

Notes

- This booklet is published biannually. Please note that figures may vary according to the exact time of the survey.
- The figures included in this booklet are based on survey and analysis of statistics as of December 2019.
 - OECD regularly publishes R&D statistics comparing various countries, and international comparisons in this booklet are mostly based on the latest version of their biannual publication, Main Science & Technology Indicators 2019–2.
- The source of each indicator is stated in detail (in some cases with URL). The sum of individual figures and the total may not be identical due to issues such as significant figures.
 - For example, figures were rounded to the nearest integer when recomputing statistics or adjusting units (ten thousand KRW → 100 million KRW). Differences between the sum of individual figures and the total may arise from these processes.
- Some figures were recalculated from original data by the publishers to suit the purpose of the indicator. Thus some figures of the final year may not have been calculated.
 - For example, if the available data for labor force is from 2018 and researchers is from 2017, total researchers per 1,000 labor force (FTE) was calculated only up to 2017.
- Rankings were based on data of the most recent year obtained (or recomputed).

100 Main Science & Technology Indicators of Korea

Volume 2019-2



2019



Ministry of Science and ICT



Korea Institute of S&T
Evaluation and Planning

CONTENTS

Category	Subcategory	Indicator	Page
R&D Expenditure	1. Gross Domestic Expenditure on R&D (GERD)	1. GERD in Korea	5
		2. GERD in major countries	5
		3. GERD per capita population and per researcher in Korea	6
		4. GERD per capita population and per researcher (FTE) in major countries	6
		5. GERD by performance sectors in Korea	6
		6. Percentage of GERD by performance sectors in major countries	7
		7. GERD by source of funds in Korea	7
		8. Percentage of GERD by source of funds in major countries	7
		9. GERD by type of R&D in Korea	8
		10. GERD by type of R&D in major countries	8
		11. GERD by future and emerging technologies (6T) in Korea	8
		12. GERD by region in Korea	9
	2. Business Enterprise Expenditure on R&D (BERD)	13. Percentage of BERD financed by government in Korea	10
		14. Percentage of BERD financed by government in major countries	10
		15. BERD by business type in Korea	10
		16. BERD by industry in Korea	11
		17. BERD by industry in major countries	11
		18. BERD performed in R&D-intensive industries of major countries	11
		19. BERD and its percentage relative to sales in Korea	12
		20. BERD of major countries as a percentage of value added in industry	12
		21. BERD intensity in Korea	12
		22. World's top 50 companies by BERD	13
	3. Government Intramural Expenditure on R&D (GOVERD)	23. Total GBAORD in Korea	14
		24. Total GBAORD in major countries	14
		25. GOVERD in Korea	15
		26. GOVERD by performance sectors in Korea	15
		27. GOVERD by type of R&D in Korea	15
		28. GOVERD by ministry in Korea	16
		29. GOVERD by future and emerging technologies (6T) in Korea	16
		30. GOVERD by region in Korea	17
		31. Total researchers and total R&D personnel in Korea	18
		32. Total researchers and total R&D personnel in major countries (FTE)	18
R&D Personnel	4. R&D Personnel	33. Total researchers per 10,000 population, per 1,000 total employment and per 1,000 labor force (FTE) in Korea	19
		34. Total researchers per 10,000 population, per 1,000 total employment and per 1,000 labor force (FTE) in major countries	19
		35. Researchers by sector of employment in Korea	19
		36. Percentage of researchers by sector of employment in major countries	19
		37. Women researchers in Korea	20
		38. Women researchers in major countries	20
		39. Distribution of researchers by sector of employment and qualification in Korea	20
		40. Researchers by qualification in Korea	21
		41. Researchers by field of study in Korea	21
		42. Researchers by age in Korea	21
		43. Researchers by region in Korea	22
		44. Researchers by company types in Korea	23
		45. Researchers by industry in Korea	23
		46. Researcher and doctoral researcher intensity of the top companies in Korea	23
		47. Principal investigators of government R&D projects by sector, gender, and degree in Korea	24
		48. Current and shortfall of S&T industry personnel in Korea	24
		49. Number of students enrolled in bachelor's, master's and doctoral programs in Korea	25
		50. Number of science and engineering graduates with master's and doctoral degrees in Korea	25
	5. Nurturing Human Capital	51. New doctorates in natural sciences and engineering as a percentage of all graduates in major countries	25
		52. Tertiary education graduates in natural sciences and engineering as a percentage of all graduates in major countries	25



Category	Subcategory	Indicator	Page
R&D Performance	6. Publications	53. Number of papers published in SCI journals in Korea	26
		54. Number of papers published in SCI journals in major countries	26
		55. Number of papers published in SCI journals per 10,000 population or per 100 researchers (FTE) in Korea	27
		56. Number of papers published in SCI journals per 10,000 population or per 100 researchers (FTE) in major countries	27
		57. Average citations per paper over five-year period in Korea	27
		58. Average citations per paper over five-year period in major countries	27
		59. Number of papers published in top 3 journals in Korea	28
		60. Number of papers published by region in Korea	28
		61. Domestic patent applications and patent grants in Korea	29
		62. Domestic patent applications and patent grants by region in Korea	29
	7. Patents	63. Number of triadic patent families in Korea	30
		64. Number of triadic patent families in major countries	30
		65. Number of patent applications to and grants from the USPTO in Korea	30
		66. Number of patent applications to and grants from the USPTO in major countries	30
		67. Top 10 companies granted U.S. Patents	31
		68. Number of patent applications to and grants from the EPO in Korea	31
		69. Number of patent applications to and grants from the EPO in major countries	32
		70. Number of patent applications filed under the PCT in Korea	32
		71. Number of patent applications filed under the PCT in major countries	32
		72. Number of patent applications filed under the PCT in the ICT and biotechnology sector in major countries	32
	8. Technology Trade	73. Technology balance of payments in Korea	33
		74. Technology balance of payments by industry in Korea	33
	9. International Trade in High-Tech Industries	75. International trade in R&D-intensive industries of Korea	34
		76. International trade in R&D-intensive industries of major countries	34
		77. ICT industry trade in Korea	35
		78. ICT industry trade in major countries	35
		79. Competitiveness ranking of Korea (IMD)	36
	10. National Competitiveness	80. Competitiveness ranking of major countries (IMD)	36
		81. Competitiveness ranking of Korea in scientific infrastructure (IMD)	37
		82. Competitiveness ranking of Korea in technological infrastructure (IMD)	38
		83. Global competitiveness of Korea (WEF)	39
		84. Global competitiveness ranking of major countries (WEF)	39
		85. Composite Science and Technology Innovation Index (COSTII) of Korea	39
Other R&D Statistics	11. Energy and Resources	86. Electricity supply and demand in Korea	40
		87. Petroleum and LNG supply in Korea	40
		88. Total primary energy supply per 1,000 USD of GDP in major countries	40
		89. Nuclear electricity as a percentage of total electricity generation in major countries	40
		90. Overseas natural resource exploitation in Korea	41
	12. Green Growth and Technology	91. Renewable energy supply in Korea	41
		92. Contribution of renewables to energy supply in major countries	41
		93. CO2 emissions in major countries (kg per PPP \$ of GDP)	42
		94. R&D budget for energy and environment as a percentage of GBAOWNRD in major countries	42
	13. Space	95. Space programs as a percentage of civil G&D in major countries	42
		96. BERD performed in aerospace industry in major countries	42
	14. Biotechnology	97. R&D expenditure in Biotechnology by company in major countries	42
		98. Biotechnology industry in Korea	43
	15. Economic Indicators	99. Population and GDP per capita in major countries	43
		100. Labor force, total employment, and value added of industry in major countries	43

I Main Science and Technology Indicators

1. R&D Expenditure and Personnel

		Korea (^{'18})	USA (^{'17})	Japan (^{'17})	Germany (^{'17})	France (^{'17})	UK (^{'17})	China (^{'17})
R&D Expenditure	Gross Domestic Expenditure on R&D (100 million USD)	779 (5 th)	5,432 (1 st)	1,561 (3 rd)	1,122 (4 th)	565 (6 th)	439 (7 th)	2,605 (2 nd)
	– Ratio	1.00	6.97	2.00	1.44	0.73	0.56	3.34
	– As a percentage of GDP (%)	4.81	2.79	3.21	3.04	2.19	1.66	2.15
	– Government*Public: Private*Foreign Ratio (%)	21:79	30:70	21:79	28:72	37:63 (^{'16})	33:67 (^{'16})	20:77
	Government Expenditure on R&D (100 million USD)	179 (^{'18})	1,305 (^{'18})	342 (^{'18})	368 (^{'18})	184 (^{'18})	140	–
	– As a percentage of GDP (%)	1.11	0.64	0.69	0.92	0.66	0.53	–
R&D Personnel	Total Researchers (1,000 FTE)	408	1,371 (^{'16})	676	420	289	290	1,740
	Total Researchers per 1,000 labor force (FTE)	14.7	8.5 (^{'16})	10.1	9.7	9.7	8.7	2.2

► Rankings were based on the data of the most recent year obtained from OECD Main Science & Technology Indicators 2019–1, and the year given in parentheses means the base year of data shown

► The sum of Government*Public: Private*Foreign Ratio in China is less than 100.0%

► Total R&D expenditure in Korea: 85.7 trillion KRW (^{'18}), Government Budget on R&D: 19.7 trillion KRW (^{'18})

2. R&D Performance

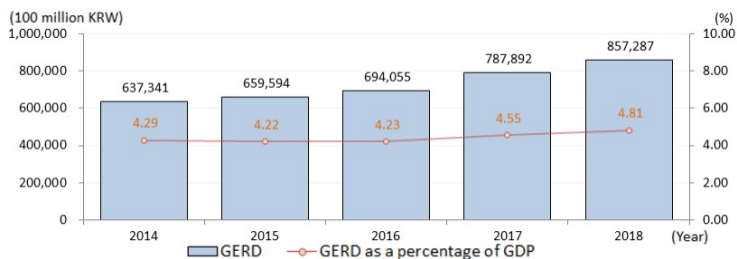
		Korea	USA	Japan	Germany	France	UK	China
Publications (^{'18})	SCI Papers	63,311 (12 th)	450,352 (1 st)	84,689 (5 th)	121,119 (4 th)	80,453 (6 th)	141,426 (3 rd)	397,717 (2 nd)
Patents	Number of triadic patent families (^{'17})	2,428 (5 th)	12,021 (2 nd)	17,591 (1 st)	4,531 (3 rd)	2,315 (6 th)	1,612 (7 th)	4,215 (4 th)
	Number of patent applications to the PCT (^{'18})	16,948 (5 th)	56,221 (1 st)	49,709 (3 rd)	19,748 (4 th)	7,919 (6 th)	5,633 (7 th)	53,348 (2 nd)
R&D-intensive industries (^{'18})	Receipts (A, 100 million USD)	1,981	3,984	1,142	2,900	1,390	1,075	6,966 (^{'17})
	Payments (B, 100 million USD)	1,056	5,946	1,498	2,359	1,191	1,293	5,676 (^{'17})
	Balance of payments ratio (A/B)	1.88	0.67	0.76	1.23	1.17	0.83	1.23 (^{'17})
	Balance of payments (100 million USD)	925	–1,962	–357	542	199	–218	1,290 (^{'17})
IMD evaluation (^{'19})	Competitiveness ranking	28	3	30	17	31	23	14
	– Science	3	1	6	5	12	11	2
	– Technology	22	6	20	23	9	12	2

II

R&D Expenditure

1. Gross Domestic Expenditure on R&D (GERD)

① GERD in Korea



▶ Since the GDP for year Y is finalized on March of Y+2yrs, there is a possibility of change in GERD as a percentage of GDP that was initially extracted from November of Y+1yr

▶ Source: MSIT·KISTEP, Survey of Research and Development in Korea

② GERD in major countries

		2015	2016	2017	2018
Korea	GERD (million USD)	58,311	59,810	69,699	77,896
	As a percentage of GDP (%)	4.22	4.23	4.55	4.81
USA	GERD (million USD)	495,098	516,254	543,249	
	As a percentage of GDP (%)	2.72	2.76	2.79	
Japan	GERD (million USD)	144,047	155,447	156,128	
	As a percentage of GDP (%)	3.28	3.16	3.21	
Germany	GERD (million USD)	98,465	101,958	112,186	
	As a percentage of GDP (%)	2.91	2.92	3.04	
France	GERD (million USD)	55,275	54,792	56,523	
	As a percentage of GDP (%)	2.27	2.22	2.19	
UK	GERD (million USD)	48,317	44,731	43,889	
	As a percentage of GDP (%)	1.67	1.68	1.66	
China	GERD (million USD)	227,538	235,936	260,494	
	As a percentage of GDP (%)	2.07	2.12	2.15	

▶ GERD is calculated by applying GERD in MSTI 2019-1 and KRW/USD currency exchange rate

▶ Source: OECD, MSTI 2019-1 (stats.oecd.org), MSIT · KISTEP, Survey of Research and Development in Korea

③ GERD per capita population and per researcher in Korea

	2015	2016	2017	2018
GERD per capita (1,000 KRW)	1,293	1,354	1,531	1,660
GERD per researcher (million KRW)	145.5	150.6	163.2	166.7

▶ Source: MSIT·KISTEP, Survey of Research and Development in Korea

④ GERD per capita population and per researcher (FTE) in major countries

		2015	2016	2017	2018
GERD per capita population (USD)	Korea	1,143	1,167	1,355	1,508
	USA	1,541	1,595	1,666	
	Japan	1,133	1,225	1,232	
	Germany	1,205	1,238	1,357	
	France	830	820	843	
	UK	742	681	665	
	China	166	171	187	
GERD per researcher (FTE) (USD)	Korea	163,591	165,545	181,933	190,748
	USA	361,579	376,473		
	Japan	217,571	233,556	230,859	
	Germany	253,787	255,147	267,354	
	France	199,095		195,865	
	UK	169,843	154,822	151,512	
	China	140,540	139,428	149,671	

▶ FTE (Full-time equivalent) takes into account the amount of researchers' actual participation in labor

▶ Source: OECD, MSTI 2019-1 (stats.oecd.org)

MSIT · KISTEP, Survey of Research and Development in Korea

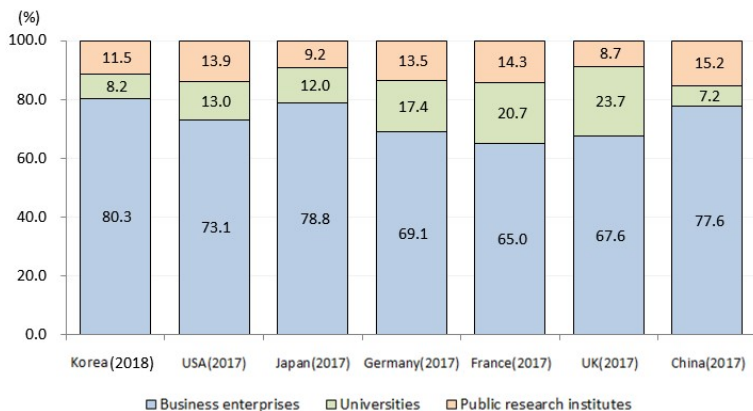
⑤ GERD by performance sectors in Korea

	2015		2016		2017		2018	
	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)
Business enterprises	511,364	77.5	539,525	77.7	625,634	79.4	688,344	80.3
Universities	59,989	9.1	63,399	9.1	66,825	8.5	70,504	8.2
Public research institutes	88,241	13.4	91,132	13.1	95,432	12.1	98,439	11.5
Total	659,594	100.0	694,055	100.0	787,892	100.0	857,287	100.0

▶ Non-profit organizations are included in public research institutes

▶ Source: MSIT·KISTEP, Survey of Research and Development in Korea

⑥ Percentage of GERD by performance sectors in major countries



► Non-profit organizations are included in public research institutes

► Source: OECD, MSTI Indicators 2019-1 (stats.oecd.org)

MSIT·KISTEP, Survey of Research and Development in Korea

⑦ GERD by source of funds in Korea

	2015		2016		2017		2018	
	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)
Government	162,935	24.7	164,100	23.6	177,371	22.5	183,630	21.4
Private	491,700	74.5	523,459	75.4	600,643	76.2	657,028	76.6
Abroad	4,959	0.8	6,496	0.9	9,878	1.3	16,629	1.9
Total	659,594	100.0	694,055	100.0	787,892	100.0	857,287	100.0

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

⑧ Percentage of GERD by source of funds in major countries (%)

	Korea (^{'18})	USA (^{'17})	Japan (^{'17})	Germany (^{'17})	France (^{'16})	UK (^{'16})	China (^{'17})
Government	21.4	30.3	21.1	28.1	36.7	32.6	19.8
Private	76.6	63.6	78.3	66.2	55.6	51.8	76.5
Abroad	1.9	6.2	0.6	5.8	7.7	15.6	0.6
Total	100.0	100.0	100.0	100.0	100.0	100.0	96.9

► The sum of Government, Private and Abroad of China is less than 100.0%

► Source: OECD, MSTI 2019-1 (stats.oecd.org)

MSIT·KISTEP, Survey of Research and Development in Korea, 2018

9 GERD by type of R&D in Korea

	2015		2016		2017		2018	
	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)
Basic research	113,617	17.2	110,867	16.0	113,911	14.5	121,805	14.2
Applied research	137,450	20.8	156,214	22.5	173,159	22.0	188,247	22.0
Development research	408,528	61.9	426,974	61.5	500,822	63.6	547,235	63.8
Total	659,594	100.0	694,055	100.0	787,892	100.0	857,287	100.0

▶ Source: MSIT · KISTEP, Survey of Research and Development in Korea

10 GERD by type of R&D in major countries (%)

	Korea (^{'18})	USA (^{'17})	Japan (^{'17})	France (^{'15})	UK (^{'16})	China (^{'17})
Basic research	14.2	17.0	13.1	21.5	18.1	5.5
Applied research	22.0	20.3	18.7	41.1	44.0	10.5
Development research	63.8	62.5	63.9	35.3	37.9	84.0

▶ For USA, Japan, and France, other sources are excluded such that the total does not add up to 100.0%

▶ Source: OECD, Research and Development Statistics, 2019 (stats.oecd.org)

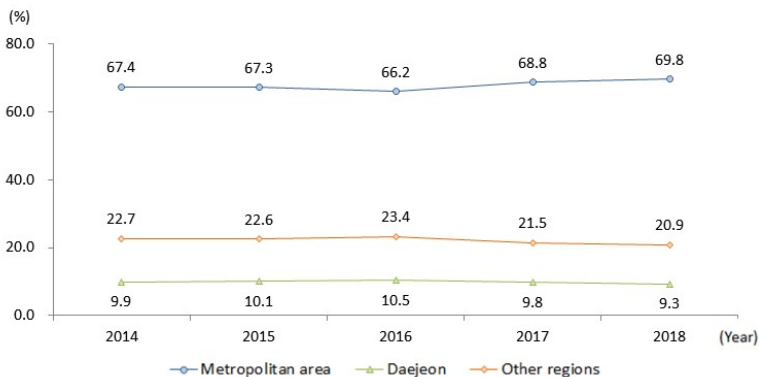
MSIT · KISTEP, Survey of Research and Development in Korea, 2018

11 GERD by future and emerging technologies (6T) in Korea

	2015		2016		2017		2018	
	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)
Information Technology (IT)	213,099	32.3	234,879	33.8	287,317	36.5	307,329	35.8
Biotechnology (BT)	59,946	9.1	56,137	8.1	62,111	7.9	66,401	7.7
Nanotechnology (NT)	86,609	13.1	85,499	12.3	76,201	9.7	87,377	10.2
Space Technology (ST)	13,049	2.0	12,230	1.8	11,603	1.5	14,789	1.7
Environment Technology (ET)	62,271	9.4	62,777	9.0	70,009	8.9	79,636	9.3
Culture Technology (CT)	7,027	1.1	9,365	1.3	7,841	1.0	8,075	0.9
Others	217,592	33.0	233,169	33.6	272,810	34.6	293,680	34.3
Total	659,594	100.0	694,055	100.0	787,892	100.0	857,287	100.0

▶ Source: MSIT · KISTEP, Survey of Research and Development in Korea

12 GERD by region in Korea



	2015		2016		2017		2018	
	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)	GERD (100 million KRW)	Percentage (%)
Seoul	100,306	15.2	104,839	15.1	131,697	16.7	134,754	15.7
Busan	12,862	1.9	12,417	1.8	14,033	1.8	15,449	1.8
Daegu	11,040	1.7	11,958	1.7	12,380	1.6	13,258	1.5
Incheon	24,996	3.8	23,895	3.4	25,482	3.2	27,613	3.2
Gwangju	7,332	1.1	8,353	1.2	7,933	1.0	9,010	1.1
Daejeon	66,551	10.1	72,741	10.5	76,985	9.8	79,922	9.3
Ulsan	9,723	1.5	8,015	1.2	7,299	0.9	11,103	1.3
Sejong	4,887	0.7	4,685	0.7	4,837	0.6	5,171	0.6
Gyeonggi	318,390	48.3	330,506	47.6	384,625	48.8	436,153	50.9
Gangwon	4,142	0.6	3,921	0.6	4,503	0.6	4,818	0.6
Chungbuk	13,797	2.1	21,054	3.0	22,129	2.8	16,287	1.9
Chungnam	22,837	3.5	29,801	4.3	25,614	3.3	25,878	3.0
Jeonbuk	8,043	1.2	9,003	1.3	10,322	1.3	10,846	1.3
Jeonnam	5,739	0.9	5,198	0.7	5,491	0.7	6,608	0.8
Gyeongbuk	26,680	4.0	24,177	3.5	28,468	3.6	30,204	3.5
Gyeongnam	20,948	3.2	21,937	3.2	24,537	3.1	28,625	3.3
Jeju	1,320	0.2	1,555	0.2	1,560	0.2	1,590	0.2
Total	659,594	100.0	694,055	100.0	787,892	100.0	857,287	100.0

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

2. Business Enterprise Expenditure on R&D (BERD)

13 Percentage of BERD financed by government in Korea (%)

	2015	2016	2017	2018
For all business enterprises	5.2	4.2	4.7	4.4
For small · medium sized businesses and start-ups	13.2	12.7	13.6	13.9

► Small·medium sized business (SME) here does not include start-ups (SMEs are broadly accepted as the combination of SMEs and start-ups shown above)

► Source: MSIT · KISTEP, Survey of Research and Development in Korea

14 Percentage of BERD financed by government in major countries (%)

	2015	2016	2017	2018
Korea	5.2	4.2	4.7	4.4
USA	7.8	6.7	6.3	
Japan	1.2	1.0	1.0	
Germany	3.6	3.6	3.3	
France	8.9	8.3		
UK	9.3	8.6		
China	4.3	3.7	3.4	

► Source: OECD, MSTI 2019-1 (stats.oecd.org)

MSIT·KISTEP, Survey of Research and Development in Korea

15 BERD by business type in Korea

	2015		2016		2017		2018	
	BERD (100 million KRW)	Percentage (%)	BERD (100 million KRW)	Percentage (%)	BERD (100 million KRW)	Percentage (%)	BERD (100 million KRW)	Percentage (%)
Large Corp.	389,303	76.1	407,787	75.6	398,038	63.6	438,236	63.7
Medium					90,687	14.5	95,954	13.9
Small	63,753	12.5	68,717	12.7	70,069	11.2	74,883	10.9
Start-up	58,308	11.4	63,021	11.7	66,840	10.7	79,272	11.5
Total	511,364	100.0	539,525	100.0	625,634	100.0	688,344	100.0

► Small·medium sized business (SME) here does not include start-ups (SMEs are broadly accepted as the combination of SMEs and start-ups shown above)

► Careful analysis is recommended as medium sized enterprises are included in the survey since 2017

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

16 BERD by industry in Korea

		2016	2017	2018
BERD (100 million KRW)	Manufacturing	480,141	559,867	611,572
	Coke, refined petroleum products, chemicals and chemical products, rubber and plastic products	55,029	63,992	67,262
	Electrical machinery and apparatus, radio, TV and communications equipment	266,277	310,776	345,206
	Motor vehicles and trailers	65,134	78,434	84,389
	Services	46,654	52,207	62,349
Percentage (%)	Manufacturing	89.0	89.5	88.8
	Coke, refined petroleum products, chemicals and chemical products, rubber and plastic products	10.2	10.2	9.8
	Electrical machinery and apparatus, radio, TV and communications equipment	49.4	49.7	50.2
	Motor vehicles and trailers	12.1	12.5	12.3
	Services	8.6	8.3	9.1

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

17 BERD by industry in major countries (%)

	Korea (¹⁸)	USA (¹⁶)	Japan (¹⁷)	Germany (¹⁷)	France (¹⁶)	UK (¹⁶)
Manufacturing	88.8	66.9	86.8	85.0	50.0	41.4
Services	9.1	31.9	11.8	14.3	46.7	56.6

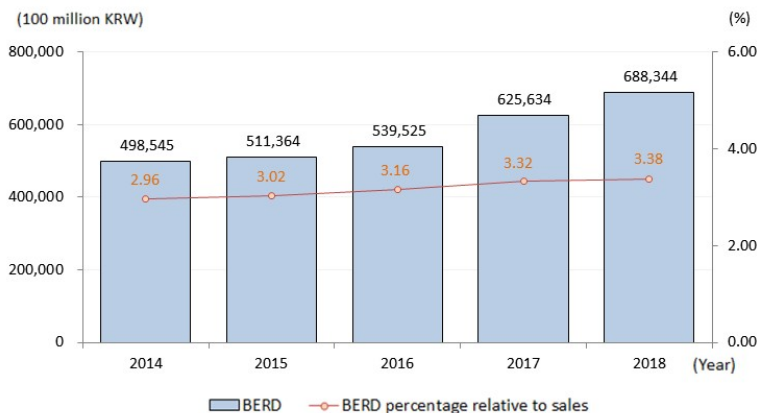
► Source: OECD, Research and Development Statistics, 2019 (stats.oecd.org)
MSIT·KISTEP, Survey of Research and Development in Korea, 2018

18 BERD performed in R&D-intensive industries of major countries

	Korea (¹⁵)	USA (¹⁶)	Japan (¹⁷)	Germany (¹⁶)	France (¹⁶)	UK (¹⁶)
BERD (million USD)	24,061	168,658	37,644	13,445	8,345	4,223
Percentage (%)	53.2	45.0	30.6	19.3	23.4	14.1

► OECD defines R&D-intensive industries as pharmaceutical, computer, electronic and optical, and aerospace industry
► Source: OECD, MSTI 2019-1 (stats.oecd.org)

19 BERD and its percentage relative to sales in Korea



► Source: MSIT·KISTEP, Survey of Research and Development in Korea

20 BERD of major countries as a percentage of value added in industry (2017)

	Korea	USA	Japan	Germany	France	UK	China
BERD as a percentage of value added in industry (%)	5.31	3.21	3.49	3.31	2.49	1.87	2.25

► Source: OECD, Main Science & Technology Indicators 2019-1 (stats.oecd.org)

21 BERD intensity in Korea (%)

	2015	2016	2017	2018
Top 5 companies	43.6	44.0	47.1	47.6
Top 10 companies	50.2	51.3	53.8	53.9
Top 20 companies	55.1	55.8	58.5	58.3

► BERD intensity is the sum of BERD of top firms (in terms of BERD size) as a percentage of the total BERD

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

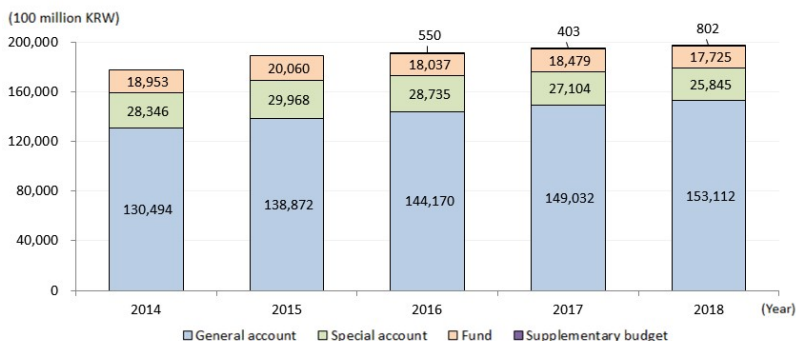
22 World's top 50 companies by BERD (2018)

Rank	Name	Country	Rank	Name	Country
1	ALPHABET	USA	26	BAYER	Germany
2	SAMSUNG	Korea	27	QUALCOMM	USA
3	MICROSOFT	USA	28	ALIBABA	China
4	VOLKSWAGEN	Germany	29	ASTRAZENECA	UK
5	HUAWEI	China	30	ABBVIE	USA
6	APPLE	USA	31	DELL TECHNOLOGIES	USA
7	INTEL	USA	32	PANASONIC	Japan
8	ROCHE	Switzerland	33	IBM	USA
9	JOHNSON & JOHNSON	USA	34	GLAXOSMITHKLINE	UK
10	DAIMLER	Germany	35	NISSAN MOTOR	Japan
11	FACEBOOK	USA	36	NOKIA	Finland
12	MERCK US	USA	37	CELGENE	USA
13	TOYOTA MOTOR	Japan	38	DENSO	Japan
14	NOVARTIS	Switzerland	39	SONY	Japan
15	FORD MOTOR	USA	40	FIAT CHRYSLER	Netherlands
16	BMW	Germany	41	GILEAD SCIENCES	USA
17	PFIZER	USA	42	PEUGEOT (PSA)	France
18	GENERAL MOTORS	USA	43	SAP	Germany
19	HONDA MOTOR	Japan	44	GENERAL ELECTRIC	USA
20	ROBERT BOSCH	Germany	45	RENAULT	France
21	SIEMENS	Germany	46	ERICSSON	Sweden
22	SANOFI	France	47	CONTINENTAL	Germany
23	CISCO SYSTEMS	USA	48	AIRBUS	Netherlands
24	BRISTOL-MYERS SQUIBB	USA	49	BROADCOM	USA
25	ORACLE	USA	50	AMGEN	USA

► Source: EC, The 2019 EU Industrial R&D Investment Scoreboard (irjrc.ec.europa.eu/scoreboard.html)

3. Government Intramural Expenditure on R&D (GOVERD)

23 Total Government Budget Appropriations or Outlays for R&D (GBAORD) in Korea



	2015	2016	2017	2018
General account (100 million KRW)	138,872	144,170	149,032	153,112
Special account (100 million KRW)	29,968	28,735	27,104	25,845
Funds (100 million KRW)	20,060	18,037	18,479	17,725
Supplementary budget (100 million KRW)		550	403	802
Total GBAORD (100 million KRW)	188,900	191,492	195,018	197,483

► Source: MSIT · KISTEP, Governmental R&D Survey and Analysis

24 Total GBAORD in major countries (2018)

	Korea	USA	Japan	Germany	France	UK (¹⁷)
Total GBAORD (million USD)	17,944	130,541	34,192	36,802	18,367	13,964
As a percentage of GDP (%)	1.11	0.64	0.69	0.92	0.66	0.53

► Source: OECD, MSTI 2019-1 (stats.oecd.org)
MSIT·KISTEP, Governmental R&D Survey and Analysis, 2018

25 GOVERD in Korea

	2015	2016	2017	2018
GOVERD (100 million KRW)	188,747	190,044	193,927	197,759
Number of projects	54,433	54,827	61,280	63,697

► Source: MSIT·KISTEP, Governmental R&D Survey and Analysis

26 GOVERD by performance sectors in Korea

	2015		2016		2017		2018	
	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)
Research institutes	87,814	46.5	88,188	46.4	88,853	45.8	90,747	45.9
Universities	42,617	22.6	42,727	22.5	44,052	22.7	45,365	22.9
Business enterprises	40,310	21.4	41,286	21.7	45,382	23.4	46,694	23.6
Ministries	6,181	3.3	6,281	3.3	4,692	2.4	2,993	1.5
Others	11,825	6.3	11,562	6.1	10,948	5.6	11,960	6.0
Total	188,747	100.0	190,044	100.0	193,927	100.0	197,759	100.0

► Source: MSIT·KISTEP, Governmental R&D Survey and Analysis

27 GOVERD by type of R&D in Korea

	2015		2016		2017		2018	
	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)
Basic research	43,118	32.3	43,713	32.5	45,898	33.5	44,651	32.7
Applied research	25,316	19.0	25,428	18.9	26,233	19.1	27,665	20.2
Development research	65,142	48.8	65,362	48.6	65,021	47.4	64,387	47.1
Total	133,577	100.0	134,502	100.0	137,152	100.0	136,703	100.0

► Figures differ from those calculated according to the Manual for Counting Basic Research Portion of the Government R&D Budget, and excludes instances where categorization was difficult

► Source: MSIT·KISTEP, Governmental R&D Survey and Analysis

28 GOVERD by ministry in Korea

	2017		2018	
	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)
Ministry of Science and ICT	67,342	34.7	66,779	33.8
Ministry of Education	17,349	8.9	17,382	8.8
Office for Government Policy Coordination	4,554	2.3	5,022	2.5
Ministry of National Defence	380	0.2	456	0.2
Ministry of Land, Infrastructure and Transport	4,709	2.4	4,565	2.3
Korea Meteorological Administration	1,285	0.7	1,329	0.7
Ministry of Agriculture, Food and Rural Affairs	1,890	1.0	1,973	1.0
Rural Development Administration	6,288	3.2	6,454	3.3
Cultural Heritage Administration	403	0.2	451	0.2
Ministry of Culture, Sports and Tourism	739	0.4	744	0.4
Defense Acquisition Program Administration	27,376	14.1	29,442	14.9
Ministry of Health and Welfare	4,999	2.6	5,150	2.6
Korea Forest Service	1,028	0.5	1,020	0.5
Ministry of Trade, Industry and Energy	30,875	15.9	31,059	15.7
Ministry of Food and Drug Safety	838	0.4	847	0.4
Nuclear Safety and Security Commission	645	0.3	692	0.3
Ministry of SMEs and Startups	10,558	5.4	10,426	5.3
Ministry of Oceans and Fisheries	5,867	3.0	6,126	3.1
Ministry of Environment	2,870	1.5	3,331	1.7
Others	3,930	2.0	4,513	2.3
Total	193,927	100.0	197,759	100.0

► Source: MSIT · KISTEP, Governmental R&D Survey and Analysis

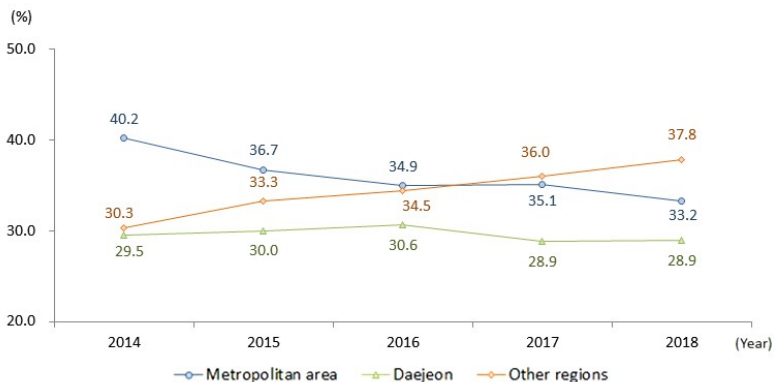
29 GOVERD by future and emerging technologies (6T) in Korea

	2015		2016		2017		2018	
	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)
Information Technology (IT)	33,368	19.0	33,617	19.0	33,465	18.5	33,451	18.1
Biotechnology (BT)	33,019	18.8	33,341	18.8	34,946	19.3	35,494	19.2
Nanotechnology (NT)	7,965	4.5	8,003	4.5	8,266	4.6	8,133	4.4
Space Technology (ST)	10,605	6.1	12,512	7.1	14,487	8.0	14,875	8.1
Environment Technology (ET)	23,928	13.7	22,697	12.8	22,924	12.7	22,294	12.1
Culture Technology (CT)	1,758	1.0	1,963	1.1	2,221	1.2	2,423	1.3
Others	64,557	36.8	64,871	36.6	64,521	35.7	67,919	36.8
Total	175,199	100.0	177,005	100.0	180,831	100.0	184,589	100.0

► Analysis on science- and technology-related R&D programs and national defense R&D programs

► Source: MSIT · KISTEP, Governmental R&D Survey and Analysis

30 GOVERD by region in Korea



	2015		2016		2017		2018	
	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)	GOVERD (100 million KRW)	Percentage (%)
Seoul	36,485	20.1	35,925	19.6	37,019	19.2	36,175	18.5
Busan	6,078	3.3	6,572	3.6	7,798	4.0	8,765	4.5
Daegu	5,465	3.0	5,661	3.1	6,104	3.2	6,233	3.2
Incheon	4,174	2.3	4,385	2.4	4,281	2.2	4,087	2.1
Gwangju	4,560	2.5	4,573	2.5	4,469	2.3	4,474	2.3
Daejeon	54,584	30.0	56,115	30.6	55,630	28.9	56,655	28.9
Ulsan	2,808	1.5	2,691	1.5	2,836	1.5	3,031	1.5
Sejong	3,682	2.0	4,170	2.3	4,234	2.2	4,696	2.4
Gyeonggi	26,112	14.4	23,740	12.9	26,326	13.7	24,763	12.7
Gangwon	2,673	1.5	2,654	1.4	2,781	1.4	2,804	1.4
Chungbuk	4,820	2.7	4,962	2.7	5,446	2.8	5,863	3.0
Chungnam	4,662	2.6	4,843	2.6	4,861	2.5	5,301	2.7
Jeonbuk	5,154	2.8	6,712	3.7	7,642	4.0	7,238	3.7
Jeonnam	3,005	1.7	3,057	1.7	2,736	1.4	2,724	1.4
Gyeongbuk	7,006	3.9	6,165	3.4	6,451	3.3	6,299	3.2
Gyeongnam	9,403	5.2	9,721	5.3	12,832	6.7	15,351	7.8
Jeju	1,136	0.6	1,410	0.8	1,242	0.6	1,286	0.7
Total	181,807	100.0	183,355	100.0	192,687	100.0	195,744	100.0

▶ Subject: Government R&D programs classified by region (except overseas and others)

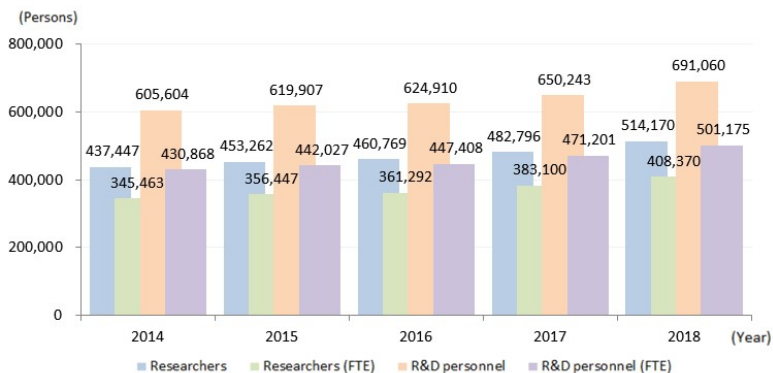
▶ Source: MSIT · KISTEP, Governmental R&D Survey and Analysis

III

R&D Personnel

4. R&D Personnel

31 Total researchers and total R&D personnel in Korea



► Source: MSIT-KISTEP, Survey of Research and Development in Korea

32 Total researchers and total R&D personnel in major countries (FTE)

		2015	2016	2017	2018
Total researchers (FTE)	Korea	356,447	361,292	383,100	408,370
	USA	1,369,267	1,371,290		
	Japan	662,071	665,566	676,292	
	Germany	387,982	399,605	419,617	
	France	277,631		288,579	
	UK	284,483	288,922	289,674	
	China	1,619,028	1,692,176	1,740,442	
Total R&D personnel (FTE)	Korea	442,027	447,408	471,201	501,175
	Japan	875,005	872,340	890,749	
	Germany	640,516	657,894	686,349	
	France	428,643		434,670	
	UK	413,860	417,390	424,510	
	China	3,758,848	3,878,057	4,033,597	

► Source: OECD, MSTI 2019-1 (stats.oecd.org)
MSIT-KISTEP, Survey of Research and Development in Korea

- 33 Total researchers per 10,000 population, per 1,000 total employment and per 1,000 labor force (FTE) in Korea

	2015	2016	2017	2018
Total researchers (FTE)	356,447	361,292	383,100	408,370
Total researchers per 10,000 population (FTE)	69.9	70.5	74.5	79.1
Total researchers per 1,000 total employee (FTE)	13.7	13.8	14.4	15.3
Total researchers per 1,000 labor force (FTE)	13.2	13.3	13.9	14.7

► Source: MSIT · KISTEP, Survey of Research and Development in Korea

- 34 Total researchers per 10,000 population, per 1,000 total employment and per 1,000 labor force (FTE) in major countries

	Korea ('18)	USA ('16)	Japan ('17)	Germany ('17)	France ('17)	UK ('17)	China ('17)
Researchers per 10,000 population (FTE)	79.1	42.4	53.4	50.8	43.0	43.9	12.5
Researchers per 1,000 total employment (FTE)	15.3	8.9	10.0	9.5	10.3	9.0	2.2
Researchers per 1,000 labor force (FTE)	14.7	8.5	10.1	9.7	9.7	8.7	2.2

► Source: OECD, MSTI 2019–1 (stats.oecd.org)
MSIT·KISTEP, Survey of Research and Development in Korea

- 35 Researchers by sector of employment in Korea

	2015		2016		2017		2018	
	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Business enterprises	317,842	70.1	321,323	69.7	343,367	71.1	368,237	71.6
Universities	99,870	22.0	103,166	22.4	102,877	21.3	108,529	21.1
Public research institutes	35,550	7.8	36,280	7.9	36,552	7.6	37,404	7.3
Total	453,262	100.0	460,769	100.0	482,796	100.0	514,170	100.0

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

- 36 Percentage of researchers (FTE) by sector of employment in major countries (%)

	Korea ('18)	Japan ('17)	France ('17)	UK ('17)	China ('17)
Business enterprises	82.0	73.7	60.3	37.9	60.7
Universities	10.0	20.5	28.3	58.2	18.8
Public research institutes	8.0	5.7	11.5	3.9	20.5

► Source: OECD, Research and Development Statistics, 2019 (stats.oecd.org)
MSIT·KISTEP, Survey of Research and Development in Korea, 2018

37 Women researchers in Korea

	2015	2016	2017	2018
Total researchers	453,262	460,769	482,796	514,170
Women researchers	85,652	90,615	97,042	104,728
Women researchers as a percentage of total researchers (%)	18.9	19.7	20.1	20.4

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

38 Women researchers in major countries

	Korea (^{'18})	Japan (^{'17})	Germany (^{'17})	France (^{'15})	UK (^{'16})
Women researchers	104,728	150,545	173,700	103,521	197,576
As a percentage of total researchers (%)	20.4	16.2	27.9	27.0	38.7

► Source: OECD, MSTI 2019–1 (stats.oecd.org)
MSIT·KISTEP, Survey of Research and Development in Korea, 2018

39 Distribution of researchers by sector of employment and qualification in Korea (2018)



► Source: MSIT·KISTEP, Survey of Research and Development in Korea, 2018

40 Researchers by qualification in Korea

	2015		2016		2017		2018	
	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Doctor	98,578	21.7	99,980	21.7	103,582	21.5	105,930	20.6
Master	129,264	28.5	132,595	28.8	137,996	28.6	144,399	28.1
Bachelor	199,019	43.9	200,189	43.4	214,752	44.5	233,922	45.5
Others	26,401	5.8	28,005	6.1	26,466	5.5	29,919	5.8
Total	453,262	100.0	460,769	100.0	482,796	100.0	514,170	100.0

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

41 Researchers by field of study in Korea

	2015		2016		2017		2018	
	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Natural science	57,976	12.8	56,710	12.3	67,736	14.0	72,884	14.2
Engineering	308,230	68.0	312,987	67.9	322,952	66.9	344,916	67.1
Medicine & health	24,066	5.3	26,347	5.7	27,911	5.8	29,774	5.8
Agricultural science	11,045	2.4	11,378	2.5	10,423	2.2	10,991	2.1
Humanities	23,996	5.3	24,734	5.4	26,576	5.5	27,931	5.4
Social science	27,949	6.2	28,613	6.2	27,198	5.6	27,674	5.4
Total	453,262	100.0	460,769	100.0	482,796	100.0	514,170	100.0

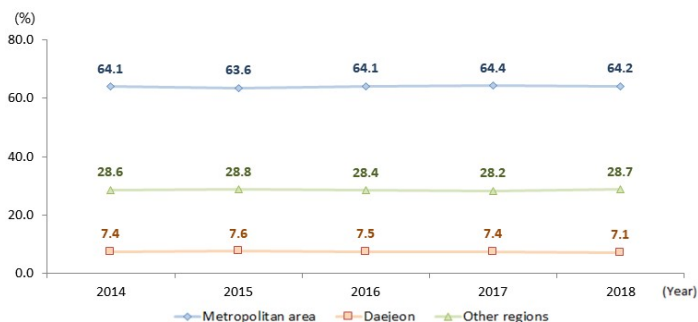
► Source: MSIT·KISTEP, Survey of Research and Development in Korea

42 Researchers by age in Korea

	2015		2016		2017		2018	
	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Under 29	71,321	15.7	71,915	15.6	73,767	15.3	76,906	15.0
30~39	197,405	43.6	197,353	42.8	201,623	41.8	208,607	40.6
40~49	124,813	27.5	128,691	27.9	139,118	28.8	151,436	29.5
50~59	48,835	10.8	50,515	11.0	54,136	11.2	61,146	11.9
Over 60	10,888	2.4	12,295	2.7	14,152	2.9	16,075	3.1
Total	453,262	100.0	460,769	100.0	482,796	100.0	514,170	100.0

► Source: MSIT·KISTEP, Survey of Research and Development in Korea

43 Researchers by region in Korea



	2015		2016		2017		2018	
	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Seoul	105,714	23.3	110,080	23.9	118,541	24.6	127,350	24.8
Busan	15,544	3.4	14,683	3.2	14,371	3.0	16,356	3.2
Daegu	11,756	2.6	11,453	2.5	11,781	2.4	13,429	2.6
Incheon	17,613	3.9	18,435	4.0	19,635	4.1	20,197	3.9
Gwangju	8,254	1.8	8,485	1.8	7,722	1.6	9,472	1.8
Daejeon	34,264	7.6	34,509	7.5	35,745	7.4	36,361	7.1
Ulsan	6,987	1.5	7,372	1.6	7,807	1.6	8,422	1.6
Sejong	3,565	0.8	3,562	0.8	4,109	0.9	4,064	0.8
Gyeonggi	165,118	36.4	166,737	36.2	172,583	35.7	182,654	35.5
Gangwon	6,295	1.4	5,886	1.3	6,668	1.4	6,730	1.3
Chungbuk	11,329	2.5	11,505	2.5	12,324	2.6	13,405	2.6
Chungnam	17,572	3.9	17,362	3.8	17,139	3.5	17,823	3.5
Jeonbuk	8,732	1.9	9,172	2.0	9,126	1.9	9,653	1.9
Jeonnam	4,229	0.9	4,199	0.9	4,493	0.9	5,106	1.0
Gyeongbuk	18,002	4.0	17,873	3.9	19,335	4.0	19,412	3.8
Gyeongnam	16,740	3.7	17,722	3.8	19,584	4.1	21,908	4.3
Jeju	1,548	0.3	1,734	0.4	1,833	0.4	1,828	0.4
Total	453,262	100.0	460,769	100.0	482,796	100.0	514,170	100.0

▶ Source: MSIT·KISTEP, Survey of Research and Development in Korea

44 Researchers by company types in Korea

	2015		2016		2017		2018	
	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Large corp.	154,809	48.7	155,658	48.4	115,791	33.7	118,022	32.1
Medium					54,408	15.8	55,683	15.1
Small	87,166	27.4	89,384	27.8	92,427	26.9	99,748	27.1
Start-up	75,867	23.9	76,281	23.7	80,741	23.5	94,784	25.7
Total	317,842	100.0	321,323	100.0	343,367	100.0	368,237	100.0

▶ Small-medium sized business (SME) here does not include start-ups (SMEs are broadly accepted as the combination of SMEs and start-ups shown above)

▶ Careful analysis is recommended as medium enterprises are included in the survey since 2017

▶ Source: MSIT-KISTEP, Survey of Research and Development in Korea

45 Researchers by industry in Korea

구 분		2016	2017	2018
Number of researchers	Manufacturing	248,169	263,045	277,250
	Coke, refined petroleum products, chemicals and chemical products, rubber and plastic products	33,497	36,424	39,679
	Electrical machinery and apparatus, radio, TV and communications equipment	93,061	95,736	97,686
	Motor vehicles and trailers	34,087	36,387	38,061
	Services	63,165	69,703	79,777
Percentage (%)	Manufacturing	77.2	76.6	75.3
	Coke, refined petroleum products, chemicals and chemical products, rubber and plastic products	10.4	10.6	10.8
	Electrical machinery and apparatus, radio, TV and communications equipment	29.0	27.9	26.5
	Motor vehicles and trailers	10.6	10.6	10.3
	Services	19.7	20.3	21.7

▶ Source: MSIT-KISTEP, Survey of Research and Development in Korea, 2018

46 Researcher and doctoral researcher intensity of the top companies in Korea (%)

		2015	2016	2017	2018
Researchers	Top 5 companies	22.7	22.6	21.9	20.3
	Top 10 companies	27.0	26.6	26.1	24.2
	Top 20 companies	30.2	29.8	29.3	27.3
Doctoral researchers	Top 5 companies	34.3	32.3	33.1	33.8
	Top 10 companies	42.0	39.2	39.7	40.2
	Top 20 companies	47.0	45.1	45.5	45.6

▶ Researcher and doctoral researcher intensities were calculated by the order of the highest from each category

▶ Source: MSIT-KISTEP, Survey of Research and Development in Korea

47 Principal investigators of government R&D programs by sector, gender, and degree in Korea

		2015		2016		2017		2018	
		Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)	Researchers	Percentage (%)
Sector	Research institutes	5,612	16.3	5,690	16.0	5,829	14.2	5,970	13.7
	Universities	16,983	49.2	17,228	48.3	20,668	50.5	21,639	49.5
	Business enterprises	10,315	29.9	11,002	30.9	12,892	31.5	14,512	33.2
	Others	1,553	4.5	1,654	4.6	1,498	3.7	1,519	3.5
	Ministries	46	0.1	61	0.2	61	0.1	60	0.1
	Total	34,509	100.0	35,635	100.0	40,948	100.0	43,700	100.0
Gender	Male	29,309	85.8	30,102	85.4	34,013	83.9	36,002	83.2
	Female	4,836	14.2	5,147	14.6	6,533	16.1	7,252	16.8
	Total	34,145	100.0	35,249	100.0	40,546	100.0	43,254	100.0
Degree	Doctor	24,194	70.9	25,102	71.2	29,284	72.2	30,122	69.6
	Master	4,929	14.4	4,936	14.0	4,711	11.6	5,122	11.8
	Bachelor and under	5,022	14.7	5,211	14.8	6,551	16.2	8,010	18.5
	Total	34,145	100.0	35,249	100.0	40,546	100.0	43,254	100.0

► Analysis includes principal investigators in science and technology R&D programs (excludes R&D programs for humanities and social sciences, and classified national security R&D programs)

► For programs by sector, individuals with multiple affiliations were counted multiple times

► Source: MSIT·KISTEP, Governmental R&D Survey and Analysis

48 Current and shortfall of S&T industry personnel in Korea

구 분	2015	2016	2017
Current personnel	1,594,398	1,617,053	1,634,346
Shortfall of personnel	36,933	36,271	36,908
Percentage of shortfall (%)	2.3	2.2	2.2

► Source: MOTIE, Survey Reports on S&T Industry Personnel

5. Nurturing Human Capital

49 Number of students enrolled in bachelor's, master's and doctoral programs in Korea

		2016	2017	2018	2019
Bachelor's program	Total	1,949,611	1,912,012	1,904,364	1,893,882
	Science & engineering	693,528	686,597	691,435	694,897
	Percentage of science & engineering (%)	35.6	35.9	36.3	36.7
Master's program	Total	223,830	218,096	214,413	277,372
	Science & engineering	46,662	45,128	45,099	44,749
	Percentage of science & engineering (%)	20.8	20.7	21.0	16.1
Doctoral program	Total	64,435	64,345	64,479	65,828
	Science & engineering	29,479	29,294	29,052	28,851
	Percentage of science & engineering (%)	45.7	45.5	45.1	43.8

► Science & engineering is the sum of students in natural sciences and engineering majors. Bachelor's program is the sum of 2/3-year curricula and 4-year curricula. Number of enrolled students excludes students on leave

► Source: MOE, Statistical Yearbook of Education (kess.vedi.re.kr)

50 Number of science and engineering graduates with master's and doctoral degrees in Korea

		2016	2017	2018	2019
Master's degree	Total	81,460	83,519	82,837	82,137
	Science & engineering	20,076	20,780	20,267	20,076
	Percentage of science & engineering (%)	24.6	24.9	24.5	24.4
Doctoral degree	Total	13,882	14,316	14,674	15,308
	Science & engineering	5,978	6,177	6,351	6,713
	Percentage of science & engineering (%)	43.1	43.1	43.3	43.9

► Science & engineering is the sum of students in natural sciences and engineering majors

► Source: MOE, Statistical Yearbook of Education (kess.vedi.re.kr)

51 New doctorates in natural sciences and engineering as a percentage of all graduates in major countries (% , 2017)

	Korea	USA	Japan	Germany	France	UK
New doctorates in natural sciences and engineering as a percentage of all doctorate graduates	37.7	38.8	36.8	42.3	57.0	43.8

► Science & engineering is the sum of students in natural sciences and engineering majors, and natural sciences here means field 4 (science, comprising the life sciences, physical sciences, mathematics and statistics and computing) in ISCED2011

► Source: OECD, Education at a Glance 2019 (www.oecd-ilibrary.org)

52 Tertiary education graduates in natural sciences and engineering as a percentage of all graduates in major countries (%)

	Korea	USA	Japan	Germany	France	UK
2016	29.9	17.9	21.1	36.1	25.6	26.3
2017	29.4	18.6	21.6	35.6	25.8	26.4

► Tertiary education graduate school indicates all forms of institutes with the purpose of official tertiary education regardless of legal status

► Source: OECD, Education at a Glance 2019 (www.oecd-ilibrary.org)

IV

R&D Performance

6. Publications

53 Number of papers published in SCI journals in Korea

	2015	2016	2017	2018
Number of papers published	58,849	60,475	61,172	63,311
World share (%)	3.52	3.49	3.41	3.52
World ranking	12	12	12	12

▶ World share (%) is the relative share to the total number of papers published worldwide. It is different from the relative share to the sum of the number of papers published yearly by each nation, which is greater than the total number of papers published worldwide due to papers co-authored by multiple countries.

▶ Source: KISTEP·KAIST, SCI Analysis Research (2004–2018)

54 Number of papers published in SCI journals in major countries

		2015	2016	2017	2018
Korea	Number of papers	58,849	60,475	61,172	63,311
	World share (%)	3.52	3.49	3.41	3.52
	World ranking	12	12	12	12
USA	Number of papers	437,060	450,754	460,899	450,352
	World share (%)	26.16	25.99	25.72	25.01
	World ranking	1	1	1	1
Japan	Number of papers	80,235	83,259	84,762	84,689
	World share (%)	4.80	4.80	4.73	4.70
	World ranking	5	5	5	5
Germany	Number of papers	113,935	119,396	122,249	121,119
	World share (%)	6.82	6.88	6.82	6.73
	World ranking	4	4	4	4
France	Number of papers	78,475	81,841	82,541	80,453
	World share (%)	4.70	4.72	4.61	4.47
	World ranking	6	6	6	6
UK	Number of papers	132,527	139,568	145,209	141,426
	World share (%)	7.93	8.05	8.10	7.86
	World ranking	3	3	3	3
China	Number of papers	282,587	312,625	348,022	397,717
	World share (%)	16.91	18.02	19.42	22.09
	World ranking	2	2	2	2

▶ World share (%) is the relative share to the total number of papers published worldwide. It is different from the relative share to the sum of the number of papers published yearly by each nation, which is greater than the total number of papers published worldwide due to papers co-authored by multiple countries.

▶ Source: KISTEP·KAIST, SCI Analysis Research (2004–2018)

55 Number of papers published in SCI journals per 10,000 population or per 100 researchers (FTE) in Korea

	2015	2016	2017	2018
Number of papers (SCI) per 10,000 population	11.54	11.80	11.89	12.26
Number of papers (SCI) per 100 researchers (FTE)	16.51	16.74	15.97	15.50

► Source: OECD, Main Science & Technology Indicators 2019-1 (stats.oecd.org)
KISTEP·KAIST, SCI Analysis Research (2004–2018)

56 Number of papers published in SCI journals per 10,000 population or per 100 researchers (FTE) in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China
Number of papers (SCI) per 10,000 population	12.26	13.73	6.70	14.61	11.96	21.28	2.50 ('17)
Number of papers (SCI) per 100 researchers (FTE)	15.50	32.87 ('16)	12.53 ('17)	29.13 ('17)	28.60 ('17)	50.13 ('17)	20.00 ('17)

► Source: OECD, Main Science & Technology Indicators 2019-1 (stats.oecd.org)
KISTEP·KAIST, SCI Analysis Research (2004–2018)

57 Average citations per paper over five-year periods in Korea

	2011–2015	2012–2016	2013–2017	2014–2018
Average citations per paper over five-year periods	5.43	5.79	6.02	6.36
World average of citations	5.49	5.68	5.85	6.04

► Average citations per paper over five-year periods are the average number of cumulative citations over the five-year periods from the year of publication

► Source: KISTEP·KAIST, SCI Analysis Research (2004–2018)

58 Average citations per paper over five-year period in major countries (2014–2018)

Korea	USA	Japan	Germany	France	UK	China
6.36	8.21	6.34	8.64	8.41	8.49	6.59

► Average citations per paper over five-year period are the average number of cumulative citations over the five-year period from the year of publication

► Source: KISTEP·KAIST, SCI Analysis Research (2004–2018)

59 Number of papers published in top 3 journals in Korea

	2015	2016	2017	2018
NATURE	19	23	27	28
SCIENCE	23	20	23	35
CELL	7	5	2	12
Total	49	48	52	75

► Only full-length papers (Articles and Reviews) were counted

► Source: KISTEP·KAIST, SCI Analysis Research (2004–2018)

60 Number of papers published by region in Korea (2018)

	Co-authorship		First authorship	
	Number of papers	Percentage (%)	Number of Papers	Percentage (%)
Seoul	31,895	33.4	20,669	39.9
Gyeonggi	13,906	14.5	6,784	13.1
Daejeon	9,691	10.1	4,970	9.6
Busan	4,704	4.9	2,595	5.0
Gyeongbuk	4,407	4.6	2,206	4.3
Daegu	4,101	4.3	2,112	4.1
Incheon	3,871	4.0	1,753	3.4
Gangwon	3,367	3.5	1,721	3.3
Gwangju	3,371	3.5	1,467	2.8
Gyeongnam	3,318	3.5	1,582	3.1
Jeonbuk	3,339	3.5	1,574	3.0
Chungnam	2,679	2.8	1,191	2.3
Chungbuk	2,572	2.7	1,047	2.0
Ulsan	2,026	2.1	1,092	2.1
Jeonnam	1,097	1.1	460	0.9
Jeju	687	0.7	328	0.6
Sejong	518	0.5	228	0.4
Others	71	0.1	26	0.1
Total	95,620	100.0	51,805	100.0

► Source: KISTEP·KAIST, SCI Analysis Research (2004–2018)

7. Patents

61 Domestic patent applications and patent grants in Korea

	2015	2016	2017	2018
Patent applications	213,694	208,830	204,775	209,992
Patent grants	101,873	108,875	120,662	119,012

► Source: KIPO, Intellectual Property Statistics (kipo.go.kr)

62 Domestic patent applications and patent grants by region in Korea

	Patent applications				Patent grants			
	2015	2016	2017	2018	2015	2016	2017	2018
Seoul	48,030	47,288	45,482	47,123	22,305	25,087	27,527	25,224
Busan	5,786	5,989	6,422	6,172	2,281	2,527	3,061	3,412
Daegu	4,864	4,735	4,779	4,619	2,043	2,365	2,612	2,519
Incheon	6,633	5,989	6,195	6,236	3,214	3,307	3,400	3,499
Gwangju	3,074	3,321	3,279	3,431	1,298	1,410	1,694	1,765
Daejeon	11,283	10,811	10,734	10,767	5,238	5,492	6,503	5,877
Ulsan	2,553	2,421	2,267	2,347	911	1,016	1,269	1,308
Sejong	462	548	736	811	198	249	307	394
Gyeonggi	52,542	48,764	46,133	47,175	22,750	23,381	24,820	25,440
Gangwon	2,571	2,410	2,572	2,666	1,090	1,291	1,459	1,479
Chungbuk	3,440	3,498	3,166	3,509	1,431	1,670	1,861	1,921
Chungnam	6,309	6,578	6,046	6,482	2,996	3,008	3,492	3,808
Jeonbuk	4,007	3,993	4,121	3,995	1,338	1,468	1,860	1,995
Jeonnam	2,660	2,700	2,902	3,223	1,079	1,201	1,616	1,605
Gyeongbuk	6,858	7,048	6,764	6,634	4,491	4,594	4,633	4,176
Gyeongnam	5,548	6,625	6,609	6,521	2,840	3,538	3,738	3,751
Jeju	630	689	817	837	290	305	384	412
Others	23	17	7	13	525	491	611	642
Total	167,273	163,424	159,031	162,561	76,318	82,400	90,847	89,227

► Refers to the first applicant's/patent holder's address

► 'Others' include those who are Korean citizens but do not have an address in Korea (overseas residents, soldiers, etc.)

► Source: KIPO, Intellectual Property Statistics (kipo.go.kr)

63 Number of triadic patent families in Korea

	2014	2015	2016	2017
Triadic patent families	2,400	2,314	2,447	2,428
Triadic patent families per million population	47.3	45.4	47.8	47.2
Triadic patent families per 10,000 researchers (FTE)	69.5	64.9	67.7	63.4

► Triadic patent families: Patents applied to EPO and JPO, and granted by USPTO

► Source: OECD, MSTI 2019–1 (stats.oecd.org)

64 Number of triadic patent families in major countries (2017)

	Korea	USA	Japan	Germany	France	UK	China
Triadic patent families	2,428	12,021	17,591	4,531	2,315	1,612	4,215
Triadic patent families per million population	47.2	36.9	138.8	54.8	34.5	24.4	3.0
Triadic patent families per 10,000 researchers (FTE)	63.4	89.5 ('16)	260.1	108.0	80.2	55.7	24.2

► Source: OECD, MSTI 2019–1 (stats.oecd.org)

65 Number of patent applications to and grants from the USPTO in Korea

	2015	2016	2017	2018
Patent applications	38,205	37,341	35,565	33,961
Patent grants	17,924	19,494	20,717	19,780

► The number of patent applications: Utility Patents by their filing year

► Source: WIPO, WIPO Statistics Database, 2019.11 (ipstats.wipo.int)

66 Number of patent applications to and grants from the USPTO in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China
Patent applications	33,961	285,095	85,322	30,691	12,290	13,681	32,615
Patent grants	19,780	144,413	47,566	16,032	6,469	6,616	14,488

► The number of patent applications: Utility Patents by their filing year

► Country: Nationality of the first patentee, Hong Kong and Macao are not included in China

► Source: WIPO, WIPO Statistics Database, 2019.11 (ipstats.wipo.int)

67 Top 10 companies granted U.S. Patents

Rank	2017		2018	
	Number of patents	Company	Number of patents	Company
1	9,043	INTERNATIONAL BUSINESS MACHINES CORPORATION	9,100	INTERNATIONAL BUSINESS MACHINES CORPORATION
2	5,837	SAMSUNG ELECTRONICS CO., LTD.	5,850	SAMSUNG ELECTRONICS CO., LTD.
3	3,285	CANON KABUSHIKI KAISHA	3,056	CANON KABUSHIKI KAISHA
4	3,023	INTEL CORPORATION	2,735	INTEL CORPORATION
5	2,701	LG ELECTRONICS INC.	2,474	LG ELECTRONICS INC.
6	2,628	QUALCOMM, INC.	2,465	TAIWAN SEMICONDUCTOR MANUFACTURING
7	2,457	GOOGLE LLC	2,353	MICROSOFT TECHNOLOGY LICENSING LLC
8	2,441	MICROSOFT TECHNOLOGY LICENSING LLC	2,300	QUALCOMM, INC.
9	2,425	TAIWAN SEMICONDUCTOR MANUFACTURING	2,160	APPLE INC.
10	2,273	SAMSUNG DISPLAY Co., Ltd.	2,123	FORD GLOBAL TECHNOLOGIES LLC

► Source: USPTO ([uspto.gov](https://www.uspto.gov))

68 Number of patent applications to and grants from the EPO in Korea

	2015	2016	2017	2018
Patent applications	6,407	6,687	6,457	7,296
Patent grants	1,993	3,210	4,435	6,262

► Source: EPO, Annual Report 2018 ([epo.org](https://www.epo.org))

69 Number of patent applications to and grants from the EPO in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China
Patent applications	7,296	43,612	22,615	26,734	10,317	5,736	9,401
Patent grants	6,262	31,136	21,343	20,804	8,610	3,827	4,831

► Source: EPO, Annual Report 2018 (epo.org)

70 Number of patent applications filed under the PCT in Korea

2015	2016	2017	2018
14,564	15,555	15,751	16,948

► PCT (Patent Cooperation Treaty): International patent law treaty that provides a unified procedure for filing patent applications to protect inventions in each of its contracting states

► Source: WIPO, WIPO Statistics Database, 2019.11 (ipstats.wipo.int)

71 Number of patent applications filed under the PCT in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China
PCT	16,948	56,221	49,709	19,748	7,919	5,633	53,348
Rank	5	1	3	4	6	7	2

► Source: WIPO, WIPO Statistics Database, 2019.11 (ipstats.wipo.int)

72 Number of patent applications filed under the PCT in the ICT and biotechnology sector in major countries (2017)

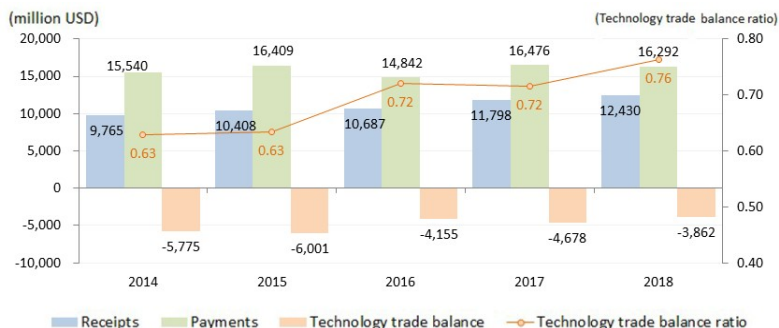
	Korea	USA	Japan	Germany	France	UK	China
ICT	5,317	17,831	11,840	2,850	1,335	1,459	23,368
Biotechnology	881	5,883	1,684	645	523	518	1,234

► The number of patent applications was from OECD data (priority year) for comparison of the same standard

► Source: OECD, MSTI 2019–1 (stats.oecd.org)

8. Technology Trade

73 Technology balance of payments in Korea



	2015	2016	2017	2018
Receipts (million USD)	10,408	10,687	11,798	12,430
Payments (million USD)	16,409	14,842	16,476	16,292
Technology trade balance (million USD)	-6,001	-4,155	-4,678	-3,862
Technology trade balance ratio (Receipts/Payments)	0.63	0.72	0.72	0.76

▶ Source: Statistics Report on the Technology Trade of Korea, published by MSTI · Korea Industrial Technology Association (www.kolta.or.kr)

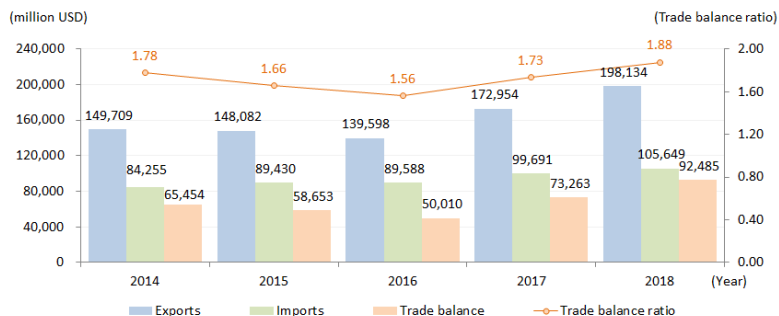
74 Technology balance of payments by industry in Korea

	Receipts (million USD)		Payments (million USD)		Balance of payments (million USD)		Balance of payments ratio (Receipts/Payments)	
	2017	2018	2017	2018	2017	2018	2017	2018
ICT	4,597	5,157	8,516	3,528	515	1,629	1.13	1.46
Electrical · electronics	4,315	4,036	4,082	8,419	-4,200	-4,383	0.51	0.48
Machine	1,308	1,406	1,593	1,733	-285	-327	0.82	0.81
Chemistry	332	302	532	702	-200	-400	0.62	0.43
Construction	134	58	366	81	35	-23	1.35	0.71
Agriculture, forestry and fisheries	64	78	175	168	-111	-90	0.36	0.46
Textiles	64	382	103	345	-302	37	0.17	1.11
Materials	15	16	99	233	-88	-218	0.15	0.07
Others	970	996	1,011	1083	-41	-87	0.96	0.92

▶ Source: Statistics Report on the Technology Trade of Korea, published by MSTI · Korea Industrial Technology Association (www.kolta.or.kr)

9. International Trade in High-Tech Industries

75 International trade in R&D-intensive industries of Korea



	2015	2016	2017	2018
Exports (million USD)	148,082	139,598	172,954	198,134
Imports (million USD)	89,430	89,588	99,691	105,649
Trade balance (million USD)	58,653	50,010	73,263	92,485
Trade balance ratio (Exports/Imports)	1.66	1.56	1.73	1.88

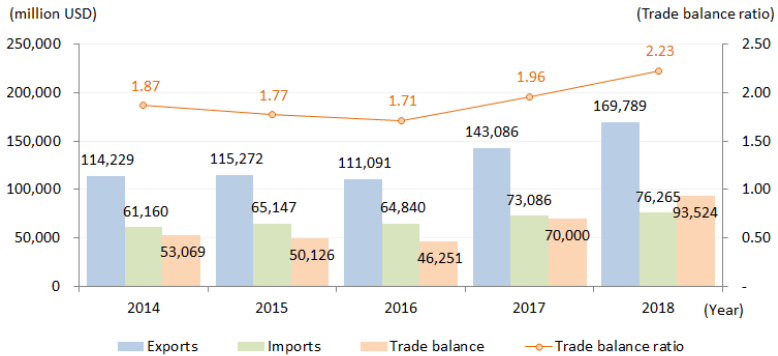
► R&D-intensive industries include pharmaceutical, computer, electronic and optical, and aerospace industries, as defined by OECD
 ► Source: OECD, MSTI 2019-1 (stats.oecd.org)

76 International trade in R&D-intensive industries of major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China ('17)
Exports (million USD)	198,134	398,409	114,156	290,045	138,953	107,483	696,581
Imports (million USD)	105,649	594,644	149,831	235,865	119,099	129,271	567,564
Trade balance (million USD)	92,485	-196,235	-35,675	54,180	19,854	-21,788	129,018
Trade balance ratio (Exports/Imports)	1.88	0.67	0.76	1.23	1.17	0.83	1.23

► R&D-intensive industries include pharmaceutical, computer, electronic and optical, and aerospace industries, as defined by OECD
 ► Source: OECD, MSTI 2019-1 (stats.oecd.org)

77 ICT industry trade in Korea



	2015	2016	2017	2018
Exports (million USD)	115,272	111,091	143,086	169,789
Imports (million USD)	65,147	64,840	73,086	76,265
Trade balance (million USD)	50,126	46,251	70,000	93,524
Trade balance ratio (Exports/Imports)	1.77	1.71	1.96	2.23

► Source: OECD, STAN Bilateral Trade Database ISIC4 ed, 2019 (stats.oecd.org)

78 ICT industry trade in major countries (2018)

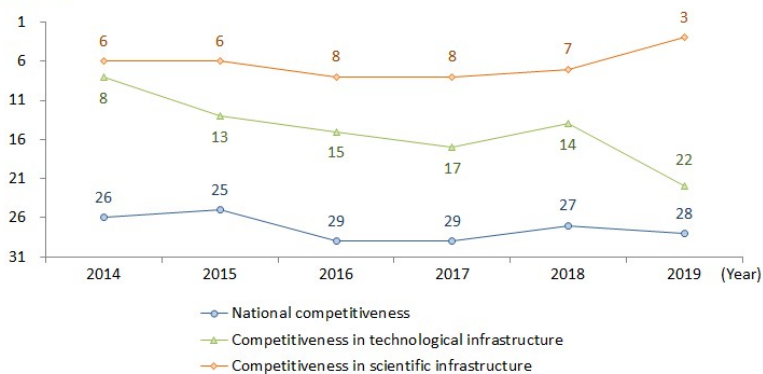
	Korea	USA	Japan	Germany	France	UK	China
Exports (million USD)	169,789	150,829	66,572	79,415	22,869	19,184	616,007
Imports (million USD)	76,265	357,233	89,698	113,661	40,769	54,627	429,411
Trade balance (million USD)	93,524	-206,403	-23,126	-34,246	-17,899	-35,443	186,596
Trade balance ratio (Exports/Imports)	2.23	0.42	0.74	0.70	0.56	0.35	1.43

► Source: OECD, STAN Bilateral Trade Database ISIC4 ed, 2019 (stats.oecd.org)

10. National Competitiveness

79 Competitiveness ranking of Korea (IMD)

(Ranking)



	2016	2017	2018	2019
Overall competitiveness	29	29	27	28
Economic performance	21	22	20	27
Government efficiency	26	28	29	31
Business efficiency	48	44	43	34
Infrastructure	22	24	18	20
– Scientific infrastructure	8	8	7	3
– Technological infrastructure	15	17	14	22

▶ Source: IMD, The World Competitiveness Yearbook (www.imd.org)

80 Competitiveness ranking of major countries (2019, IMD)

	Korea	USA	Japan	Germany	France	UK	China
Competitiveness	28	3	30	17	31	23	14
– Scientific infrastructure	3	1	6	5	12	11	2
– Technological infrastructure	22	6	20	23	9	12	2

▶ Source: IMD, The World Competitiveness Yearbook 2019 (www.imd.org)

81 Competitiveness ranking of Korea in scientific infrastructure (IMD)

	2016	2017	2018	2019
Total expenditure on R&D	6	5	5	5
Total expenditure on R&D as a percentage of GDP	1	2	2	1
Total expenditure on R&D per capita	14	13	14	9
Business expenditure on R&D	5	5	5	5
Business expenditure on R&D as a percentage of GDP	2	2	2	2
Total R&D personnel nationwide	6	5	6	6
Total R&D personnel nationwide per 1,000 people	8	8	8	5
Total R&D personnel in business enterprise	5	6	6	6
Total R&D personnel in business per 1,000 people	4	4	5	3
Researcher in R&D per 1,000 people	4	4	3	2
Percentage of total first university degrees in science and engineering	16	17	11	11
Scientific articles	9	9	9	9
Nobel prizes	28	29	29	29
Nobel prizes per 1,000,000 people	28	29	29	29
Number of patent applications	4	4	4	4
Number of patent applications filed per 100,000 inhabitants	3	3	3	3
Number of patents granted	4	4	4	4
Number of patents in force per 100,000 inhabitants	3	3	3	4
Medium- and high-tech value added	–	–	–	4
Laws relating to scientific research do encourage innovation*	34	34	37	34
Intellectual property rights are adequately enforced*	38	44	39	37
Knowledge transfer is highly developed between companies and universities*	34	32	29	35
Overall Ranking	8	8	7	3

► *Indicators by survey

► Source: IMD, The World Competitiveness Yearbook (www.imd.org)

82 Competitiveness ranking of Korea in technological infrastructure (IMD)

	2016	2017	2018	2019
Investment in telecommunications as a percentage of GDP	52	24	47	46
Mobile broadband subscribers	4	12	5	10
Monthly telephone costs per capita	50	54	52	57
Communications technology*	12	16	14	12
Computers in use (worldwide share)	11	11	11	11
Number of computers per 1,000 people	18	18	17	17
Number of internet users per 1,000 people	16	17	16	16
Number of broadband subscribers per 1,000 inhabitants	20	22	22	21
Internet bandwidth speed	1	1	1	27
Digital technology skills are readily available*		22	26	26
Qualified engineers are available in labor market*	34	32	32	31
Public and private sector ventures are supporting technological development*	36	29	37	41
Development and application of technology are supported by the legal environment*	51	47	52	50
Funding for technological development is readily available*	44	46	46	42
High-tech exports	5	6	6	8
High-tech exports as a percentage of manufactured exports	6	7	9	19
ICT as a percentage of total service exports	39	35	32	28
Cyber security is being adequately addressed by corporations*	45	49	24	23
Overall Ranking	15	17	14	22

► *Indicators by survey

► Source: IMD, The World Competitiveness Yearbook (www.imd.org)

83 Global competitiveness of Korea (WEF)

	2017	2018	2019
Global competitiveness	17	15	13
Institutions	28	27	26
Infrastructure	7	6	6
ICT adoption	1	1	1
Macroeconomic stability	1	1	1
Health	20	19	8
Skills	31	27	27
Product market	65	67	59
Labor market	47	48	51
Financial system	22	19	18
Market size	13	14	14
Business dynamism	22	22	25
Innovation capability	10	8	6

► New ranking was calculated by Global Competitiveness Index 4.0

► Source: WEF, The Global Competitiveness Report (www.weforum.org)

84 Global competitiveness ranking of major countries (2019, WEF)

Korea	USA	Japan	Germany	France	UK	China
13	2	6	7	15	9	28

► Source: WEF, The Global Competitiveness Report, 2019 (www.weforum.org)

85 Composite Science and Technology Innovation Index (COSTII) of Korea

	2016		2017		2018		2019	
	Indicator (Score)	Ranking	Indicator (Score)	Ranking	Indicator (Score)	Ranking	Indicator (Score)	Ranking
COSTII	12.322	5	11.440	7	11.558	7	11.424	7
Resource	1.823	5	1.918	7	1.942	6	2.016	6
Activities	3.777	3	3.637	3	3.998	3	4.156	2
Network	1.540	15	1.310	20	1.413	17	1.550	11
Environment	2.733	20	2.598	21	2.445	22	2.592	22
Performance	1.658	14	1.641	14	1.487	14	1.110	22

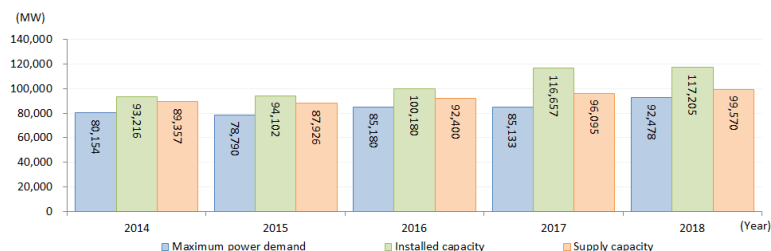
► Source: MSIT · KISTEP, COSTII, 2019

V

Other R&D Statistics

11. Energy and Resources

86 Electricity supply and demand in Korea



► Installed capacity and supply capacity is standardized by each year's time of occurrence for maximum power demand

► Source: KEPCO, Electric Power statistics (September, 2019) (home.kepcoco.kr)

87 Petroleum and LNG supply in Korea

		2015	2016	2017	2018
Petroleum	Crude oil imports (million barrels)	1,026	1,078	1,118	1,116
	Amount of crude oil imports (million USD)	55,120	44,295	59,603	80,393
LNG	Imports (1,000 tons)	33,366	33,453	37,537	44,015

► Source: Statistics Korea (Korea National Oil Corporation, Korea Gas Corporation, and Korea Customs) (www.index.go.kr)

88 Total primary energy supply per 1,000 USD of GDP in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China ('17)
Energy supply (toe)/ 1,000 USD (PPP)	0.15	0.13	0.09	0.08	0.10	0.07	0.15

► Source: OECD (2018), Primary energy supply (indicator)

89 Nuclear electricity as a percentage of total electricity generation in major countries (% , 2016)

Korea	USA	Japan	Germany	France	UK
28.8	19.4	1.7	13.0	72.5	21.1

► Source: International Energy Agency, World Energy Statistics 2018

90 Overseas natural resource exploitation in Korea

		2015	2016	2017	2018
Number of overseas resource exploitation programs (cumulative)	Petroleum/Gas	376	378	380	380
	– In progress	166	141	131	122
	* Production	78	81	79	73
	* Exploitation	25	19	12	11
	* Exploration	63	41	40	38
	– Completed programs	210	237	249	258
	General minerals	525	533	538	544
	– In progress	334	335	322	316
	– Completed programs	191	198	216	228
Self-sufficient exploitation ratio (%)	Petroleum/Gas	16.0	15.0	13.0	13.0
	Bituminous coal	53.0	50.0	38.0	30.0
	Iron	15.0	28.0	26.0	32.0
	Bronze	6.0	7.0	8.0	8.0
	Zinc	21.2	22.8	20.6	19.9
	Nickel	68.9	63.2	61.8	55.2

► Self-sufficient exploitation ratio indicates the percentage of resource developed and produced by domestic companies compared to total imports

► Source: Statistics Korea (Ministry of Trade, Industry & Energy) (www.index.go.kr)

12. Green Growth and Technology

91 Renewable energy supply in Korea (1,000 toe, %)

	2015	2016	2017	2018
Renewable energy supply	13,293	14,178	16,448	17,838
Supply percentage (%)	4.6	4.8	5.4	5.8
Solar heat	28	28	28	27
Sunlight	849	1,093	1,516	1,977
Bio	2,766	2,765	3,599	4,442
Waste	8,436	8,743	9,359	9,084
Water power	454	603	601	719
Wind power	283	355	462	525
Geothermal heat	135	162	184	205
Hydrogen/Fuel cell	230	242	313	376
Marine	105	105	104	103

► Supply percentage indicates the percentage of renewable energy in primary energy

► Solar heat refers to the facilities that utilize heat energy from the sun as the source of energy, and Sunlight refers to the facilities that utilize light energy from the sun to produce electricity

► Rounding figures at one decimal place might be possibly different from the source data such as KOSIS

► Source: Statistics Korea (New Renewable Energy Center) (www.index.go.kr)

92 Contribution of renewable energy to energy supply in major countries (% , 2018)

Korea	USA	Japan	Germany	France	UK	China ('17)
1.91	7.77	5.94	14.14	10.53	11.54	9.07

► Source: OECD (2018), Renewable energy (indicator)

93 CO₂ emissions in major countries (kg per PPP \$, 2018)

Korea	USA	Japan	Germany	France	UK	China
0.33	0.27	0.23	0.18	0.11	0.13	0.44

► Source: IEA, Data Services, 2019

94 R&D budget for energy and environment as a percentage of GBAORD in major countries (%)

	Korea ('17)	USA ('18)	Japan ('18)	Germany ('18)	France ('17)	UK ('17)
Environment	2.8	0.4	4.1	2.8	1.7	2.4
Energy	6.3	2.7	12.4	5.0	12.7	2.9
Environment and Energy	9.1	3.1	16.5	7.8	10.4	5.4

► Source: OECD, Research and Development Statistics, 2019 (stats.oecd.org)

13. Space**95** Space programs as a percentage of civil Government Budget Allocation for R&D (GBARD) in major countries

	Korea ('17)	USA ('18)	Japan ('18)	Germany ('18)	France ('18)	UK ('17)
Civil GBARD for space programs (million USD)	453	9,735	1,727	1,794	2,131	187
Space programs as a percentage of civil GBARD (%)	3.1	13.9	5.2	5.0	12.4	1.6

► Government R&D budget does not include national defense budget

► Source: OECD, MSTI 2019–1 (stats.oecd.org)

96 BERD performed in aerospace industry in major countries

	Korea ('15)	USA ('16)	Japan ('17)	Germany ('15)	France ('16)	UK ('16)
Aerospace industry R&D expenditure (million USD)	209	26,645	782	1,893	3,156	2,234
Percentage of aerospace industry R&D expenditure in BERD (%)	0.5	7.1	0.6	2.8	8.9	7.4

► Source: OECD, MSTI 2019–1 (stats.oecd.org)

14. Biotechnology**97** R&D expenditure in biotechnology by company in major countries

	Korea ('17)	USA ('17)	Germany ('18)	France ('17)
Biotechnology R&D expenditures in the business sector (million ppp \$)	1,729	51,637	1,572	3,792
Number of biotech R&D firms	945	1,772	820	2,082

► OECD, Key Biotechnology Indicators, October 2019 (<http://oe.cd/kbi>)

98 Biotechnology industry in Korea

		2015	2016	2017	2018
Industry trends (trillion KRW)	Output	8.50	9.26	10.15	10.48
	Domestic demand	5.63	6.09	6.55	7.00
	Exports	4.29	4.63	5.17	5.18
	Imports	1.41	1.46	1.57	1.71
Personnel	R&D personnel	12,782	13,151	14,143	14,888
	Production personnel	13,564	14,605	15,874	16,477
	Total	26,346	27,756	30,017	31,365

► R&D personnel indicates personnel for R&D in bio-industry

► Production personnel indicates personnel for production, facility and quality management in biotechnology

► Source: MOTIE, Korea Biotechnology Industry Organization, Report on Survey of Domestic Bioindustry

15. Economic and Social Indicators

99 Population and GDP per capita in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China ('17)
Population (thousands)	51,655	328,012	126,443	82,902	67,274	66,466	1,390,080
GDP per capita (USD)	31,351	62,480	39,313	48,211	41,287	42,506	8,736

► Source: OECD, MSTI 2019-1 (stats.oecd.org)

100 Labor force, total employment, and value added of industry in major countries (2018)

	Korea	USA	Japan	Germany	France	UK	China
Labor force (thousands)	27,723	163,503	68,042	43,262	29,860	33,674	806,860 ('17)
Total employment (thousands)	26,646	156,016	68,905	44,491	28,160	32,441	776,400 ('17)
Value added of industry (100 million USD)	11,027	129,967	36,102	25,363	15,859	17,025	99,659 ('18)

► Source: OECD, MSTI 2019-1 (stats.oecd.org)



Glossary

Abbreviation	Full name
EPO	European Patent Organization
IMD	International Institute for Management Development
ISIC	International Standard Industrial Classification
JPO	Japan Patent Office
KAIST	Korea Advanced Institute of Science and Technology
KEPCO	Korea Electric Power Corporation
KIPO	Korea Intellectual Property Office
KSIC	Korean Standard Industrial Classification
MOE	Ministry of Education
MOTIE	Ministry of Trade, Industry & Energy
MSIT	Ministry of Science and ICT
MSTI	Main Science and Technology Indicators
OECD	Organization for Economic Cooperation and Development
PCT	Patent Cooperation Treaty
PPP	Purchasing Power Parity
SCI	Science Citation Index
USPTO	United States Patent and Trademark Office
WEF	World Economic Forum
WIPO	World Intellectual Property Organization

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