



Taiwan's Next Science *Frontier*

Building on semiconductor
leadership to diversify the research
and innovation landscape



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This report is part of Elsevier's Science Nations and Regions series, which profiles research and innovation systems across a range of national, sub-national, and regional geographies — including, in other volumes, the European Union and Scotland. Consistent with this series-wide approach, geographic and economic groupings used throughout reflect standard bibliometric classification conventions, applied uniformly across entities. In line with this convention, the economy profiled in this volume is referred to as 'Taiwan', consistent with its designation in Scopus and other scientometric databases.

This report was produced by Elsevier's Global Strategic Networks Associate Mia Yamakawa Lewis during March to October 2026. Other contributors: Dr. Michiel Kolman, SVP Information Industry Relations; Dr. Anders Karlsson, VP Academic and Research Relations Asia Pacific; Weiwei Cheng, Senior Manager, Field Marketing, APAC; Dana Jang, Regional Director, RI & Engineering Solutions APAC.

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Executive summary

This report is part of Elsevier's [Science Nations and Regions series](#), which profiles research and innovation systems across national, sub-national, and regional geographies including, in other volumes, the European Union and Scotland, using standard bibliometric classification conventions applied uniformly for comparability across entities.

Taiwan is a global science and technology powerhouse: a small, densely resourced economy producing outsized research output and impact, anchored by a global semiconductor and electronics base. This report asks a harder question than that foundation alone answers — whether Taiwan's semiconductor-honed model of industry-institute collaboration can power new strategic verticals. The evidence says yes, take strategic technologies; AI, quantum information science, and biotechnology show a stronger research focus than global benchmarks, though not yet with the institutional depth or academia-industry integration that built the semiconductor sector. All data in this report covers 2020-2024, unless otherwise stated, in line with the OSTP Key Technology Areas as defined in SciVal.

- **Scale and academic impact:** Taiwan produces about 1% of global scholarly output (50k publications in 2025, up 18% since 2021) from just 0.29% of world population, with a normalized, so-called Field-Weighted Citation Impact (FWCI) of 1.21, meaning that citations are 21% above the global average. This impact extends internationally: co-publications have risen from 16% (2000) to 42% (2025), ahead of regional peers Japan and Korea.
- **R&D investment:** Gross Expenditure on R&D (GERD) reached NT\$937B (~US\$29B) in 2023, about 4.0% of GDP, the world's third-highest R&D intensity after Israel and South Korea. Investment is heavily industry-concentrated (85% corporate, 9% public institutes, 6% academia), reflecting semiconductor dominance (NSTC, 2024): the sector alone accounts for over 17% of GDP and nearly 74% of exports.
- **Broadening Taiwan's innovation portfolio:** Taiwan's growth strategy extends semiconductor leadership into a more diverse portfolio: the Chip-based Industrial Innovation Program (CBI) applies mature-process manufacturing to biotech and gene-sequencing chips through the TSMC-modeled Taiwan Bio-Manufacturing Corporation, while Taiwan's NDC's Ten AI Initiatives Promotion Plan (2025–2028) applies the same model to AI.

- **Sector collaboration gap:** Academia-industry co-publication (3.1%) is close to the global average (2.7%) but lags behind Korea (6.2%) and Japan (7.2%) — largely because Taiwan's innovation system has historically relied on public institutes, consortia, and technology-transfer intermediaries rather than direct university-corporate ties.
- **Core research strength in strategic technologies:** Semiconductors remain Taiwan's defining strength, with a Relative Activity Index (RAI) of 2.69 — meaning Taiwan's share of scholarly output in the topic is nearly three times its share of output across all fields globally, anchored by TSMC and ITRI in a well-integrated industry-institute pipeline connecting through to academia. Secondary strengths include AI (RAI 1.31), and to a lesser extent Quantum Information Science (RAI 1.16), and Biotechnology (RAI 1.13).
- **Strategic gaps:** Nuclear energy research sits well below global activity (RAI 0.37, reflecting the phase-out policy), though clean energy research overall remains a strength (SDG 7, RAI 1.20, 20% above the world average).

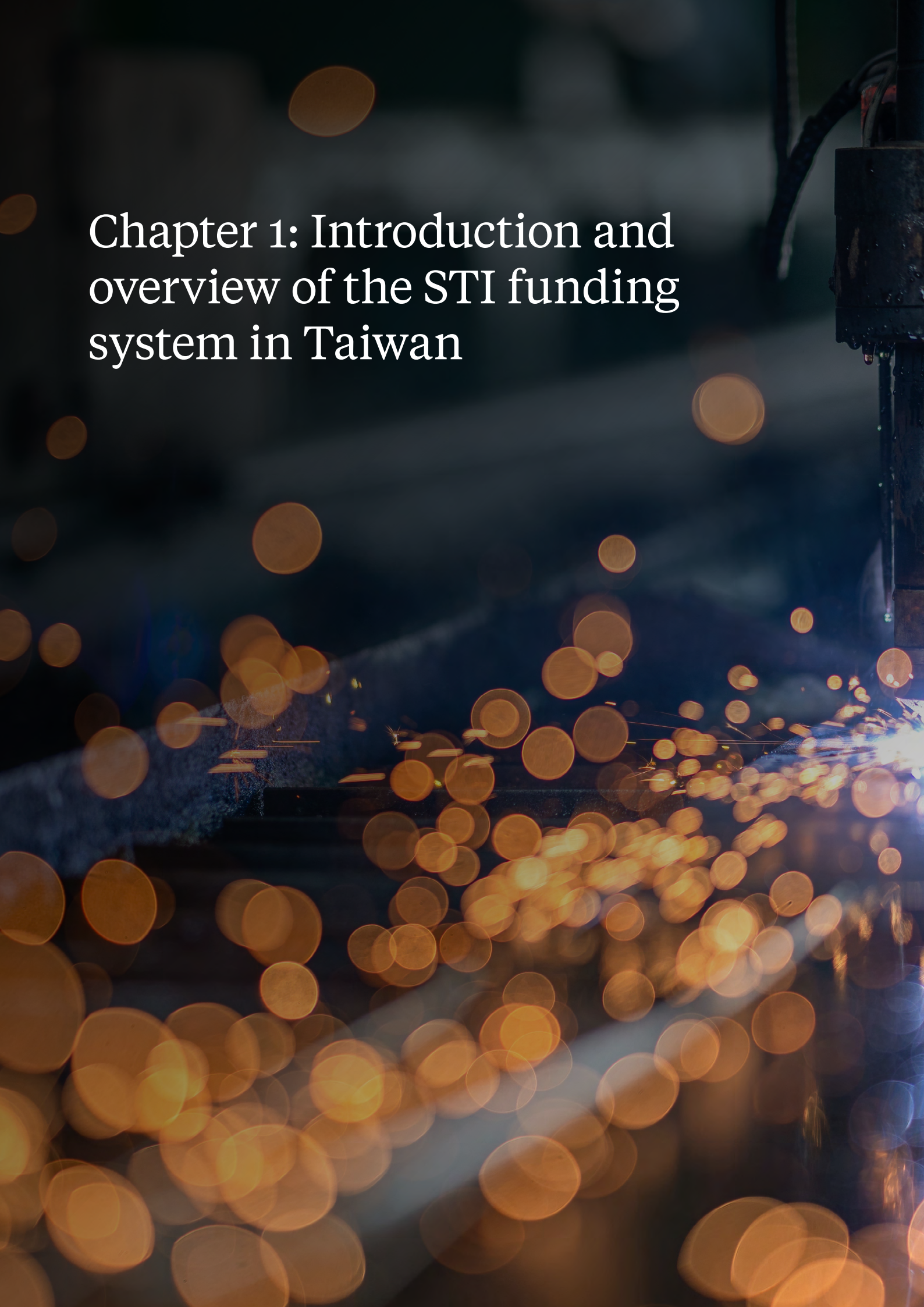
“Taiwan’s Next Science Frontier is an insightful report. It describes Taiwan’s research activities in different strategic fields and their share in scholarly output and impact compared to other economies. It provides a quick portrait of Taiwan’s science and technology characteristics and in particularly points out the crucial role that ITRI plays in academia-industry connection.

More importantly, for the “next science frontier”, be it AI, quantum information or biotech, it is suggested that, although the previous ITRI model worked well for semiconductor industry, a multidisciplinary university-anchored collaboration between academia and industry is needed. This is the most insightful point in this report. For those who are interested in Taiwan’s science and technology development or who are in charge of relevant policy making, this report is a must-read.”

Professor Hsiang-Kuang Chang

Senior Vice President, National Tsing Hua University
Vice Chancellor, University System of Taiwan

Chapter 1: Introduction and overview of the STI funding system in Taiwan



Taiwan's impact on the modern world is in many ways seen through how the Taiwan Semiconductor Manufacturing Company (TSMC) alone produces more than 90% of the world's most advanced logic chips, making an island economy of 23 million people the engine of the global semiconductor supply chain, driving the information and AI society.

Taiwan's excellence in semiconductor technology is not accidental. The Industrial Technology Research Institute (ITRI), founded in 1973 on semiconductor technology transferred from RCA in the United States, absorbed applied research risk and matured technologies in-house before spinning off United Microelectronics Corporation (UMC) in 1980 and TSMC in 1987, now the world's fourth- and first-largest foundries. ITRI remains the structural engine behind Taiwan's semiconductor miracle and explains why much of Taiwan's industry-relevant research happens outside university co-authorship channels.

Taiwan's dominance in semiconductor manufacturing raises a harder question: can an innovation system built to execute at one technology's frontier also generate the disruptive science and innovation a broader AI-driven economy needs next? Drawing on proprietary bibliometric data from Elsevier's SciVal and Scopus, complemented by academic policy literature via LeapSpace, the research grade AI workspace, this report examines Taiwan's underlying research base, its scholarly output and impact, international collaboration, and policy contribution to assess how far its chip success translates the broader science and innovation system Taiwan will need moving forward.

In terms of financial input, Taiwan's gross domestic expenditure on research and development (GERD) reached NT\$937 billion (~US\$29B) in 2023, 4.0% of GDP, the third-highest R&D intensity of an economy after Israel and South Korea (OECD, 2023). Its R&D profile is highly industry-concentrated, 85% enterprise-performed (NT\$801.5bn (\$24.8B USD) in 2023), 8.5% by public research institutes, and 6.3% by higher education (NSTC, 2024), second only to Israel's 93.0% business share. TSMC, MediaTek, Hon Hai and peers self-fund R&D at scale, supported by tax credits and targeted public programs. Industry accounted for more than 17% of GDP in 2024, up from just over 4% in 1999 (European Centre for International Political Economy [ECIPE], 2026), and combined ICT and electronic component exports made up 73.7% of Taiwan's total export value in the first eleven months of 2025 (Finance Agency [Taiwan], 2025).

Public investment runs through several leading institutions. The NSTC sets Taiwan's overall R&D strategy and budget, channeling funding to Academia Sinica and universities for basic research. Academia Sinica, founded in 1928, is Taiwan's most prestigious research institution, spanning 24 institutes and centers across the sciences and humanities. ITRI, named among the world's top global innovators, remains the applied-research engine behind Taiwan's semiconductor sector, while the Higher Education SPROUT Project channels funding to universities by performance and enrollment, and the NHRI supports biomedical and precision-health R&D. Further, the NARLabs oversees Taiwan's infrastructure including the Center for High-Performance Computing (NCHC), the Synchrotron Radiation Research Center (NSRRC), and the Taiwan Space Agency (TASA), which underpins compute, materials-science, and space capabilities across the research system.

The dependence on semiconductors is recognized as both a strength and a concern; the current strategy is to extend that knowledge into new verticals spanning artificial intelligence, biotechnology, quantum technology, next-generation communications, green energy, and space (NSTC OSTP, n.d.; NDC, n.d.). This reflects Taiwan's September 2024 layered shift from the "Six Core Strategic Industries" to the "Five Trusted Industry Sectors" (semiconductors, AI, next-generation communications, along with security and defense related industries) (NDC, 2024b), with the "Ten AI Initiatives Promotion Plan 2025–2028" as the flagship initiative and complementary NSTC programs in quantum, biotechnology (via the Taiwan Precision Health Initiative), and space, though budget realization depends on annual legislative appropriation. Delivering on this strategy is as much about people as funding: Taiwan's declining birth rate is shrinking the student population, threatening the university sector and research community (NDC, 2024a), while talent competition and brain drain from rising global competitors make retaining researchers a key challenge.

In response, the Talent Competitiveness Jumpstart Program targets 120,000 additional professionals from outside Taiwan by 2028 (NDC, 2024a), the Yushan Fellow Program recruits overseas faculty (Education Agency, n.d.-a), and in 2025 new rules widened the Employment Gold Card eligibility (NDC, 2025).

The report is organized as follows: Following this introductory chapter, Chapter 2 covers Taiwan's scholarly output against selected comparators; Chapter 3 examines the scholarly impact of international and cross-sectorial collaboration; Chapter 4 investigates key strategic technologies of global interest; and Chapter 5 looks at broader societal impact through the UN Sustainable Development Goals (SDGs). The report closes with conclusions and recommendations; references, methodology, and tools are in the appendices.



Chapter 2: Research output and performance

Taiwan's research output over the past 25 years

Over the past 25 years, Taiwan's scholarly output has grown considerably, transitioning from a mid-tier research producer in the late 1990s to a consistently significant contributor in the Asia-Pacific region. Figure 1 below captures this long-run trajectory compared with key regional and global peers. Economies proximate to Taiwan in both Northern and Southern regions (the latter

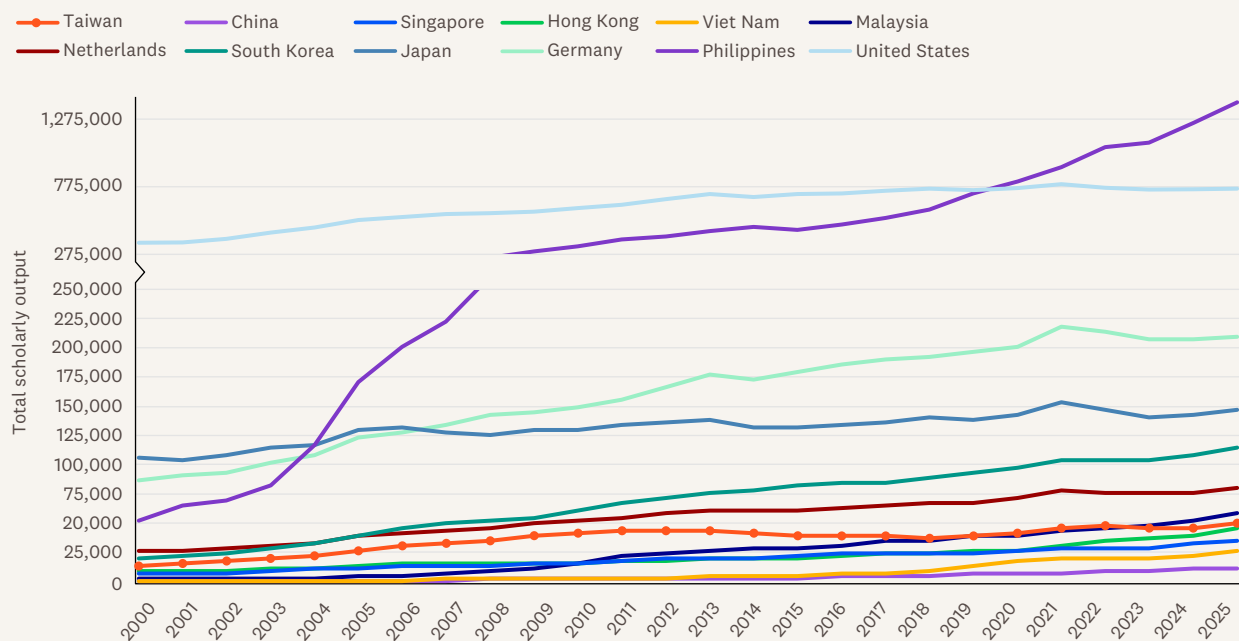
reflecting Taiwan's New Southbound Policy) have been selected as key candidates for collaboration, as well as global powerhouses that have high collaboration with Taiwan and European peers for comparison due to their similar technology foci. Further note the broken scale in the figure, with the lower section in increments of 25k, and the upper section in increments of 500k.

Figure 1

Taiwan's scholarly output over 25 years vs. regional and global peers

Source: Scopus (Elsevier)

Country and economy groupings follow Scopus author-affiliation metadata, based on the institutional address listed on each publication; this convention is applied consistently across all entities in this report for comparability of bibliometric indicators. Further note is that China according to bibliometric convention refers to China's mainland



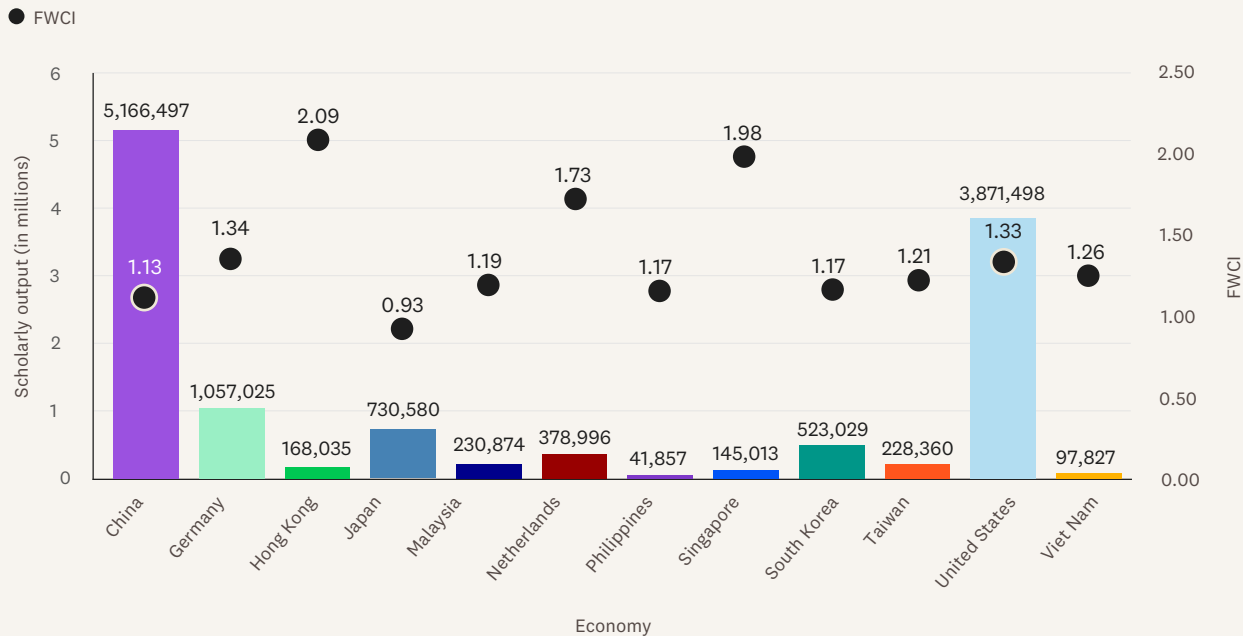
Taiwan produced 49.8k publications in 2025, with an average growth rate over the past five years of 3.39%. This is similar to the World average at 3.5% and South Korea (at 3.44%).

Research output and scholarly impact

As a proxy of academic/scholarly impact, citations are generally seen as a good indicator of scholarly impact. As citations vary by discipline, year, and type of publications, the Field-Weighted Citation Impact (FWCI) is an advanced indicator that normalizes citation counts by field, year, and document type, where a score of 1.0 is the world average, and above 1.0 means an entity’s publications are cited more than the global average. Taiwan achieves an FWCI of 1.21, very similar to South Korea (1.19), Malaysia (1.17), and China (1.13).

Japan with a FWCI of 0.93 is the outlier here. For Japan with many universities (over 800) and the FWCI measuring an overall average below the world average, it obscures the impact of the several high-performing, world-class institutions, e.g. the University of Tokyo, Kyoto University, and Tohoku University. Regional peers, smaller economies Singapore (FWCI 2.09), Hong Kong (FWCI 1.98), and globally the Netherlands (FWCI 1.73), Germany (FWCI 1.34) and the United States (FWCI 1.33) all perform well above the global average and above Taiwan’s FWCI. As will be discussed later, citations also correlate positively with international collaboration, as having a strong international collaboration network comes with increased visibility as well as reaching critical mass in areas of interest.

Figure 2
Scholarly output and FWCI for 2020–2024 for Taiwan and selected economies
Source: Scopus (Elsevier)



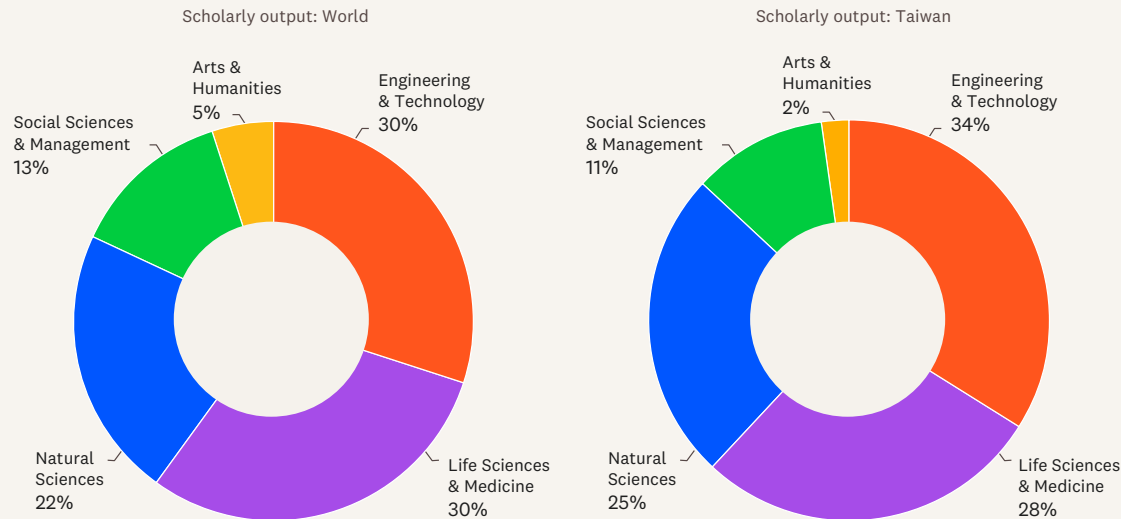
Research by subject area

Compared to the world’s distribution per subject area (Figure 3) Taiwan is more active in Engineering & Technology (+4%) and Natural Sciences (+3%), and less active in all other subject areas such as Arts & Humanities (-3%), Social Sciences & Management (-2%) and Life Sciences & Medicine (-2%).

Figure 3

Global and Taiwan’s distribution of output across QS subject areas

Source: Scopus (Elsevier)



University and institutional performance

Academic sector performance

With approximately 140 universities, Taiwan boasts a large selection of higher education institutions for a medium-sized economy. As mentioned in the introduction, Taiwan's shrinking college-age population means these universities now and over time will have more capacity than students to fill, just as the research base needs to scale up. Enrollment has already fallen from 1.2 million students (2020) to 1.05 million (Education Agency, 2026a). NDC's international-student recruitment initiative and ongoing institutional mergers are the NDC's two active responses.

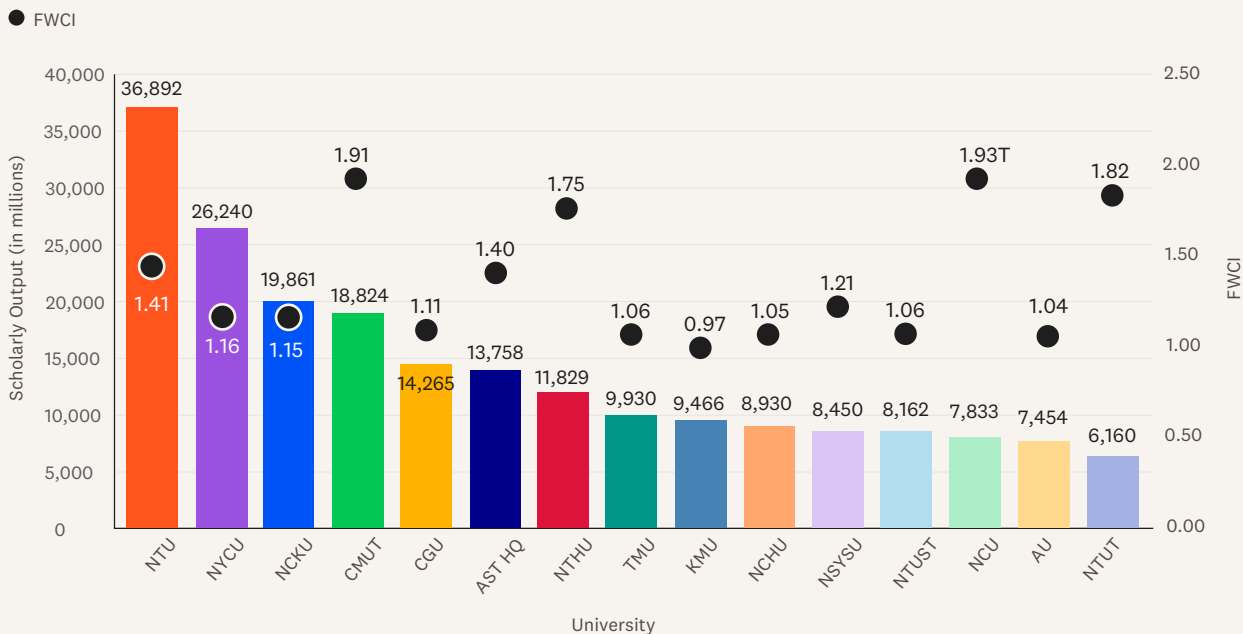
In terms of scholarly contributions (Figure 4), NTU leads in volume with 36.9k publications, followed by NYCU (26.2k) and NCKU (19.9k). China Medical University Taichung and Asia University, which are already collaborating closely, post the highest FWCI (1.91) among major universities. As with similarly sized institutions internationally, this could reflect participation in large-scale, highly cited international collaborations, for example multi-center clinical trials or global research consortia, which can lift an institution's citation average independent of overall scholarly output volume. Globally, NTU remains the most recognized, being ranked 54th in the 2027 QS (Quacquarelli Symonds) World University Rankings, with a high rate of citations per faculty and high academic reputation overall.

Figure 4

Top 15 Taiwanese universities by scholarly output and FWCI

See Appendix 2 for full institution details

Source: Scopus (Elsevier)



Institutional sector performance

Looking into the research institute sector, as shown in Table 1, Academia Sinica, Taiwan's premier public research institution, leads Taiwan in scholarly output, with an FWCI of 1.43, slightly above NTU's 1.41. The Synchrotron Radiation Research Center (NSRRC) stands out with an FWCI of 1.87 on 2.2k publications, showing the academic impact of large-scale scientific infrastructure investment. NSRRC operates under the Applied Research Laboratories (NARLabs), which also ranks among Taiwan's top institutes by output (1,543 publications, FWCI 1.15) and coordinates additional infrastructure spanning supercomputing and space research.

However, the broader impact of the research institute sector cannot be judged by scholarly output alone. For instance, ITRI receives both public and industry funding for contract research, and much of its research is not published in academic literature. With Academia Sinica having an overall funding estimated at 12.5 BNT\$ (400MUS\$), ITRI is estimated to have almost twice the funding around 25 BNT\$ (800MUS\$), both from public and the private sector (approximate numbers, several sources) resulting in a likely broader impact that is not fully reflected in the academic literature data alone.

Table 1
Top 10 research institutes by scholarly output and FWCI
Source: Scopus (Elsevier)

Institution	Output	FWCI
Academia Sinica Taiwan	13,853	1.43
Health Research Institutes (NHRI)	4,409	1.33
Synchrotron Radiation Research Center (NSRRC)	2,232	1.87
Industrial Technology Research Institute (ITRI)	1,890	1.10
Applied Research Laboratories (NARLabs)	1,543	1.15
Ministry of Agriculture	1,213	0.80
Institute of Nuclear Energy Research	412	0.56
Museum of Marine Biology and Aquarium (NMMBA)	363	0.71
Taiwan Centers for Disease Control	265	1.40
Museum of Natural Science (NMNS)	187	0.81

Corporate sector scholarly performance

As noted in the introduction, Taiwan has a very strong corporate sector dominated by the semiconductor and information technology industry. Overall corporate R&D supplies approximately 85% of GERD in Taiwan, but most research, due to its competitive nature, is not published in academic literature.

Indeed, this is confirmed in Table 2 below showing TSMC as leading in scholarly output and FWCI among the top corporates. Yet TSMC's total output is only 639 papers, albeit with a high citation impact FWCI (4.6) reflecting a clear interest in and relevance of their research published within academic literature.

Table 2
Top 10 corporate institutions by scholarly output and FWCI
Source: Scopus (Elsevier)

Company	Output	FWCI
Taiwan Semiconductor Mfg Co. (TSMC)	639	4.60
MediaTek	474	1.90
Hon Hai Precision Industry (Foxconn)	371	1.36
Chunghwa Telecom	321	0.68
Advanced Semiconductor Engineering	256	1.39
China Steel Corporation	154	0.74
Delta Electronics	149	0.99
AU Optronics Taiwan	145	0.85
Realtek Semiconductor	139	1.41
Macronix International	137	1.38

Patent landscape: a complementary view to scholarly output

Patent activity offers a complementary lens to this report's primary focus on the scholarly-publication metrics, particularly given Taiwan's industry-concentrated R&D model. Taiwan's IP Office (TIPO) received 50,823 invention patent applications in 2024, a stable volume reflecting a mature, high-intensity innovation base (TIPO, 2025). Applicants from outside Taiwan substantially outweigh filers from Taiwan: in 2025, international filings rose 2% to 31,719, continuing an upward trend since 2021, against 19,511 Taiwanese applications (down 0.4%) — reflecting Taiwan's centrality to the global semiconductor supply chain, which draws international firms to protect IP within its jurisdiction (Japan, the US, China, South Korea, and Germany are the top international filer origins).

TSMC leads domestic applicants by a wide margin (1,412 filings in 2024), reinforcing the semiconductor sector's dominance also evident in the scholarly data, and consistent with the earlier finding that TSMC's research shows up more in patents than in publications (639 papers vs. 1,412 patents in the same year). Digital Communication and Semiconductors lead in TIPO filings. Moving beyond the narrow concentration, deeply commercialized in semiconductor manufacturing, our analysis indicates less strength in translating university and SME patent output into new ventures or diversified sectors as a challenge the Taiwanese innovation system needs to address.

Chapter 3: Scholarly impact of collaboration

International collaboration and scholarly impact

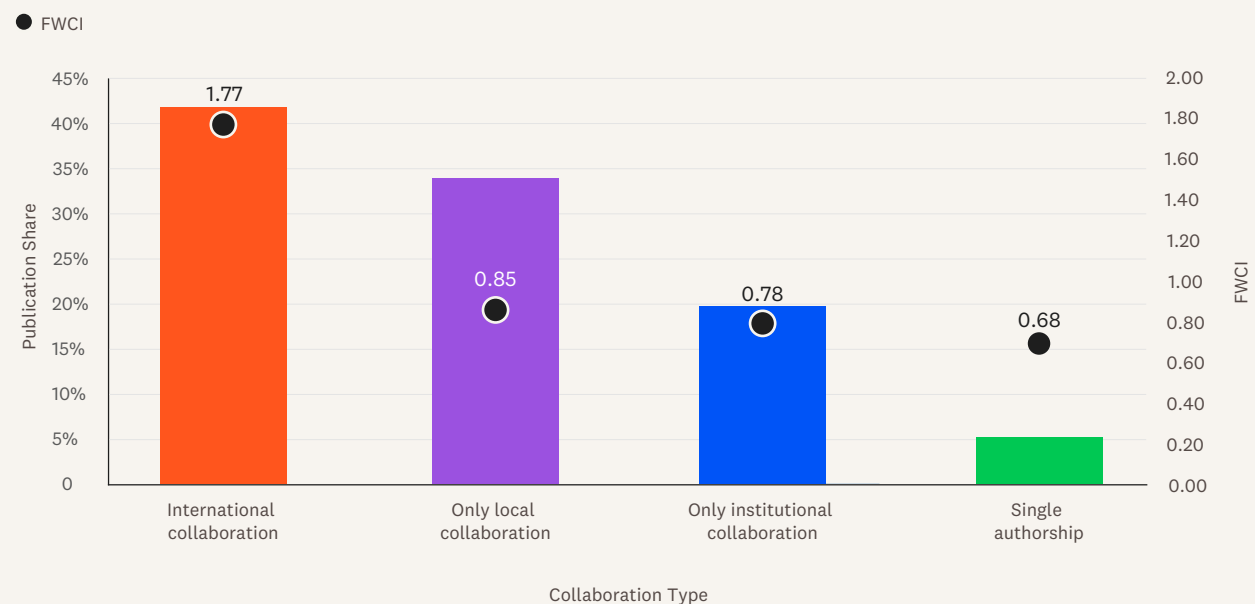
International collaboration is defined here as co-authorship of authors in Taiwan with authors outside of Taiwan, which, following bibliometric conventions, also covers the cross-strait collaboration between Taiwan and China's mainland. International collaboration in science and innovation lets researchers pool ideas, data, talent, and infrastructure, outcomes ranging from co-authored articles and joint patents to researcher exchanges and broader knowledge sharing.

This pooling effect also tends to lift quality and reach: collaborative work draws on more diverse expertise and datasets, typically reaching wider audiences and higher citation rates than domestically produced research alone. Figure 5 highlights this effect, FWCI rises steadily as authorship moves from single, to institutional, to international collaboration.

Figure 5

Different types of collaboration within Taiwanese research and their Field-Weighted Citation Impact

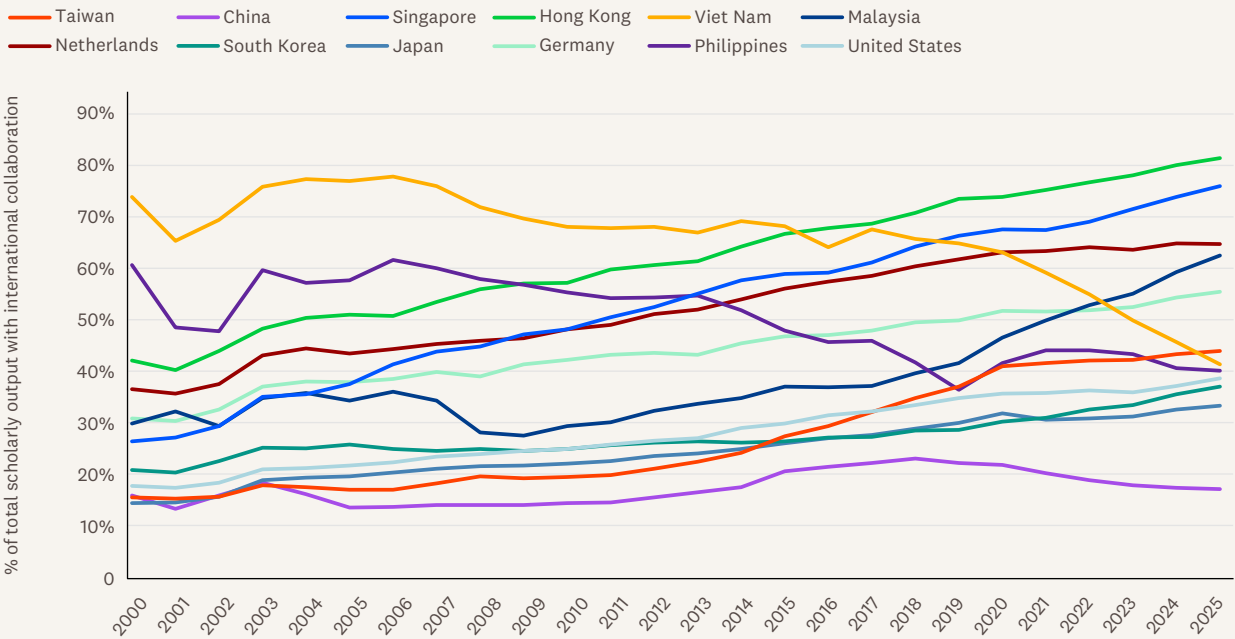
By international is simply meant collaboration between Taiwan and other economies
Source: Scopus (Elsevier)



Over time, Taiwan has progressed from approximately 15.6% international co-authorship in 2000 to 42% by 2024, seen in Figure 6. Globally, international co-authorship also increased in this period, but at a slower rate from 12.5% to 20%. Taiwan has also surpassed local neighbors such as Japan and Korea, which saw international collaboration rates of 32.6% and 35.5%, respectively.

Taiwan's international co-publication surge stems from a period of active regional science-funding expansion (2016 onward) mainly targeting ASEAN, South Asia, Australia, and New Zealand, paired with NSTC's dense network of funding agreements. Taiwan's increased collaboration rate is undoubtedly a success story. However, the outcome does remain below smaller and more open economies such as Singapore (75.6%) and the Netherlands (64.4%), visualized in Figure 6. The Netherlands' model of high collaboration achieved through active participation in large multi-lateral programs reflects how Taiwan's research system could further enhance collaborations.

Figure 6
International collaboration rate per region over time
Source: Scopus (Elsevier)

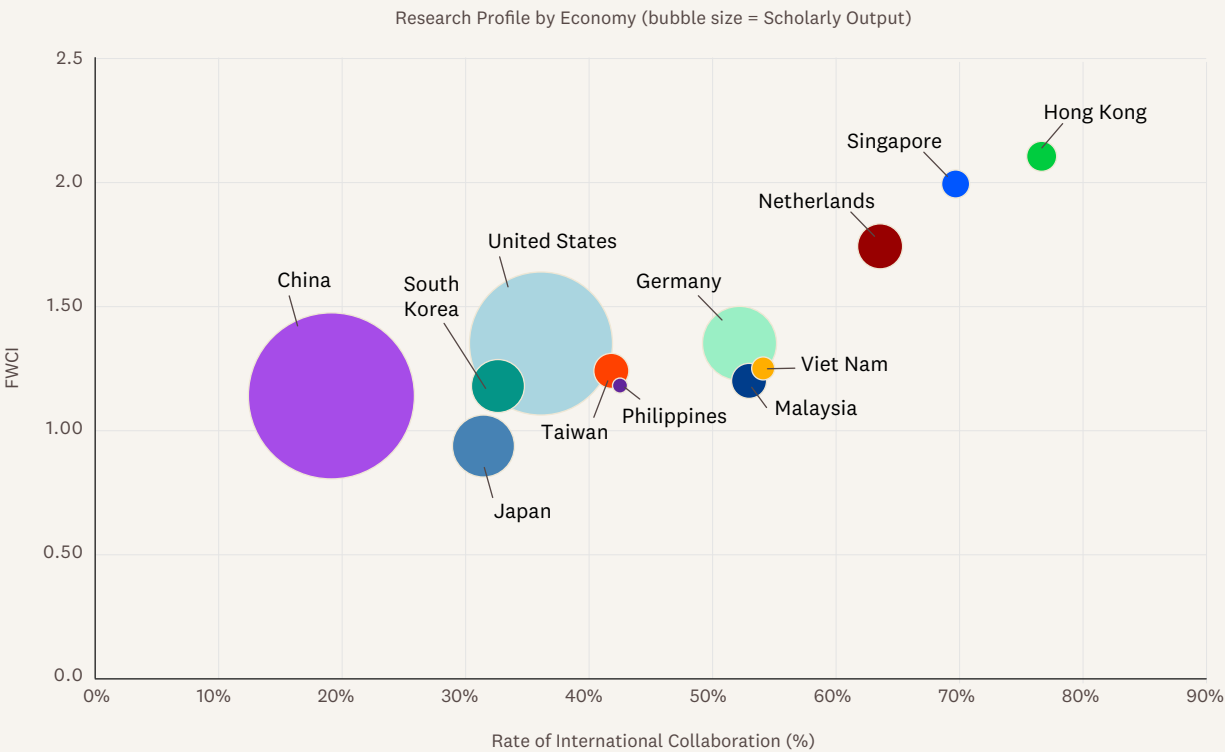


The bubble chart (Figure 7) illustrates the correlation of international collaboration to scholarly impact, with the size of bubbles representing total publication volume. Taiwan sits firmly in the middle, showing stronger collaboration than regional medium sized peer economies such as Japan and South Korea, but seeing room for improvement in comparison to Southeast Asian peers and the Netherlands.

Figure 7

International collaboration rate vs. FWCI by country/region

Source: Scopus (Elsevier)



Taiwan’s collaboration partners

Looking closer into Taiwan's research partnerships, the United States and China represent the two largest sources of co-authored output, at 28.1k and 26.7k publications respectively, reflecting strong research ties with the US and China alongside Taiwan's wider international network. Both partnerships also produce strong scholarly impact, with FWCI of 2.47 (US) and 2.49 (China), well above the global average of 1.0. FWCI varies further by partner, medium-sized economies Canada (5.43), Germany (4.79), Australia (4.70), South Korea (4.55), and the UK (4.22) posting higher averages still; this largely reflects that many of these bilateral pairings sit within larger multilateral consortia, which tend to draw higher citation rates, rather than any difference in the underlying quality of a given bilateral relationship.

Table 3

Taiwan's top 10 collaborating economies by co-publication volume and FWCI for 2020–2024

Source: Scopus (Elsevier)
Country/Economy naming following bibliometric conventions

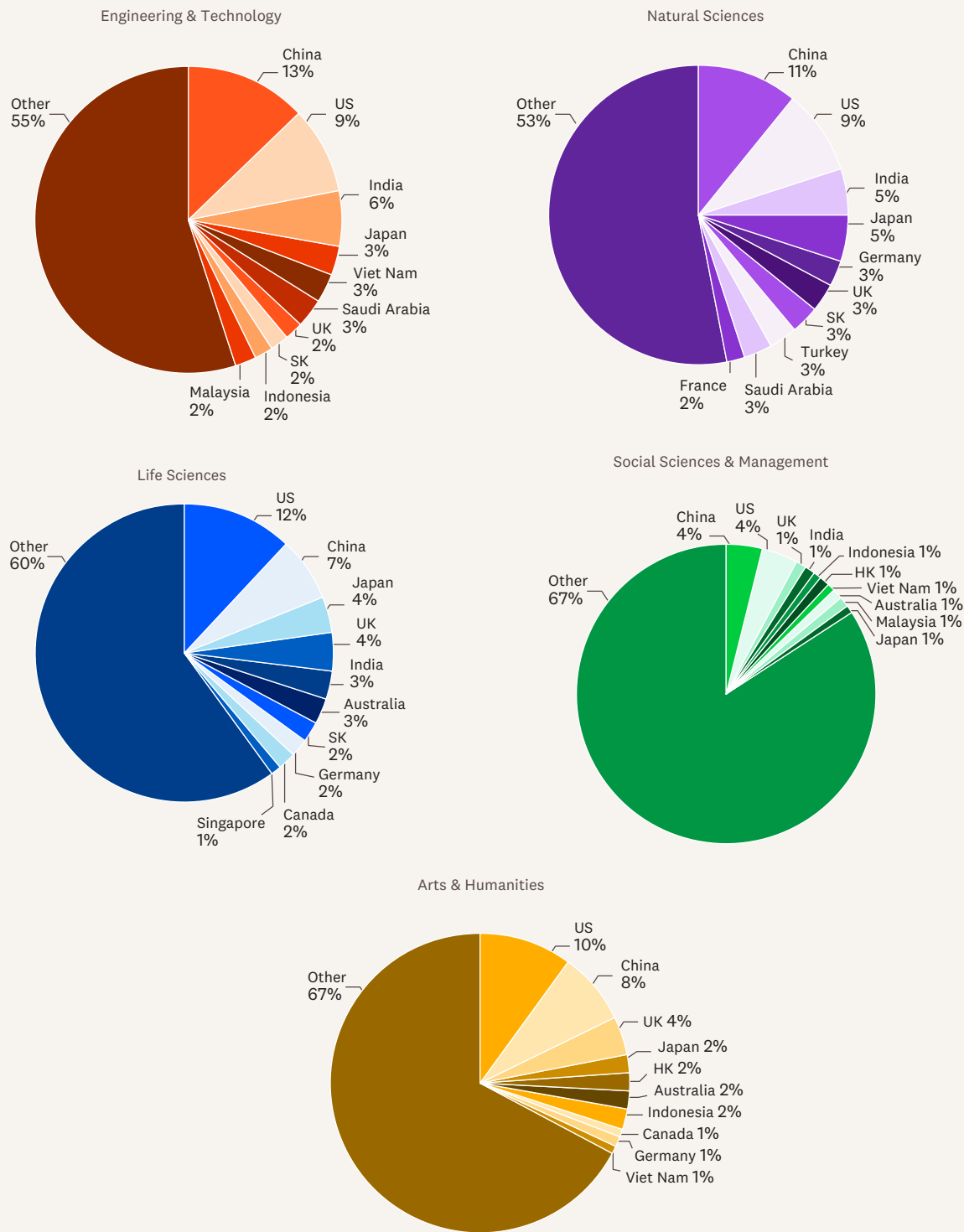
Partner	Co-publications	FWCI
United States	28,061	2.47
China	26,658	2.49
India	11,432	3.00
Japan	11,327	3.27
United Kingdom	9,203	4.22
Germany	7,041	4.79
South Korea	6,759	4.55
Australia	6,753	4.70
Indonesia	5,273	2.84
Canada	5,176	5.43

Research council partnerships allow strategic areas to be targeted. Some (non-exhaustive) examples include the US and NSTC funding the NSTC-NSF Advanced Semiconductor Chip program, while the Taiwan S&T Hub at Stanford anchors talent and startup ties. With the EU, Taiwan participates in Horizon Europe as self-funded with NSTC co-funding Taiwan-side costs. As for the UK, NSTC holds seven channels, including the Royal Society and British Academy International Exchanges (cost-share, parallel funding on both sides) and the Royal Society of Edinburgh's Scotland-Taiwan Research and Innovation Workshop Grant. Other examples include the NSTC-NWO (Netherlands) scientific cooperation agreement, which funds joint research visits, and the NSTC-SSF (Sweden) flagship program, which co-funds joint projects in semiconductors, quantum, 6G, AI and green energy.

International collaboration by subject areas

To understand Taiwan’s key collaboration across subject areas, we used the QS ranking agency classification of subject areas. In Figure 8, the Top 10 collaborations per subject area are displayed in pie charts, showing each economy with the highest proportion of co-authored papers across QS Subject areas. In Engineering and Technology — Taiwan’s strongest field — China (13%) and the United States (9%) lead, followed by India (6%) and Japan (3%). For Life Sciences and Medicine, the United States tops the list (12%), reinforcing deep biomedical research links. European partners are notably underrepresented relative to the high-impact returns they yield in FWCI of research with international collaboration as shown in Figure 7. Other regional partners such as Hong Kong, Singapore and Viet Nam also show high rates (above 50% of total scholarly output) of papers with co-publishers but are not proportionately represented among Taiwan's collaborators. These gaps between expected and actual percentages of collaboration present a clear case for targeted programs with regional and European partners.

Figure 8
Top 10 collaborating economies with Taiwan per QS subject area
Source: Scopus (Elsevier)



Cross-sectorial collaboration

Cross-sectorial collaboration allows academia and industry to collaborate on topics of common interest. Outcomes could range from academic-corporate co-publications, patents, licensing, contract research, talent transfer, or tacit knowledge transfer. Here, we look at the academia-corporate co-publications as a proxy of this knowledge interaction.

Taiwan's academic-industry co-publication rate of 3.1% exceeds the world average of 2.7%, but as Figure 9 shows, it trails Korea (6.2%) and Japan (7.2%) as well as the Netherlands, Germany, and Singapore.

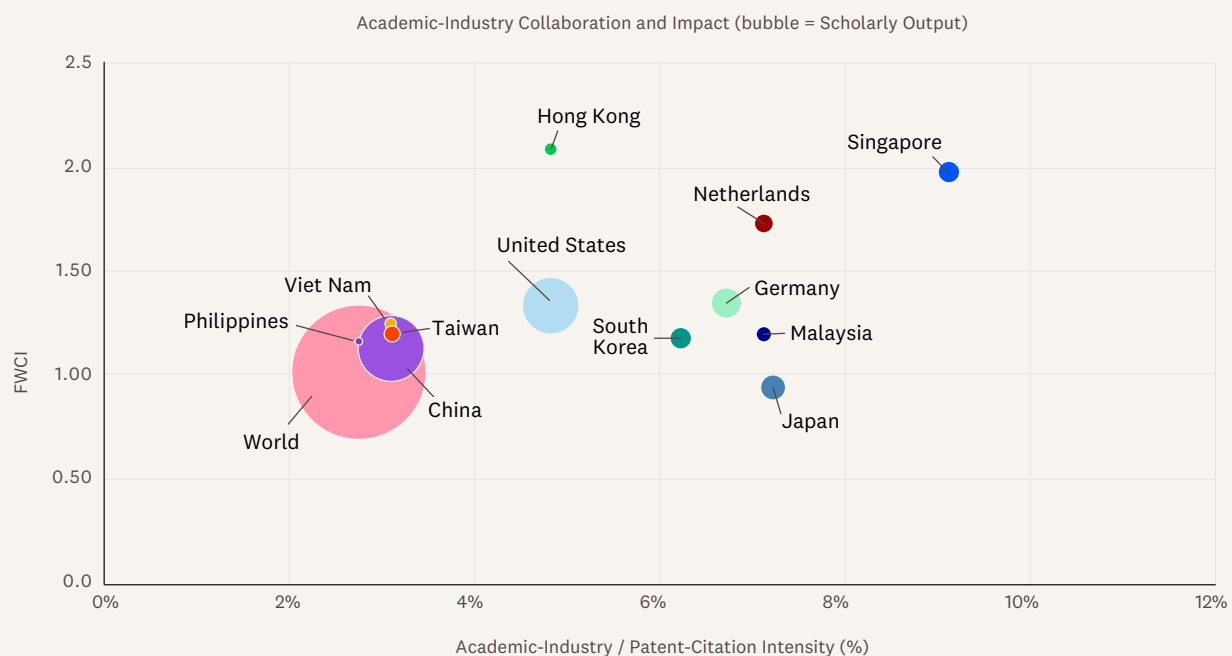
This gap likely reflects Taiwan's foundry/OEM-centric industry: firms like TSMC hold substantial in-house corporate R&D as tacit knowledge/trade secrets rather than academic output.

Historically, ITRI filled the intermediary role between academia and industry, maturing technology into spin-offs, TSMC and UMC among them, so applied research matured inside ITRI rather than through university co-authorship (Jan & Chen, 2005). A targeted intervention could be NSTC-mandated industry-university cooperation foundations modeled on Korea's system, with co-publication metrics built into R&D tax incentives and grant evaluation.

Figure 9

Academic-industry co-publications and scholarly output cited in patents for selected nations/regions

Source: Scopus (Elsevier)



Singapore and Hong Kong lead on patent-citation intensity (8.0% and 6.7% respectively) while also posting the highest citation impact for academic-corporate publications (FWCI 1.92 and 1.99), evidence that small, open, international-investment-dependent research systems that can combine strong applied relevance with strong fundamental science quality, although both show trade-offs from dependency, ranking pressure, and uneven absorptive capacity (Wong et al., 2018). Japan presents the clearest anomaly: it has the highest academic-corporate collaboration rate of any entity shown (7.2%, tied with the Netherlands) and above-average patent-citation intensity (5.1%), yet the lowest FWCI (0.94), the only entity below the global citation benchmark. This suggests Japan's industry-linked research is heavily applied and domestically oriented, generating patents and collaboration but not translating into internationally visible, highly cited science, a structural signal worth testing against Japan's lower international co-publication rate.

Taiwan sits in the middle on all three metrics (4.9% patent-citation, 3.1% academic-corporate collaboration, 1.15 FWCI), collaboration is identical to China's despite Taiwan's far smaller research base, consistent with the previously identified structural explanation: ITRI absorbs much of Taiwan's applied, patent-relevant research internally, suppressing the academic-corporate co-publication signal that would otherwise be expected given Taiwan's semiconductor-driven patent activity.

Southeast Asian entities (Philippines, Viet Nam, Malaysia) cluster at the lower end of both patent-citation intensity and collaboration, but Viet Nam's FWCI (1.24) already exceeds Japan's, South Korea's, and China's, with this mainly coming from a small research base with international collaborations driving citations.

In terms of industries collaborating with Taiwan's academics on scholarly output, South Korea's Samsung has the most co-publications, followed by TSMC, MediaTek and Hon Hai, with the remainder of the Top 10 collaborating industries seen in Figure 8. Apart from AstraZeneca and the Mayo Clinic, Rochester, most of the industry partners are within the APAC region. Of recent interest, as the Ten AI Initiatives Promotion Plan 2025–2028 explicitly targets academic-industry convergence in AI, any increase in co-publication rates between academia and industry within this subject area could be tracked annually to monitor the effectiveness of the policy.

Table 4
Academic-industry co-publications and top corporate collaborators
Source: Scopus (Elsevier)

Top 10 corporates in terms of collaboration
Samsung
Taiwan Semiconductor Manufacturing Company (TSMC)
Hon Hai Precision Industry
MediaTek
Chunghwa Telecom Co. LTD
MOH Holdings Pte Ltd.
The Mayo Clinic Rochester, Minnesota
AstraZeneca
China Steel Corporation Kaohsiung
Realtek Semiconductor Corp

Chapter 4: Taiwan and key strategic technologies

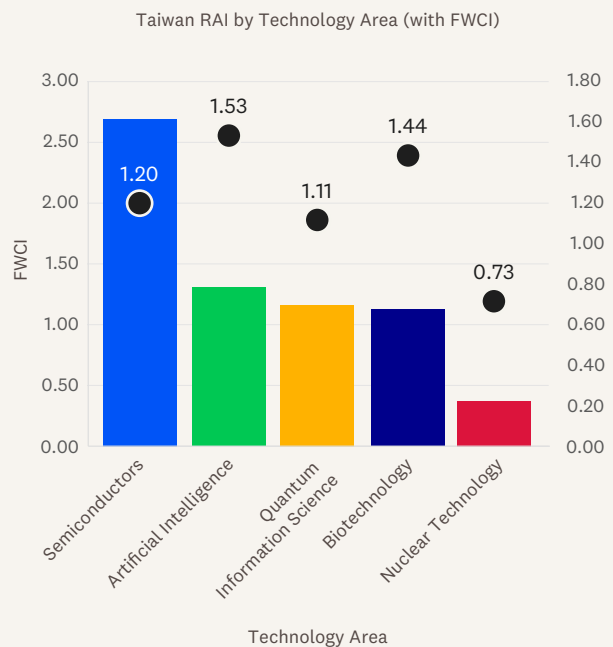
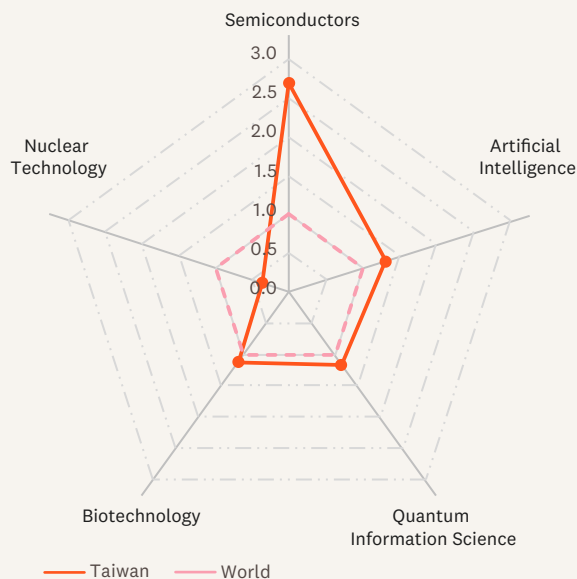
Increasingly, economies identify the needs of research around strategic technologies, such as AI, quantum technologies, and biotechnology. Globally, the following five key technologies identified have been recognized as focus areas of R&D, by Taiwan as well as other economies such as the United States, Japan, China and the European Union: Semiconductors, Artificial Intelligence, Quantum Information Science, Biotechnology, and Nuclear Technology. For simplicity, in terms of definition of scholarly output across these technologies, we use a methodology earlier developed internally by Elsevier for the US Office of Science and Technology Policy – OSTP.

We show here as proxies of quantity/focus and scholarly impact, the Relative Activity Index (RAI) and FWCI. As expected, semiconductor research stands as Taiwan's greatest research priority, with an RAI of 2.69 and an FWCI of 1.20, driven by an unrivaled industry-institute-academia pipeline. The ecosystem sustains this advantage, e.g. by embedding TSMC, Academia Sinica's Research Center for Applied Sciences, NYCU's Institute of Electronics and International College of Semiconductor Technology, NARLabs' Nano Device Laboratories, ITRI's translational research, and ITRI's technology-transfer legacy. Taiwan is well ahead of the global average, and this expertise creates an extremely strong foundation for this area and adjacent areas.

Figure 10

Taiwan's RAI and FWCI in key strategic technologies

Source: Scopus (Elsevier)



Taiwan's Nuclear Technology research gap has a distinct explanation. Unlike AI, biotechnology, and quantum, which are newer priorities still building momentum, nuclear's low RAI (0.37) and FWCI (0.73) reflect a sustained shift away from nuclear power over the past decade, culminating in the shutdown of Taiwan's last operating reactor in May 2025 (World Nuclear Association, 2025). This mirrors a broader global de-nuclearization trend following the 2011 Fukushima disaster, which reduced nuclear research activity worldwide. Global research in advanced nuclear science, including next-generation reactors and fusion technologies, has grown recently as research systems reassess nuclear's role in decarbonization. Independent of Taiwan's energy-mix policy, its limited research base here means it is less connected to this growing field than other low-carbon energy domains. Taiwan's SDG 7 RAI (1.20, 20% above global average) shows renewables and grid technologies, not nuclear specifically, have been the priority.

Diving deeper into Taiwan's key strategic technologies reveals where strengths are concentrated and where the greatest room for growth remains. With an RAI of 1.31 and an FWCI of 1.53 in AI, Taiwan is both prolific and impactful. The Ten AI Initiatives Promotion Plan 2025 to integrate AI across academic, industrial, and public-sector context provides an enabling framework. Key strengths include AI hardware, machine learning for medical imaging, and manufacturing automation. The priority for coming years is human-centric AI research, which covers ethics, governance, and societal implications, to balance the current hardware-heavy orientation with a broader research base.

Biotechnology (RAI 1.13, FWCI 1.44) represents one of Taiwan's most balanced strategic technology profiles: above-average specialization combined with high citation impact. Taiwan's world-class medical university system, including China Medical University, Taipei Medical University, and Chang Gung University, provides research capacity and clinical translation infrastructure. To strengthen biotechnology, the policy is to transfer semiconductor-sector capability into biotech with the Chip-based Industrial Innovation Program (Taiwan CBI, 2024–2033). NSTC has committed roughly NT\$4bn across 33 projects applying mature-process manufacturing to gene-sequencing chips and implantable medical electronics, while the 2023-launched Taiwan Bio-Manufacturing Corporation (TBMC), 40% publicly owned and modeled on TSMC's contract-manufacturing structure, targets mRNA, gene therapy, and biologics.

Finally, Quantum Information Science (RAI 1.16, FWCI 1.11) is an emerging area where Taiwan is building a credible presence. The NSTC has identified quantum technologies as a priority investment area. Early-stage collaboration with some leading quantum regions, for instance the European Union, the United States and the UK, may be beneficial for sustaining momentum and access to frontier infrastructure.

Chapter 5: Research alignment to the United Nations Sustainable Development Goals

The UN Sustainable Development Goals provide a globally accepted framework for assessing the societal relevance of research. Using the classification of SDG relevant research developed by Elsevier, where scholarly output is SDG-tagged, Taiwan's SDG Research Relative Activity Index reveals both genuine strengths and areas demanding attention.

Domestically, Taiwan's Science & Technology Policy Research and Information Center (STPI), operating under NARLabs, produces the foresight and evaluation work that feeds NSTC strategy, the institutional counterpart to the SDG alignment discussed below.

Figure 11

Taiwan's SDG research distribution

Source: Scopus (Elsevier)
To be noted the large scholarly output volume in SDG3 is commonly seen globally

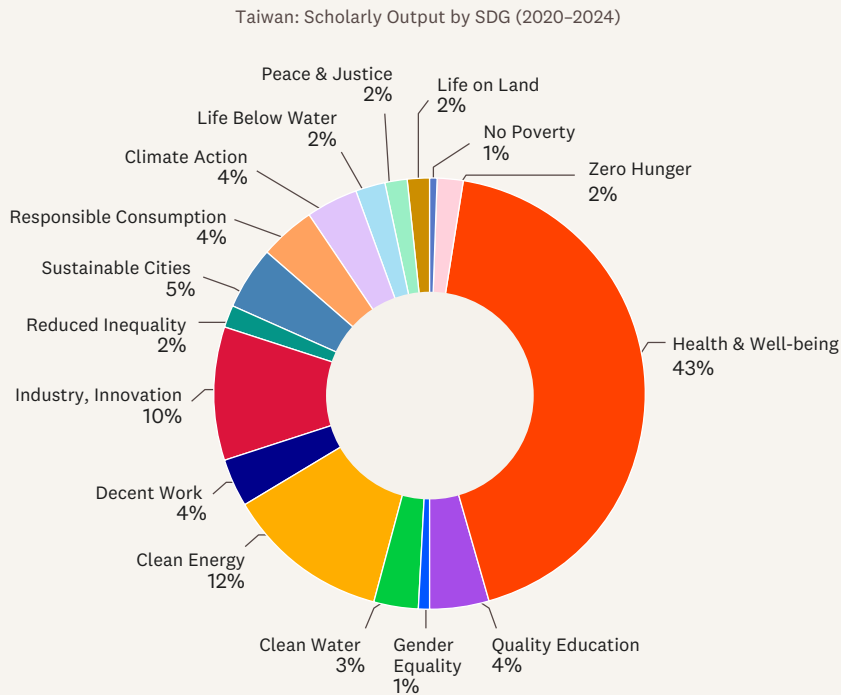


Figure 12
Taiwan's SDG Research Activity Index vs. World average
Source: Scopus (Elsevier)

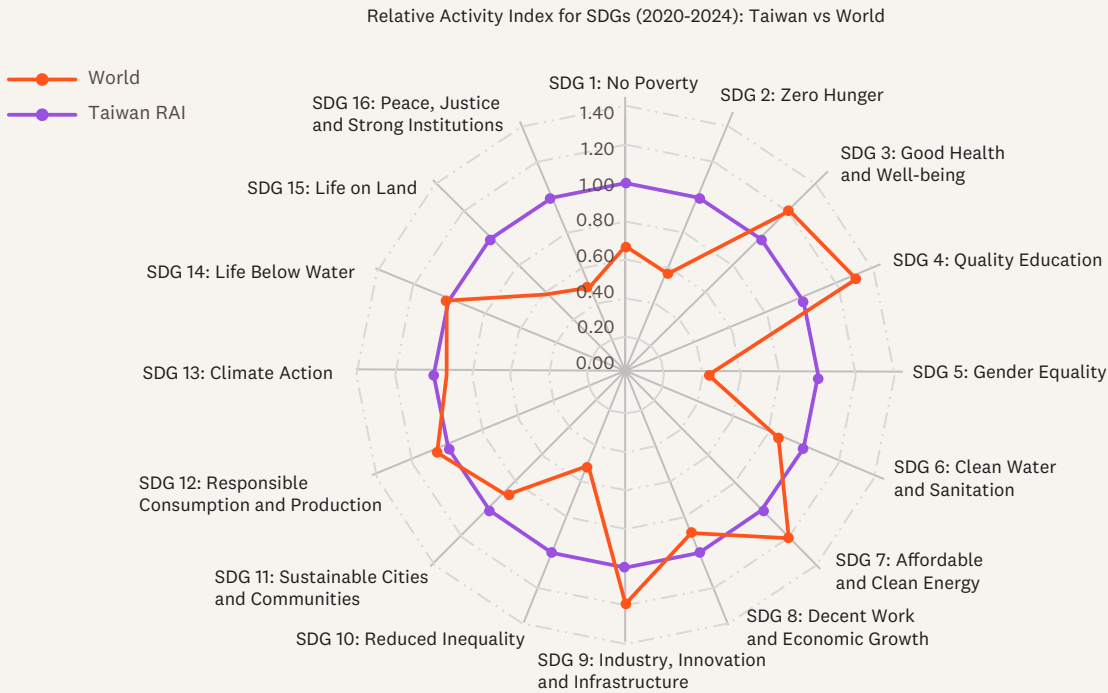


Figure 11 shows the distribution of Taiwanese research across the SDGs, while Figure 12 shows the RAI in comparison to the world average. Taiwan records above-average research activity (Activity Index > 1.0) in approximately half of the categories, particularly leading in SDG 4 of Quality Education (1.30), which reflects the strong education policy priorities. This is then followed by Good Health and Well-being (1.21), driven by strong biomedical research and dedicated focus on public health. Third comes SDG 7, Affordable and Clean Energy (1.20), which will be increasingly important and a key area to focus on given ongoing energy transition towards Net Zero, and fourth SDG 9 Industry, Innovation and Infrastructure (1.19) reflecting the corporate-dominated R&D landscape. On the other hand, Taiwan records notably below-average activity in SDG 5 Gender Equality (0.43), creating a significant and visible gap among other objectives.

This can be partially attributed to local languages being reflected less in global databases. Still, dedicated funding for gender studies, women in STEM research, and intersectional health research would simultaneously raise this score and strengthen the social license of Taiwan's research system. Further, with a strong engineering focus overall, humanities and social sciences, as reflected in SDG 1 and SDG 10, show lower activity. With the increasing use of AI in society, the importance of humanities and social sciences is, somewhat in contradiction, increasing as successful technology adoption rests on societal acceptance. Finally, SDG 15 Life on Land (0.51) also receives lower focus but may be an opportunity to focus on, in tandem with SDG 7, to expand biodiversity and conservation research within the energy transition to cleaner energy and more sustainable futures.

Beyond publication metrics alone to look at the SDGs, Taiwan's universities are increasingly represented in the THE Impact Rankings, which assess institutional performance against the SDGs from a broader perspective than research publications alone. Details will not be listed here. A growing cohort of Taiwanese institutions, led by NTU and several medical universities, are gaining international recognition for sustainability-oriented research. Additionally, in Sustainable University Rankings such as those by UI GreenMetric, as seen below in Table 5 (see Appendix 2 for full institution details), universities that often do not lead in the THE or QS rankings have high reputations, showing the strengths of Taiwan's institutions from a new angle. Dedicated sustainability research funding streams and explicit alignment between public science policies and SDG frameworks would reinforce this trajectory. MOE's University Social Responsibility Program, now in its fourth phase and funding 257 projects across 121 institutions (Education Agency, 2025), is the existing channel through which this alignment could be strengthened, particularly for Gender Equality SDG 5 and Life on Land SDG 15.

Table 5

Taiwanese universities in the UI GreenMetric Sustainability Rankings. See Appendix 2 for full institution details

Source: UI GreenMetric, Sustainable University Rankings

World rank	Local rank	University
21	1	NPUST
30	2	NCNU
37	3	DYU
43	4	NYUST
45	5	THU
49	6	CYUT
58	7	NTTU
70	8	NCUT
72	9	NCKU
105	10	NPTU



Conclusions

The analysis presented has put a lens beyond Taiwan's well-known semiconductor dominance to examine the broader research landscape behind it. The data point to a single central conclusion: Taiwan's next phase of research and innovation strength will depend on diversifying beyond the semiconductor vertical that has much defined its technological base to date.

The scale of that concentration is stark: semiconductor research carries a Relative Activity Index of 2.69, nearly three times the global average, and the semiconductor industry underpins 17% of GDP and almost 74% of exports (Chapters 1 and 4). On the positive side, several strategic technologies already see a stronger research focus than the global average: AI (RAI 1.31), quantum information science (RAI 1.16), and biotechnology (RAI 1.13). With respect to nuclear research, due to a phase-out policy, it carries a lower focus RAI (0.37), compensated by a relative activity on SDG 7 Clean and Renewable Energy RAI (1.20), 20% higher than the global average.

The data and analysis points to three structural factors that will determine whether this diversification can be scaled effectively. The first is academia-industry collaboration. Taiwan's academia-industry co-publication rate (3.1%) trails Korea (6.2%) and Japan (7.2%) by a wide margin (Chapter 2), a gap that reflects an ecosystem built around institutes such as ITRI absorbing applied research rather than universities. That model suited a semiconductor foundry industry organized around large-scale manufacturing; it is potentially a weaker fit for AI, quantum, and biotechnology, all of which depend on the multidisciplinary, university-anchored collaboration this ecosystem has not historically prioritized.

The second is international collaboration, and here the picture is a genuine strength with an opening for the diversification agenda. Taiwan's international co-authorship rate rose from 15.6% in 2000 to 42% in 2024, more than double the global rate of increase (12.5% to 20% over the same period), and now exceeds both Japan (32.6%) and Korea (35.5%) (Chapter 3). The United States and China are Taiwan's two largest research partners by co-publication volume, both generating strong academic impact with a FWCI around 2.5 times the global average, evidence that Taiwan's collaboration base is not just broad but high impact. The lever for diversification lies in extending that strength further: Chapter 3 notes that Singapore (75.6%) and the Netherlands (64.4%) achieve materially higher collaboration rates through deeper participation in large multilateral programs, a model that could help move Taiwan's network into broader, multidisciplinary partnerships that AI, quantum, and biotechnology are more likely to require.

The third is talent. University enrollment fell from 1.2 million to 1.05 million between 2020 and 2025, over precisely the period in which Taiwan's scholarly output continued to grow (Chapter 2). Diversifying into new strategic verticals requires a larger, not a smaller, pool of research talent; a contracting university sector could be a genuine constraint on how far diversification can go.

This report was prepared by Elsevier using SciVal based on Scopus data (analysis period 2021–2025 unless otherwise stated) and LeapSpace to provide further policy insights from the academic literature. For further information, customized analytics, or institutional benchmarking, please contact the Elsevier APAC Global Strategic Networks and Taiwan teams.

Building upon “Taiwan’s Next Science Frontier”

This report provides a quick portrait of Taiwan’s research and innovation system, and the analysis is balanced overall. Yet, it can certainly enhance coverage on the current programs and initiatives implemented by the government. The report could be more strategically focused for policymakers. In particular, it would benefit from bringing together scientific strength, talent scale, fiscal capacity and market opportunity to identify where Taiwan is best positioned and which fields to prioritise. This would give the conclusions a clearer strategic direction.

Dr. Huey-Jen Jenny Su

Professor Emeritus of Environmental NCKU,
Chairman, NCKU Research and Development
Foundation and Former President of NCKU,
Taiwan (2015–2023)

The “Taiwan’s Next Science Frontier” report provides a comprehensive evidence base for the view that Taiwan’s next science frontier will depend on extending its semiconductor strengths into AI, quantum science, and biotechnology, while building the research depth each field requires. The report also highlights ITRI’s historical role in translating academia research into industrial applications through technology transfer and spin-offs such as TSMC and UMC.

The report notes that Taiwan’s relatively low rate of university–industry co-publication merits attention. However, publications do not capture the full range of collaboration that takes place through research institutes such as ITRI. ITRI, for example, works with and supports more than 22,000 companies each year, most of them being small and medium-sized enterprises. More broadly, Taiwan’s industry, government, academia, and applied research institutions have built international partnerships that help attract talent and connect Taiwan to cross-disciplinary programs in AI, uncrewed vehicles, robotics, and other fields.

Stephen Su

Senior Vice President, Industry Technology
Research Institute (ITRI)



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Appendix 2: University details

Abbreviation	Full name	Website
NTU	National Taiwan University	https://www.ntu.edu.tw/english/
NYCU	National Yang Ming Chiao Tung University	https://www.nycu.edu.tw/en
NCKU	National Cheng Kung University	https://www.ncku.edu.tw/index.php?Lang=en
CMUT	China Medical University Taichung	https://english.cmu.edu.tw/
CGU	Chang Gung University	https://www.cgu.edu.tw/index_e.html
AST HQ	Academia Sinica Taiwan HQ	https://www.sinica.edu.tw/en
NTHU	National Tsing Hua University	https://www.nthu.edu.tw/
TMU	Taipei Medical University	https://www.tmu.edu.tw/
KMU	Kaohsiung Medical University	https://www.kmu.edu.tw/
NCHU	National Chung Hsing University	https://www.nchu.edu.tw/
NSYSU	National Sun Yat-sen University	https://www.nsysu.edu.tw/
NTUST	National Taiwan University of Science and Technology	https://www.ntust.edu.tw/
NCU	National Central University	https://www.ncu.edu.tw/
AU	Asia University	https://www.asia.edu.tw/
NTUT	National Taipei University of Technology	https://www.ntut.edu.tw/
NPUST	National Pingtung University of Science and Technology	https://www.npust.edu.tw/
NCNU	National Chi Nan University	https://www.ncnu.edu.tw/
NYUST	National Yunlin University of Science and Technology	https://www.yuntech.edu.tw/
NTTU	National Taitung University	https://www.nttu.edu.tw/
NCUT	National Chin-Yi University of Technology	https://www.ncut.edu.tw/
NPTU	National Pingtung University	https://www.nptu.edu.tw/
DYU	Da-Yeh University	https://fa.dyu.edu.tw/en/
THU	Tunghai University	https://eng.thu.edu.tw/
CYUT	Chaoyang University of Technology	https://web.cyut.edu.tw/

Appendix 3: Definitions

This report is primarily based on analysis made with Elsevier's SciVal, which draws on output and usage data from Scopus, a source-neutral abstract and citation database curated by independent subject-matter experts. The terminology used in the report is defined below.

Academic-corporate (academic-industry) collaboration

Academic-corporate collaboration in this report is indicated by papers with at least one author from an academic institution and one author from a corporate institution listed in the authorship byline.

Citation

A citation is a formal reference to earlier work made in document, frequently to other scholarly papers, but also to policy documents or patents. A citation is used to credit the originator of an idea or finding and is typically used to indicate that the earlier work supports the claims of the work citing it. The number of citations received by a paper from subsequently published papers and/or policy documents as well as patents, can be used as a proxy of the quality, importance, societal impact or economic translational value of the reported research.

FWCI (Field-Weighted Citation Impact)

Field-weighted citation impact (FWCI) is an indicator of mean citation impact and compares the actual number of citations received by a paper with the expected number of citations for papers of the same document type (article, review, or conference proceeding), publication year, and subject area. When the paper is classified in two or more subject areas, the harmonic mean of the actual and expected citation rates is used. The indicator is therefore always defined with reference to a global baseline of 1.0 and intrinsically accounts for differences in citation accrual over time, differences in citation rates for different document types (e.g., reviews typically attract more citations than research articles), as well as subject specific differences in citation frequencies overall and over time and document types. It is one of the most sophisticated indicators in the modern bibliometric toolkit.

International collaboration

International collaboration in this report is indicated by papers with at least two different regions listed in the authorship byline.

Patent Citations

This is the count of scholarly output published by an entity (e.g., a university) that have been cited by Patents. In the report we use the percentage of total output of an entity which is cited in patents. The SciVal tool used in the report collects Patent data from 107 Patent Offices worldwide.

RAI (Relative Activity Index)

Relative Activity Index is defined as the share of an entity's publications in a subject relative to the global share of publications in the same subject. A value of 1.0 indicates that an entity's research activity in a field corresponds exactly with the global activity in that field; higher than 1.0 implies a greater emphasis while lower than 1.0 suggests a lesser focus.

Scholarly output

Scholarly output describes the products of scholarly activity, such as journal articles, books, book chapters, conference papers, and other forms of research dissemination. Throughout the report, when looking at collaborations, we use whole counting, meaning that collaborating entities on a scholarly publication all get a full count in terms of contribution.

Appendix 4:

Data sources

SDG output

The United Nations Sustainable Development Goals (SDGs) challenge the global community to build a world where no one is left behind.

Since 2018, Elsevier has generated SDG search queries to help researchers and institutions track and demonstrate progress toward the SDG targets. In the past 3 years, these queries, along with the university's own data and evidence supporting progress and contributions to the particular SDG outside of research-based metrics, are used for the THE Impact Rankings.

For 2025, the SDGs use the exact same search query and ML algorithm as the Elsevier 2023 SDG mappings (<https://elsevier.digitalcommonsdata.com/datasets/y2zyy9vwzy/1>), with only minor modifications coming from changes to the search engine handling the SDG queries. Because of this, while the vast majority of publications retain their original mapping, the number of publications in each SDG has slightly changed.

All these changes were implemented to streamline how SDG queries are handled. Users should note that running these in Scopus should be done for reference purposes only, as the Scopus search engine behaves slightly differently than the classifier used to formerly tag SDGs to publications.

Strategic technologies

The Office of Science and Technology Policy (OSTP) advises the President on the impacts of science and technology on domestic and international affairs. The OSTP Research Areas in SciVal represent 5 OSTP focus areas: Artificial Intelligence, Quantum Information Science, Nuclear Technology, Biotechnology, and Semiconductors.

Subject area classification

The subject area classification used in this report is based on the Quacquarelli Symonds codes. This classification is used in QS World University Rankings. It covers 5 subject areas and 51 subjects. Each QS subject area is mapped to one or more All Science Journal Classification (ASJC — the default subject area classification used in SciVal).

Scopus

Scopus is a comprehensive, source-neutral abstract and citation database curated by independent subject-matter experts. It indexes tens of millions of records from thousands of publishers and forms the underlying data source for the analyses in this report.

www.scopus.com

Country and economy assignment uses author-affiliation addresses, applied consistently across the report. “China” means mainland China, and Taiwan is labelled “Taiwan” as is in Scopus.

SciVal

SciVal is an advanced research-analytics tool built on Scopus data. It enables visualisation of research performance, benchmarking against peers, analysis of collaboration and emerging trends, and the creation of tailored reports. All bibliometric indicators in this report are derived from SciVal for the 2021–2025 period unless otherwise stated.

www.scival.com

LeapSpace

LeapSpace™ is the research-grade AI-assisted workspace that lets researchers work faster, think deeper, and achieve more in a secure environment.

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