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Bolstering South Korea's Role in Science and Engineering Research

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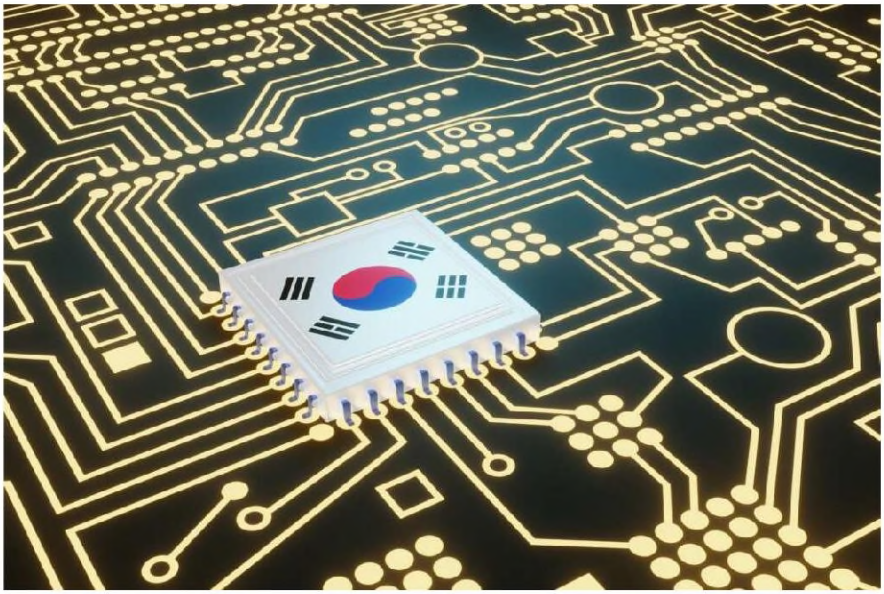

South Korea stands out for its investments in innovation, notably high enrollment rates in tertiary education and large investments in research and development (R&D) and patents. Nevertheless, labor productivity (output per worker) in South Korea was 23 percent below the average among OECD countries in 2021. Strengthening the innovation ecosystem and boosting the return on investment in innovation is crucial to raising South Korean productivity and sustaining its economic growth in the face of a shrinking working-age population. Better integration of R&D in the business sector, universities, and government research institutes (GRIs), as well as greater involvement in the international innovation system, would boost the return on South Korea's investments in innovation.

Increasing the quantity and quality of scientific research is another priority for South Korea. Research findings are disseminated primarily through the publication of peer-reviewed journal articles and conference proceedings. Published literature is thus an indicator of scientific activity and global research partnerships. Global data from the US National Science Foundation's *Publication Output: U.S. Trends and International Comparisons* shows a continued upward trend in worldwide research activity and a research ecosystem that has become increasingly internationally connected throughout the past few decades.

The number of science and engineering (S&E) articles produced worldwide in 2022 reached 3.3 million, 73 percent more than in 2010, based on the Scopus database of scientific literature with English-language titles and abstracts. High and middle-income countries accounted for 86 percent of the total number of articles in 2022. Notably,

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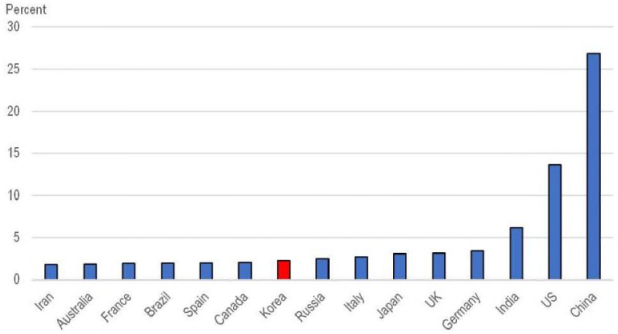
middle-income countries have significantly increased their share of articles. China, which surpassed the publication output of the United States in 2016, accounted for 27 percent of the world total in 2022, as shown in Figure 1. Moreover, India has risen to third place.

Figure 1. South Korea Ranked Ninth in the World in the Number of S&E Publications in 2022



Note: The 15 countries in the figure account for three-quarters of S&E publications in 2022. The data are based on the Scopus database, which includes non-English publications if they contain an English-language title and abstract. In the NSF calculation, the country of origin for each article is based on the location of the author. For articles with authors from two or more countries, each country is credited with a fraction of the article.

Source: Publications Output: U.S. Trends and International Comparisons | NSF – National Science Foundation.

International Comparisons of the Quantity and Quality of South Korea's Research Output Suggest Room for Improvement

South Korea's S&E publications increased at an average annual rate of 3.6 percent between 2010 and 2022, compared to the global annual rate of 4.7 percent. In 2022, South Korea ranked ninth in its S&E publications (see Figure 1), accounting for 2.3 percent of the world total, down from 2.6 percent in 2012.

In addition to the quantity of publications, it is essential to judge their scientific impact to assess the competitiveness of a country's research. An article that is referenced by a large number of subsequent articles by other authors is deemed to have a significant scientific impact. Similarly, countries whose authors produce a disproportionate share of the most highly cited articles are regarded as generating research with greater impact.

The NSF defines "highly cited articles" (HCAs) as the top 1 percent of all articles worldwide in terms of their accumulated citations in each scientific field. If 1 percent of a country's S&E articles qualify as an HCA, it has a score of 1.0 and is considered "on par" with the global scientific community. A country with an HCA share above 1.0 means more than 1 percent of its articles achieved HCA status, indicating that the nation's published research has disproportionately more impact relative to the total volume of articles produced. The US score has decreased in recent years as more S&E articles from China and India qualify as HCAs. The share of South Korea's S&E articles ranking in the top 1 percent rose from 0.68 percent in 2003 to 1.18 percent in 2020, shown in Panel A of Figure 2. While South Korea's share has risen since 2003, it remains below China, Iran, and all high-income countries except Japan (see Panel B of Figure 2).

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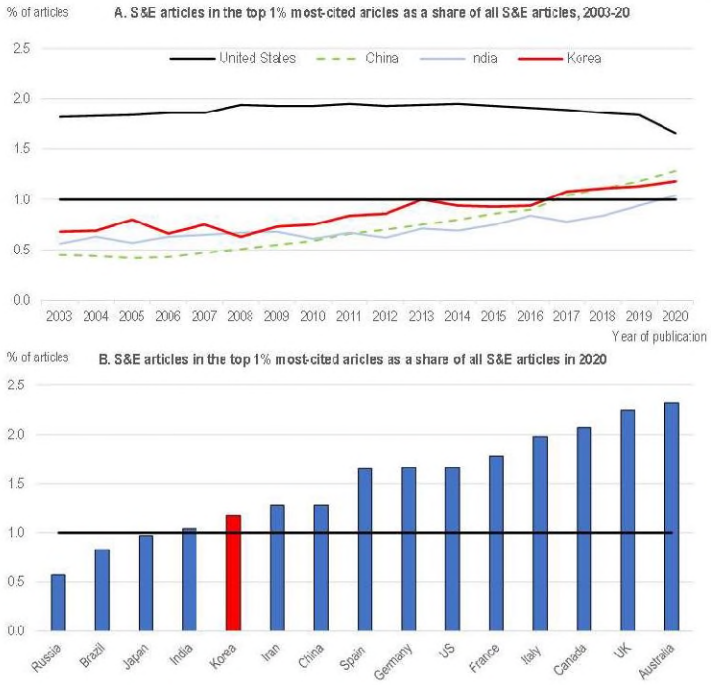
Figure 2. South Korea's Share of Highly Cited Articles Has Risen But Remains Relatively Low



Note: The figure includes the top 15 countries in terms of the number of S&E articles. Each HCA is attributed to a nation if at least one of its authors is located in that country. The world average is 1.0 for each year.

Source: Publications Output: U.S. Trends and International Comparisons | NSF – National Science Foundation.

South Korea Has Scope to Increase Its Integration in the International Research Ecosystem

International collaboration in research continues to expand. Globally, the share of articles with co-authors from multiple countries increased from one in seven in 2000 to nearly one in four articles in 2022. South Korea has also seen an upward trend in international cooperation in research since 2007, rising from 24 percent of its S&E articles to 33 percent in 2022 (see Panel A of Figure 3). For the top 15 countries shown in Figure 1, the share of articles resulting from international collaboration ranged from two-thirds for the United Kingdom to less than one-quarter for Russia, China, and India (see Panel B of Figure 3). South Korea thus ranks at the low end of internationalization of research, below all high-income countries except Japan. This reflects South Korea's exceptionally low levels of R&D funding from overseas.

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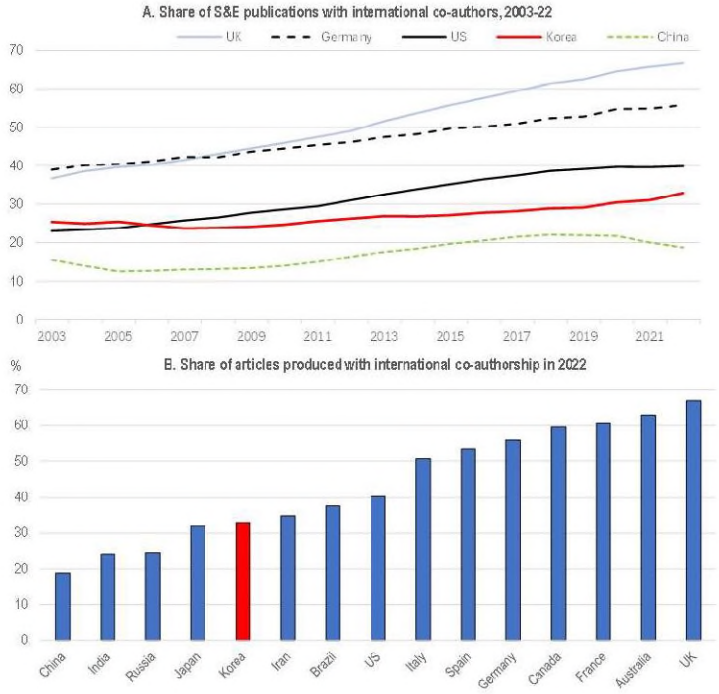
Figure 3. The Share of South Korea's Articles with International Co-authorship Has Risen But Remains Low



Note: Articles are credited on a whole count basis (i.e., each collaborating country is credited with one article).

Source: Publications Output: U.S. Trends and International Comparisons | NSF – National Science Foundation.

Research Cooperation Between the United States and South Korea

International co-authorship of S&E articles by researchers in the United States and South Korea is significant but one-sided, as seen below in Panel A of Figure 4. In 2003, South Korean researchers co-authored 4.5 percent of US international articles, while the US share of South Korean international articles was 56.2 percent. The gap between the two shares was the largest among the top producers of S&E research.

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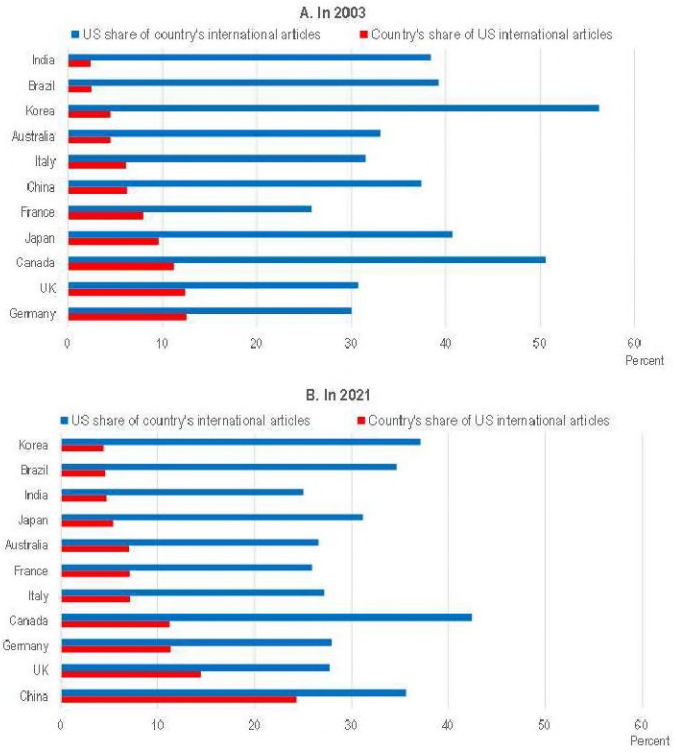
Figure 4. US-Korea Cooperation in International Co-authorship is Large But One-sided



Source: Publications Output: U.S. Trends and International Comparisons | NSF – National Science Foundation.

During the past few decades, the US share of South Korea's internationally co-authored S&E articles fell significantly to 37.2 percent in 2021, as China accounted for a significantly higher share of world publications (see Panel B of Figure 4). Still, the gap with South Korea's share of US international articles, which has remained constant at 4.5 percent since 2003, is still the largest in the world. The different focus of US and South Korean scientific research may impact joint authorship between the two countries. Research on health accounts for 38 percent of research publications in the United States and 25 percent in South Korea, while social science publications are 9 percent in the United States compared to 3 percent in South Korea. On the other hand, engineering accounts for 20 percent of South Korea's S&E publications compared to 11 percent in the United States. However, research collaboration between the United States and China is the largest in the world, even though the share of Chinese articles in the fields of health (14 percent) and social sciences (1 percent) is lower than South Korea.

Conclusion

The ability of GRIs and universities to perform outstanding research is a priority in South Korea's now that Korea has converged to the high-income countries. Increasing the quantity and quality of scientific and engineering publications is essential to increase the return on South Korean investments in innovation. Strengthening the ability of universities and GRIs to perform cutting-edge and critical basic research would further South Korea's ambition to become a global leader in science, technology, and innovation. Steps to reach that goal include: i) enhancing the autonomy of academic institutions while effectively incentivizing them to pursue high-quality research; ii) improving evaluation and assessment systems by moving away from rather onerous project supervision; iii) ensuring appropriate financing by moving away from time-consuming applications that ultimately

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provide similar funding to nearly all requests; iv) creating targeted programs for high-risk, high-reward research; and v) promoting greater cooperation between GRIs and universities.

At the same time, the internationalization of South Korea's R&D is essential to help it benefit from the international research ecosystem. This could include measures such as facilitating the international mobility of researchers, innovators, and entrepreneurs in the public and private sectors, attracting foreign talent by expanding the share of English-language curricula in Korean universities, and creating stronger incentives for researchers to participate in international collaboration.

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