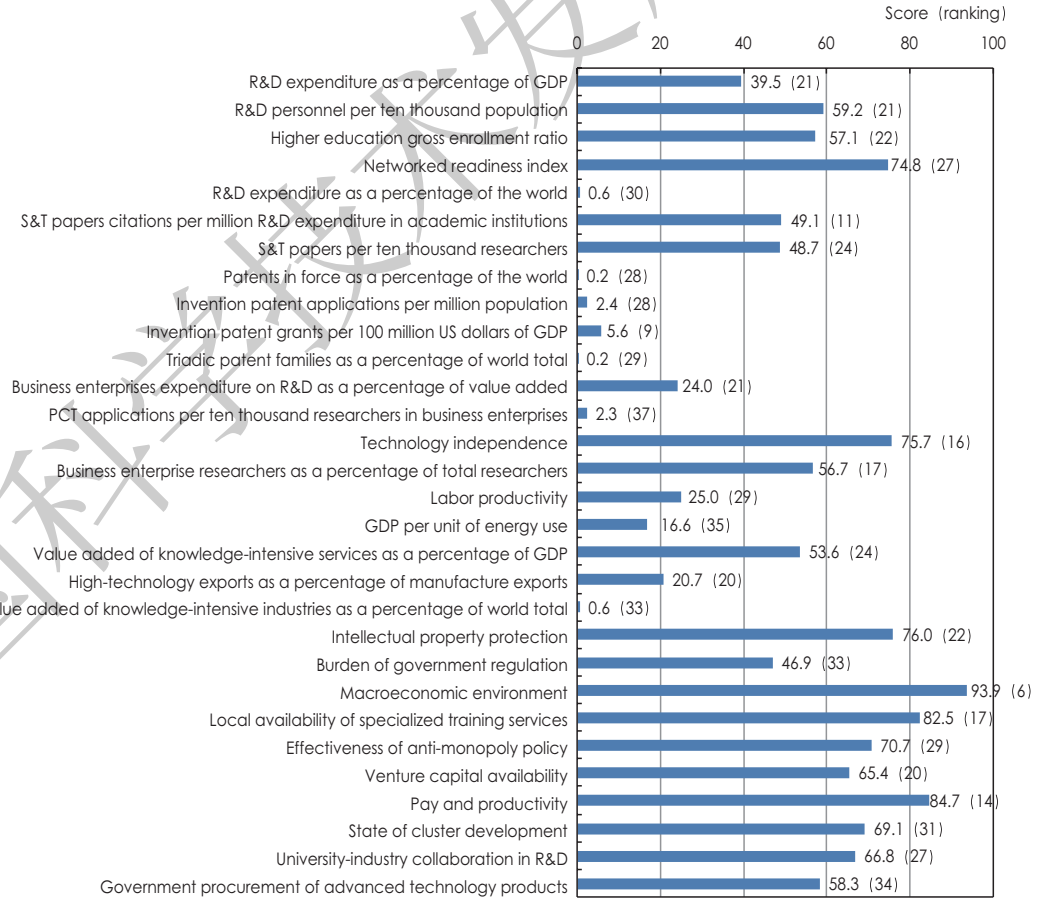
China remains stable at the 17th in the national innovation index. It is the only developing country to make into top 20, with a clear lead over other countries in a similar stage of economic development. Among the five first-level indicators, it moves up 3 places to the 25th in innovation resources and 1 place to the 7th in knowledge creation, stays at the 11th in enterprise innovation, drops 6 places to the 18th in innovation performance, and climbs by 4 places to the 16th in innovation environment.



Czech Republic

As a European country, the Czech Republic has a population of 10.56 million and a territory of approximately 79 thousand square kilometers with a GDP of USD 195.3 billion and GDP per capita of USD 18 492 in 2016 and is a high-income country. It records USD 4.6 per kg of oil equivalent in GDP per unit of energy use, USD 3.3 billion in R&D expenditure, 1.7% in R&D intensity, 13 thousand in SCI indexed papers, 199 in PCT applications, and 14.0% in high-technology exports as a percentage of manufacture exports.

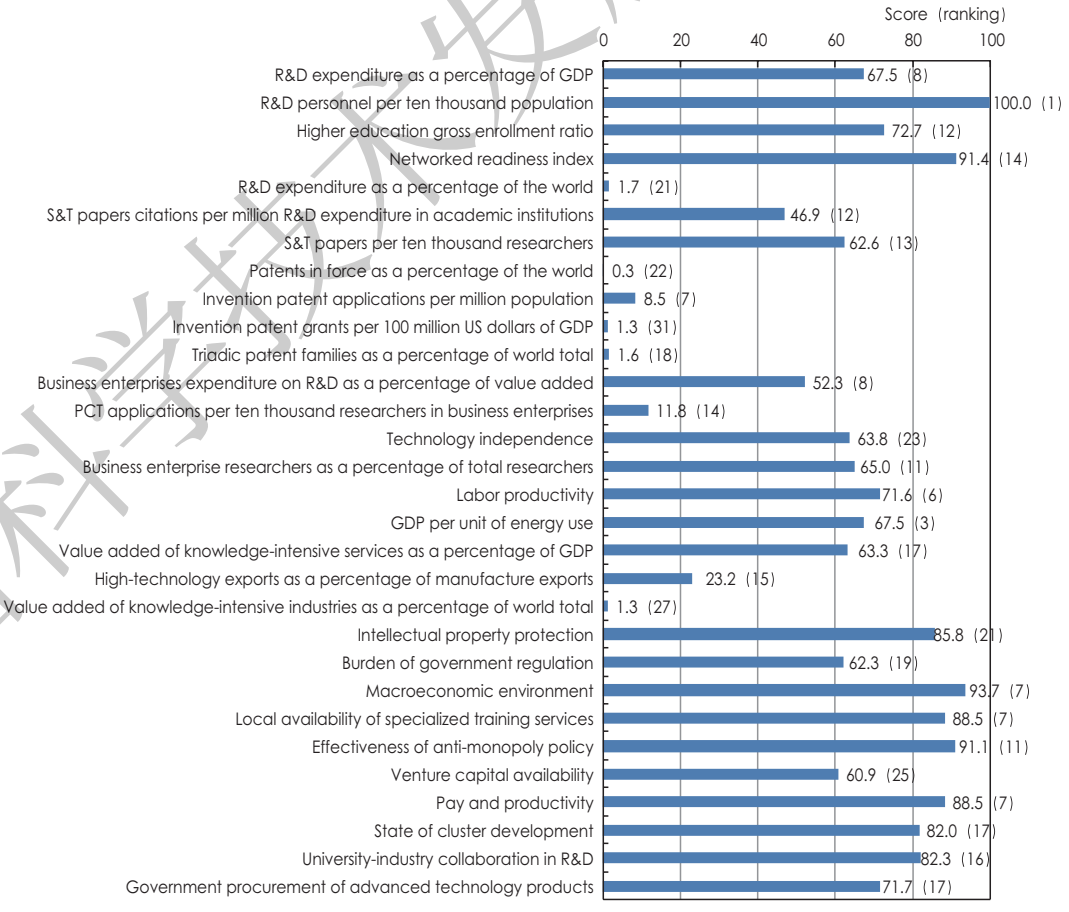
The Czech Republic keeps its 27th place in the national innovation index. Among the five first-level indicators, it remains stable at the 23rd in innovation resources, advances by 6 places to the 25th in knowledge creation, stays at the 20th in enterprise innovation, goes down 1 place to the 30th in innovation performance, and improves by 1 place to the 25th position in innovation environment.



Denmark

As a European country, Denmark has a population of 5.73 million and a territory of approximately 43 thousand square kilometers with a GDP of USD 306.9 billion and GDP per capita of USD 53 550 in 2016 and is a high-income country. It records USD 18.5 per kg of oil equivalent in GDP per unit of energy use, USD 8.8 billion in R&D expenditure, 2.8% in R&D intensity, 19 thousand in SCI indexed papers, 1356 in PCT applications, and 15.7% in high-technology exports as a percentage of manufacture exports.

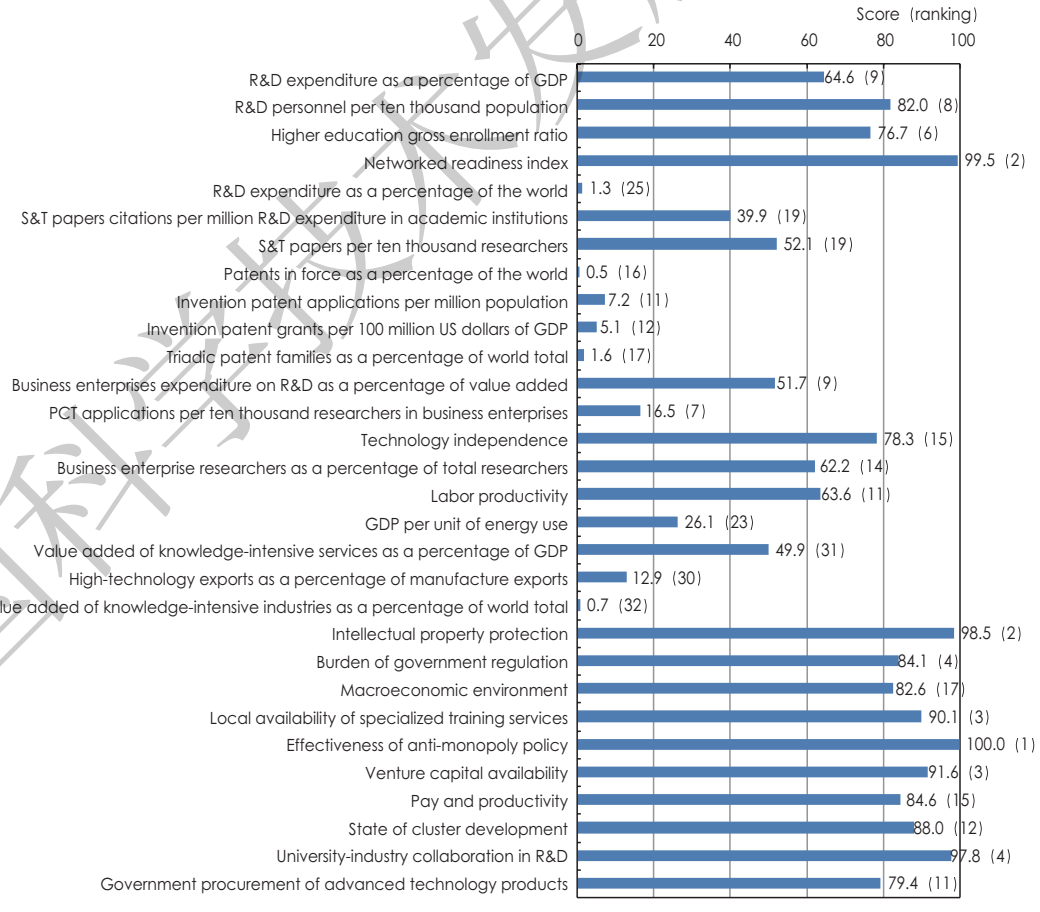
Denmark drops 1 place to the 6th in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 4th in innovation resources and 2 places to the 17th in knowledge creation, stays at the 6th in enterprise innovation, and climbs 2 places to the 6th in innovation performance and 3 places to the 13th in innovation environment.



Finland

As a European country, Finland has a population of 5.50 million and a territory of approximately 338 thousand square kilometers with a GDP of USD 238.5 billion and GDP per capita of USD 43 403 in 2016 and is a high-income country. It records USD 7.1 per kg of oil equivalent in GDP per unit of energy use, USD 6.6 billion in R&D expenditure, 2.8% in R&D intensity, 14 thousand in SCI indexed papers, 1525 in PCT applications, and 8.7% in high-technology exports as a percentage of manufacture exports.

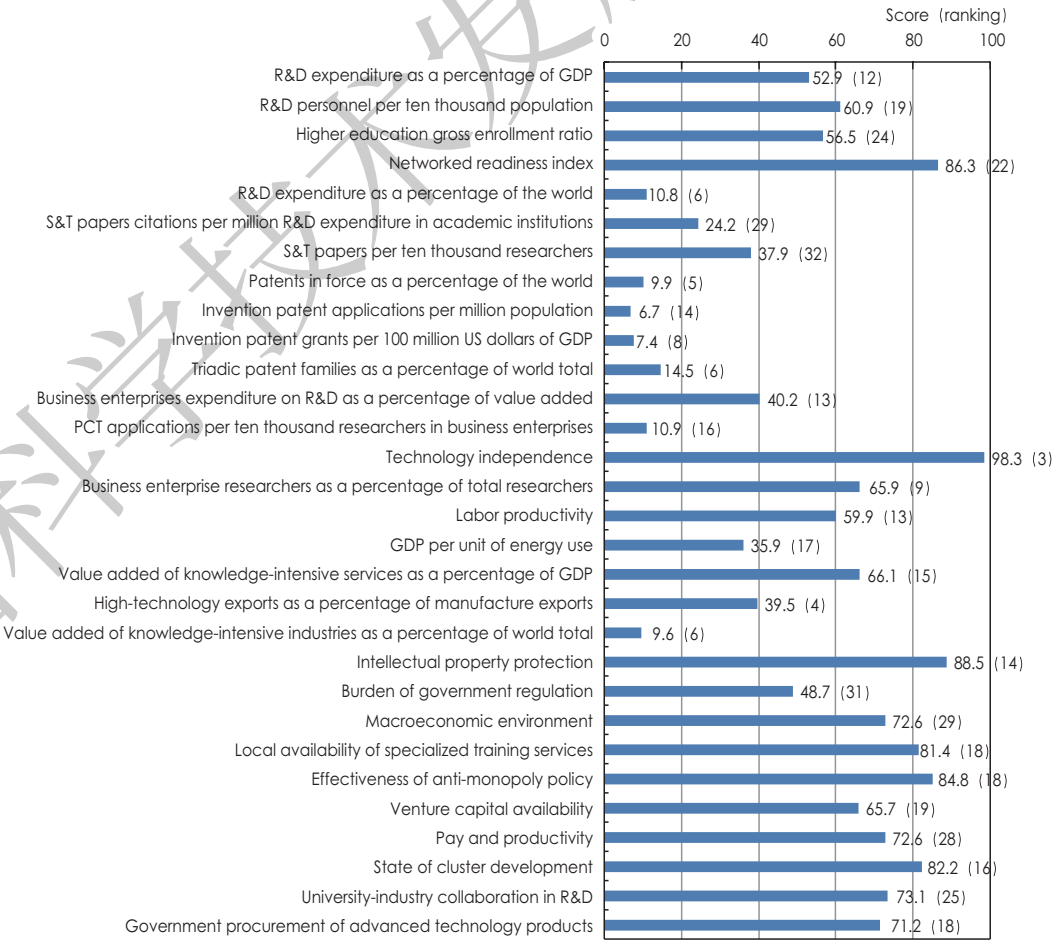
Finland improves by 1 place to the 10th in the national innovation index. Among the five first-level indicators, it falls 1 place to the 5th in innovation resources, moves up 2 places to the 26th in knowledge creation, stays at the 10th in enterprise innovation and the 23rd in innovation performance, and drops 2 places to the 5th in innovation environment.



France

As a European country, France has a population of 66.90 million and a territory of approximately 550 thousand square kilometers with a GDP of USD 2.47 trillion and GDP per capita of USD 36 855 in 2016 and is a high-income country. It records USD 9.8 per kg of oil equivalent in GDP per unit of energy use, USD 55.4 billion in R&D expenditure, 2.3% in R&D intensity, 76 thousand in SCI indexed papers, 8210 in PCT applications, and 26.7% in high-technology exports as a percentage of manufacture exports.

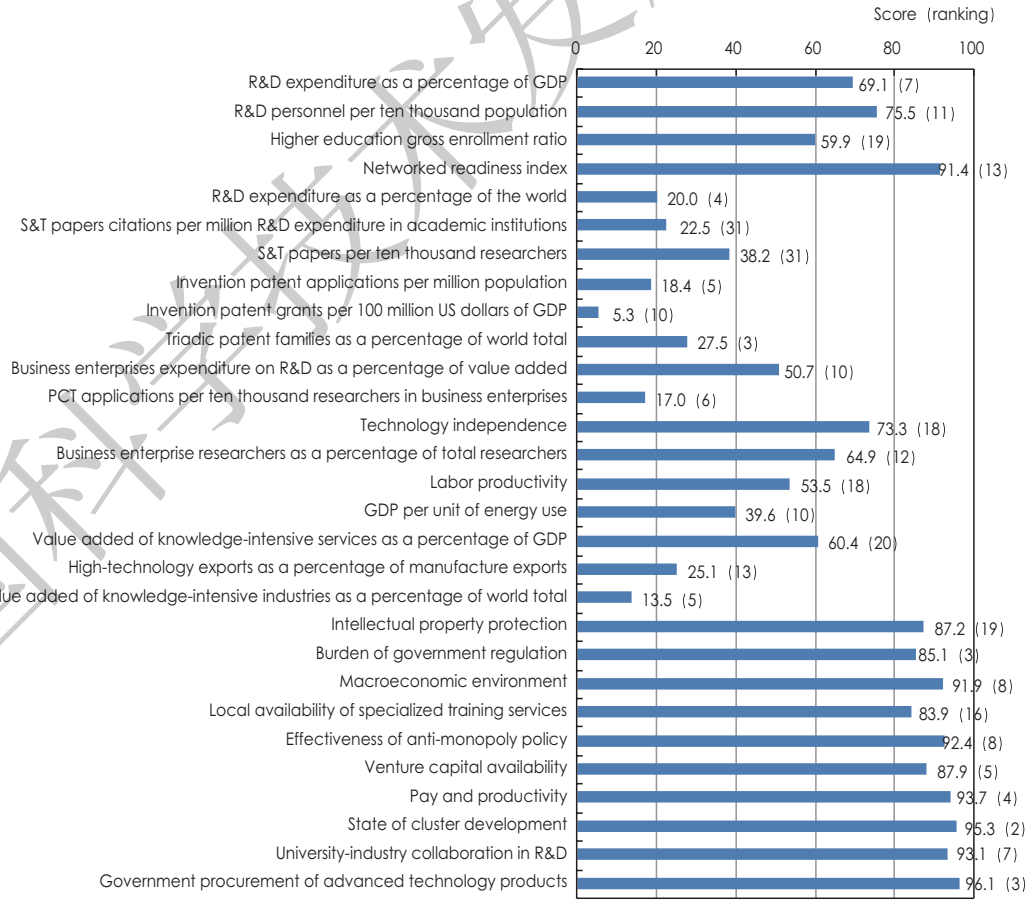
France falls 1 place to the 13th in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 17th in innovation resources, falls 3 places to the 24th in knowledge creation and 3 places to the 8th in enterprise innovation, stays at the 9th in innovation performance and drops 2 places to the 24th in innovation environment.



Germany

As a European country, Germany has a population of 82.67 million and a territory of approximately 357 thousand square kilometers with a GDP of USD 3.48 trillion and GDP per capita of USD 42 070 in 2016 and is a high-income country. It records USD 10.8 per kg of oil equivalent in GDP per unit of energy use, USD 102.2 billion in R&D expenditure, 2.9% in R&D intensity, 111 thousand in SCI indexed papers, 18 305 in PCT applications, and 16.9% in high-technology exports as a percentage of manufacture exports.

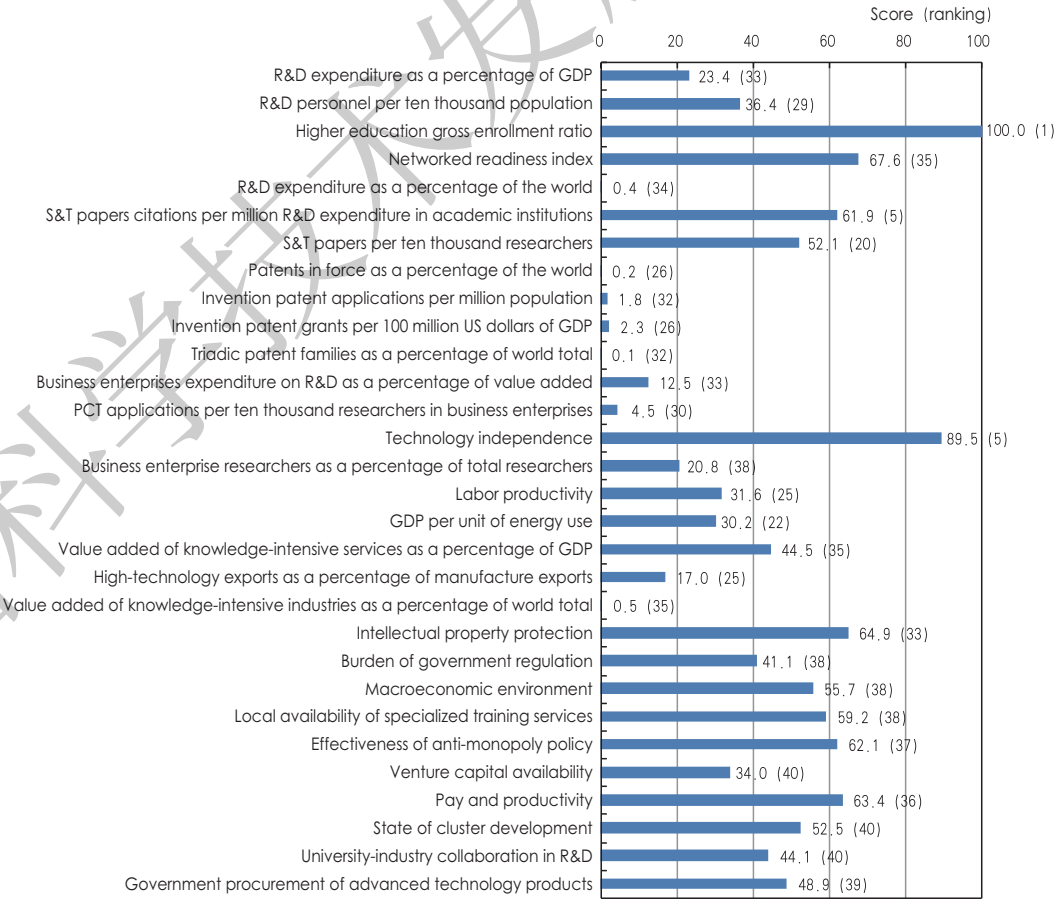
Germany moves up 2 places to the 5th in the national innovation index. Among the five first-level indicators, it goes down 1 place to the 10th in innovation resources and 5 places to the 30th in knowledge creation, moves up 1 place to the 5th in enterprise innovation, falls 2 places to the 16th in innovation performance, and improves by 3 places to the 4th in innovation environment.



Greece

As a European country, Greece has a population of 10.75 million and a territory of approximately 132 thousand square kilometers with a GDP of USD 192.7 billion and GDP per capita of USD 17 930 in 2016 and is a high-income country. It records USD 8.3 per kg of oil equivalent in GDP per unit of energy use, USD 1.9 billion in R&D expenditure, 1.0% in R&D intensity, 11 thousand in SCI indexed papers, 111 in PCT applications, and 11.4% in high-technology exports as a percentage of manufacture exports.

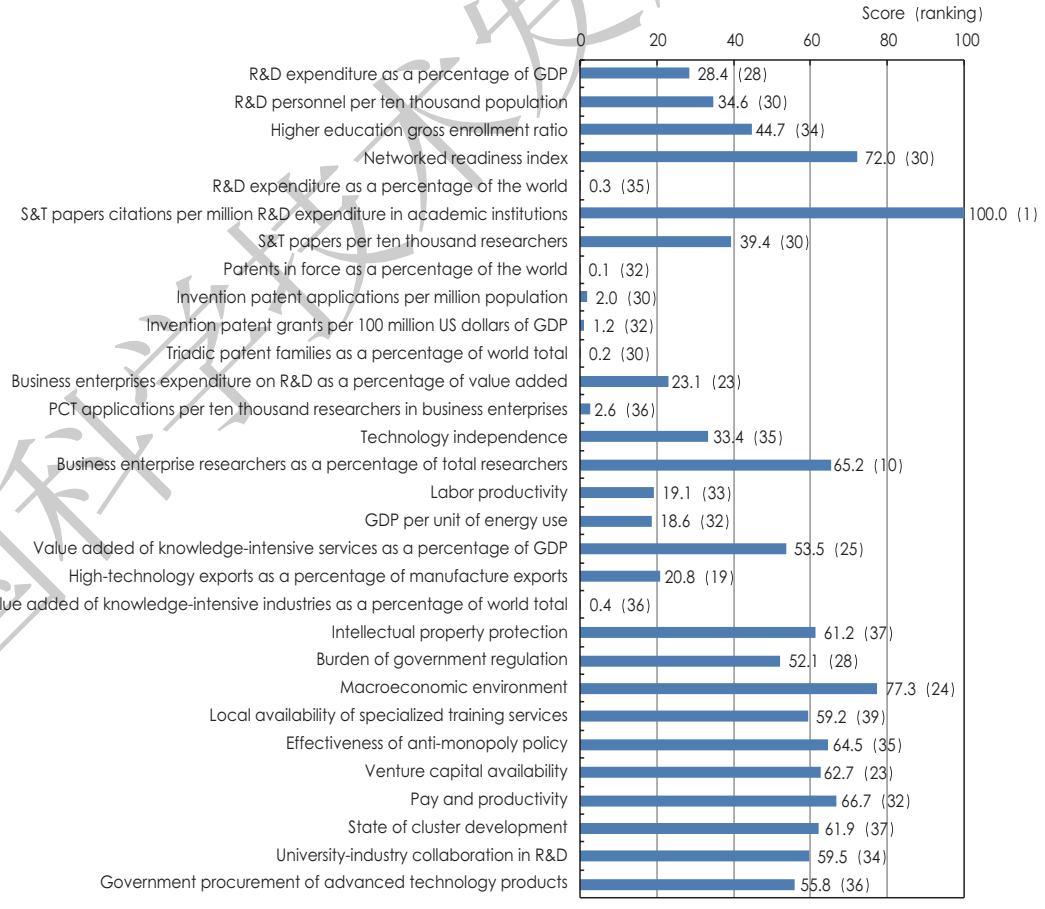
Greece improves by 1 place to the 30th in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 26th in innovation resources, improves by 11 places to the 19th in knowledge creation and 3 places to the 29th in enterprise innovation, and stays at the 26th in innovation performance and the 40th in innovation environment.



Hungary

As a European country, Hungary has a population of 9.82 million and a territory of approximately 93 thousand square kilometers with a GDP of USD 125.8 billion and GDP per capita of USD 12 815 in 2016 and is an upper-middle income country. It records USD 5.1 per kg of oil equivalent in GDP per unit of energy use, USD 1.5 billion in R&D expenditure, 1.2% in R&D intensity, 7346 in SCI indexed papers, 178 in PCT applications, and 14.0% in high-technology exports as a percentage of manufacture exports.

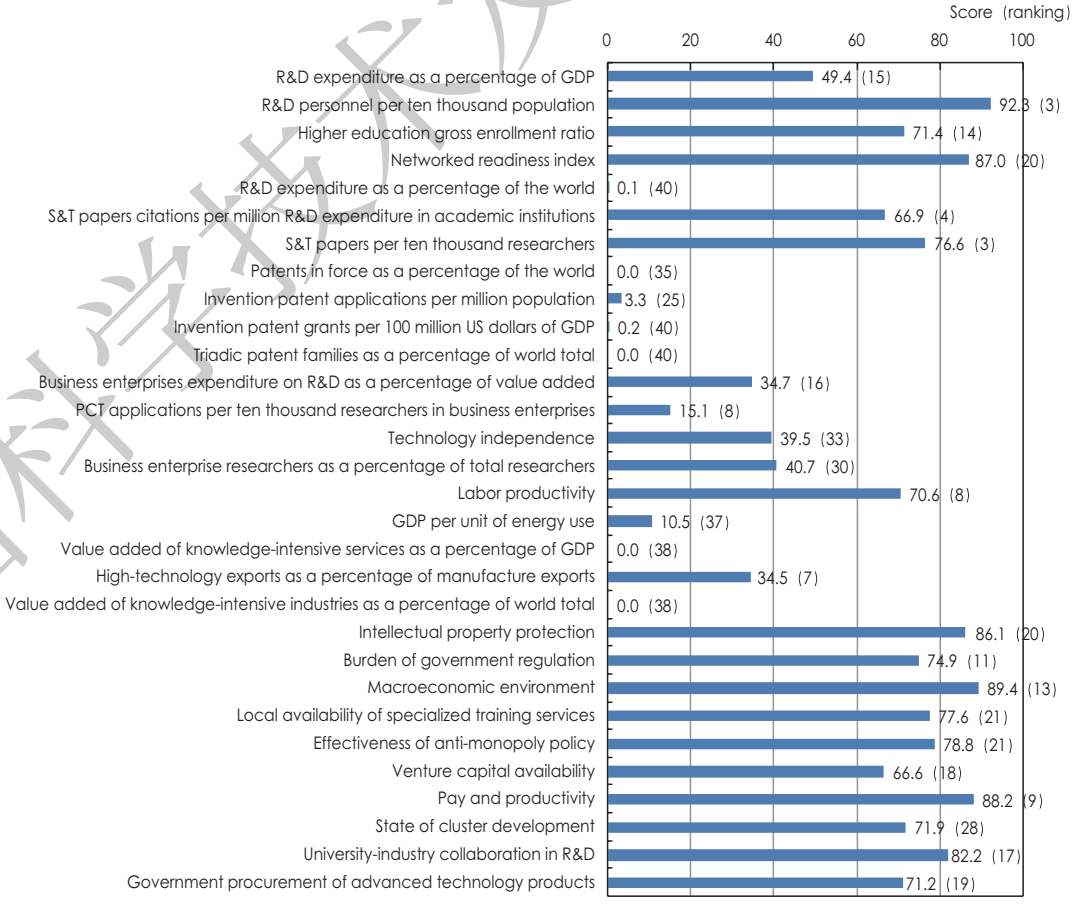
Hungary stays at the 29th in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 33rd in innovation resources, moves up 3 places to the 9th in knowledge creation, falls 1 place to the 31st in enterprise innovation, improves by 1 place to the 32nd in innovation performance, and stays at the 36th in innovation environment.



Iceland

As a European country, Iceland has a population of 330 thousand and a territory of approximately 103 thousand square kilometers with a GDP of USD 20.1 billion and GDP per capita of USD 59 977 in 2016 and is a high-income country. It records USD 2.9 per kg of oil equivalent in GDP per unit of energy use, USD 420 million in R&D expenditure, 2.1% in R&D intensity, 1223 in SCI indexed papers, 56 in PCT applications, and 23.3% in high-technology exports as a percentage of manufacture exports.

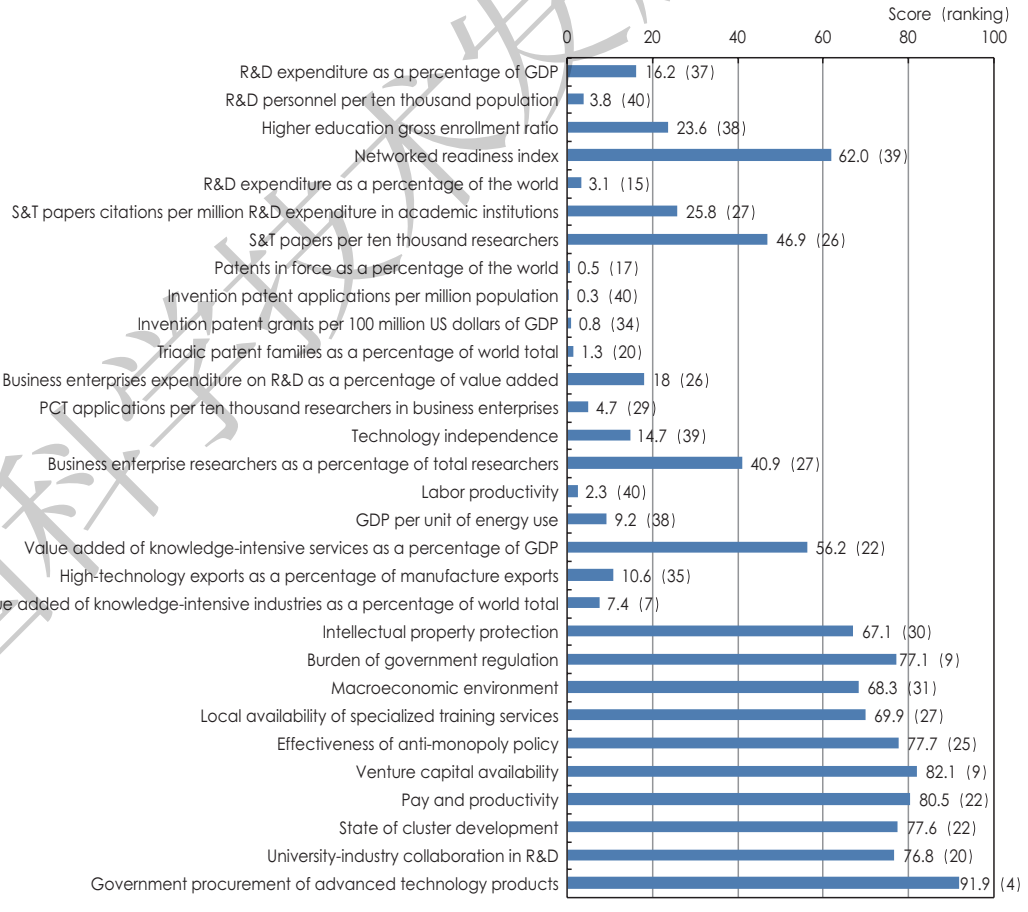
Iceland improves by 3 places to the 18th in the national innovation index. Among the five first-level indicators, it stays at the 11th in innovation resources, improves by 18 places to the 6th in knowledge creation, moves down 1 place to the 27th in enterprise innovation, climbs 7 places to the 15th in innovation performance, and drops 2 places to the 19th in innovation environment.



India

As an Asian country, India has a population of approximately 1.32 billion and a territory of approximately 2.98 million square kilometers with a GDP of USD 2.26 trillion and GDP per capita of USD 1710 in 2016 and is a lower-middle income country. It records USD 2.5 per kg of oil equivalent in GDP per unit of energy use, USD 15.6 billion in R&D expenditure, 0.7% in R&D intensity, 65 thousand in SCI indexed papers, 1528 in PCT applications, and 7.1% in high-technology exports as a percentage of manufacture exports.

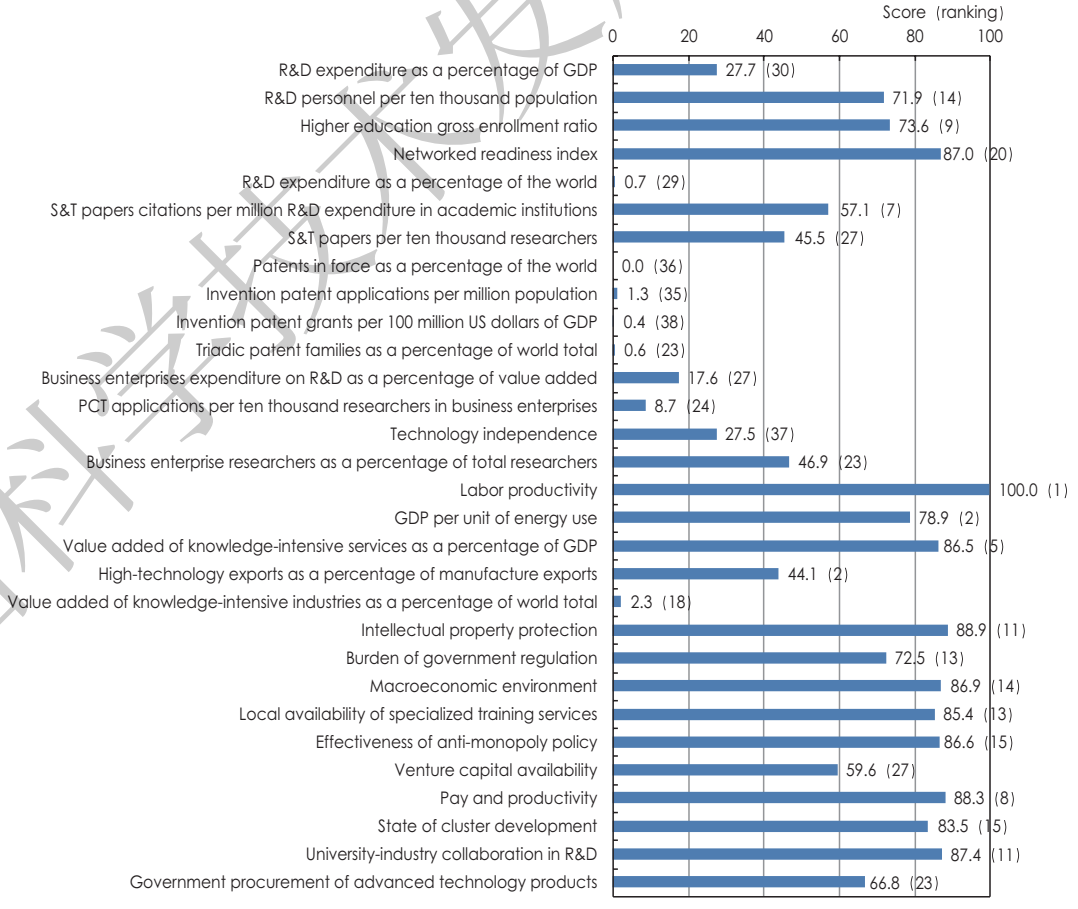
India remains at the 38th in the national innovation index. Among the five first-level indicators, it falls 1 place to the 40th in innovation resources and 3 places to the 36th in knowledge creation, stays at the 39th in enterprise innovation, improves by 1 place to the 39th in innovation performance, and remains stable at the 21st in innovation environment.



Ireland

As a European country, Ireland has a population of 4.77 million and a territory of approximately 70 thousand square kilometers with a GDP of USD 304.8 billion and GDP per capita of USD 63 862 and is a high-income country. It records USD 21.6 per kg of oil equivalent in GDP per unit of energy use, USD 3.6 billion in R&D expenditure, 1.2% in R&D intensity, 8660 in SCI indexed papers, 441 in PCT applications, and 29.8% in high-technology exports as a percentage of manufacture exports.

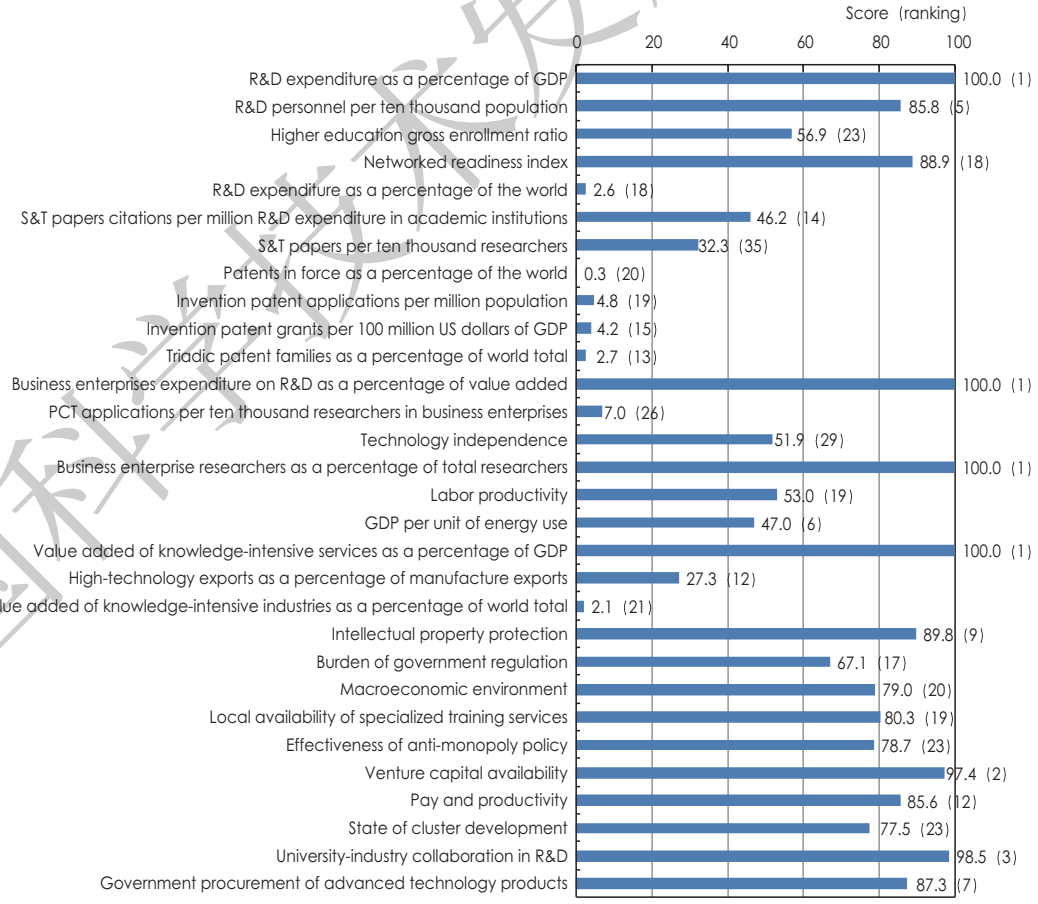
Ireland jumps 1 notch to the 15th in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 19th in innovation resources, drops 9 places to the 27th in knowledge creation and 3 places to the 34th in enterprise innovation, moves up 1 place to the 3rd in innovation performance, and falls 2 places to the 14th in innovation environment.



Israel

As an Asian country, Israel has a population of 8.55 million and a territory of approximately 25 thousand square kilometers with a GDP of USD 317.7 billion and GDP per capita of USD 37 176 in 2016 and is a high-income country. It records USD 12.9 per kg of oil equivalent in GDP per unit of energy use, USD 13.5 billion in R&D expenditure, 4.3% in R&D intensity, 15 thousand in SCI indexed papers, 1838 in PCT applications, and 18.4% in high-technology exports as a percentage of manufacture exports.

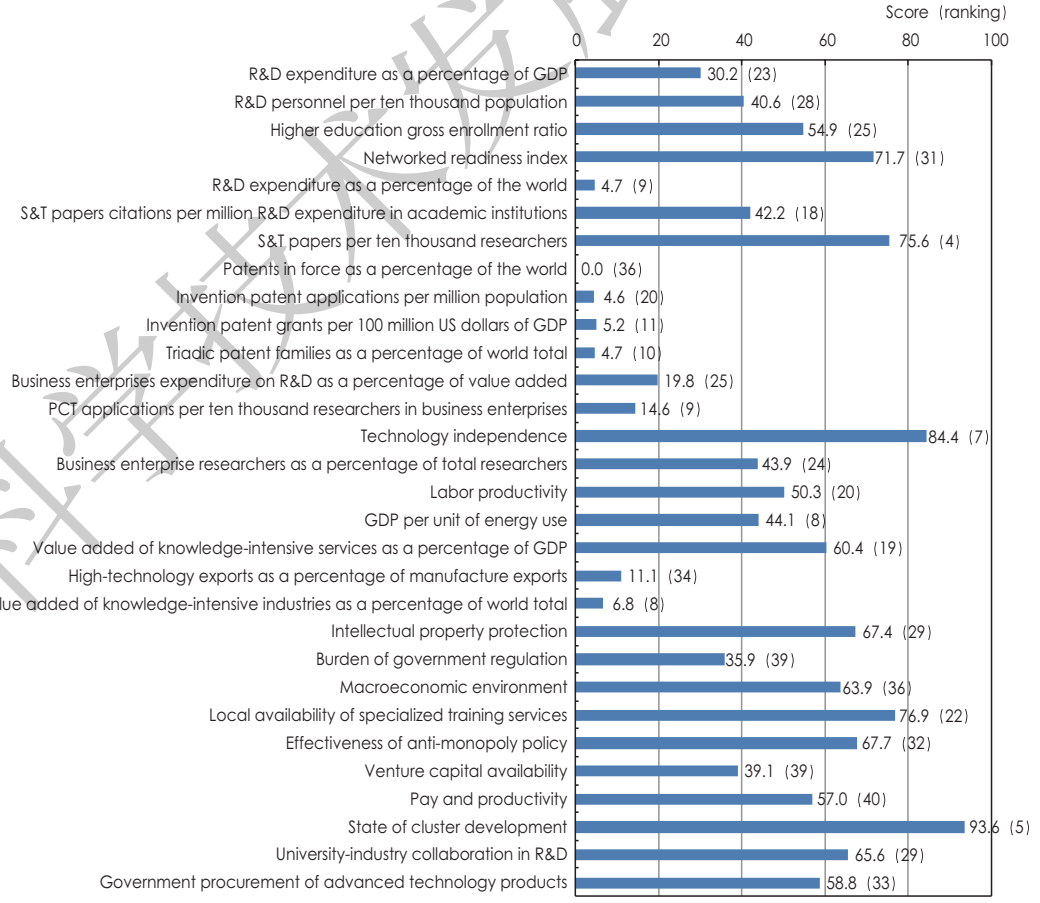
Israel improves by 5 places to the 8th in the national innovation index. Among the five first-level indicators, it remains stable at the 3rd in innovation resources, advances 5 places to the 33rd in knowledge creation, stays at the 4th in enterprise innovation, drops 2 places to the 19th in innovation performance, and improves by 1 place to the 12th in innovation environment.



Italy

As a European country, Italy has a population of 60.60 million and a territory of approximately 301 thousand square kilometers with a GDP of USD 1.86 trillion and GDP per capita of USD 30 675 in 2016 and is a high-income country. It records USD 12.1 per kg of oil equivalent in GDP per unit of energy use, USD 23.9 billion in R&D expenditure, 1.3% in R&D intensity, 69 thousand in SCI indexed papers, 3362 in PCT applications, and 7.5% in high-technology exports as a percentage of manufacture exports.

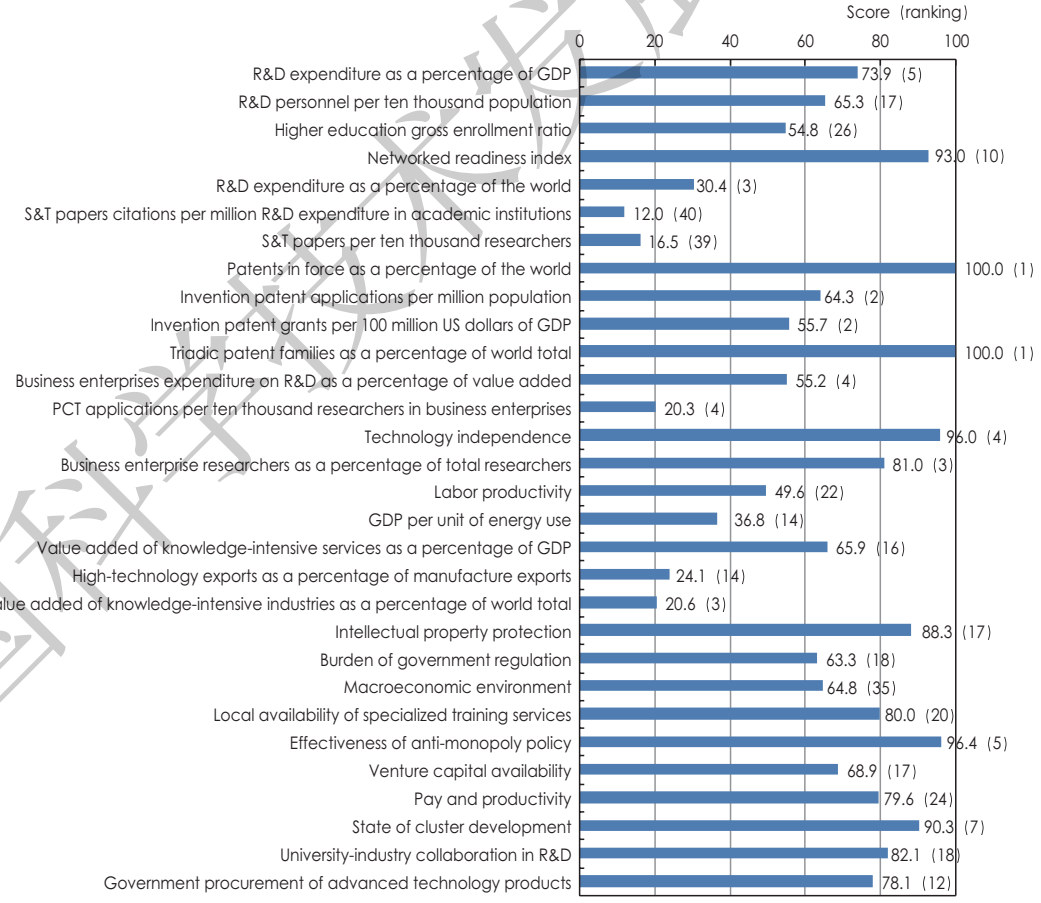
Italy keeps its 25th position in the national innovation index. Among the five first-level indicators, it remains stable at the 30th in innovation resources, moves up 5 places to the 5th in knowledge creation and 1 place to the 16th in enterprise innovation, and drops 1 place to the 21st in innovation performance and 1 place to the 35th in innovation environment.



Japan

As an Asian country, Japan has a population of approximately 127 million and a territory of approximately 378 thousand square kilometers with a GDP of USD 4.94 trillion and GDP per capita of USD 38 901 in 2016 and is a high-income country. It records USD 10.1 per kg of oil equivalent in GDP per unit of energy use, USD 155.5 billion in R&D expenditure, 3.1% in R&D intensity, 79 thousand in SCI indexed papers, 45 210 in PCT applications, and 16.2% in high-technology exports as a percentage of manufacture exports.

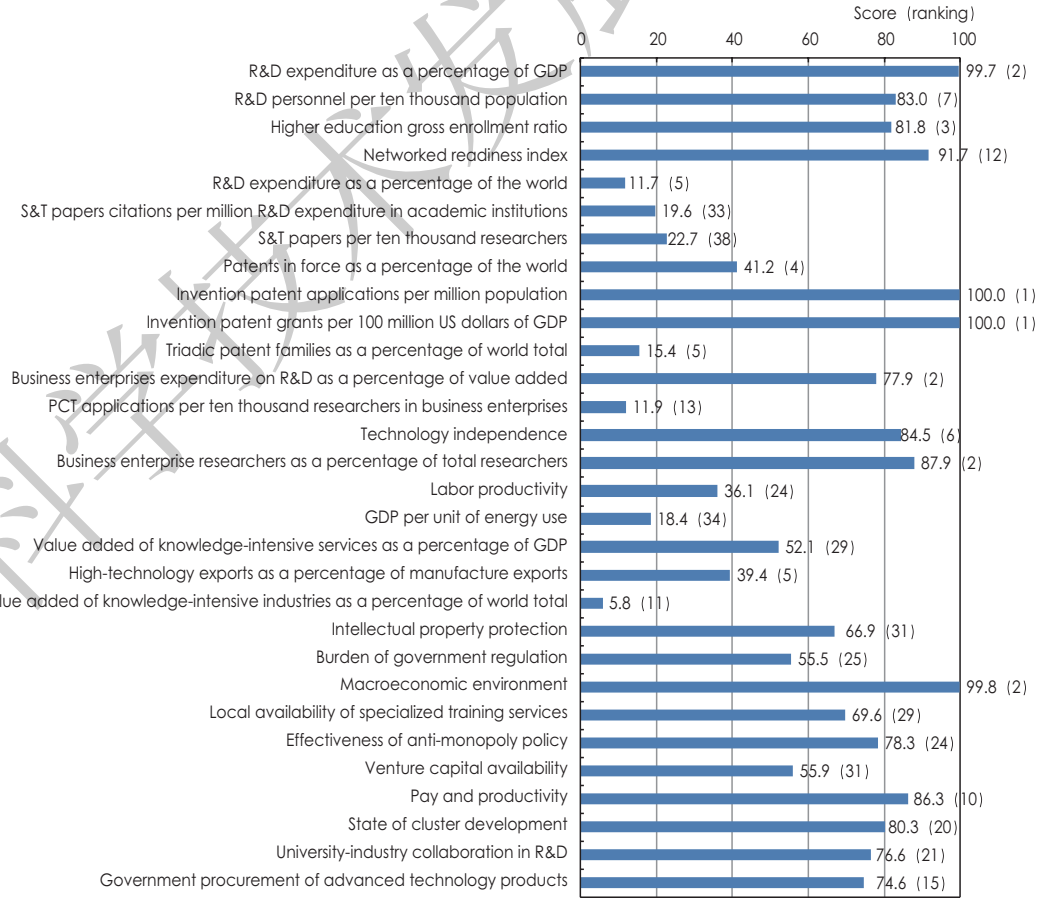
Japan remains at the 2nd in the national innovation index. Among the five first-level indicators, it falls 2 places to the 8th in innovation resources, climbs 1 place to the 2nd in knowledge creation, remains stable at the 1st in enterprise innovation, and drops 11 places to the 14th in innovation performance and 3 places to the 18th in innovation environment.



Korea

As an Asian country, Korea has a population of 51.25 million and a territory of approximately 100 thousand square kilometers with a GDP of USD 1.41 trillion and GDP per capita of USD 27 539 in 2016 and is a high-income country. It records USD 5.0 per kg of oil equivalent in GDP per unit of energy use, USD 59.8 billion in R&D expenditure, 4.2% in R&D intensity, 59 thousand in SCI indexed papers, 15 555 in PCT applications, and 26.6% in high-technology exports as a percentage of manufacture exports.

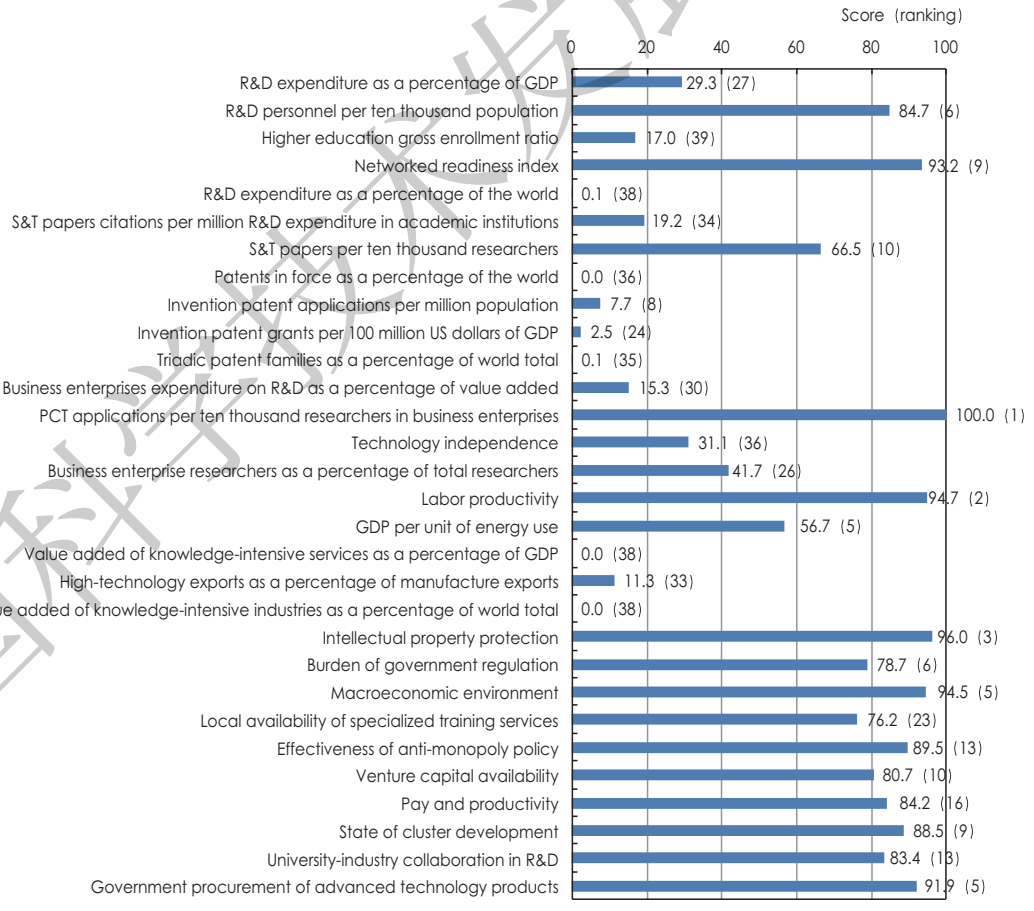
Korea remains in the 4th place in the national innovation index. Among the five first-level indicators, it keeps its 2nd position in innovation resources, 1st position in knowledge creation and 3rd position in enterprise innovation, drops 13 places to the 24th in innovation performance, and moves up 1 place to the 23rd in innovation environment.



Luxembourg

As a European country, Luxembourg has a population of 0.58 million and a territory of approximately 2586.4 square kilometers with a GDP of USD 58.6 billion and GDP per capita of USD 100 573 in 2016 and is a high-income country. It records USD 15.5 per kg of oil equivalent in GDP per unit of energy use, USD 730 million in R&D expenditure, 1.2% in R&D intensity, 1206 in SCI indexed papers, 431 in PCT applications, and 7.6% in high-technology exports as a percentage of manufacture exports.

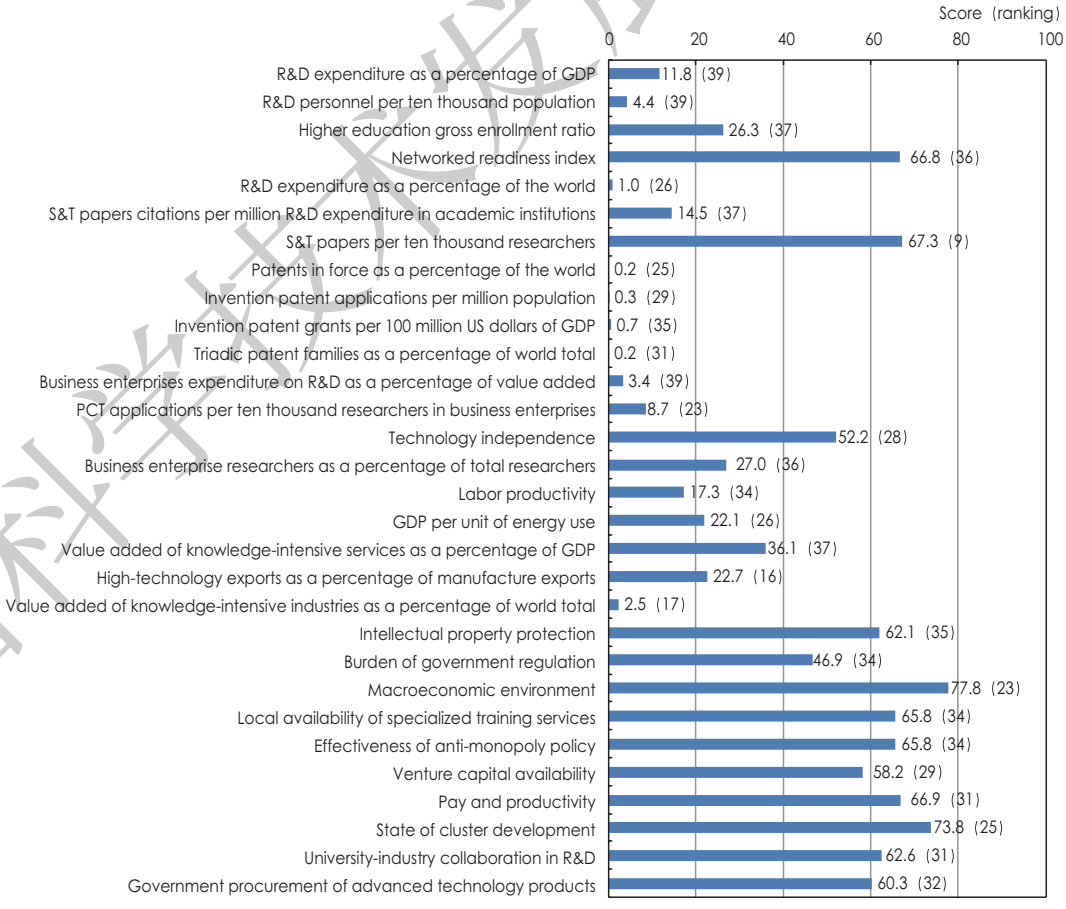
Luxembourg retains its 20th position in the national innovation index. Among the five first-level indicators, it falls 4 places to the 28th in innovation resources, moves up 24 places to the 16th in knowledge creation, stays at the 13th in enterprise innovation and the 10th in innovation performance, and drops 3 places to the 8th in innovation environment.



Mexico

As a North American country, Mexico has a population of approximately 128 million and a territory of approximately 1.96 million square kilometers with a GDP of USD 1.05 trillion and GDP per capita of USD 8209 in 2016 and is an upper-middle income country. It records USD 6.1 per kg of oil equivalent in GDP per unit of energy use, USD 5.2 billion in R&D expenditure, 0.5% in R&D intensity, 15 thousand in SCI indexed papers, 289 in PCT applications, and 15.3% in high-technology exports as a percentage of manufacture exports.

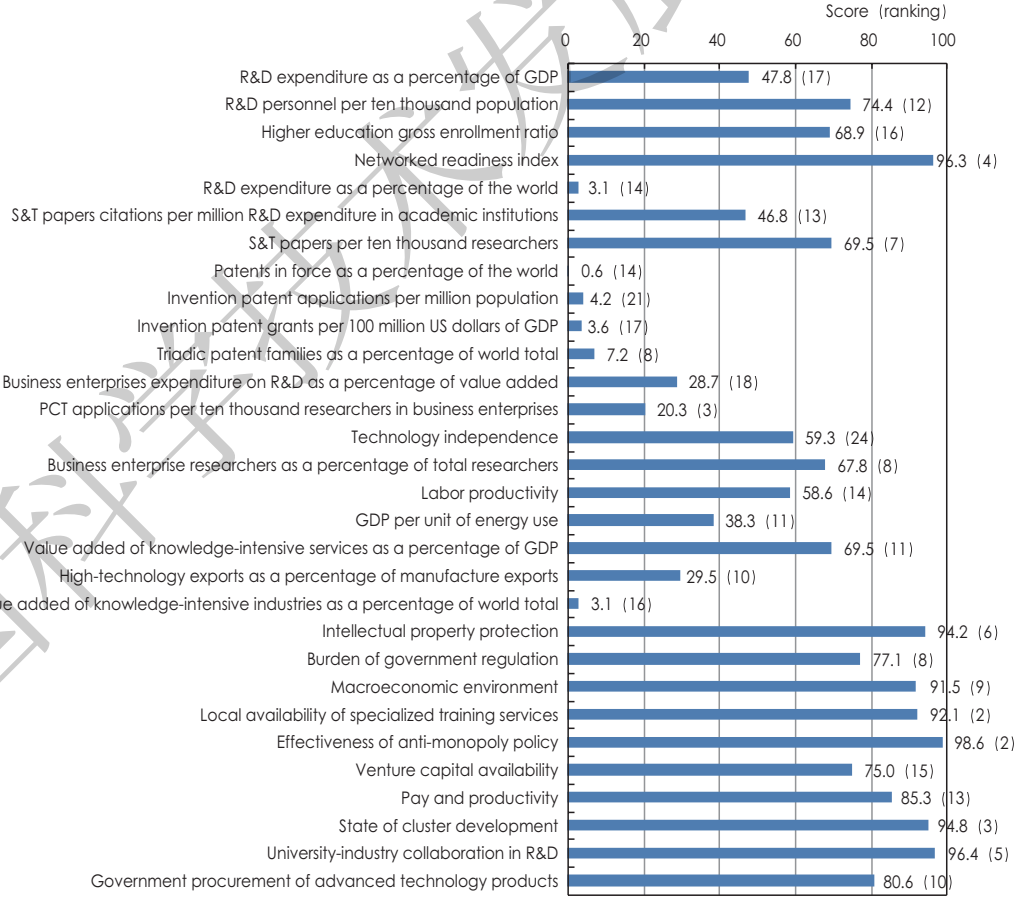
Mexico stays at the 37th in the national innovation index. Among the five first-level indicators, it remains stable at the 38th in innovation resources, the 34th place in knowledge creation and the 36th in enterprise innovation and drops 8 places to the 36th in innovation performance and 5 places to the 32th in innovation environment.



Netherlands

As a European country, the Netherlands has a population of 17.02 million and a territory of approximately 42 thousand square kilometers with a GDP of USD 777.2 billion and GDP per capita of USD 45 670 in 2016 and is a high-income country. It records USD 10.5 per kg of oil equivalent in GDP per unit of energy use, USD 15.8 billion in R&D expenditure, 2.0% in R&D intensity, 41 thousand in SCI indexed papers, 4676 in PCT applications, and 19.9% in high-technology exports as a percentage of manufacture exports.

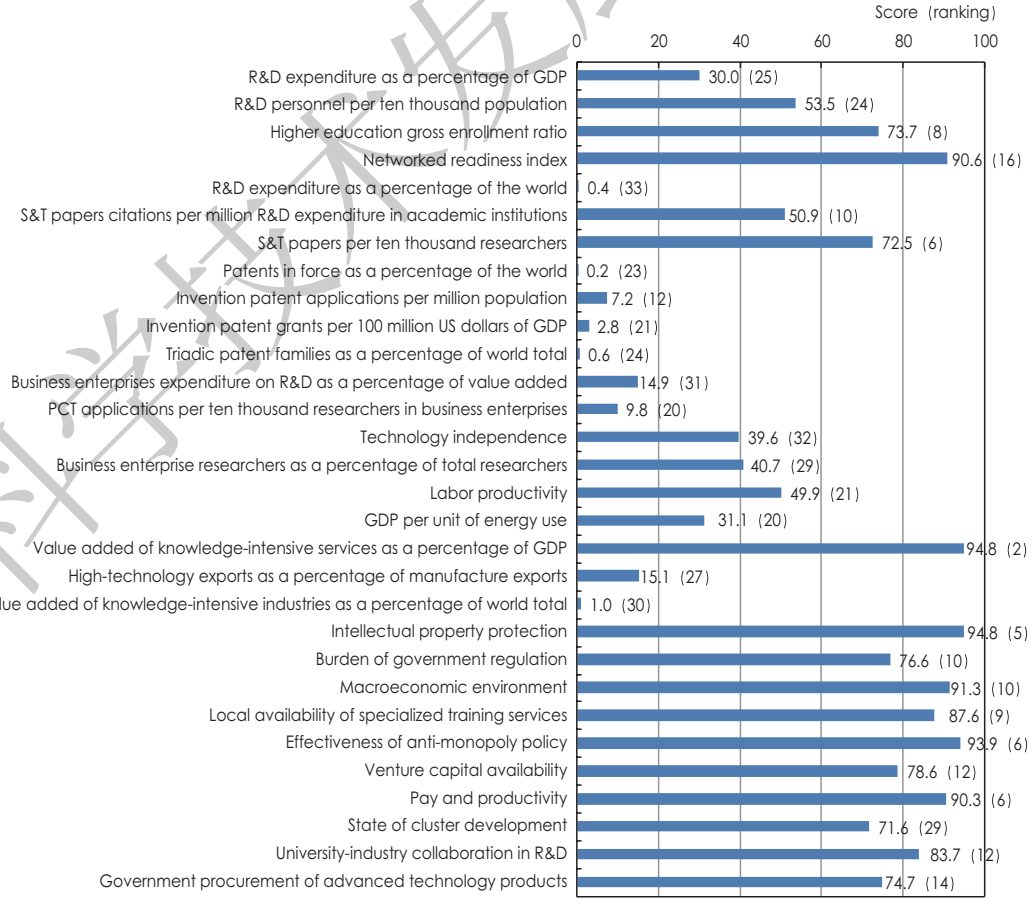
The Netherlands drops 4 ranks to the 12th in the national innovation index. Among the five first-level indicators, it stays at the 13th in innovation resources, falls 6 places to the 13th in knowledge creation and 3 places to the 18th in enterprise innovation, and improves by 5 places to the 11th in innovation performance and 3 places to the 6th in innovation environment.



New Zealand

As an Oceanian country, the New Zealand has a population of 4.69 million and a territory of approximately 268 thousand square kilometers with a GDP of USD 185.0 billion and GDP per capita of USD 39 416 in 2016 and is a high-income country. It records USD 8.5 per kg of oil equivalent in GDP per unit of energy use, USD 2.2 billion in R&D expenditure, 1.3% in R&D intensity, 9808 in SCI indexed papers, 307 in PCT applications, and 10.2% in high-technology exports as a percentage of manufacture exports.

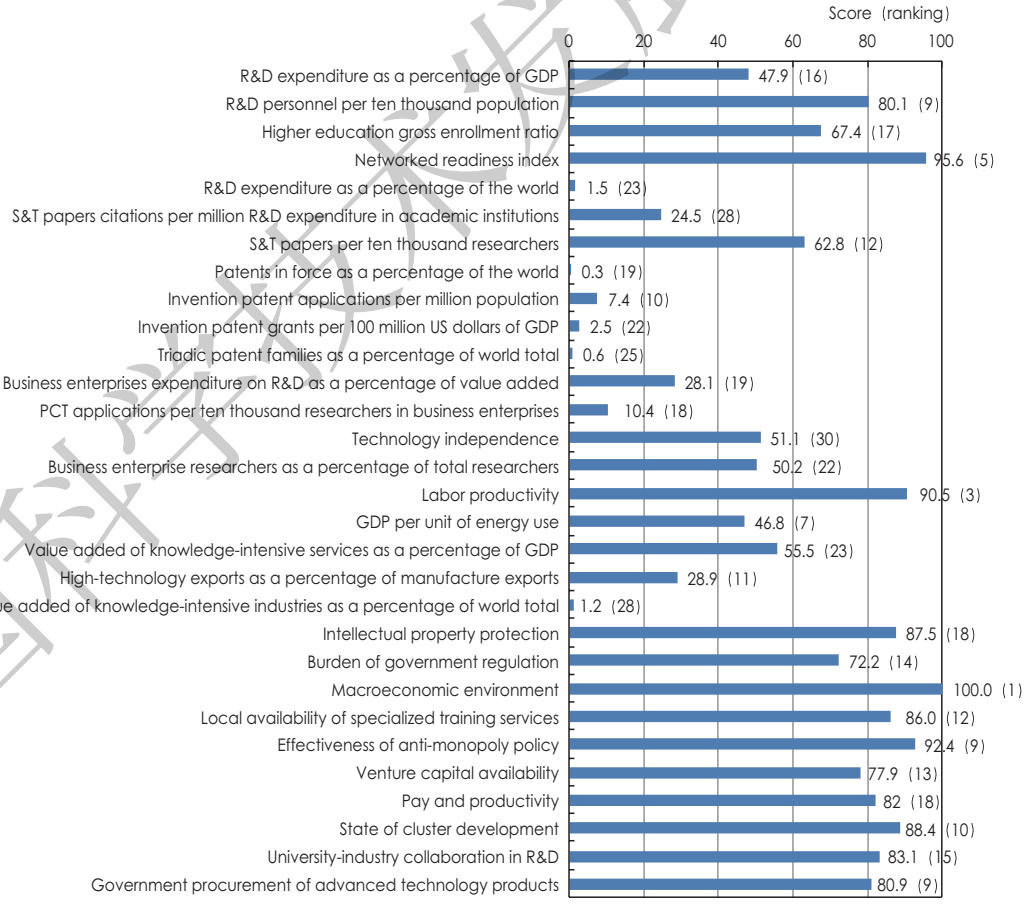
New Zealand remains at the 22nd place in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 21st in innovation resources, drops 6 places to the 11th in knowledge creation, improves by 4 places to the 30th in enterprise innovation and 8 places to the 17th in innovation performance, and remains stable at the 11th in innovation environment.



Norway

As a European country, Norway has a population of 5.23 million and a territory of approximately 385 thousand square kilometers with a GDP of USD 371.1 billion and GDP per capita of USD 70 912 in 2016 and is a high-income country. It records USD 12.8 per kg of oil equivalent in GDP per unit of energy use, USD 7.6 billion in R&D expenditure, 2.0% in R&D intensity, 14 thousand in SCI indexed papers, 653 in PCT applications, and 19.5% in high-technology exports as a percentage of manufacture exports.

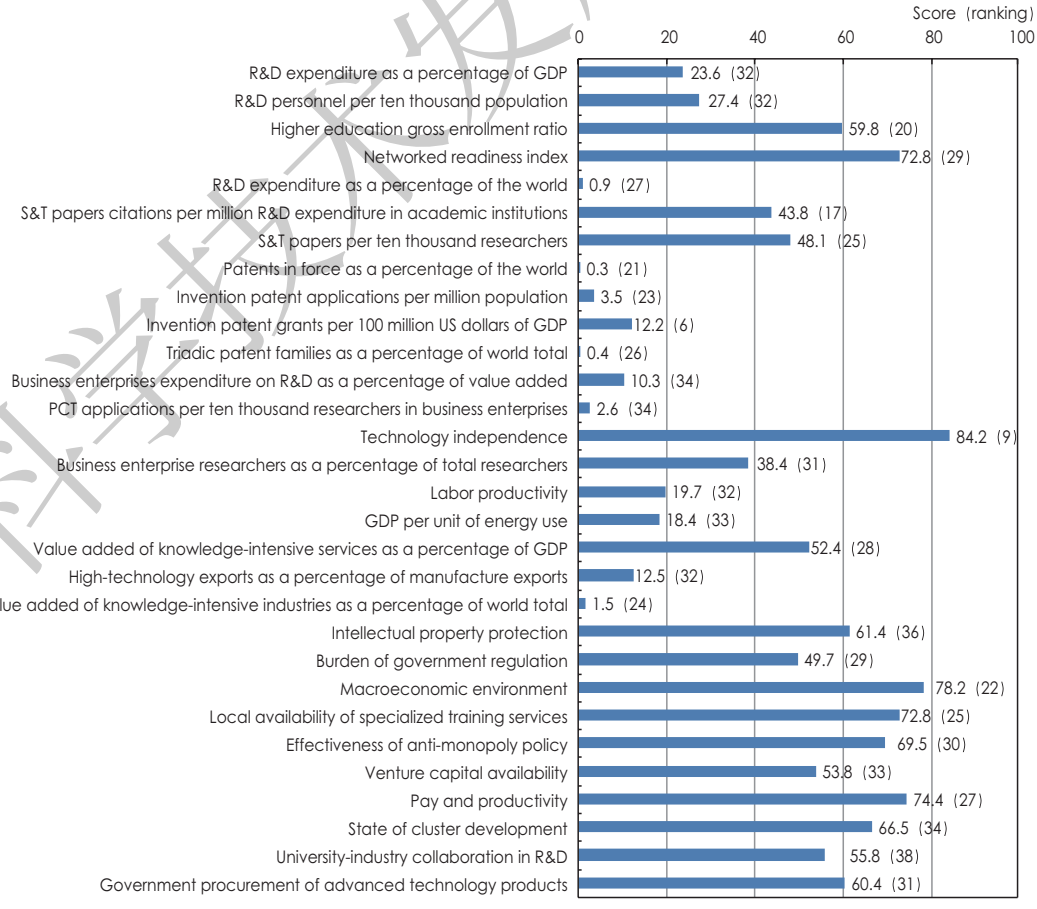
Norway drops 1 place to the 16th in the national innovation index. Among the five first-level indicators, it stays at the 12th in innovation resources, improves by 14 places to the 18th in knowledge creation, and falls 3 places to the 26th in enterprise innovation, 2 places to the 7th in innovation performance and 3 places to the 9th in innovation environment.



Poland

As a European country, Poland has a population of 37.95 million and a territory of approximately 313 thousand square kilometers with a GDP of USD 471.4 billion and GDP per capita of USD 12 421 in 2016 and is an upper-middle income country. It records USD 5.0 per kg of oil equivalent in GDP per unit of energy use, USD 4.6 billion in R&D expenditure, 1.0% in R&D intensity, 29 thousand in SCI indexed papers, 344 in PCT applications, and 8.5% in high-technology exports as a percentage of manufacture exports.

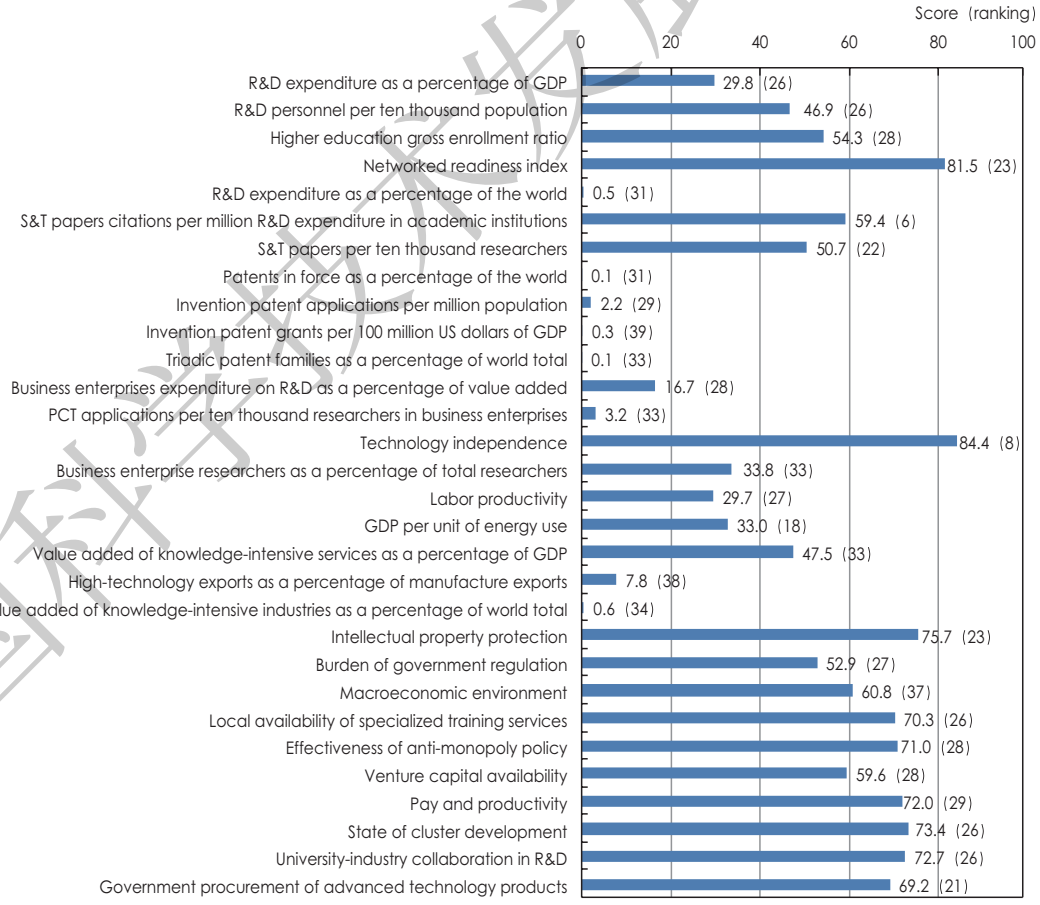
Poland improves by 1 place to the 31st in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 32nd in innovation resources, improves by 3 places to the 23rd in knowledge creation, falls 3 places to the 28th in enterprise innovation and 2 places to the 34th in innovation performance, and moves up 2 places to the 30th in innovation environment.



Portugal

As a European country, Portugal has a population of 10.32 million and a territory of approximately 92 thousand square kilometers with a GDP of USD 204.8 billion and GDP per capita of USD 19 840 in 2016 and is a high-income country. It records USD 9.0 per kg of oil equivalent in GDP per unit of energy use, USD 2.6 billion in R&D expenditure, 1.3% in R&D intensity, 15 thousand in SCI indexed papers, 184 in PCT applications, and 5.3% in high-technology exports as a percentage of manufacture exports.

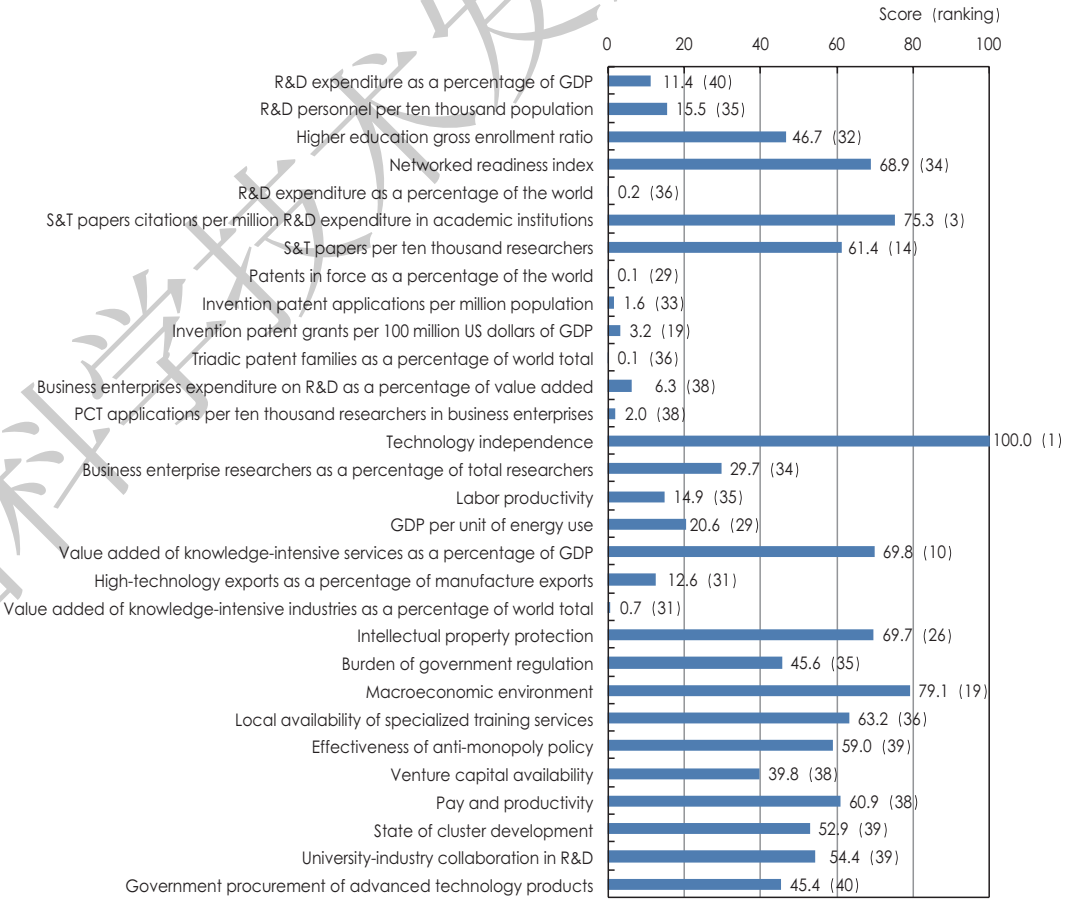
Portugal remains at the 28th place in the national innovation index. Among the five first-level indicators, it stays at the 29th in innovation resources, falls 4 places to the 21st in knowledge creation, climbs 3 places to the 24th in enterprise innovation, drops 1 place to the 28th in innovation performance, and moves up 1 place to the 27th in innovation environment.



Romania

As a European country, Romania has a population of approximately 19.71 million and a territory of approximately 238 thousand square kilometers with a GDP of USD 187.6 billion and GDP per capita of USD 9520 in 2016 and is an upper-middle income country. It records USD 5.6 per kg of oil equivalent in GDP per unit of energy use, USD 910 million in R&D expenditure, 0.5% in R&D intensity, 8014 in SCI indexed papers, 44 in PCT applications, and 8.5% in high-technology exports as a percentage of manufacture exports.

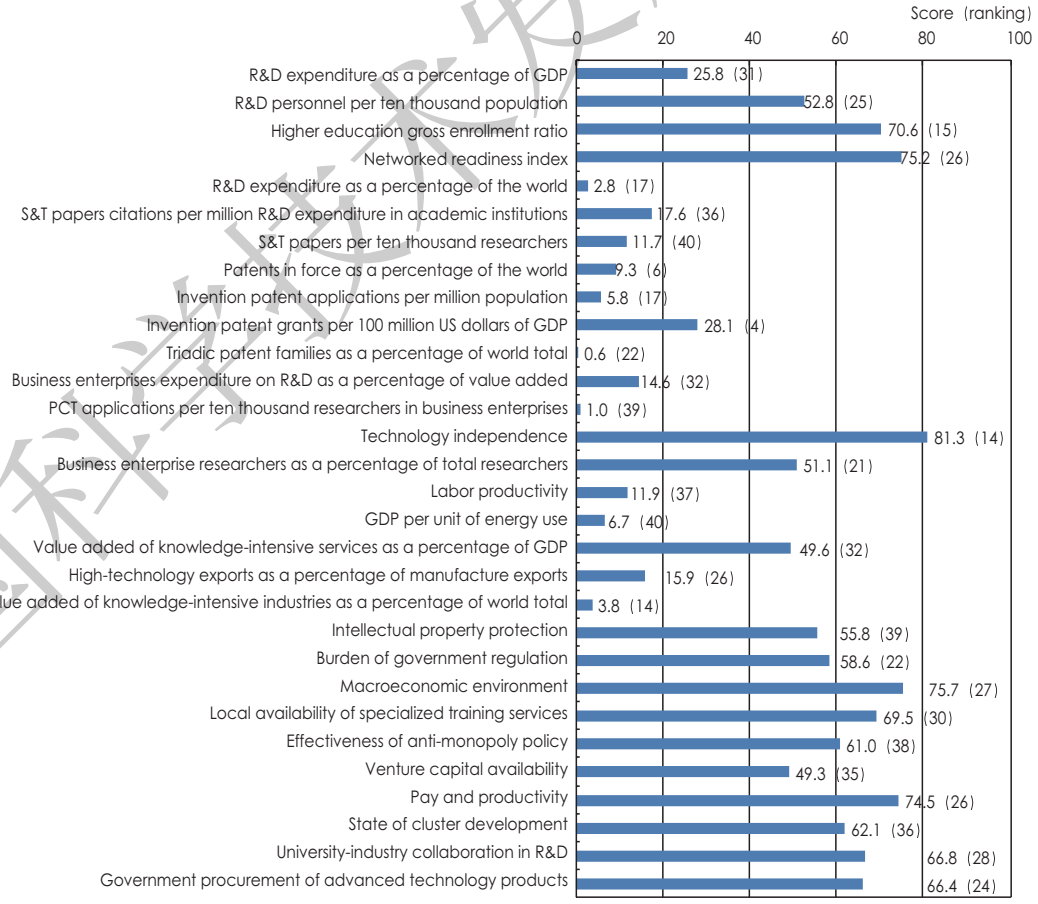
Romania moves up 2 places to the 32nd in the national innovation index. Among the five first-level indicators, it remains stable at the 37th in innovation resources, improves by 10 places to the 10th in knowledge creation, 4 places to the 25th in enterprise innovation and 10 places to the 27th in innovation performance, and stays at the 37th in innovation environment.



Russian Federation

As a European country, the Russian Federation has a population of approximately 144 million and a territory of approximately 17.10 million square kilometers with a GDP of USD 1.28 trillion and GDP per capita of USD 8748 in 2016 and is an upper-middle income country. It records USD 1.8 per kg of oil equivalent in GDP per unit of energy use, USD 14.1 billion in R&D expenditure, 1.1% in R&D intensity, 36 thousand in SCI indexed papers, 893 in PCT applications, and 10.7% in high-technology exports as a percentage of manufacture exports.

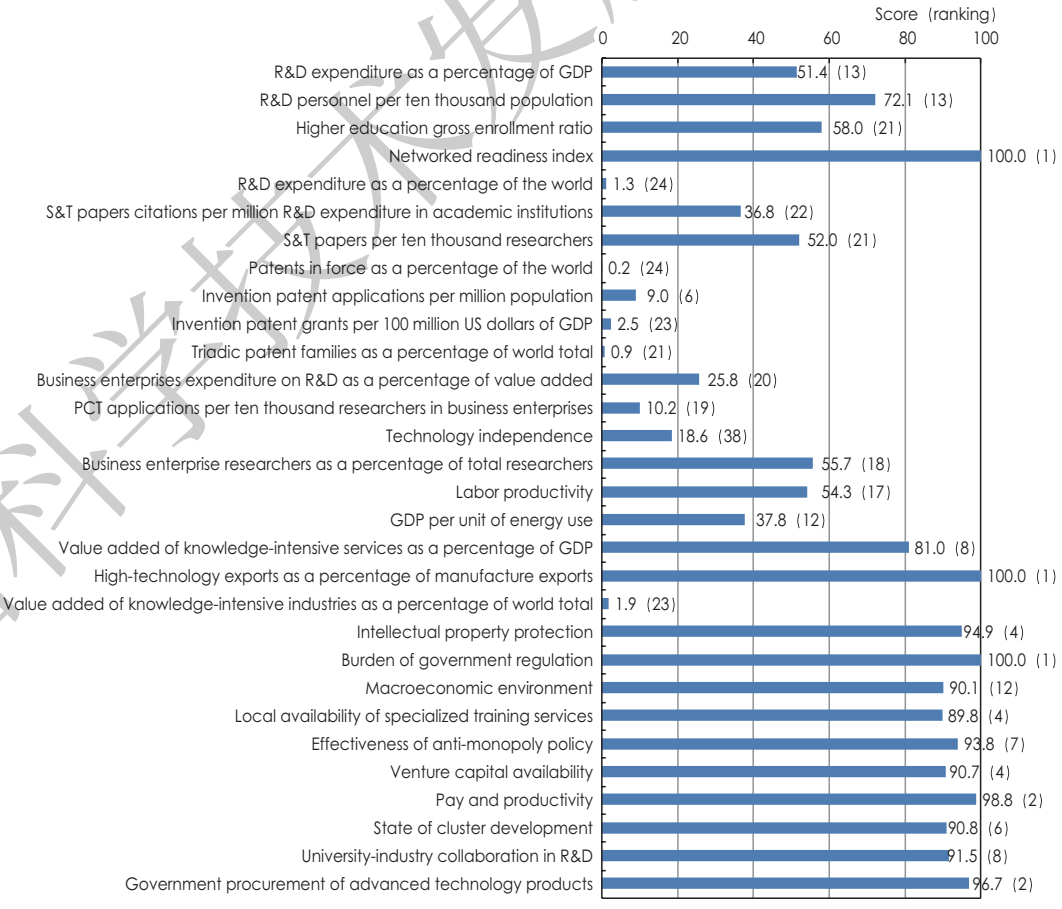
The Russian Federation retains its 33rd position in the national innovation index. Among the five first-level indicators, it stays at the 27th in innovation resources, falls 2 places to the 37th in knowledge creation, 1 place to the 23rd in enterprise innovation and 3 places to the 38th in innovation performance, and improves by 2 places to the 33rd in innovation environment.



Singapore

As an Asian country, Singapore has a population of 5.61 million and a territory of approximately 719.9 square kilometers with a GDP of USD 297.0 billion and GDP per capita of USD 52 962 in 2016 and is a high-income country. It records USD 10.3 per kg of oil equivalent in GDP per unit of energy use, USD 6.7 billion in R&D expenditure, 2.2% in R&D intensity, 14 thousand in SCI indexed papers, 864 in PCT applications, and 67.4% in high-technology exports as a percentage of manufacture exports.

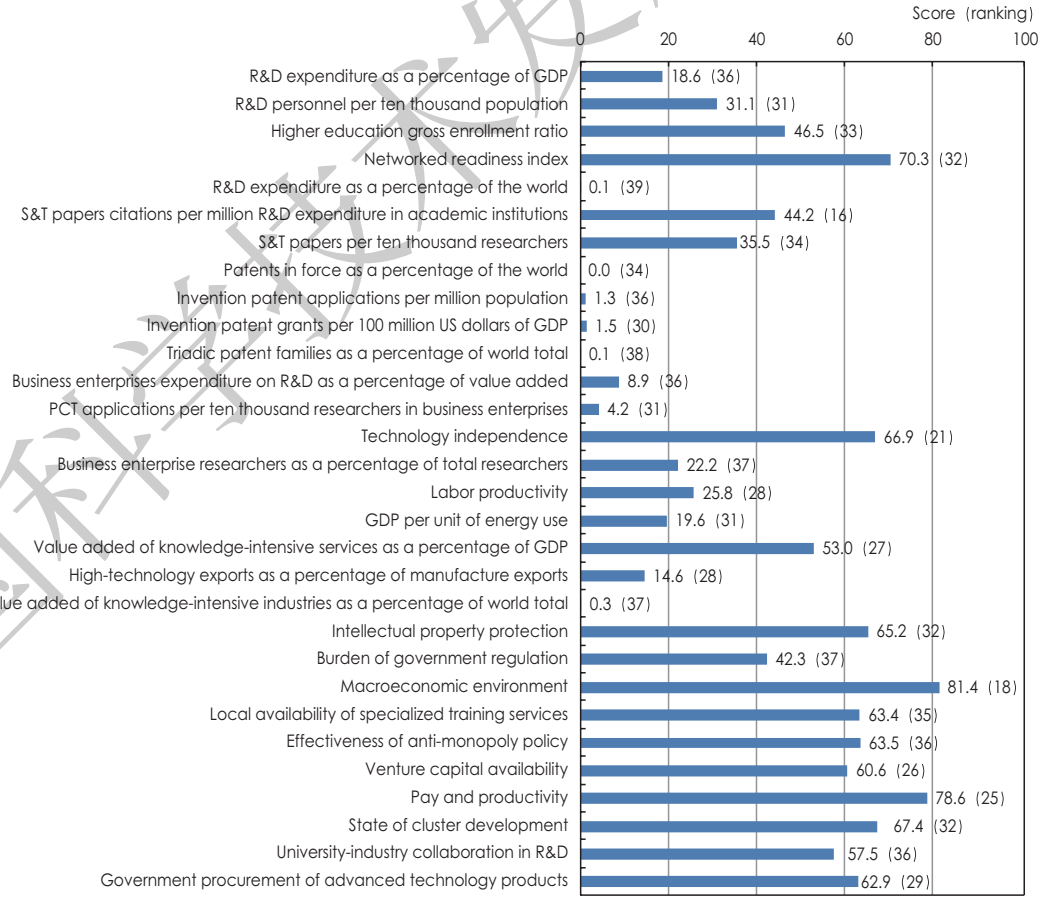
Singapore retains its 9th position in the national innovation index. Among the five first-level indicators, it retains the 14th position in innovation resources, drops 15 places to the 31st in knowledge creation, stays at the 33rd in enterprise innovation, improves by 2 places to the 4th in innovation performance, and remains stable at the 1st in innovation environment.



Slovak Republic

As a European country, the Slovak Republic has a population of 5.43 million and a territory of approximately 49 thousand square kilometers with a GDP of USD 89.8 billion and GDP per capita of USD 16 536 in 2016 and is a high-income country. It records USD 5.4 per kg of oil equivalent in GDP per unit of energy use, USD 710 million in R&D expenditure, 0.8% in R&D intensity, 3638 in SCI indexed papers, 55 in PCT applications, and 9.8% in high-technology exports as a percentage of manufacture exports.

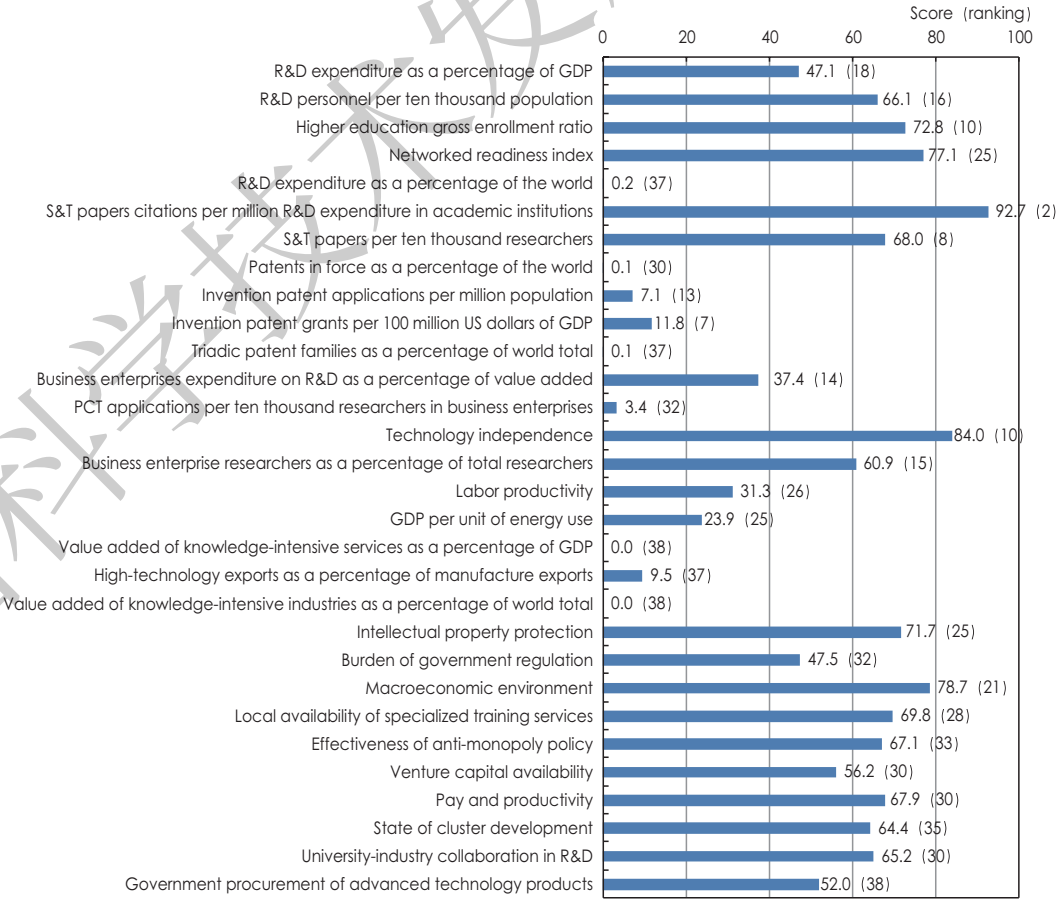
The Slovak Republic remains stable at the 35th place in the national innovation index. Among the five first-level indicators, it moves down 1 place to the 35th in innovation resources, goes up 1 place to the 35th in knowledge creation, stays at the 35th in enterprise innovation, drops 1 place to the 31st in innovation performance, and improves by 2 places to the 29th in innovation environment.



Slovenia

As a European country, Slovenia has a population of approximately 2.06 million and a territory of approximately 20 thousand square kilometers with a GDP of USD 44.7 billion and GDP per capita of USD 21 652 in 2016 and is a high-income country. It records USD 6.5 per kg of oil equivalent in GDP per unit of energy use, USD 900 million in R&D expenditure, 2.0% in R&D intensity, 3988 in SCI indexed papers, 69 in PCT applications, and 6.4% in high-technology exports as a percentage of manufacture exports.

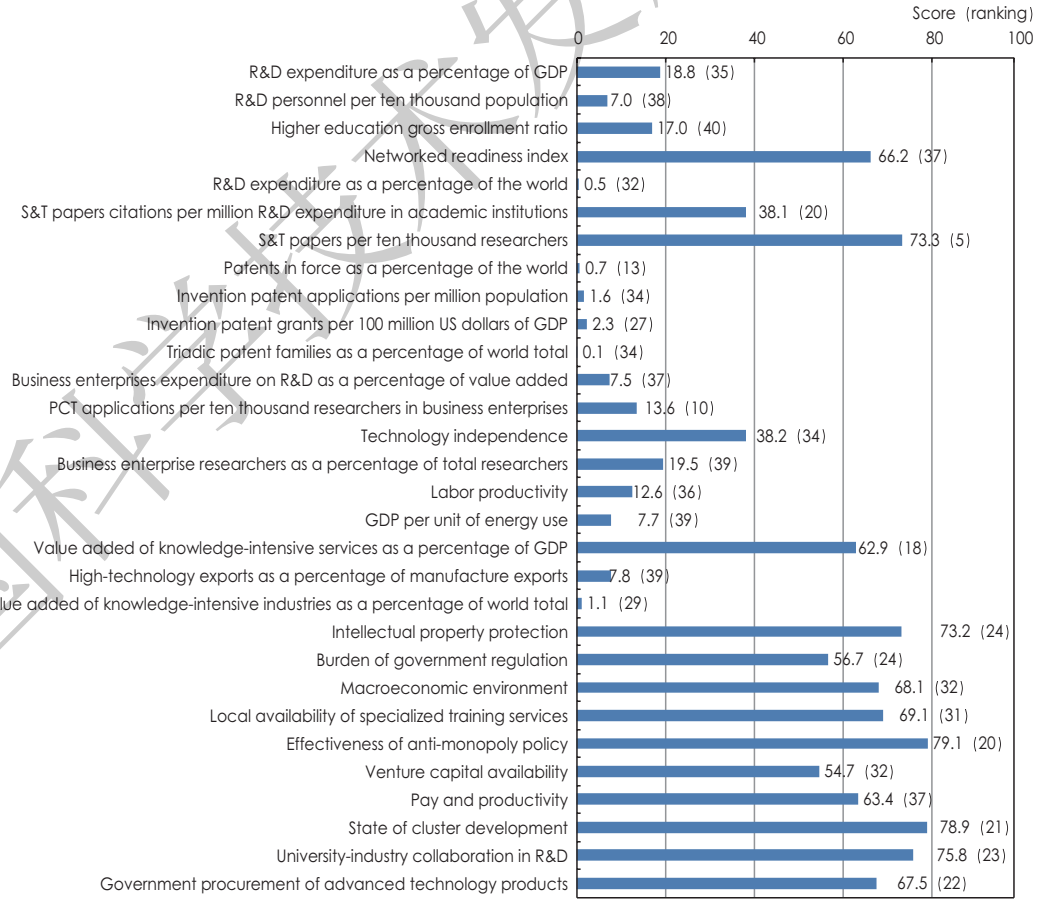
Slovenia goes up 1 notch to the 23rd in the national innovation index. Among the five first-level indicators, it goes down 1 place to the 18th in innovation resources, climbs 10 places to the 4th in knowledge creation, falls 1 place to the 15th in enterprise innovation and 2 places to the 33rd in innovation performance, and improves by 2 places to the 31st in innovation environment.



South Africa

As an African country, South Africa has a population of approximately 55.91 million and a territory of approximately 1.22 million square kilometers with a GDP of USD 295.5 billion and GDP per capita of USD 5285 in 2016 and is an upper-middle income country. It records USD 2.1 per kg of oil equivalent in GDP per unit of energy use, USD 2.5 billion in R&D expenditure, 0.8% in R&D intensity, 14 thousand in SCI indexed papers, 287 in PCT applications, and 5.3% in high-technology exports as a percentage of manufacture exports.

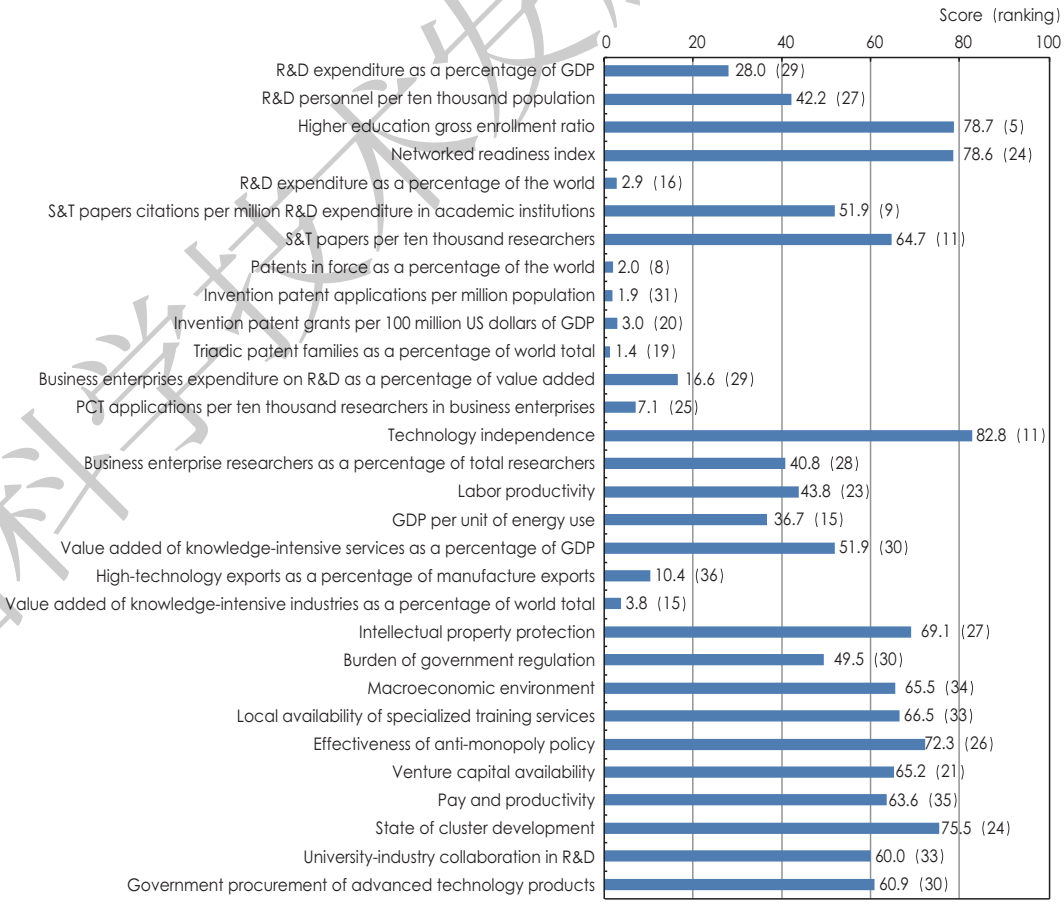
South Africa maintains its 36th position in the national innovation index. Among the five first-level indicators, it moves up 1 place to the 39th in innovation resources, moves down 5 places to the 20th in knowledge creation and 1 place to the 38th in enterprise innovation, improves by 2 places to the 37th in innovation performance, and drops 1 place to the 26th in innovation environment.



Spain

As a European country, Spain has a population of 46.44 million and a territory of approximately 506 thousand square kilometers with a GDP of USD 1.24 trillion and GDP per capita of USD 26 640 in 2016 and is a high-income country. It records USD 10.1 per kg of oil equivalent in GDP per unit of energy use, USD 14.7 billion in R&D expenditure, 1.2% in R&D intensity, 59 thousand in SCI indexed papers, 1506 in PCT applications, and 7.0% in high-technology exports as a percentage of manufacture exports.

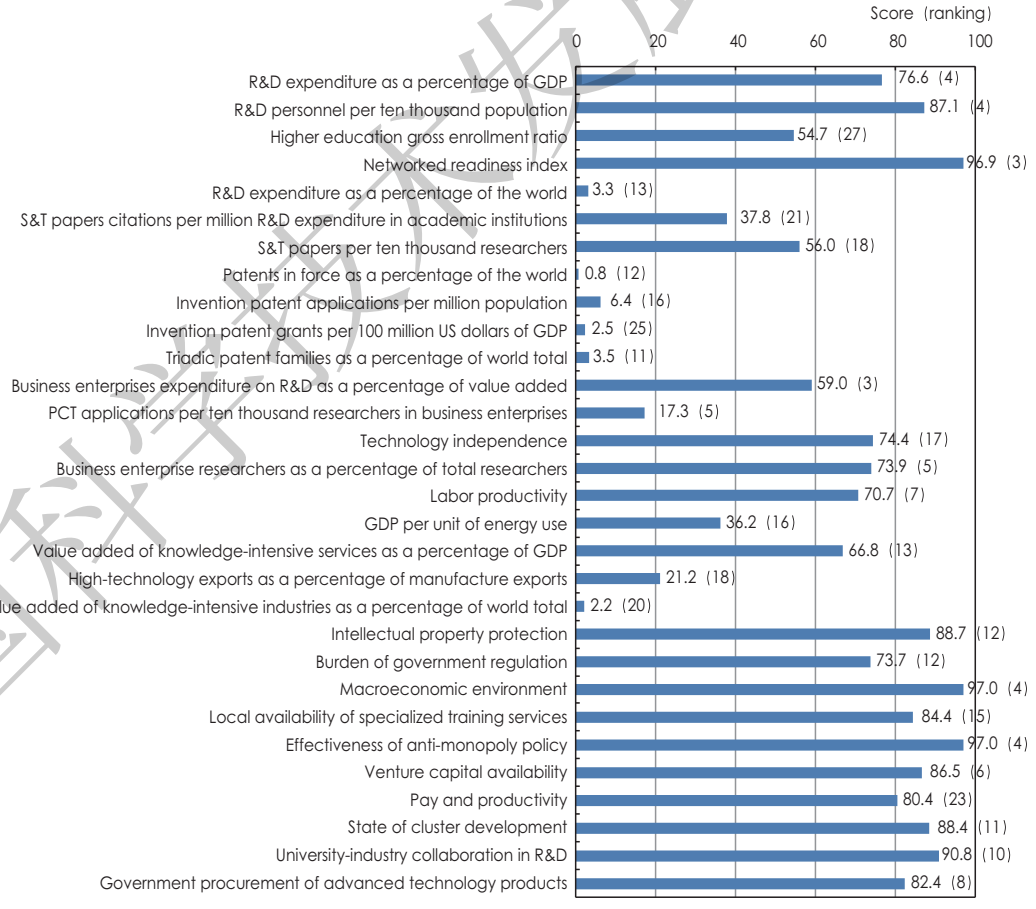
Spain stays at the 26th place in the national innovation index. Among the five first-level indicators, it improves by 2 places to the 24th in innovation resources, falls 1 place to the 14th in knowledge creation, climbs 2 places to the 22nd in enterprise innovation, drops 1 place to the 25th in innovation performance, and goes up 1 place to the 28th in innovation environment.



Sweden

As a European country, Sweden has a population of approximately 9.90 million and a territory of approximately 450 thousand square kilometers with a GDP of USD 514.5 billion and GDP per capita of USD 51 949 in 2016 and is a high-income country. It records USD 9.9 per kg of oil equivalent in GDP per unit of energy use, USD 16.8 billion in R&D expenditure, 3.3% in R&D intensity, 29 thousand in SCI indexed papers, 3720 in PCT applications, and 14.3% in high-technology exports as a percentage of manufacture exports.

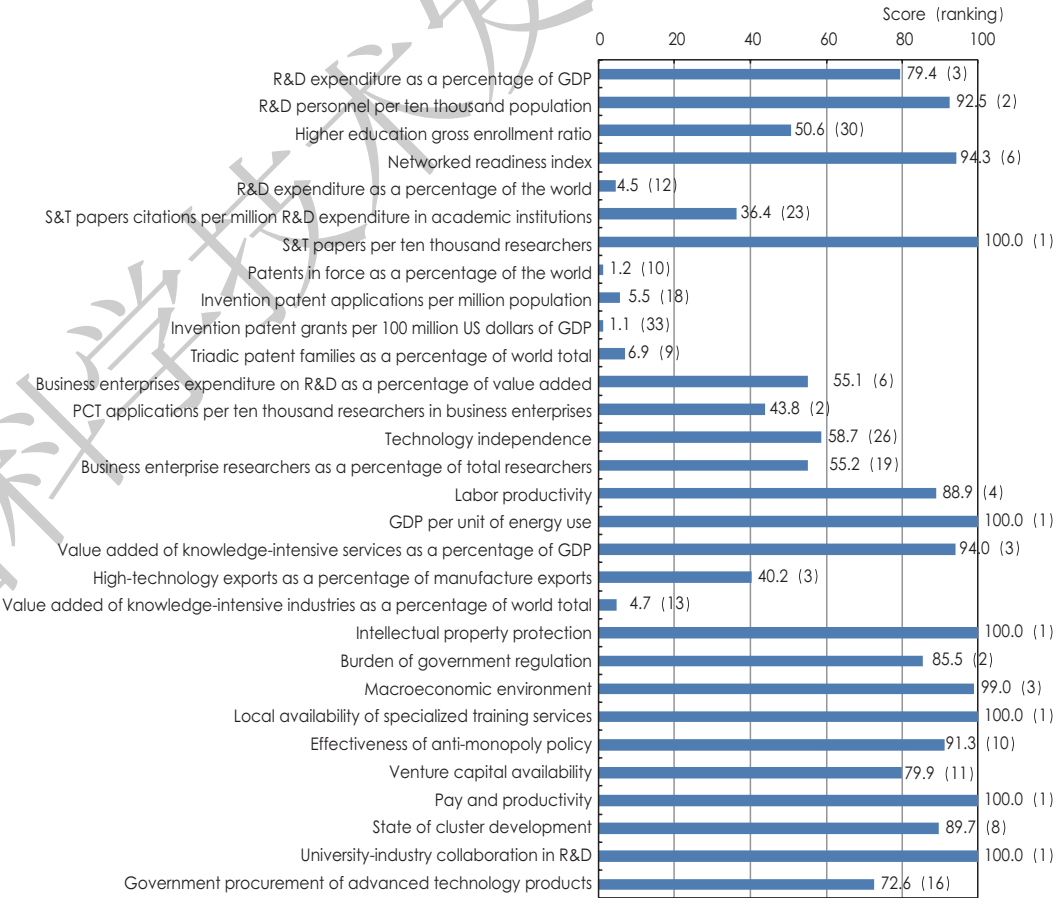
Sweden drops 1 rank to the 7th in the national innovation index. Among the five first-level indicators, it remains stable at the 7th in innovation resources, falls 6 places to the 29th in knowledge creation, stays at the 7th in enterprise innovation, and improves by 3 places to the 12th in innovation performance and 1 place to the 7th in innovation environment.



Switzerland

As a European country, Switzerland has a population of approximately 8.37 million and a territory of approximately 41 thousand square kilometers with a GDP of USD 668.9 billion and GDP per capita of USD 79 891 in 2016 and is a high-income country. It records USD 27.4 per kg of oil equivalent in GDP per unit of energy use, USD 22.9 billion in R&D expenditure, 3.4% in R&D intensity, 32 thousand in SCI indexed papers, 4367 in PCT applications, and 27.1% in high-technology exports as a percentage of manufacture exports.

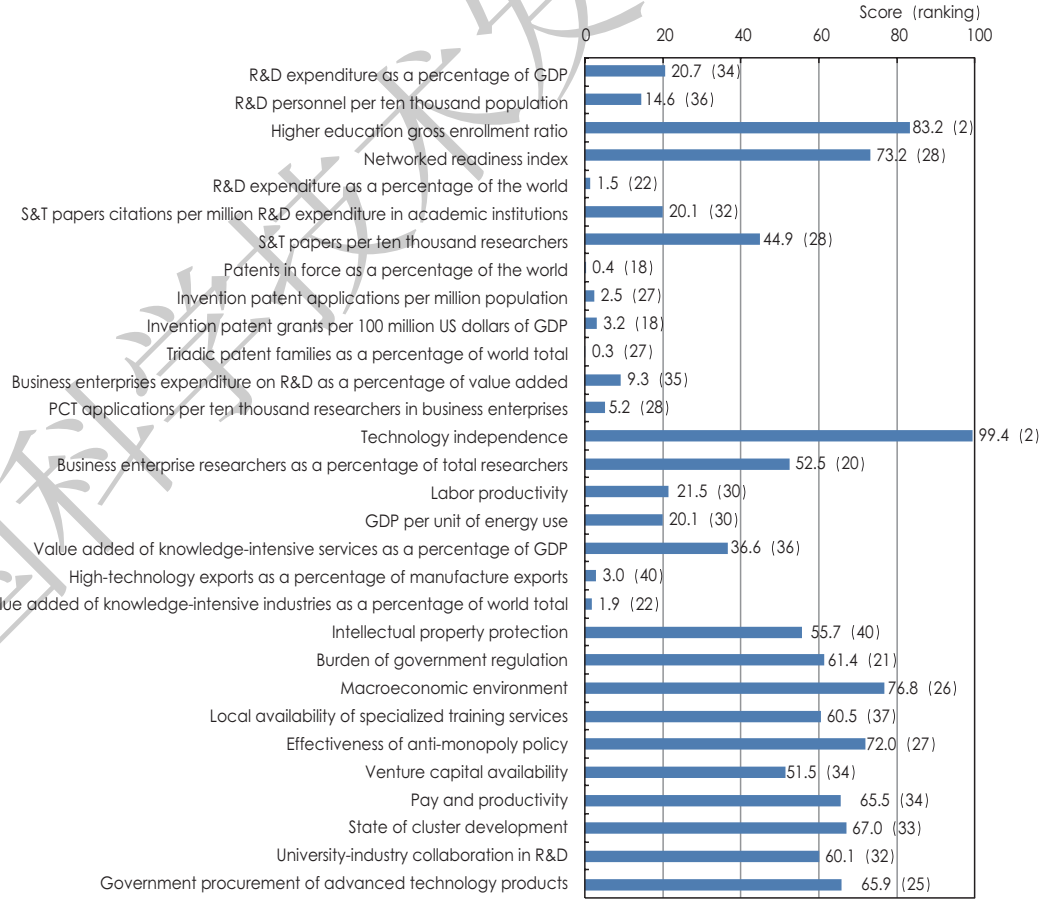
Switzerland retains its 3rd position in the national innovation index. Among the five first-level indicators, it moves up 4 places to the 6th in innovation resources, drops 6 places to the 8th in knowledge creation, improves by 2 places to the 6th in enterprise innovation and 1 place to the 1st in innovation performance, and falls 1 place to the 3rd in innovation environment.



Turkey

As an Asian country, Turkey has a population of approximately 79.51 million and a territory of approximately 784 thousand square kilometers with a GDP of USD 863.7 billion and GDP per capita of USD 10 863 in 2016 and is an upper-middle income country. It records USD 5.5 per kg of oil equivalent in GDP per unit of energy use, USD 7.6 billion in R&D expenditure, 0.9% in R&D intensity, 31 thousand in SCI indexed papers, 1065 in PCT applications, and 2.0% in high-technology exports as a percentage of manufacture exports.

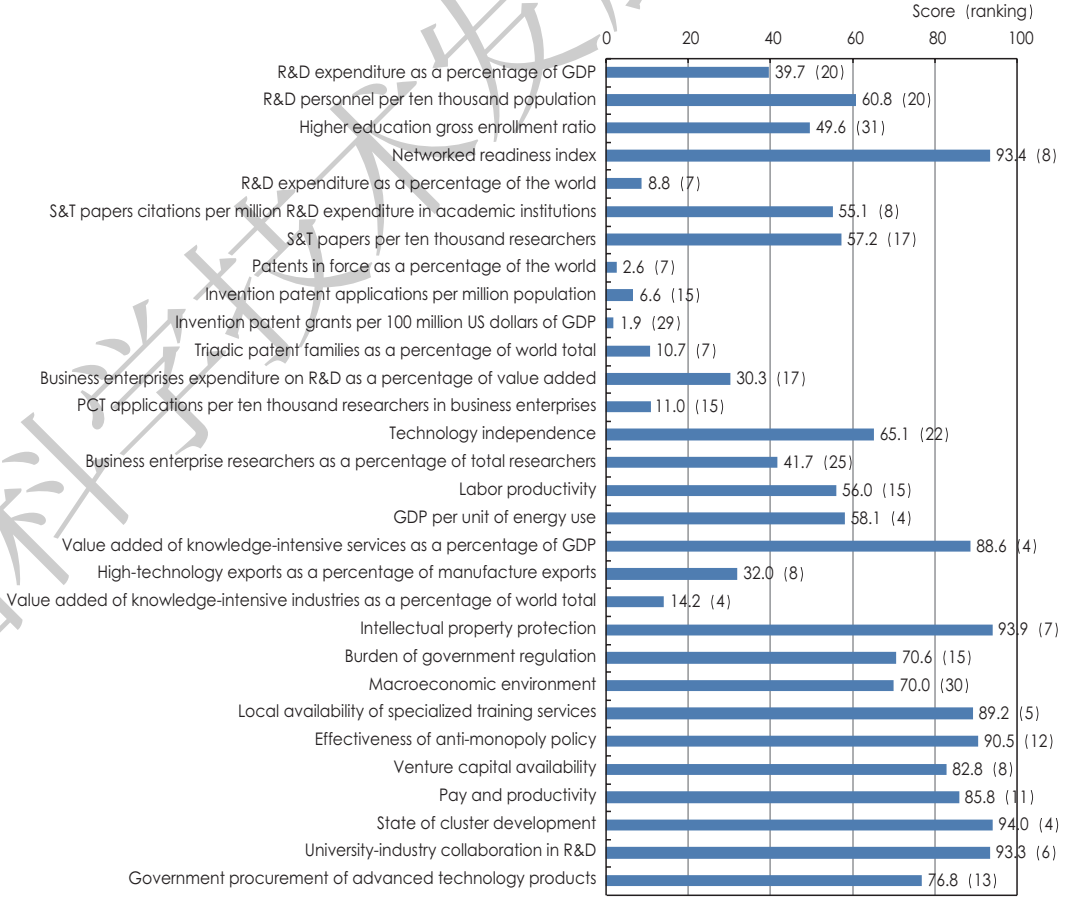
Turkey falls 4 ranks to the 34th in the national innovation index. Among the five first-level indicators, it goes up 2 places to the 31st in innovation resources, falls 9 places to the 38th in knowledge creation, improves by 1 place to the 17th in enterprise innovation, and declines by 2 places to the 40th in innovation performance and 4 places to the 34th in innovation environment.



United Kingdom

As a European country, the United Kingdom has a population of approximately 65.64 million and a territory of approximately 244 thousand square kilometers with a GDP of USD 2.65 trillion and GDP per capita of USD 40 341 in 2016 and is a high-income country. It records USD 15.9 per kg of oil equivalent in GDP per unit of energy use, USD 44.8 billion in R&D expenditure, 1.7% in R&D intensity, 120 thousand in SCI indexed papers, 5502 in PCT applications, and 21.6% in high-technology exports as a percentage of manufacture exports.

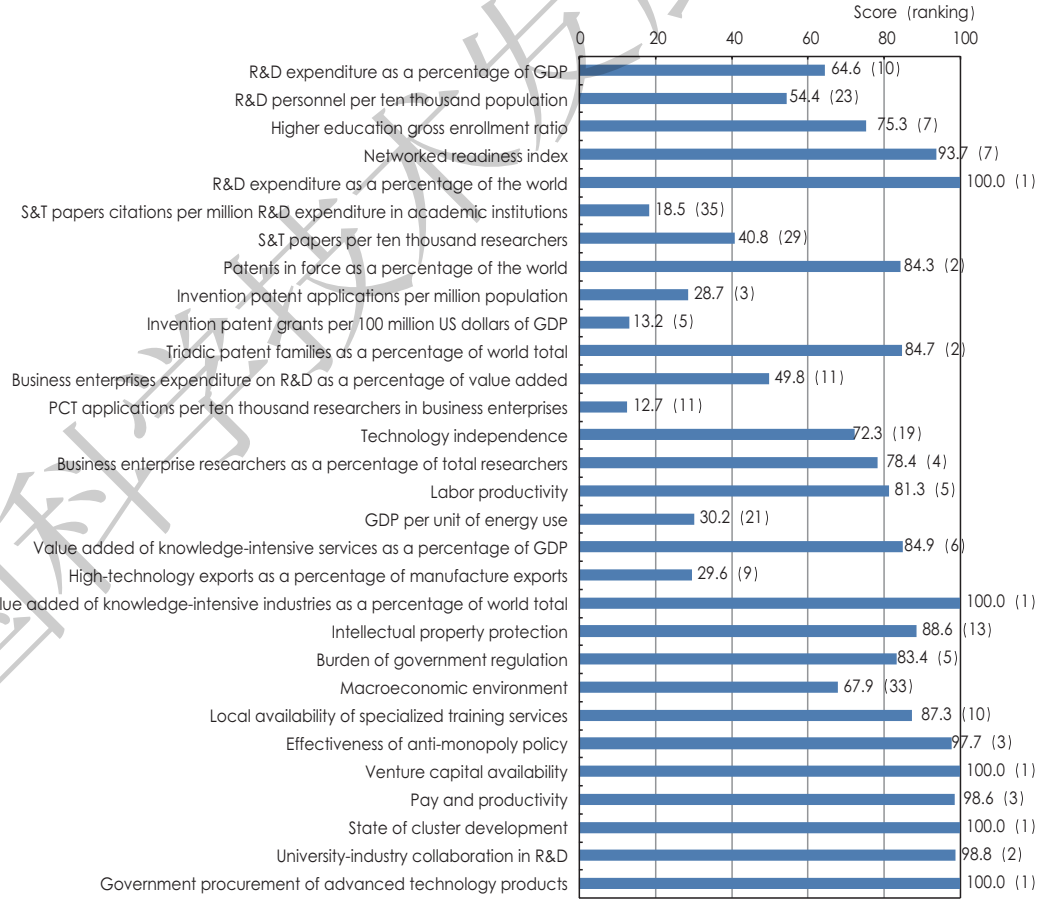
The United Kingdom drops 1 rank to the 11th in the national innovation index. Among the five first-level indicators, it falls 1 place to the 20th in innovation resources and 9 places to the 15th in knowledge creation, stays at the 19th in enterprise innovation, moves up 2 places to the 5th in innovation performance, and remains stable at the 10th in innovation environment.



United States

As a North American country, the United States has a population of 323 million and a territory of approximately 9.37 million square kilometers with a GDP of USD 18.62 trillion and GDP per capita of USD 57 638 in 2016 and is a high-income country. It records USD 8.3 per kg of oil equivalent in GDP per unit of energy use, USD 511.1 billion in R&D expenditure, 2.8% in R&D intensity, 407 thousand in SCI indexed papers, 56 595 in PCT applications, and 20.0% in high-technology exports as a percentage of manufacture exports.

The United States retains its No. 1 position in the national innovation index. Among the five first-level indicators, it stays at the 1st in innovation resources, advances by 1 place to the 3rd in knowledge creation, keeps the 2nd position in enterprise innovation, falls 1 place to the 2nd in innovation performance, and improves by 2 places to the 2nd in innovation environment.



National Innovation Index Report 2018

Part III

Assessment Methodology

I. Assessment Approach

(I) Objective of Assessment

By constructing a multivariate indicator matrix and measuring the national innovation index, this study aims to comprehensively, objectively and accurately depict the characteristics of China's national innovation capability in different dimensions and its position in the world. The national innovation capability indicator matrix, indicator definitions, calculation methods and analysis framework formed in the process of this study will provide a strong support and valuable services for monitoring the progress of China's effort to build itself into an innovation-driven country and improve its S&T innovation policies.

(II) Meaning of an Innovation-driven Country

Countries can be roughly divided into three categories by development pattern: resource export-oriented countries, economically dependent countries and technological innovation-driven countries. Countries in the first two categories face a significant risk of being marginalized while technological innovation-driven countries have taken center stage and an overwhelming lead in the global development. For China which neither has excess resources to export nor is possible to follow the path of economic dependence and be marginalized, technological innovation-driven development is the only feasible choice. For this reason, ranking among innovation-driven countries is set as a strategic goal in China's *National Program for Long- and Medium-Term Scientific and Technological Development*(*2006–2020*).

There is often a positive correlation between S&T progress and economic prosperity. According to statistics, among the 220 countries and regions in the world, only 137 countries have R&D activities, and there are only 35 countries whose R&D expenditure as a percentage of GDP exceeds 1%. These 35 countries, while representing only 39% of the world population, contribute 90% of the world's total R&D expenditure and 80% of the global GDP. This shows that economic powers of the world are primarily supported by their S&T strength rather than the population and natural resources. Further analysis shows that although some small countries can rely on natural resources to achieve economic growth and national prosperity, not a single large country becomes a global economic power by mainly relying on natural resources.

A comparison between the top 15 countries and the rest countries in S&T and economic development rankings finds that innovation-driven countries embrace a model of social and economic development that is fundamentally different from the traditional model. The yardstick of whether a country is an innovation-driven country is whether its social and economic development and wealth increase are mainly driven by productive factors (consumption of natural resources and investments) or by innovation activities characterized by the creation, dissemination and application of knowledge.

An innovation-driven country is characterized by five main attributes:

(1) High investment of innovation resources;
(2) Active knowledge creation and dissemination;
(3) Strong enterprise innovation capability;
(4) Strong innovation output and impact;
(5) Favorable innovation environment.

(III) Theoretical Basis

As innovation involves the whole process from conceptualization to knowledge creation to

commercialization, the national innovation capability has to reflect these dimensions. In this study, the national innovation capability is assessed on the basis of main links of the entire innovation process including investment of innovation resources, knowledge creation and application, enterprise innovation and innovation output and performance, using an index-based approach with reference to the EU's methods of national innovation performance assessment. This study's indicator matrix consists of five first-level indicators including innovation resources, knowledge creation, enterprise innovation, innovation performance and innovation environment and 30 second-level indicators, which are used to comprehensively analyze, compare and assess the national innovation capability.

(IV) Criteria of Indicator Selection

Authoritativeness of data sources: Basic data must be from official statistics and surveys of recognized international organizations and national governments. The data are collected from official sources on a regular basis to ensure their correctness, authoritativeness, continuousness and timeliness.

Representativeness of subjects for assessment: The subjects for assessment have to be countries with remarkable innovation resources and significant innovation output. Eventually 40 countries are selected, whose combined R&D spending accounts for more than 95% of the global total and whose combined GDP accounts for more than 86% of the global total.

International comparability of indicators: Internationally commonly used indicators are selected to construct the indicator matrix. The definitions and statistical methodology of indicators are consistent with international norms.

Insensitivity of indicators to country size: The indicators are mostly of a relative nature while the characteristics of countries of different sizes in efficiency, scale and scope of innovation activities are also taken into account.

Combination of quantitative measurement and qualitative analysis: Both quantitative and qualitative indicators, all from authoritative sources, are used to provide a comprehensive picture.

Integration of historical analysis and contemporaneous comparison: Countries are both contemporaneously compared and historically, developmentally analyzed.

II. Indicator Matrix

The indicator matrix of the national innovation index in this study consists of five first-level indicators (innovation resources, knowledge creation, enterprise innovation, innovation performance and innovation environment) and 30 second-level indicators.

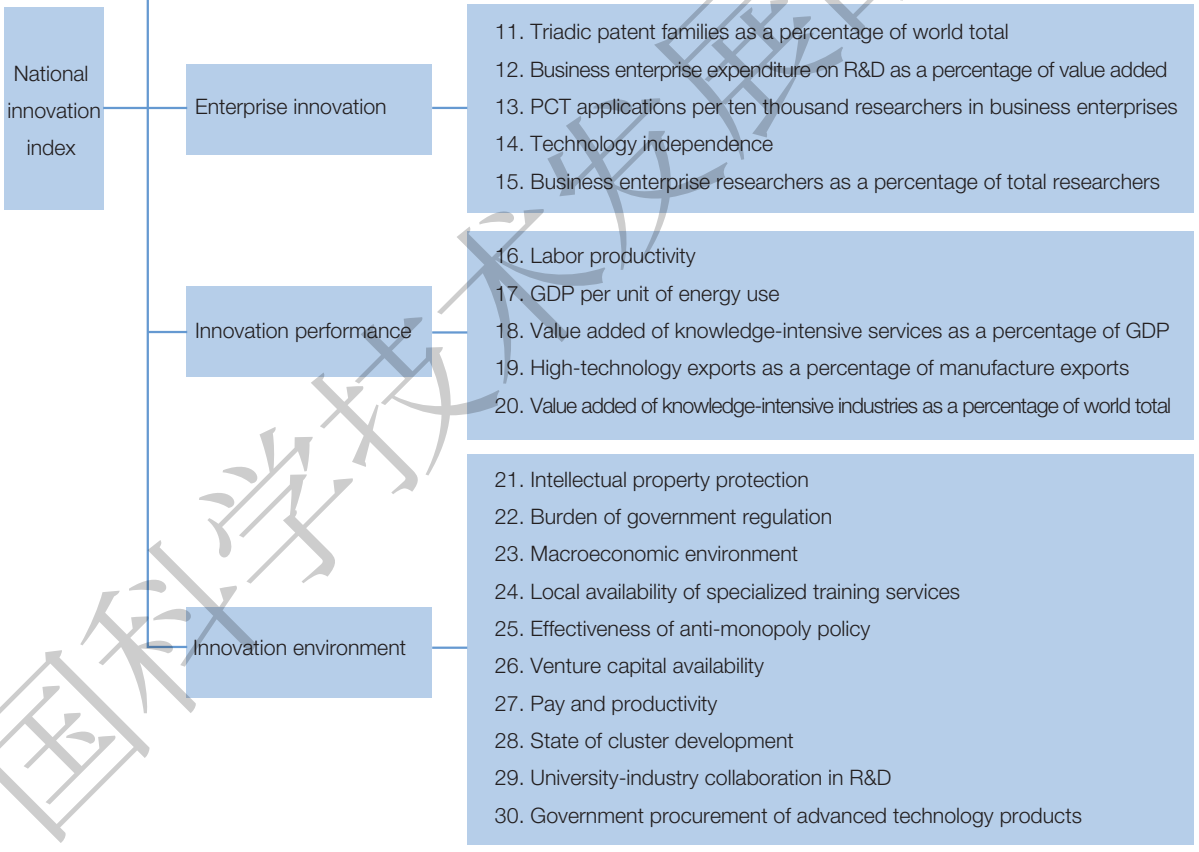
Innovation resources: This indicator reflects a country's availability of resources for innovation activities such as funds, talent and infrastructures.

Knowledge creation: This indicator reflects a country's strength in scientific output and knowledge dissemination.

Enterprise innovation: This indicator reflects the intensity, efficiency and sophistication of enterprises' innovation activities.

Innovation performance: This indicator reflects the effect and impact of a country's innovation activity on its economic, social and industrial development.

Innovation environment: This indicator reflects the external soft environment of innovation activity and consists of ten second-level indicators (selected from indicators used in the World Economic Forum's *Global Competitiveness Report*).



III. Calculation Methodology

This study uses the international generally applied benchmarking method. This method assigns a base value to a subject and uses it to assess all subjects to identify their comparative positions and rank them according to their respective scores.

(I) Treatment of Second-level Indicator Data

The original values of the 40 countries in the 30 second-level indicators are non-dimensionalized.

Non-dimensionalization is used for the purpose of removing the discrepancies in quantitative units and the differences in order of magnitude and form of relative number and enabling the generalization of indicators in assessment using multiple indicators.

Second-level indicator data are treated using linear non-dimensionalization, as in:

$$y_{ij} = \frac{x_{ij} - \min x_{\bullet j}}{\max x_{\bullet j} - \min x_{\bullet j}},$$

where: i=1~40; j=1~30.

(II) Calculation of First-level Indicator Score

Calculation of first-level indicator score: $\overline{Y}_{ik}$

$$Y_{ik} = \sum_{l=1}^{n_k} \beta_k y_{i\,(l+5k-5)},$$

$$\overline{Y}_{ik} = 100 \times Y_{ik} / \max Y_{\cdot k},$$

where: β_k is the weight; i=1~40; k=1~5; l=1~n_k, n_k being the number of second-level indicators of a first-level indicator.

(III) Calculation of National Innovation Index Score

National innovation index score, denoted as $\overline{Y}_i$, is calculated to produce the rankings of the 40 countries.

$$Y_i = \sum_{k=1}^{5} \omega_k \overline{Y}_{ik},$$

$$\overline{Y}_i = Y_i / \max (Y_{i,\, i=1\sim40}),$$

where ω_k is the weight; k =1~5; i =1~40.

(IV) Calculation of China's National Innovation Index Score Increase

Method of calculation of changes in index and sub-index scores with 2005 as the base year: values of the index and sub-index scores for the base year 2005 are set equal to 100 and the values of the index and sub-index scores for subsequent years are transformed accordingly, thus revealing the changes in the scores.

1. Calculation of first-level indicator score

Calculation of first-level indicator scores: $\overline{Z}_k$

$$Z_{jt} = 100 X_{jt} / X_{j1},$$

where: j=1~30 is the serial number of an indicator; t=1~12 denotes a year between 2005 and 2016.

$$\overline{Z}_k = \sum_{l=1}^{n_k} \beta_k Z_{(l+5k-5)},$$

where: β_k is the weight; k =1~5; l =1~n_k, n_k being the number of second-level indicators of a first-level indicator.

2. Calculation of the index of national innovation capacity

The national innovation index $\overline{Z}$ is calculated, and the values for previous years are derived.

$$\overline{Z} = \sum_{k=1}^{5} \omega_k \overline{Z}_k,$$

where: ω_k is the weight; k =1~5.

National Innovation Index Report 2018

Appendixes

Appendix I Index and Sub-index Scores and Rankings

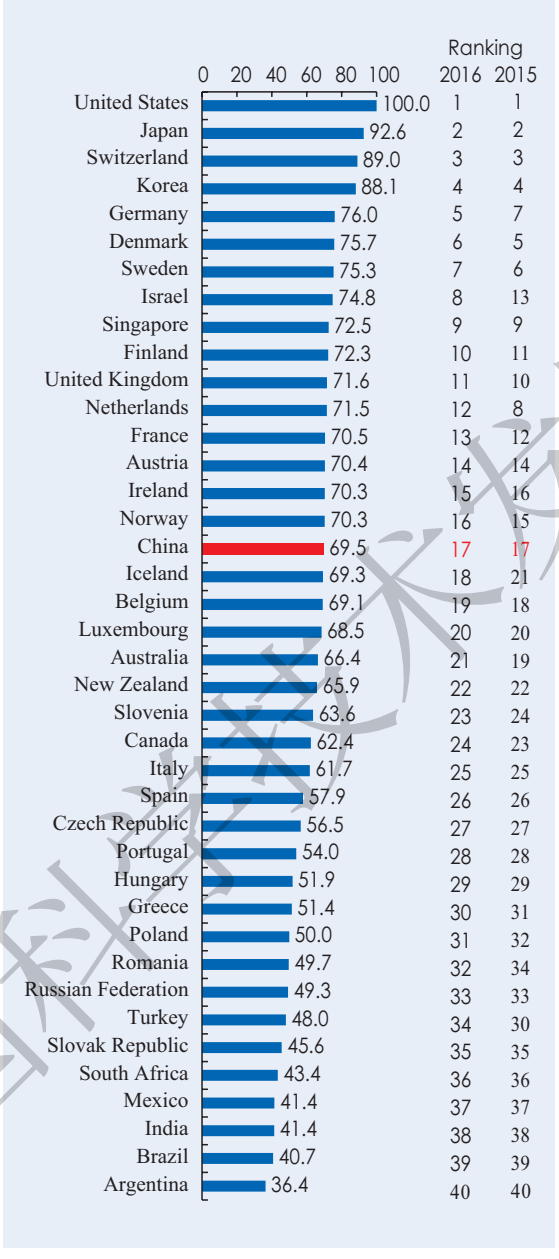


Figure A-1 National Innovation Index

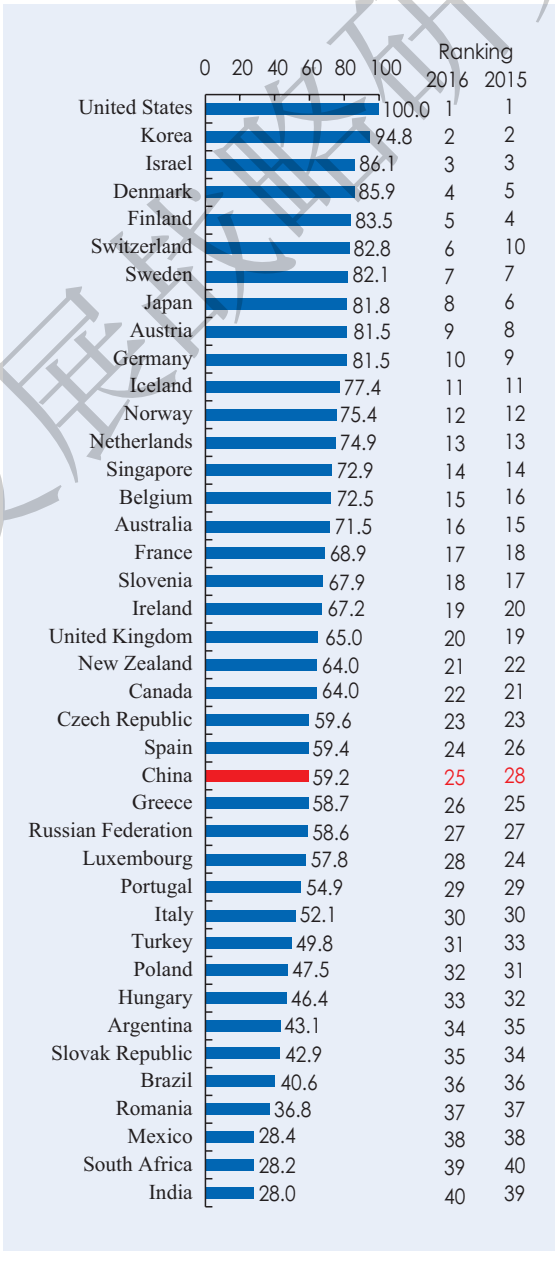


Figure A-2 Innovation Resources

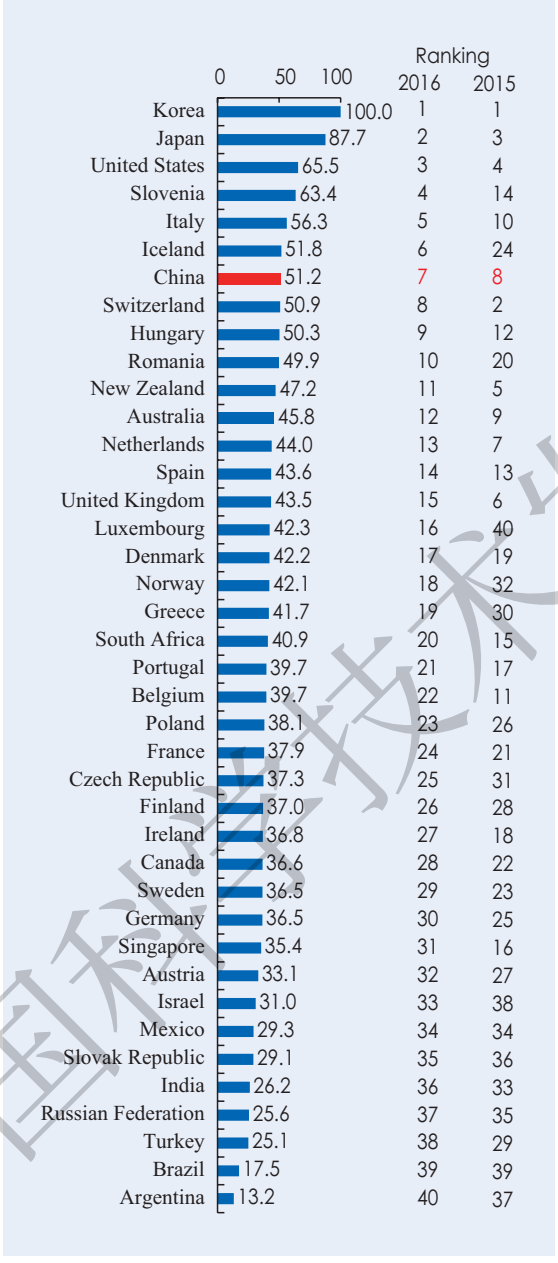


Figure A-3 Knowledge Creation

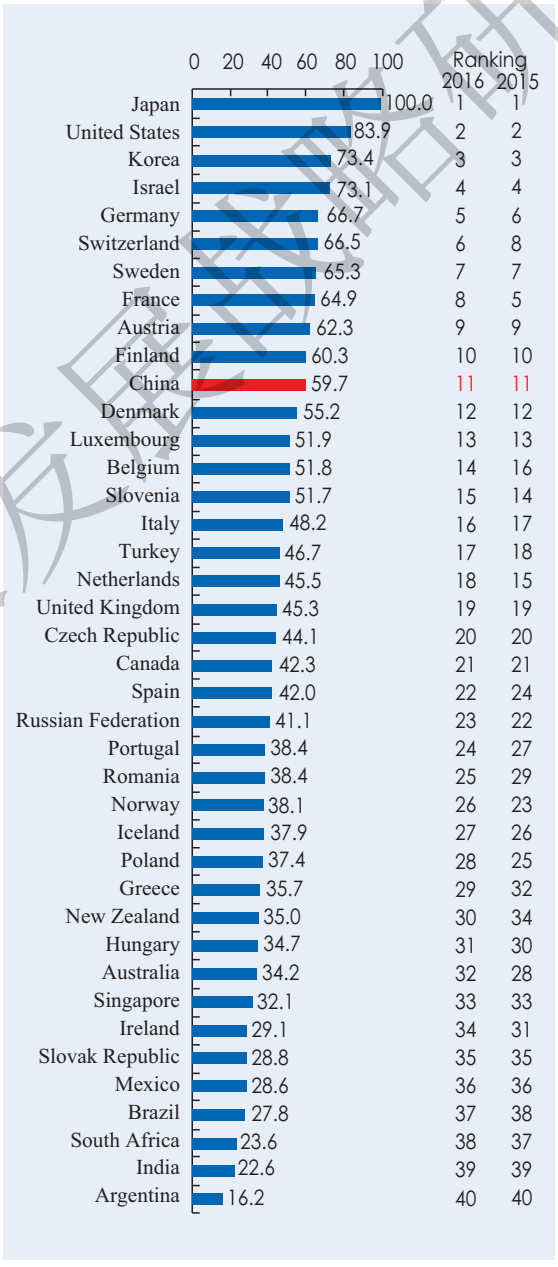


Figure A-4 Enterprise Innovation

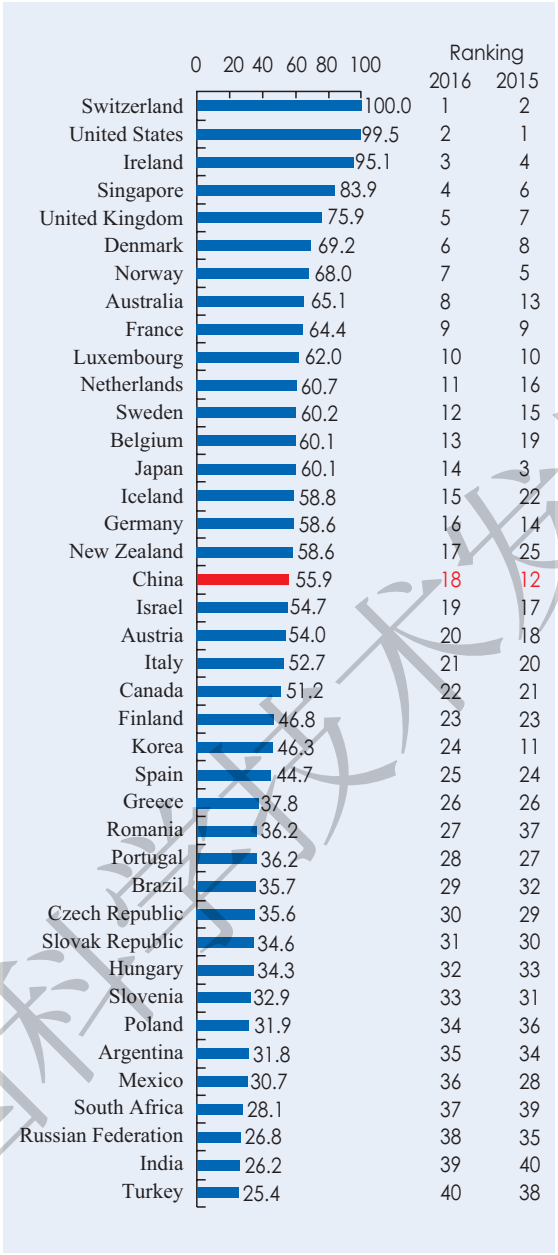


Figure A-5 Innovation Performance

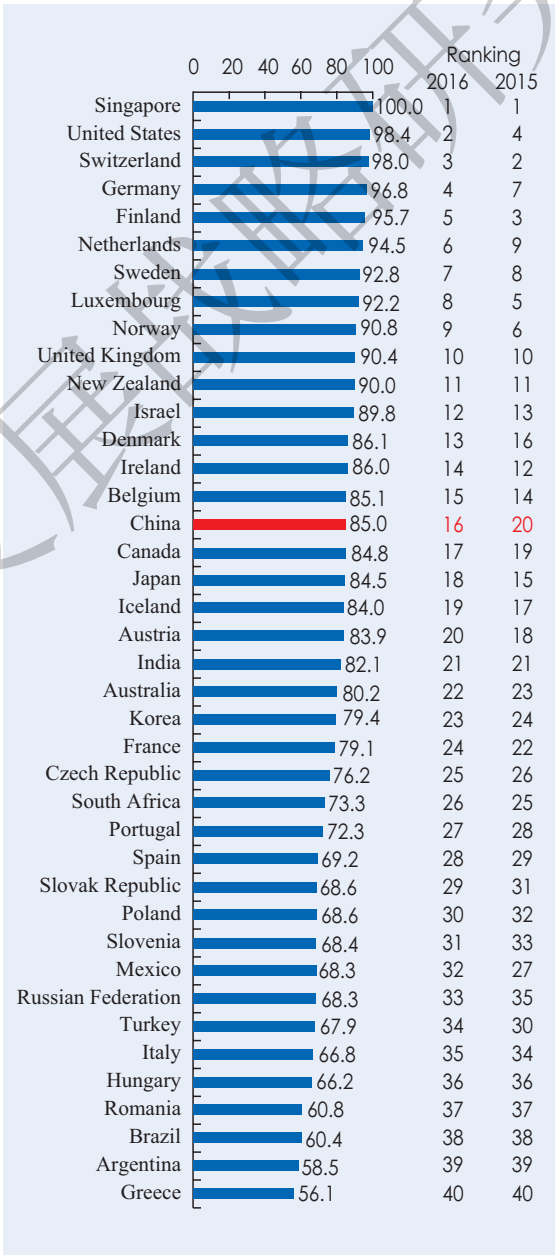


Figure A-6 Innovation Environment

Appendix II Definitions of Indicators

1. R&D expenditure as a percentage of GDP

Refers to the ratio of the total R&D expenditure to the GDP, measuring a country's monetary investment in innovation.

2. R&D personnel per ten thousand population

Refers to the number of R&D personnel per 10 000 population, measuring a country's human resource investment in innovation.

3. Higher education gross enrollment ratio (number of enrollments as a percentage of the population aged 18~22)

Refers to the percentage of 18~22 age group enrolled in tertiary education, measuring the development and availability of a country's human resources in S&T.

4. Networked readiness index

Borrowed from the World Economic Forum's *Global Information Technology Report*, measuring a country's availability of infrastructures for knowledge creation and dissemination.

5. R&D expenditure as a percentage of the world

Refers to the percentage of the gross domestic expenditure on R&D (GERD) of the world, measuring a country's scale of R&D activities and availability of innovation resources.

6. S&T paper citations per million R&D expenditure in academic institutions

Refers to the citation count of SCI-indexed papers produced by universities and research institutes in a country (on a five-year basis) divided by their total R&D expenditure, expressed in ratio, reflecting the quality of a country's efficiency of R&D investment and knowledge output.

7. S&T papers per ten thousand researchers

Refers to the total number of SCI-indexed papers produced by a country divided by the total number of its researchers, expressed in ratio, reflecting the output efficiency of R&D activities.

8. Patents in force as a percentage of the world

Refers to the number of invention patents owned by a country as a percentage of all invention patents in the world. Patents in force refer to resident invention patents that are still valid, whose number reflects the scale of enterprise technology buildup and independent innovation capacity of a country.

9. Invention patent applications per million population

Refers to the number of invention patent applications of a country divided by its population, reflecting its technological creativity.

10. Invention patent grants per 100 million US dollars of GDP

Refers to the number of resident invention patents granted of a country divided by its GDP (converted into the unit of USD 100 million at the exchange rate), reflecting its independent innovation capacity and technological output efficiency.

11. Triadic patent families as a percentage of world total

Refers to the share of a country's triadic patents in the global total. Triadic patents are a

series of corresponding patents filed with the European Patent Office (EPO), the Japan Patent Office (JPO) and the United States Patent and Trademark Office (USPTO), for the same invention, by the same applicant or inventor. This indicator measures a country's technological innovation capability and international competitiveness.

12. Business enterprise expenditure on R&D as a percentage of value added

Refers to the ratio of a country's business enterprise expenditure on R&D to its industrial value added, used to measure business enterprise R&D intensity.

13. PCT applications per ten thousand researchers in business enterprises

Refers to the ratio of PCT applications to researchers in business enterprises, mainly reflecting the efficiency, quality and international competitiveness of a country's enterprise innovation.

14. Technology independence

Refers to the mean value of 100×R&D expenditure / (R&D expenditure + technology import costs) and 100×number of resident invention patent granted / (number of resident invention patent granted + number of non-resident invention patent granted), reflecting a country's industrial and technological self-sufficiency.

15. Business enterprise researchers as a percentage of total researchers

Refers to the percentage of researchers of business enterprises in a country's total researchers, reflecting a country's enterprises' availability of R&D personnel.

16. Labor productivity

Refers to the ratio between GDP and labor force, reflecting the effect of innovation activities on economic output.

17. GDP per unit of energy use

Refers to GDP per kilogram of oil equivalent of energy use, used to measure the effect of technological innovation on energy efficiency, also reflecting the energy intensity of a country's economic growth.

18. Value added of knowledge-intensive services as a percentage of GDP

Refers to the share of value added of services such as information dissemination, software and information technology services, finance, lease and commercial services, and scientific research and technical services in the GDP, reflecting the development level of a country's knowledge-intensive services, used to measure the knowledge economy output and industry sophistication of a country.

19. High-technology exports as a percentage of manufacture exports

Refers to the share of high-technology exports in manufacture exports, reflecting the international competitiveness of a country's high-tech products and the effect of its innovation activities on improving the economic structure.

20. Value added of knowledge-intensive industries as a percentage of world total

Refers to the share of value added of a country's high-tech industries (manufacturing) and knowledge-intensive services in the world's total, reflecting the size and sophistication of a country's innovation-driven industries.

21. Intellectual property protection

Refers to the degree to which intellectual property is protected (1 = not at all, 7 = to a great extent).

22. Burden of government regulation

Refers to the degree to which it is burdensome for companies to comply with public

administration's requirements, e.g., permits, regulations and reporting (1 = extremely burdensome, 7 = not burdensome at all).

23. Macroeconomic environment

Consists of a series of indicators including central government revenue and expenditure, savings rate, inflation, interest rate spread, government debt and sovereign credit rating, reflecting the stability of the macroeconomic environment (1 = low macroeconomic stability, 7 = high macroeconomic stability).

24. Local availability of specialized training services

Refers to the degree to which high-quality, professional training services are available (1 = not available at all, 7 = widely available).

25. Effectiveness of anti-monopoly policy

Refers to the degree to which anti-monopoly policies effectively ensure fair competition (1 = not effective at all, 7 = extremely effective).

26. Venture capital availability

Refers to the degree to which it is easy for start-up entrepreneurs with innovative but risky projects to obtain equity funding (1 = extremely difficult, 7 = extremely easy).

27. Pay and productivity

Refers to the degree to which pay is related to employee productivity (1 = not at all, 7 = to a great extent).

28. State of cluster development

Refers to the degree to which well-developed and deep clusters (geographic concentrations of firms, suppliers, producers of related products and services, and specialized institutions in a particular field) are widespread (1 = nonexistent, 7 = widespread in many fields).

29. University-industry collaboration in R&D

Refers to the degree to which business and universities collaborate on R&D (1 = do not collaborate at all, 7 = collaborate extensively).

30. Government procurement of advanced technology products

Refers to the degree to which government purchasing decisions foster innovation (1 = not at all, 7 = to a great extent).

Appendix III Data Sources

[1] *World Development Indicators 2018*, World Bank.

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[4] *The Global Competitiveness Report 2017–2018,* World Economic Forum.

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[7] *Statistics and Analysis of Chinese Articles*, Institute of Scientific and Technical Information of China (ISTIC).

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[10] *China Statistical Yearbook on Science and Technology 2017*, National Bureau of Statistics, Ministry of Science and Technology.

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[15] Overseas offices of the Ministry of Science and Technology, China.