National Innovation Index Report 2016–2017

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National Innovation Index Report 2016–2017

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Foreword

Improving indigenous innovation capability and building an innovation-oriented country is a strategic goal set forth in China's *National Guideline on Medium- and Long-Term Plan for Science and Technology 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 itself into an innovation-oriented 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 2016–2017* is the 7th 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* and the *Measures for Implementation of the National Innovation Survey System*, 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 the previous release, 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 ten 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 are internationally comparable and authoritative. It calculates the innovation index scores of the 40 countries based on the latest statistical data (2015 data unless otherwise indicated) 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 innovation resources to strengthen their innovation capacity. Against the backdrop of global competition, China moved up to the 17th spot in the national innovation index with a higher overall index score, further narrowing its gap with advanced countries.

In May 2016, China released the *Outline of the National Strategy of Innovation-Driven Development*, officially sounding the bugle for its drive to build a global power in science and technology. With the implementation of the innovation-driven development strategy, there will be new opportunities and challenges in respect of the assessment of national innovation capacity, which requires constant exploration and in-depth research. We sincerely hope that the annual *National Innovation Index Report* will provide a window through which people can 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 as we witness the great historical process of China becoming an innovation-oriented country.

Editorial Committee of
National Innovation Index Report 2016–2017

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National Innovation Index Report 2016–2017

Part One:

China's Innovation Landscape Through Data

I. China's Innovation Progress Reflected in Key Indicators

Since the promulgation of the *National Guideline on Medium- and Long-Term Plan for Science and Technology Development (2006–2020)* (the "MLP"), China's innovation capacity has improved significantly. China has kept increasing investment in innovation resources, having risen to the 2nd place globally in gross domestic expenditure on R&D in addition to having held the No. 1 position in R&D personnel for many years. China has been steadily climbing up in knowledge creation capacity, ranking the 2nd in scientific output, staying on top in resident patent applications, and having overtaken Japan to lead the world in resident patent granted. China has also made giant strides in MFP contribution to economic growth (55.3%) and R&D intensity (2.06%), further closing the gap with innovative countries. China's knowledge-intensive industries have also maintained a strong momentum of growth as its industrial structure is continuously optimized.

With the effective implementation of the innovation-driven development strategy, China has significantly strengthened its innovation capacity with a positive trajectory in key indicators including input of innovation resources, scientific output, MFP contribution to economic growth, and the development of knowledge-intensive industries, as innovation plays an increasing role in supporting and leading economic and social development. China has reached a new stage in its drive to develop into an innovative country.

(I) Input of Innovation Resources Steadily Increased

Rich innovation resources provide an important condition for innovation activities. R&D expenditure and personnel are core elements of innovation resources and have a direct bearing on a country's activity of innovation. In recent years, China has maintained high levels of R&D expenditure and personnel input.

1. China maintained the 2nd place in R&D expenditure

The global (referring to the 40 countries included in this study, the same below) total R&D expenditure reached USD1.45 trillion, down 2.0% from a year earlier①. The global R&D expenditure was mainly distributed in the three pillar regions of North America, Asia and Europe② (Figure 1-1). Specifically, North America took up 37.0%, down 7.0 percentage points from 2000, Asia 32.6%, up 5.3 percentage points, and Europe 25.6%, slightly down 0.7 percentage point.

The top three countries in R&D expenditure were the United States, China and Japan, respectively. China maintained the 2nd place with USD 227.54 billion, or 15.6% of the global total, further narrowing the gap with the United States (Figure 1-2). The United

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, Netherlands, Norway, Poland, Portugal, Romania, Italy, Luxembourg, Russian Federation, Slovak Republic, Slovenia, Spain, Sweden, Switzerland and United Kingdom; North American countries: United States, Canada and Mexico; South American countries: Argentina and Brazil; Oceanian countries: Australia and New Zealand; African country: South Africa.

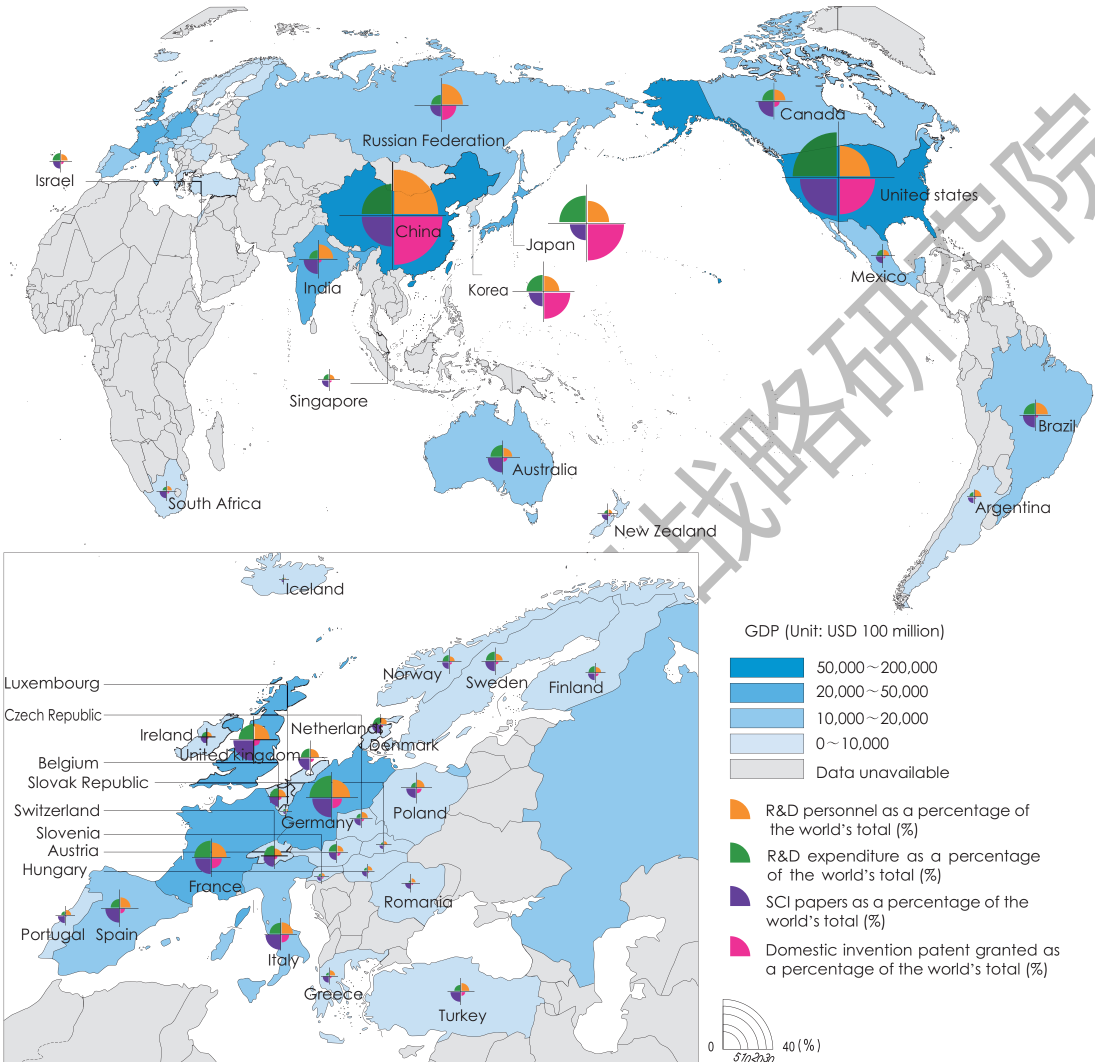

Figure 1–1 Global distribution of GDP, R&D expenditure, R&D personnel, SCI papers and resident invention patents

States' R&D expenditure maintained its clear lead, accounting for 34.6% of the global total, being 2.2 times of China's. Japan's R&D expenditure dropped by USD 20.88 billion from a year earlier to USD 144.05 billion, accounting for 9.9% of the global total.

With the rapid rise of emerging economies and developing countries, the concentration of global R&D expenditure among developing countries went down significantly. The combined R&D expenditure of G7 countries as a percentage of the global total slipped down by 21.2 percentage points from 2000 to 61.8%. In contrast, the combined R&D expenditure of the BRICS countries maintained a steady growth, rising to 20.0% in 2015 from 3.8% in 2000.

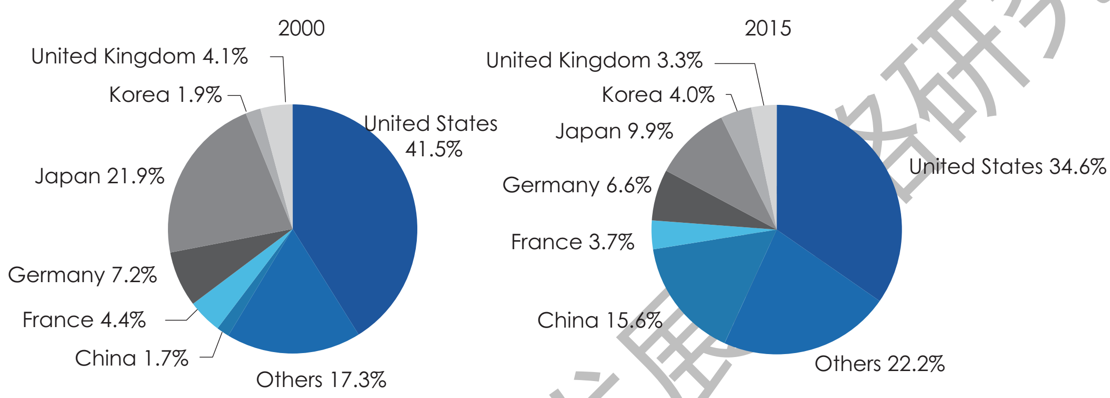

Figure 1–2　Percentage of R&D expenditure in the world's total

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

Since the onset of the 21st century, the R&D expenditures of countries have maintained an upward trend overall. On a constant price basis, China had the world's highest average annual growth of R&D expenditure at 15.9% for the period from 2000 to 2015, ranking the 1st in the world and leading other countries by a big margin. Korea and India, representatives of emerging markets, also maintained an impressive average annual growth at 8.6% and 7.2%, respectively, significantly higher than G7 countries such as the United States (2.2%), Japan (1.7%) and the United Kingdom (2.0%)（Figure 1-3）.

Impacted by the financial crisis, the European debt crisis and other factors, countries like Finland, Spain and Greece slowed down in their R&D expenditure growth from 2010, with some even experiencing a negative growth. Countries like Japan and the United States went out of the financial crisis, and their R&D expenditures returned to the upward trend as well. Judging from their recent performance, countries such as the United States and the

United Kingdom remained on track of steady growth in R&D expenditure, while countries such as Japan and India slowed down, even posting a negative growth in 2015. Against the backdrop of challenging international and domestic economic situations, China's R&D expenditure also experienced a slowdown, though remaining at high levels.

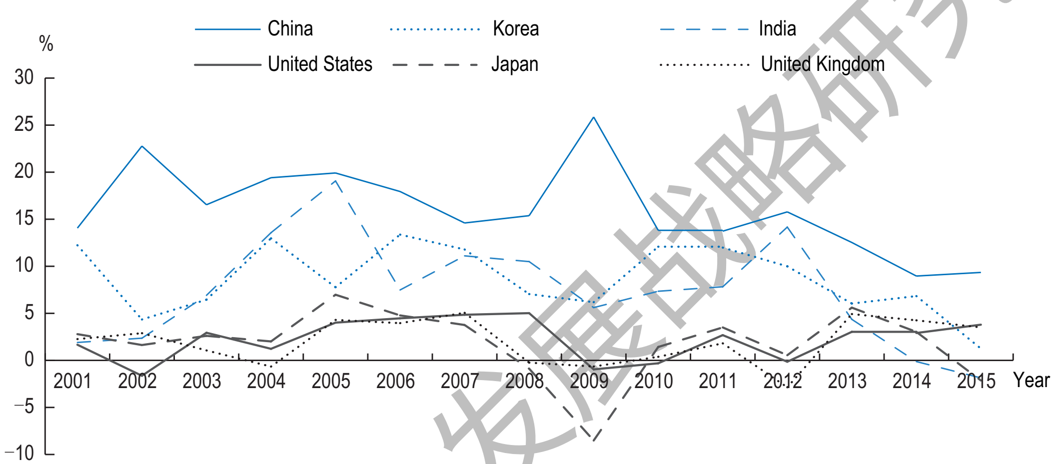

Figure 1–3 R&D expenditure growth of countries (on constant price basis)

3. China ranked the 1st in R&D personnel

The number of global R&D personnel reached 12.1 million representing a growth of 67.5% from 2000. They were mainly distributed in Asia (47.2%) and Europe (30.9%). From 2000, most countries, with the exception of a few countries such as Finland, Japan, Romania and the Russian Federation, saw a steady growth in R&D personnel, especially emerging economies represented by China and Korea which recorded an average annual growth rate of 9.8% and 8.1%, respectively, significantly higher than the global average growth rate of 3.5%.

China's R&D personnel reached 3.8 million, or 31.1% of the global total, leading the world for the ninth consecutive year from 2007. Japan and the Russian Federation, both rich in R&D human resources with more than 800,000 R&D personnel, saw a steady fall of their share in the global total, to 7.2% and 6.9%, respectively.

As emerging economies became increasingly active in R&D activities, there was a significant change in the distribution of R&D personnel in developed and developing countries. In 2000, the global R&D personnel were mainly concentrated in developed countries, with G7 countries taking up 50.4% of the global total, versus only 32.5% for the BRICS countries. In 2015, the share of the G7 countries in the global total decreased to 38.1%, and that of the BRICS countries jumped to 43.8%, overtaking the G7 countries.

(II) Knowledge Output Significantly Increased

The knowledge creation capacity is an important indicator of the level of innovation activities and innovation capacity and reflects a country's capacity of original innovation, the activity of innovation, and the level of technological innovation. Internationally published S&T papers (SCI papers) and invention patent applications and granted are key measures of the knowledge output capacity. China strengthened significantly in its knowledge output capacity, underscored by its steady improvement in published scientific papers and invention patent applications and granted.

1. Output of SCI papers steadily increased[①]

The global SCI papers continued to grow, reaching 2 million, being 2.5 times the number in 2000. The top three countries in the number of SCI papers were the United States, China and the United Kingdom, respectively. The United States maintained its top spot with 423,000 SCI papers, accounting for 21.7% of the global total. China remained in the 2nd place for the eighth consecutive year with 281,000 SCI papers, or 14.4% of the global total, doubling the 3rd-ranked United Kingdom's.

From 2000, countries saw a growth in their published SCI papers to varying degrees,

① Data source: Thomson Reuters. Statistics: all authors included. Document type: Article and Review. China's data excludes Hong Kong and Macao data.

with emerging countries like China, Korea, Brazil and India outclassing developed countries. In the 2000–2015 period, China posted an average annual growth rate of 16.1% in SCI papers, outstripping other countries by a big margin. Emerging market countries such as Korea (10.1%), Brazil (9.6%) and India (9.0%) were also above the global average (6.2%). In contrast, developed countries such as the United States (3.1%), Germany (3.2%), the United Kingdom (3.5%) and Japan (0.4%) were low in growth as their shares in the global total taking on a downward trend (Figure 1-4).

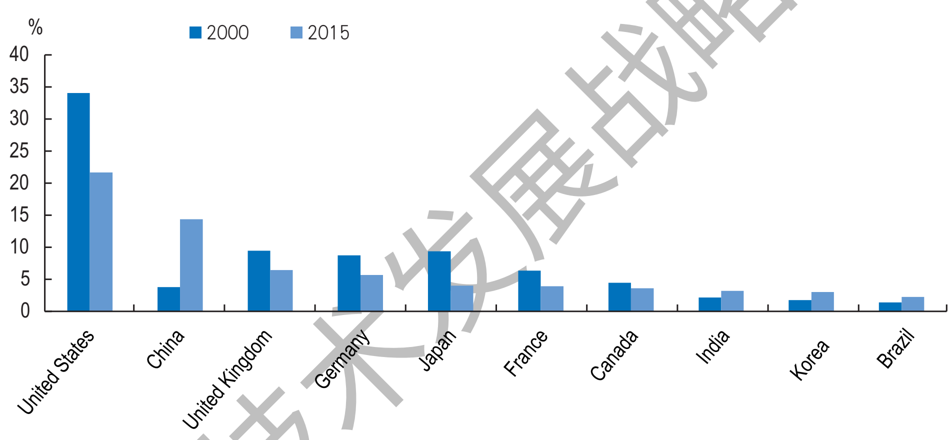

Figure 1–4 SCI papers as a share of the global total by country

Since the promulgation of the MLP(2006–2020), China has achieved a significant improvement in the quality as well as the quantity of SCI papers published. In 2015, China's SCI papers received 600,000 citations, or 19.9% of the global total, up 15.2 percentage points from 2015, raising its position in the global ranking to the 2nd place from the 8th place. For the same period, the United States maintained its top position in SCI citation, but its share in the global total slipped down 9.9 percentage points. The United Kingdom dropped to the 3rd place from the 2nd, with its share in the global total remaining stable.

2. China ranked among the top in resident invention patent applications and granted

Global resident invention patent applications and granted were largely concentrated in four countries — China, Japan, the United States and Korea, whose combined amount accounted for more than 90% of the world's total. China's resident invention patent applications reached 968,000, or 52.1% of the global total, keeping the top spot, followed by the United States (15.5%) in the 2nd place and Japan (13.9%) in the 3rd place. China's resident invention patent granted reached 263,000, or 37.5% of the global total, overtaking Japan to take the No. 1 position for the first time. Japan ranked the 2nd with 20.9% and the United States the 3rd with 20.1%.

From 2000, global invention patent applications and granted both experienced a slowdown of growth amid fluctuations, with some countries experiencing negative growth. Against this backdrop, China maintained a strong growth in resident invention patent applications and grants, with average annual growth rate reaching 27.5% and 28.4%, respectively. China contributed up to 90.0% and 61.8%, respectively, of the increases of global resident invention patent applications and grants in 2000–2015. Japan, a patent power, saw a steady decline in its resident invention patent applications, which fell by 32.6% in 2015 compared to 2000. Its resident invention patent grants reversed their upward trajectory before 2013 and decreased for two consecutive years after that, reaching 147,000 in 2015, or 20.9% of the global total, ranking the 2nd in the world. Korea's resident invention patent applications returned to an upward track after experiencing a temporary decline in 2008–2009 and reached 167,000 in 2015, or 9.0% of the global total, and its resident invention patent grants decreased by 21.6% in 2015 from a year earlier after maintaining growth for six consecutive years (Figure 1-5).

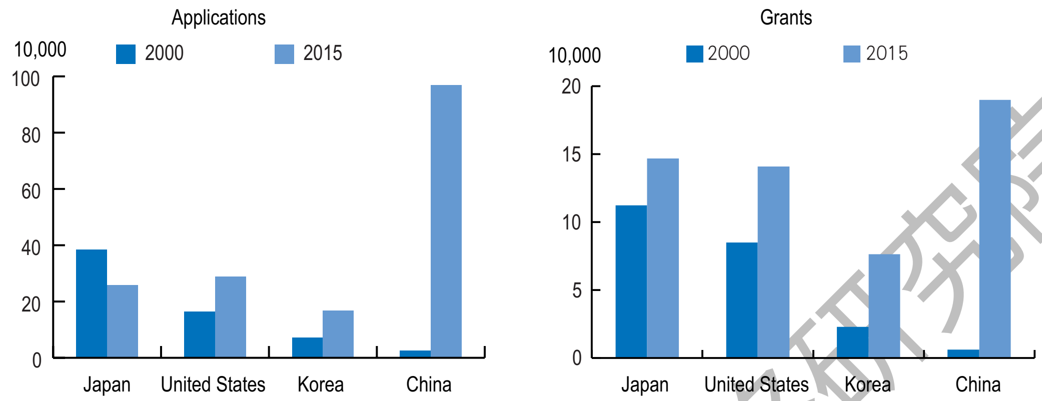

Figure 1–5　Number of resident invention patent applications and grants

(III) Innovation Made Increasing Contribution to Economic Growth

Since the reform and opening up, China has maintained a rapid economic growth with huge achievements and become the world's second largest economy. On the back of a strong economy, China has kept investing in innovation resources with the innovation playing an increasing role in supporting and leading the economic and social development.

1. Steadily increasing MFP contribution to economic growth

As the Chinese economy steps into the new normal mode of slower growth, innovation has become the No. 1 driver of further development. Innovation-driven development was highlighted at the Fifth Plenary Session of the 18th CPC Central Committee as the first of the country's five main development concepts, giving prominence to the leading role of technology innovation in comprehensive innovation. MFP contribution to economic growth is an indicator which reflects the contribution of scientific and technological progress to economic growth and can effectively measure the performance of economic transformation and the quality of economic development. In 2016, the "MFP contribution to economic growth" indicator was included in the China's *13th Five-Year Plan for Economic and Social Development*. In the same year, the *Outline of the National Strategy of Innovation-Driven*

Development was released, in which the goal of increasing MFP contribution to economic growth to more than 60% was put forward. According to *China Statistical Yearbook on Science and Technology 2016*, China's MFP contribution to economic growth saw a steady improvement in recent years, reaching 55.3% in 2015, up 15.6 percentage points from 2003. ① This reflects the increasing role of innovation in China's economic stabilization and restructuring.

2. Steady increase in R&D intensity

R&D intensity (R&D expenditure as a percentage of GDP) is an important indicator of innovation input, which also reflects a country's economic structure and synergy between the innovation and the economic development. Stable R&D expenditure is a basic condition for innovation activities. Main developed countries are all committed to raising their R&D intensity as an important means to achieve innovation-driven development. China's R&D intensity reached an all-time high of 2.06%. While still having a significant gap with countries such as Korea (4.23%) and Israel (4.25%), it exceeded the overall level of 28 EU countries (1.95%). Domestically, China had eight provinces and municipalities whose R&D intensity exceeded 2%, with Beijing's reaching 6.01% and Shanghai's reaching 3.73%. 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 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 the economic growth.

3. Continuous optimization of industrial structure

With the advent of the knowledge economy, factors including human resources, knowledge, technology and education are gaining prominence in the economic and social development. The development of knowledge-intensive industries characterized by the concentration

① 2015 MFP contribution to economic growth calculated as the five-year average based on relevant data for the 2010–2015 period.

of high-tech equipment and high-caliber talent reflects the transformation and upgrade of the industrial structure. According to OECD's definition, knowledge-intensive industries include high-tech industries and knowledge-intensive services. High-tech industries are a strategic pillar of the national economy and play an important role in economic restructuring and transformation. China's high-tech industries reached RMB 14 trillion in main revenue, accounting for 14.1% of the manufacturing sector, up 1.1 percentage points from a year earlier. China's high-tech exports as a percentage of its manufacturing exports reached 25.8%, up 0.4 percentage point. China's knowledge-intensive services is an important part of the value chain of industry development, also maintained a sound momentum of growth. In 2014, the added value of China's knowledge-intensive services as a percentage of its GDP increased slightly from the previous year to 11.1%, and that as a percentage of the value added of global knowledge-intensive services reached 10.4%, continuing the upward trajectory over the years, and representing an increase of 7.6 percentage points from 2000. The steady growth of knowledge-intensive industries provided a powerful boost to China's industrial restructuring and upgrade.

II. China's Innovation Capability in the World

The global innovation landscape remained stable overall, with the United States, Japan and European countries taking the lead and developing countries generally ranking low with slow progress in the index. China's national innovation index (NII) ranked the 17th, up one spot from the previous year. Thanks to its steadily increasing input of innovation resources, China's innovation capacity has far surpassed its stage of economic development and outclassed other developing countries, prominently reflected in the rapid improvement in efficiency and quality of knowledge output and steady improvement of enterprise innovation capacity. Compared to the United States, Japan and Korea, China's NII score was still relatively low, but the gap with them was narrowing. With the continuous input of innovation resources and the deepening of the country's science and technology system, China's innovation efficiency will further increase to fuel the upward movement of China's ranking towards innovative countries.

R&D and innovation have become key tools adopted by 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 been moving ahead steadily to rank among innovative countries.

(I) Global Innovation Landscape Remained Led by United States, Japan and European Countries

The national innovation index (NII) is a comprehensive index measuring a country's science, technology and innovation competitiveness. The 40 countries included in this study, distributed across six continents, represent the countries with the largest R&D expenditures in the world. Overall, the results of this study show that the global innovation landscape remains largely stable.

Based on the comparison of the results of previous editions of the *National Innovation Index Report*, the 40 countries can be divided into three blocs. Bloc 1 are the top 15 countries in the ranking, mainly developed countries in Europe and America, which are generally recognized as innovative countries. Bloc 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 ranks towards the top of this bloc. Bloc 3 are those ranking after the 30th, mostly developing countries (Figure 2-1). Compared to the previous edition, the ranking positions of the 40 countries remain stable overall and belonging to their respective blocs, with only minor ranking movement within the blocs, and no country moving across blocs.

Specifically, countries in Bloc 1 include one in America — the United States; four in Asia — Japan, Korea, Singapore and Israel; and ten in Europe — Switzerland, Denmark,

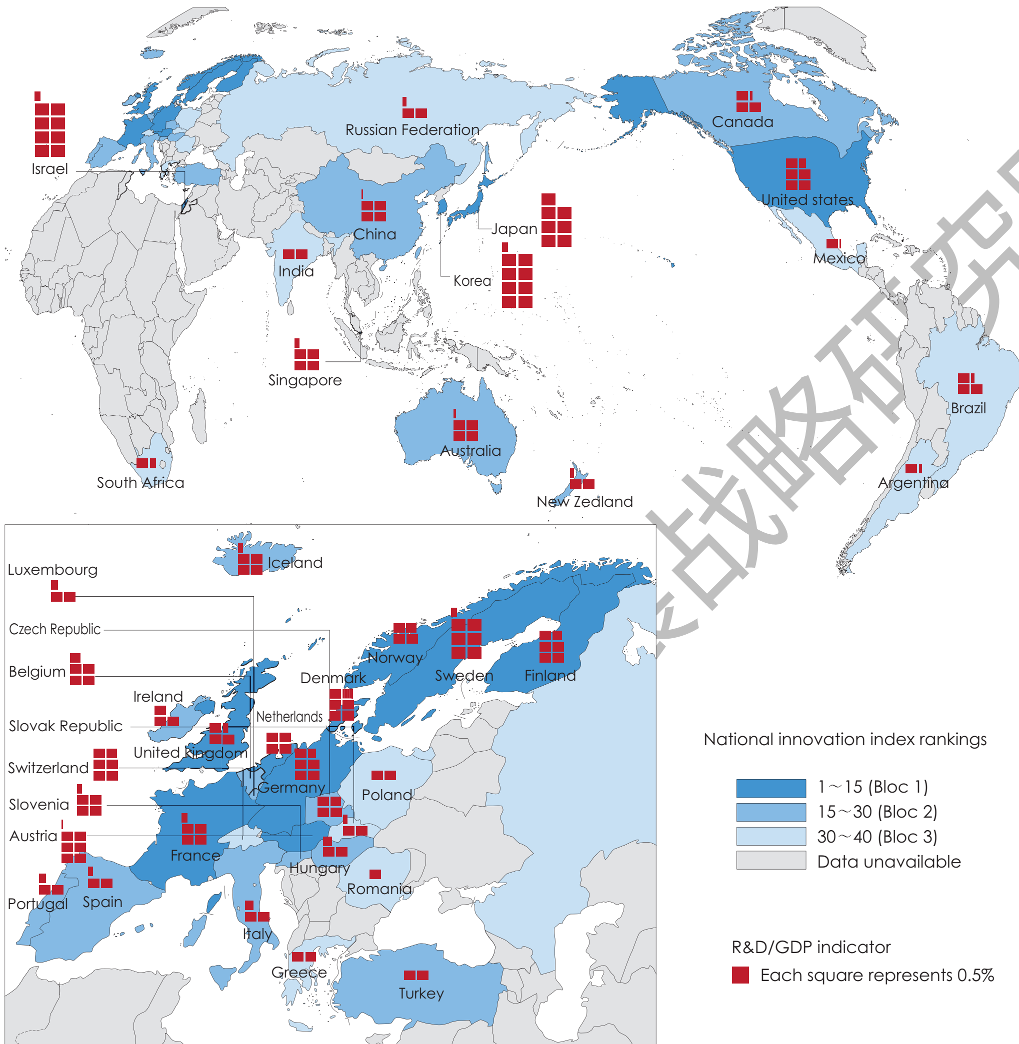

Figure 2–1 Innovation capability of countries

Sweden, Germany, the Netherlands, the United Kingdom, Finland, France, Austria and Norway. The United States, with rich innovation resources and an outstanding innovation performance, remained in the 1st place in the index. Among Asian countries, Japan and Korea ranked the 2nd and the 4th, respectively, both with outstanding performance in enterprise innovation and knowledge creation; Israel, in spite of a decline on the knowledge creation indicator, moved up one spot to the 13th on the back of high input of innovation resources and strong enterprise innovation capacity, and improvements in innovation performance and innovation environment. Singapore also moved up one place to the 9th in the overall ranking, buttressed in particular by a strong performance in innovation performance and innovation environment where it ranked the 6th and the 1st, respectively. Europe remained one of the most innovative regions in the world. Switzerland came the 3rd in overall ranking, moving up one spot in enterprise innovation. Scandinavian countries Denmark and Sweden maintained their strong performance in innovation capacity and ranked the 5th and the 6th, respectively. The Netherlands moved up one spot to the 8th. Germany moved down one position to the 7th, and the United Kingdom was down two places to the 10th. In terms of the overall score and rank, China further closed its gap with the above-mentioned innovative countries.

(II) China's Innovation Capability Was Significantly Ahead of Its Development Stage

China overtook Belgium to be in the 17th place in the NII ranking, up one place from the previous year, becoming the only developing country to make into the top 20. While China's GDP per capita stood at USD 8028, only higher than India and South Africa among the 40 countries included in this study, China's index score was already close to European countries with a GDP per capita of approximately USD 50,000 (Figure 2-2). In other words, China was far ahead of countries at a comparative level of economic development in innovation capacity.

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 supports a greater role of large corporations in making breakthroughs in key areas and building the country's international competitiveness. An example standing on the opposite side of these countries is Luxembourg which is located below the stripe, with its index score falling behind its GDP per capita, because its economic growth is to a greater extent driven by resource-intensive industries such as steel and chemicals and service industries such as financial service and media.

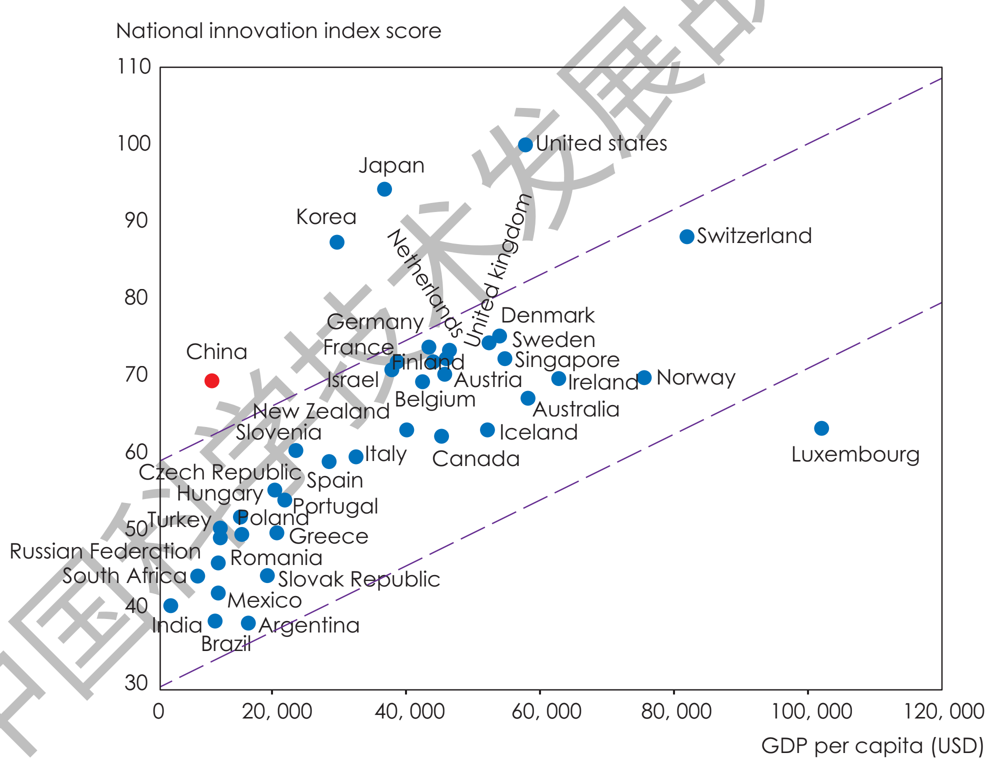

Figure 2–2 GDP per capita and national innovation index score

International organizations such as the World Bank and the International Monetary Fund generally use GDP per capita as the main criterion for determination of the stage of the development of countries. Analysis of GDP per capita data puts China together with Brazil, Romania, Mexico, the Russian Federation and Turkey in terms of the stage of development (Table 2-1). As shown in the table, although China is slightly behind the rest five countries in GDP per capita, China is far ahead of them in R&D expenditure and intensity and innovation performance, with all the rest countries falling in Bloc 3 and progressing very slowly. China is the only country in the group to have an R&D intensity of more than 2%, with its R&D expenditure being approximately four times the combined R&D expenditure of the five countries, its invention patents in force being approximately six times those of the five countries combined, and its high-tech exports being eight times those of the five countries combined, holding a position near the top in Bloc 2. This underscores the huge leap-forward achievements attained by China in its drive to pursue innovation-driven development in recent years.

Table 2-1 Comparison of China and comparable countries in index ranking

Country	GDP per capita (USD)	R&D expenditure (USD 100 million)	R&D intensity (%)	Invention patents in force	High-tech exports (USD 100 million)	NII ranking
China	8028	2275	2.06	921,757	5543	17
Brazil	8539	296	1.67	2882	88	39
Romania	8973	9	0.49	1228	35	34
Mexico	9005	63	0.55	2794	458	37
Russian Federation	9093	150	1.13	147,606	97	33
Turkey	9126	80	1.01	5782	23	30

(III) China Led Developing Countries in Innovation Capacity

Among the ten emerging economies covered by the study, China ranked near the top in Bloc 2 at the 17th, while other developing countries were ranked either towards the bottom in

Bloc 2 or in Bloc 3 (Table 2-2). Compared to the previous year, China was the only country among the ten to move up in its ranking position (by one spot), with the Russian Federation moving down one spot and the other eight countries remaining in the same places.

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 was ranked the 33rd, leading Bloc 3 countries. South Africa, India and Brazil were ranked towards the bottom of Bloc 3 at the 36th, the 38th and the 39th, respectively.

Table 2–2 NII rankings and their changes of emerging economies

Country	NII 2016–2017		NII 2015	
	Ranking	Score	Ranking	Score
China	17	69.8	18	68.6
Hungary	29	52.2	29	53.1
Turkey	30	50.5	30	51.7
Russian Federation	33	49.7	32	49.3
Romania	34	46.3	34	47.7
South Africa	36	44.5	36	44.2
Mexico	37	42.7	37	41.7
India	38	40.7	38	40.1
Brazil	39	38.9	39	38.7
Argentina	40	38.6	40	38.7

China led the BRICS countries in four first-level indicators — knowledge creation, enterprise innovation, innovation performance and innovation environment (Figure 2-3). As knowledge creation, China ranked the 8th with a score of 71.1, outclassing South Africa in the 15th place by 7.3. In enterprise innovation, China ranked the 11th with 57.8, further expanding its strength, with the Russian Federation, the 2nd-ranked among the BRICS countries, taking the 22nd in the indicator with 41.3. As innovation performance, China ranked the 12th with 46.6, leading the 32nd-ranked Brazil by 21.4 with a clear comparative edge. As innovation environment, China improved by 1 to 82.4, but its ranking fell one place to the 20th. India, the second-ranked among the BRICS, ranked the 21st with 81 in this indicator, which means China had a smaller advantage over India.

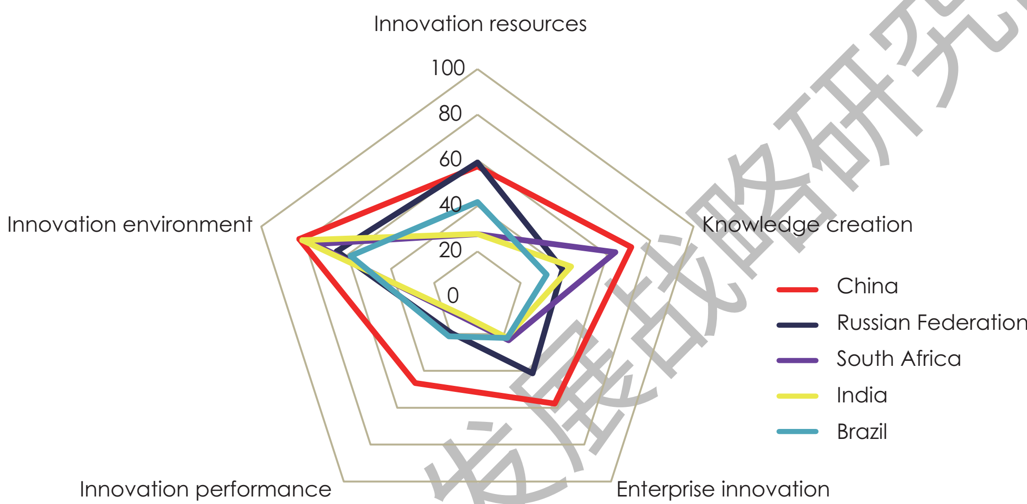

Figure 2–3 Comparison of BRICS countries in first-level indicators

The innovation resources indicator was the only indicator where China did not take the lead (2nd) among the BRICS countries, with the Russian Federation keeping the No. 1, but China's gap with the Russian Federation narrowed from 3 to 1.7. China was still significantly behind the Russian Federation in R&D personnel intensity, R&D personnel development and networked readiness.

Overall, China progressed the fastest with steadily widening advantages among the developing country camp. China maintained a steep upward trajectory in R&D expenditure. It was unchallenged in the top position globally in the number of R&D personnel. It was also top-ranked in patents and published S&T papers. As long as China keeps a moderately fast growth of its innovation resources, China is set to gradually transition from factor-driven to innovation-driven development and achieve leap-forward development.

(IV) China Still Had Remarkable Potential of Innovation Capacity Improvement

China has made huge progress in innovation capacity. As shown in Figure 2-4, China's index ranking moved up from the 38th in 2000 to the 17th. In spite of some fluctuations in the process, the overall trajectory was upward. From 2009, in particular, China showed a steady improvement in overall innovation capacity without being affected by the weak global economic environment.

China's index score increased by 1.2 to 69.8, overtaking Belgium and further narrowing the gap (from 0.8~4.1 to 0.3~2.6) with countries ranked between the 10th and the 15th such as the United Kingdom, France and Israel. In overall score, China was behind Ireland in the 16th place by a thin margin of only 0.2. Therefore, from China's index score and ranking the outlook of China's innovation capacity improvement looks highly optimistic.

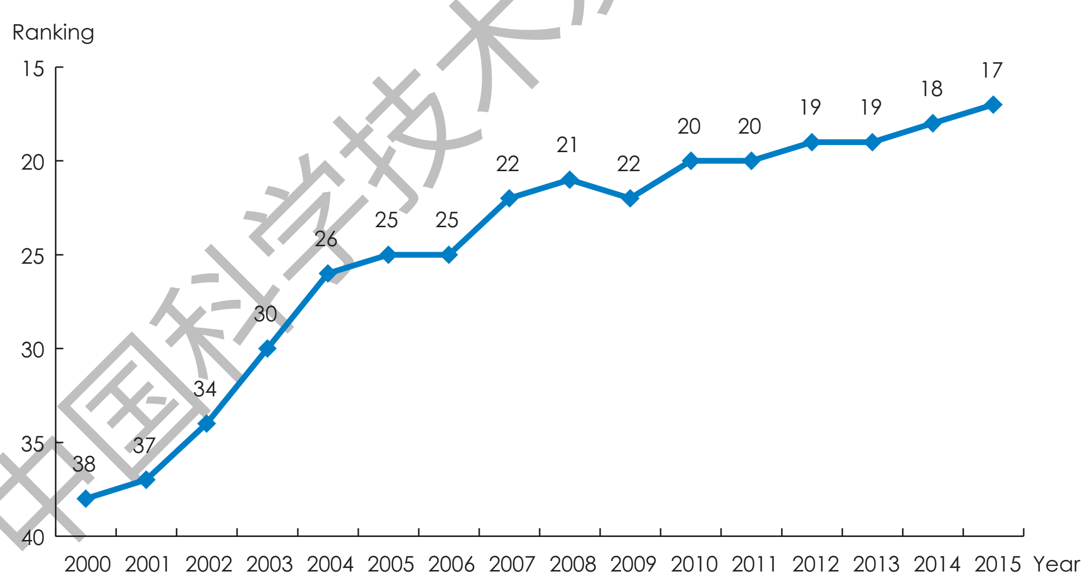

Figure 2–4 China's NII ranking

China achieved a varying degree of progress in five first-level indicators of the innovation index（Table 2-3）. The most impressive progress China made after 2005 was in the indicator of knowledge creation, driven by the rapid growth of scientific output such as published S&T papers and patents, with its ranking in this indicator jumping by a whopping 29 places from the 37th in 2005 to the 8th in 2015, underscoring China's significantly increasing influence in the international R&D landscape. In the innovation performance indicator, China also improved by 17 places to the 12th in 2015, benefiting from China's substantial growth of intellectual properties and its rapidly developing knowledge-intensive industries. In enterprise innovation, China moved up 6 places from 2005 to the 11th in 2015, reflecting the steady improvement of Chinese enterprises' innovation capacity and international competitiveness. In innovation environment, China went up from the 27th to the 20th. The indicator of innovation resources saw China make the slowest improvement, with its ranking staying at around the 30th during the 11th Five-year Plan period — bottoming at the 33rd in the 2007–2008 release — before making into the top 30 during the 12th Five-year Plan period and reaching the 27th in 2014, only to fall one spot back to the 28th in 2015. 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, China still needs to make a lot of efforts in the long term.

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

Continue

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment	NII ranking
2012	30	18	15	14	14	19
2013	29	19	13	11	13	19
2014	27	12	12	11	19	18
2015	28	8	11	12	20	17

In comparison with leading innovative countries such as the United States, Japan and Korea, China scored relatively low in the index rankings due to a weak foundation and inadequate accumulation of innovation resources, but it has a huge potential for improvement in overall innovation capacity and strength in the future. In the four first-level indicators other than innovation environment, China was still far behind the United States, Japan and Korea which were top-ranked in those indicators with a full score of 100 (Figure 2-5). ① Specifically, China scored below 60 in innovation resources, enterprise innovation and innovation performance at 57.4, 57.8 and 46.6, respectively, and scored slightly higher in knowledge creation at 71.1. Compared to its scores in the previous release, China experienced a decline only in innovation performance by 1.3 due to a difficult global economic situation; it improved by 2, 3.9 and 1.2, respectively, in innovation resources, knowledge creation and enterprise innovation, further narrowing its gap with the top-ranked countries, the United States, Japan and Korea in the respective indicators, and by 1 in innovation environment, becoming closer to Singapore. The movement of China's index scores indicates both that China has a significant gap with the top-ranked countries, the United States, Japan and Korea, in first-level indicators and that China is 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.

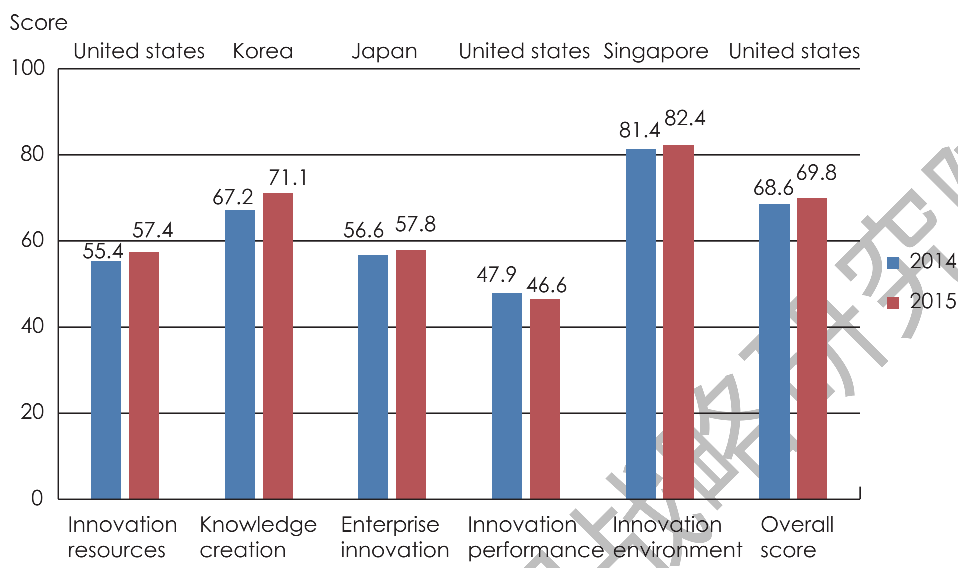

Figure 2–5 China versus top-ranked countries in index indicator scores

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 and quality. 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, are lower than the scores 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. With the improvement of the overall education of the population and greater informatization, China's population advantage will transition from advantage in labor to advantage in high-caliber science and technology talent, and the dividend from informatization and the enormous human resources in science and technology will drive the further increase of China's innovation capability.

The potential of China's innovation capacity improvement comes from the continuous input of innovation resources. Qualitative change comes from the accumulation of quantitative changes. China has put science, technology and innovation at the core of its overall development strategy. In recent years, China's R&D expenditure has maintained fast growth, surpassing Japan to become the world's second largest country in R&D expenditure in 2013 and quickly closing the gap with the United States, with its R&D expenditure as a percentage of the United States' increasing from less than 10% in 2005 to approximately 57% in 2015. One year's R&D expenditure can hardly generate immediate results, but if China maintains this growth momentum in R&D expenditure, it will certainly translate into a huge power in the course of time and gradually narrow China's gap with developed countries, thus impacting and changing the global innovation landscape.

The potential of China's innovation capability improvement comes from the scale of the country's innovation activities. According to the history of global innovation-driven development, the scale of national innovation to a certain extent reflects the momentum and stability of innovation-driven development. This is of great importance for a large country like China. After overtaking Japan to become the world's second largest economy in 2010, China's GDP accounts for 15.5% of global GDP in 2015. This massive economy provides a huge demand and financial support for innovation activities and a huge market for the commercial application of innovation outcomes.

The potential of China's innovation capacity improvement comes from the innovation vitality released by the country's comprehensive deepening of reforms. In recent years, China's reforms of its government system have made important breakthroughs. In a drive to streamline administration and delegate government powers, the central government has promulgated the *Law on Promoting the Transformation of Scientific and Technological Achievements* and formulated the *Several Opinions on Implementing Allocation Policies to Increase the Value of Knowledge* to encourage R&D personnel to engage in conversion of R&D achievements through incentive measures including performance pay raise and conversion rewards. A series of reform measures, including the reform in the management of science and technology initiatives financed by the central government, management of funds for science and technology projects, promotion of pilot policies in innovation demonstration zones, and sharing of national science and research infrastructure facilities, have strongly facilitated the implementation of the innovation-driven development strategy. A full range of pro-innovation policies, including financing support for small and micro-sized enterprises, tax reduction and exemption for high-tech enterprises, and additional tax deductions for enterprise R&D, have boosted China's mass entrepreneurship and innovation strategy and unleashed the power of innovation.

To sum up, China's innovation activities remain in a stage of rapid growth. China needs to maintain the steady growth of R&D expenditure, leverage the advantages and potential of the domestic market, put a greater emphasis on the dissemination and application of innovation achievements, and effectively implement measures introduced in furtherance of the science and technology system in order to constantly increase social innovation performance and productivity and accelerate the building of China into an innovative country.

III. Assessment of National Innovation Index Indicators

In the innovation resources sub-index, China ranked the 28th, down one place from the previous year. Among the five second-level indicators, China's ranking improved in four indicators, remained unchanged in three indicators, and dropped in two indicators. Developed countries in Asia ranked in leading places, with Korea, Israel, Japan and Singapore staying in Bloc 1. The BRICS countries generally ranked low in innovation resources.

China rose by four places to the 8th in knowledge creation, entering the top 10 for the first time in a first-level indicator. Among the five second-level indicators, China ranked towards the top in the level and efficiency of invention patent output, ranking the 2nd for the sixth consecutive year in the number of invention patents per USD 100 million of GDP and among the top five for the sixth consecutive year in the number of invention patent granted per 10,000 researchers. Half of Asian countries entered the top 10, and there was a polarization in the ranking positions of BRICS countries.

China saw a steady rise in enterprise innovation after entering Bloc 1 in 2010 and reached the 11th. Its ranking was relatively balanced in the five second-level indicators, slight improving in three indicators and dropping in one indicator. China came the 5th in triadic patents as a percentage of global total, the 6th in technology independence, and the 7th in business enterprise researchers as a percentage of national total. Asian countries performed prominently, with Japan, Korea and Israel ranking among the top five.

China's ranking in the innovation performance sub-index fell one spot from the previous year to the 12th. It stayed in the same places in four of the five second-level indicators, and moved down three ranks in high-tech exports as a percentage of manufactured exports. The top 15 countries in innovation performance remained exactly the same as in the previous year, only with a few countries changing places.

China slipped one spot to the 20th in innovation environment. It entered the top 10 in four of the ten second-level indicators with a gradient distribution in ranks in other indicators with both upward and downward movements compared to the previous year. The BRICS countries ranked towards the bottom overall, with the Russian Federation falling four spots.

(I) Input of Innovation Resources Dropped Slightly

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, gross enrollment ratio in higher education, 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's ranking slipped down one place with Bloc 1 composition remaining stable overall

China was ranked the 28th in innovation resources, down one position from a year earlier (Figure 3-1). In this indicator, China's score increased by 2 from the last year to 57.4. China showed an improvement in its scores in four of the five second-level indicators measuring innovation resources. Specifically, China's score jumped from 25.5 in the previous year to 35.8 in gross enrollment ratio in higher education, and increased slightly by 2.0 in networked

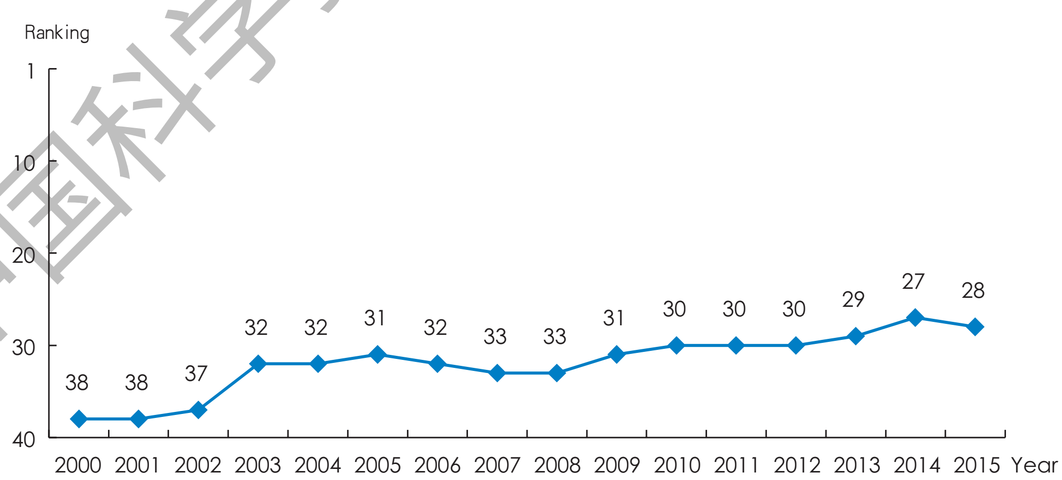

Figure 3–1　China's rankings in the innovation resources sub-index from 2000 to 2015

readiness index, by 0.7 in R&D expenditure intensity and by 0.1 in R&D personnel intensity, and decreased from 46.4 to 45.2 in R&D expenditure as a percentage of the world.

The ranking of the top 15 countries in the innovation resources sub-index was the United States, Korea, Israel, Finland, Denmark, Japan, Sweden, Austria, Germany, Switzerland, Iceland, Norway, the Netherlands, Singapore and Australia, respectively. Compared to the previous year, the only change in the top 15 was Iceland which came back and edged Slovenia out from the 15th to the 17th.

2. China's R&D expenditure ranked high but R&D personnel input lingered at low levels

China's place remained unchanged in three of the five second-level indicators of innovation resources — R&D personnel intensity, networked readiness and R&D expenditure as a percentage of the world, and fell in two indicators, to the 17th in R&D expenditure intensity from the 15th and to the 36th in gross enrollment ratio in higher education from the 34th (Figure 3-2).

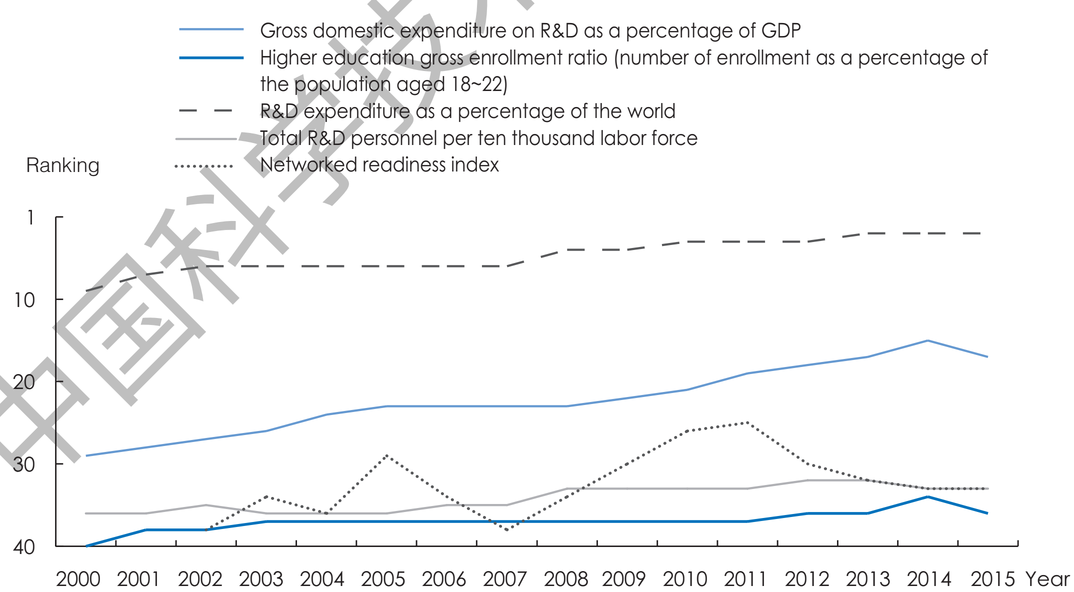

Figure 3–2 China's rankings in indicators of the innovation resources sub-index from 2000 to 2015

China underperformed and ranked among Bloc 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. In R&D personnel, China was in a world-leading position in the scale of R&D resources and personnel, but underperformed in gross enrollment ratio in higher education and R&D personnel intensity, falling behind in the rankings worldwide without much improvement. In addition, its ranking in networked readiness was subject to significant fluctuations and basically stayed beyond the 30th. China should step up efforts in these weak links in increasing its innovation resources.

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

Among the six Asian countries in the index, there was not much change in their ranks compared to the previous year. Korea, Israel, Japan and Singapore continued to be in Bloc 1 in innovation resources, with the first three ranking among the top 10. China was high-ranked in Bloc 2. India was bottom-ranked at the 39th in Bloc 3. Historically, China and Korea showed a remarkable upward trajectory in innovation resources from the year 2000, with their ranking jumping from the 38th and the 10th in 2000 to the 28th and the 2nd, while Singapore's ranking fell significantly by 6 places from the 8th to the 14th in the same period. Japan, Israel and India were stable in their positions from 2000.

The BRICS countries were low-ranked overall, staying towards the bottom among the 40 main countries. The Russian Federation dropped from the 23rd to the 27th; Brazil remained in the 36th; India declined by one place to the 39th; and South Africa stayed in the 40th for the fifth consecutive year from 2011.

(II) China Made Strides in Knowledge Creation

Knowledge creation and application 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 has five second-level indicators, including citation per million R&D dollars, S&T papers per ten thousand researchers, value added of knowledge-intensive services as a percentage of GDP, invention patent applications per 100 million US dollars GDP and invention patent granted per ten thousand researchers, which are used to assess a country's performance in knowledge creation and application.

1. China continued moving up with top eight countries remaining largely stable in ranking

China rose by four places to the 8th in knowledge creation, entering the top 10 for the first time in a first-level indicator (Figure 3-3). China's score in knowledge creation sub-index improved to 71.1 from 67.2 in the previous year. Compared to the previous year, China improved in three of the five second-level indicators, rising by three spots to the 30th in S&T papers citations per million R&D expenditure in academic institutions, by one spot to the 32nd in value added of knowledge-intensive services as a percentage of GDP, and by one spot to the 3rd in invention patent granted per ten thousand researchers. Its ranking remained

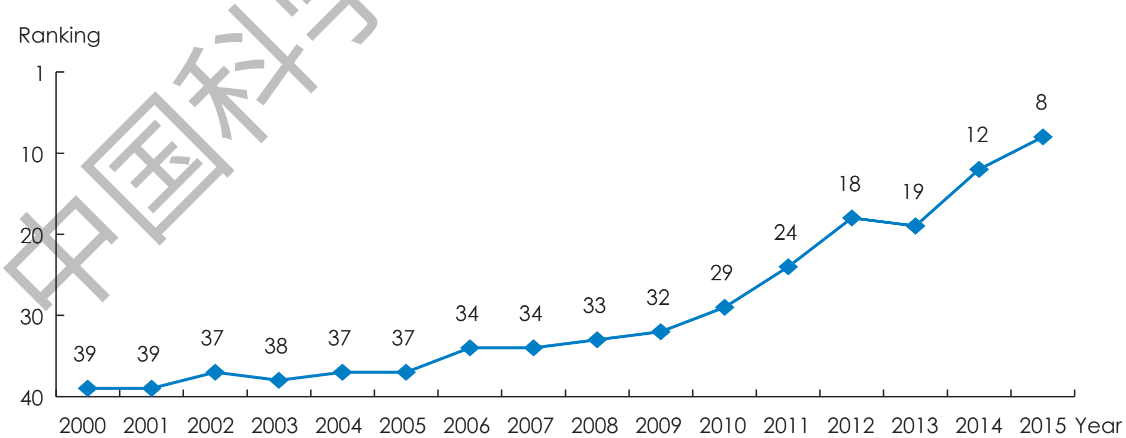

Figure 3-3　China's rankings in the knowledge creation sub-index from 2000 to 2015

unchanged at the 37th in S&T paper per ten thousand researchers and the 2nd in invention patent applications per 100 million US dollars GDP.

The top 15 countries in knowledge creation were Korea, Switzerland, Japan, the United States, New Zealand, the United Kingdom, the Netherlands, China, Australia, Italy, Belgium, Hungary, Spain, Slovenia and South Africa. With the exception of the top three which remained unchanged compared to 2014, all other countries in the top 15 saw their positions changed. Ireland and Singapore dropped out of the top 15 and were replaced by Slovenia and South Africa. Among the 40 countries, Ireland saw the largest position movement with a nosedive to the 18th from the 5th in the previous year.

2. China led the world in invention patent output but left room for improvement in the quality of S&T papers

Among the five second-level indicators, China was already in a leading position in invention patent output in terms of quantity and efficiency. China ranked the 2nd for the sixth consecutive year in invention patent applications per 100 million US dollars GDP and among the top five in invention patent granted per ten thousand researchers for the sixth consecutive year (Figure 3-4).

In S&T papers, the recent years have seen China secure its leading position in the total output and citation count with an outstanding performance in highly cited papers as well, reflecting the steady improvement of China's overall basic research strength. However, China was ranked rather low in two paper-related indicators of the knowledge creation sub-index, which showed that China still needs to make further progress in the output efficiency and overall influence of its S&T papers.

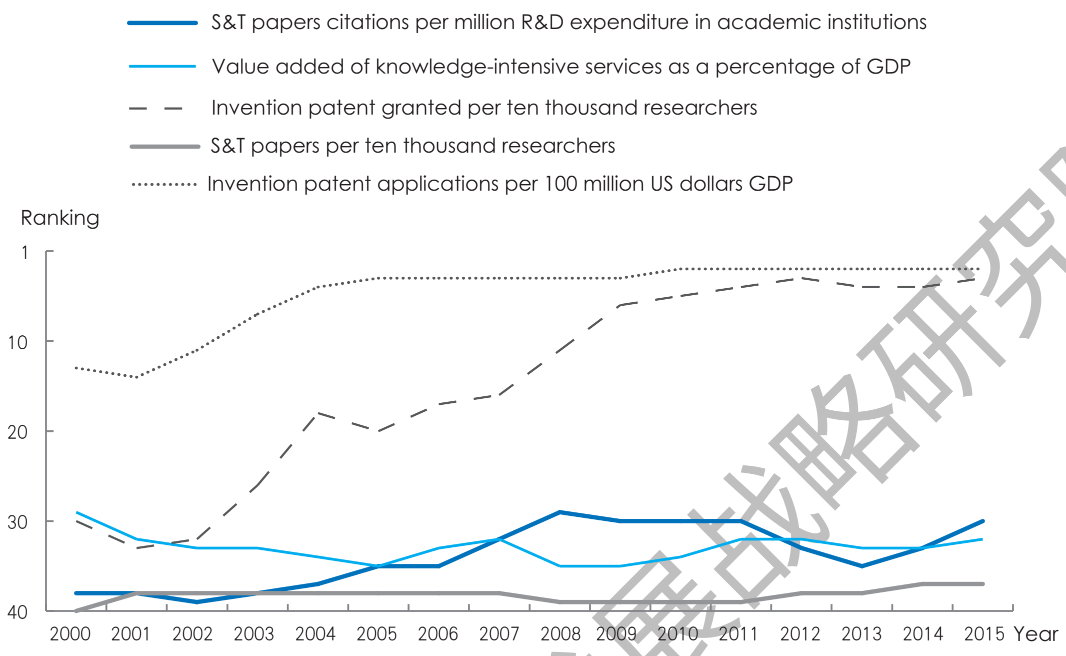

Figure 3–4 China's rankings in indicators of the knowledge creation sub-index from 2000 to 2015

3. Half of Asian countries entered the top 10 as BRICS countries polarize

Korea and Japan maintained their lead in the knowledge creation sub-index in the 1st and the 3rd place; Singapore fell one place to the 16th; and India and Israel were in Bloc 3 in the 33rd and the 38th, respectively. Israel's ranking continued to move down, ranking after the 20th in four of the five second-level indicators (as low as the 35th in S&T papers per ten thousand researchers and the 37th in value added of knowledge-intensive services as a percentage of GDP), with the exception of the indicator of paper citations per million R&D expenditure in academic institutions where it ranked the 10th. Historically, China progressed the fastest after 2000, improving by 31 places from the 39th in 2000 to the 8th in 2015.

Among the BRICS countries, China and South Africa improved significantly in their ranking in the knowledge creation sub-index after 2011, holding places far higher than those of other BRICS countries, with South Africa entering Bloc 1 in 2015. In contrast, India, Brazil and the Russian Federation stayed among the bottom 10 of the 40 countries in this study.

(III) China Improved Steadily in Enterprise Innovation

Enterprises are the main factors in innovation and feature importantly in the national innovation system. The scale and quality of enterprise innovation represents, to a large extent, a country's innovation capability and level. This report measures enterprise innovation activities from a country perspective using five indicators — triadic patent families as a percentage of the world, business enterprise expenditure on R&D 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 national total.

1. China steadily improved in ranking and countries in the first group remained stable

China advanced one spot to the 11th in the enterprise innovation sub-index (Figure 3-5). Compared to the previous year, China improved in two of the five second-level indicators (triadic patent families as a percentage of the world and technology independence) and regressed to varying degrees in the rest three indicators, with a significant fall in business enterprise researchers as a percentage of national total from 76.2% to 70.5%.

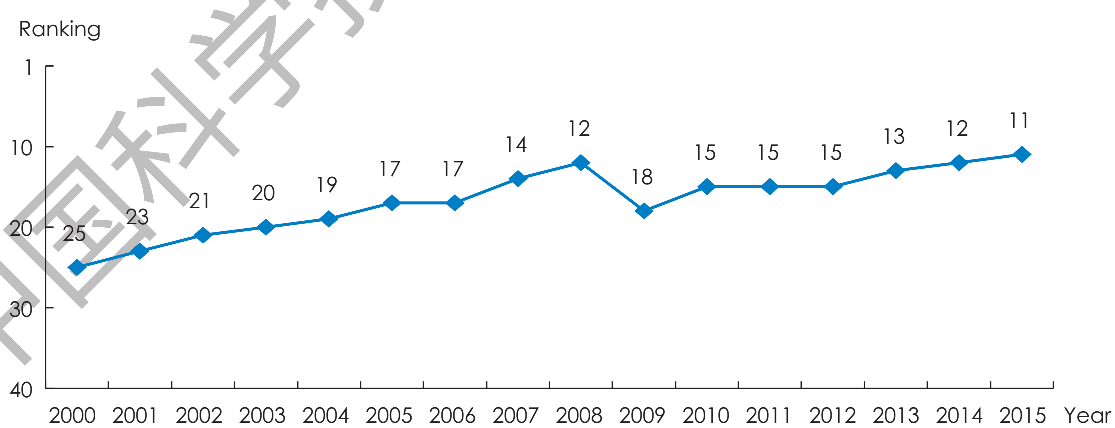

Figure 3–5　China's rankings in enterprise innovation sub-index from 2000 to 2015

Ranking in the top 15 in the enterprise innovation sub-index were Japan, the United States, Korea, Israel, France, Germany, Sweden, Switzerland, Austria, Finland, China, Denmark, Luxembourg, Slovenia and the Netherlands. The top 15 countries are the same as in the previous year, with only a few position changes among them. France, Switzerland, Austria, China and Luxembourg all moved up by one spot. Finland slipped down two spots, and Germany, Denmark and Slovenia each fell down one spot.

There is a high positive correlation between a country's enterprise innovation capability and its national innovation capability. Among the top 15 countries in the enterprise innovation sub-index, 12 were ranked among the top 15 in the overall index between 2014 and 2015.

2. China performed strongly in second-level indicators overall with PCT application output efficiency calling for improvement

China improved in three of the five second-level indicators and regressed in one. It moved up one spot in triadic patent families as a percentage of the world at the 5th, three spots in technology independence at the 6th and one spot in business enterprise researchers as a percentage of national total at the 7th. It regressed one spot to the 16th in business enterprises expenditure on R&D as a percentage of value added. It kept its 27th place in PCT applications per ten thousand researchers in business enterprises.

China performed strongly in the enterprise innovation sub-index and stayed on a steady upward trajectory after it entered Bloc 1 in 2010. Its ranks in the five second-level indicators were relatively balanced. With the exception of PCT applications per ten thousand researchers in business enterprise where it was ranked in Bloc 2, it was middle-ranked in Bloc 1 in all other four indicators. In PCT applications, China ranked the 3rd globally for the third consecutive year in absolute numbers. In terms of input-output efficiency, China was still significantly behind most developed countries. China needs to prioritize PCT applications in its efforts to improve its enterprise innovation capacity.

3. Asian countries stood out with Japan ranking among top 5 in all second-level indicators

Among the top 15 countries in the enterprise innovation sub-index, Asian countries had the best performance. Japan, Korea and Israel ranked the 1st, the 3rd and the 4th, respectively, with outstanding performance in all five second-level indicators. Japan was the only country that entered the top 5 in all five second-level indicators. Korea entered the top 10 in four second-level indicators, and the top 5 in three. Israel ranked the 1st in two second-level indicators. China ranked among the top 10 in three second-level indicators.

Other strong performers in the top 15 in the enterprise innovation sub-index were the United States, Sweden, Germany, France and the Netherlands. The United States entered the top 10 in four second-level indicators, and the rest four countries in three. One standout among the countries outside the top 15 was Italy which entered the top 10 in three second-level indicators.

(IV) China's Innovation Performance Remained Stable with a Slight Drop

Innovation performance epitomizes the achievements and impact of a country's innovation activities. The innovation performance sub-index consists of five second-level indicators, including labor productivity, GDP per unit of energy use, invention patents in force as a percentage of world total, high-tech exports as a percentage of manufactured 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.

1. China's ranking moved down one place with Bloc 1 countries maintaining stability

China's ranking in the innovation performance sub-index came the 12th, down one spot from the previous year (Figure 3-6). Among the five second-level indicators of innovation performance, China improved in score by 2.6 in labor productivity and 0.1 in GDP per unit of energy use, fell by 1.6 in invention patents in force as a percentage of the world and 5.1 in high-tech exports as a percentage of manufactured exports, and stayed the same in value added of knowledge-intensive industries as a percentage of the world.

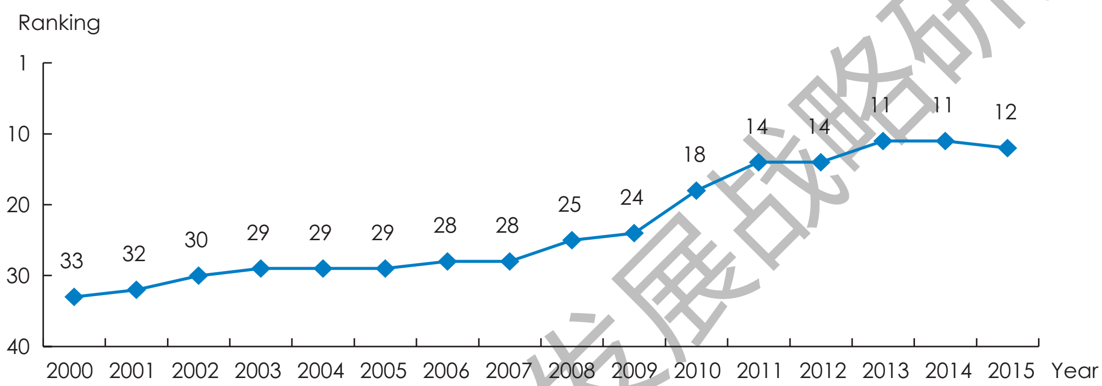

Figure 3–6 China's rankings in innovation performance sub-index from 2000 to 2015

The top 15 countries in the innovation performance sub-index were the United States, Switzerland, Japan, Ireland, Norway, Singapore, the United Kingdom, Denmark, France, Luxembourg, Korea, China, Australia, Germany and Sweden, exactly the same ones as in previous year, only with some position changes among them. Korea saw the largest improvement by rising from the 15th to the 11th, followed by Ireland which moved up two places to the 4th.

2. Performance polarization in second-level indicators underscores challenged facing China's economic transformation

Compared to the previous year, China stayed in the same places in four of the five second-level indicators of innovation performance and continued to drop in high-tech exports as a percentage of manufactured exports from the 3rd to the 6th (Table 3-1).

Although China is set to rank among the top 10 in the innovation performance sub-index very soon, judging from its performance in second-level indicators of the sub-index, its deep-seated structural defects are yet to be solved fundamentally. In spite of China's steady improvement in labor productivity and GDP per unit of energy use since 2000, the pace has been rather slow, with its ranking remaining in the bottom five. In the other three indicators, China has performed strongly and basically stayed in Bloc 1, ranking among the top five from 2009 to 2014. This indicates that China's innovation performance remains mainly driven by the scale of its high-tech industries and high-tech output, with a huge pressure in transforming its mode of economic development and upgrading its industries.

Table 3–1 China's rankings in innovation performance sub-index from 2000 to 2015

Year	Labor productivity	GDP per unit of energy use	Valid invention patents as a percentage of world total	High-tech exports as a percentage of manufacture exports	Value added of knowledge-intensive industries as a percentage of the world
2000	39	38	—	16	6
2001	39	36	—	13	6
2002	39	37	—	10	6
2003	39	39	—	6	7
2004	39	39	—	6	6
2005	39	39	6	6	6
2006	39	40	6	6	6
2007	39	40	5	6	5
2008	39	38	4	6	3
2009	39	37	4	4	3
2010	39	37	4	3	3
2011	39	37	4	2	2
2012	39	36	4	2	2
2013	39	36	4	2	2
2014	39	36	3	3	2
2015	39	36	3	6	2

3. Top 10 countries had balanced development in second-level indicators and China stood out from BRICS

The top 10 countries in the innovation performance sub-index showed balanced performance in second-level indicators. The United Kingdom and Switzerland had the best performance, both ranking among the top 10 in four indicators. The United States, France, China and Ireland were in top 10 in three indicators. Denmark, Japan and Luxembourg were ranked among top 10 in two indicators.

The BRICS countries other than China ranked rather low, with Brazil coming at the 32nd, the Russian Federation the 35th, South Africa the 39th and India the 40th. In terms of second-level indicators, the Russian Federation entered Bloc 1 in invention patents in force and value added of knowledge-intensive industries as a percentage of the world, and Brazil and India entered Bloc 1 in value added of knowledge-intensive industries as a percentage of the world.

(V) Innovation Environment Called for Further Improvement

A country's innovation environment provides an important basis and guarantee for it to improve its innovation capacity. The innovation environment sub-index has ten second-level indicators, including intellectual property protection, burden of government regulation, macroeconomic stability, local availability of specialized research and training services, effectiveness of anti-monopoly policy, flexibility of wage determination, venture capital availability, 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 slipped down one place with remarkable position movement among Bloc 1 countries

China continued to fall in the innovation environment sub-index, to the 20th from the 19th a year earlier (Figure 3-7). From 2005, China's performance in this sub-index stayed in a state of fluctuation, which moved on an overall upward trajectory with little fluctuation to reach the 16th in 2009, then fell to the 19th in the subsequent two years, and then moved up to the 13th in 2013, before regressing to the lowest level in seven years in 2015. Among the ten second-level indicators, China improved to varying degrees in all indicators other than macroeconomic stability and flexibility of wage determination where it dropped by 4.9 and 1.0 in score respectively.

The top 15 countries among the 40 countries in the innovation environment sub-index are Singapore, Switzerland, Finland, the United States, Luxembourg, Norway, Germany, Sweden, the Netherlands, the United Kingdom, New Zealand, Ireland, Israel, Belgium and Japan. Among them, Singapore remained in the 1st place which it has kept for many years; Belgium replaced Canada to enter Bloc 1; Finland moved up to the 3rd place from the 8th; Sweden advanced from the 12th to the 8th; and the United Kingdom slipped from the 6th to the 10th. These countries have significant advantages over other countries in innovation environment.

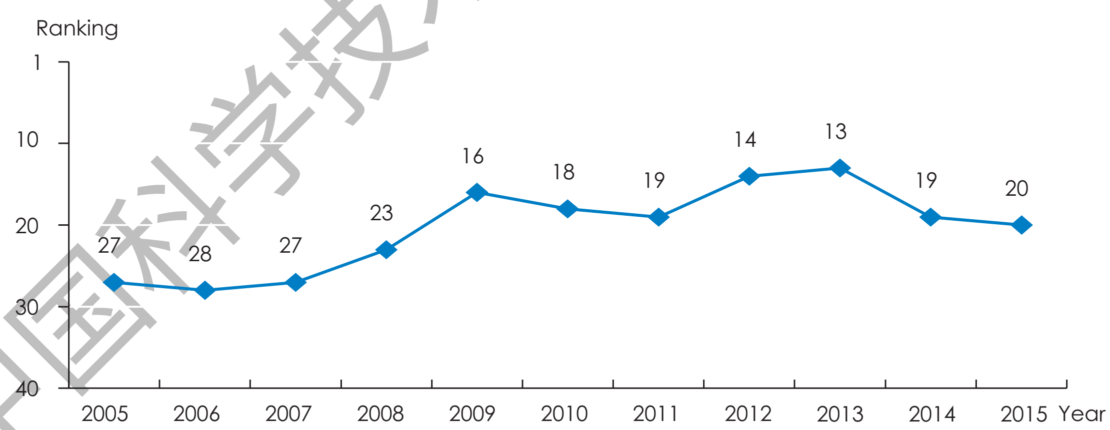

Figure 3–7 China's rankings in innovation environment sub-index from 2005 to 2015

2. China's performance showed a gradient distribution in second-level indicators and calls for improvement in intellectual property protection

China made into the top 10 in four of the second-level indicators: burden of government regulation, macroeconomic stability, venture capital availability, and government procurement of advanced technology products (Table 3-2). Among them, it remained high-ranked at the 6th in both macroeconomic stability and government procurement of advanced technology products, though on the basis of falling two places from their ranks in 2014, and moved up two places to rank among the top 10 in venture capital availability, reversing the steep drop in the previous year. In other indicators, its performance showed a gradient distribution with upward and downward movements compared to the previous year. Specifically, it improved by three spots to the 21st in effectiveness of anti-monopoly policy, by two places in state of cluster development and university-industry collaboration in R&D to the 16th and the 23rd, respectively, and by one place to the 33rd in local availability of specialized research and training services; it moved down one place to the 33rd in intellectual property protection, and fell two places to the 20th, representing the third consecutive year of regression.

Table 3–2 China's rankings in innovation environment sub-index from 2007 to 2015

Indicator	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ranking in innovation environment sub-index	27	23	16	18	19	14	13	19	20
Including: Intellectual property protection	31	28	27	28	28	27	25	32	33
Burden of government regulation	11	6	5	7	6	3	6	9	9
Macroeconomic stability	2	5	—	—	4	3	4	4	6
Local availability of research and training services	29	30	32	30	33	30	33	34	33
Effectiveness of anti-monopoly policy	37	35	28	28	28	27	22	24	21
Venture capital availability	34	29	12	11	12	8	5	11	9
Flexibility of wage determination	8	6	12	9	28	5	9	18	20
State of cluster development	19	16	12	12	16	18	18	18	16
University-industry collaboration in R&D	23	21	22	24	26	25	25	25	23
Government procurement of advanced technology products	17	13	6	8	8	3	4	4	6

3. China led BRICS comprehensively with the Russian Federation seeing the steepest decline

The BRICS countries were low-ranked overall in the innovation environment sub-index. In 2015, China maintained its lead over other BRICS countries, with South Africa coming at the 25th, India at the 21st, Brazil at the 38th and the Russian Federation at the 35th (Table 3-3). Compared to the previous year, the Russian Federation suffered the biggest fall from the 31st to the 35th. In contrast, South Africa improved by two places, and India four places.

Table 3–3 Rankings of BRICS countries in innovation environment sub-index and second-level indicators

Nation	China	South Africa	India	Brazil	Russian Federation
Ranking in innovation environment sub-index	20	25	21	38	35
Including: Intellectual property protection	33	19	27	36	40
Burden of government regulation	9	27	11	40	25
Macroeconomic stability	6	31	30	38	34
Local availability of research and training services	33	23	29	40	28
Effectiveness of anti-monopoly policy	21	7	23	35	36
Venture capital availability	9	26	6	36	35
Flexibility of wage determination	20	36	24	33	25
State of cluster development	16	22	20	29	36
University-industry collaboration in R&D	23	21	20	37	29
Government procurement of advanced technology products	6	34	4	35	28

In innovation environment, China, South Africa and India were in Bloc 2, and Brazil and the Russian Federation in Bloc 3. In respect of the performance of the BRICS countries in the second-level indicators of this sub-index, China had comparative advantages in macroeconomic stability and state of cluster development; China and India had clear advantages in burden of government regulation, venture capital availability and government procurement of advanced technology products; and South Africa enjoyed clear advantages in effectiveness of anti-monopoly policy. In other indicators, the BRICS countries were low-ranked overall. Brazil and the Russian Federation, in particular, were low-ranked in basically all second-level indicators.

IV. China's Innovation Capability Development and Evolution

Historically, China's national innovation capability has been steadily increasing, but it still faces a huge challenge to enter the first bloc. From 2000 to 2015, China has been on a clear upward trend in innovation resources, knowledge creation, enterprise innovation and innovation performance, increasing at the average annual growth rate at 10.3% in innovation resources, 11.2% in knowledge creation, 16.3% in enterprise innovation and 10.9% in innovation performance, in addition to improvement in seven of the ten indicators of innovation environment.

China's STI development plan for the 13th Five-Year Plan period has set forth 12 indicators taking into full consideration inheritance, continuation, innovativeness and up-to-dateness. To guide the efforts to build an innovation-driven country, the plan identified two indicators — global ranking in national innovation capacity and MFP contribution to economic growth. In reflecting innovation-driven development and economic restructuring, it provided five indicators — R&D expenditure as a percentage of GDP, R&D personnel per ten thousand labor force, operating revenue of high-tech enterprises, value added of knowledge-intensive services as a percentage of GDP, and R&D expenditure of enterprises above designated size as a percentage of operating revenue. For efforts to improve independent innovation capacity and internationalization it set forth three indicators — international ranking in S&T paper citations, PCT patent applications, and resident invention patents in force per ten thousand population. In innovation and start-up environment, it provided two indicators — combined contract value in the domestic technology market and scientific literacy.

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

1. China's basic pattern of historical movement in the index

In today's world, competition in core innovation factors is becoming increasingly intense, with developed countries emphasizing innovation capacity buildup as a means to maintain their leading positions and emerging economies scaling up investment in innovation in a bid to catch up with and surpass developed countries. Since the onset of the 21st 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. China is quickly closing its gap with innovation-driven countries in innovation capacity, as shown by the trajectory of its performance in the national innovation index over the years.

Since 2000, China has undergone three Five-Year Plan periods. A survey of China's performance in the national innovation index over the years can provide a better understanding of the historical development of China's innovation capacity. The 15 years after 2000 saw China steadily increase its innovation capacity on a trajectory of exponential growth. This is clearly based on a comparison of China's performance in the index in the three five-year periods based on its scores in 2000, 2005 and 2010. According to the data, China's index score increased by 51% from 2000 to reach 151 in 2005 (Figure 4-1). With the promulgation and implementation of the MLP (2006–2020) and related measures, China's score improvement accelerated with a 75% growth (Figure 4-2). During the 12th Five-Year Plan period, China's index score maintained a sound momentum of growth on the basis of the increased levels, though at a slower pace of growth, at 45% (Figure 4-3). As China steadily improves its innovation capacity and comes into direct competition with Bloc 1 countries in innovation capacity, China's effort to build an innovation-driven country has entered the decisive stage.

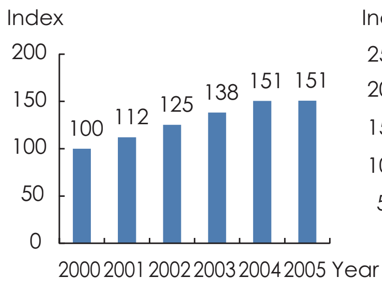

Figure 4–1 China's evolution in national innovation index performance during the 10th Five-Year Plan

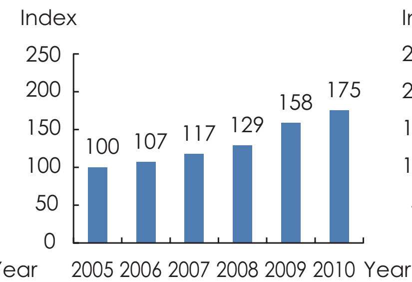

Figure 4–2 China's evolution in national innovation index performance during the 11th Five-Year Plan

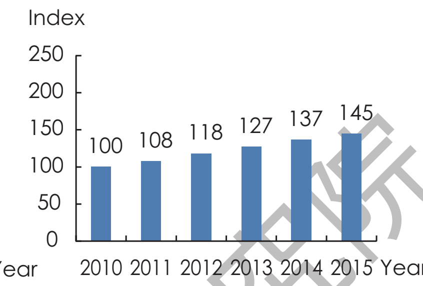

Figure 4–3 China's evolution in national innovation index performance during the 12th Five-Year Plan

2. Factors underlying China's movement in the index

China showed a clear upward trend in four of the five first-level indicators of the national innovation index, i.e. innovation resources, knowledge creation, enterprise innovation and innovation performance, with the exception of innovation environment where its ranking experienced slight fluctuations. In the enterprise innovation sub-index, in particular, it enjoyed a high-speed growth (Table 4-1).

Table 4–1 China's scores in first-level indicators of NII from 2000 to 2015

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment
2000	100	100	100	100	
2001	113	102	124	109	
2002	127	103	154	117	
2003	143	113	172	126	
2004	155	133	185	130	
2005	150	147	218	139	100
2006	163	157	247	155	98
2007	200	170	297	178	102
2008	220	168	349	215	108
2009	257	234	511	240	115
2010	282	257	570	278	112

Continue

Year	Innovation resources	Knowledge creation	Enterprise innovation	Innovation performance	Innovation environment
2011	309	297	618	328	109
2012	346	342	760	372	112
2013	379	385	831	410	112
2014	418	428	944	446	111
2015	438	491	966	475	113

Capital, human resources and information resources are essential to innovation activities. From 2000 to 2015, China's input of innovation resources increased substantially, as attested by its up to 10.3% average growth in the innovation resources sub-index during the period. The 15 years saw China's R&D expenditure increase eight-fold, which as a percentage of the global total jumped from 1.7% in 2000 to 15.6% in 2015. China's R&D expenditure as a percentage of GDP increased from 0.9% to 2.06%, earning the top spot among developing countries. China's human resources in innovation grew significantly as well, with its R&D personnel per ten thousand labor force increasing from 7.3 to 27.4. Its gross enrollment ratio in higher education grew by more than four times from 7.7% to 39.4%. The rapid increase in innovation resources, which is the foundation for improving the national innovation capacity, has provided a fundamental support for China's economic restructuring and industrial transformation.

S&T papers and patents are outcomes of knowledge creation activities and a direct output of innovation activities. From 2000 to 2015, China's R&D strength improved quickly, achieving an average annual growth of 11.2% in the knowledge creation sub-index during the period. The period saw China's S&T papers per ten thousand researchers increase by more than three times. China's invention patent granted per ten thousand researchers in 2015 were 13 times that in 2000. The improvement in knowledge creation and conversion has provided a strong support for China's innovation activities and significantly boosted its original innovation capacity building.

The innovation capacity of enterprises which are the main source of innovation is a core factor which determines a country's innovation capacity. From 2000 to 2015, China's enterprise innovation capacity increased rapidly, achieving an average annual growth of 16.3% in the enterprise innovation sub-index, the highest among the five second-level indicators of the sub-index. China's triadic patents as a percentage of the world increased from less than 0.2% in 2000 to 4.8% in 2014. China's PCT patent applications per ten thousand researchers in enterprises increased by 10.5 times from 22.0 to 252.6. As Chinese enterprises become increasingly conscious of intellectual property protection and compete with their international counterparts, there will be an even stronger growth in Chinese enterprises' innovation capacity.

Innovation performance is measured by the extent to which innovation promotes economic development, industrial structure optimization and social progress and is the ultimate goal of innovation activities. China's innovation performance maintained a steady upward trend, recording an average annual growth of 10.9% in the sub-index from 2000 to 2015, while China's labor productivity increased from USD 1,700 per person employed to USD 14,200 in the same period. And its GDP per unit of energy use increased by 2.5 times from USD 1.0 per kg of oil equivalent to USD 3.5. Compared to other first-level indicators, innovation performance has a certain time lag and therefore has a large potential for improvement in the future.

Innovation environment is the setting in which innovation activities take place. Since the promulgation and implementation of the MLP, China's innovation environment has improved greatly. Compared to 2005, China improved to varying degrees in seven of the ten indicators of the innovation environment sub-index, and stayed in the same place in one indicator and dropped slightly in two. With the implementation of a set 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 STI Development Plan for the 13th Five-Year Plan period as a measure of development targets. 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. It means that by that time China will become an innovation-driven country. 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 efficiency and quality. Measures outlined for 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 of resource input; 2) further increasing knowledge creation to provide a solid foundation for the building 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, economic and technological service environment that is favorable to innovation.

(II) Indicators and Targets Set by the STI Development Plan for the 13th Five-Year Plan Period

1. Indicator design and underlying principles

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. The indicators determined in the STI Development Plan for the 13th Five-Year Plan period should reflect the inheritance and continuation on the one hand and innovativeness and currency on the other hand, and take into full consideration the characteristics of economic and social development and STI during the period in order to provide precise regulation and guidance for the entire nation's STI activities. The design of the indicators mainly highlights the following aspects.

Firstly, it highlights the building of an innovation-driven country as the strategic objective. The 13th Five-Year Plan period represents the last five years for the accomplishment of the goal of making China an innovation-driven country. To realize this goal, it is necessary to strengthen dynamic monitoring of the progress towards that goal and straighten targeted support.

Secondly, it highlights the performance of innovation-driven development. The 13th Five-Year Plan period is a key period for the thorough implementation of the innovation-driven development strategy. To adopt to and lead the new normal of economic development, greater scope should be given to the role of innovation in supporting and leading the economic and social development by further strengthening the monitoring of the contribution of innovation to economic transformation and industrial restructuring.

Thirdly, it highlights the quality and capacity building of innovation. The 13th Five-Year Plan period is a crucial period for the leap from quantitative to qualitative change in China's innovation capacity building. The innovation indicators determined for this period should bring more attention to the quality and efficiency of R&D, the improvement of the national innovation capacity, and the position and influence of China's innovation in the world.

Fourthly, it highlights environment building for innovation and entrepreneurship. Promoting mass innovation and entrepreneurship is an important task during the 13th Five-

Year Plan period. In this respect, the government should accelerate its efforts to transform government functions, further invigorate the market and foster a pro-innovation ecosystem. With this task in mind, the indicators determined in the plan should give greater prominence to the monitoring and guidance regarding environment building for innovation and entrepreneurship and transfer of R&D achievements.

The design of the indicators mainly complies with the following principles:

INHERITANCE. Strengthen alignment with the goals set forth in relevant documents and meetings including the government's work report to the 18th CPC National Congress, resolution adopted at the third plenary session of the 18th CPC Central Committee, the No. 6 Document of the CPC Central Committee, the Central Economic Work Conference, and the relevant indicators specified in the *National Guideline on Medium- and Long-Term Plan for Science and Technology Development*, the *National Guideline on Medium- and Long-Term Plan for Education Reform and Development*, the *National Guideline on Medium- and Long-Term Plan for the Development of Competent Personnel* to create a comprehensive STI development indicator system for the 13th Five-Year Plan period.

SYSTEMATICITY. Serving as a strategic guide to the national economic and social development, the indicator system should consider the quantitative development of independent innovation capacity and innovation achievements, and also emphasize the quality and efficiency of innovation and the contribution of innovation to economic and social development by both allowing the decisive role of the market in resource allocation and reflecting the government's strategies.

OPERABILITY. Firstly, use the existing indicators wherever possible and reduce the use of subjective indicators to ensure good availability of data on the indicators. Secondly, draw upon advanced foreign practices to ensure international comparability. And thirdly, the indicators should be sensitive in measuring performance movement with consistent statistical specifications to ensure historical comparability on the same indicators.

2. Specific indicators

Based on the abovementioned considerations, the STI development plan for the 13th Five-Year Plan period set forth 12 indicators. To guide the efforts to build an innovation-driven country, the plan identified two indicators — global ranking in national innovation capacity and MFP contribution to economic growth. In reflecting innovation-driven development and economic restructuring, it provided five indicators — R&D expenditure as a percentage of GDP, R&D personnel per ten thousand labor force, revenue from principle business of high-tech enterprises, value added of knowledge-intensive services as a percentage of GDP, and R&D expenditure of enterprises above designated size as a percentage of operating revenue. For efforts to improve independent innovation capacity and internationalization, it set forth three indicators — international ranking in S&T paper citations, PCT patent applications, and resident invention patents in force per ten thousand population. In innovation and entrepreneurship environment, it provided two indicators — contract value in the domestic technology market and scientific literacy (Table 4-2).

Table 4–2 Indicators and targets set by the STI Development Plan for the 13th Five-Year Plan period

	Indicator	Indicator value — 2015	Indicator target — 2020
	Innovation-driven country building		
1	China's ranking in the national innovation index	18	15
2	MFP contribution to economic growth (%)	55.3	60
	Innovation-driven development and economic restructuring		
3	R&D expenditure as a percentage of GDP (%)	2.06	2.5
4	R&D personnel per ten thousand labor force (person per year)	48.5	60
5	Revenue from principle business of high-tech enterprises (RMB trillion)	22.2	34
6	Value-added of knowledge-intensive services as a percentage of GDP (%)	15.6	20
7	R&D expenditure of enterprises above designated size as a percentage of operating revenue (%)	0.9	1.1

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	Indicator	Indicator value — 2015	Indicator target — 2020
Independent innovation capacity and internationalization			
8	International ranking in S&T paper citations	4	2
9	PCT patent applications (10,000)	3.05	Doubled
10	Invention patents in force per ten thousand population	6.3	12
Innovation and entrepreneurship environment			
11	Contact value in domestic technology market (RMB 100 million)	9835	20, 000
12	Scientific literacy (%)	6.2	10

Compared to the 12th Five-Year Plan period, the indicators in the STI development plan for the 13th Five-Year Plan period mainly have the following characteristics:

Firstly, the indicators are broadly based. Important STI indicators generally adopted in China's scientific and technological development plans in history, including those used in national economic and social development plans, which need to be monitored historically in the long term, are all retained in the STI development plan for the 13th Five-Year Plan period, including ranking in the national innovation index, MFP contribution to economic growth, R&D expenditure as a percentage of GDP, R&D personnel per ten thousand labor force, invention patents owned per ten thousand population, combined contract value in domestic technology market and scientific literacy.

Secondly, some indicators are adjusted and optimized. To better direct the work of the R&D community to improve the quality and international competitiveness of R&D output, the plan adjusted and optimized volume-based indicators and international ranking indicators where China performed well previously and introduced new indicators in weak areas where more efforts should be made.

In terms of patents, while China has topped the world in resident invention patent applications for six consecutive years and surpassed Japan to rank the first globally in resident invention patent granted, the longstanding situation of patents far outnumbering their real-world applications and domestic patents far outnumbering international patents has remained to be solved fundamentally. During the 13th Five-Year Plan period, more emphasis is placed on improving the quality and international competitiveness of patent output. PCT patent applications refer to patent applications filed under the Patent Cooperation Treaty (PCT) and a patent granted under the treaty is automatically recognized and protected in all countries signing the treaty. Therefore, the number of PCT patent application has become an important indicator measuring a country's position in leading-edge technologies, national innovation capacity and technology-driven economic development. Therefore, the plan replaced the "invention patent applications per hundred R&D personnel" with the "PCT patent applications".

In terms of high-tech industries, considering that the data on the value added of high-tech industries were no longer published by the National Bureau of Statistics from 2009, the "value added of high-tech industries as a percentage of manufactured value added" was replaced by the "operating revenue of high-tech enterprises" to reflect enterprises' innovation output more systematically and guide industrial development, transformation and upgrade.

Thirdly, the plan introduced new indicators. In accordance with the new requirements put forward by national economic and social development for innovation, the plan added two indicators to bring greater prominence to the role of innovation in supporting and leading economic restructuring:

R&D expenditures above designated size as a percentage of operating revenue. This is an important indicator which measures enterprise innovation capacity and input and reflects enterprise commitment to innovation. Efforts will be stepped up to guide enterprises to increase investment in R&D, especially in basic research, to strongly support the achievement of the national R&D intensity target and the building of an innovation-driven country.

Value-added of knowledge-intensive services as percentage of GDP. Knowledge-intensive services have a high reliance on high-tech equipment and knowledgeable and highly skilled talents. This indicator measures the knowledge content of economic output and the status of industrial restructuring and upgrade, and reflects the role of knowledge and technology in leading national economic restructuring.

National Innovation Index Report 2016–2017

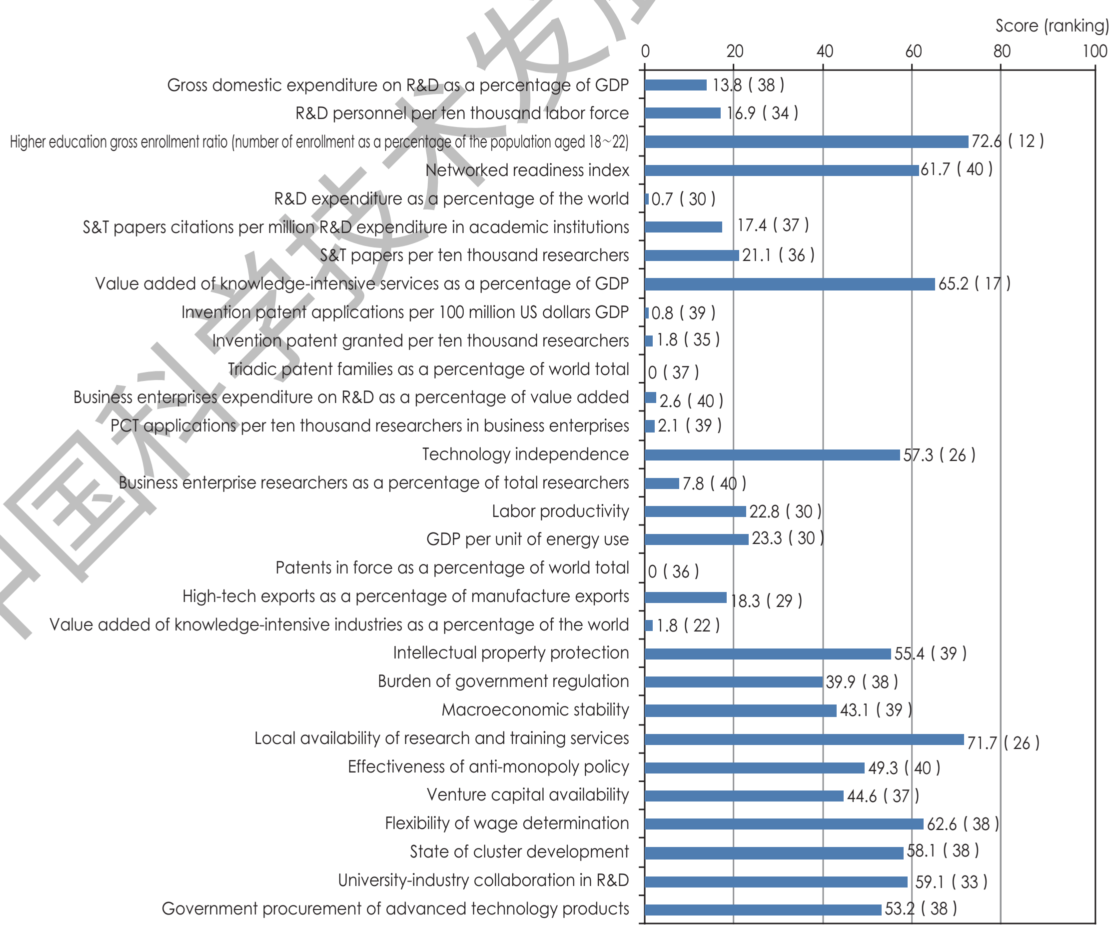
Part Two:

Country Analysis

Argentina

A South American country, Argentina has a population of 43.42 million and a territory of approximately 2.78 million square kilometers with a GDP of USD 583.17 billion and GDP per capita of USD 13,432 and is an upper-middle income country. It recorded USD 6.51 per kilogram of oil equivalent in GDP per unit of energy use, USD 3.36 billion in R&D expenditure, 0.59% in R&D intensity, 9359 in SCI indexed papers, 29 in PCT applications, and 9.01% in high-tech exports as a percentage of manufactured exports.

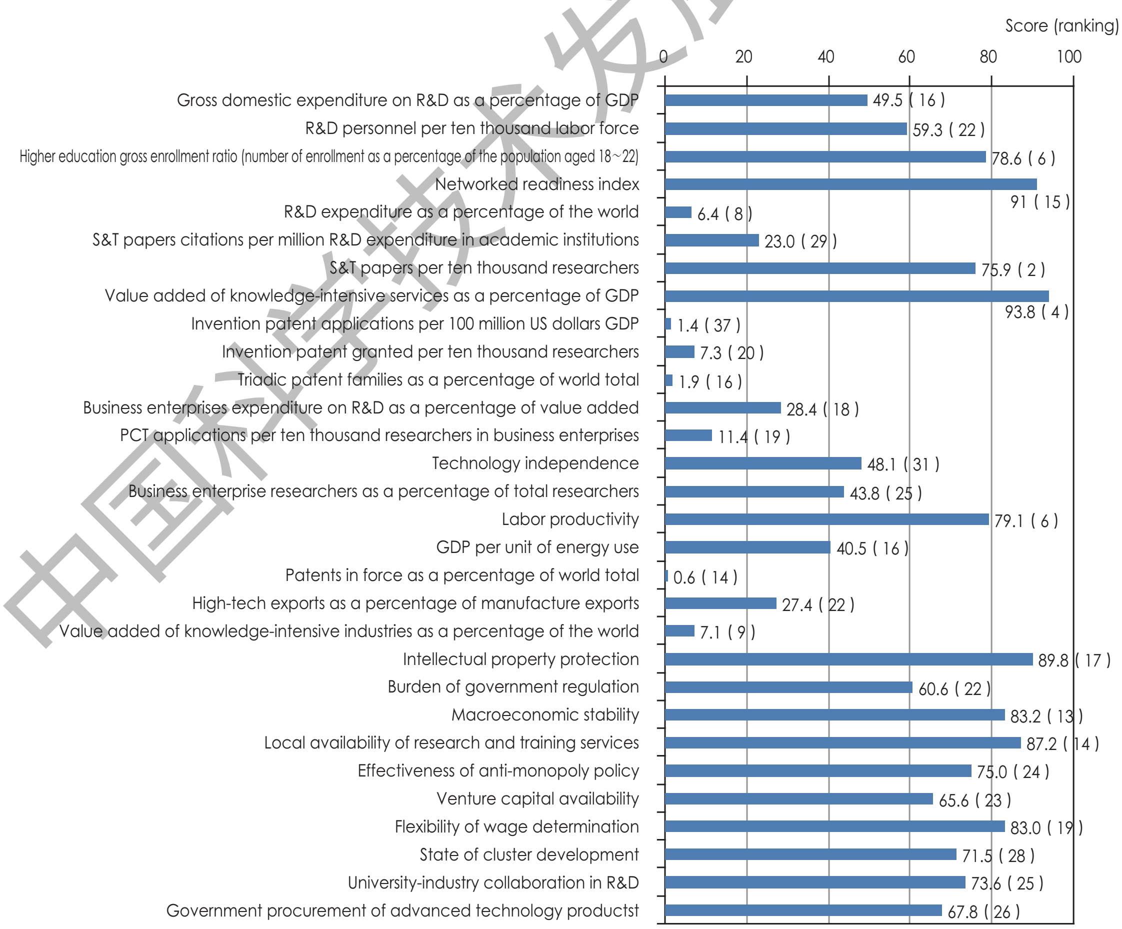
Argentina kept its 40th position in the national innovation index. Among the five first-level indicators, it retained its 35th place in innovation resources, dropped one spot to the 37th in knowledge creation, stayed at the 40th in enterprise innovation and the 34th in innovation performance, and moved up one place to the 39th in innovation environment.



Australia

An Oceanian country, Australia has a population of 23.78 million and a territory of approximately 7.62 million square kilometers with a GDP of USD 1339.14 billion and GDP per capita of USD 56,311 and is a high-income country. It recorded USD 11.30 per kilogram of oil equivalent in GDP per unit of energy use, USD 32.31 billion in R&D expenditure, 2.11% in R&D intensity, 66,000 in SCI indexed papers, 1741 in PCT applications, and 13.51% in high-tech exports as a percentage of manufactured exports.

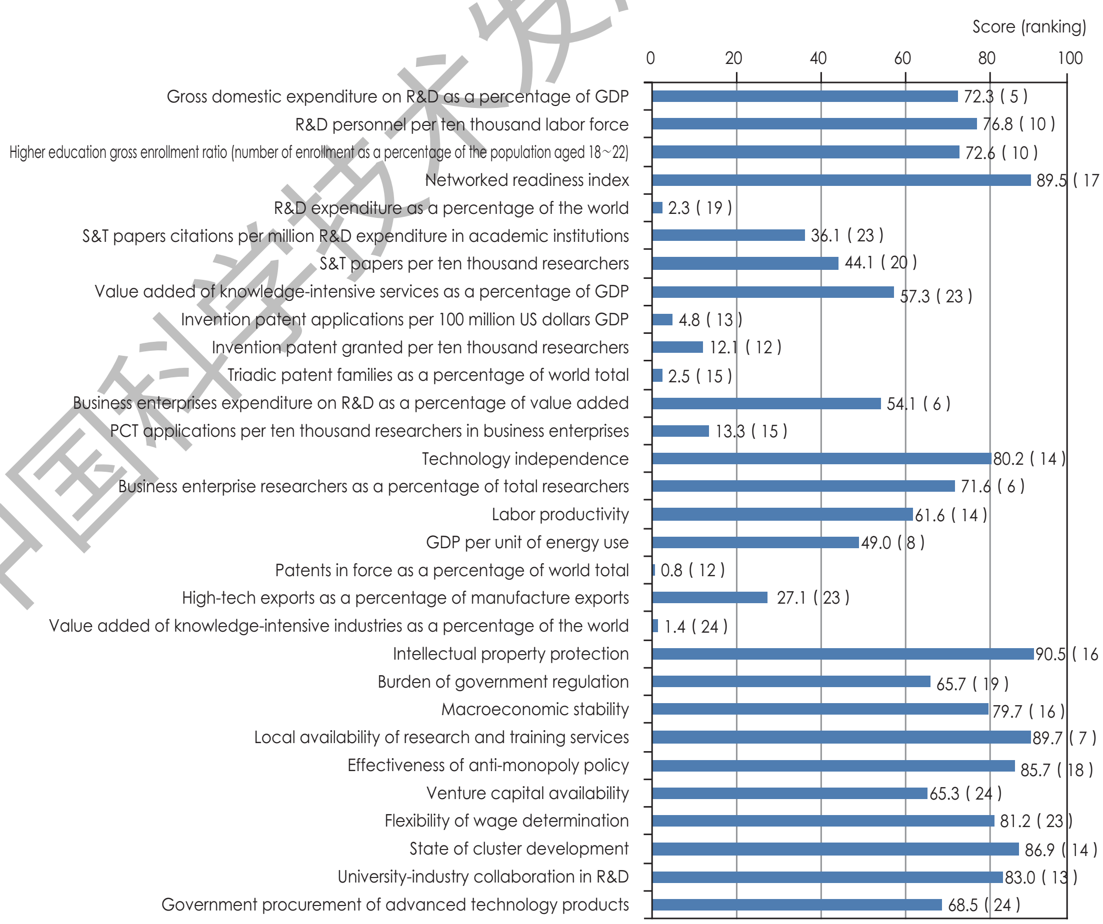
Australia kept its 19th position in the national innovation index. Among the five first-level indicators, it dropped three places to the 15th place in innovation resources, advanced one spot to the 9th in knowledge creation, stayed at the 28th in enterprise innovation, and fell down one place to the 13th in innovation performance and three places to the 23rd in innovation environment.



Austria

A European country, Austria has a population of 8.61 million and a territory of approximately 84,000 square kilometers with a GDP of USD 376.95 billion and GDP per capita of USD 43,775 and is a high-income country. It recorded USD 13.67 per kilogram of oil equivalent in GDP per unit of energy use, USD 11.58 billion in R&D expenditure, 3.07% in R&D intensity, 16,000 in SCI indexed papers, 1399 in PCT applications, and 13.35% in high-tech exports as a percentage of manufactured exports.

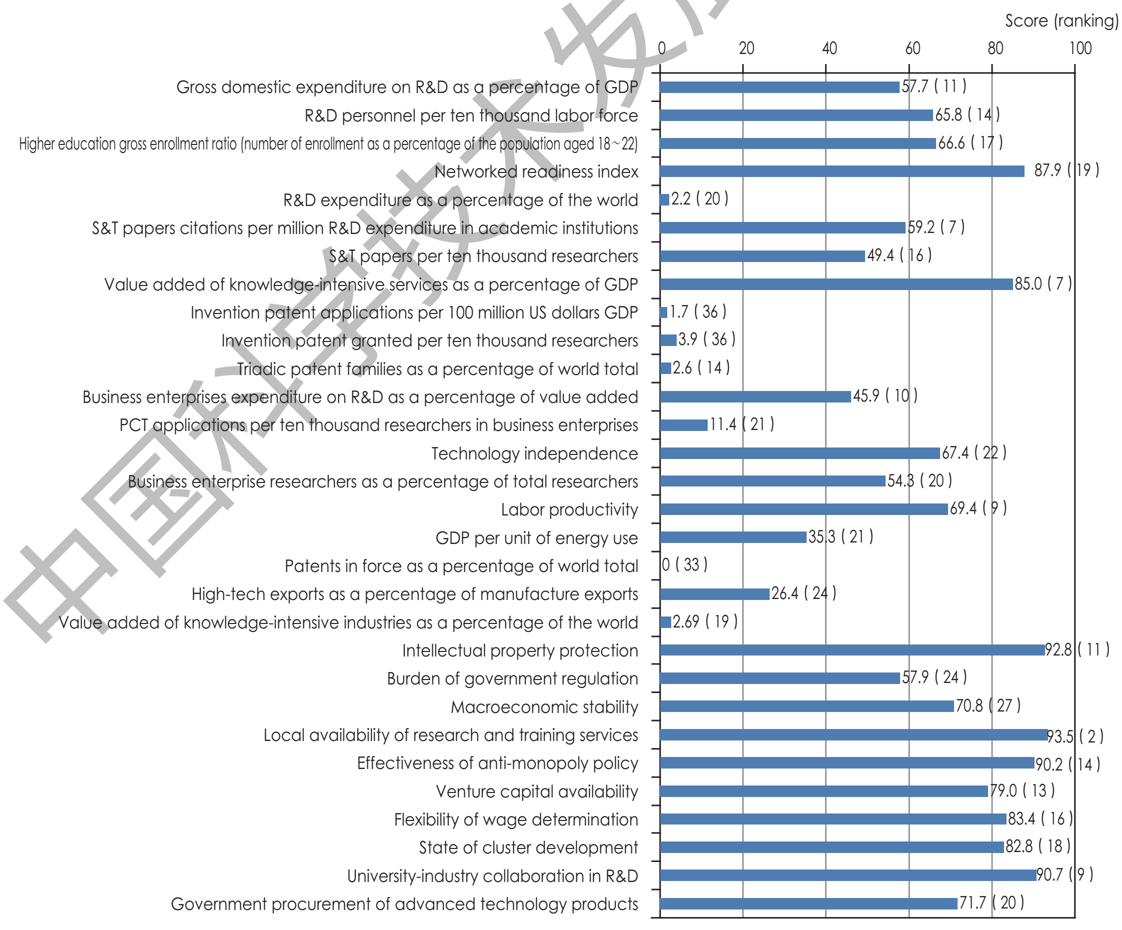
Austria improved by one place to the 14th in the overall national innovation index rankings. Among the five first-level indicators, it stayed at the 8th place in innovation resources, moved up two places to the 27th in knowledge creation and one place to the 9th in enterprise innovation, fell down one place to the 18th in innovation performance, and improved by five notches to the 18th in innovation environment.



Belgium

A European country, Belgium has a population of 11.29 million and a territory of approximately 31,000 square kilometers with a GDP of USD 455.09 billion and GDP per capita of USD 40,324 and is a high-income country. It recorded USD 9.84 per kilogram of oil equivalent in GDP per unit of energy use, USD 11.2 billion in R&D expenditure, 2.45% in R&D intensity, 23,000 in SCI indexed papers, 1180 in PCT applications, and 13.02% in high-tech exports as a percentage of manufactured exports.

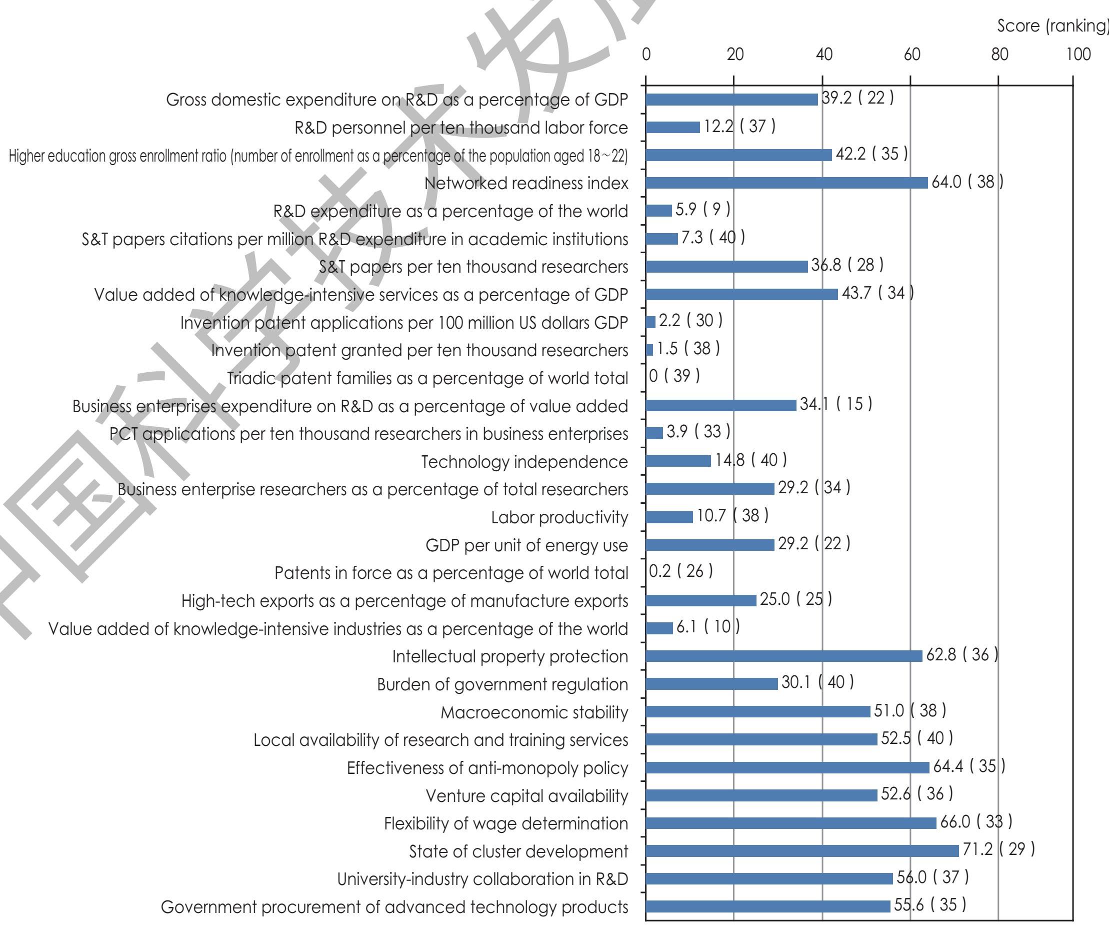
Belgium dropped two places to the 18th in the overall national innovation index rankings. Among the five first-level indicators, it retained its 16th place in innovation resources, dropped two spots to the 11th in knowledge creation, stayed at the 16th in enterprise innovation and the 19th in innovation performance, and moved up two places to the 14th in innovation environment.



Brazil

A South American country, Brazil has a population of approximately 208 million and a territory of approximately 8.55 million square kilometers with a GDP of USD 1774.73 billion and GDP per capita of USD 8539 and is an upper-middle-income country. It recorded USD 8.16 per kilogram of oil equivalent in GDP per unit of energy use, USD 29.57 billion in R&D expenditure, 1.67% in R&D intensity, 44,000 in SCI indexed papers, 548 in PCT applications, and 12.31% in high-tech exports as a percentage of manufactured exports.

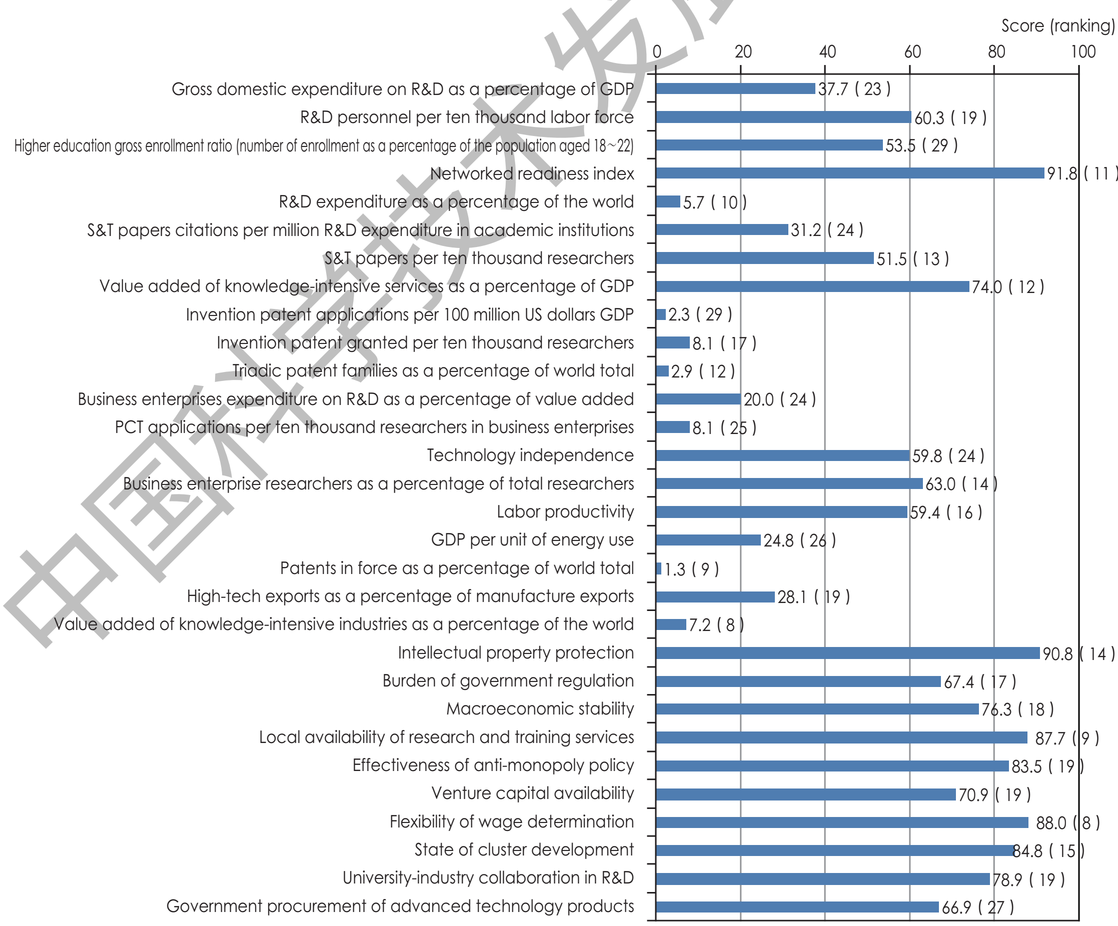
Brazil kept its 39th position in the national innovation index. Among the five first-level indicators, it stayed at the 36th in innovation resources, the 39th in knowledge creation, and the 38th in enterprise innovation, moved down one spot to the 32nd in innovation performance, and stayed at the 38th in innovation environment.



Canada

A North American country, Canada has a population of 35.85 million and a territory of approximately 9.99 million square kilometers with a GDP of USD 1550.54 billion and GDP per capita of USD 43,249 and is a high-income country. It recorded USD 6.92 per kilogram of oil equivalent in GDP per unit of energy use, USD 28.77 billion in R&D expenditure, 1.60% in R&D intensity, 70,000 in SCI indexed papers, 2821 in PCT applications, and 13.83% in high-tech exports as a percentage of manufactured exports.

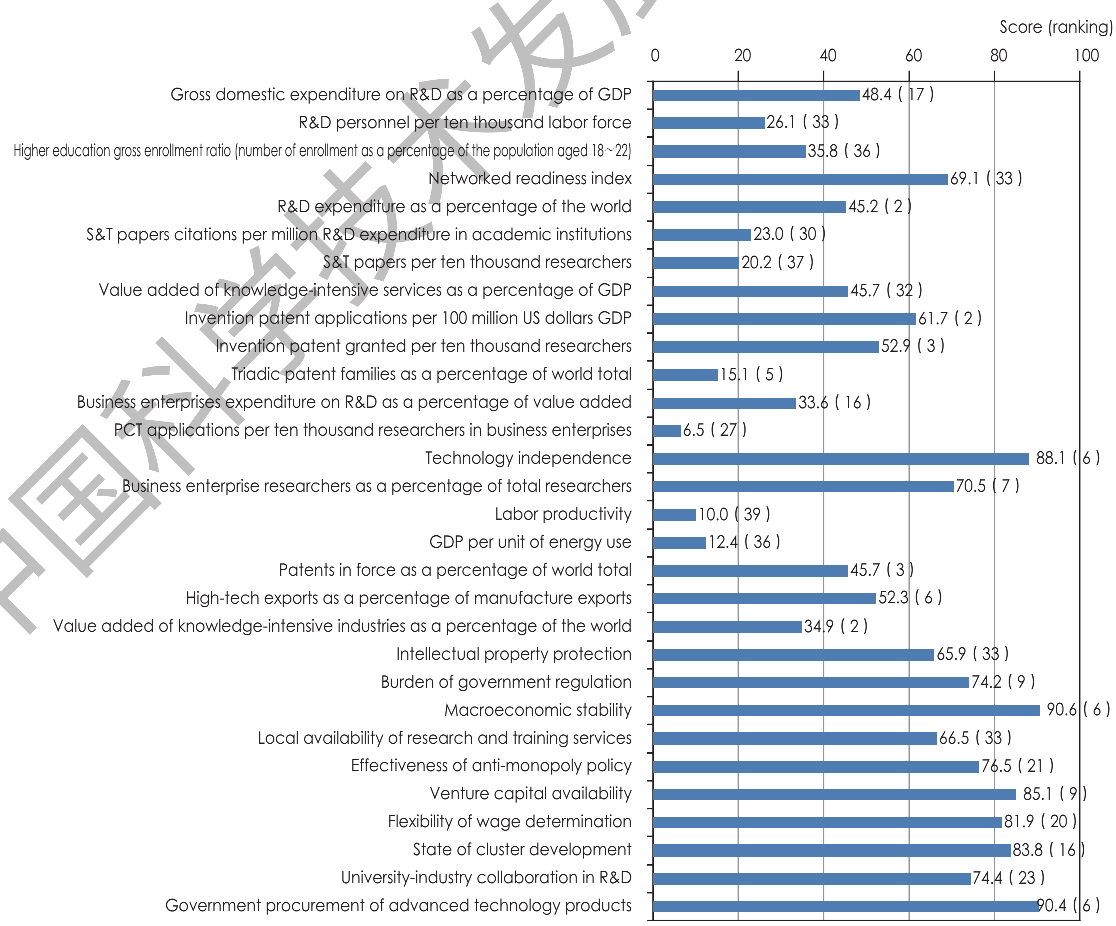
Canada dropped three ranks to the 23rd in the national innovation index. Among the five first-level indicators, it moved down two places to the 21st in innovation resources and four places to the 22nd in knowledge creation, improved by one place to the 21st in enterprise innovation, and dropped one place to the 21st in innovation performance and six places to the 19th in innovation environment.



China

An Asian country, China has a population of 1371 million and a territory of approximately 9.63 million square kilometers with a GDP of USD 11,007.72 billion and GDP per capita of USD 8028 and is an upper-middle-income country. It recorded USD 3.45 per kilogram of oil equivalent in GDP per unit of energy use, USD 227.54 billion in R&D expenditure, next only to the United States in the 2nd place in the world, 2.06% in R&D intensity, 280,000 in SCI indexed papers, 25,600 in PCT applications, and 25.75% in high-tech exports as a percentage of manufactured exports.

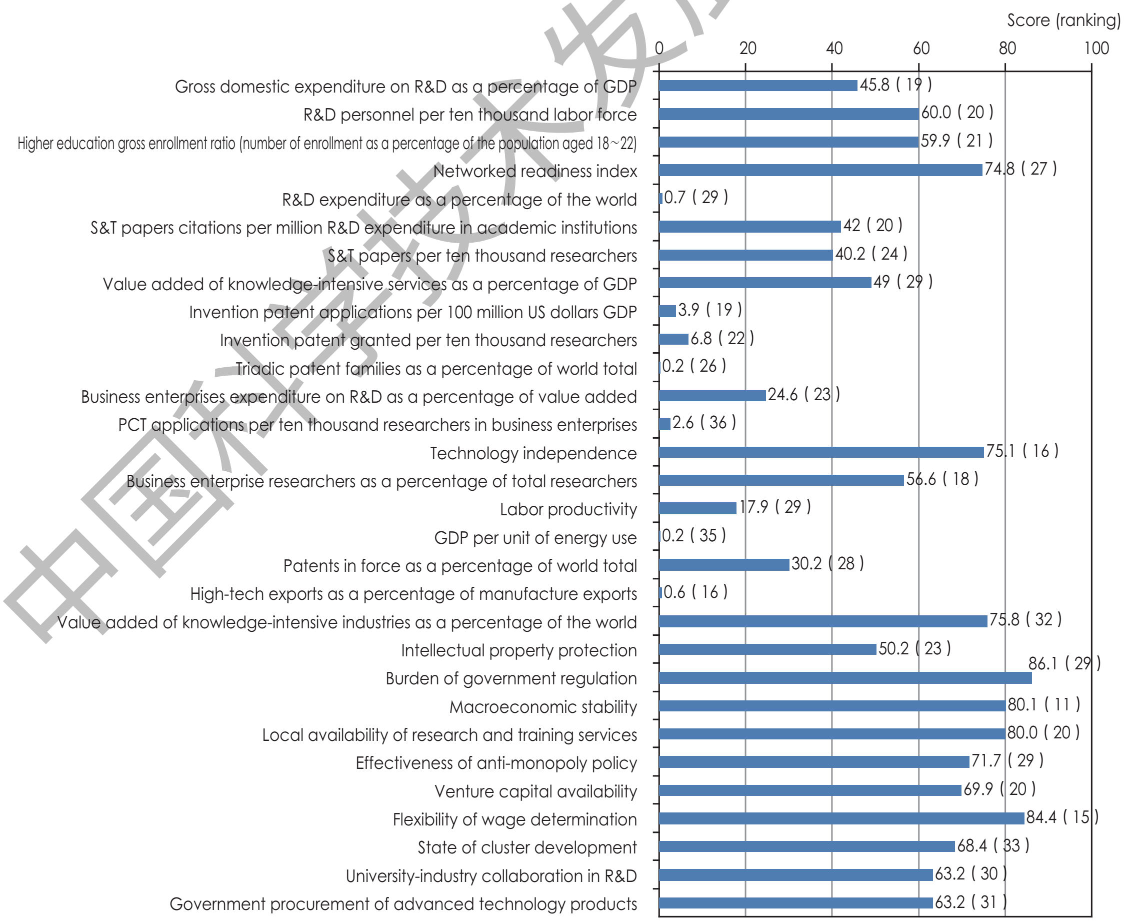
China improved by one place to the 17th in the national innovation index. It was the only developing country to make into the top 20, with a clear lead over other countries in a similar stage of economic development. Among the five first-level indicators, it moved down one place to the 28th in innovation resources, jumped four ranks to the 8th in knowledge creation and one place to the 11th in enterprise innovation, and dropped one place to the 12th in innovation performance and one place to the 20th in innovation environment.



Czech Republic

A European country, the Czech Republic has a population of 10.55 million and a territory of approximately 79,000 square kilometers with a GDP of USD 185.12 billion and GDP per capita of USD 17,548 and is a high-income country. It recorded USD 5.0 per kilogram of oil equivalent in GDP per unit of energy use, USD 3.6 billion in R&D expenditure, 1.95% in R&D intensity, 13,000 in SCI indexed papers, 191 in PCT applications, and 14.9% in high-tech exports as a percentage of manufactured exports.

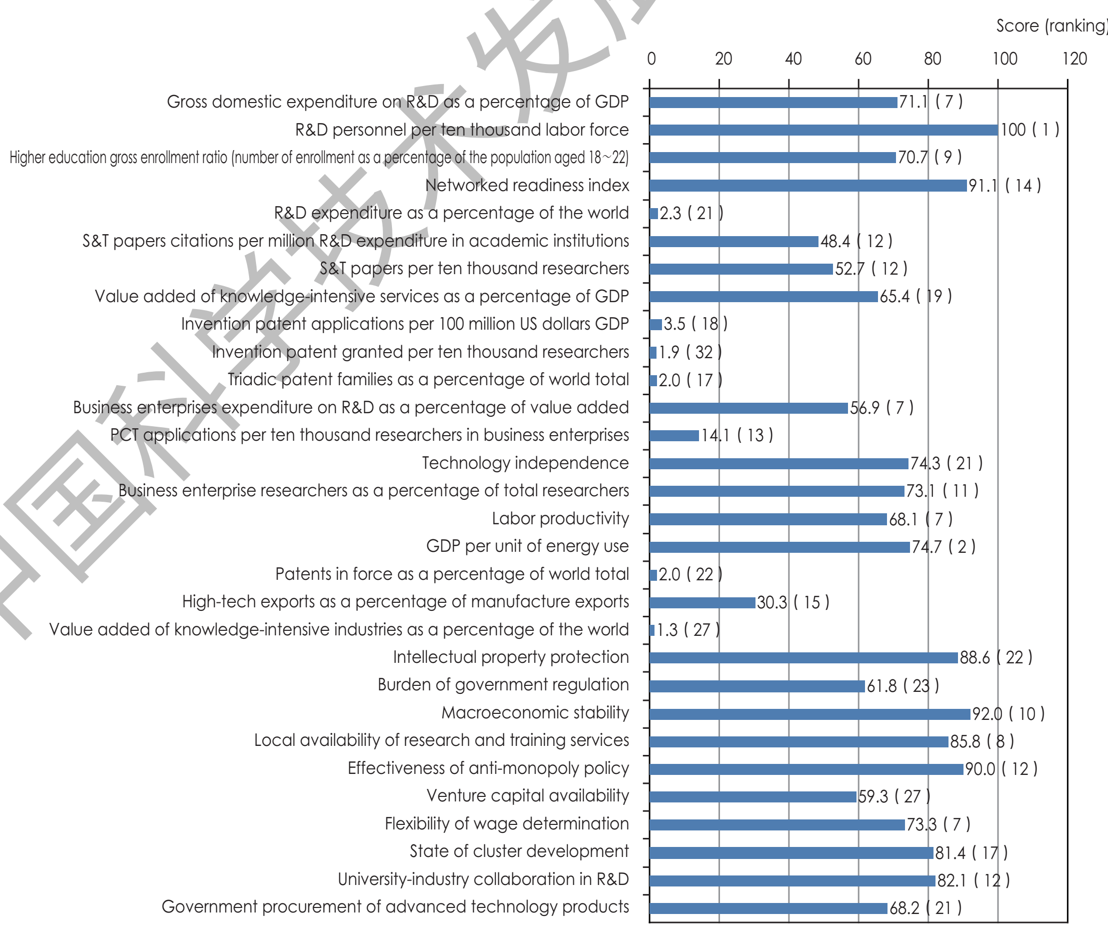
The Czech Republic kept its 27th place in the national innovation index. Among the five first-level indicators, it moved down two ranks to the 23rd in innovation resources, stayed at the 31st in knowledge creation, moved up three places to the 20th in enterprise innovation and one place to the 29th in innovation performance, and dropped two notches to the 26th in innovation environment.



Denmark

A European country, Denmark has a population of 5.68 million and a territory of approximately 43,000 square kilometers with a GDP of USD 295.09 billion and GDP per capita of USD 51,989 and is a high-income country. It recorded USD 21.12 per kilogram of oil equivalent in GDP per unit of energy use, USD 8.92 billion in R&D expenditure, 2.96% in R&D intensity, 19,000 in SCI indexed papers, 1327 in PCT applications, and 15.96% in high-tech exports as a percentage of manufactured exports.

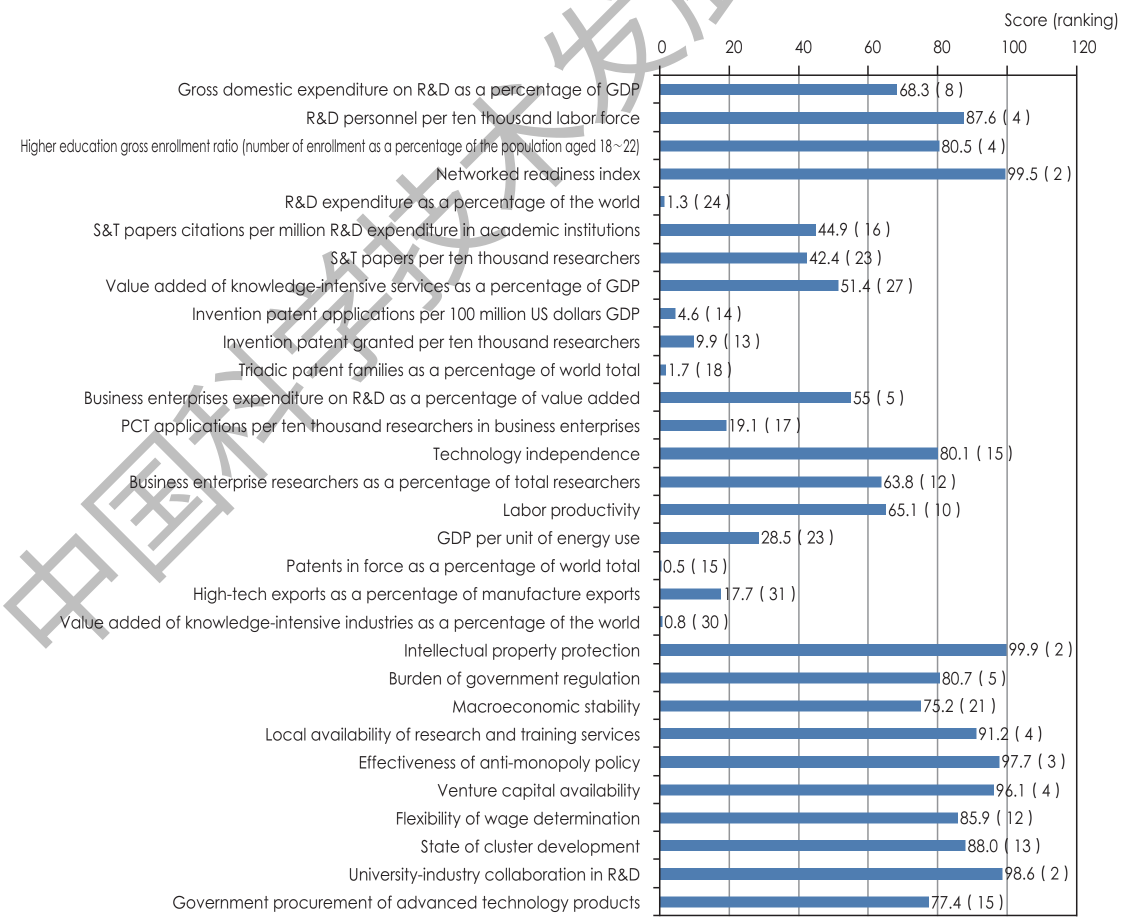
Denmark kept its 5th position in the national innovation index. Among the five first-level indicators, it stayed at the 5th place in innovation resources, improved by two places to the 19th in knowledge creation, dropped one place to the 12th in enterprise innovation, and moved up one place to the 8th in innovation performance and one place to the 16th in innovation environment.



Finland

A European country, Finland has a population of 5.482 million and a territory of approximately 338,000 square kilometers with a GDP of USD 231.95 billion and GDP per capita of USD 42,311 and is a high-income country. It recorded USD 7.96 per kilogram of oil equivalent in GDP per unit of energy use, USD 6.73 billion in R&D expenditure, 2.90% in R&D intensity, 14,000 in SCI indexed papers, 1584 in PCT applications, and 8.7% in high-tech exports as a percentage of manufactured exports.

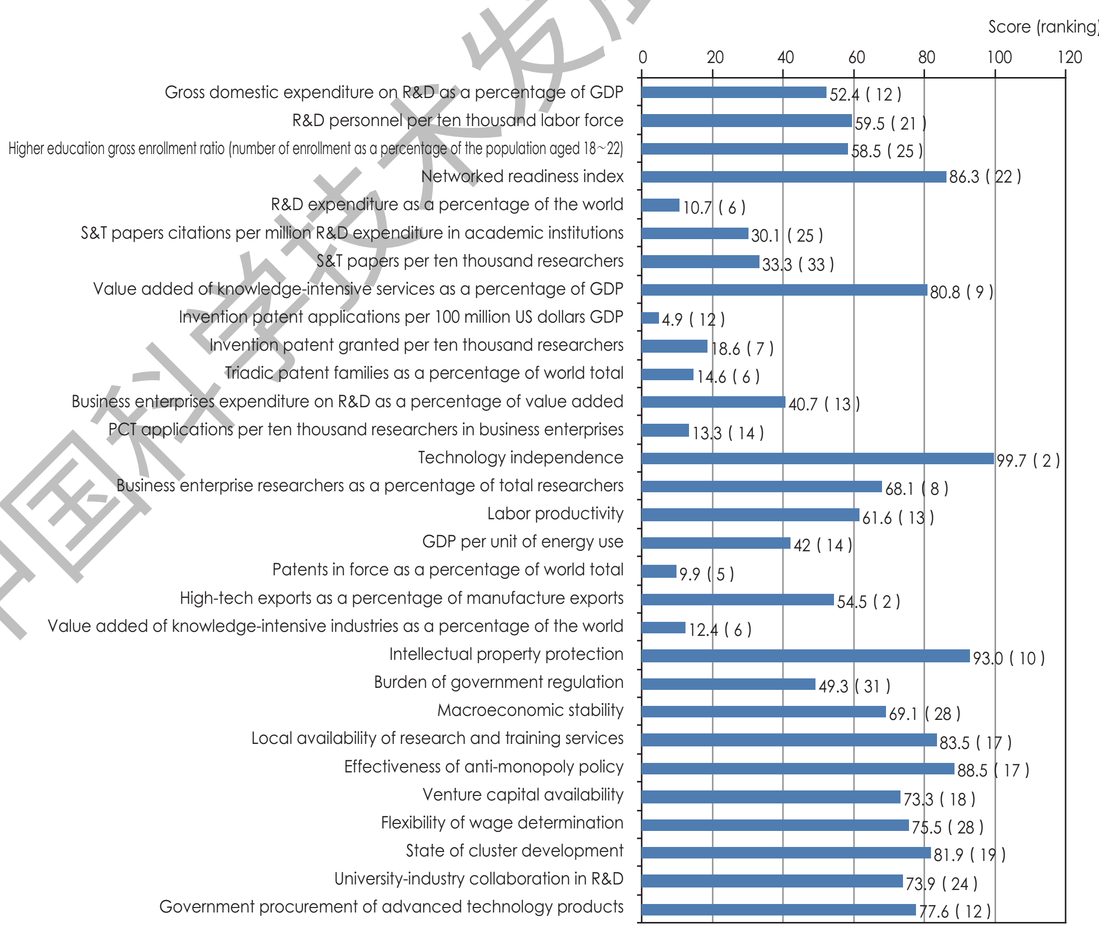
Finland improved by one place to the 11th in the national innovation index. Among the five first-level indicators, it moved down one place to the 4th place in innovation resources, improved by two places to the 28th in knowledge creation, dropped two places to the 10th in enterprise innovation, stayed at the 23rd in innovation performance, and jumped five ranks to the 3rd in innovation environment.



France

A European country, France has a population of 66.81 million and a territory of approximately 673,000 square kilometers with a GDP of USD 2418.84 billion and GDP per capita of USD 36,206 and is a high-income country. It recorded USD 11.73 per kilogram of oil equivalent in GDP per unit of energy use, USD 53.95 billion in R&D expenditure, 2.23% in R&D intensity, 76,000 in SCI indexed papers, 8421 in PCT applications, and 26.85% in high-tech exports as a percentage of manufactured exports.

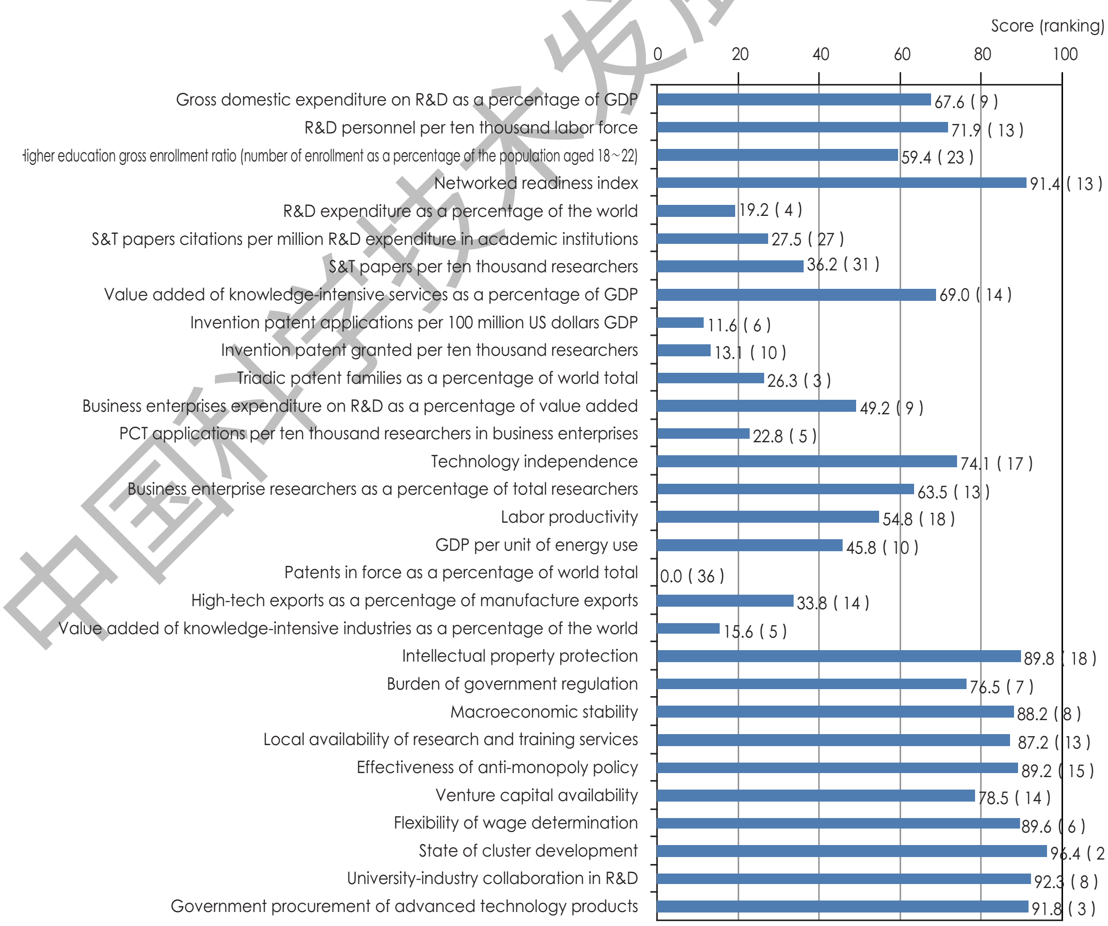
France dropped one rank to the 12th in the national innovation index. Among the five first-level indicators, it moved down one place to the 18th in innovation resources, moved up three places to the 21st in knowledge creation and one place to the 5th in enterprise innovation, and dropped one place to the 9th in innovation performance and four places to the 22nd in innovation environment.



Germany

A European country, Germany has a population of 81.41 million and a territory of approximately 357,000 square kilometers with a GDP of USD 3363.48 billion and GDP per capita of USD 41,313 and is a high-income country. It recorded USD 12.78 per kilogram of oil equivalent in GDP per unit of energy use, USD 96.7 billion in R&D expenditure, 2.87% in R&D intensity, 110,000 in SCI indexed papers, 18,000 in PCT applications, and 16.7% in high-tech exports as a percentage of manufactured exports.

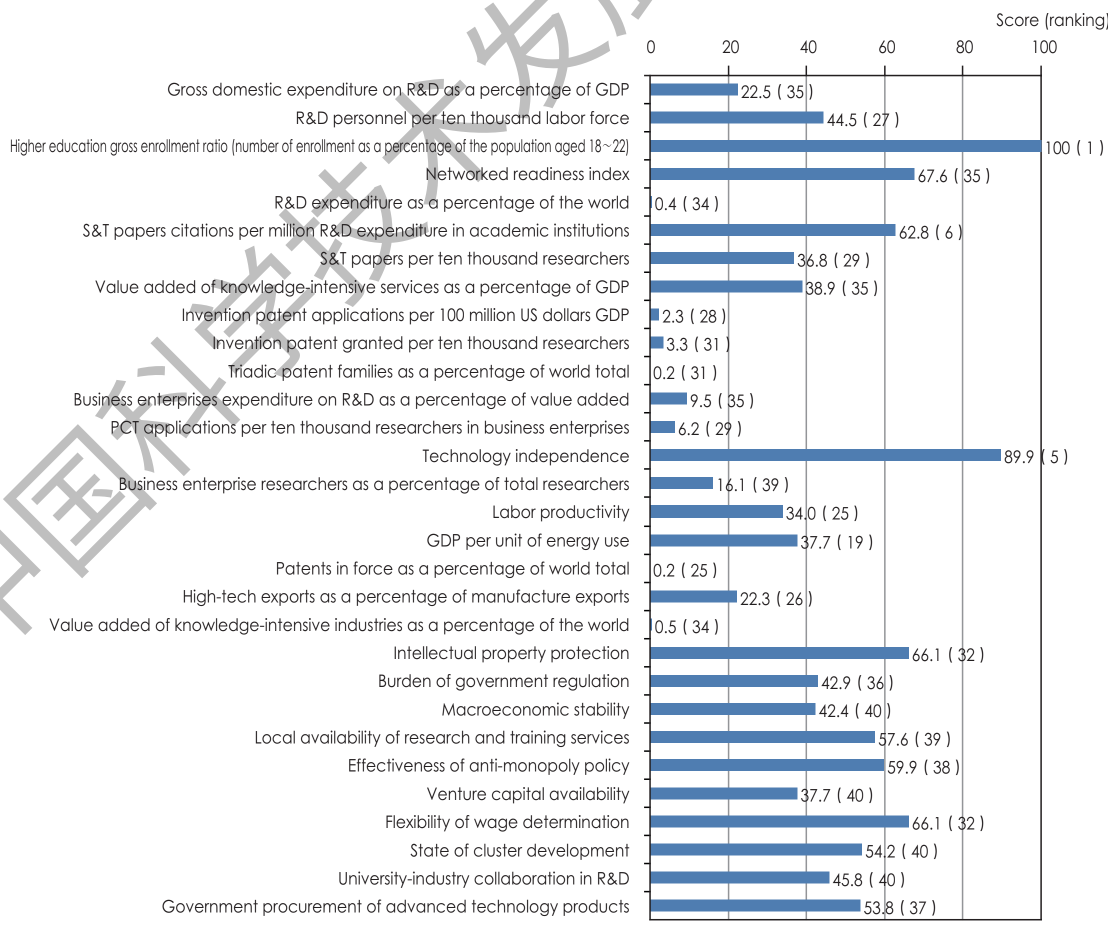
Germany dropped one notch to the 7th in the national innovation index. Among the five first-level indicators, it stayed at the 9th in innovation resources, improved by one place to the 25th in knowledge creation, and dropped one place to the 6th in enterprise innovation, four places to the 14th in innovation performance and two places to the 7th in innovation environment.



Greece

A European country, Greece has a population of 10.82 million and a territory of approximately 132,000 square kilometers with a GDP of USD 194.85 billion and GDP per capita of USD 18,002 and is a high-income country. It recorded USD 10.51 per kilogram of oil equivalent in GDP per unit of energy use, USD 1.87 billion in R&D expenditure, 0.96% in R&D intensity, 11,000 in SCI indexed papers, 121 in PCT applications, and 10.99% in high-tech exports as a percentage of manufactured exports.

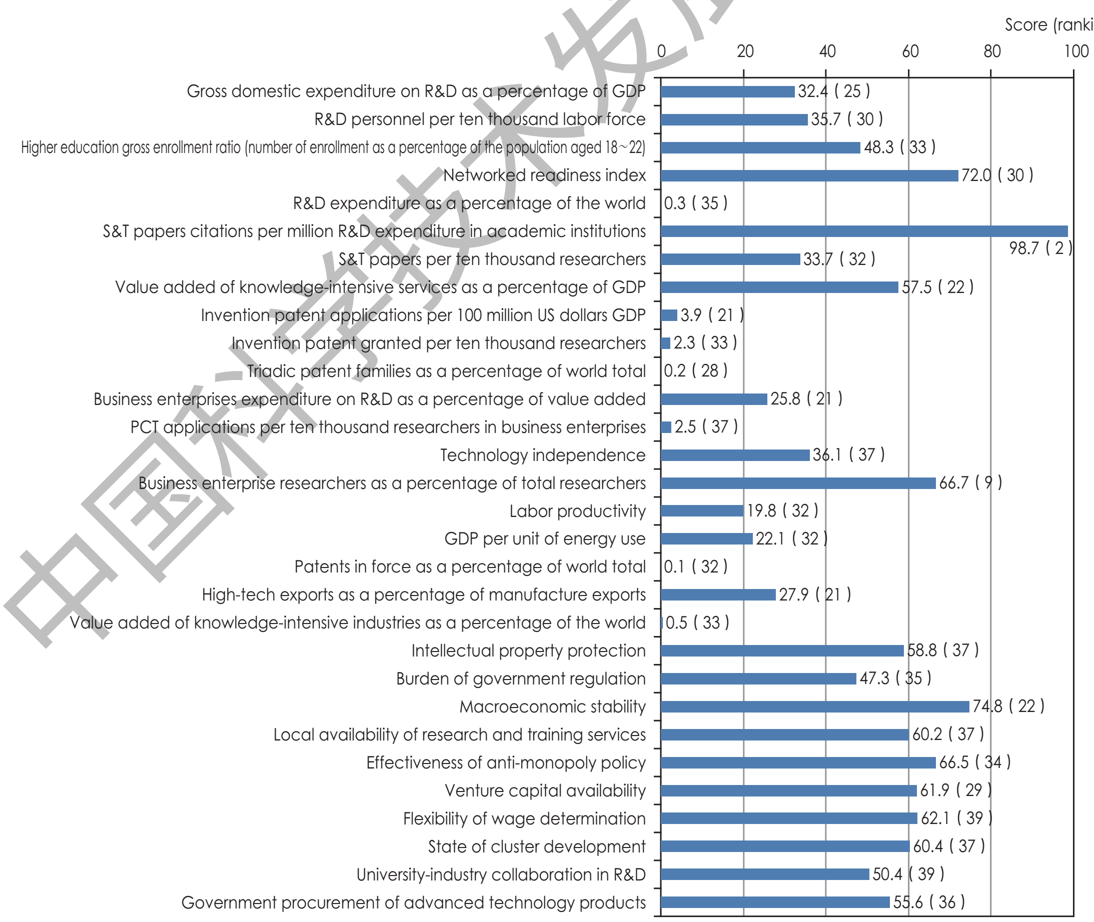
Greece kept its 31st position in the national innovation index. Among the five first-level indicators, it was down one place to the 25th in innovation resources, five places to the 30th in knowledge creation and one place to the 32nd in enterprise innovation, unchanged at the 26th in innovation performance, and down one place to the 40th in innovation environment.



Hungary

A European country, Hungary has a population of 9.85 million and a territory of approximately 93,000 square kilometers with a GDP of USD 121.72 billion and GDP per capita of USD 12,364 and is an upper-middle-income country. It recorded USD 6.16 per kilogram of oil equivalent in GDP per unit of energy use, USD 1.68 billion in R&D expenditure, 1.38% in R&D intensity, 7334 in SCI indexed papers, 148 in PCT applications, and 13.74% in high-tech exports as a percentage of manufactured exports.

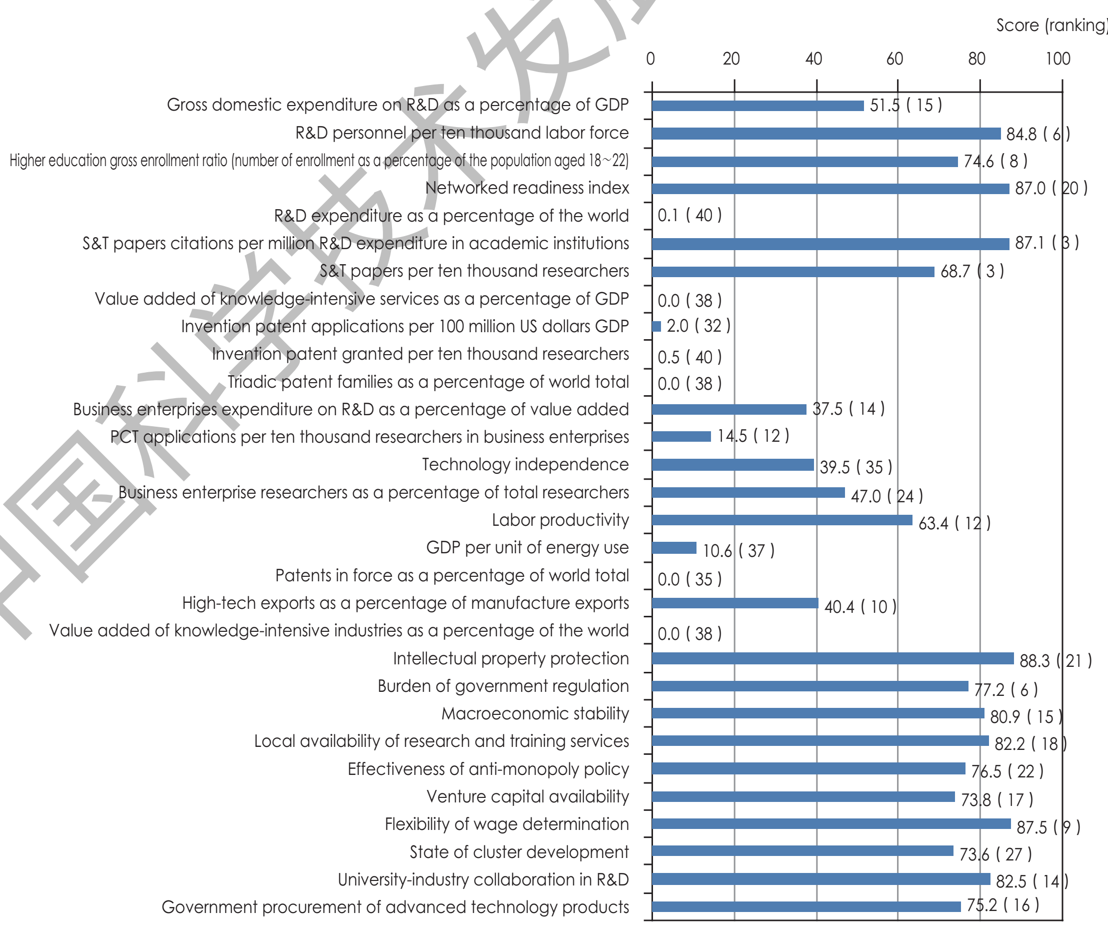
Hungary kept its 29th position in the national innovation index. Among the five first-level indicators, it moved down two places to the 32nd in innovation resources, moved up two places to the 12th in knowledge creation, dropped one place to the 30th in enterprise innovation, jumped six ranks to the 23rd in innovation performance and fell one place to the 36th in innovation environment.



Iceland

A European country, Iceland has a population of 330,000 and a territory of approximately 103,000 square kilometers with a GDP of USD 16.6 billion and GDP per capita of USD 50,173 and is a high-income country. It recorded USD 2.96 per kilogram of oil equivalent in GDP per unit of energy use, USD 370 million in R&D expenditure, 2.19% in R&D intensity, 1148 in SCI indexed papers, 46 in PCT applications, and 19.90% in high-tech exports as a percentage of manufactured exports.

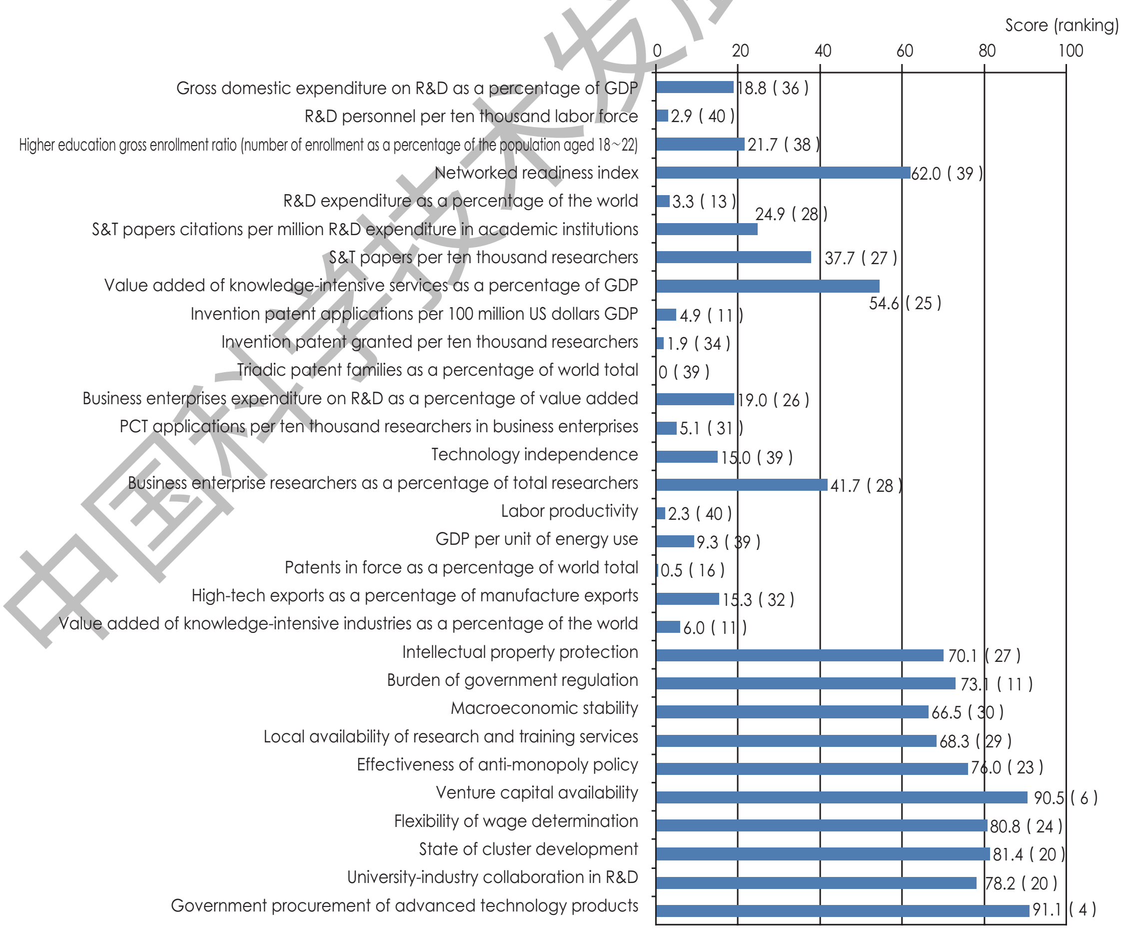
Iceland jumped five notches to the 21st in the national innovation index. Among the five first-level indicators, it jumped 15 places to the 11th in innovation resources, moved down two places to the 24th in knowledge creation, and moved up six places to the 26th in enterprise innovation, three places to the 22nd in innovation performance and four places to the 17th in innovation environment.



India

An Asian country, India has a population of approximately 1.31 billion and a territory of approximately 2.98 million square kilometers with a GDP of USD 2095.4 billion and GDP per capita of USD 1598 and is a lower-middle-income country. It recorded USD 2.60 per kilogram of oil equivalent in GDP per unit of energy use, USD 16.73 billion in R&D expenditure, 0.80% in R&D intensity, 62,326 in SCI indexed papers, 1412 in PCT applications, and 7.52% in high-tech exports as a percentage of manufactured exports.

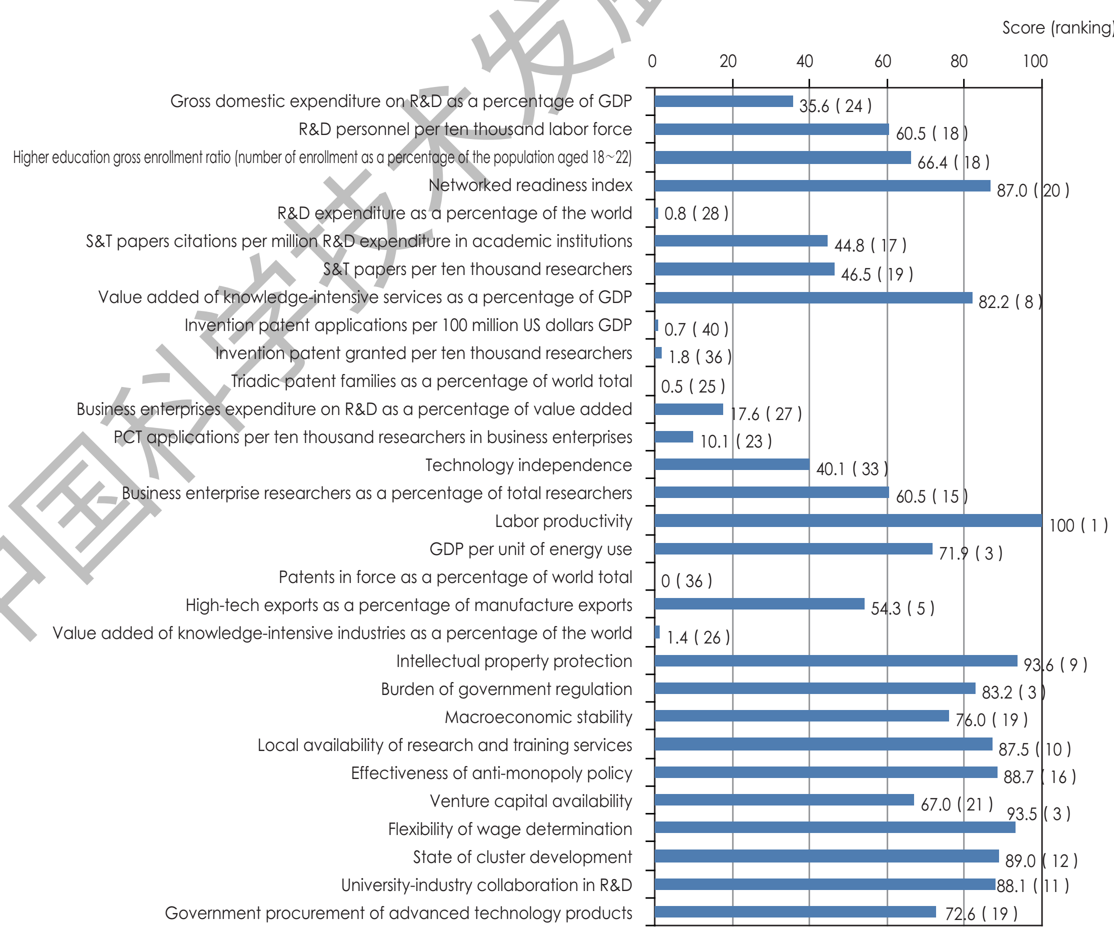
India remained in the 38th in the national innovation index. Among the five first-level indicators, it moved down one place to the 39th in innovation resources, stayed at the 33rd in knowledge creation, the 39th in enterprise innovation and the 40th in innovation performance, and moved up four places to the 21st in innovation environment.



Ireland

A European country, Ireland has a population of 4.64 million and a territory of approximately 70,000 square kilometers with a GDP of USD 283.7 billion and GDP per capita of USD 61,134 and is a high-income country. It recorded USD 20.06 per kilogram of oil equivalent in GDP per unit of energy use, USD 3.88 billion in R&D expenditure, 1.51% in R&D intensity, 8574 in SCI indexed papers, 453 in PCT applications, and 26.76% in high-tech exports as a percentage of manufactured exports.

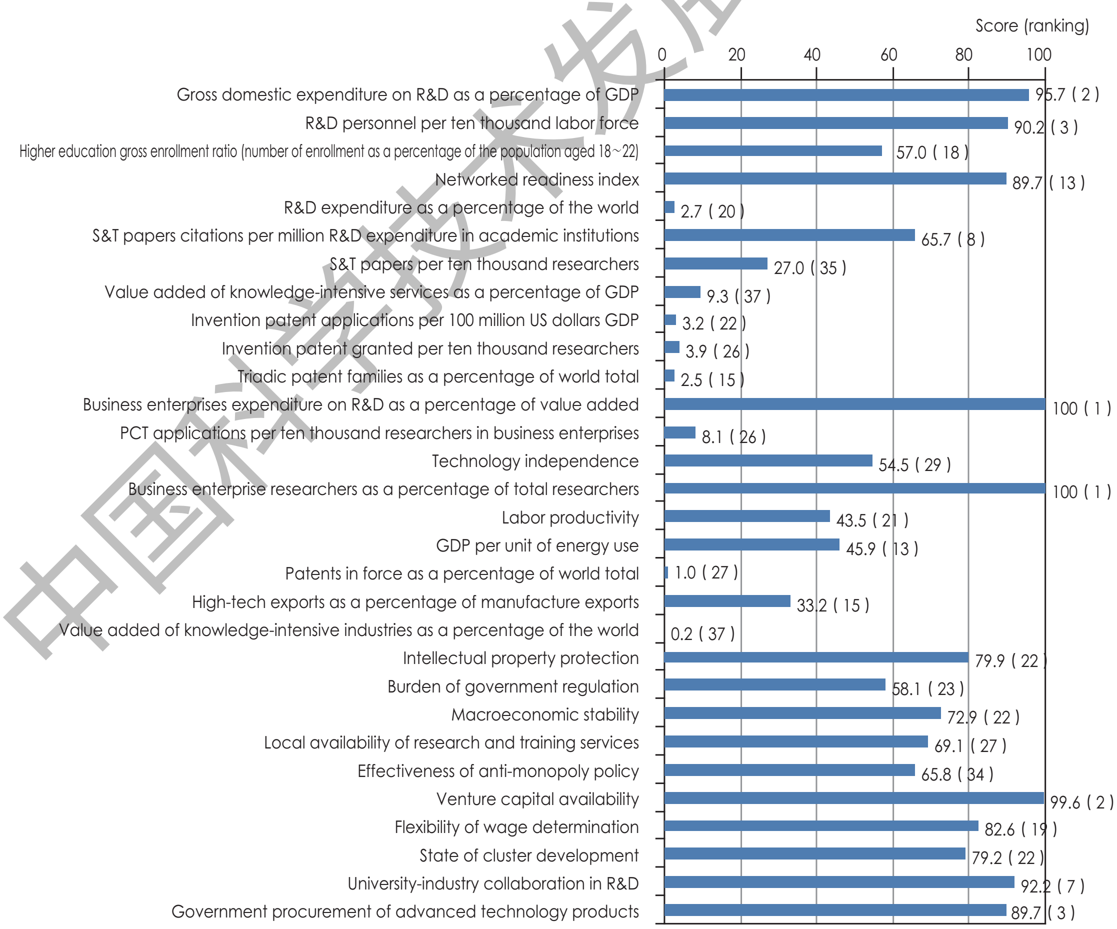
Ireland moved up one place to the 16th in the national innovation index. Among the five first-level indicators, it improved by 13 places to the 20th in innovation resources, dropped 13 places to the 18th in knowledge creation and ten places to the 31st in enterprise innovation, and moved up two places to the 4th in innovation performance and two places to the 12th in innovation environment.



Israel

An Asian country, Israel has a population of 8.38 million and a territory of approximately 26,000 square kilometers with a GDP of USD 299.42 billion and GDP per capita of USD 35,728 and is a high-income country. It recorded USD 13.19 per kilogram of oil equivalent in GDP per unit of energy use, USD 12.73 billion in R&D expenditure, 4.25% in R&D intensity, 14,898 in SCI indexed papers, 1685 in PCT applications, and 19.66% in high-tech exports as a percentage of manufactured exports.

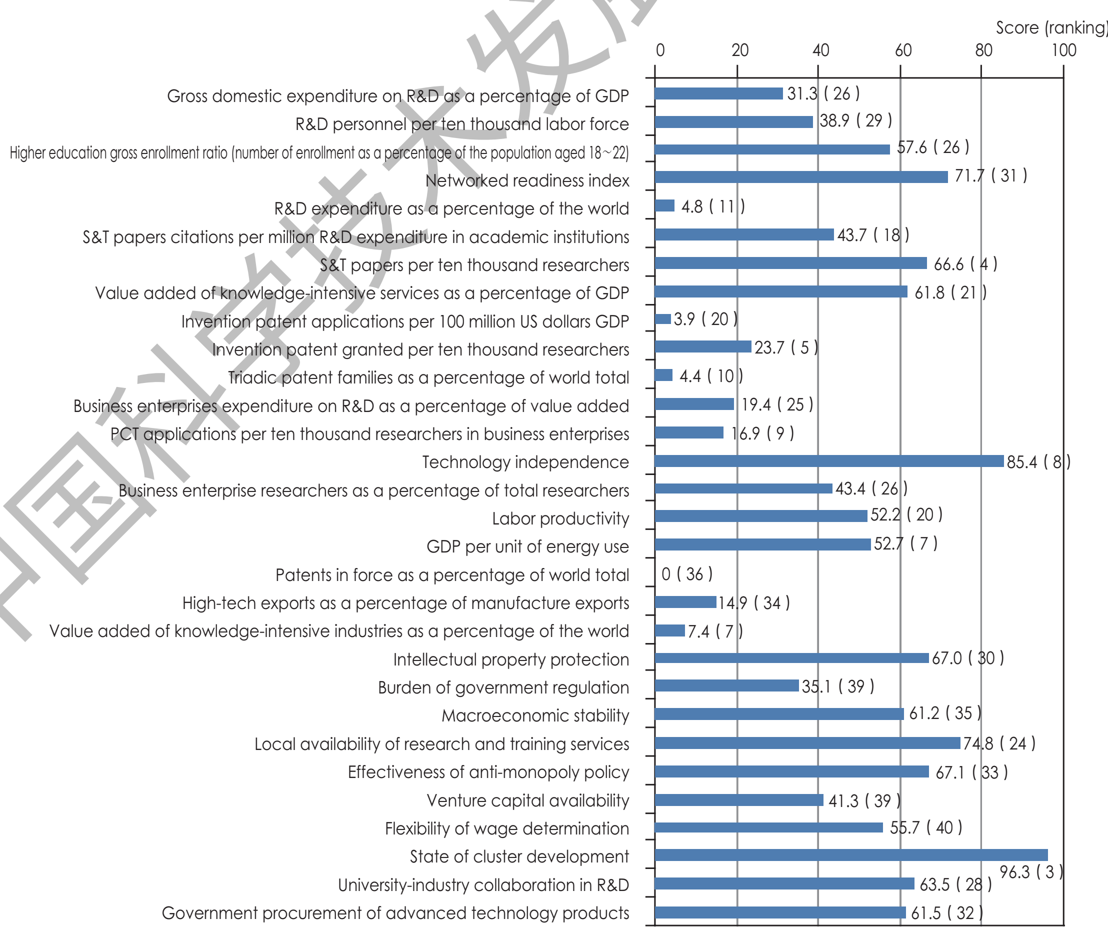
Israel improved by one place to the 13th in the national innovation index. Among the five first-level indicators, it improved by one spot to the 3rd in innovation resources, dropped three places to the 38th in knowledge creation, stayed at the 4th in enterprise innovation, and moved up four places to the 17th in innovation performance and two places to the 13th in innovation environment.



Italy

A European country, Italy has a population of 60.80 million and a territory of approximately 301,000 square kilometers with a GDP of USD 1821.5 billion and GDP per capita of USD 29,958 and is a high-income country. It recorded USD 14.70 per kilogram of oil equivalent in GDP per unit of energy use, USD 24.28 billion in R&D expenditure, 1.33% in R&D intensity, 69,063 in SCI indexed papers, 3072 in PCT applications, and 7.34% in high-tech exports as a percentage of manufactured exports.

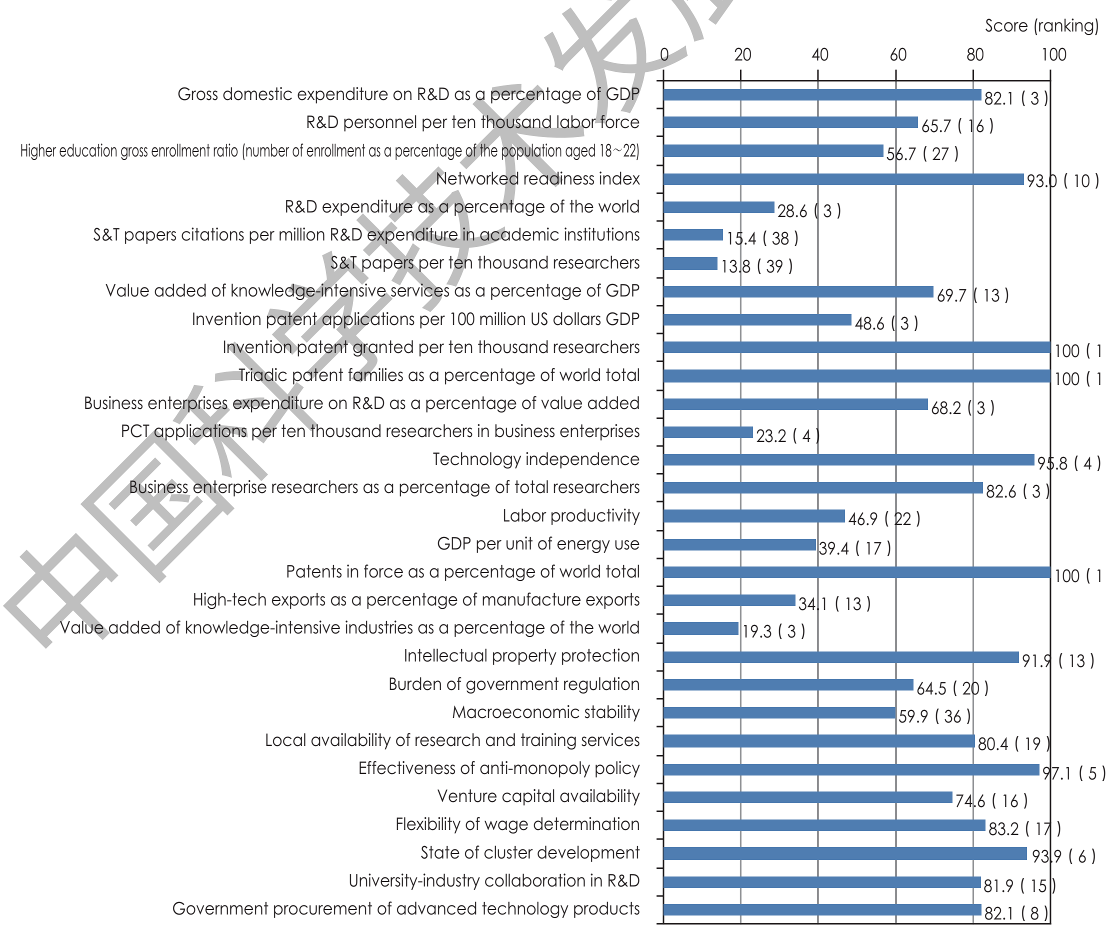
Italy dropped one notch to the 25th in the national innovation index. Among the five first-level indicators, it moved down one place to the 30th in innovation resources, jumped 25 places to the 10th in knowledge creation, stayed at the 18th in enterprise innovation, dropped two places to the 20th in innovation performance, and improved by three notches to the 34th in innovation environment.



Japan

An Asian country, Japan has a population of approximately 127 million and a territory of approximately 378,000 square kilometers with a GDP of USD 4383.08 billion and GDP per capita of USD 34,524 and is a high-income country. It recorded USD 10.99 per kilogram of oil equivalent in GDP per unit of energy use, USD 144.05 billion in R&D expenditure in the third place in the world, 3.49% in R&D intensity, 78,669 in SCI indexed papers, 44,053 in PCT applications, and 16.78% in high-tech exports as a percentage of manufactured exports.

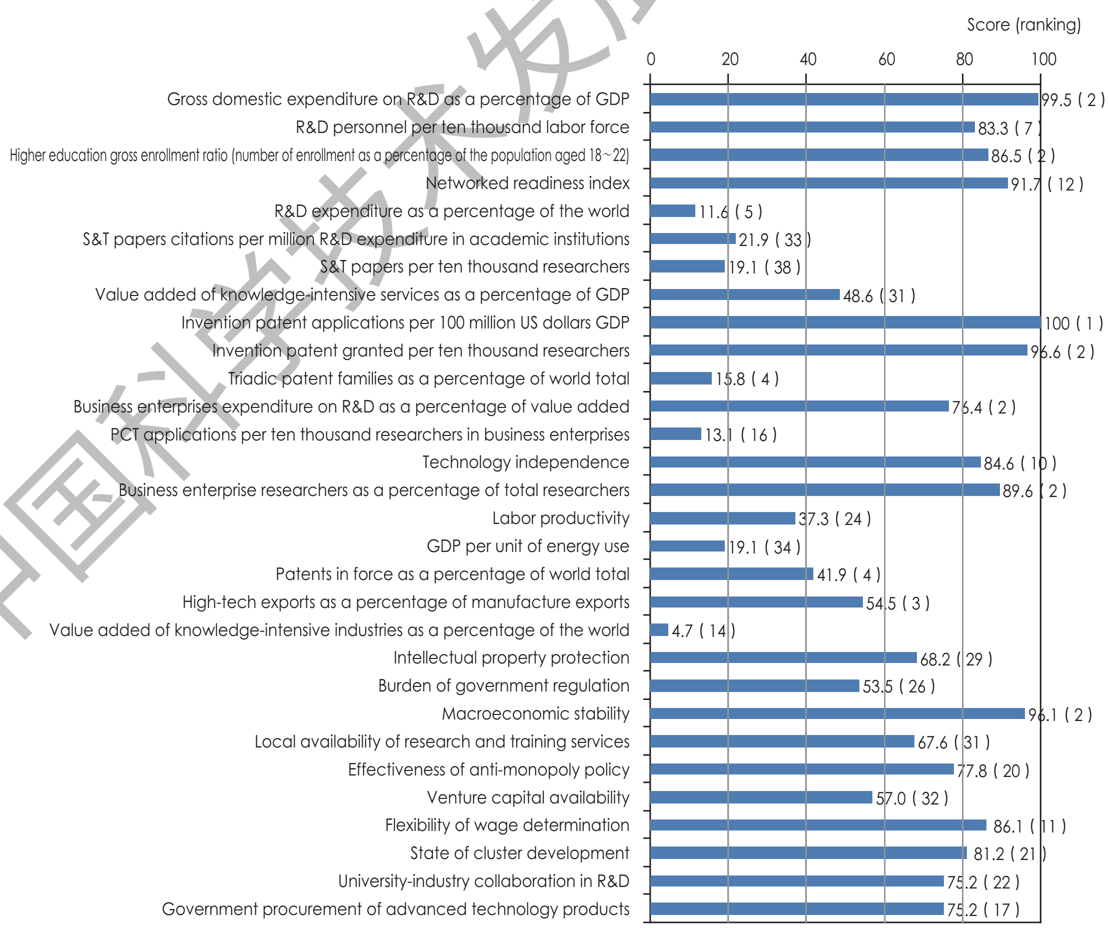
Japan kept its No. 2 position in the national innovation index. Among the five first-level indicators, it stayed at the 6th in innovation resources, the 3rd in knowledge creation, the 1st in enterprise innovation and the 3rd in innovation performance, and dropped four places to the 15th in innovation environment.



Korea

An Asian country, Korea has a population of 50.62 million and a territory of approximately 100,000 square kilometers with a GDP of USD 1377.87 billion and GDP per capita of USD 27,222 and is a high-income country. It recorded USD 5.32 per kilogram of oil equivalent in GDP per unit of energy use, USD 58.31 billion in R&D expenditure, 4.23% in R&D intensity, 58,473 in SCI indexed papers, 14,564 in PCT applications, and 26.84% in high-tech exports as a percentage of manufactured exports.

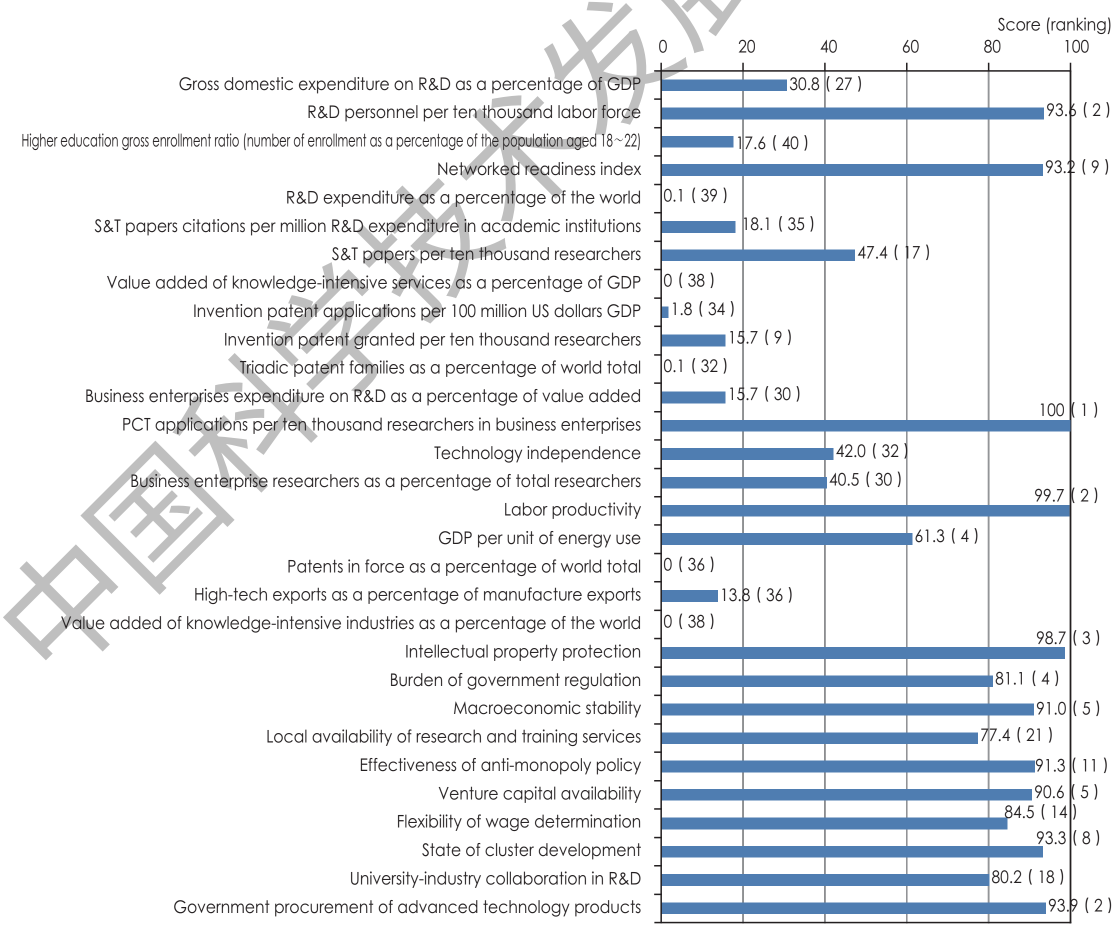
Korea remained in the 4th place in the national innovation index. Among the five first-level indicators, it stayed at the 2nd in innovation resources, the 1st in knowledge creation, and the 3rd in enterprise innovation, moved up four places to the 11th in innovation performance, and dropped two places to the 24th in innovation environment.



Luxembourg

A European country, Luxembourg has a population of 570,000 and a territory of approximately 2586.4 square kilometers with a GDP of USD 57.79 billion and GDP per capita of USD 101,450 and is a high-income country. It recorded USD 17.12 per kilogram of oil equivalent in GDP per unit of energy use, USD 744 million in R&D expenditure, 1.31% in R&D intensity, 1168 in SCI indexed papers, 403 in PCT applications, and 6.82% in high-tech exports as a percentage of manufactured exports.

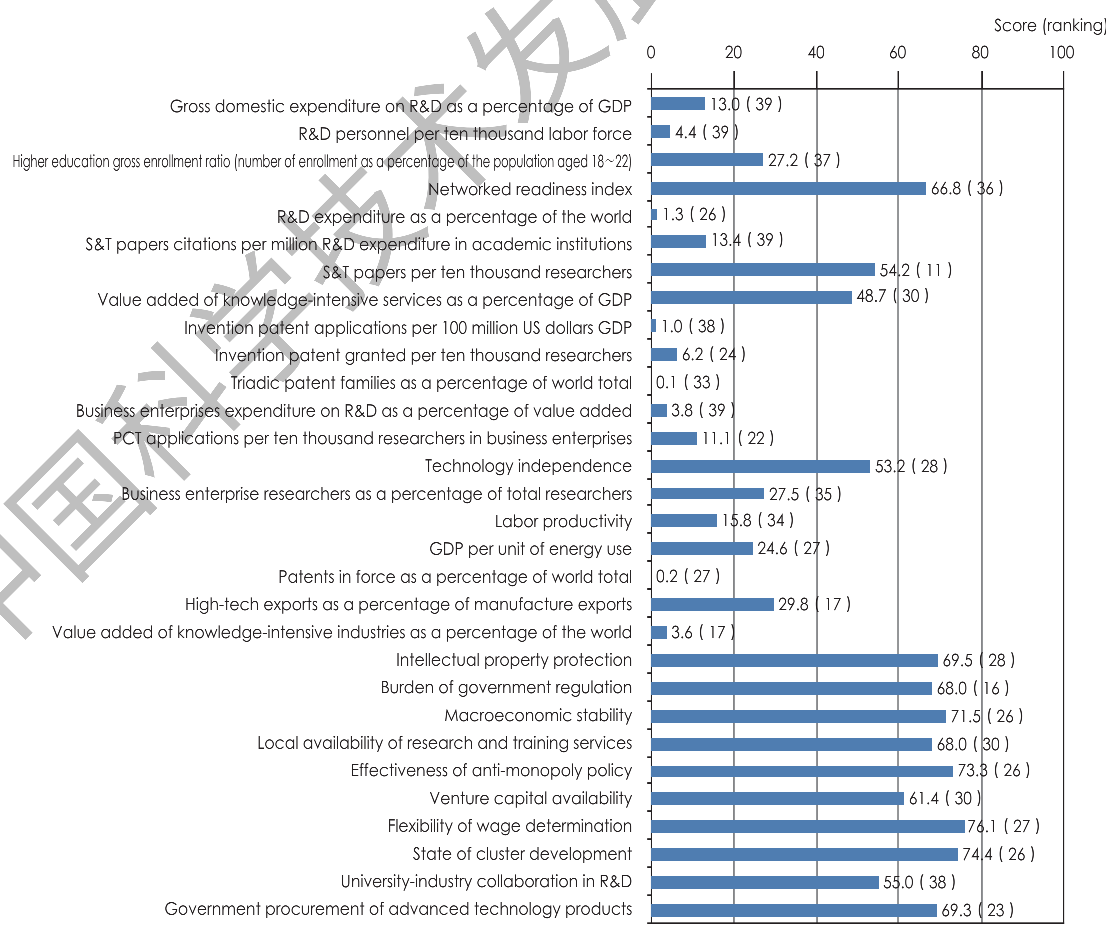
Luxembourg improved by two spots to the 20th in the national innovation index. Among the five first-level indicators, it moved down two places to the 24th in innovation resources, stayed at the 40th in knowledge creation, moved up one place to the 13th in enterprise innovation and three places to the 10th in innovation performance, and dropped two places to the 5th in innovation environment.



Mexico

A North American country, Mexico has a population of approximately 130 million and a territory of approximately 1.97 million square kilometers with a GDP of USD 1143.79 billion and GDP per capita of USD 9005 and is an upper-middle-income country. It recorded USD 6.86 per kilogram of oil equivalent in GDP per unit of energy use, USD 6.31 billion in R&D expenditure, 0.55% in R&D intensity, 13,922 in SCI indexed papers, 317 in PCT applications, and 14.69% in high-tech exports as a percentage of manufactured exports.

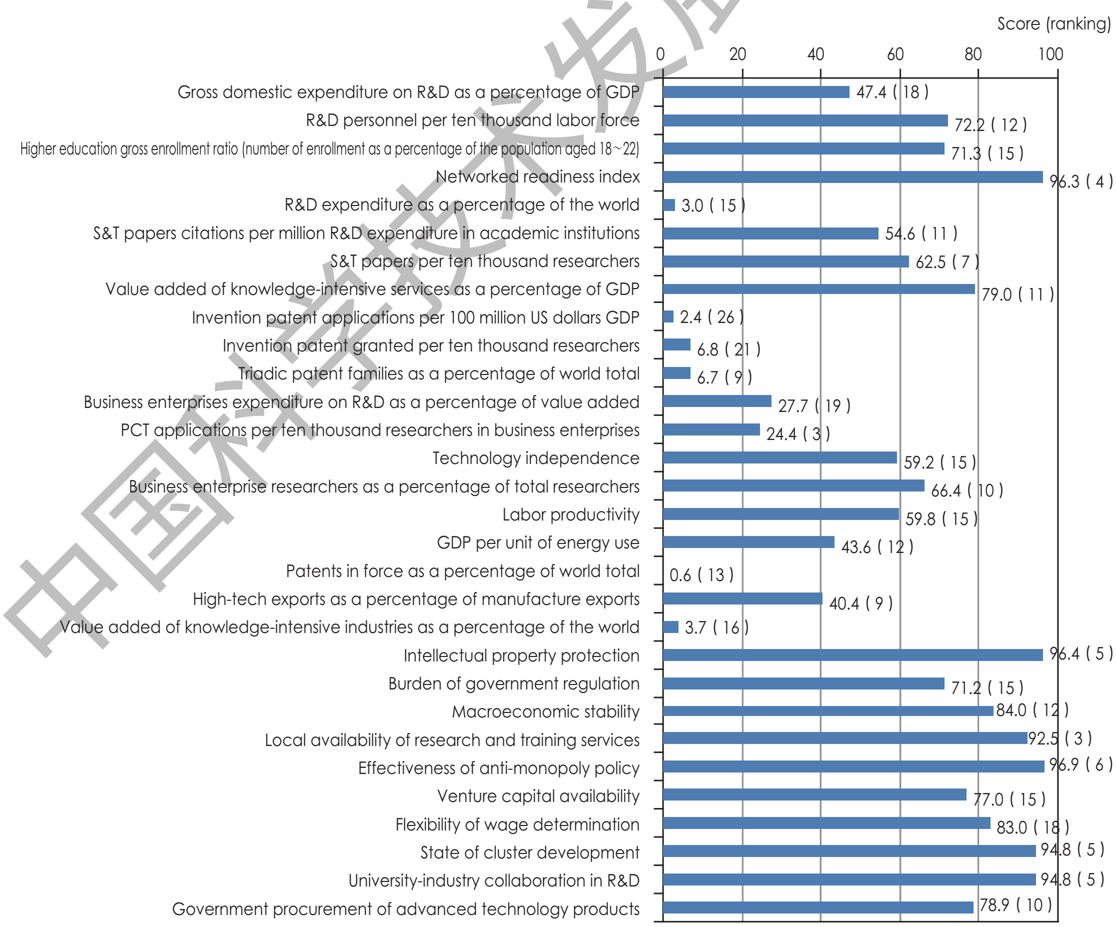
Mexico retained its 37th position in the national innovation index. It improved across all the five first-level indicators, reaching the 38th in innovation resources (up one place), the 34th in knowledge creation (up three), the 36th in enterprise innovation (up one), the 28th in innovation performance (up one), and the 27th in innovation environment (up three).



Netherlands

A European country, the Netherlands has a population of 16.94 million and a territory of approximately 42,000 square kilometers with a GDP of USD 750.28 billion and GDP per capita of USD 44,300 and is a high-income country. It recorded USD 12.16 per kilogram of oil equivalent in GDP per unit of energy use, USD 15.12 billion in R&D expenditure, 2.01% in R&D intensity, 41,321 in SCI indexed papers, 4334 in PCT applications, and 19.90% in high-tech exports as a percentage of manufactured exports.

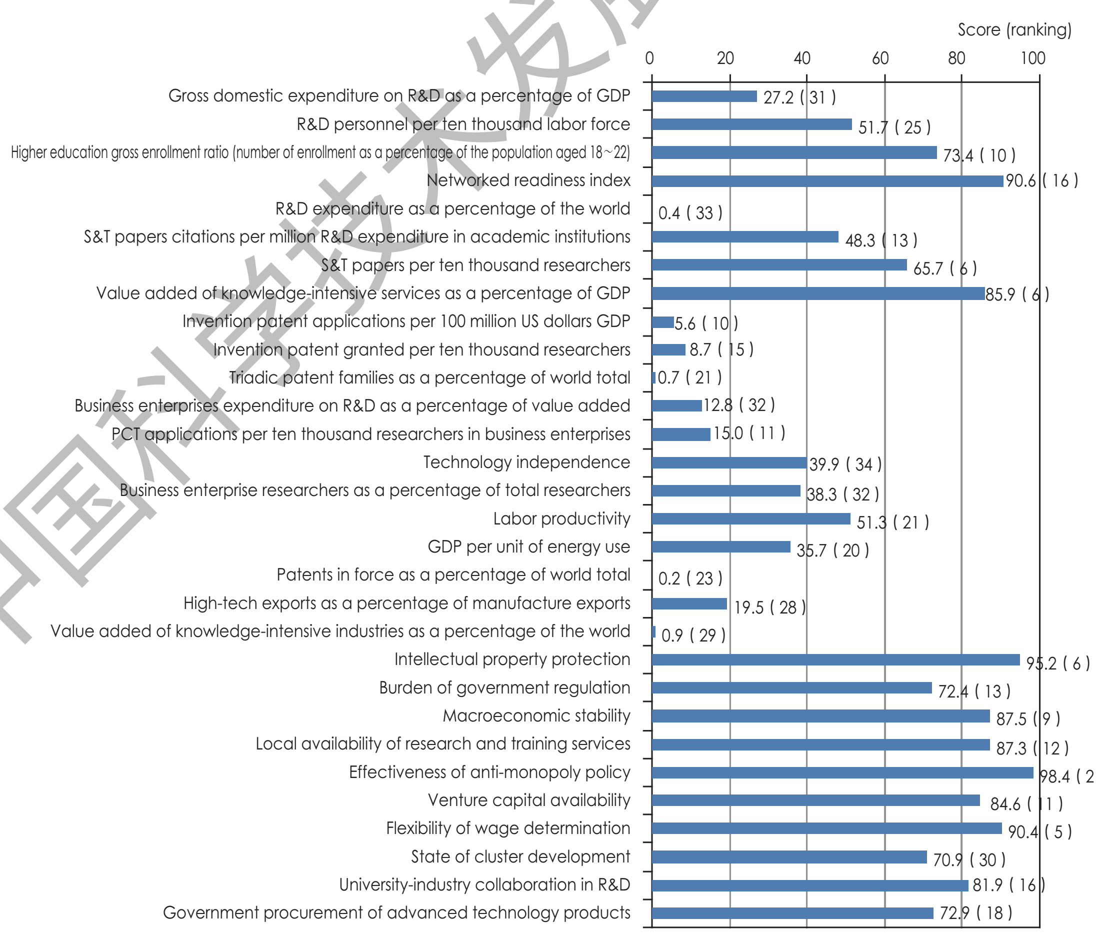
The Netherlands improved by one place to the 8th in national innovation index. Among the five first-level indicators, it dropped two places to the 13th place in innovation resources, moved up one place to the 7th in knowledge creation, stayed at the 15th in enterprise innovation and the 16th in innovation performance, and moved down two places to the 9th in innovation environment.



New Zealand

An Oceanian country, New Zealand has a population of 4.60 million and a territory of approximately 268,000 square kilometers with a GDP of USD 173.75 billion and GDP per capita of USD 37,808 and is a high-income country. It recorded USD 9.96 per kilogram of oil equivalent in GDP per unit of energy use, USD 2.20 billion in R&D expenditure, 1.15% in R&D intensity, 10,104 in SCI indexed papers, 358 in PCT applications, and 9.96% in high-tech exports as a percentage of manufactured exports.

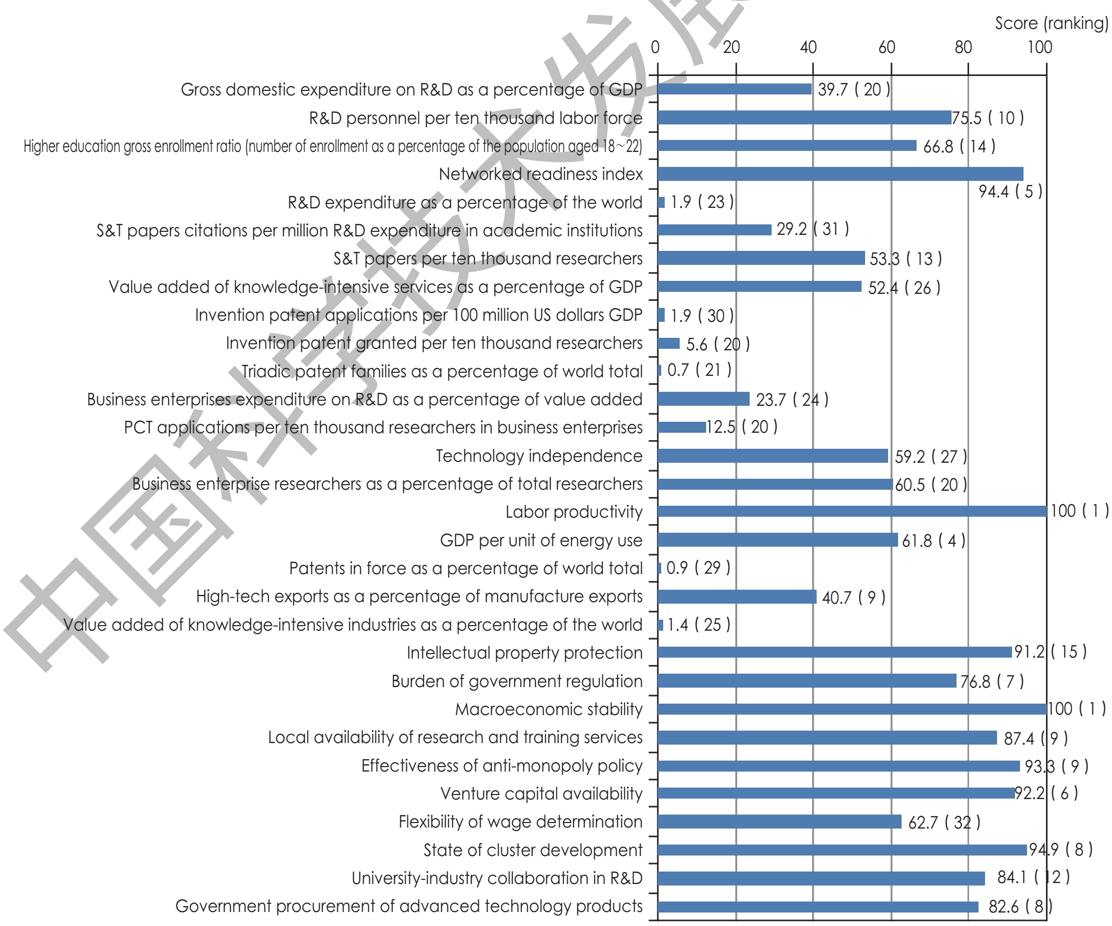
New Zealand dropped one rank to the 22nd in the national innovation index. Among the five first-level indicators, it moved down two places to the 22nd in innovation resources and one place to the 5th in knowledge creation, stayed at the 34th in enterprise innovation, and dropped one place to the 25th in innovation performance and one place to the 11th in innovation environment.



Norway

A European country, Norway has a population of 5.20 million and a territory of approximately 385,000 square kilometers with a GDP of USD 386.58 billion and GDP per capita of USD 74,400 and is a high-income country. It recorded USD 16.57 per kilogram of oil equivalent in GDP per unit of energy use, USD 7.48 billion in R&D expenditure, 1.93% in R&D intensity, 13,348 in SCI indexed papers, 679 in PCT applications, and 20.52% in high-tech exports as a percentage of manufactured exports.

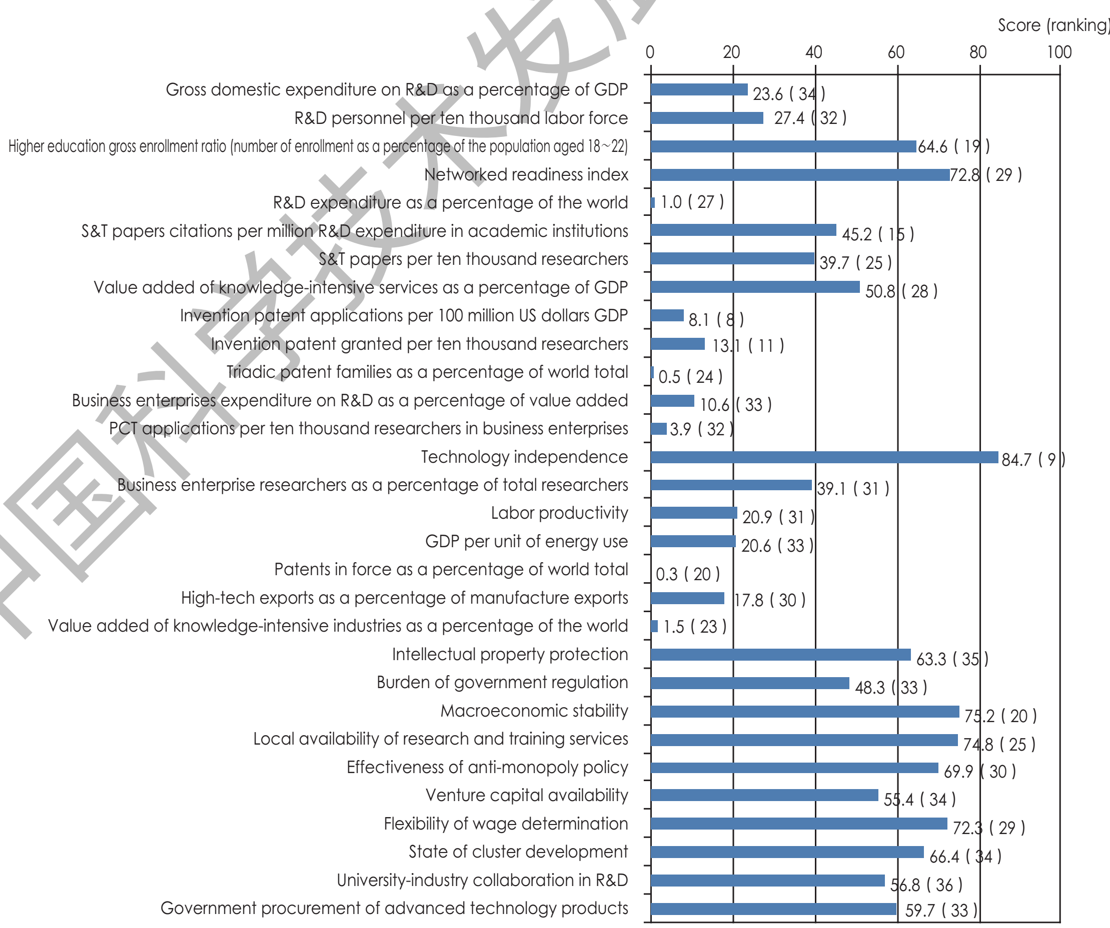
Norway dropped two notches to the 15th in the national innovation index. Among the five first-level indicators, it moved up one place to the 12th in innovation resources, one place to the 32nd in knowledge creation, and two places to the 23rd in enterprise innovation, and dropped one place to the 5th in innovation performance and one place to the 6th in innovation environment.



Poland

A European country, Poland has a population of 37.8 million and a territory of approximately 313,000 square kilometers with a GDP of USD 477.07 billion and GDP per capita of USD 12,555 and is an upper-middle income country. It recorded USD 5.75 per kilogram of oil equivalent in GDP per unit of energy use, USD 4.79 billion in R&D expenditure, 1.0% in R&D intensity, 28,203 in SCI indexed papers, 439 in PCT applications, and 8.78% in high-tech exports as a percentage of manufactured exports.

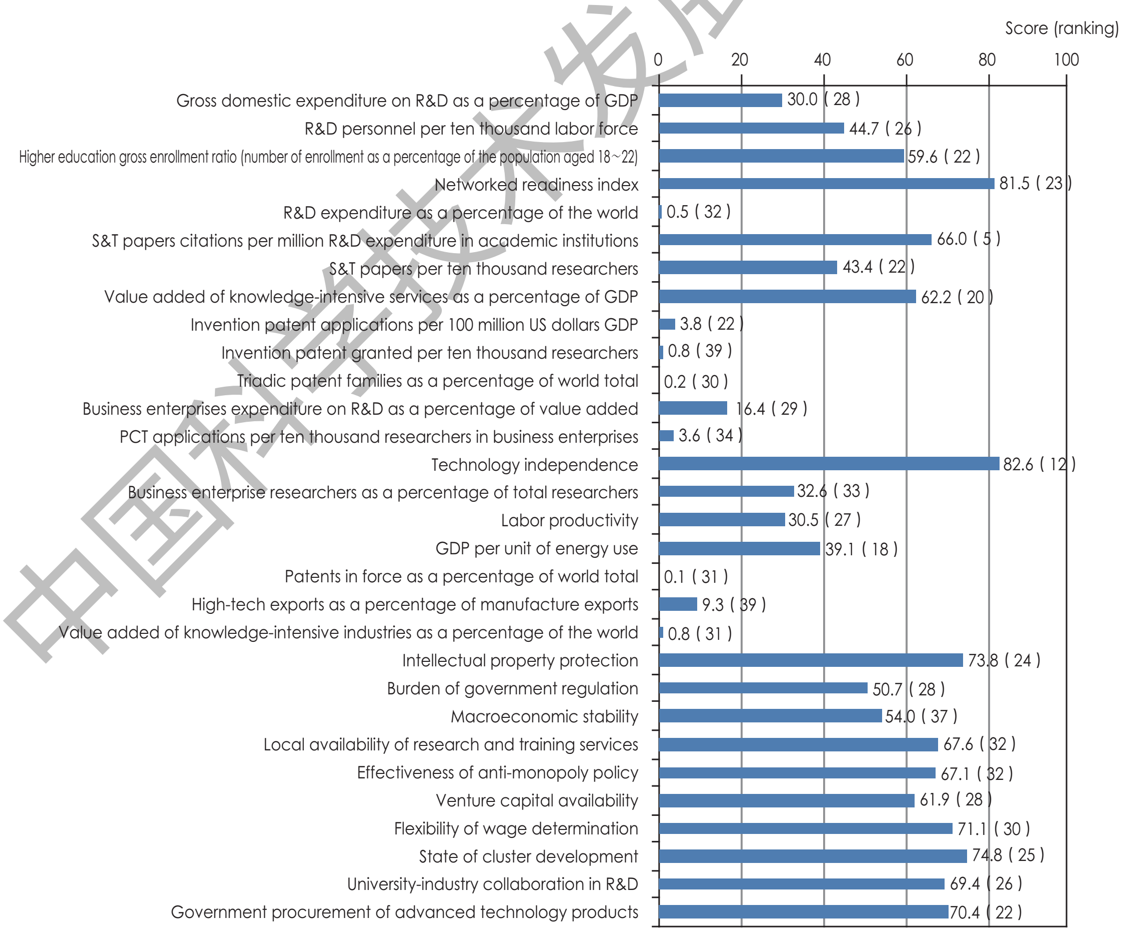
Poland improved by one place to the 32nd in the national innovation index. Among the five first-level indicators, it stayed at the 31st in innovation resources, moved up one place to the 26th in knowledge creation and five places to the 25th in enterprise innovation, and dropped one place to the 36th in innovation performance and three places to the 32nd in innovation environment.



Portugal

A European country, Portugal has a population of 10.35 million and a territory of approximately 92,000 square kilometers with a GDP of USD 198.92 billion and GDP per capita of USD 19,222 and is a high-income country. It recorded USD 10.91 per kilogram of oil equivalent in GDP per unit of energy use, USD 2.54 billion in R&D expenditure, 1.28% in R&D intensity, 114,760 in SCI indexed papers, 161 in PCT applications, and 4.59% in high-tech exports as a percentage of manufactured exports.

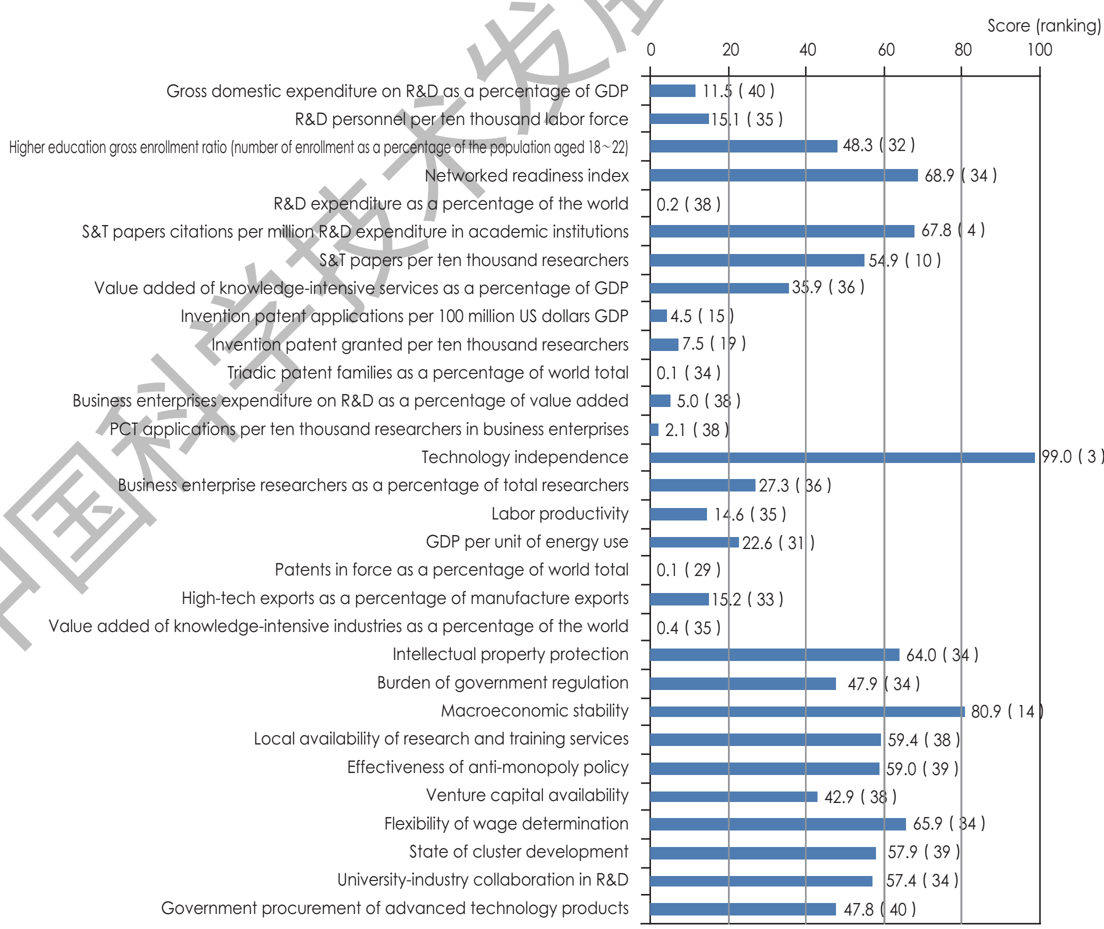
Portugal remained in the 28th place in the national innovation index. Among the five first-level indicators, it moved down one place to the 29th in innovation resources, jumped three places to the 17th in knowledge creation, stayed at the 27th in enterprise innovation, improved by one place to the 27th in innovation performance, and dropped two places to the 28th in innovation environment.



Romania

A European country, Romania has a population of 19.83 million and a territory of approximately 238,000 square kilometers with a GDP of USD 198.32 billion and GDP per capita of USD 8973 and is an upper-middle income country. It recorded USD 6.29 per kilogram of oil equivalent in GDP per unit of energy use, USD 870 million in R&D expenditure, 0.49% in R&D intensity, 8232 in SCI indexed papers, 35 in PCT applications, and 7.50% in high-tech exports as a percentage of manufactured exports.

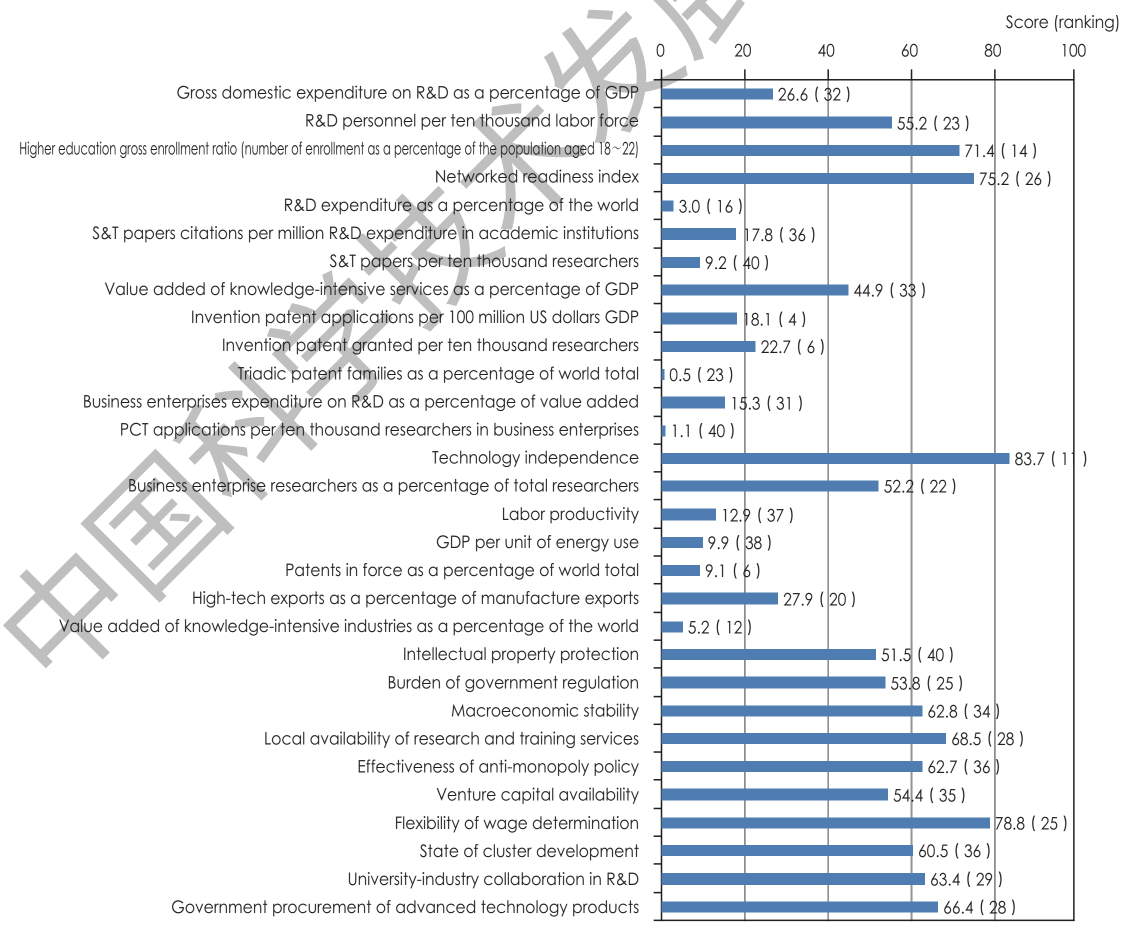
Romania remained in the 34th place in the national innovation index. Among the five first-level indicators, it stayed the 37th in innovation resources, slipped down three places to the 20th in knowledge creation and three places to the 29th in enterprise innovation, improved by one place to the 37th in innovation performance, and dropped four places to the 37th in innovation environment.



Russian Federation

A European country, the Russian Federation has a population of approximately 144 million and a territory of approximately 17.08 million square kilometers with a GDP of USD 1331.21 billion and GDP per capita of USD 9093 and is an upper-middle-income country. It recorded USD 2.76 per kilogram of oil equivalent in GDP per unit of energy use, USD 15.01 billion in R&D expenditure, 1.13% in R&D intensity, 35,488 in SCI indexed papers, 876 in PCT applications, and 13.76% in high-tech exports as a percentage of manufactured exports.

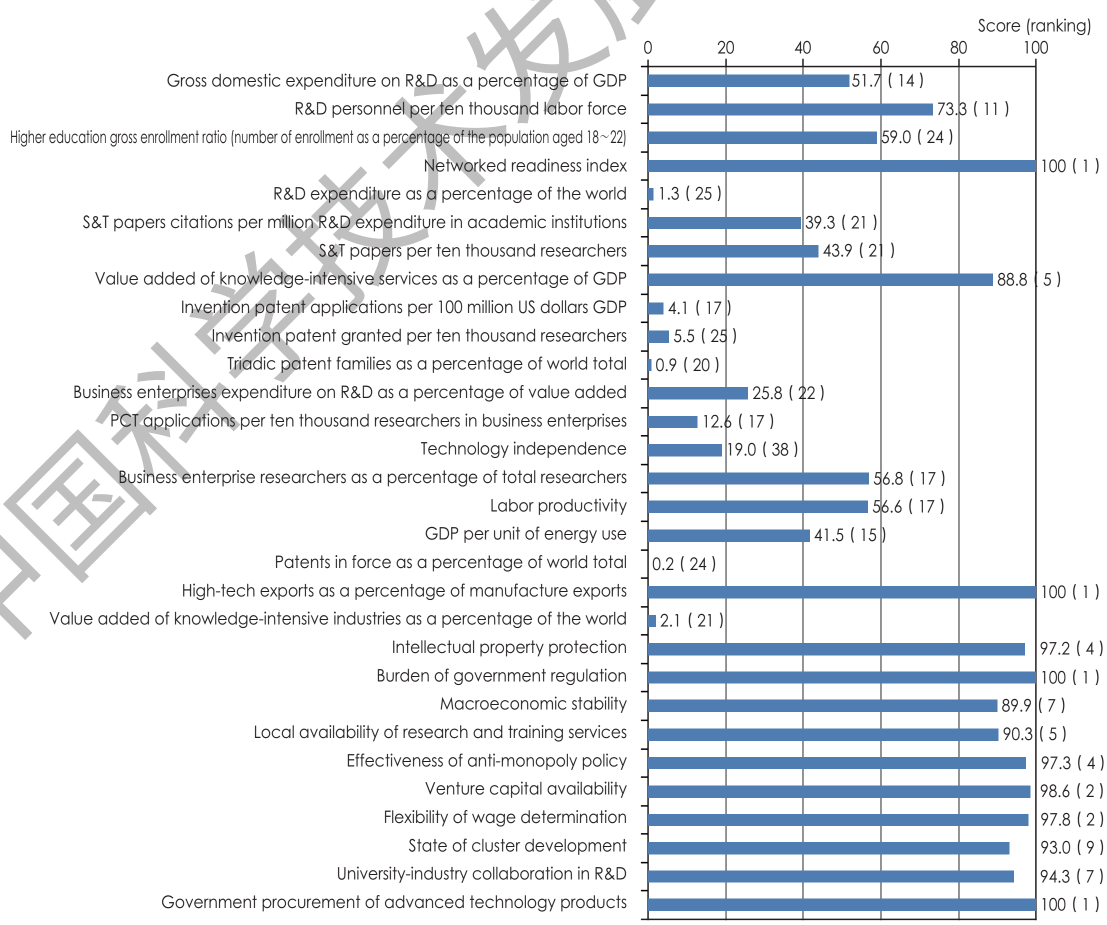
The Russian Federation dropped one rank to the 33rd in the national innovation index. Among the five first-level indicators, it moved down four places to the 27th in innovation resources, jumped three places to the 35th in knowledge creation, dropped two places to the 22nd in enterprise innovation, moved up one place to the 35th in innovation performance, and fell four places to the 35th in innovation environment.



Singapore

An Asian country, Singapore has a population of 5.54 million and a territory of approximately 714.3 square kilometers with a GDP of USD 292.74 billion and GDP per capita of USD 52,889 and is a high-income country. It recorded USD 11.59 per kilogram of oil equivalent in GDP per unit of energy use, USD 6.73 billion in R&D expenditure, 2.2% in R&D intensity, 13,822 in SCI indexed papers, 908 in PCT applications, and 49.28% in high-tech exports as a percentage of manufactured exports.

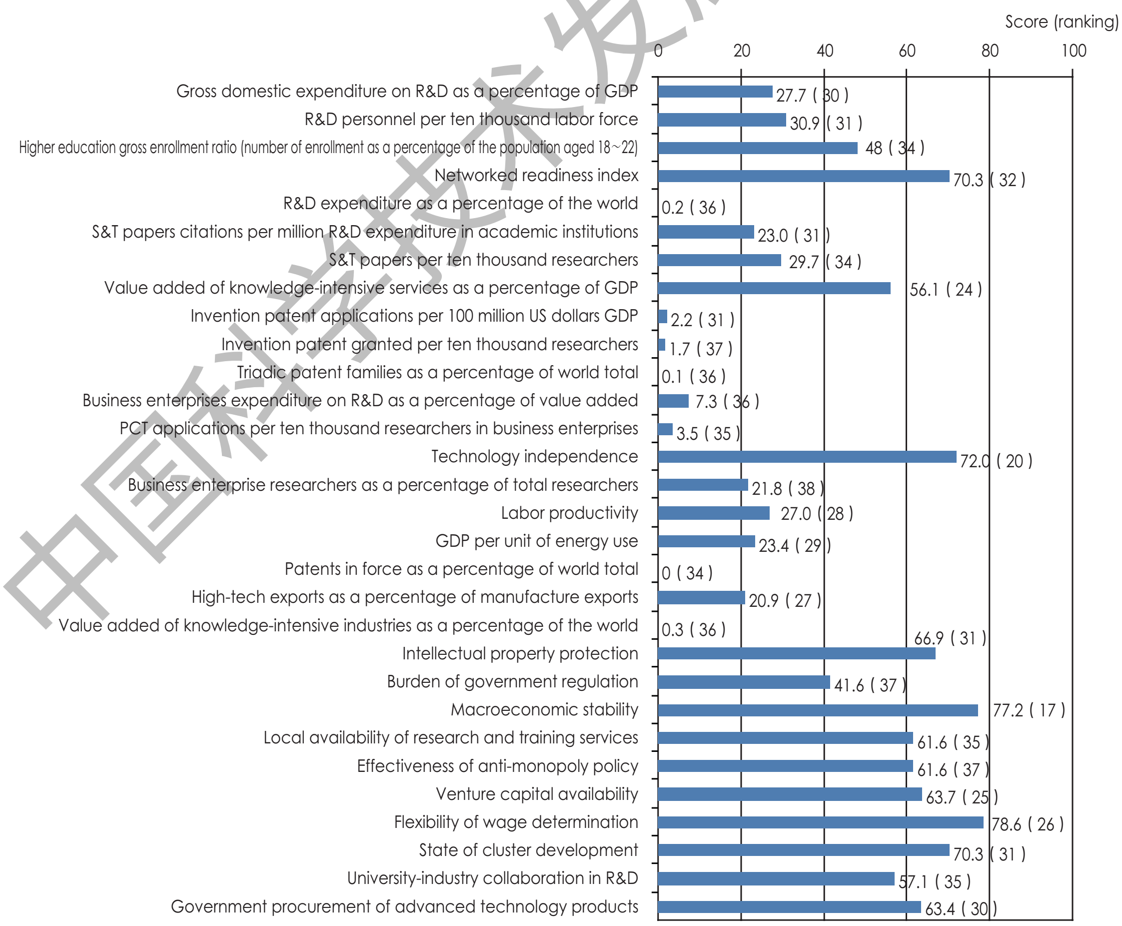
Singapore improved by one place to the 9th in the national innovation index. Among the five first-level indicators, it retained its 14th place in innovation resources, dropped one spot to the 16th in knowledge creation, stayed at the 33rd in enterprise innovation, moved down one place to the 6th in innovation performance, and kept its No. 1 position in innovation environment.



Slovak Republic

A European country, the Slovak Republic has a population of 5.42 million and a territory of approximately 49,000 square kilometers with a GDP of USD 87.26 billion and GDP per capita of USD 16,088 and is a high-income country. It recorded USD 6.53 per kilogram of oil equivalent in GDP per unit of energy use, USD 1.03 billion in R&D expenditure, 1.18% in R&D intensity, 3672 in SCI indexed papers, 38 in PCT applications, and 10.29% in high-tech exports as a percentage of manufactured exports.

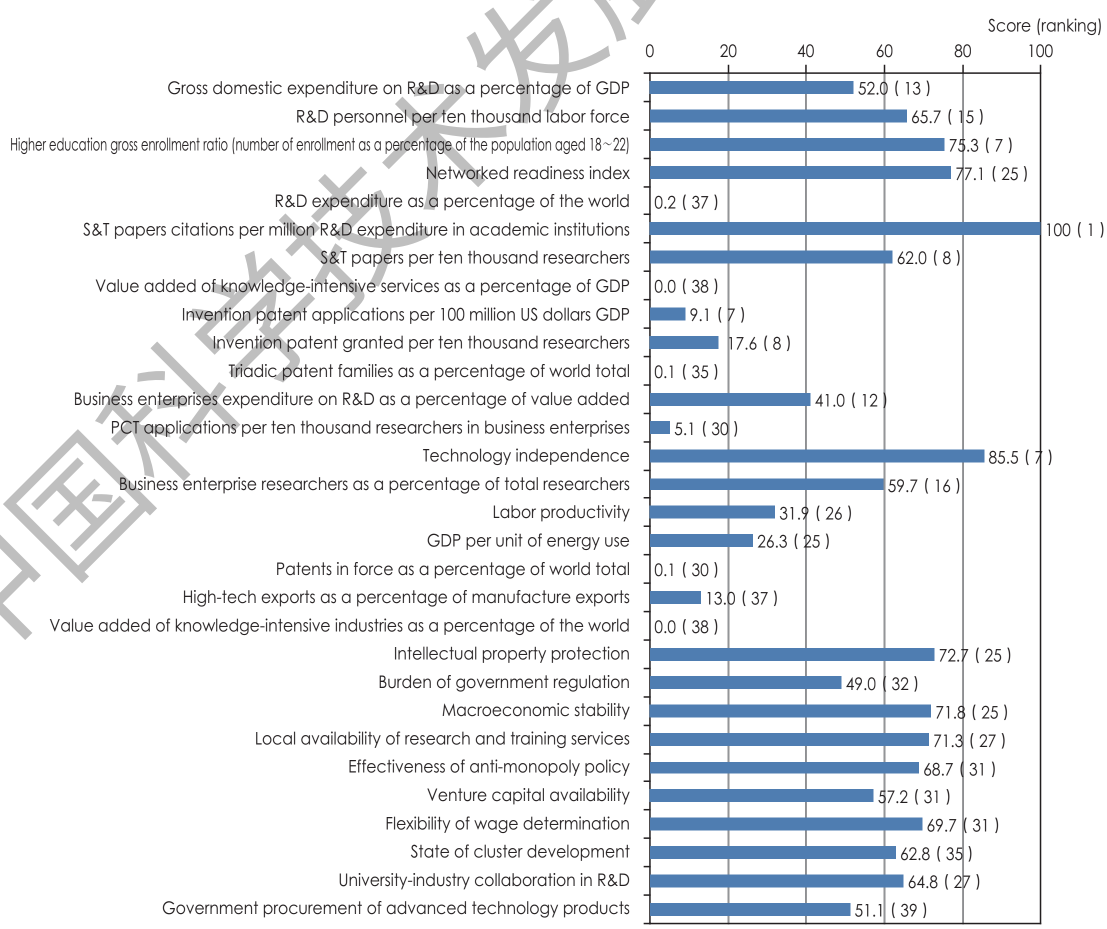
The Slovak Republic remained in the 35th place in the national innovation index. Among the five first-level indicators, it maintained its 34th place in innovation resources, dropped two places to the 36th place in knowledge creation, and moved up one place to the 35th in enterprise innovation, three places to the 30th in innovation performance and three places to the 31st in innovation environment.



Slovenia

A European country, Slovenia has a population of 2.06 million and a territory of approximately 20,000 square kilometers with a GDP of USD 42.78 billion and GDP per capita of USD 20,727 and is a high-income country. It recorded USD 7.34 per kilogram of oil equivalent in GDP per unit of energy use, USD 950 million in R&D expenditure, 2.21% in R&D intensity, 3672 in SCI indexed papers, 84 in PCT applications, and 6.42% in high-tech exports as a percentage of manufactured exports.

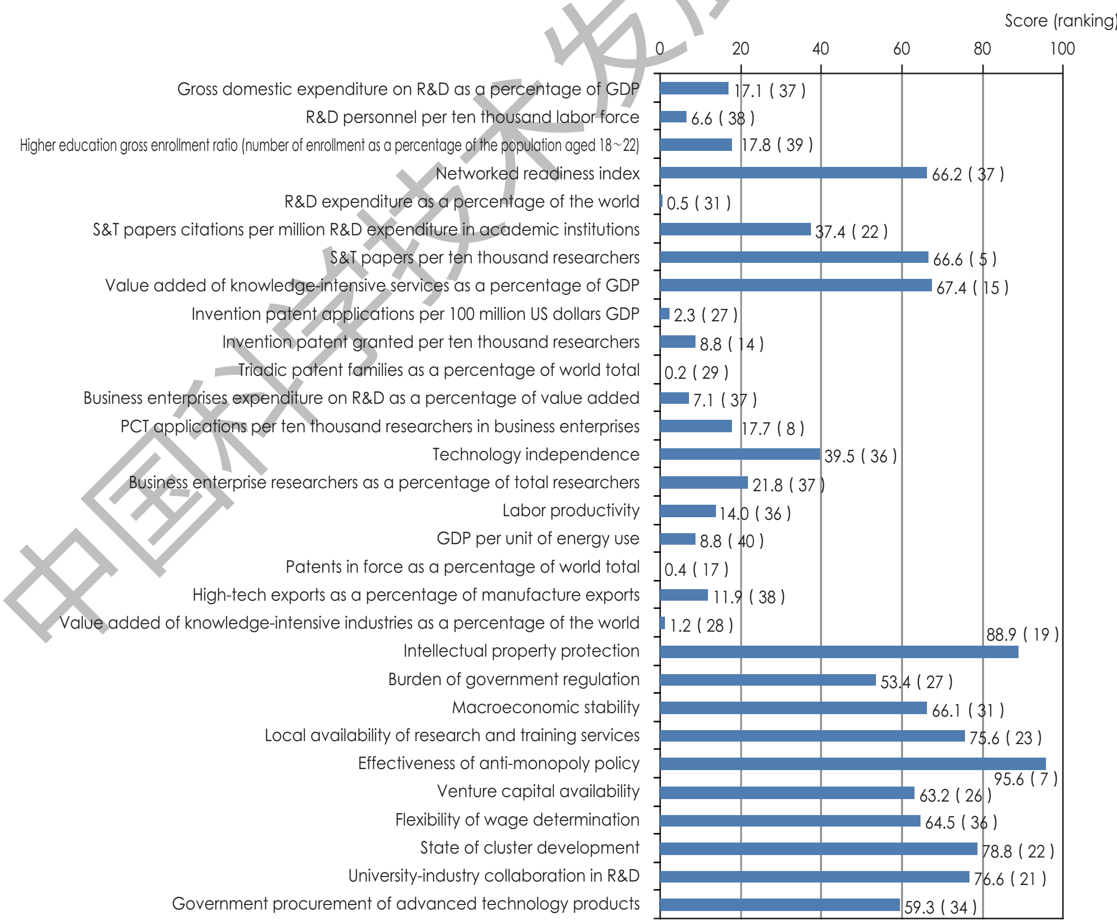
Slovenia dropped one place to the 24th in the national innovation index. Among the five first-level indicators, it moved down two places to the 17th in innovation resources, jumped five places to the 14th in knowledge creation, dropped one place to the 14th in enterprise innovation, and moved up one place to the 31st in innovation performance and three places to the 33rd in innovation environment.



South Africa

An African country, South Africa has a population of approximately 54.96 million and a territory of approximately 1.22 million square kilometers with a GDP of USD 314.57 billion and GDP per capita of USD 5724 and is an upper-middle income country. It recorded USD 2.45 per kilogram of oil equivalent in GDP per unit of energy use, USD 2.66 billion in R&D expenditure, 0.73% in R&D intensity, 13,355 in SCI indexed papers, 313 in PCT applications, and 5.88% in high-tech exports as a percentage of manufactured exports.

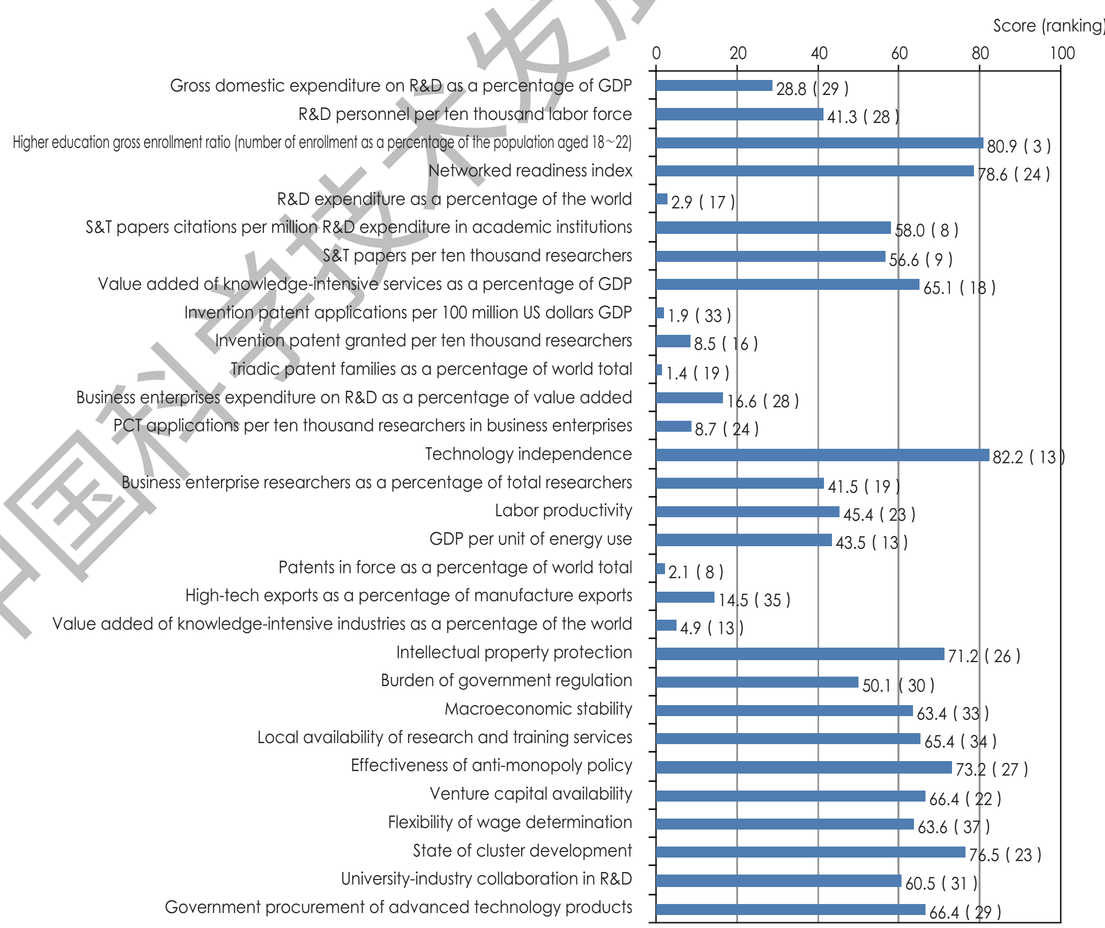
South Africa maintained its 36th position in the national innovation index. Among the five first-level indicators, it stayed at the 40th in innovation resources, moved up one place to the 15th in knowledge creation, retained its 37th place in enterprise innovation and the its 39th place in innovation performance, and moved up two places to the 25th in innovation environment.



Spain

A European country, Spain has a population of 46.42 million and a territory of approximately 506,000 square kilometers with a GDP of USD 1199.01 billion and GDP per capita of USD 25,832 and is a high-income country. It recorded USD 12.13 per kilogram of oil equivalent in GDP per unit of energy use, USD 14.61 billion in R&D expenditure, 1.22% in R&D intensity, 59,484 in SCI indexed papers, 1530 in PCT applications, and 7.15% in high-tech exports as a percentage of manufactured exports.

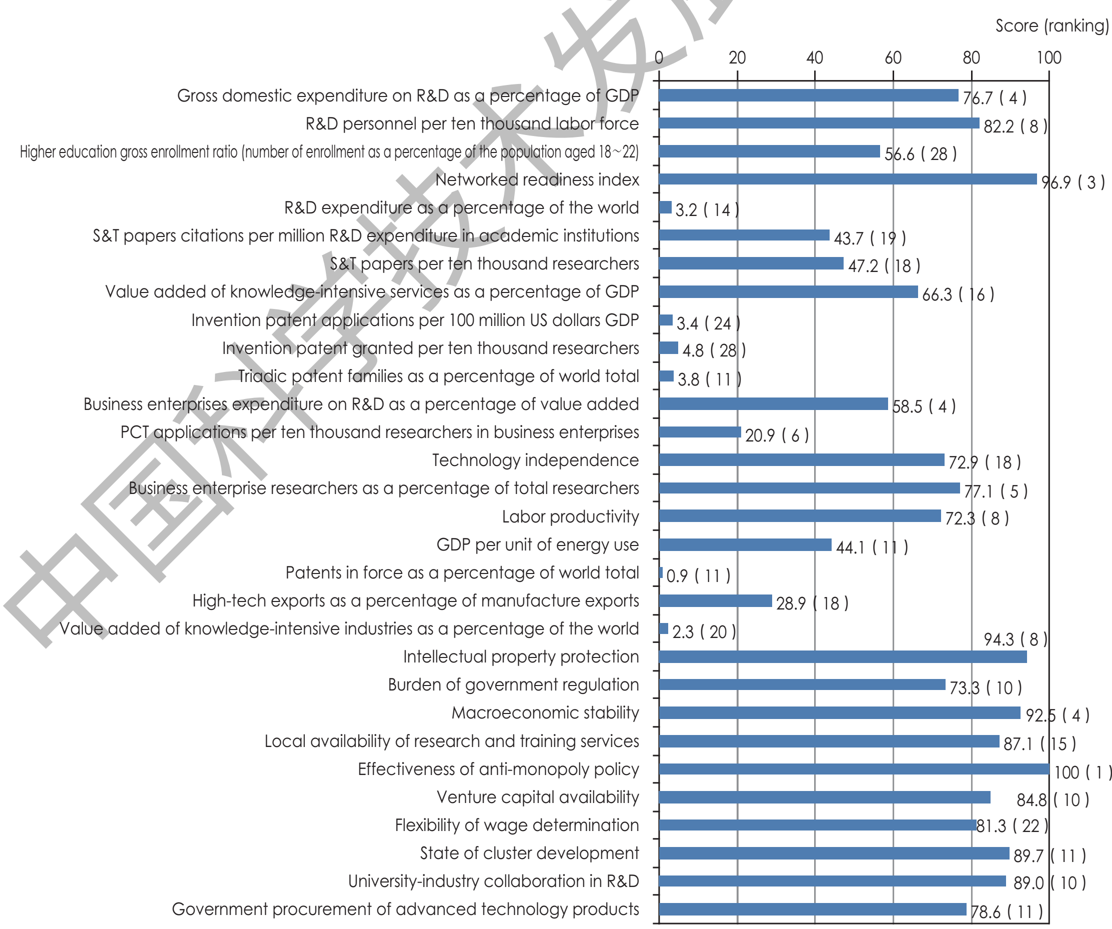
Spain dropped one rank to the 26th in the national innovation index. Among the five first-level indicators, it dropped one place to the 26th in innovation resources, stayed at the 13th in knowledge creation and the 24th in enterprise innovation, dropped two places to the 24th in innovation performance, and moved up three places to the 29th in innovation environment.



Sweden

A European country, Sweden has a population of approximately 9.80 million and a territory of approximately 450,000 square kilometers with a GDP of USD 495.63 billion and GDP per capita of USD 50,580 and is a high-income country. It recorded USD 12.30 per kilogram of oil equivalent in GDP per unit of energy use, USD 16.17 billion in R&D expenditure, 3.26% in R&D intensity, 27,839 in SCI indexed papers, 3842 in PCT applications, and 14.26% in high-tech exports as a percentage of manufactured exports.

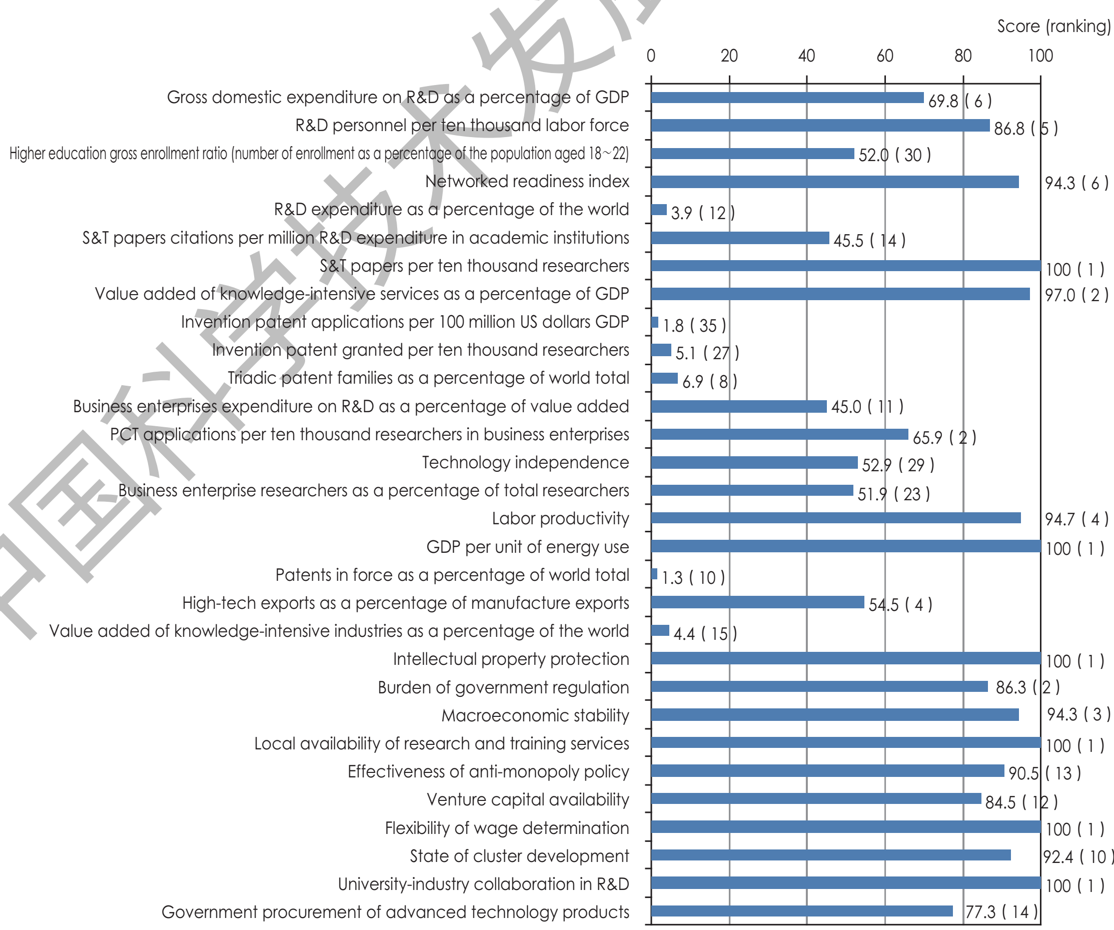
Sweden improved by one place to the 6th in the national innovation index. Among the five first-level indicators, it retained its 7th place in innovation resources, the 23rd place in knowledge creation and the 7th place in enterprise innovation, moved down one place to the 15th in innovation performance, and jumped four places to the 8th in innovation environment.



Switzerland

A European country, Switzerland has a population of approximately 8.29 million and a territory of approximately 41,000 square kilometers with a GDP of USD 670.79 billion and GDP per capita of USD 80,945 and is a high-income country. It recorded USD 27.91 per kilogram of oil equivalent in GDP per unit of energy use, USD 19.74 billion in R&D expenditure, 2.97% in R&D intensity, 30,885 in SCI indexed papers, 4265 in PCT applications, and 26.84% in high-tech exports as a percentage of manufactured exports.

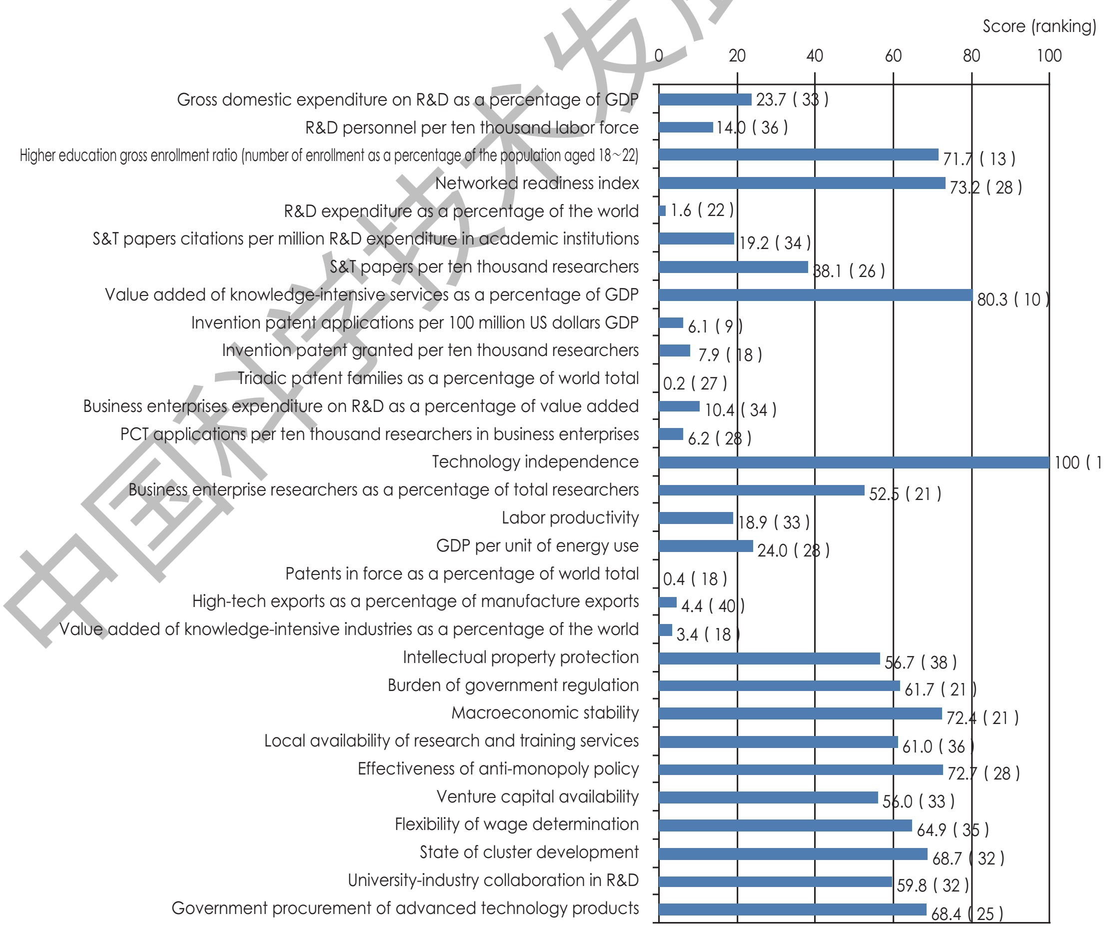
Switzerland retained its 3rd position in the national innovation index. Among the five first-level indicators, it stayed at the 10th in innovation resources and the 2nd in knowledge creation, moved up one place to the 8th in enterprise innovation, and maintained its 2nd place in innovation performance and the 2nd place in innovation environment.



Turkey

An Asian country, Turkey has a population of approximately 78.67 million and a territory of approximately 784,000 square kilometers with a GDP of USD 717.88 billion and GDP per capita of USD 9126 and is an upper-middle income country. It recorded USD 6.69 per kilogram of oil equivalent in GDP per unit of energy use, USD 8.04 billion in R&D expenditure, 1.01% in R&D intensity, 29,319 in SCI indexed papers, 1010 in PCT applications, and 2.16% in high-tech exports as a percentage of manufactured exports.

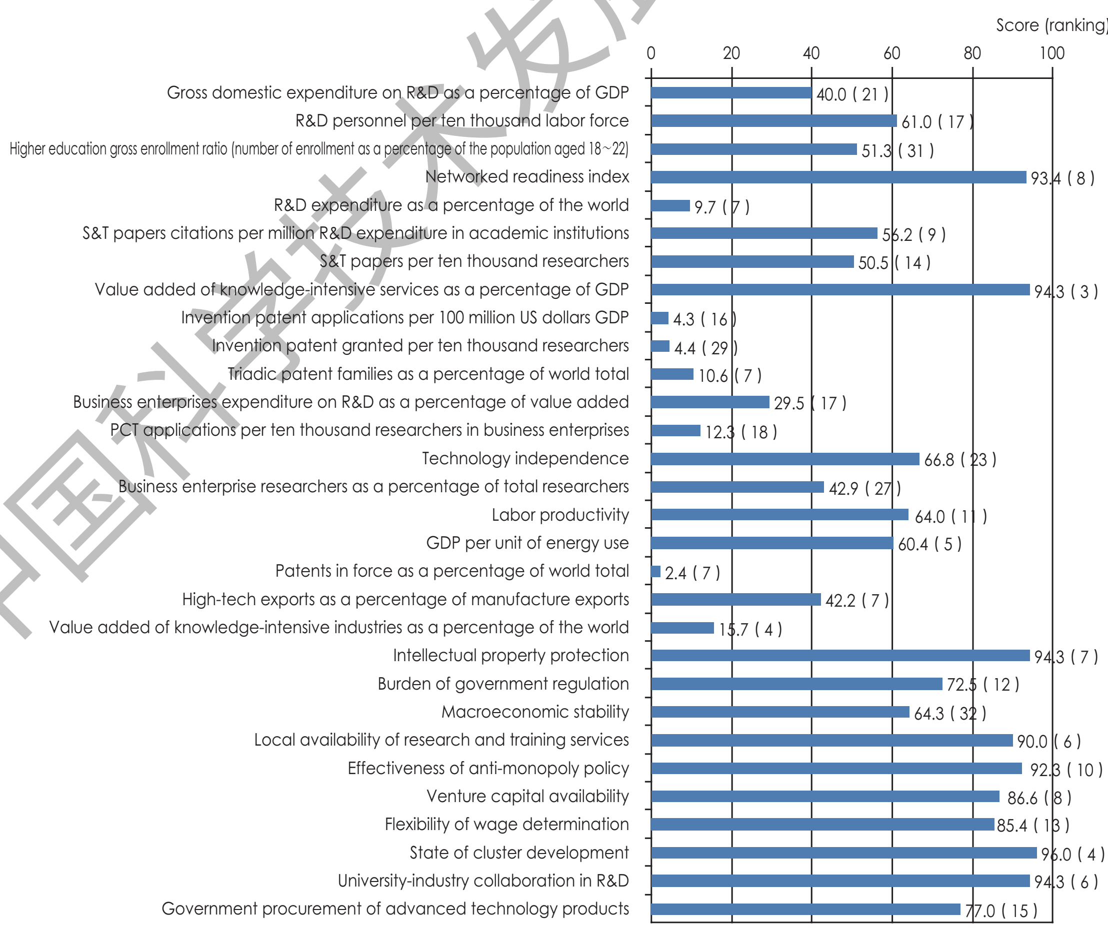
Turkey stayed at the 30th in the national innovation index. It moved down in all the five first-level indicators, and dropped one place to the 33rd in innovation resources, one place to the 29th in knowledge creation, one place to the 18th in enterprise innovation, one place to the 38th in innovation performance and two places to the 30th in innovation environment.



United Kingdom

A European country, the United Kingdom has a population of approximately 65.14 million and a territory of approximately 244,000 square kilometers with a GDP of USD 2858.0 billion and GDP per capita of USD 43,876 and is a high-income country. It recorded USD 16.87 per kilogram of oil equivalent in GDP per unit of energy use, USD 48.66 billion in R&D expenditure, 1.70% in R&D intensity, 125,499 in SCI indexed papers, 5290 in PCT applications, and 20.81% in high-tech exports as a percentage of manufactured exports.

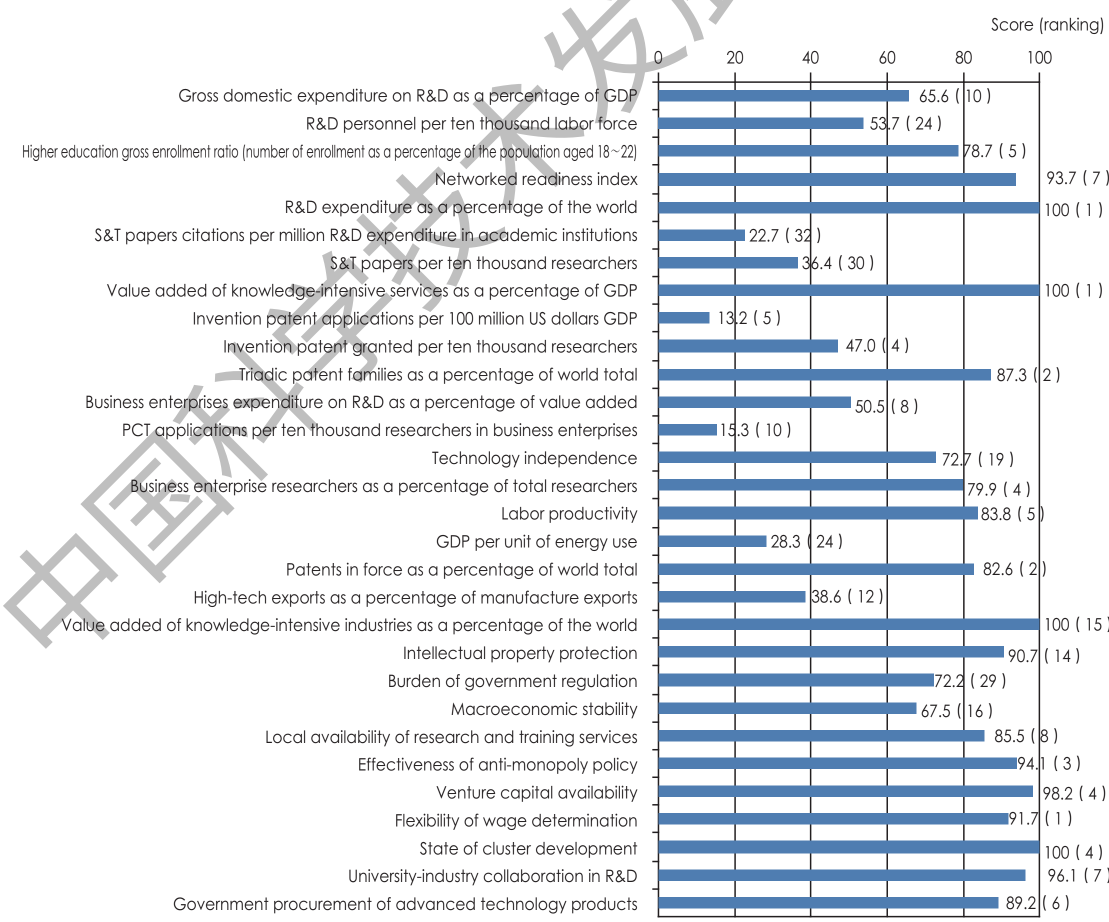
The United Kingdom dropped two ranks to the 10th in the national innovation index. Among the five first-level indicators, it moved down one place to the 19th in innovation resources, moved up one place to the 6th in knowledge creation, stayed at the 19th in enterprise innovation and the 7th in innovation performance, and dropped four places to the 10th in innovation environment.



United States

A North American country, the United States has a population of approximately 320 million and a territory of approximately 9.63 million square kilometers with a GDP of USD 18,036.65 billion and GDP per capita of USD 56,116 and is a high-income country. It recorded USD 7.88 per kilogram of oil equivalent in GDP per unit of energy use, USD 502.89 billion in R&D expenditure, 2.79% in R&D intensity, 420,000 in SCI indexed papers, 57,123 in PCT applications, and 19.01% in high-tech exports as a percentage of manufactured exports.

The United States retained its No. 1 position in the national innovation index. Among the five first-level indicators, it retained its top spot in innovation resources, moved up two ranks to the 4th in knowledge creation, and stayed at the 2nd in enterprise innovation, the 1st in innovation performance and the 4th in innovation environment.



National Innovation Index Report 2016–2017

Part Three:

Assessment Methodology

I. Assessment Approach

This national innovation index study draws upon domestic and international theories and methods of assessment of national competitiveness and innovation. It bases the national innovation index on the five pillars of innovation resources, knowledge creation, enterprise innovation, innovation performance and innovation environment according to the purpose of assessment and the definition of an innovation-driven country with a comprehensive framework of assessment principles and methods.

1. Objective of assessment

By constructing a multivariate indicator matrix and measuring the national innovation index, this study aims to comprehensively, objectively and accurately depict China's national innovation capability in all 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-oriented country and improve its S&T innovation policies.

2. Meaning of an innovation-oriented country

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

There is often a positive correlation between S&T progress and economic prosperity. According to the statistical data, 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 finds 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-oriented 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-oriented 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-oriented country is characterized by five main attributes:

(1) High availability of innovation resources;

(2) Active knowledge creation and dissemination;

(3) Strong enterprise innovation capability;

(4) Strong innovation output and impact;

(5) Favorable innovation environment.

3. 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 nationalinnovation capability is assessed on the basis of main links of the entire innovation process including availability of innovation resources, knowledge creation and application, enterprise innovation and innovation output and innovation 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.

4. 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 used to construct the indicator matrix and are used based on the same definitions and statistical methodology as used internationally.

Scalability of indicators: Each indicator has unique expressiveness of a specific dimension of innovation and is encompassing in meaning rather than corresponds to narrowly defined data, thus facilitating scalability and adjustment.

Insensitivity of indicator 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 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 performance and impact of a country's innovation activities.

Innovation environment: this indicator reflects a country's soft and hard environments where innovation activities take place, consisting of ten second-level indicators (selected from indicators used in the *Global Competitiveness Report* released by the World Economic Forum).


National innovation index
Innovation resources
1. Gross domestic expenditure on R&D as a percentage of GDP
2. R&D personnel per ten thousand labor force
3. Higher education gross enrollment ratio (number of enrollment as a percentage of the population aged 18 ~ 22)
4. Networked readiness index
5. R&D expenditure as a percentage of world total
Knowledge creation
6. S&T papers citations per million R&D expenditure in academic institutions
7. S&T papers per ten thousand researchers
8. Value added of knowledge-intensive services as a percentage of GDP
9. Invention patent applications per 100 million US dollars GDP
10. Invention patent granted per ten thousand researchers
Enterprise innovation
11. Triadic patent families as a percentage of world total
12. Business enterprises expenditure on R&D as a percentage of value added
13. PCT applications per ten thousand researchers in business enterprises
14. Technology independence
15. Business enterprise researchers as a percentage of total researchers
Innovation performance
16. Labor productivity
17. GDP per unit of energy use
18. Patents in force as a percentage of world total
19. High-tech exports as a percentage of manufacture exports
20. Value added of knowledge-intensive industries as a percentage of world total
Innovation environment
21. Intellectual property protection
22. Burden of government regulation
23. Macroeconomic stability
24. Local availability of research and training services
25. Effectiveness of anti-monopoly policy
26. Venture capital availability
27. Flexibility of wage determination
28. State of cluster development
29. University-industry collaboration in R&D
30. Government procurement of advanced technology products

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 identity their comparative positions and rank them according to their respective scores.

1.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:

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

where i=1～40； j=1～30.

2. Calculation of first-level indicator score

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

$$Y_{ik} = \sum_{j=1}^{5} \beta_i \mathrm{y}_{i\,(j+5k\text{-}5)} \qquad Y_{i5} = \sum_{\theta=1}^{10} \beta_i \mathrm{y}_{i\theta}$$

$$\overline{Y}_{ik} = 100 \times Y_{ik} / \max\,(\overline{Y}_{ik,\,i=1\sim40})$$

where β_i is the weighting factor; i=1～40; k=1～5; θ=1～10.

3. 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.

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

$$\overline{Y}_i = Y_i / \max(Y_{i,\ i=1\sim 40})$$

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

4. 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 score: $\overline{Y}_{ik}$

$$y_{ij} = 100 X_{ij} / X_{1j}$$

where j=1～30 denotes indicator number and i =1～10 denotes year 2005–2014.

$$\overline{Y}_{ik} = \sum_{j=1}^{5} \beta_i \mathrm{y}_{i(j+5k-5)}$$

$$\overline{Y}_{i5} = \sum_{\theta=1}^{10} \beta_i \mathrm{y}_{i\theta}$$

where β_i is the weighting factor; i=1~10; k=1～5; θ=1～10.

(2) Calculation of index score

Calculate of the index score $\overline{Y}_i$, from which the scores for the previous years are derived:

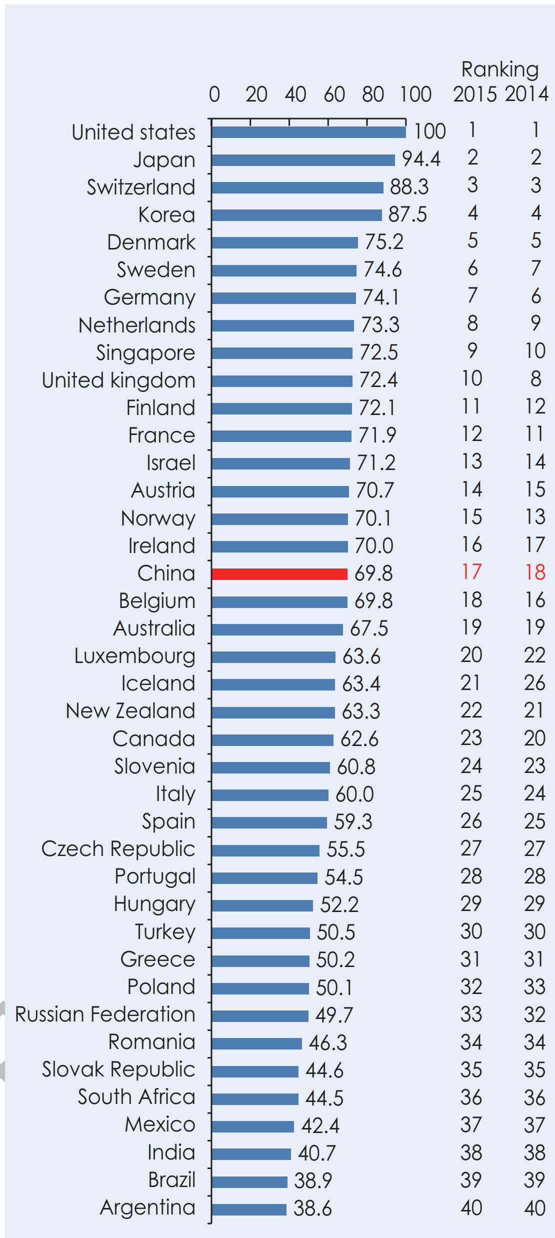
$$\overline{Y}_i = \sum_{k=1}^{5} \omega_k \overline{Y}_{ik}$$

where ω_k is the weighting factor; k=1～5; i=1～10.

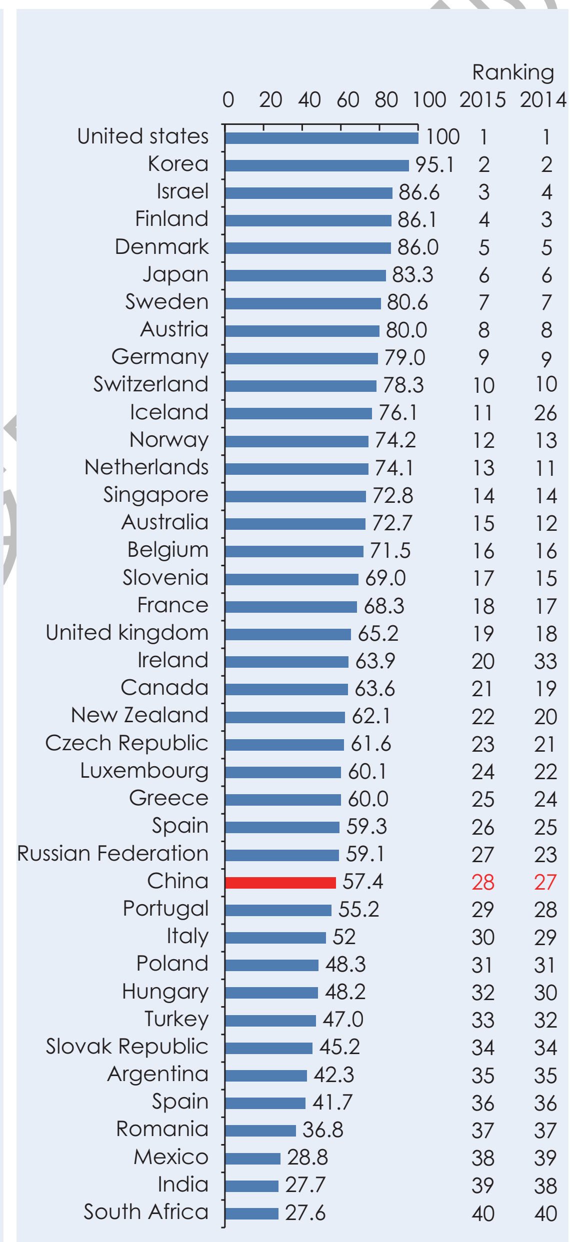
National Innovation Index Report 2016–2017

Appendixes

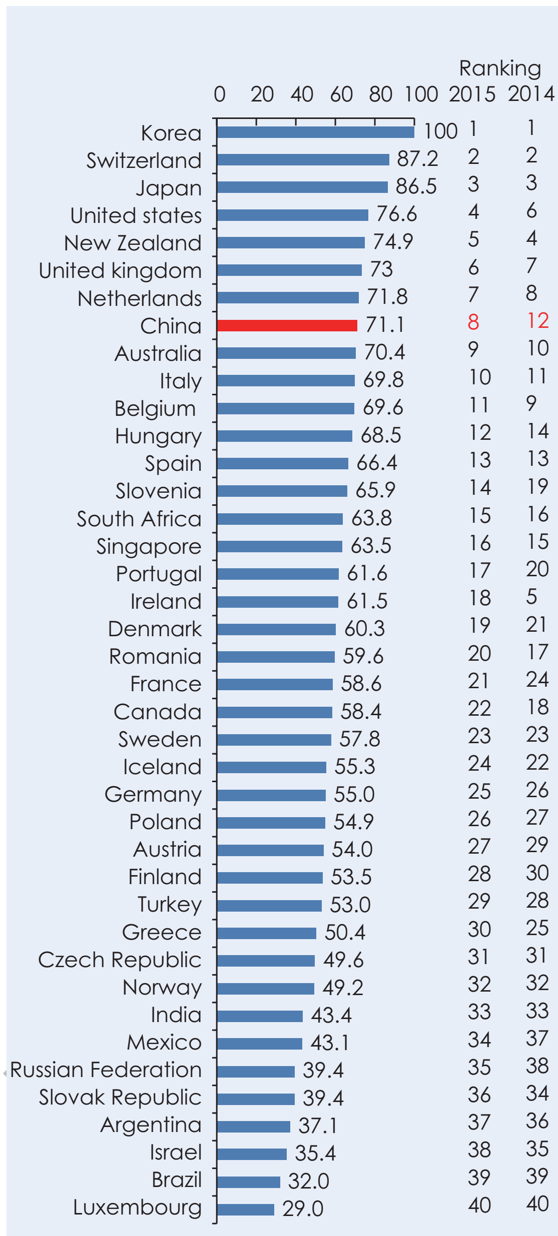
Appendix I Index and Sub-index Scores and Rankings



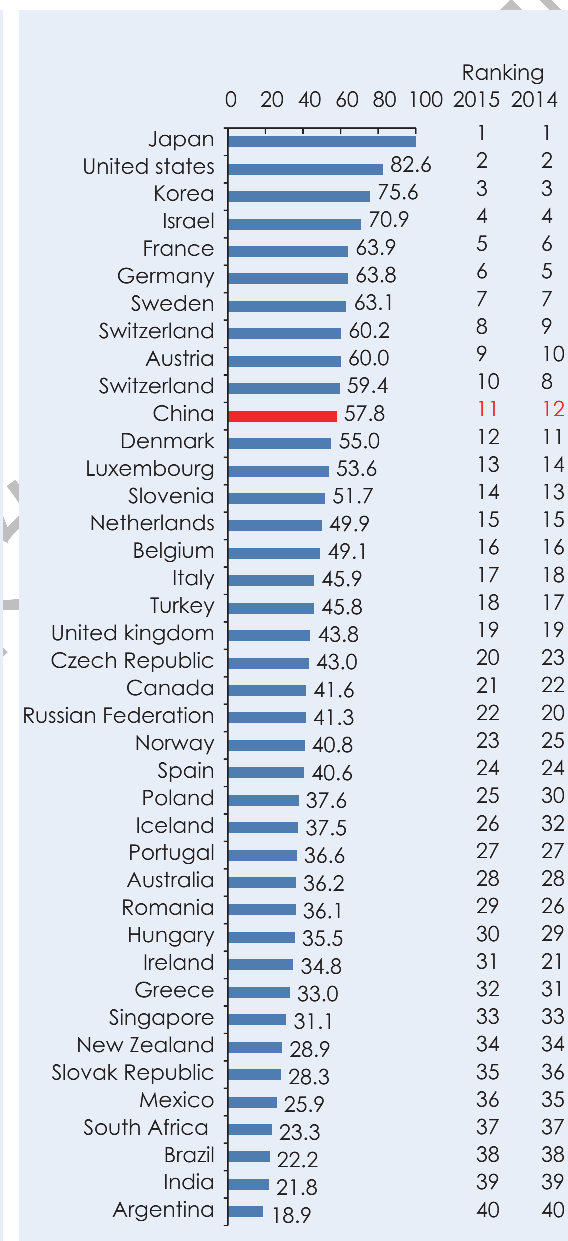
Attached Graph 1 National innovation index



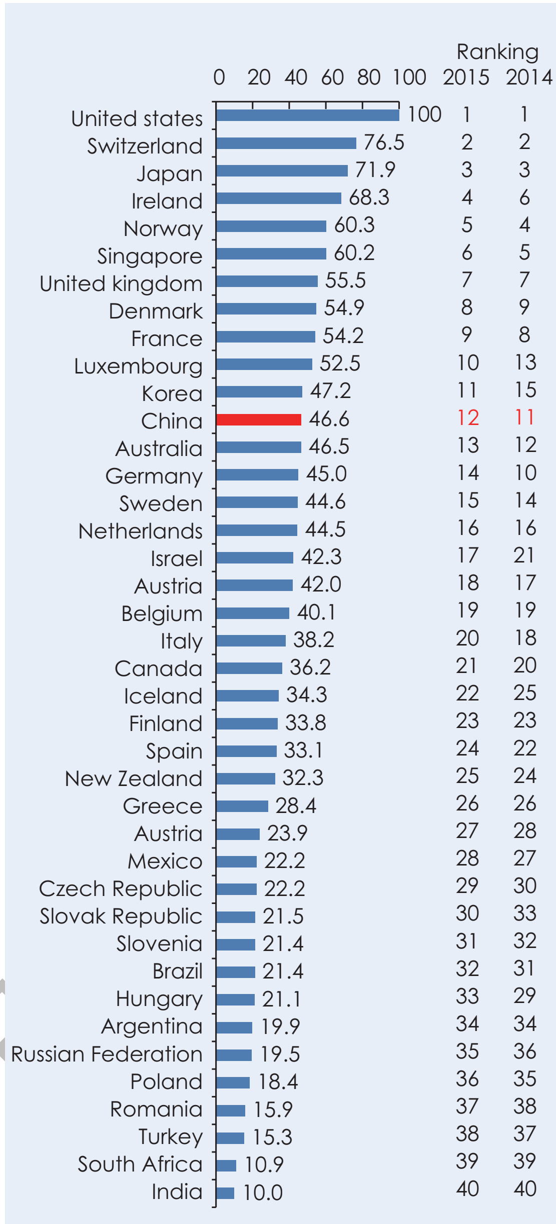
Attached Graph 2 Innovation resources



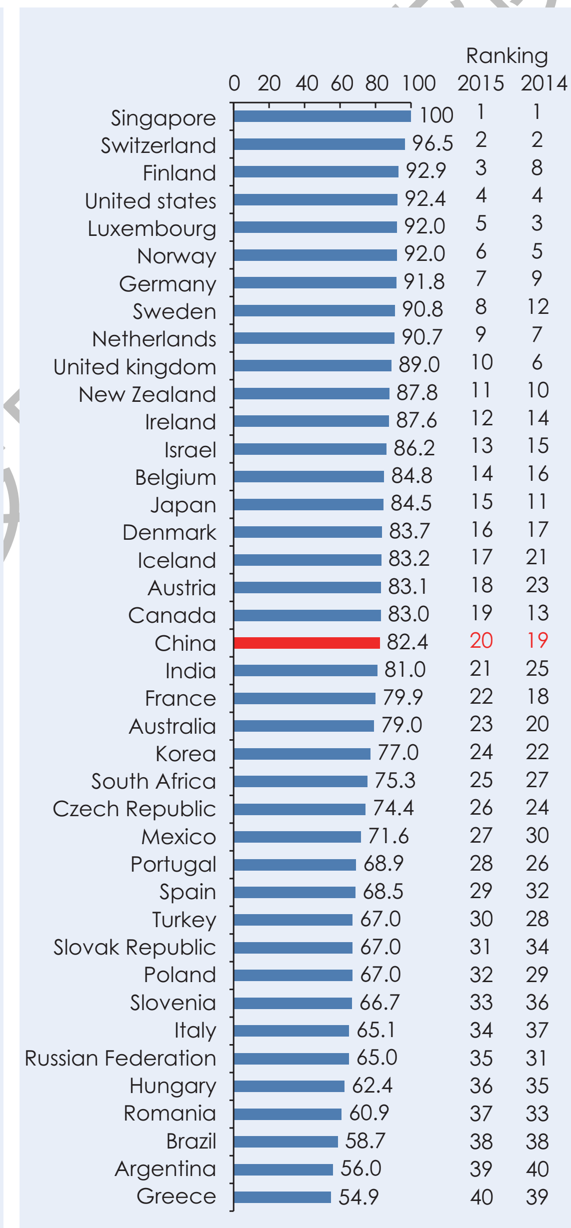
Attached Graph 3 Knowledge creation



Attached Graph 4 Enterprise innovation



Attached Graph 5 Innovation performance



Attached Graph 6 Innovation environment

Appendix II Definitions of Indicators

1. Gross domestic expenditure on R&D as a percentage of GDP

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

2. R&D personnel per ten thousand labor force

Refers to the number of researchers per 10,000 labor force, measuring a country's human resource investment in innovation.

3. Higher education gross enrollment ratio (number of enrollment 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 *World Competitiveness 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 gross domestic expenditure on R&D (GERD), 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 R&D personnel, expressed in ratio, reflecting the output efficiency of R&D activities.

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

Refers to the share of value added in services such as information dissemination, software and information technology services, finance, lease and business 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 content of economic output and industry sophistication of a country.

9. Invention patent applications per 100 million US dollars GDP

Refers to the number of a country's invention patent applications divided by its GDP (converted and expressed in USD 100 million), reflecting a country's activeness of technological creation.

10. Invention patent granted per ten thousand researchers

Refers to the number of resident invention patent granted per ten thousand R&D personnel, reflecting a country's indigenous innovation capability 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 domestic resident invention patent granted / (number of domestic resident invention patent granted + number of foreign 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 R&D personnel of business enterprises in a country's total R&D personnel, 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. Patents in force as a percentage of the world

Refers to a country's patents in force, i.e. those owned by its residents, expressed as a percentage of the world's total patents in force, reflecting its enterprises' indigenous innovation capacity and market competitiveness.

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

Reflects 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

Intellectual property protection (1 = weak or not protected by law, 7 = strong or protected by law).

22. Burden of government regulation

Burden brought by government requirements (permits, regulations, reporting) to enterprises (1 = heavy burden, 7 = no burden).

23. Macroeconomic stability

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

24. Local availability of research and training services

Degree to which research and training services are locally available (1 = unavailable, 7 = available from locally based world-class organizations).

25. Effectiveness of anti-monopoly policy

Degree to which anti-monopoly policy is effective (1 = failing to effectively promote competition, 7 = able to effectively promote competition).

26. Venture capital availability

Degree to which venture capital is available to innovation projects (1 = unavailable, 7 = readily available).

27. Flexibility of wage determination

Degree to which wage determination is flexible (1 = no positive correlation with employee performance, 7 = strong positive correlation with employee performance).

28. State of cluster development

Presence of well-developed industrial clusters nationwide (1 = not at all, 7 = to a great degree).

29. University-industry collaboration in R&D

Degree to which enterprises collaborate with local universities in R&D (1 = not at all or little, 7 = to a great degree).

30. Government procurement of advanced technology products

Government procurement of high-tech products (1 = merely price motivated, 7 = emphasizing technological sophistication and innovativeness).

Appendix III Data Sources

[1] *World Development Indicators 2017*, World Bank.

[2] *Main Science and Technology Indicators 2016-2*, Organization for Economic Cooperation and Development.

[3] *IP Statistics Data Center*, World Intellectual Property Organization.

[4] *The Global Competitiveness Report 2016–2017*, World Economic Forum.

[5] *Science and Engineering Indicators 2016*, National Science Foundation (U.S.).

[6] *Web of Science database*, Thomson Reuters.

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

[8] National Science Library under the Chinese Academy of Sciences.

[9] *China Statistical Yearbook 2016*, National Bureau of Statistics.

[10] *China Statistical Yearbook on Science and Technology 2016*, National Bureau of Statistics, Ministry of Science and Technology.

[11] *Statistical Communique of the People's Republic of China on the National Economic and Social Development*, National Bureau of Statistics.

[12] *China Patent Statistical Yearbook*, State Intellectual Property Office of China.

[13] China Research Institute for Science Popularization under China Association for Science and Technology (CAST).

[14] Torch High Technology Industry Development Center, Ministry of Science and Technology, China.

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