TAIWAN AND THE GLOBAL SEMICONDUCTOR SUPPLY CHAIN

- China's Pursuit of Semiconductor Self-Sufficiency

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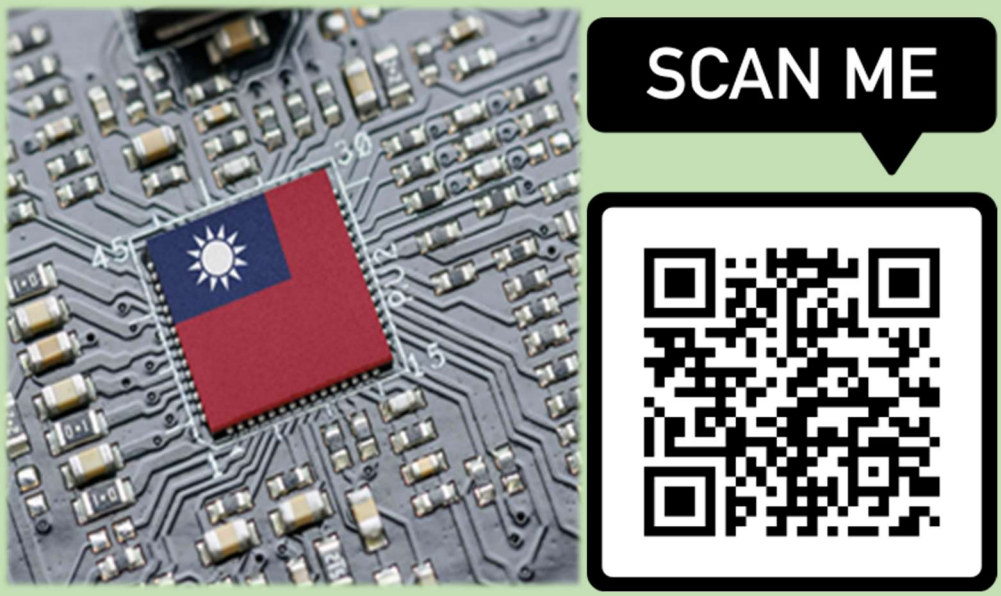

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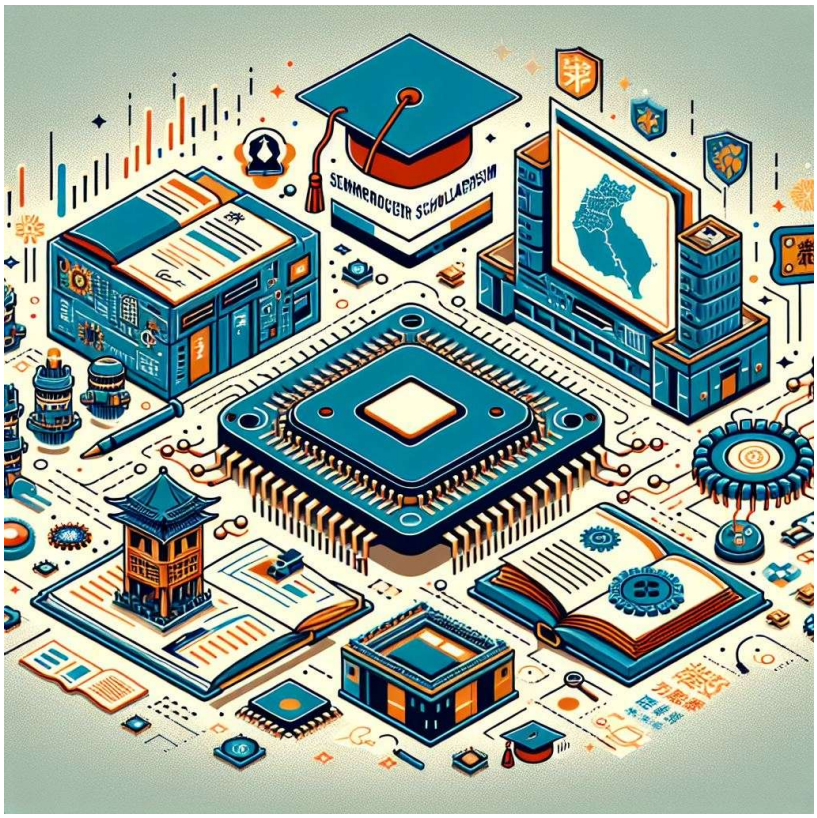

We warmly welcome our Singaporean friends to explore semiconductor studies in Taiwan, a country renowned for its cutting-edge semiconductor technology. Our semiconductor companies like the Taiwan Semiconductor Manufacturing Company (TSMC), United Microelectronics Corporation (UMC), MediaTek and ASE Technology are global leaders in the semiconductor industry.

Semiconductors play a critical role in various electronic devices, including smartphones, computers, and automobiles. The semiconductor industry has been instrumental in fostering bilateral trade and investment between Taiwan and Singapore. To enhance collaboration further—particularly in talent development—the Taipei Representative Office in Singapore proudly presents the latest guidebook titled 'Study Semiconductor in Taiwan.' This comprehensive resource covers application details for scholarships at nine Taiwanese universities. Download the full text of "Study Semiconductor in Taiwan" https://shorturl.at/jNd5E

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IN THE SPOTLIGHT

China’s Pursuit of Semiconductor Self-Sufficiency

- **From zero wafer production capacity in 1990, China has grown to hold 24% of the world's semiconductor manufacturing capacity by site in 2022.**
- **China's "Made in China 2025" initiative set an ambitious target of achieving 70% self-sufficiency in semiconductor production by 2025. TrendForce reports that China's domestic chip self-sufficiency rate increased from 14% in 2014 to 23% in 2023, with projections indicating it could reach 26.6% by 2027.**
- **For the most advanced chips (≤7nm), China still depends largely on Taiwan and South Korea.**
- **Due to its leadership in semiconductor manufacturing, Taiwan plays an important role in China’s semiconductor industry.**

Source: Created by Microsoft Copilot

THE CHINESE SEMICONDUCTOR INDUSTRY

Semiconductors, or "chips," are integral to our modern world, driving innovation and efficiency across a plethora of applications, from medical devices and clean energy to transportation and advanced defense systems. With increasing demand for semiconductors across various sectors, the global semiconductor industry is poised to become a trillion-dollar industry by 2030.[1] The importance of semiconductors, therefore, extends far beyond the realm of technology; they are the lifeline of modern economies and crucial to a nation's strategic interests.

In recent years, geopolitical tensions have made semiconductors a focal point. Major players like the U.S.A., Taiwan, South Korea, Japan, Europe and China are fiercely competing to secure a robust position in the semiconductor industry. On its part, China is bolstering its semiconductor industry as it strives to achieve semiconductor self-sufficiency and secure a competitive edge in the global market.

China in the Global Semiconductor Value Chain

China plays a significant role in the global semiconductor industry. According to a Boston Consulting Group (BCG) report in May 2024, China contributed 11% to the overall semiconductor value chain in 2022. China's assembly, test and packaging (ATP) segment was its most significant contributor, accounting for 30% of the global semiconductor added value. Its wafer manufacturing came in second at 24% while semiconductor materials came in third at 18% of the global semiconductor value-added. Other value-add activities include design of discrete, analog, and other (DAO) chips (9%), design of logic chips (5%), design of memory chips (3%), semiconductor equipment (3%), and EDA and Core IP (less than 1%) (see Figure 1).

[1] Ondrej Burkacky, Julia Dragon, and Nikolaus Lehmann, "The semiconductor decade: A trillion-dollar industry," McKinsey & Company, April 1, 2022.

Figure 1: Semiconductor industry value-added by activity and region: 2022 (%)

Precompetitive Research		Segment value-added		USA	EU	Japan	S. Korea	Taiwan	China	RoW
EDA	**Design**	EDA & Core IP	3%	68%	25%	<1%	<1%	3%	<1%	3%
Core IP	• Logic	Design-Logic	30%	65%	9%	4%	3%	11%	5%	4%
	• DAO	Design-DAO	17%	41%	17%	18%	4%	5%	9%	6%
	• Memory	Design-Memory	9%	25%	<1%	7%	60%	4%	3%	<1%
Equipment	**Manufacturing**	Mfg equipment	12%	47%	18%	25%	3%	<1%	3%	2%
Materials	• Wafer fabrication	Materials	5%	9%	6%	12%	18%	28%	18%	10%
		Wafer fabrication	19%	10%	8%	17%	17%	18%	24%	7%
	• Assembly, test and packaging	ATP	6%	3%	3%	6%	9%	28%	30%	20%
		Overall value chain	100%	38%	11%	12%	12%	11%	11%	5%

Notes on regional breakdown:

- EDA, design, manufacturing equipment, and raw materials based on company revenues and company headquarters location.
- Wafer fabrication and assembly & testing based on installed capacity and geographic location of the facilities.
- RoW includes Singapore, Israel, India and the rest of the world.

Source: Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, “Emerging Resilience in The Semiconductor Supply Chain,” Boston Consulting Group, May 2024, p. 10.

Just as different activities contribute differently to the overall value chain, distinct regions excel in specific segments of the semiconductor industry. For instance, companies based in the U.S.A. lead in research and development, chip design, core IP, and EDA. The U.S.A., Japan and the European Union collectively dominate in equipment manufacturing. Companies headquartered in Taiwan, South Korea, China and Japan are leaders in materials. Taiwanese and South Korean companies are at the forefront of advanced node fabrication, particularly for leading-edge semiconductors with process nodes of 7 nanometers (nm) and below. Additionally, assembly, testing, and packaging (ATP) operations are primarily concentrated in China and Taiwan.

Research and Development

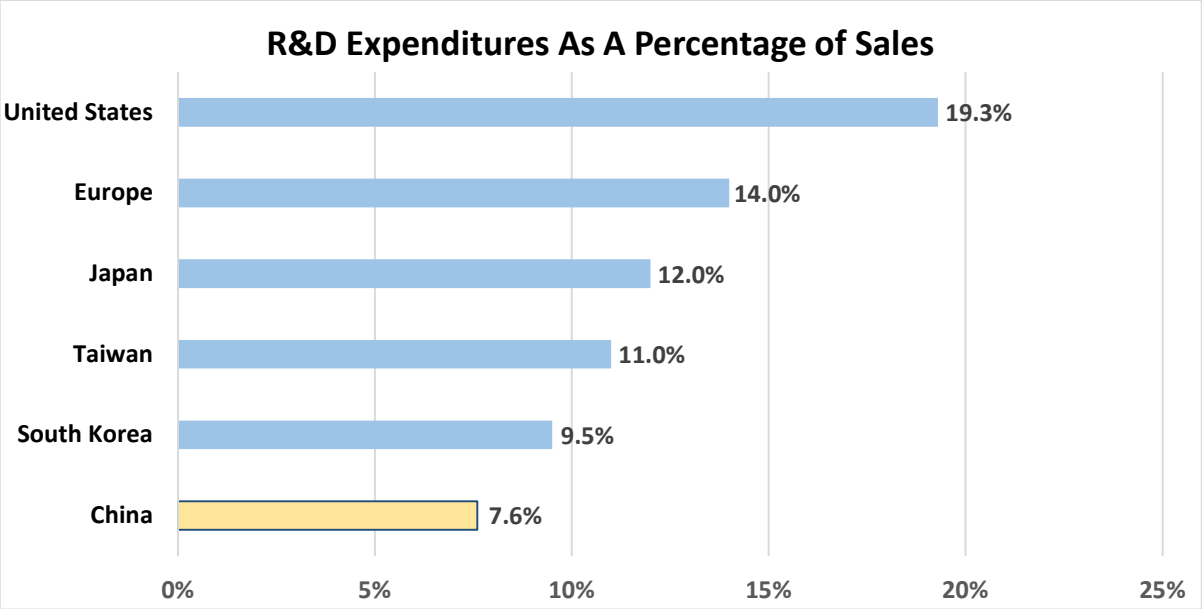
The outline of China's 14th Five-Year Plan (2021-25) for National Economic and Social Development and the Long-Range Objectives through the Year 2035 stated China will speed up the development of high-end chips.[2] To bolster semiconductor R&D, China has poured significant resources into creating research centers, universities, and industrial parks dedicated to semiconductor technology.[3] In early 2023, for example, reports surfaced that the Chinese government had designated five key firms— Huawei, Semiconductor Manufacturing International Corporation (SMIC), Yangtze Memory Technologies Company (YMTC), and toolmakers Naura and Advanced Micro-Fabrication Equipment Inc. (AMEC) — to gain privileged access to government R&D.[4] Universities like Tsinghua University and Peking University, which are known for their research and innovation in semiconductor materials, design, and manufacturing processes, have strong connections with major industry players.[5]

According to the Semiconductor Industry Association, China's semiconductor companies invested 7.6% of the total sales in R&D in 2023, putting it behind its counterparts in other countries. The U.S. semiconductor

[2] "China makes breakthrough in system-integrated memristor computing-in-memory chips," Global Times, October 10, 2023.
[3] "Intelligent Manufacturing in China+ project begins," School of Economics and Management, Tsinghua University, December 11, 2023.
[4] Qianer Liu, "China Gives Chipmakers New Powers to Guide Industry Recovery," Financial Times, March 20, 2023.
[5] Francisco Pires, "Despite Chip Ban, U.S. Trails China in Published Research Papers," Tom's Hardware, November 23, 2022.

companies led with 19.3%, followed by semiconductor companies in Europe (14.0%), Japan (12.0%), Taiwan (11.0%) and South Korea (9.5%). In terms of semiconductor industry R&D intensity, China's rate of 7.6% was just 39% of America's and 54% of Europe's semiconductor firms (see Figure 2).

Figure 2: Semiconductor Industry R&D Spending Across Regions: 2023



Source: Semiconductor Industry Association, State of the U.S. Semiconductor Industry 2024, September 17, 2024, p. 29.

China remains behind global semiconductor leaders in key areas of R&D and advanced manufacturing technology. Specifically, it is approximately five years behind in achieving high-volume production of cutting-edge logic semiconductor chips and continues to face significant gaps in memory chip development and semiconductor manufacturing equipment.[6] Due to U.S. export controls, China's access to advanced AI chips and semiconductor technologies has been significantly limited, making it more challenging for China to catch up with the rest of the world in semiconductor R&D.[7]

[6] Stephen Ezell, "How Innovative Is China in Semiconductors?" Information Technology and Innovation Foundation, August 19, 2024.

[7] Gregory C. Allen, "Choking off China's Access to the Future of AI," Center for Strategic and International Studies, October 11, 2022; Aamna Zaheer, "The Impact of U.S. AI Chip Export Controls on China and the Gulf States," The Asian Politico, August 16, 2024.

EDA and Core IP

EDA is a market segment consisting of software, hardware, and services with the collective goal of assisting in the definition, planning, design, implementation, verification, and subsequent manufacturing of semiconductor devices, or chips.[8] EDA tools provide a simulated environment where circuits and designs are conceived and analyzed before being realized in the physical world. EDA tools are, therefore, widely used in the design of almost all types of chips and have become indispensable as chip designs get complicated. Additionally, EDA tools are also used by chip manufacturers to verify that a design is feasible before production.[9]

An IP core, on the other hand, is a reusable unit of logic or integrated circuit (IC) layout design.[10] IP cores are essential for chip design and functionality. They provide pre-designed and pre-verified blocks of logic that can be integrated into semiconductor devices, significantly speeding up the design process and ensuring reliability. This also allows companies that choose not to build fully customizable chip designs from scratch to focus on innovation and differentiation in other areas of their chip.

Even though the EDA and Core IP segment contributed only 3% to the value-added in the semiconductor value chain in 2022, it is indispensable to the success of semiconductor design and manufacturing (see Figure 1). By ensuring that chips meet performance, power, and area requirements, EDA software and IP cores are crucial for enabling the creation of highly complex and efficient chips.[11]

China accounted for less than 1% of the global value-added EDA market share (see Figure 1). The EDA market is oligopolistic, dominated by U.S.

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[8] "What is EDA," Synopsys, https://www.synopsys.com/glossary/what-is-electronic-design-automation.html, Accessed on November 11, 2024.

[9] Zeyi Yang, "Inside the software that will become the next battle front in US-China chip war," MIT Technology Review, August 18, 2022.

[10] Rahul Awati, "What is an intellectual property core (IP core)?" TechTarget, https://www.techtarget.com/whatis/definition/IP-core-intellectual-property-core#, Accessed on November 11, 2024.

[11] Ramiro Palma, Raj Varadarajan, Jimmy Goodrich, Thomas Lopez, and Aniket Patil, "The Growing Challenge of Semiconductor Design Leadership," Boston Consulting Group and Semiconductor Industry Association, November 2022.

headquartered companies like Synopsys, Cadence, and Siemens EDA.[12] These companies have established strong reputations and extensive portfolios, making it difficult for new entrants to compete. Moreover, developing EDA tools requires significant investment in research and development, as well as deep expertise in semiconductor design and manufacturing processes, making the barriers to entry to the EDA and Core IP segment even higher.

Leading Chinese EDA companies include Empyrean Technology, GWX Technology, Primarius, Semitronix, Shenzhen Giga Design Automation, UniVista, and X-EPIC. Chinese companies captured 11.5% of the domestic EDA market in 2020 and this is expected to increase to 14% by 2025.[13] Empyrean Technology is the leader of China's EDA industry but even its technology, revenue scale, and overall influence fall far behind the American EDA industry.[14]

Due to U.S. export controls, Chinese companies have been denied access to advanced EDA software and design IP.[15] On December 2, 2024, Empyrean Technology and its subsidiaries were placed on the U.S. Department of Commerce's Entity List, restricting Empyrean from accessing U.S. technology and components, which can directly impact its ability to develop and produce EDA tools.[16] Following the blacklisting, Empyrean transferred full control to its state-owned shareholder, China Electronics Corporation (CEC).[17]

In June 2023, China established the National Center of Technology Innovation for EDA (NCTI-EDA), its first national innovation center dedicated to advancing IC design.[18] This initiative reflects China's strategic push to develop domestic EDA tools and reduce its dependence on foreign technologies, particularly in light of U.S. export restrictions. However, building a competitive, homegrown EDA ecosystem is a complex and resource-intensive process that requires sustained investment, long-term talent development, and

[12] TrendForce, Press Release: "New US EDA Software Ban May Affect China's Advanced IC Design, Says TrendForce," August 15, 2022.

[13] "芯片 EDA 国产化率已超过 11%，思尔芯将与腾讯云联合打造 EDA 云服务," TMT Post, January 22, 2024.

[14] Ibid.

[15] Zeyi Yang, "Inside the software that will become the next battle front in US-China chip war," MIT Technology Review, August 18, 2022.

[16] TrendForce, Press Release: "China's EDA Giant Empyrean Technology Shifts Control to State-Owned Company after U.S. Blacklist," December 11, 2024.

[17] Ibid.

[18] "Nanjing hosts China's first national EDA innovation center," Jiangsu Now, June 30, 2023.

technological breakthroughs — all of which will take considerable time to materialize.[19]

Chip Design

Chip design is a crucial activity that determines the function and value of a semiconductor device.[20] In 2022, chip design contributed 56% value-added to the global semiconductor industry (see Figure 1).

Semiconductor chips can be broadly classified into three main categories, namely, Logic, Memory, and Discrete, Analog and Other (DAO) chips. Each category of chips performs different functions and requires specialized design and manufacturing processes.[21] Logic chips are crucial for processing and executing instructions in electronic devices; memory chips, such as dynamic random-access memory (DRAM) and Not And (NAND) flash memory, are essential for storing and retrieving data in devices; while DAO chips are used in the design and optimization of semiconductor manufacturing processes.

Chip design is carried out by fabless companies and IDMs.[22] Fabless companies focus on designing semiconductor chips and partner with other companies (foundries) for the manufacturing phase while IDMs design and manufacture their own chips in their own fabs.[23]

In 2022, China's share in chip design was modest. In the design of logic chips, its value-added share was 5%. In contrast, the U.S.A. led the way with a dominant 65% value-added, followed by Taiwan at 11% value-added and the EU at 9% value-added. In the design of memory chips, China's share was 4% value-added, significantly lower compared to Taiwan, which led the market

[19] Janjeva, A., Baek, S., & Sellars, A., "China's Quest for Semiconductor Self-Sufficiency," Centre for Emerging Technology and Security," Center for Emerging Technology and Security, The Alan Turing Institute, December 4, 2024.

[20] "Strengthening U.S. Leadership In Chip Design," Semiconductor Industry Association, https://www.semiconductors.org/wp-content/uploads/2023/07/Chip-Design-Leadership-One-pager_062623.pdf, Accessed on November 11, 2024.

[21] Congressional Research Service, CRS Report: "Semiconductors and the Semiconductor Industry," April 19, 2023.

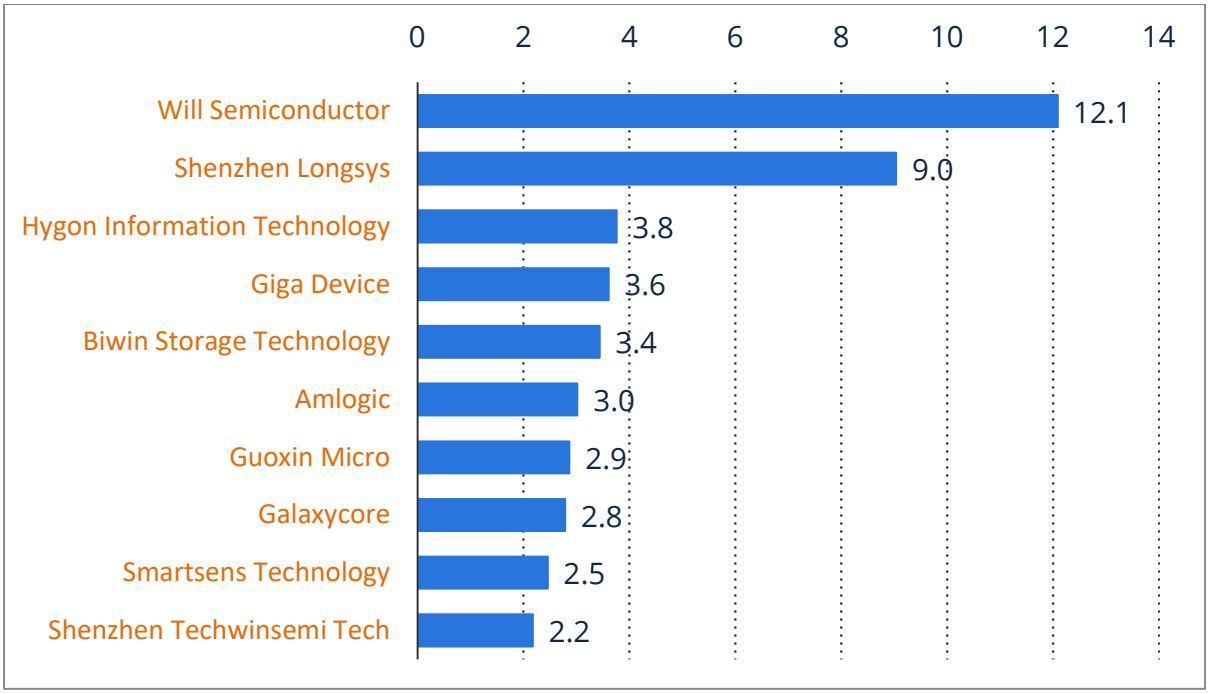
[22] "Strengthening U.S. Leadership In Chip Design," Semiconductor Industry Association, https://www.semiconductors.org/wp-content/uploads/2023/07/Chip-Design-Leadership-One-pager_062623.pdf, Accessed on November 11, 2024.

[23] Ibid.

with a 60% value-added share. In the design of DAO chips, China's global value-added share was 5%, significantly lower compared to the U.S., which held a dominant 41% value-added share in this segment (see Figure 1). As a result, China still has substantial ground to cover before it can match the capabilities of the world's leading chip designers.

In fact, Intel, Samsung, and TSMC are industry giants with extensive resources, advanced technologies, and decades of experience that put them far ahead in the semiconductor design and manufacturing field. Will Semiconductor and Shenzhen Longsys, while significant homegrown players in China's semiconductor industry, do not yet match the scale and global reach of these global leaders. In 2023, for example, Will Semiconductor's revenue was RMB 21 billion (US$ 3.1 billion), far below TSMC's revenue of US$ 69.3 billion, Intel's US$ 51.2 and Samsung's US$ 44.4 billion (see Figure 3 and Table 3).

Figure 3: Leading Domestic Digital Semiconductor Design Companies in China based on revenue (in billion yuan): 1st half of 2024



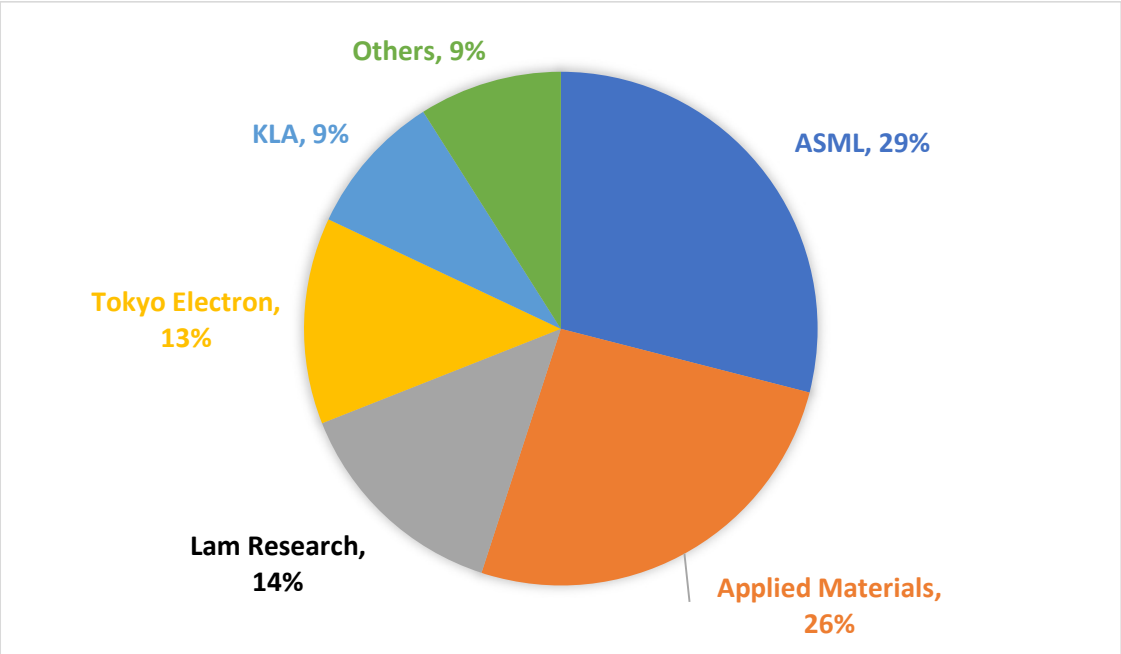
Source: AskCI Consulting. (September 4, 2024). Leading digital semiconductor design companies in China in 1st half of 2024, based on revenue (in billion yuan) [Graph]. In Statista. Retrieved February 06, 2025, from https://www.statista.com/statistics/1545900/china-leading-digital-ic-design-companies-by-revenue/

Semiconductor Equipment Manufacturing

Semiconductor equipment manufacturing, the third highest value-added activity within the semiconductor value chain, accounted for 12% value-added to the global semiconductor value chain in 2022. In 2022, China's value-added share of the global semiconductor manufacturing equipment market was 3%. This is relatively low compared to other leading countries, highlighting the challenges China faces in this sector.

The semiconductor equipment manufacturing market is dominated by a handful of key players, with the U.S.A. the clear leader. Three of the five leading equipment companies—Applied Materials, Lam Research, and KLA—are based in Silicon Valley and are thriving.[24] Netherland's ASML, for example, led the pack with a 29% market share in 2023.[25] Applied Materials followed closely behind with 26%, Lam Research held a significant share with 14%, Japan's Tokyo Electron accounted for 13% of the market while KLA Corporation rounded out the top five with 9% (see Figure 4).

Figure 4: Semiconductor Manufacturing Equipment Vendor Market Share by Revenue Worldwide: 2023



[24] Richard Elkus Jr., "A Strategy for The United States to Regain its Position in Semiconductor Manufacturing," February 13, 2024.

[25] "The Global Semiconductor Equipment: Markets, Market Shares, Market Forecasts," The Information Network, April 11, 2023.

Source: Market share derived from revenue figures from CompaniesMarketCap.com, https://companiesmarketcap.com/ accessed on February 3, 2025; "Semiconductor Manufacturing Equipment Market Report," Grand View Research, https://www.grandviewresearch.com/industry-analysis/semiconductor-manufacturing-equipment-market-report, accessed on February 3, 2025.

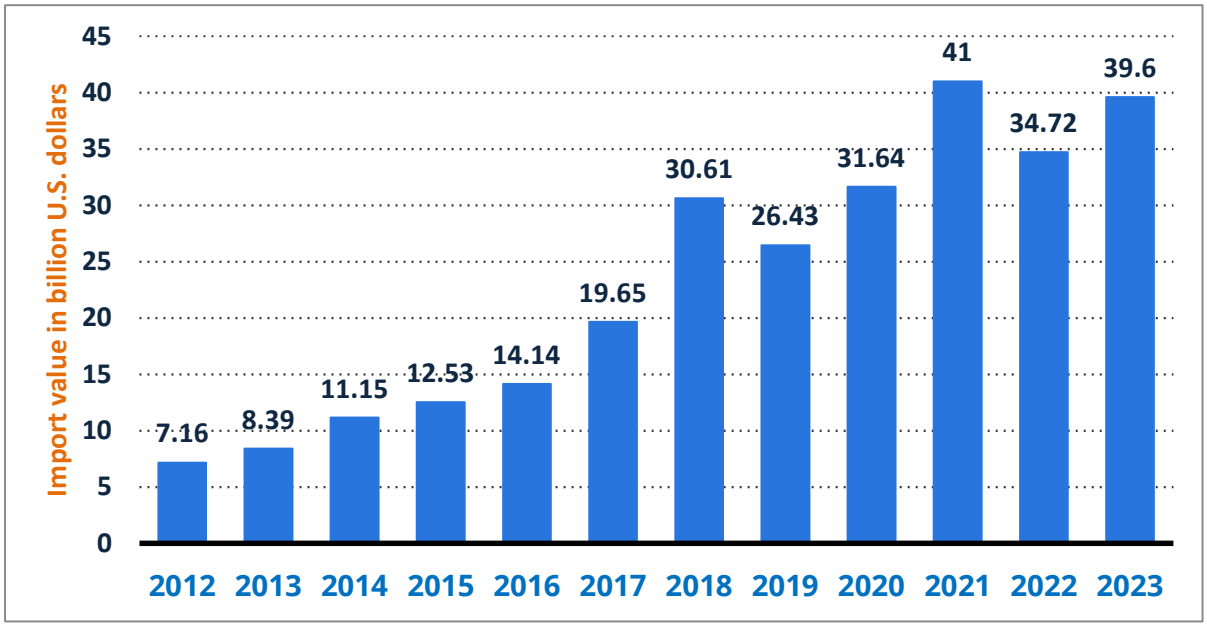
According to TrendForce, while China's local equipment industry has made much progress and appears to be able to cover the various stages required in semiconductor manufacturing processes, lithography machines remain a challenge.[26] Furthermore, Chinese semiconductor manufacturers still have room to catch up with international giants like Applied Materials, ASML, Lam Research, Tokyo Electron and KLA Corporation, which command billion-dollar scales and offer diverse high-end product lines.[27]

Due to export restrictions, China has been prevented from acquiring Extreme Ultraviolet (EUV) machines from ASML, the primary supplier of this advanced technology.[28] In recent years, Chinese companies have been stockpiling deep ultraviolet (DUV) machines from Japan's Tokyo Electron and Nikon and the Netherlands' ASML to maintain their semiconductor manufacturing capabilities.[29]

In 2023, China imported semiconductor machines valued at US$ 39 billion, marking a US$ 5 billion increase compared to 2022. One of the most important machines are lithography machines that are crucial equipment in the semiconductor industry and the chip manufacturing process. For this critical technology, China relies heavily on imports (see Figure 5).

[26] TrendForce, Press Release: "Overview of China's Semiconductor Equipment Industry," February 17, 2024.
[27] Ibid.
[28] Anton Shilov, "ASML CEO says China is 10 to 15 years behind in chipmaking capabilities," Tom's Hardware, December 25, 2024.
[29] TrendForce, Press Release: "Surge in Chip Manufacturing Equipment Imports from the Netherlands to China, Soaring Tenfold After U.S. Tightens Restrictions," December 27, 2023.

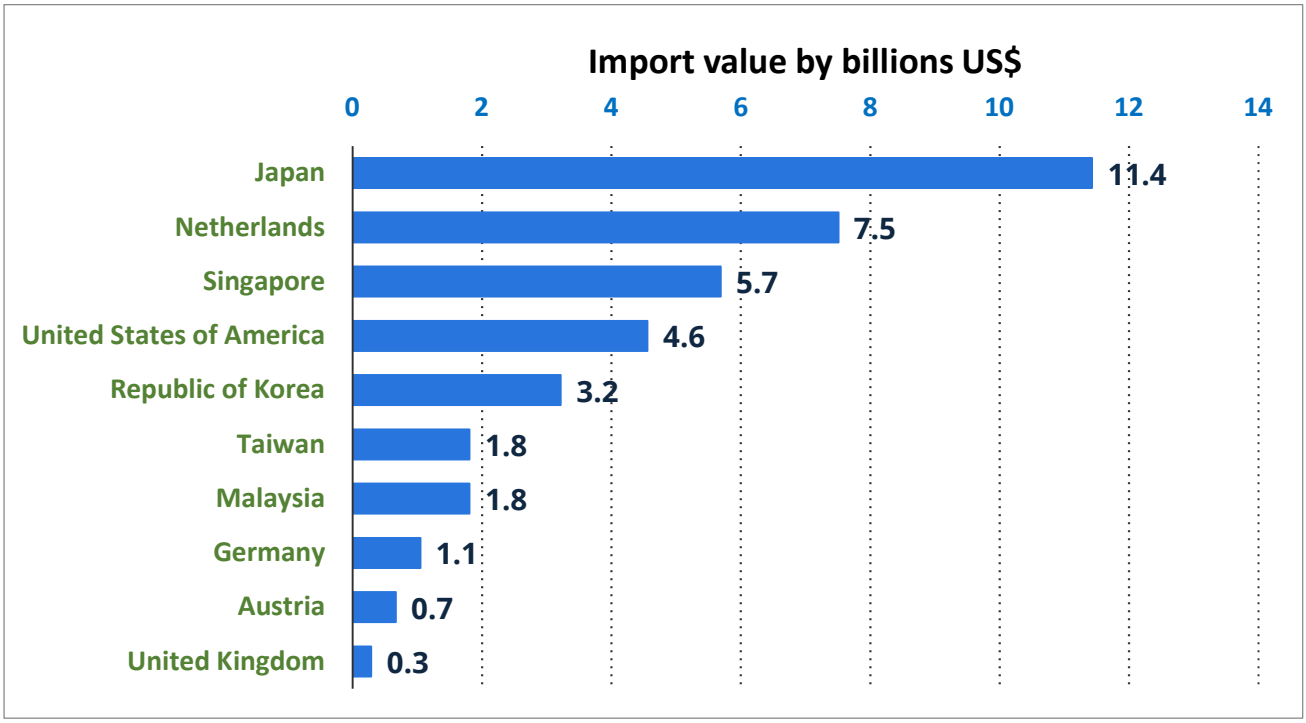
Figure 5: Import Value of Machines for Manufacturing Semiconductors in China: 2012 to 2023



Source: Trade Map. (September 9, 2024). Import value of machines for manufacturing semiconductors in China from 2012 to 2023 (in billion U.S. dollars) [Graph]. In Statista. Retrieved February 06, 2025, from https://www.statista.com/statistics/1345297/china-import-value-of-semiconductor-equipment/

In 2023, China imported semiconductor equipment worth US$ 11.4 billion from Japan, US$ 7.5 billion from the Netherlands and US$ 5.7 billion from Singapore. These figures highlight the significant reliance of China on these key regions for advanced semiconductor manufacturing technology (see Figure 6).

Figure 6: Leading region of origin for imported semiconductor equipment in China by import value: 2023



Note: List of countries is not exhaustive.
Source: Trade Map. (September 9, 2024). Leading region of origin for imported semiconductor equipment in China in 2023, based import value (in billion U.S. dollars) [Graph]. In Statista. Retrieved February 03, 2025, from https://www.statista.com/statistics/1345341/china-export-value-of-semiconductor-equipment-by-origin-region/

Additionally, Chinese companies like Shanghai Micro Electronics Equipment (SMEE) and Huawei are actively working on developing their own EUV lithography tools.[30] In March 2024, Huawei Technologies filed a patent application for a technique called self-aligned quadruple patterning (SAQP).[31] This method involves etching lines on silicon wafers multiple times to increase transistor density and improve performance. By using SAQP with DUV lithography machines, Chinese semiconductor manufacturers aim to produce advanced 5 nm chips without the need for more advanced EUV tools only available from ASML.[32]

[30] Anton Shilov, "China's SMEE files patent for an EUV chipmaking tool — tool aims to break the shackles of ASML export restrictions," Tom's Hardware, September 13, 2024.
[31] Che Pan, "Tech war: China quietly making progress on new techniques to cut reliance on advanced ASML lithography machines," South China Morning Post, April 1, 2024.
[32] Ibid.

Semiconductor Materials

The materials segment of the semiconductor value chain accounted for only 5% global value-added in 2022. In 2022, China's value-added share of the global semiconductor materials market was 18%, behind Taiwan's 28% value-added share. Other regions such as South Korea (18%), and Japan (12%) also play a significant role in the production of essential materials used in semiconductor manufacturing (see Figure 1).

Brookings Institution has reported that China is a major player in the global supply of rare earth elements, producing around 60% of the world's supply and processing 85% of them.[33] Rare earths are critical for producing components used in various electronic devices, including magnets, catalysts, and lighting systems. Additionally, they are also essential for the manufacturing of semiconductor-related materials like neodymium, lanthanum, and cerium. The concentration of rare earth elements in China poses risks for countries and companies heavily reliant on these materials, as any disruptions in supply or export restrictions could impact chip production and innovation.[34]

Semiconductor Assembly, Test and Packaging

The semiconductor assembly, test and packaging (ATP) segment contributed 6% value-added to the overall value chain. ATP, especially traditional ATP, generally involves fewer complex processes and tools than other portions of manufacturing and is correspondingly more labor-intensive. The ATP footprint is concentrated in China, and Taiwan, which held 30% value-added and 28% value-added of the global market share in 2022, respectively (see Figure 1).

[33] Gracelin Baskaran, "Could Africa replace China as the world's source of rare earth elements?" Brookings, December 29, 2022

[34] Shubham Rajendra Ekatpure, "Rare Earth Elements for Semiconductor Manufacturing: Global Supply Chain and Dominance," Journal of Marketing & Supply Chain Management, February 16, 2022.

Semiconductor Manufacturing

Semiconductor manufacturing requires high capital expenditure, and many highly specialized inputs and skilled workers.[35] Wafer manufacturing is the second highest value-added segment in the semiconductor value chain. In 2022, China led the global semiconductor manufacturing value-added contributions with 24%, followed by Taiwan (18%), Japan (17%), South Korea (17%), the U.S.A. (10%), and Europe (7%) (see Figure 1).

Overall Semiconductor Value Chain

China's share of overall value-added to the global semiconductor industry is significant. Its largest contribution was in the assembly, test and packaging segment. China is also known for its chip fabrication capabilities, particularly in mature nodes (28nm and above). China's domestic capabilities in EDA and core IP, however, are still developing, making it reliant on foreign technology. China's ability to produce high-end equipment is also limited, necessitating imports to meet its manufacturing needs.

China's Semiconductor Production Capacity

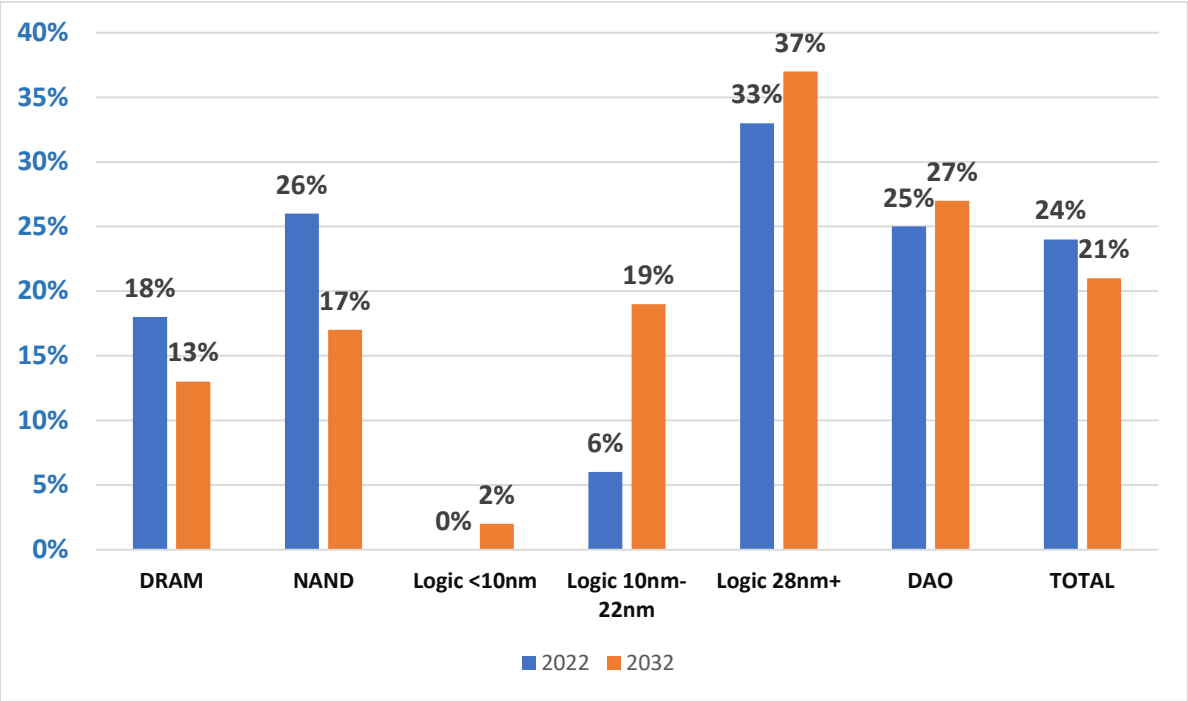
- China is a major producer of memory and legacy chips.

According to the May 2024 report by Boston Consulting Group (BCG), Chinese companies accounted for approximately 24% of the global wafer fabrication capacity in 2022 (see Figure 7).[36]

[35] Antonio Varas, Raj Varadarajan, Jimmy Goodrich and Falan Yinug, "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," Semiconductor Industry Association, April 1, 2021.

[36] Raj Varadarajan, Iacob Koch-Weser, Christopher Richards, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton and Robert Casanova "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group and Semiconductor Industry Association, May 2024.

Figure 7: China's Share of Global Fabrication Capacity on Site (Quantity): 2022 and 2032



Source: Raj Varadarajan, Iacob Koch-Weser, Christopher Richards, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton and Robert Casanova "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group and Semiconductor Industry Association, May 2024, p. 14.

China holds a significant share in the global memory chip fabrication sector. In 2022, Chinese companies held about 18% of the global wafer fabrication capacity for Dynamic Random-Access Memory (DRAM) chips, which are widely used in computers and electronic devices to store data that is frequently accessed. For NAND Flash Memory category, companies in China accounted for approximately 26% of the global wafer fabrication capacity in 2022.

Besides memory chips, China's wafer manufacturing has also been focused on the production of legacy chips. China's share of global logic chip fabrication in 2022 was zero for chips (<10nm), about 6% share for the 10-22nm category, and a notable 33% share for mature logic chips with feature sizes of 28nm and larger. According to TrendForce, foundries in China are set to drive the bulk of mature process capacity growth in 2025. Major capacity expansion plans for 2025 include Taiwan's TSMC's Japan Advanced Semiconductor Manufacturing (JASM) fab in Kumamoto, Japan; Singapore-headquartered VisionPower Semiconductor Manufacturing Company Pte Ltd (VSMC), a joint venture between Taiwan's Vanguard International

Semiconductor Corporation (VIS) and Netherlands' NXP Semiconductors; and China's SMIC's fabs in Lingang (Shanghai), Beijing, HuaHong Group's Fab9 in Wuxi and Fab10 in Shanghai, and Nexchip's N1A3 in Hefei (see Table 1).

Table 1: Major Mature Process Expansion Plans: 4Q24 – 4Q25

Company (Country of Headquarters)	**Fab**	**Technology Node**
TSMC (Taiwan)	JASM	28/22-16/12nm
VSMC (Singapore)	VSMC 300mm Wafer Manufacturing Facility (Joint venture between Taiwan's VIS and Netherlands' NXP Semiconductors)	up to 40nm
SMIC (China)	Jingcheng	40-28nm
	Oriental	110-28nm
Huahong Group (China)	Fab9 (Operated by Shanghai Huahong Grace Semiconductor Manufacturing Corporation)	55/40nm, Power discrete
	Fab10 (Operated by Shanghai Huali Microelectronics Corporation)	28/22nm
Nexchip (China)	N1A3	55-28nm

Source: TrendForce, "Mature Process Capacity to Grow 6% in 2025; Chinese Foundries Lead Expansion, Says TrendForce," October 24, 2024; Ministry of Trade and Industry, Singapore, Press Release: "GOH Address by 2M Tan See Leng at Visionpower Semiconductor Manufacturing Company's (VSMC) New Wafer Fabrication Groundbreaking Ceremony," December 4, 2024.

Meanwhile, in the category of discrete, analog, and other (DAO) chips, companies in China held roughly 25% of the global wafer fabrication capacity in 2022 (see Figure 7).[37]

In 2032, China's share of the global chip fabrication capacity is projected to be 21%, down from 24% in 2022. Additionally, its share of chips below 10nm is expected to be only around 2% of the global market (see Figure 7). China's advancements in semiconductor manufacturing have faced numerous challenges.

Advanced chips, specifically those with process nodes of 7nm or less, represent the cutting edge of semiconductor technology. Taiwan's TSMC, South Korea's Samsung, and U.S.A.'s Intel are leading the industry in manufacturing advanced chips using EUV lithography machines. ASML, the sole company that manufactures EUV lithography machines, is required to comply with U.S. export controls and is prohibited from selling EUV machines to

[37] Ibid.

China.[38] Unable to access EUV lithography technology, China's largest chipmaker, SMIC has reportedly achieved a quasi-7nm process using DUV machines. [39]

TechInsights confirmed that Huawei's Mate 60, introduced in 2023, featured a 7nm chip fabricated by SMIC, marking a significant achievement in China's semiconductor industry.[40] Huawei's Mate 70 Pro, launched in November 2024, continues to use the 7nm chip, which represents only incremental improvements.[41] Although Huawei and SMIC have made notable strides, their innovations are currently plateauing. They are focusing on refining their existing technologies, which can still deliver solid performance but might not match the advancements seen in the chips from industry leaders like TSMC or Samsung. Various media reports suggest that SMIC may be able to make 7nm and 5nm chips with yields of 50% and 30-40%, respectively, but priced at a 40-50% premium over what TSMC charges for similar technology nodes.[42] According to Christophe Fouquet, the CEO of ASML, Chinese companies like SMIC and Huawei are about 10 to 15 years behind industry giants like Intel, TSMC, and Samsung.[43]

China is expected to continue to hold a substantial position in the industry, especially in more mature nodes. Its share for the 10-22nm category is forecasted to triple from 6% in 2022 to 19% in 2032 and its share for chips for the 28nm and above category is projected to increase from 33% in 2022 to 37% in 2032 (see Figure 7).

China's Semiconductor Revenue

According to World Semiconductor Trade Statistics (WSTS) and the Semiconductor Industry Association (SIA), global semiconductor sales

[38] Tim Kelly, Kiysho Takenaka, Mayu Sakoda, Kantaro Komiya and Satoshi SugiyamaJapan, "Netherlands to join U.S. in restricting chip equipment exports to China, Bloomberg reports," Reuters, January 27, 2023.

[39] Majeed Ahmad, "The truth about SMIC's 7-nm chip fabrication ordeal," EDN, August 23, 2022.

[40]

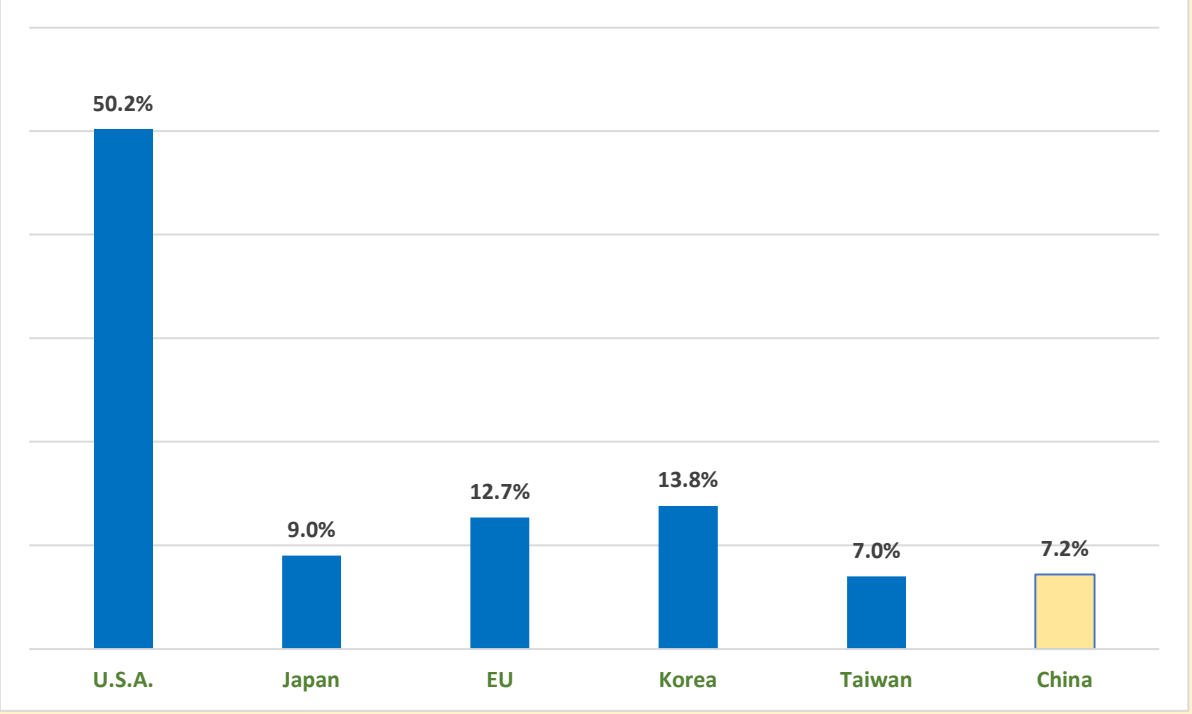
[41] "Huawei's new Mate 70 phone chip shows no major redesign, TechInsights says," Reuters, December 11, 2024.

[42] Jeff Pao, "SMIC to sell Huawei costly, inefficient 5nm chips," Asia Times, February 8, 2024; Qianer Liu, "China on cusp of next-generation chip production despite US curbs," Financial Times, February 6, 2024.

[43] Anton Shilov, "ASML CEO says China is 10 to 15 years behind in chipmaking capabilities," Tom's Hardware, December 25, 2024.

increased from US$ 139.0 billion in 2001 to US$ 526.9 billion in 2023.[44] China accounted for 7.2% share of global semiconductor sales or US$ 37.9 billion in sales revenue in 2023, behind that of the U.S.A. (50.2%), South Korea (13.8%), EU (12.7%) and Japan (9.0%), and only slightly ahead of Taiwan (7%) (see Figure 8).[45] The U.S. semiconductor industry, with its pole position in the market, is able to heavily invest in R&D, keeping it at the forefront of global tech advancements and reinforcing its sales leadership.

Figure 8: Share of Semiconductor Revenue by Region: 2023



Source: SIA 2024 Factbook, Semiconductor Industry Association, May 14, 2024.

A report from the U.S. Department of Commerce (DOC)'s Bureau of Industry and Security (BIS) in December 2023 showed that China is a significant player in fabless semiconductor design and manufacturing services, including outsourced semiconductor assembly and test (OSAT) and foundry. China-based companies accounted for 12% of all fabless revenue, 9% of foundry revenue, 20% of OSAT revenue and 6% of global semiconductor revenue in 2022 (see Table 2).[46]

[44] SIA 2024 Factbook, Semiconductor Industry Association, May 14, 2024.
[45] Ibid.
[46] Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce, "Assessment of the Status of the Microelectronics Industrial Base in the United States," December 2023.

Table 2: Market Share of Process Roles by Location of Company Headquarters: 2022

	Fabless	IDM	Total Semiconductor Providers	Foundry	OSAT	Total Outsourced Manufacturing
Total (US$ billion)	**248**	**412**	**660***	**139**	**50**	**190**
United States	72%	42%	53%	6%	15%	8%
Taiwan	14%	2%	6%	65%	58%	63%
South Korea	1%	22%	14%	16%	1%	12%
Japan	1%	17%	11%	1%	0%	0%
China	**12%**	**2%**	**6%**	**9%**	**20%**	**12%**
Germany	0%	5%	3%	1%	0%	0%
Switzerland	0%	4%	3%	0%	0%	0%
Netherlands	0%	4%	2%	0%	0%	0%

BIS's data is based on publicly reported sales and estimates of the revenues of major non-public companies

* The BIS estimates may exceed those of the Semiconductor Industry Association (US$ 574 billion, via SIA 2023 Factbook) and Gartner (US$ 600 billion, April 26 2023 press release) in part because it is revenue focused, and thus may not have fully accounted for non-semiconductor revenue or integration of semiconductors into other semiconductor devices. Foundry and ATP revenue are not part of these vendor-specific reports.

Source: Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce, "Assessment of the Status of the Microelectronics Industrial Base in the United States," December 2023.

Table 3 lists the world's 20 largest semiconductor companies by revenue in 2023, according to Omdia. These 20 largest semiconductor companies accounted for approximately US$ 480 billion or 88.2% of global semiconductor revenue in 2023. SMIC, China's largest and most advanced semiconductor manufacturer, is absent from the top 20 list. With US$ 6.3 billion in revenue in 2023, SMIC accounted for 1.2% share of global revenue.[47] This places the total output value of the Chinese semiconductor industry behind that of the U.S.A., Taiwan, South Korea, Japan and Europe. The U.S.A., which had 11 semiconductor companies, including fabless, IDMs and foundries among the top 20 ranks, accounted for an overwhelming 55% share of the world's 20 largest semiconductor companies, or US$ 261.3 billion in total revenue in 2023. Second-place Taiwan, with TSMC and MediaTek among the top 20, had a total output value of US$ 83.2 billion in 2023, which was about one-third of the output value of the United States.

[47] SMIC, Press Release: "SMIC Announces 2023 Annual Results," March 28, 2023.

Table 3: World's 20 Largest Semiconductor Companies (including foundries) by Revenue: 2023

Rank	Company	Headquarters	2023 Revenue (US$ Billions)	% of Industry Revenue
1	TSMC	Taiwan	$69.3	12.7%
2	Intel	U.S.A.	$51.2	9.4%
3	NVIDIA	U.S.A.	$49.2	9.0%
4	Samsung Electronics	South Korea	$44.4	8.1%
5	Qualcomm	U.S.A.	$31.0	5.7%
6	Broadcom	U.S.A.	$28.4	5.2%
7	SK Hynix	South Korea	$23.7	4.4%
8	Advanced Micro Devices (AMD)	U.S.A.	$22.4	4.1%
9	Apple	U.S.A.	$18.6	3.4%
10	Infineon Tech	Germany	$17.3	3.2%
11	STMicroelectronics	Switzerland	$17.3	3.2%
12	Texas Instruments	U.S.A.	$16.6	3.1%
13	Micron Technology	U.S.A.	$16.0	2.9%
14	MediaTek	Taiwan	$13.9	2.6%
15	NXP	Netherlands	$13.1	2.4%
16	Analog Devices	U.S.A.	$11.8	2.2%
17	Renesas Electronics Corporation	Japan	$10.5	1.9%
18	Sony Semiconductor Solutions Corporation	Japan	$10.2	1.9%
19	Microchip Technology	U.S.A.	$8.2	1.5%
20	Onsemi	U.S.A.	$7.9	1.4%
N/A	**TOP 20**		**$481.0**	**88.2%**
N/A	**Others**		**$64.0**	**11.8%**
N/A	**Total**		**$545.0**	**100%**

Note: Revenue figures rounded to 1 decimal place.
Source: Omdia, "New Omdia Research Reveals 2023 Semiconductor Market Revenue down 9% from 2022," March 27, 2024; TSMC Annual Report 2023.

Limited Production of Most Advanced Logic Chips

Today, chips are fabricated in a wide variety of nodes, the smallest currently in production are 3nm chips produced by Taiwan's TSMC and South

Korea-based Samsung.[48] China had zero capacity to produce chips below 10nm in 2022, and advanced logic capacity (≤7nm) was 100% concentrated in Taiwan and South Korea (see Figure 9).

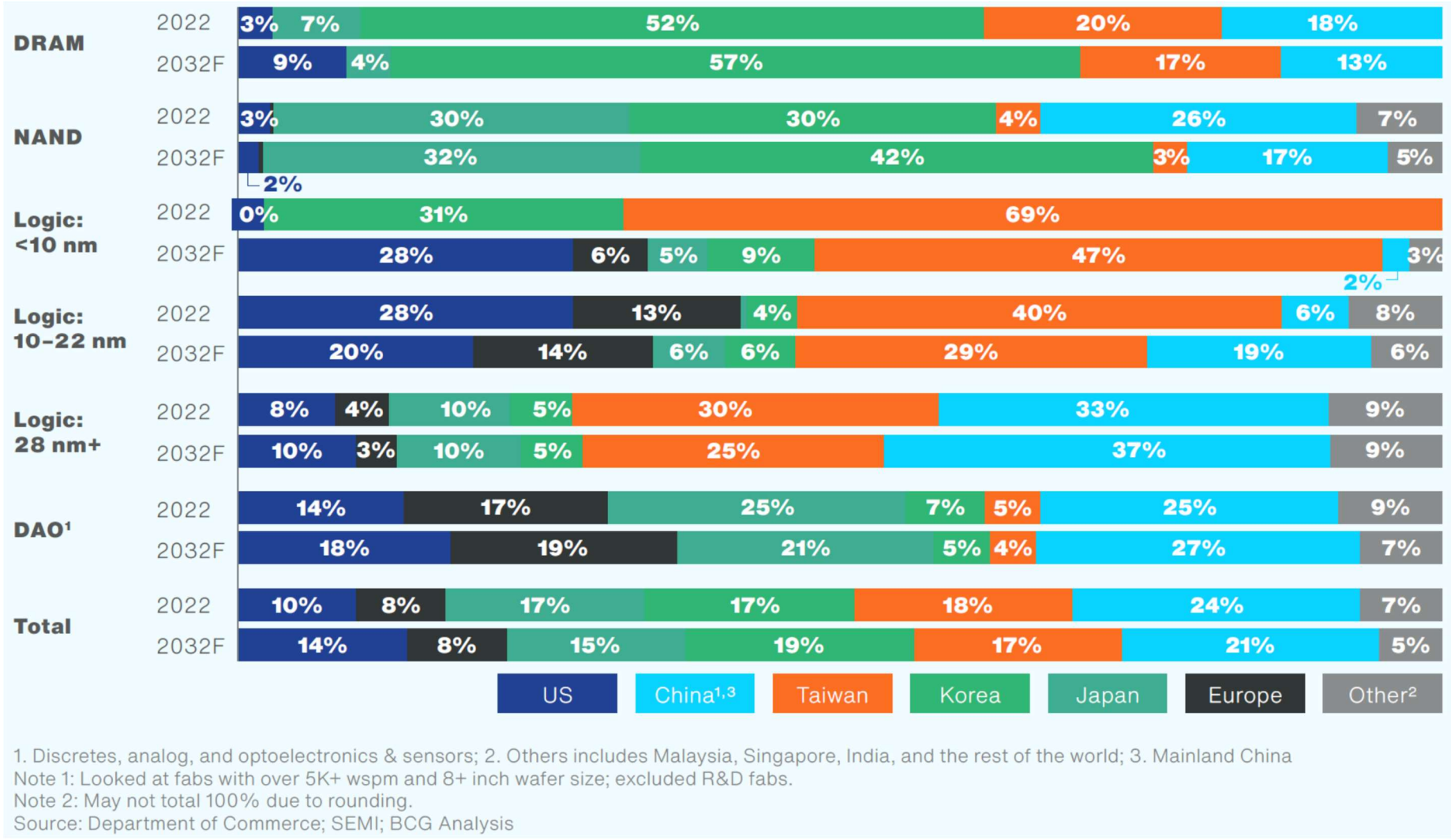
Leading-edge logic chips are needed to power artificial intelligence (AI) and other fast-growing industries like high-performance computing, consumer electronics, automotive, and Internet of Things. China's government recognizes the strategic importance of producing sub-7nm chips and has been making significant efforts to transition to more advanced semiconductor manufacturing.

China, however, remains reliant on the United States, Japan, the EU, and other economies for many of the most advanced semiconductor inputs, including design software, core IP, manufacturing equipment, and materials. Both sophisticated EDA tools and Deep or Extreme Ultraviolet Lithography tools are dependent on US IP which gives the U.S. government the right to determine who can purchase them. Faced with challenges, such as restrictions on acquiring high-end chip-making equipment, SMIC has managed to produce 7nm chips and is working towards more advanced nodes. In November 2024, Huawei announced that its Mate 70 series featured the Kirin 9020 chip, a 7nm (7nm+) chip was manufactured by SMIC.[49]

[48] "3nm Technology," TSMC, https://www.tsmc.com/english/dedicatedFoundry/technology/logic/l_3nm, Accessed on November 24, 2024; Samsung, Press Release: "Samsung Begins Chip Production Using 3nm Process Technology With GAA Architecture," June 30, 2022.

[49] Emiko Matsui, "Huawei Mate 70 series uses 100% China-made chips: Chairman," Huawei Central, December 9, 2024; "Huawei Mate 70 Pro+: Exploring the HiSilicon Kirin 9020 Processor," TechInsights, December 11, 2024; Huawei's new Mate 70 phone chip shows no major redesign, TechInsights says, Reuters, December 11, 2024.

Figure 9: Global Wafer Fabrication Capacity by Technology Category by Region: 2022 and 2032 Forecast



Source: Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024, p. 14.

POLICY MEASURES

- Two Initiatives: National Integrated Circuit Industry Investment Fund ('Big Fund') and Made in China 2025 (MIC 2025)

China's semiconductor industrial policy is focused on boosting its domestic semiconductor industry. The country's semiconductor self-sufficiency objectives are driven by a desire to reduce dependence on foreign technologies and to become a global leader in the semiconductor industry.

China started its journey to self-sufficiency in 2014 after its State Council released the "National Guidelines for Development and Promotion of the Integrated Circuit (IC) Industry", where the IC industry was identified as a strategic industry "supporting national economic and social development and maintaining national security"; and where China's dependence on imported ICs is deemed a risk to the competitiveness of the industry and the country's information security.[50]

Accordingly, the Chinese government launched a state-backed investment fund called 'National Integrated Circuit Industry Investment Fund' in 2014 and rolled out its 'Made in China 2025' plan a year later.

National Integrated Circuit Industry Investment Fund

The National Integrated Circuit Industry Investment Fund, known as the "Big Fund," has acted as China's most centralized instrument for directing money to the various segments of the semiconductor value chain, including design, manufacturing, packaging, testing, equipment, and materials (see Table 4).[51]

[50] State Council of the People's Republic of China, "Guideline for the Promotion of the Development of the National Integrated Circuit Industry," World Trade Organization, 2014, https://members.wto.org/CRNAttachments/2014/SCMQ2/law47.pdf.

[51] Lizzi C. Lee, "China's Big Fund 3.0: Xi's Boldest Gamble Yet for Chip Supremacy," The Diplomat, June 6, 2024.

Table 4: National Integrated Circuit Industry Investment Fund Initiative

Initiative: National Integrated Circuit Industry Investment Fund ('Big Fund')

The National Integrated Circuit Industry Investment Fund, known as the "Big Fund," seeks to enhance China's technological self-sufficiency and global competitiveness by making strategic financial investments. Its goal is to foster coordinated development across the semiconductor supply chain's upstream and downstream sectors.[52]

Measures include:

- **Direct investment in domestic semiconductor companies**: Funding promising startups, established players, and research institutions to foster innovation and strengthen the domestic ecosystem.
- **Intensified R&D support**: Allocating resources to advance cutting-edge technologies in areas like chip design, manufacturing equipment, manufacturing, and materials science.
- **Strategic foreign direct investment (FDI)**: Leveraging the Big Fund to acquire critical foreign technology through overseas acquisitions of companies or intellectual property.
- **Facilitating inbound FDI**: Attracting foreign investment through incentives and joint ventures to bring in advanced manufacturing capabilities, expertise, and market access.[53]

The Big Fund is managed by Sino IC Capital, a company established by China Development Bank in 2014. The fund's shareholders include the Ministry of Finance, China Tobacco, China Telecom, and several local governments and investment funds. It operates as a corporate entity under the guidance and supervision of the Ministry of Industry and Information Technology and the Ministry of Finance.[54]

The fund has three phases, each with different fundraising targets and investment focuses:

- **Phase I (2014-2019)**: RMB 138.7 billion (~US$ 19 billion) in 2014 invested in 23 domestic semiconductor companies, mainly in chip manufacturing, design, and packaging. The fund also facilitated several mergers, acquisitions, and IPOs in the industry.[55]
- **Phase II (2019-2024)**: RMB 204 billion (~US$27 billion) with increased focus on etching machines, film, test, and cleaning equipment, and new applications enabled by 5G and AI.[56]
- **Phase III (2024-2029)**: RMB 344 billion (~US$47.5 billion) with focus on semiconductor equipment and advancing third-generation semiconductors requiring materials like silicon carbide (SiC) and gallium nitride (GaN), and high-value-added dynamic random-access memory chips.[57]

[52] Li Na and Fan Xuehan, "China's Third Big Fund to Have Wider Investment Scope, Insiders Say," YiCai Global, May 28 2024.

[53] John VerWey, "Chinese Semiconductor Industrial Policy: Past and Present," United States International Trade Commission, Journal of International Commerce and Economics, July 2019, p. 13.; James Andrew Lewis, "Rethinking Technology Transfer Policy toward China," Center for Strategic and International Studies, November 17, 2023.

[54] TrendForce, "China's Big Fund Faces Hurdles in Organizing Third Phase, Initial Funding Encounter Challenges," September 28, 2023.

[55] Luffy Liu, "China's 'Big Fund' Phase II Aims at IC Self-Sufficiency," EE Times, October 30, 2019; Julie Zhu, Kevin Huang, Yelin Mo and Roxanne Liu, "Exclusive: China to launch $40 billion state fund to boost chip industry," Reuters, September 5, 2023.

[56] Luffy Liu, "China's 'Big Fund' Phase II Aims at IC Self-Sufficiency," EE Times, October 30, 2019.

[57] Reuters staff, "China Sets up $47.5 Billion State Fund to Boost Semiconductor Industry," Reuters, 27 May 2024; Liu Zhihua and Ma Si, "Six banks to invest in big way in IC fund," China Daily, May 29, 2024.

The "Big Fund," aims to foster technological self-sufficiency and enhance the coordinated development of the semiconductor supply chain. Policy measures include direct investment in domestic semiconductor companies, and research institutions to foster innovation and strengthen the domestic ecosystem; intensified R&D support to advance cutting-edge technologies in areas like chip design, manufacturing equipment, manufacturing, and materials science; strategic foreign direct investment (FDI) abroad to acquire critical foreign technology through overseas acquisitions of companies or intellectual property; and facilitating inbound FDI to bring in advanced manufacturing capabilities, expertise, and market access (See Table 4).[58]

Despite being a key player in China's semiconductor investment landscape, the "Big Fund" faced a scandal in mid-2022 involving allegations of illegal activities. Several officials, including Ding Wenwu, the former General Manager of the National Big Fund, and senior executives from SINO-IC Capital, the fund manager, were investigated by the Central Commission for Discipline Inspection of the Chinese Communist Party (CCP). This incident raised concerns about its potential impact on the development of China's semiconductor industry.[59]

The latest Big Fund III saw US$ 47.5 billion in funding from 19 government and state-owned entities in 2024.[60] China is also using a range of levers, including local content preferences, domestic standards, and informal government directives to create demand for domestically produced semiconductors.[61] Big Fund III's initial investment of RMB 93 billion (US$ 12.7 billion) targets key material and equipment manufacturers, including Advanced Chemical Materials (ACM), NAURA Technology Group and Advanced Micro-Fabrication Equipment Inc. China (AMEC).[62] Big Fund III focuses on supporting foundries and equipment manufacturers and fabless companies, creating a comprehensive and self-sufficient semiconductor ecosystem (see Table 5).

[58] Li Na and Fan Xuehan, "China's Third Big Fund to Have Wider Investment Scope, Insiders Say," YiCai Global, May 28 2024.
[59] TrendForce, "China's Big Fund Faces Hurdles in Organizing Third Phase, Initial Funding Encounter Challenges," September 28, 2023.
[60] "China sets up third fund with $47.5 billion to boost semiconductor sector," Reuters, May 27, 2024.
[61] Semiconductor Industry Association (SIA), "State of the Industry Report 2024," September 11, 2024.
[62] TrendForce, Press Release: "China Races Ahead in AI: Updates on Huawei's Advancements and Big Fund's Semiconductor Moves," January 22, 2025.

Table 5: Big Fund's Key Industry Players

Big Fund I	Big Fund II	Big Fund III
• Anji Micro • Zhejiang Juhua • NAURA • SMIC • Navtech • Changchuan Tech • YMTC • Unisoc • Sanechips Technology • JCET • Huahong Group • AMEC • Tongfu Microelectronics • Huatian Technology • Giga Device	• NAURA • AMEC • SMIC • Huahong Group • Jiangsu Nata Opto • G-Gas	Existing foundries are expanded and new foundries are established in China, but they lack profitability. First half of 2024 results: *(Net profit)* • SMIC (year on year), -45.1% • Huahong Group, -83.3% • CR Micro, -64% • National Silicon Industry Group (NSIG), -307.4% In contrast, semiconductor equipment companies have seen strong revenue growth due to rebound gains from US pressure: *(Revenue)* • NAURA (year-over-year), +46.4% • AMEC, +36.5% • ACM, +49.3% Design, CPU, and packaging and test are performing well due to recovering demand in mobile and automotive markets in China: *(Net profit)* • WillSemi (year-over-year), +792.8% • Montage, +624.6% • GigaDevice, +53.9%

Source: Ardi Janjeva, Seoin Baek, Andy Sellars, CETaS Briefing Paper: "China's Quest for Semiconductor Self-Sufficiency: The impact on UK and Korean industries," The Alan Turing Institute, December 4, 2024, pp 16 & 17.

In addition, the "Made in China 2025" (MIC 2025) plan is a strategic initiative aimed at transforming China into a global manufacturing powerhouse by improving innovation, technology, and efficiency across various sectors, including semiconductors.

With regards to China's semiconductor industry, some key measures under MIC 2025 include investment in R&D to foster technological innovation and reduce dependence on foreign technology, encouraging the localization of semiconductor production to ensure a stable and self-sufficient supply chain, forming alliances with global tech leaders and local manufacturing hubs to accelerate the growth of China's semiconductor ecosystem and scaling up operations of Chinese domestic foundries to meet global demand and compete with established players like TSMC and Samsung (see Table 6).[63]

Table 6: Made in China 2025 (MIC 2025) Initiative

Initiative: Made in China 2025 (MIC 2025)
Formulated in 2015, the policy seeks to transform China's manufacturing sector by decreasing China's reliance on foreign technology imports and cementing its position in the global supply chains of critical technologies.[64] MIC 2025 focuses on intelligent manufacturing in 10 strategic sectors: 1) advanced information technology; 2) automated machine tools and robotics; 3) aerospace and aeronautical equipment; 4) ocean engineering equipment and high-tech shipping; 5) modern rail transport equipment; 6) energy saving and new energy vehicles; 7) power equipment; 8) new materials; 9) medicine and medical devices; and 10) agricultural equipment. MIC 2025 entails a 3-step strategy: • **Step 1 (2015-2025):** basic industrialization, progress made in smart and green manufacturing; • **Step 2 (2025-2035):** complete industrialization, tier-2 manufacturing leader with solid indigenous R&D, breakthrough in key sectors; and • **Step 3 (2035-2050):** Tier-1 manufacturing leader with advanced technology and industrial system.[65]

[63] "Chinese Semiconductor Developments: Navigating the Future of Global Chip Manufacturing," Tech Insights, https://www.techinsights.com/chinese-semiconductor-developments, Accessed on February 24, 2025.
[64] Daxue Consulting, "China's semiconductor industry: Seeking for self-sufficiency amid tensions with Taiwan and the US chip export ban", September 28, 2022.
[65] The State Council, People's Republic of China, "Made in China 2025", March 30, 2017; Michael Settelen, "'Made in China 2025' And China's Evolving Industrial Policy," Switzerland Global Enterprise, January 3, 2023.

With reference to semiconductors, the goals are:

1) To develop the IC design industry, speed up the development of the IC manufacturing industry, upgrade the assembly, testing and packaging (ATP), and facilitate breakthroughs in the key equipment and materials of integrated circuits.[66]
2) By 2020, China's semiconductor design and manufacturing should be one to two generations behind industry leaders and supported by a robust domestic supply chain of equipment, material and ATP service suppliers.
3) By 2030 the main segments of the IC industry should reach advanced international levels.[67]

The goal of raising local content of semiconductor chips to 40% by 2020 and 70% by 2025 was revised in 2019, with a new goal of reaching US$ 305 billion in output by 2030, and meeting 80% of domestic demand.[68]

"Made in China 2025" Initiative

The "Made in China 2025" initiative encompasses several measures to bolster the semiconductor industry. These measures include tax incentives, Special Economic Zone subsidies, a whole-of-nation approach for semiconductor R&D, the establishment of the Central Science and Technology Commission (CSTC), and the promotion of new national champions within the local semiconductor industry (see Table 7).

The CSTC was established in March 2023 to beef up the Chinese Communist Party (CCP) Central Committee's "centralized and unified leadership over science and technology-related work" (see Figure 10).[69] This reflects the CCP's commitment to centralized control over scientific and technological development, its prioritizing of national security concerns in technological advancement and its goal to drive economic growth through technological innovation.

The original "Made in China 2025" plan included ambitious targets for increasing the local content of semiconductor chips to 40% by 2020 and 70% by 2025. However, these targets were revised in 2019.[70] The new focus shifted to reaching US$ 305 billion in semiconductor output by 2030 and meeting 80%

[66] State Council of the People's Republic of China, "Made in China 2025 Technical Roadmap," October 29, 2015.
[67] U.S. Chamber of Commerce, Made in China 2025, March 16, 2017, p. 65.
[68] Congressional Research Service, "China's New Semiconductor Policies: Issues for Congress," April 20, 2021.
[69] State Council of the People's Republic of China, "China to restructure ministry in sci-tech self-reliance drive," March 7, 2023.
[70] Congressional Research Service, "China's New Semiconductor Policies: Issues for Congress," April 20, 2021.

of domestic demand for semiconductors. This change reflects a more realistic approach while still emphasizing the importance of developing a robust domestic semiconductor industry.

Table 7: Measures Under "Made in China 2025" Initiative

MEASURE	DETAILS
Tax Incentives	**Corporate Tax Breaks** Preferential tax treatment from the first profitable year for domestic semiconductor players in 2020: • Qualifying integrated circuit (IC) projects and enterprises that have operated for more than 15 years will be exempt from corporate income tax for up to 10 years if they employ the 28 nm process or more advanced nodes. • Those producing 65 nm to 28 nm chips will get 5 years of tax exemption and a 50% discount on the corporate tax rate for the subsequent five years.[71]
	Exemption of Import Duties in Chip Equipment and Inputs until 2030 Exemption of tariffs from July 27, 2020 to December 31, 2030 on imports of some semiconductor companies that are critical to the country's IC development, including IC production equipment parts, raw materials and other consumables.[72]
	Tax Credit for Investments in Semiconductor Research and Development Tax credit for investments in semiconductor R&D was upgraded by 20%. For the entire calendar years from 2023 to 2027, the pre-tax deduction rate for R&D related expenses will increase from the current 100% to 120%.[73] **"Super-input" value added tax (VAT) credit** From 1 January 2023 to 31 December 2027, general VAT taxpayers engaging in IC design, manufacturing, equipment, materials, packaging and testing would be eligible for an extra 15% "super-input VAT credit." This allows qualified IC enterprises to credit their eligible input VAT at a rate of 115%.[74]
Special Economic Zone Subsidies	**Lin-gang Special Area** Established in 2019, Lin-gang New Area is part of the Shanghai Pilot Free Trade Zone to build a comprehensive industrial base for integrated circuits. It provides guidance on its entire supply chain layout, innovation, openness and cooperation. Besides promoting the development of key areas such as core chips, specialty processes, key equipment, and basic materials, it also supports multinational companies in setting up offshore R&D and manufacturing centers.

[71] State Taxation Administration of the People's Republic of China, "Tax breaks to lend IT sector helping hand," December 25, 2020; Jane Zhang and Che Pan, "China unveils major tax incentive policy to encourage innovation in domestic semiconductor industry", August 5, 2020.

[72] Global Times, "Import duties in chip equipment, inputs exempted until 2030", March 29, 2021.

[73] Arrian Ebrahimi, "China Boosts Semiconductor Subsidies as US Tightens Restrictions", The Diplomat, September 28, 2023.

[74] Carolyn Wright, Tax News Update (Global Edition): "China introduces 'super-input VAT credit' policy for integrated circuit enterprises", Ernst & Young LLP, June 6, 2023.

MEASURE	DETAILS
	According to its action plans, it aims to achieve: 1) IC industry output value of RMB 100 billion (US$ 15.27 billion) by 2025, compared to RMB 10 billion (US$ 1.5 billion) in 2021. 2) Build a high-level industrial ecosystem with global influence - the "Oriental Chip Port" by 2035. Corporate income tax rates for companies specializing in IC, artificial intelligence, biomedicine and civil aviation have been set at 15% in Lin-gang for five years from the date of establishment, compared to the usual 25% in the rest of China.[75] <u>Lin-gang As A Hub for Wide-Bandgap Semiconductors</u> On March 29, 2024, a wide-bandgap semiconductor industry base was unveiled in Lin-gang.[76] The Lin-gang Special Area aims to hit its "Double Hundred Billion" goal by 2026, with equipment materials and wafer manufacturers topping 10 billion (US$ 1.6 billion) each in value – making it a leading base for the wide bandgap semiconductors sector in China.[77]
Special Economic Zone Subsidies	**China-Korea Integrated Circuit Industrial Park** The municipal government of Wuxi and memory chip giant SK Hynix started construction of the industrial park in October 2021.[78] The project involves a total investment of about RMB 2 billion (US$ 310 million) and aims to strengthen the high-quality development of the IC industry in Wuxi by attracting more upstream and downstream projects in its industrial chain. The city is expected to become home to 19 new semiconductor-related projects with a combined investment of US$ 4.7 billion.[79]
	Special Economic Zone in Hengqin Established in July 2022 as a major new outpost for China's semiconductor industry, the Hengxin Special Economic Zone offers: 1) Up to RMB 30 million (US$ 4.4 million) each for semiconductor firms to set up new offices or conduct R&D activities in Hengqin; 2) RMB 5 million (US$ 686,502) and 50% of tapeout cost to firms that establish R&D programs in Hengqin;

[75] State Council of the People's Republic of China, "Notice on the overall plan of Lingang New Area," August 6, 2019, https://www.gov.cn/zhengce/content/2019-08/06/content_5419154.htm; Invest in China, "Lin-gang outlines ambitious 2025 IC development goals," August 15, 2022. "Shanghai zone to be home of 1,000 high-tech firms by 2025," China Daily, August 23, 2022.

[76] Wide bandgap semiconductors boast significantly higher conductivity that regular semiconductors and can operate at much higher temperatures, frequencies and voltages – making them suitable for a wider range of applications for next generation devices. Silicon Carbide (SiC) and Gallium Nitride (GaN) are widely promoted in China due to their exceptional properties as wide band-gap semiconductors.

[77] Lingang Government, "Lin-gang emerges as hub for wide-bandgap semiconductors," April 2, 2024.

[78] Justin Feng, "How are Washington and Beijing Utilizing Industrial Policy to Bolster Domestic Semiconductor Manufacturing?" Center for Strategic and International Studies, March 29, 2022.

[79] Tracy Qu, "New China-Korea semiconductor industrial complex starts construction amid Beijing's push for tech self-reliance," South China Morning Post, October 8, 2021; The Information Office of Wuxi Municipal People's Government, "S Korean semiconductor giant to expand development in Wuxi," January 30, 2021.

MEASURE	DETAILS
	3) Up to RMB 25 million (US$ 3.43 million) to firms involved in 14 nm or lower chip processing design; 4) More than RMB 100,000 (US$ 13,930) each to researchers and senior managers who signed contracts with Chinese semiconductor firms and were assigned to work in Hengqin for a three-year period; and 5) RMB 1 million (US$ 139,300) to companies that can nurture semiconductor talent in Hengqin.[80] The zone leverages resources from institutions like the State Key Laboratory of Analog and Mixed-Signal VLSI and the Microelectronics R&D Center at the University of Macau to create a training base for integrated circuit talents.[81]
"Whole Nation System" for Chip R&D	The new "Whole Nation System" is embedded in China's 14th five-year plan, as well as its local and sector-specific versions, which collectively map key strategies for advancing the country's development from 2021 to 2025. Specifically, the new "Whole Nation System" for R&D consists of key elements including integrating and diverting resources to priority cutting-edge technologies such as artificial intelligence and quantum science, strengthening basic research, and establishing national labs and industry clusters.[82]
Central Science and Technology Commission	Established in March 2023, the commission, which sits directly under the Communist Party of China's Politburo, is higher ranking than all government ministries.[83] It is likely to focus on the semiconductor industry, given its importance to China's goal of technological self-sufficiency. It has authority over the Ministry of Science and Technology, and is intended to accelerate progress towards China's goal of scientific self-reliance and to ease China's technological chokepoints.[84] To date, few details on the commission have been made public. Analysts attributed China's secrecy to worries about policy pressure from Washington, fears about espionage and potential links between the commission and the People's Liberation Army.[85] Many, however, see the establishment of the commission as a direct response to the tough measures adopted by the U.S.A. designed to dent China's ambitions of technology supremacy.[86]

[80] Jiaxing Li, "China ramps up subsidies to lure chip firms to Hengqin, an island near Macau, turning it into a major semiconductor outpost," South China Morning Post, July 28, 2022; Gary Clyde Hufbauer and Megan Hogan, Policy Brief 22-13 CHIPS Act Will Spur US Production but Not Foreclose China, Peterson Institute for International Economics, October, 2022, p. 10.

[81] "Sci-Tech Research and Development & High-End ManufacturingIndustrial Achievements," Hengqin government, https://www.hengqin.gov.cn/invest-hengqin-en/cyfx/kjyf/index.html, Accessed on January 21, 2025.

[82] Xiao Tan and Yao Song, "China's 'Whole Nation' Effort to Advance the Tech Industry," April 21, 2022.

[83] Eduardo Baptista, "China to restructure sci-tech ministry to achieve self-reliance faster', Reuters, March 7, 2023.

[84] Charles Mok, "The Party Rules: China's New Central Science and Technology Commission, The Diplomat, August 23, 2023.

[85] Jane Cai, William Zheng and Echo Xie, "Mystery around China's new science and tech body a sign of secrecy to come, analysts say," South China Morning Post, September 4, 2023.

[86] Dr. Yu Jie, "The emerging leaders behind Beijing's drive for technological self-reliance", Chatham House, July 24, 2023.

MEASURE	DETAILS
Foster New National Champions	China is nurturing closer co-operation with a select group of companies, namely, chipmakers SMIC, Hua Hong Semiconductor and Huawei, as well as equipment suppliers Naura and Advanced Micro-Fabrication Equipment Inc China. These chosen few will have access to additional government funding without having to achieve performance goals that were previously necessary. They will also be able to play a bigger role in state-backed research projects, reducing the influence of state-owned companies and academic institutes.[87]

China's MIC 2025 initiative shows its determination to assert its technological and economic dominance on the global stage. Its centralized approach through initiatives like the Big Fund is having a profound impact on its semiconductor industry. By strategically directing substantial investments, the Big Fund has been able to support various companies across the semiconductor value chain, from chip design and manufacturing to equipment production and testing.

POLICY OUTCOMES

- China's Semiconductor Self-Sufficiency Below 25%
- Divergence in Market Share Between TSMC and Chinese Foundries
- China Focused on Mature Process Chips
- Surge in Chip Companies in China Going Bankrupt Since 2022
- China Faces Challenges in Producing Sub-7nm Chips
- Foreign Companies Localizing Chip Production in China

China's Semiconductor Self-Sufficiency Below 25%

In the "Made in China 2025" plan announced in 2015, the Chinese government aimed to achieve a semiconductor self-sufficiency rate of 70% by 2025. The "Big Fund" was launched to promote the development of the domestic semiconductor industry, aiming for technological independence and localization of the supply chain, was launched in three phases.

The first phase of the fund (2014–2019) raised US$ 19 billion, the second phase (2020–2024) raised US$ 27 billion, and the third phase (2024–2029) raised US$ 47.5 billion. The third phase, launched in May 2024, focuses on investments in advanced chips, equipment, and materials to counter the

[87] Qianer Liu, "China gives chipmakers new powers to guide industry recovery," Financial Times, March 21, 2023.

restrictions placed by the United States and its allies on China's semiconductor development.

The rapid growth of China's electronics industry coupled with the restrictions imposed by Western countries have widened the gap between the country's IC market and its production. As demand for consumer electronics, smartphones, electronic vehicles and other technology products continues to rise, the need for semiconductors has soared in China.[88] The complexity of semiconductor manufacturing, technological barriers, and global competition for advanced semiconductor equipment and expertise, however, have placed hurdles on China's efforts to ramp up IC production.

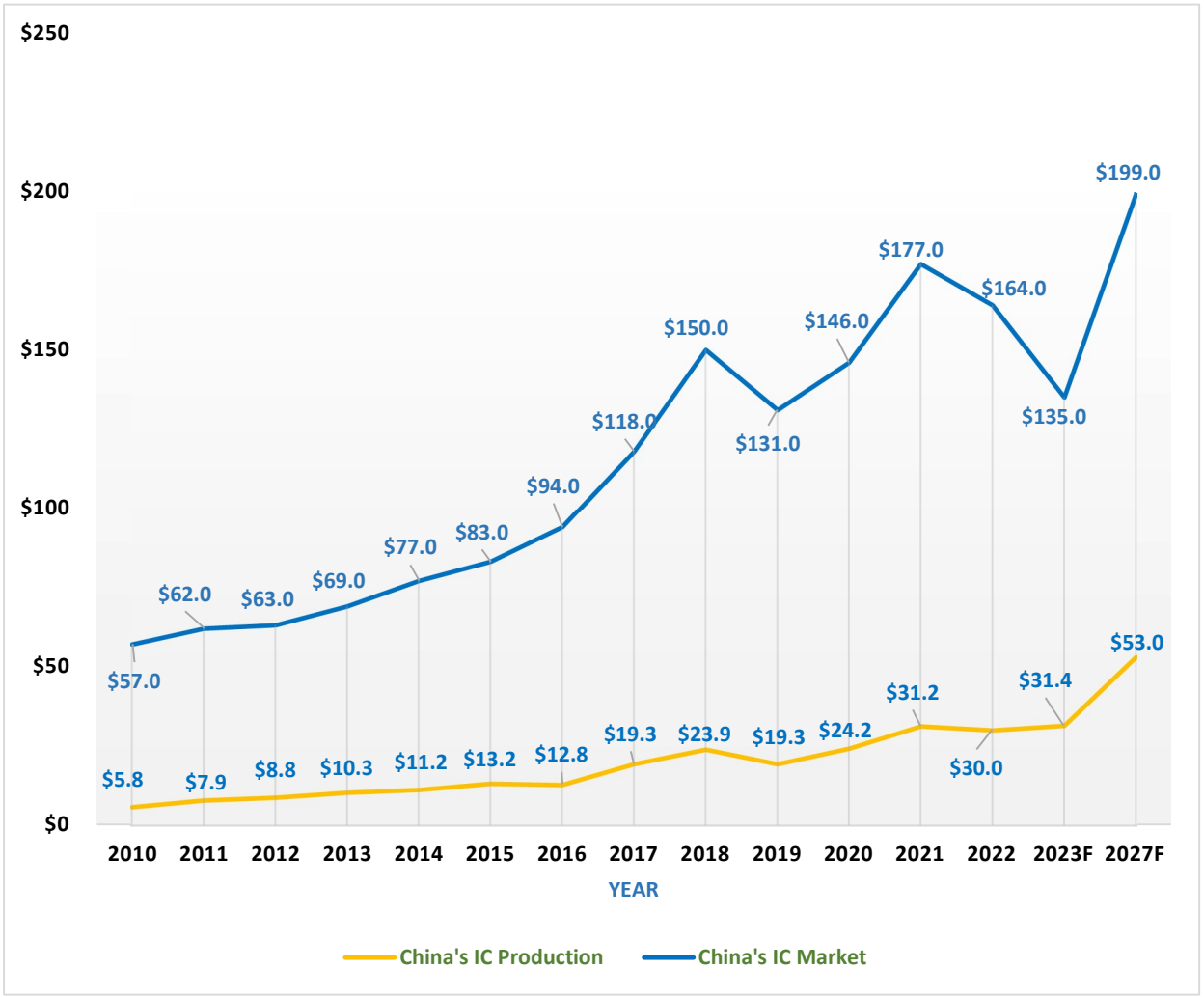
Data from TechInsights shows that the Big Fund has significantly boosted domestic semiconductor production, which increased from US$ 11.2 billion in 2014 to US$ 31.2 billion in 2021. However, China's semiconductor market demand also grew substantially, from US$ 77 billion in 2014 to US$ 177 billion in 2021. Consequently, the semiconductor self-sufficiency rate only slightly improved, rising from 14.5% in 2014 to 17.6% in 2021, fluctuating between 13.6% and 17.6% during this period (see Figures 10 and 11). In addition, of the US$ 31.2 billion worth of ICs manufactured in China in 2021, China-headquartered companies produced US$ 12.3 billion (39.4%), accounting for only 6.9% of the country's US$ 177 billion IC market.[89] TSMC, SK Hynix, Samsung, Intel, UMC, and other foreign companies that have IC wafer fabs located in China produced the rest.

Through continued investments, China's domestic chip self-sufficiency rate increased to 23.3% in 2023, with projections indicating it could reach 26.6% by 2027. At the 2024 China International Semiconductor Expo (IC China), industry leaders and government officials highlighted China's progress in strengthening its semiconductor capabilities.[90] According to SEMI China Senior Director Feng Li, China's semiconductor industry's self-sufficiency rate is expected to reach 26.6% by 2027 but there remains a significant gap of US$

[88] Kim Eun-jin, "Surge in Semiconductor Demand Propelled by China's 'Old-for-New' Policy," Business Korea, February 12, 2025.
[89] David Manners, "Chinese chip companies supplied 6.6% of China market in 2021," Electronics Weekly, May 19, 2022.
[90] Chiang, Jen-Chieh, "China accelerates chip independence push in face of Trump 2.0," DigiTimes Asia, November 21, 2024.

146 billion in the industry (see Figures 10 and 11).[91]

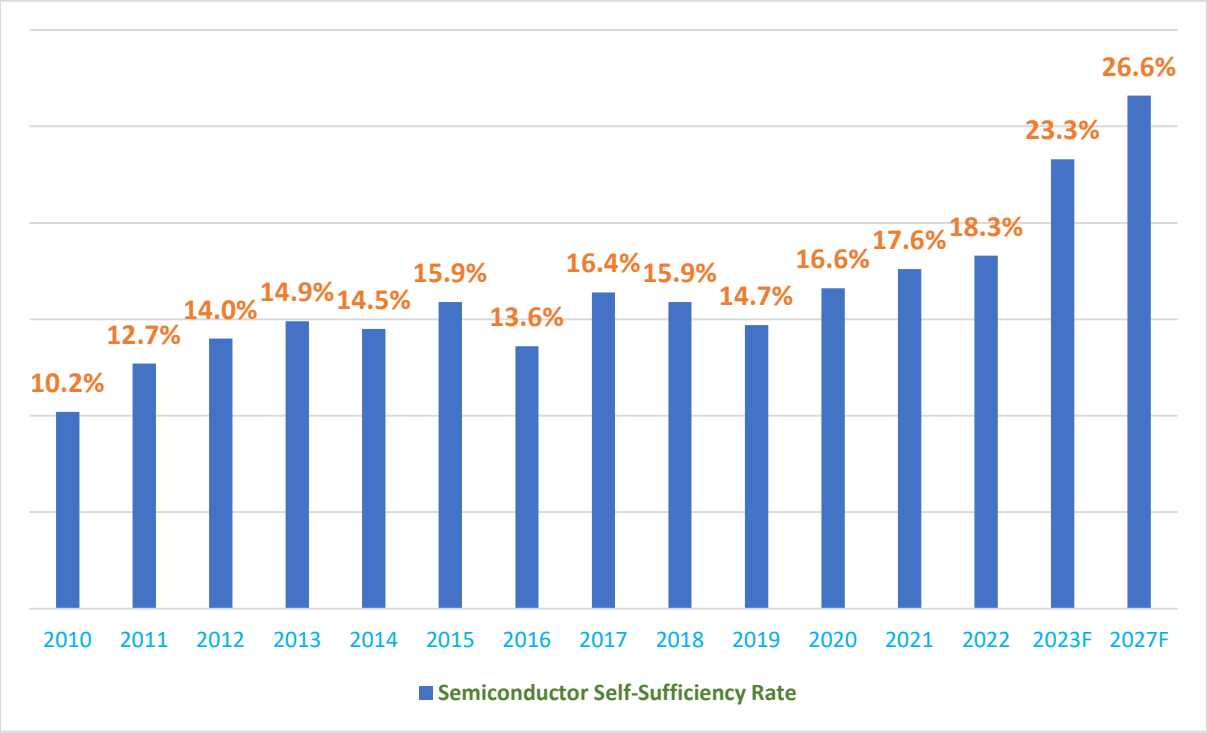
Figure 10: China's IC Market vs IC Production Trends: 2010-2027



Source: Data from TechInsights cited in Nikkei Asia, "China rushes to boost domestic chip supply ahead of Trump's return," November 19, 2024, https://asia.nikkei.com/Business/Tech/Semiconductors/China-rushes-to-boost-domestic-chip-supply-ahead-of-Trump-s-return.

[91] "China's Semiconductor Industry Self-Sufficiency Rate Continues to Rise, Expected to Reach 26.6% by 2027," MIRU News and Reports, October 2, 2024.

Figure 11: China's Semiconductor Self-Sufficiency Rate: 2010-2027



Source: Data from TechInsights cited in Nikkei Asia, "China rushes to boost domestic chip supply ahead of Trump's return," November 19, 2024, https://asia.nikkei.com/Business/Tech/Semiconductors/China-rushes-to-boost-domestic-chip-supply-ahead-of-Trump-s-return.

Although China's significant investments in semiconductor manufacturing has led to increased semiconductor production, its semiconductor production continues to lag behind its IC demand and falls short of its ambitious 'Made in China 2025' self-sufficiency targets.

According to the Semiconductor Industry Association (SIA), China's semiconductor market was valued at approximately US$ 154.3 billion in 2023.[92] SMIC, as China's largest and most advanced domestic semiconductor foundry, recorded a revenue of US$ 6.3 billion in 2023, accounting for around 4.1% of China's semiconductor market.[93] Hua Hong Semiconductor, the second-largest domestic chipmaker in China, had a revenue of US$ 2.3 billion, making up about 1.5% of the Chinese market.[94] Nexchip, another Chinese giant supported by the "Big Fund" had an annual revenue of approximately RMB 7.24 billion (US$ 1.0 billion), accounting for 0.6% of China's semiconductor market. In total,

[92] "SIA Factbook 2024," Semiconductor Industry Association, May 14, 2024.
[93] SMIC, Press Release: "SMIC Announces 2023 Annual Results," March 28, 2024.
[94] Hua Hong Semiconductor Limited, Press Release: "Reports 2023 Fourth Quarter Results," February 6, 2024, https://media-huahonggrace.todayir.com/20240207161550175839390 4_en.pdf.

the three leading Chinese chipmakers raked in a revenue of about US$ 9.6 billion, or 6.2% share of China's semiconductor market.

In contrast, TSMC's revenue from China in 2023 was approximately NT$ 267.15 billion (US$ 8.7 billion), accounting for 5.6% of China's semiconductor market.[95] Meanwhile, Samsung's total revenue from the Chinese market in 2023 was KRW 28.3 trillion (US$ 21.1 billion).[96] Together, Taiwan's TSMC and Korea's Samsung generated a combined revenue of US$ 29.8 billion from China. This figure significantly surpasses the US$ 9.6 billion combined revenue achieved by China's three leading foundries in 2023. With their advanced manufacturing capabilities, TSMC and Samsung hold a larger share of China's semiconductor market compared to SMIC and other Chinese semiconductor companies, even those supported by China's Big Fund. Despite the support from the Big Fund, TSMC and Samsung's technological advancements and production scale give them a competitive edge in the market.

Divergence in Market Share Between TSMC and Chinese Foundries

- TSMC's Global Market Share Hits a Record High of 67.1%, Contributing 95.6% to Q4 2024 Global Revenue Growth

According to the latest statistics from TrendForce, the total revenue of the world's top ten semiconductor foundries reached US$ 38.48 billion in Q4 2024, marking a new historical high. This represents an increase of US$ 3.48 billion (9.9%) compared to Q3. The growth was primarily driven by strong demand for advanced process chips used in AI servers, flagship smartphone application processors, and next-generation desktop platforms, which offset the decline in demand for mature process technologies.

TSMC demonstrated absolute dominance in this wave of growth, contributing an impressive 95.6% of the global semiconductor foundry revenue increase. In Q4 2024, TSMC's revenue reached US$ 26.85 billion, an increase of

[95] TSMC 2023 Annual Report, https://investor.tsmc.com/sites/ir/annual-report/2023/2023%20Annual%20Report_E.pdf

[96] Samsung Electronics Co., Ltd. And Its Subsidiaries Consolidated Financial Statements, December 31, 2024 and 2023, February 18, 2025, p. 80. https://images.samsung.com/is/content/samsung/assets/global/ir/docs/2024_con_quarter04_all.pdf The sales figures for China reported by Samsung encompass not only its flagship semiconductor products but also others like smartphones and home appliances. Semiconductors, however, are believed to constitute the majority of sales in China.

US$ 3.33 billion from the previous quarter. This pushed its global market share to 67.1%, up 2.4 percentage points from Q3 2024, further widening the gap with its competitors (see Table 8).

Table 8: Top Global Foundries Revenue: 2024Q3-Q4

US$ Million

Ranking	Company	2024Q4	2024Q3	Difference	QoQ	Contribution
1	TSMC	26,854	23,527	3,327	14.1%	95.6%
2	Samsung	3,260	3,305	-45	-1.4%	-1.3%
3	SMIC	2,207	2,171	36	1.7%	1.0%
4	UMC	1,867	1,873	-6	-0.3%	-0.2%
5	GlobalFoundries	1,830	1,739	91	5.2%	2.6%
6	Huahong Group	1,042	982	60	6.1%	1.7%
7	Tower	387	371	16	4.5%	0.5%
8	VIS	357	366	-9	-2.3%	-0.3%
9	Nexchip	344	332	12	3.7%	0.3%
10	PSMC	333	336	-3	-0.7%	-0.1%
Total of Top 10		**38,482**	**35,001**	**3,481**	**9.9%**	**100.0%**

Source: Trendforce, Press Releases, March 10, 2025.

The combined market share of the top ten foundries remained steady at 96.2%, with little change in the market landscape. The only shift in rankings was Nexchip surpassing PSMC. However, apart from TSMC, most major foundries saw a decline in market share. Samsung maintained its position as the second-largest foundry, but its Q4 revenue dropped slightly to US$ 3.26 billion, down US$ 45 million and 1.4% from Q3. Its global market share also declined from 9.1% to 8.1%. SMIC and UMC saw their global market shares decrease by 0.5 and 0.4 percentage points, respectively, while other foundries experienced declines of 0.1 to 0.2 percentage points (see Table 9).

Table 9: Ranking and Market Share of Global Top 10 Foundries by Revenue: 2022Q1-2024Q4

Ranking	Company	Market Share											
		2024 Q4	2024 Q3	2024 Q2	2024 Q1	2023 Q4	2023 Q3	2023 Q2	2023 Q1	2022 Q4	2022 Q3	2022 Q2	2022 Q1
1	TSMC (TW)	67.1%	64.7%	62.3%	61.7%	61.2%	57.9%	56.4%	60.1%	58.5%	56.1%	53.4%	53.6%
2	Samsung (KR)	8.1%	9.1%	11.5%	11.0%	11.3%	12.4%	11.7%	12.4%	15.8%	15.5%	16.4%	16.3%
3	SMIC (CN)	5.5%	6.0%	5.7%	5.7%	5.2%	5.4%	5.6%	5.3%	4.7%	5.3%	5.6%	5.6%
4	UMC (TW)	4.7%	5.1%	5.3%	5.7%	5.4%	6.0%	6.6%	6.4%	6.3%	6.9%	7.2%	6.9%
5	GlobalFoundries (USA)	4.6%	4.8%	4.9%	5.1%	5.8%	6.2%	6.7%	6.6%	6.2%	5.8%	5.9%	5.9%
6	Huahong Group (CN)	2.6%	2.7%	2.1%	2.2%	2.0%	2.6%	3.0%	3.0%	2.6%	3.3%	3.1%	3.2%
7	Tower (IL)	1.0%	1.0%	1.1%	1.1%	1.1%	1.2%	1.3%	1.3%	1.2%	1.2%	1.3%	1.3%
8	VIS (TW)	0.9%	1.0%	1.0%	1.0%	1.0%	1.1%	1.2%	1.0%	0.9%	1.2%	1.5%	1.5%
9	Nexchip (CN)	0.9%	0.9%	0.9%	1.0%	1.0%	1.0%	n.a.	n.a.	n.a.	1.0%	1.4%	1.4%
10	PSMC (TW)	0.8%	0.9%	1.0%	1.0%	1.0%	1.0%	1.2%	1.2%	1.2%	1.6%	1.9%	2.0%
Total of Top 10		96.2%	96.2%	96.0%	96.0%	95.0%	95.0%	94.0%	98.0%	98.0%	97.0%	98.0%	98.0%

Source: Trendforce, Press Releases, March 10, 2025.

- TSMC's Market Share Continues to Rise

Looking at annual trends, TSMC's market share has continued to grow, rising from 55.4% in 2022 to 58.9% in 2023, and further to 64.0% in 2024, reflecting a cumulative increase of 8.6 percentage points over two years. Meanwhile, SMIC was the only other foundry to see a slight increase, growing from 5.3% in 2022 to 5.7% in 2024.

In contrast, Samsung's market share has declined significantly, dropping from 16.0% in 2022 to 12.0% in 2023, and further to 9.9% in 2024, representing a 6.1 percentage point decrease over three years. Other foundries such as UMC, GlobalFoundries, Hua Hong Group, and PSMC also experienced market share declines. UMC's share fell from 6.8% in 2022 to 5.2% in 2024, GlobalFoundries from 6.0% to 4.9%, Hua Hong Group from 3.1% to 2.4%, and PSMC from 1.7% to 0.9%. Additionally, Tower Semiconductor, VIS, and Nexchip saw minor declines, with their market shares dropping to 1.1%, 1.0%, and 0.9%, respectively (see Table 10).

Table 10: Ranking and Market Share of Global Top 10 Foundries by Revenue: 2022-2024

Ranking	Company	Market Share		
		2024	2023	2022
1	TSMC (TW)	64.0%	58.9%	55.4%
2	Samsung (KR)	9.9%	12.0%	16.0%
3	SMIC (CN)	5.7%	5.4%	5.3%
4	UMC (TW)	5.2%	6.1%	6.8%
5	GlobalFoundries (USA)	4.9%	6.3%	6.0%
6	Huahong Group (CN)	2.4%	2.7%	3.1%
7	Tower (IL)	1.1%	1.2%	1.3%
8	VIS (TW)	1.0%	1.1%	1.3%
9	Nexchip (CN)	0.9%	1.0%	1.3%
10	PSMC (TW)	0.9%	1.1%	1.7%

Source: Trendforce, Press Releases, March 10, 2025.

- China's Foundries Struggle to Gain Global Market Share

Despite the Chinese government's ongoing efforts to promote its semiconductor industry, China's three major foundries have not significantly increased their global market share. Their combined share fell from 9.6% in 2022 to 9.0% in 2023, with only a minor increase to 9.1% in 2024, indicating that their capacity remains focused on low-cost mature process chips, with limited competitiveness in the advanced process market (see Table 11).

Table 11: Global Market Share of Top 3 Chinese Foundries by Revenue: 2022-2024

	2024	2023	2022
SMIC (CN)	5.7%	5.4%	5.3%
Huahong Group (CN)	2.4%	2.7%	3.1%
Nexchip (CN)	0.9%	1.0%	1.3%
Sum	9.1%	9.0%	9.6%

Source: Trendforce, Press Releases, March 10, 2025. Due to rounding, some totals may not correspond with sum of separate figures.

China Focused on Mature Process Chips

As Chinese companies are increasingly blocked from access to modern process nodes and manufacturing equipment, China's fast-growing semiconductor sector has pivoted to the manufacture of 'legacy chips', with increased semiconductor production primarily concentrated on mature process chips (>28nm).[97] China's fabs are expected to account for 28% of global mature chip capacity by the end of 2025.[98]

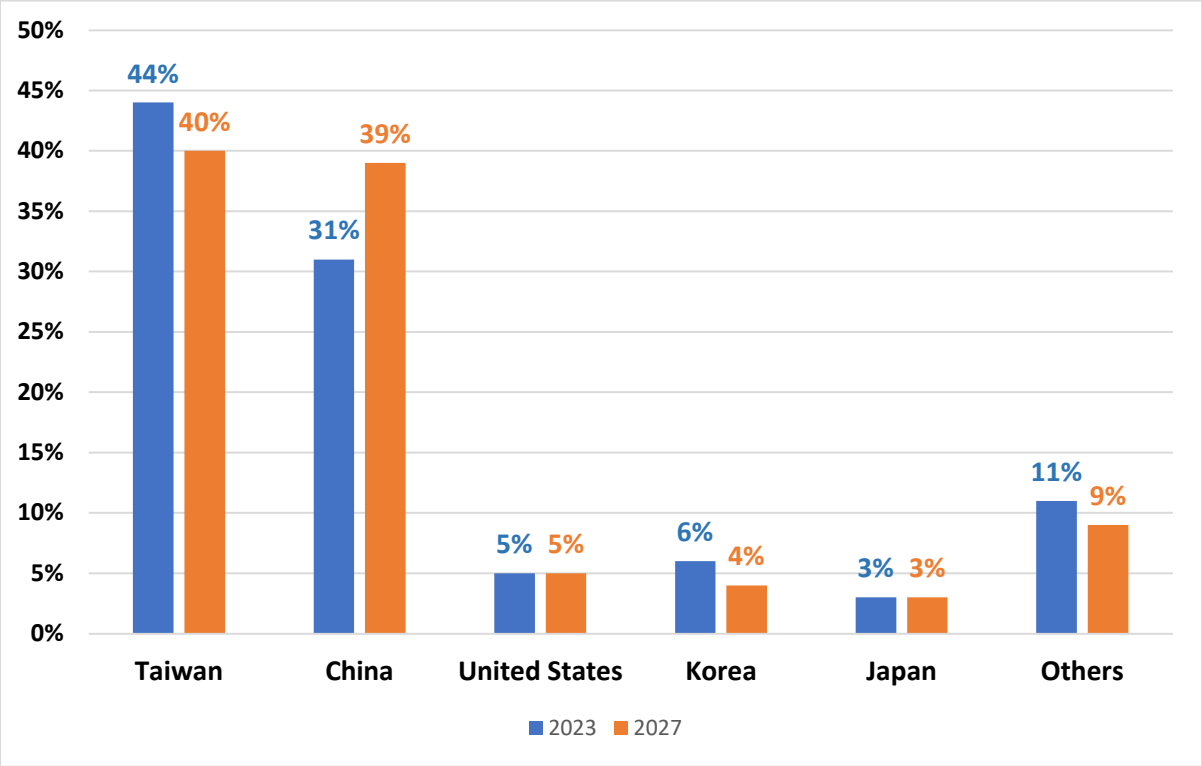
According to TrendForce's data in January 2024, China has 44 operational semiconductor wafer fabs, with an additional 22 under construction.[99] By the end of 2024, 32 Chinese wafer fabs will expand their capacity for 28nm and older mature chips.

TrendForce predicts that by 2027, China's share of mature process capacity in the global market will increase from 31% in 2023 to 39%, with further growth potential if equipment procurement progresses smoothly.[100] Leading the charge in this growth are Chinese giants like SMIC, HuaHong Group, and Nexchip.[101] All three Chinese domestic foundries have experienced rapid expansion and significant technological advancements thanks to the support of the "Big Fund."

Taiwan, which holds a 44% share in mature chip capacity (in terms of quantity) in 2023, is expected to maintain its lead, although its share may decrease by 4 percentage points in 2027. Korea, too, is expected to see its share fall from 6% in 2023 to 4% in 2027. The United States and Japan's share in mature chip capacity are expected to hold steady, remaining at 5% and 3% respectively (see Figure 12).

[97] Alexandra Alper, "Chamber of Commerce sees new US export crackdown on China, email says," Reuters, November 23, 2024.
[98] Dallin Grimm, "China's mature chips to make up 28% of world production, creating oversupply — Western companies express concern for their survival," Tom's Hardware
[99] TrendForce, press Release: "Overview of China's Semiconductor Equipment Industry," February 17, 2024.
[100] TrendForce, Press Release: China's ICs Imports Decrease in 2023, Chinese Manufacturers Focus on Mature Processes, January 16, 2024.
[101] Ibid.

Figure 12: Distribution of Global Mature Foundry Capacity (Wafer Quantity) by Region: 2023 and 2027



Source: TrendForce, Press Release: "China's ICs Imports Decrease in 2023, Chinese Manufacturers Focus on Mature Processes," January 16, 2024.

China's rapid expansion of mature chip production capacity has contributed to a glut of mature-node ICs.[102] The aggressive pricing strategies and increased production capacity of Chinese foundries have squeezed profit margins for many established semiconductor companies.

Chinese foundries supported by China's "Big Fund" are threatening the long-held dominance of Taiwan's Powerchip Semiconductor Manufacturing Corporation (PSMC), UMC, and Vanguard International Semiconductor Corporation (VIS) in China's market.[103] PSMC, for example, entered into a deal with the Chinese city, Hefei in 2015 to set up a new chip foundry for better access to the country's market. It is currently facing challenges in maintaining its market share due to the aggressive expansion and steep discounts made

[102] TrendForce, Press Release: "China's Chip Production Capacity Reportedly Set to Grow 60% in 3 Years, Doubling in 5 Years," January 15, 2024.

[103] Wen-Yee Lee, "Taiwan's legacy chip industry contemplates future as China eats into share," Reuters, February 10, 2025.

possible by the "Big Fund" support for Nexchip.[104] As a result, Taiwanese firms are considering shifting to more advanced chips. UMC, for example, is working with Intel to develop more advanced, smaller chips and diversify beyond legacy chipmaking.[105]

Similarly, other established foreign-owned chip makers in China like Samsung, GlobalFoundries, and Micron are facing overcapacity issues, reduced profitability and increased competition due to the rapid increase in mature node chip production by Chinese foundries.[106]

Surge in Chip Companies in China Going Bankrupt Since 2022

The "Made in China 2025" and Big Fund initiatives have led to a rush to enter the semiconductor market, attracting many inexperienced operators who struggled to sustain their businesses.

The number of chip companies in China that went bankrupt or deregistered has been surging since 2022. In 2023, this number reportedly reached 10,900, and as of December 5, 2024, 14,648 chip-related companies in China closed in 2024.[107] In addition to the intensifying industry competition, support from investors and local governments for chip design firms is gradually weakening, making it more difficult for startups to secure funding, attract top talent, and improve R&D and operational capabilities.[108] The closure of 14,648 chip companies in China in 2024 is a significant development that could impact the country's semiconductor self-sufficiency rate (see Table 12).[109]

Despite the bleak market, the enthusiasm of new entrants seems relatively unfazed. As of December 13, 2024, 52,401 new chip-related companies were registered in China, a decline from roughly 66,000 registrations in 2023.[110] Analysts believe the wave of closures reflects the

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104 Ibid.
105 Ibid.
106 Alan Patterson, "Mature-Node Foundries Face Overcapacity from China," EE Times, February 1, 2025.
107 TrendForce, Press Release: "Over 14,000 Chinese Chip Firms Reportedly Shut down in 2024 amid Accelerating Reshuffle," December 24, 2024.
108 Kumar Priyadarshi, "14,000+ Chinese Chip Firms Shut Down in 2024 Amid Industry Turmoil," Techovedas, December 24, 2024.
109 TrendForce, Press Release: "Over 14,000 Chinese Chip Firms Reportedly Shut down in 2024 amid Accelerating Reshuffle," December 24, 2024.
110 Ibid.

beginning of industry restructuring and internal optimization, adding that the entire Chinese semiconductor industry may take about two years to complete the reshuffling (see Table 12).[111]

Table 12: New Chip-Related Company Bankruptcies and Registrations: 2017 to 2024

Year	Bankruptcies/Deregistrations (Companies)	New Registrations (Companies)
2017	5,000	57,000
2018	7,000	74,000
2019	13,000	84,000
2020	14,000	230,000
2021	34,000	470,000
2022	57,000	620,000
2023	109,000	660,000
2024*	146,000 (as of Dec 13, 2024)	520,000 (as of Dec 5, 2024)

Note: Figures for 2017 to 2023 are rounded to the nearest 1000.
*2024 numbers are up to early/mid December, so full-year figures could be slightly higher.
Source: 賴瑩綺, 大陸晶片市場競爭大 今年新註冊 5.2 萬家 倒 1.46 萬家, 工商時報 (Commercial Times), December 24, 2024, citing data from Qichacha, Wind.

The disbursements by the "Big Fund" indicate that China is more focused on supporting its established homegrown semiconductor giants. The fund has made significant investments in key players like SMIC, Hua Hong Semiconductor, and YMTC, aiming to strengthen their capabilities and accelerate technological advancements. This strategy is part of China's broader goal to achieve self-sufficiency in the semiconductor industry and reduce reliance on foreign technology.

China Faces Challenges in Producing Sub-7nm Chips

Currently, the only domestic foundry in China capable of producing chips at the 7 nm process node is SMIC. With the support of the Chinese government's semiconductor self-reliance promotion program, SMIC has grown rapidly.

[111] 賴瑩綺, "大陸晶片市場競爭大 今年新註冊 5.2 萬家 倒 1.46 萬家," 工商時報, December 24, 2024.

Sub-7nm manufacturing requires access to advanced intellectual property (IP), including designs, processes, and tools like EUV lithography. The U.S.-led response to China's "Made in China 2025" and Big Fund initiatives has significantly impacted China's ability to produce sub-7nm chips.[112] SMIC has faced difficulties in ramping up production as companies are prohibited from selling cutting-edge, U.S.-origin technology to either SMIC or Huawei. In addition, domestic Chinese alternatives to U.S. technology are not yet at the level needed for cutting-edge semiconductor manufacturing.[113]

Leading EDA software providers like Cadence Design Systems, Synopsys, and Mentor Graphics (now part of Siemens) offer essential tools for designing and verifying complex chips. These tools are critical for advanced semiconductor manufacturing, and China currently lacks access to them due to export controls and restrictions.[114]

EUV lithography is used to make chips on advanced process technologies, such as 7nm, 6nm, 5nm, 4nm, 3nm and even 2nm.[115] Currently, SMIC produces processors on its 2nd Generation 7nm-class process technologies using immersion DUV lithography and multi-patterning.[116] SMIC's approach is a workaround due to restrictions on acquiring EUV tools from global leaders like ASML.

Chinese semiconductor manufacturing equipment companies are making strides in developing their own technologies, such as patents for EUV scanners. Huawei's patent titled "Reflective Mirror, Lithography Apparatus, and Control Method," disclosed on November 15, 2022, covers key components of an EUV scanner, including reflective mirrors and control methods, which are essential for the operation of such machines. Shanghai Micro Electronics Equipment (SMEE), China's leading producer of lithography equipment, filed a patent in March 2023 for "EUV Radiation Generators and

[112] Sujai Shivakumar, Charles Wessner, and Thomas Howell, "Balancing the Ledger: Export Controls on U.S. Chip Technology to China," Center for Strategic and International Studies, February 21, 2024.
[113] China chip index nears 3-year high as TSMC order fuels self-reliance bets, Reuters, November 11, 2024
[114] "The U.S.-China Chip War: Who Dares to Win?" Citigroup, January 02, 2024, https://www.citigroup.com/global/insights/the-u-s-china-chip-war-who-dares-to-win, Accessed on February 7, 2025.
[115] TrendForce, Press Release: "TSMC Reportedly Invests over USD 12.3 Billion in EUV, Advancing in 2nm Production," June 28, 2024.
[116] Anton Shilov, "China's SMEE files patent for an EUV chipmaking tool — tool aims to break the shackles of ASML export restrictions," Tom's Hardware, September 13, 2024.

Lithography Equipment," showcasing progress in China's effort to create indigenous EUV tools.[117]

China's work on developing its own EUV scanner tools is a step in advancing its semiconductor manufacturing capabilities. The journey from filing a patent to commercializing a product like an EUV machine, however, is lengthy and complex. Global leader ASML's journey to bring EUV lithography to high-volume manufacturing spanned approximately four decades.[118] ASML's foundational research began in the mid-1980s, and after significant investments in R&D, collaborations, and overcoming numerous technical challenges, its EUV technology was finally commercialized for high-volume production in the late 2010s.[119] Given that many technologies from the early to mid-1990s are publicly documented, Chinese companies would not need to start entirely from scratch. However, by the time China's semiconductor industry develops the current generation Low Numerical Aperture (NA) EUV tools, the Western chip industry is likely to have advanced to High-NA EUV lithography and potentially even Hyper-NA EUV equipment. In fact, on February 24, 2025, Intel said that its two new high NA EUV machines from ASML are in production.[120]

SMIC, as China's largest foundry, has witnessed impressive growth from 2013 to 2024. However, an oversupply of mature process chips in recent years has led to price declines, severely impacting profitability. In 2022, SMIC's revenue stood at US$ 7.27 billion. In 2023, its revenue fell to US$ 6.32 billion, but it rebounded to US$ 8.03 billion in 2024, a 27% year-on-year increase.

Meanwhile, SMIC's gross profit reached a high of US$ 2.76 billion in 2022. This marked a significant increase compared to previous years, reflecting strong performance in the semiconductor industry. In 2023, SMIC's gross profit fell to US$ 1.22 billion. For 2024, SMIC's gross profit increased to US$ 1.45 billion, largely supported by significant revenue growth (see Figure 13).

[117] Che Pan, "Chinese chip making shows progress with new EUV patent from domestic lithography champion," South China Morning Post, September 12, 2024.
[118] Sander Hofman, "Making EUV: from lab to fab," ASML, March 30, 2022, https://www.asml.com/en/news/stories/2022/making-euv-lab-to-fab, Accessed on March 6, 2025.
[119] Ibid.
[120] Stephen Nellis, "Intel says new ASML machines are in production, with positive results," Reuters, February 26, 2025.

Figure 13: Revenue and Gross Profit of SMIC: 2013 to 2024

Source: Statista for the data from 2013-2023 and news release from SMIC for the data of 2024.

In 2022, SMIC's gross profit margin reached a high of 38.0%. However, in 2023, as SMIC's revenue fell to US$ 6.32 billion, its gross profit margin also took a hit, dropping to 19.3%. In 2024, despite an increase in revenue to US$ 8.0 billion, its gross profit margin further declined to 18.0%.

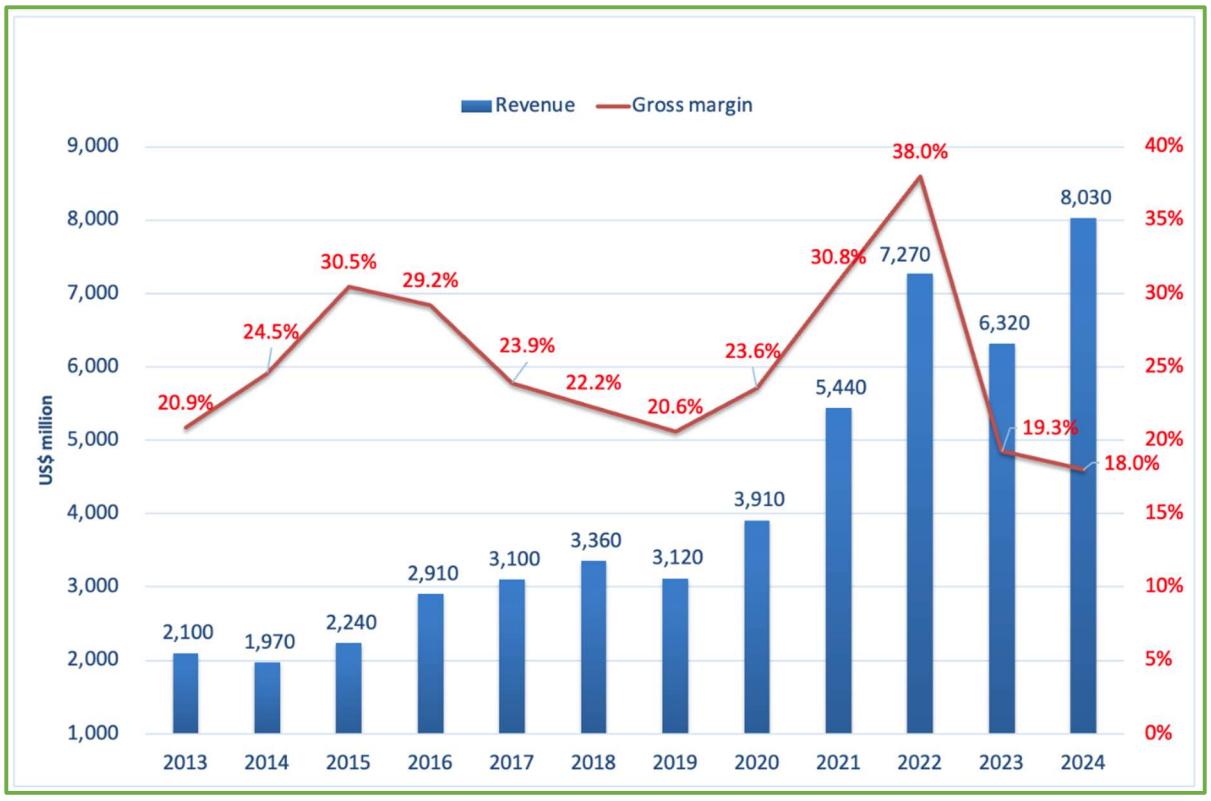
Additionally, the pressure on SMIC's net profit intensified over the years. In 2022, SMIC achieved a net profit of US$ 1.82 billion with a robust net profit margin of 25.0%.[121] However, in 2023, these figures dropped significantly to approximately US$ 903 million, with the net profit margin declining to 14.3%.[122] By 2024, despite achieving record revenue of US$ 8.0 billion, SMIC's net profit further plummeted to US$ 493 million, while its net profit margin fell sharply to 6.1%.[123]

The fluctuations in SMIC's gross and net profit margins reflect the

[121] "Chinese chipmaker SMIC warns of weak outlook despite record 2022 revenue," Reuters, February 10, 2023.
[122] SMIC Q4 2023 Financial Presentation, February 2024.
[123] SMIC Q4 2024 Financial Presentation, February 2025.

company's challenges in maintaining profitability despite achieving record revenue levels (see Figure 14). Specifically, SMIC's focus on legacy chips, increased operating expenses due to continued large-scale investment expenditures, and an oversupply of legacy chips in the Chinese market leading to price declines have impacted its profits (see Figures 13 and 14).

Figure 14: **Revenue and Gross Profit Margin of SMIC: 2013 to 2024**



Source: Statista for the data from 2013-2023 and news release from SMIC for the data of 2024.

Although SMIC has developed a 7nm process, it is not yet capable of mass-producing it at the scale or efficiency of leading global players like TSMC or Samsung. SMIC's 7nm (N+2) process has reportedly improved its yield rate to nearly 40% in 2024 but still falls short of the 60% yield rate often regarded as the industry standard for a 7nm process to be considered economically viable for large-scale production.[124] Limited to using DUV lithography machines, SMIC has been forced to rely on multi-patterning techniques in an effort to manufacture 7nm chips. Multi-patterning involves dividing a mask (which contains the circuit design) into sections, allowing each part to be "printed"

[124] Mavis Tsai and Levi Li, "Huawei Ascend 910C reportedly hits 40% yield, turns profitable; aims for 60% industry standard," DIGITIMES Asia, February 25, 2025.

onto silicon separately to achieve the resolution required for smaller feature sizes. However, this process increases production time and poses quality challenges.[125] SMIC also faces challenges from government pressure to use local equipment, which tends to be technologically inferior to that of global leaders. [126]

Bloomberg reported that SMIC's 7nm production lines have been hampered by low yields and reliability issues, and that SMIC is battling to churn out 7nm chips at steady volumes.[127] Struggling with both multi-patterning and domestic manufacturing equipment, China is likely to be stuck at 7nm chips till at least 2026.[128]

Huawei's Mate 60 smartphone series, featuring a 7nm chip manufactured by SMIC, was considered a major leap forward. However, according to Bloomberg, SMIC relied on U.S. technology from Applied Materials and Lam Research to produce the advanced chip in 2023.[129] Specifically, SMIC had obtained the American machinery and equipment before the U.S. banned such sales to China in October 2022.[130] These machinery and equipment were then used by SMIC to manufacture more advanced chips.[131]

Additionally, ASML's development of the High-NA EUV machines is expected to revolutionize the semiconductor industry and widen the technology gap between China and the leading chip manufacturers. The High-NA EUV technology offers enhanced resolution and precision, enabling the production of smaller, more powerful, and more efficient chips. Intel received ASML's High-NA EUV machine in 2024.[132] TSMC, on the other hand, plans to

[125] TrendForce, Press Release: "Huawei's AI Ambition Set Back as Its Chips Reportedly Fall Three Generations Behind NVIDIA," November 20, 2024.
[126] TrendForce, Press Release: "Overview of China's Semiconductor Equipment Industry,"
[127] Yuan Gao and Debby Wu, "China's Chip Advances Stall as US Curbs Hit Huawei AI Product," Bloomberg, November 19, 2024
[128] Omar Sohail, "SMIC To Remain On The 7nm Lithography Until At Least 2026, Limiting Huawei's Advancement, Despite Receiving A Near-Unlimited Budget From The Government," WCCFtech, November 20, 2024.
[129] Cagan Koc and Mackenzie Hawkins, "Huawei chip breakthrough used tech from two U.S. gear suppliers," Bloomberg, March 8, 2024.
[130] Ibid.
[131] "Huawei's China-made chip used US gear from Applied Materials and Lam Research, complicating self-sufficiency drive," South China Morning Post, March 8, 2024.
[132] Josh Norem, "Report: Intel Bought All of ASML's High-NA EUV Machines for 2024," ExtremeTech, May 9, 2024.

start mass production using High-NA EUV technology around 2028.[133] This new technology is expected to widen the gap between leading chip manufacturers like Intel and TSMC, who will benefit from this advanced equipment, and China, which currently faces challenges in accessing such state-of-the-art technology.

SMIC's lower production capabilities for advanced nodes has limited its ability to compete in the high-end market. This disparity in technology and market positioning is reflected in the substantial difference in profit margins between SMIC and TSMC (see Table 12).

Table 13: Comparison of SMIC and TSMC's Gross Profit Margin: 2022 to 2024

SMIC	2024	2023	2022
Gross Margin	18%	19.3%	38.0%
Net Margin	6.1%	17.8%	30.2%

Source: SMIC 2023 Annual Report, SMIC Press Release: "SMIC REPORTS 2024 FOURTH QUARTER RESULTS," February 11, 2025.

TSMC	2024	2023	2022
Gross Margin	56.1%	54.4%	59.6%
Net Margin	43.1%	38.8%	44.9%

Source: TSMC 2023 Annual Report, TSMC 4Q24 Quarterly Management Report January 16, 2025

Compared to the industry leader TSMC's gross profit margin of 56.1% in 2024, SMIC's gross profit margin for the same year was significantly lower at 18%.[134] TSMC's 2024 gross profit margin was a 1.7 percentage point increase compared to 2023, showcasing its continued efficiency and leadership in advanced semiconductor manufacturing.[135] SMIC, on the other hand, saw its gross profit margin drop from 19.3% in 2023 to 18% in 2024, a fall of 1.3 percentage point.

SMIC's net profit margin was 6.1% in 2024, compared to TSMC's net profit margin of 43.1% for the same year. TSMC's 2024 net profit margin was a 4.3 percentage point increase compared to 2023. In contrast, SMIC saw its net profit margin drop from 17.8% in 2023 to 6.1% in 2024, a fall of 11.7

[133] TrendForce, Press Release: "ASML to Ship First Second-Gen High-NA EUV Machine in the Coming Months, Aiming for 2026 Production, February 5, 2025.

[134] Charlotte Lee, "TSMC reports record revenue and profit for 2024," Taiwan News, January 16, 2025; SMIC, Press Release: "SMIC REPORTS 2024 FOURTH QUARTER RESULTS," February 11, 2025.

[135] TSMC Annual Report 2023, p. 123, https://investor.tsmc.com/static/annualReports/2023/english/pdf/2023_tsmc_ar_e_ch6.pdf, Accessed on March 7, 2025.

percentage point. Various media outlets have reported that this substantial decrease in SMIC's net profit margin is attributed to the high costs incurred in mass-producing 7nm chips for Huawei.[136]

China is also facing challenges in international collaboration on semiconductor R&D. Collaboration between the Interuniversity Microelectronics Centre (IMEC) and Chinese companies and researchers, for example, has become almost impossible due to U.S.-led restrictions. IMEC is a non-profit firm that has become important in the semiconductor industry because it offers a "neutral" space for competing companies and researchers to conduct research. It operates a "clean room" test facility with cutting edge tools such as those made by Dutch equipment maker ASML Holding NV.[137]

The gap in domestic IP and technology is a major hurdle for achieving Chinese self-sufficiency in advanced semiconductor manufacturing. It also means that China will lag further behind Taiwan and the U.S.A. in 2025, when TSMC — chipmaker to Apple Inc. and Nvidia — begins to mass produce 2nm chips, which are about three generations ahead.

TAIWAN'S ROLE IN CHINA'S SEMICONDUCTOR INDUSTRY

Taiwanese semiconductor companies have played a critical role in shaping China's semiconductor landscape. Their impact extends beyond just investment, as they bring technological expertise, talent development, and supply chain integration. Through their investments in China, companies like MediaTek, TSMC and UMC support China's goal of achieving greater self-sufficiency in semiconductor production.

Investments in China

MediaTek

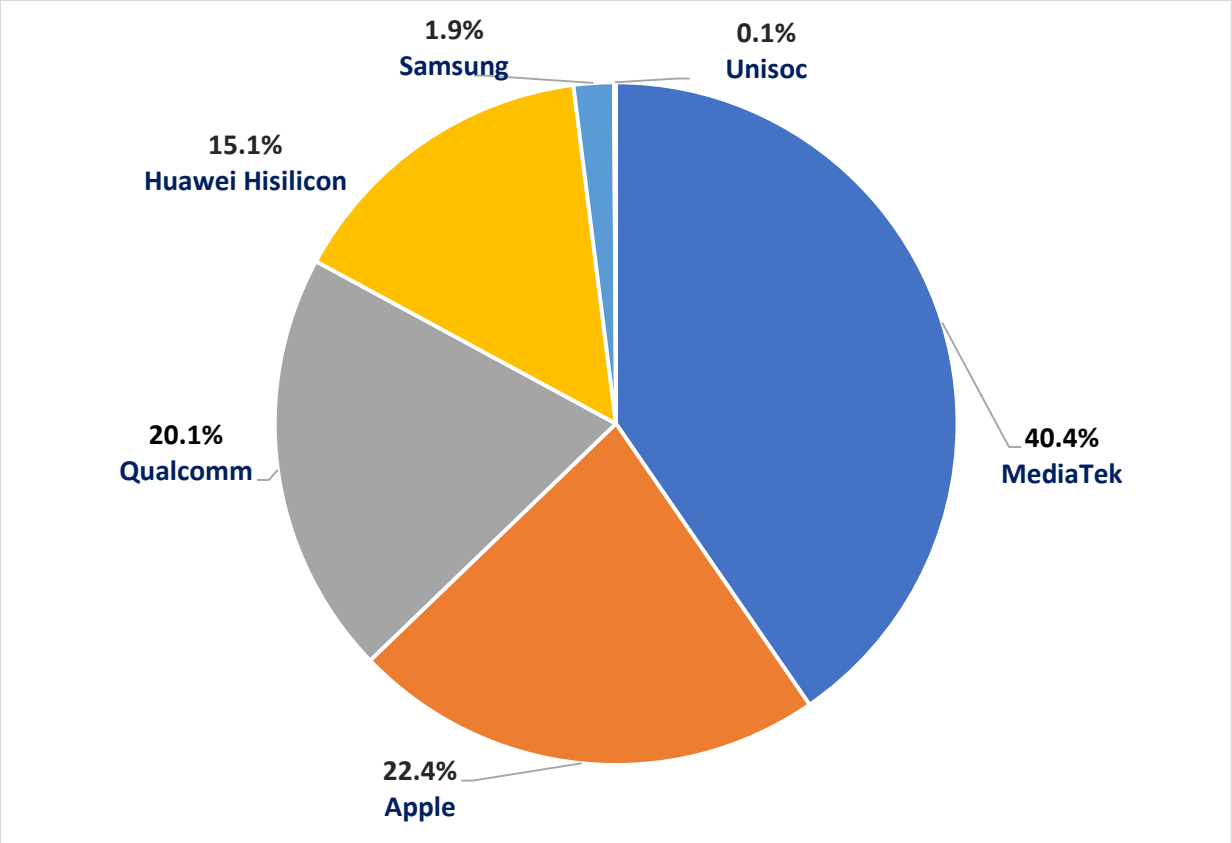
MediaTek, the world's largest supplier of mobile phone chips, is highly concentrated on the Chinese smartphone market.[138] Alongside Apple and

[136] TrendForce, Press Release: "SMIC 2024 Sales Hit Record, But Profit Drops Reportedly Due to High Huawei Chip Costs,"February 12, 2025.
[137] "imec CEO says Chinese partnerships winding down amid chip tensions," Reuters, May 17, 2023.
[138] Lisa Wang, "MediaTek sees sales growing up to 10%," Taipei Times, February 8, 2025.

Qualcomm, MediaTek dominates the smartphone chipset industry, a position driven by the substantial investments and cutting-edge technological expertise required to excel in this competitive field.[139]

The 5G chipset market in China is highly concentrated, with MediaTek, Apple, and Qualcomm collectively commanding approximately 82.9% of the market share in the last quarter of 2020. MediaTek dominated the 5G smartphone chip segment in China with a 40.4% share, followed by Apple at 22.4% and Qualcomm at 20.1%. Chinese domestic chipset manufacturers, such as Huawei Hisilicon and Unisoc accounted for 15.1% and 0.1% while Samsung accounted for only 1.9% market share. During this period, MediaTek emerged as the global leader in the smartphone Application Processor/System-on-Chip (AP/SoC) market, holding 37% of the global smartphone market share (see Figure 15).[140]

Figure 15: Market Share of 5G Smartphone Chips Manufacturers in China: 4th Quarter 2020



[139] Takeshi Niwa, "Smartphone Chipset Market Update," EE Times Asia, May 6, 2024.
[140] Mariyan Slavov, "Samsung loses Exynos market share, MediaTek models to blame," Phone Arena, Mar 02, 2022.

Source: IDC. (February 1, 2021). Market share of 5G smartphone chips manufacturers in China in fourth quarter 2020 [Graph]. In Statista. Retrieved March 15, 2025, from https://www.statista.com/statistics/1150665/china-market-share-of-5g-smartphone-chip-by-company/

Since MediaTek's entry into China with its first office in Shenzhen in 2001, it has expanded its presence in China, including the establishment of R&D centers in major cities like Shanghai and Beijing, which allowed the company to engage more deeply with Chinese companies in the electronics and telecommunications industries.[141] One example is the opening of a joint laboratory between MediaTek and Xiaomi at the latter's Shenzhen R&D Center in July 2024, with the new "Redmi K70 Supreme Edition" being the first product from the joint lab.[142]

MediaTek's Dimensity chips have been making waves in China's flagship smartphone market. Its smartphone market share climbed from over 30% in 2023 to approximately 40% in 2024, driven by the success of their high-performance Dimensity series, including the Dimensity 9400.[143] This growth reflects MediaTek's strong partnerships with leading Chinese smartphone brands like Vivo, Oppo, and Xiaomi, as well as their focus on innovation and competitive pricing.[144]

During the OPPO AI Tech Summit at the Mobile World Congress 2025, Oppo highlighted a partnership with MediaTek to optimize chips for high-efficiency, real-time AI processing, ensuring powerful performance without excessive battery drain.[145] OPPO aims to bring generative AI features to 100 million users by the end of 2025 (doubling its 2024 target of 50 million).

Despite efforts by the Chinese government to actively support the domestic semiconductor supply chain, it will take time for Chinese IC suppliers to secure a leading position in the competitive 5G smartphone chips manufacturing market.

[141] "MediaTek Milestones," https://i.mediatek.com/mediatek20, Accessed on March 7, 2025.
[142] TrendForce, Press Release: "MediaTek and Xiaomi Opened a Joint Lab, the First Product with Stellar Performance Unveiled," July 4, 2024.
[143] Chloe Liao, Jingyue Hsiao, "AI to transform smartphone industry in two years, says MediaTek," DigiTimes Asia, March 6, 2025.
[144] Lisa Wang, "MediaTek expects higher Q4 revenue," Taipei Times, October 31, 2024.
[145] IDC, Press Release: "MWC 2025: The Future of Mobile Devices Unfolds," March 12, 2025.

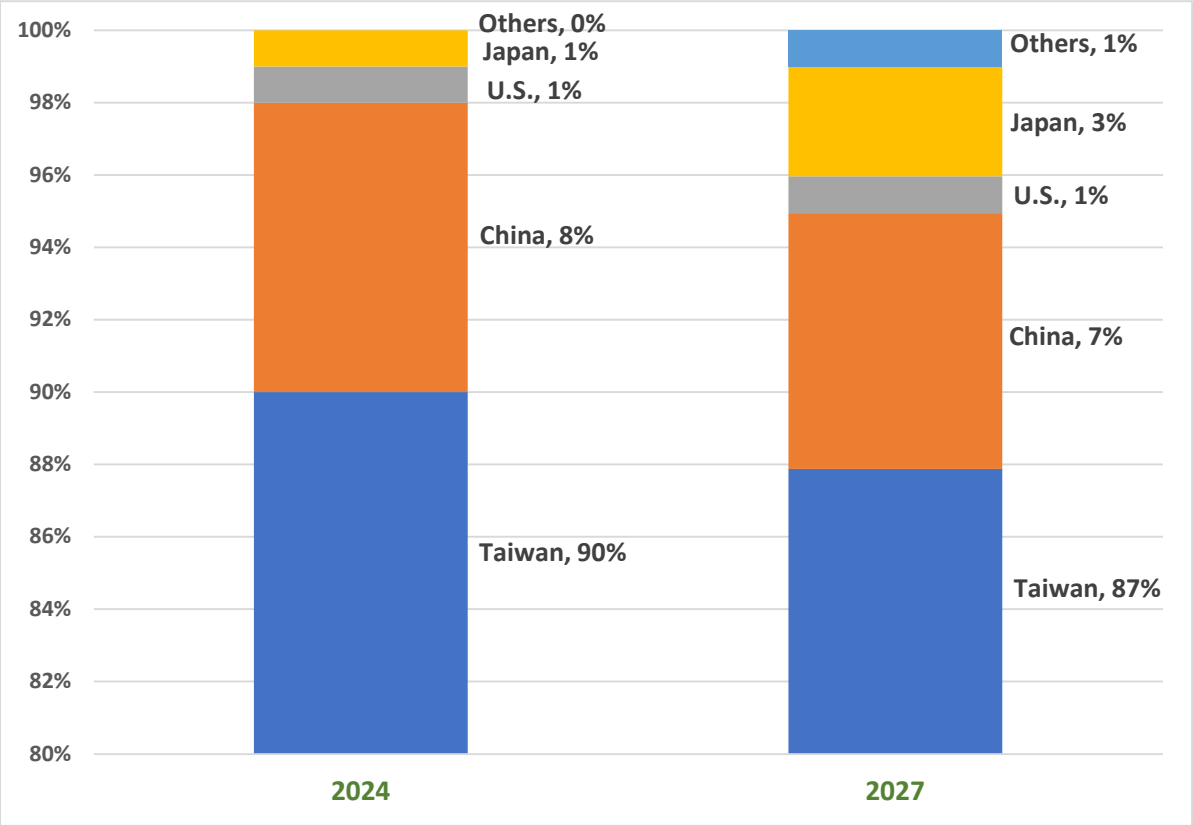
TSMC

In 2004, TSMC became the first Taiwanese chipmaker to build a factory in China.[146] Currently, TSMC operates an 8-inch fab in Shanghai which focuses on 200mm wafer fabrication, and a 12-inch fab in Nanjing which specializes in 300mm wafers and advanced process technologies like 16nm.[147]

In 2024, 90% of TSMC's production capacity was in Taiwan, 8% in China, 1% in the United States and 1% in Japan. TSMC's fabs cater to local Chinese chip design companies by providing high-quality manufacturing processes. This allows TSMC to contribute to the Chinese semiconductor ecosystem without breaching global trade restrictions, especially regarding the export of cutting-edge technology.[148] However, the company plans to diversify its production regionally, which is a general trend in the industry following increasing tensions between the United States and China. In 2027, TSMC is expected to have 87% of its production capacity in Taiwan, 7% in China, 1% in the United States, 3% in Japan and 1% elsewhere (see Figure 16).

[146] Jessie Ho, "TSMC's Shanghai fab formally approved," Taipei Times, May 1, 2004.
[147] "TSMC Fabs," TSMC, https://www.tsmc.com/english/aboutTSMC/TSMC_Fabs, Accessed on March 12, 2025.
[148] TrendForce, Press Release: "TSMC's Nanjing Plant Reportedly Pushes for Indefinite Exemption From US Before the May 31 Deadline, May 23, 2024.

Figure 16: Estimated Regional Breakdown of TSMC's Production Capacity: 2024 & 2027



Source: TrendForce. (June 4, 2024). Estimated regional breakdown of Taiwan Semiconductor Manufacturing's production capacity in 2024 and a forecast for 2027 [Graph]. In Statista. Retrieved March 16, 2025, from https://www.statista.com/statistics/1472228/tsmc-regional-distribution-of-manufacturing-capacity/

The U.S. Department of Commerce's Bureau of Industry and Security (BIS) implemented a series of increasingly stringent chip restrictions on China between 2022 and 2025. These measures significantly affected TSMC's operations in China and its business relationships with Chinese entities.

BIS's 2022 chip restrictions focused on blocking China's access to advanced chips and manufacturing tools.[149] Key measures included export bans on advanced Artificial Intelligence (AI) and High-Performance Computing (HPC) chips (NVIDIA A100, H100, AMD MI250), restrictions on semiconductor manufacturing equipment for nodes ⩽14nm (logic), ⩽18nm (DRAM), ⩾128 layers (NAND), prohibition of U.S. persons from working with Chinese advanced chip manufacturing without a license, and the application of the

[149] U.S. Department of Commerce's Bureau of Industry and Security, Press Release: "Commerce Implements New Export Controls on Advanced Computing and Semiconductor Manufacturing Items to the People's Republic of China (PRC)," October 7, 2022.

Foreign Direct Product Rule (FDPR) to foreign companies using U.S. technology.[150] TSMC, which manufactures chips for global clients, including NVIDIA's A100/H100, was legally required to stop shipping these chips to Chinese customers.

In 2023, BIS introduced new measures to prevent China from circumventing the 2022 controls and tighten global compliance. Key additions include the expansion of the list of controlled chips, including modified chips such as the NVIDIA H800 and A800, amongst others, were added to the controlled list; banning the exports of certain mid-performance chips that could still be aggregated for large AI clusters; tightening of FDPR enforcement for third-country subsidiaries supplying China; and broadening of restrictions on cloud services that could give indirect access to AI compute.[151] The adding of modified chips to the restricted list limited TSMC's ability to fulfill high-value orders from NVIDIA and AMD destined for Chinese clients (such as Alibaba and Baidu).[152]

The 2024 BIS chip controls built on the 2022 and 2023 restrictions, evolving to become more sophisticated by shifting their focus from simply banning specific chip models to targeting performance benchmarks, entire computing systems, and cutting-edge packaging technologies.[153] Following the 2024 chip controls, TSMC faced limitations on exporting chips with advanced packaging technologies and high-bandwidth memory (HBM) critical for AI applications to China.

BIS imposed a new rule banning foundries from making advanced AI chips designed by Chinese firms was imposed on January 15, 2025.[154] The 2025 rule represents a more proactive approach by addressing the design stage,

[150] Ibid.

[151] U.S. Department of Commerce's Bureau of Industry and Security, Press Release: "Commerce Strengthens Restrictions on Advanced Computing Semiconductors, Semiconductor Manufacturing Equipment, and Supercomputing Items to Countries of Concern," October 17, 2023.

[152] TrendForce, Press Release: "China Advances In-House AI Chip Development Despite U.S. Controls," November 16, 2023.

[153] U.S. Department of Commerce's Bureau of Industry and Security, Press Release: "Commerce Strengthens Export Controls to Restrict China's Capability to Produce Advanced Semiconductors for Military Applications," December 2, 2024.

[154] U.S. Department of Commerce's Bureau of Industry and Security, Press Release: "Commerce Strengthens Restrictions on Advanced Computing Semiconductors to Enhance Foundry Due Diligence and Prevent Diversion to PRC," January 15, 2025.

effectively preventing Chinese firms from leveraging global foundries for advanced AI chip production.

China (excluding Taiwan) ranks as TSMC's second-largest revenue source after the United States. In fiscal year 2023, TSMC generated NT$ 267 billion (US$ 8 billion) from China, marking a 9% increase compared to fiscal year 2022. TSMC derives 12% of its revenue coming from China. Over the past five years, TSMC's revenue share from China has gradually declined from 20% in 2019 to 12% in 2023.[155] Its revenue from China-based clients further fell to about 11% in the July to September quarter of 2024.

The reduction in revenue share from China, despite its substantial growth in absolute terms, highlights TSMC's efforts at diversifying its customer base globally, with significant investments in regions like the U.S. and Europe.[156] Additionally, TSMC's advanced nodes, such as 5nm and 3nm, are in higher demand from markets like the U.S. and Europe, reducing the relative share of revenue from China.[157]

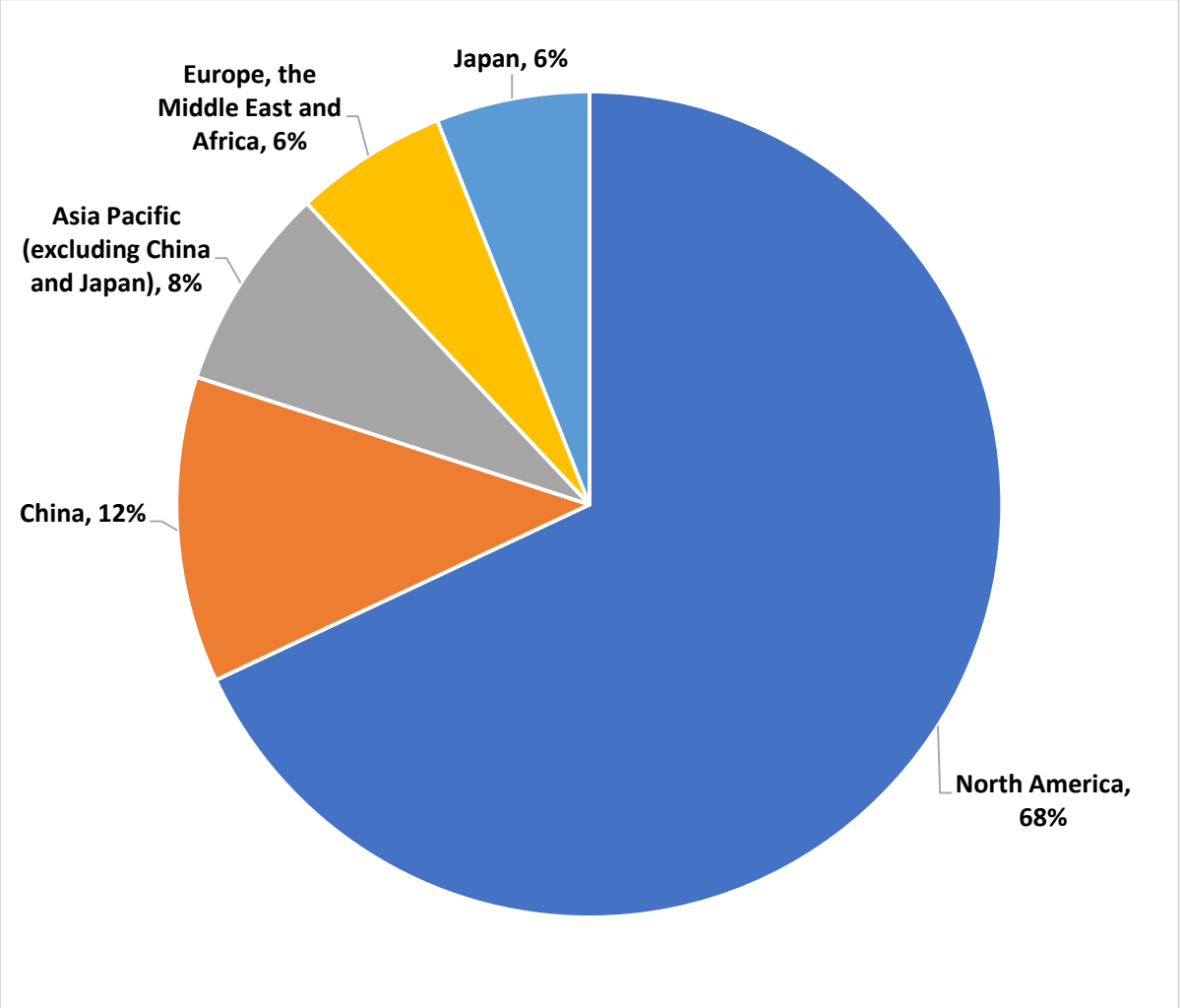
In 2023, TSMC's revenue from China was about US$ 8.7 billion, accounting for 5.6% of China's semiconductor market. TSMC's business in China remains significant, and its fabs in China play a crucial role in contributing to China's chip self-sufficiency drive.

[155] TSMC Annual Report 2023, https://investor.tsmc.com/static/annualReports/2023/english/index.html, Accessed on March 10, 2025.

[156] Anton Shilov, "TSMC expands investments in the U.S. to $165 billion with new fabs and R&D center: A closer look," Tom's Hardware, March 7, 2025.

[157] TSMC, Edited Transcript: "Q4 2024 Taiwan Semiconductor Manufacturing Co Ltd Earnings Call," JANUARY 16, 2025.

Figure 17: Distribution of Net Profit of TSMC by Region: 2023



Source: TSMC. (March 12, 2024). Net profit of Taiwan Semiconductor Manufacturing Company in 2023, by region (in million New Taiwan dollars), In Statista. Retrieved March 16, 2025, from https://www.statista.com/statistics/1178152/taiwan-semiconductor-manufacturing-company-net-income-by-region/

UMC

UMC, the second Taiwanese semiconductor company to enter the Chinese market, operates two fabs in China. Its United Semi in Xiamen started as a 3-way joint venture foundry company between UMC, Xiamen Municipal People's Government and Fujian Electronics & Information Group.[158] As southern China's first 12-inch foundry fab, United Semi began volume production in 2016. United Semi focuses on mature nodes like 40nm, 28nm

[158] UMC, Press Release: "UMC Holds Grand Opening Ceremony for New 12-inch Wafer Fab in China," November 16, 2016.

and 22nm process technologies, catering to a wide range of applications.[159] UMC's other fab, HeJian Technology in Suzhou, is an 8-inch fab that serves various applications, offering high-capacity production for mature node technologies.[160]

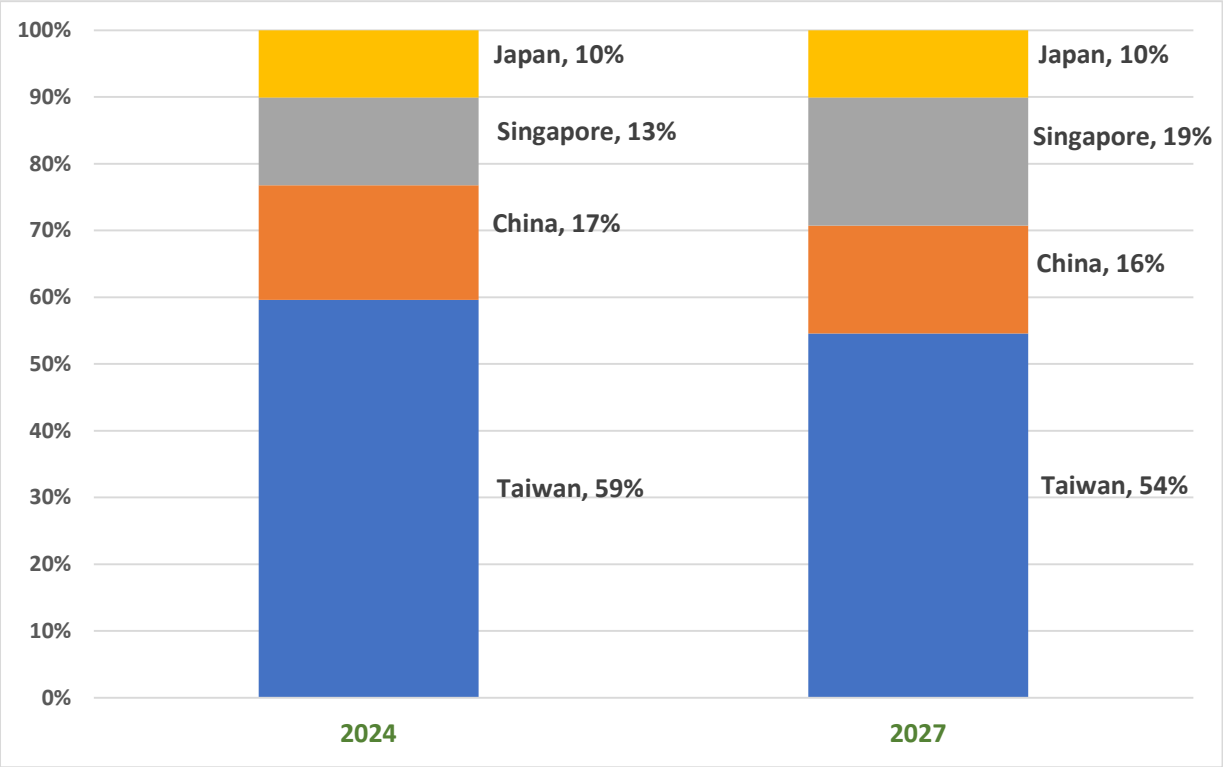
In 2024, China held the second largest share of UMC's production capacity at 17%. Taiwan held the largest share of UMC's production capacity at 59%. Singapore's share of production stood at 13% while Japan accounted for 10% of UMC's production capacity.

By 2027, China's share of UMC's production capacity is forecasted to decrease slightly to 16%. Taiwan's share is projected to decrease to 54%, indicating a shift in production capacity to Singapore. In fact, Singapore's share of production is expected to increase significantly to 19% in 2027 while Japan's share is expected to hold steady at 10% (see Figure 18). Despite the expected slight decline in UMC's China fab capacity, its continued presence supports China's self-sufficiency efforts.

[159] "About USCXM," UMC, https://www.uscxm.com/English/aboutUSCXM/aboutUs.asp. ACessed on March 10, 2025.

[160] "About HJTC," UMC, https://www.hjtc.com.cn/English/aboutHJ/aboutUs.asp. Accessed on March 10, 2025.

Figure 18: Estimated Regional Breakdown of UMC's Production Capacity: 2024 & 2027



Source: TrendForce. (June 5, 2024). Estimated regional breakdown of United Microelectronics Corporation's production capacity in 2024 and a forecast for 2027 [Graph]. In Statista. Retrieved March 16, 2025, from https://www.statista.com/statistics/1472230/umc-regional-distribution-of-manufacturing-capacity/

Powerchip Technology Corporation

In 2015, Powerchip Technology Corporation (PSMC) partnered with the city of Hefei to establish Nexchip Semiconductor Corporation, China's third 12-inch wafer foundry involving Taiwanese investment. By transferring its expertise in manufacturing less-advanced chips, such as display driver ICs, PSMC significantly boosted Nexchip's production capabilities. Notably, PSMC's contributions of technology, resources, and skilled Taiwanese personnel—who accounted for one-quarter of Nexchip's 1,200 employees in 2018—played a crucial role in the company's growth and technological progress.[161] This partnership aligned seamlessly with China's ambition to achieve semiconductor self-sufficiency and reduce dependence on foreign suppliers. In 2024, Powerchip withdrew from Nexchip's management, influenced by China's localization initiatives. Despite stepping away from operations, Powerchip

[161] Jess Macy Yu and Yimou Lee, "ANALYSIS: China's ties with Taiwan's chip firms under scrutiny," Taipei Times, November 8, 2018.

Investment Holding retains a 27.44 % stake in Nexchip, remaining its second-largest shareholder.[162]

In a nutshell, Taiwan's semiconductor companies like MediaTek, TSMC, UMC, and PSMC have played a crucial role in China's tech industry. While their investments and operations provide significant economic and technological benefits, their future growth in China will be shaped by geopolitical dynamics and China's ongoing push for semiconductor self-sufficiency.

Taiwan's Integrated Circuit Trade with China

Although Taiwan is making efforts to diversify its IC export destinations, China (including Hong Kong) remains a major importer of Taiwan's integrated circuits (ICs). In 2023, China accounted for 54.3% of Taiwan's IC exports. This is a slight decline from 57.7% in 2022 and 59.7% in 2021, indicating a decreasing trend in dependency and Chinese smartphone manufacturers facing a sluggish global smartphone market.[163]

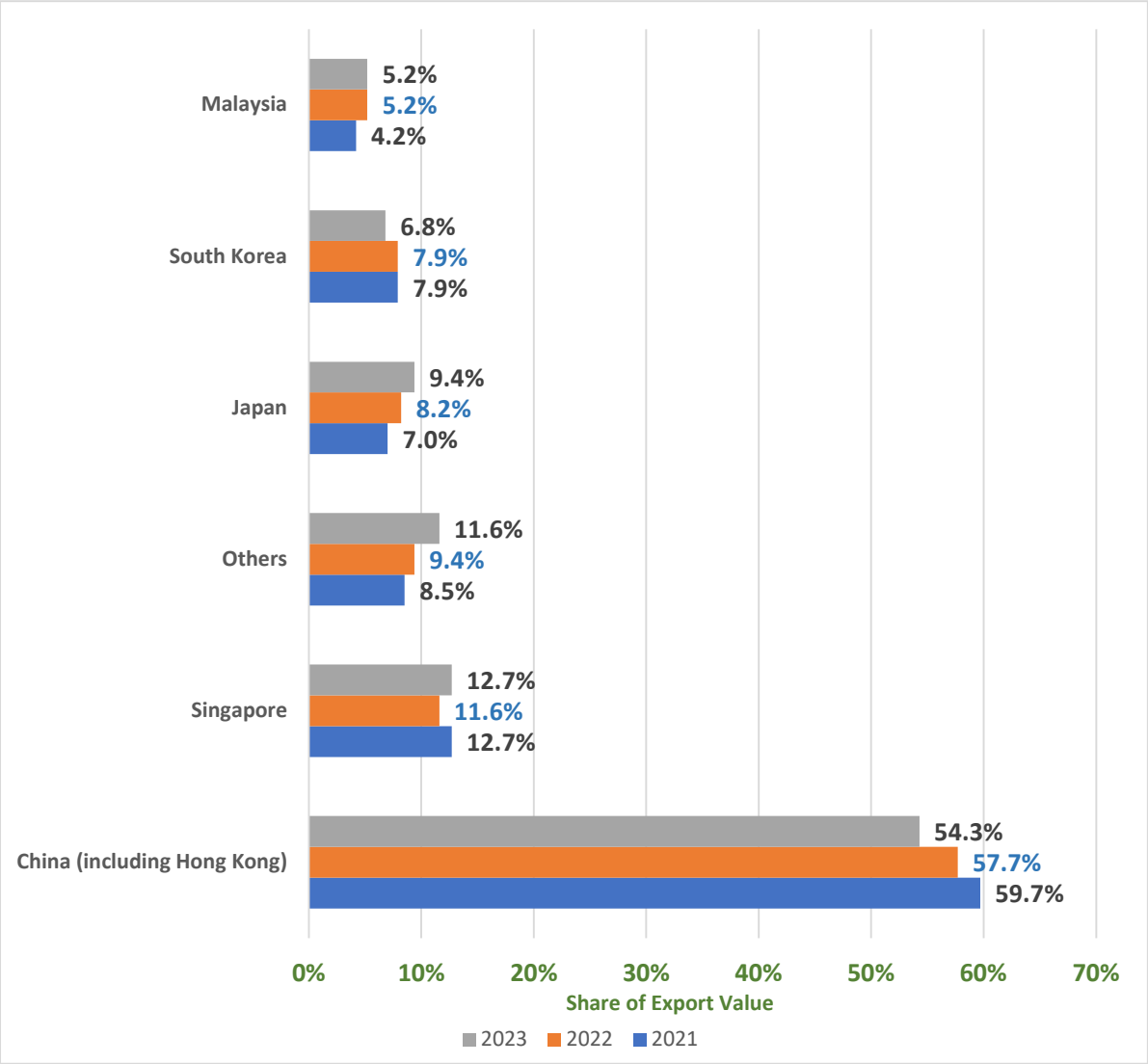
Foxconn (Hon Hai Precision Industry Co.), in particular, plays a significant role in China's IC imports from Taiwan. Since China's domestic fabs such as SMIC cannot yet produce cutting-edge at scale, Foxconn relies on TSMC chips in electronics manufacturing for global brands like Apple, Dell, and HP. Foxconn remains a bridge between Taiwan's semiconductor industry and China's manufacturing sector, but geopolitical pressures may force supply chain adjustments in the coming years.

Singapore's share of IC imports from Taiwan increased to 12.7% in 2023, up from 11.6% in 2022 and equal to its 2021 level. The share of exports categorized under "Others" also increased, standing at 11.6% in 2023, compared to 9.4% in 2022 and 8.5% in 2021. Japan's share rose to 9.4% in 2023, from 8.2% in 2022 and 7% in 2021, suggesting stronger semiconductor collaboration between Taiwan and Japan (see Figure 19).

[162] "About Powerchip Investment Holding Corporation (PIHC)," PIHC, https://www.powerchiptech.com/en/about, Accessed on March 18, 2025.

[163] Canalys, Press Release: "Global smartphone market declined just 4% in 2023 amid signs of stabilization.", 31 January 2024.

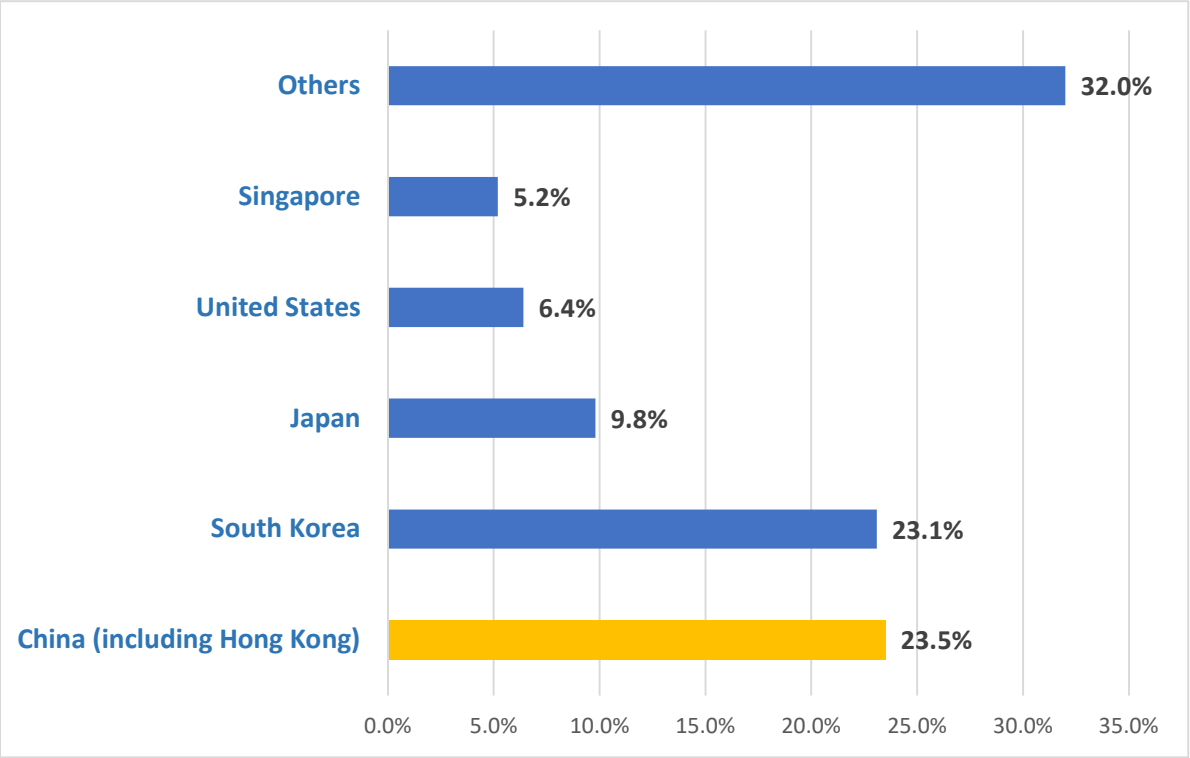
Figure 19: Leading Export Destinations of Integrated Circuits from Taiwan: 2023



Source: TSIA. (June 26, 2024). Leading destinations of exported integrated circuits from Taiwan in 2023 [Graph]. In Statista. Retrieved March 17, 2025, from https://www.statista.com/statistics/1246417/taiwan-major-export-markets-for-integrated-circuits/

Taiwan relies on a diverse set of suppliers for IC imports. In 2023, 23.5% of Taiwan's IC imports came from China, making it the top source. South Korea accounted for 23.1% of Taiwan's IC imports, nearly equal to China's share. Japan, the United States and Singapore contributed 9.8%, 6.4% and 5.2% of Taiwan's IC imports respectively. A large share (32%) comes from various other countries under the "Others" category (see Figure 20).

Figure 20: Breakdown by Share of Leading Origins of Imported Integrated Circuits in Taiwan: 2023



Taiwan remains essential to China's semiconductor industry. However, geopolitical factors and China's continuing push for chip self-sufficiency indicate that the trade relationship is evolving toward Taiwan's diversification of its chip import and export markets.

CONCLUSION

China plays a key role in the global semiconductor value chain, contributing 11% in 2022. Its assembly, test, and packaging (ATP) segment is its strongest, accounting for 30% of global value-added. Other significant contributions include wafer fabrication (24%) and semiconductor materials (18%). While China excels in certain areas, it lags in high-volume manufacturing of advanced chips (≤7nm), and key R&D metrics. U.S. export controls further limit China's access to AI chips and cutting-edge semiconductor technologies.

China's semiconductor industrial policy seeks to bolster its domestic semiconductor sector, reduce reliance on foreign technologies, and attain global leadership. Initiated in 2014 with the "National Guidelines for Development and Promotion of the Integrated Circuit Industry," this strategy gained momentum with the "Made in China 2025" (MIC 2025) initiative.

The "Big Fund," launched in three phases since 2014, has been a key driver of China's domestic semiconductor development. However, a 2022 corruption scandal raised concerns over its governance and allocation efficiency. Despite these setbacks, Phase 3 of the Big Fund, launched in 2024 with an investment of approximately US$ 47.5 billion, underscores China's continued commitment to semiconductor self-sufficiency. This phase prioritizes advancements in cutting-edge chip design, semiconductor materials, domestic manufacturing equipment and manufacturing processes to reduce reliance on foreign suppliers. These initiatives are further supported by the "Made in China 2025" strategy, which emphasizes the growth of domestic IC design and manufacturing capabilities, aims to decrease foreign dependency, and positions China to compete for global semiconductor leadership.

Despite progress, challenges remain. China's semiconductor self-sufficiency rate only achieved 23.3% in 2023, with projections indicating it could reach 26.6% by 2027, falling short of the ambitious 70% target set by the MIC 2025 plan.

China's semiconductor industry faces significant constraints due to U.S. export controls and its technological gap compared to global leaders like Taiwan's TSMC and South Korea's Samsung. On the one hand, TSMC continues to strengthen its position in the global semiconductor foundry market, reaching a record-high 67.1% market share in Q4 2024, with its revenue of US$ 26.85 billion. On the other hand, Chinese foundries, including SMIC, Hua Hong Group, and Nexchip, struggles to expand their global market presence as they are increasingly blocked from access to modern process nodes and manufacturing equipment. Although their combined market share rose slightly to 9.1% in 2024, their focus on mature, cost-effective technologies restricts their ability to compete in cutting-edge semiconductor processes.

China’s rapidly expanding semiconductor sector has increasingly pivoted toward the production of legacy chips, with growth concentrated in mature process nodes (>28nm). This surge in production has contributed to a global oversupply of mature-node ICs. Aggressive pricing strategies and expanded capacity by Chinese foundries have placed downward pressure on profit margins for many established semiconductor companies operating in this segment. By the end of 2025, Chinese fabs are projected to account for approximately 28% of global mature chip capacity, further intensifying competition and reshaping the pricing dynamics of the legacy chip market.

The "Big Fund" has spurred the entry of numerous domestic players into China’s semiconductor industry. However, intense competition, coupled with technological and operational challenges faced by inexperienced entrants, has led to a notable wave of bankruptcies and business closures since 2022. In response, China's "Big Fund" has prioritized investment in leading domestic firms such as SMIC, Hua Hong Semiconductor, and YMTC, focusing on enhancing their technological capabilities and progress. This strategic shift plays a crucial role in China's broader ambition to achieve semiconductor self-sufficiency and could profoundly impact its position in the global semiconductor landscape.

For example, SMIC — China’s only domestic foundry capable of producing chips at the 7nm process node — has experienced rapid growth under the government’s semiconductor self-reliance initiatives. However, it faces substantial obstacles due to U.S. export restrictions on critical technologies, including EUV lithography systems and advanced EDA tools, which are essential for scaling below 7nm. In response, SMIC has relied on workarounds such as multi-patterning techniques using DUV lithography, but these methods result in low yields, higher production costs, and significant inefficiencies. These limitations highlight the structural challenges China faces in achieving parity with global leaders in advanced-node manufacturing.

Chinese efforts to develop indigenous EUV technology are advancing, with notable patents filed by companies like Huawei and SMEE. Yet, the complex path to commercialization puts China years behind global leaders like ASML, which has already moved to High-NA EUV technology, further widening the gap.

In 2024, despite achieving record revenues of US$ 8 billion, SMIC's profit margins declined sharply due to an oversupply of legacy chips, increased operating expenses, and government pressure to use less advanced local equipment. Its gross profit margin dropped to 18%, far below TSMC's 56.1%, reflecting its inability to compete effectively in the high-end market. China is likely to remain at the 7nm level until at least 2026, while global leaders advance to more sophisticated nodes.

Additionally, China faces significant challenges in semiconductor R&D collaboration due to U.S.-led restrictions, which have strained partnerships with organizations like IMEC. IMEC, known for its "neutral" research environment and cutting-edge facilities, plays a critical role in global semiconductor innovation. However, China's inability to access such international resources underscores its struggle with domestic IP and technology gaps. This shortfall further delays China's progress in advanced semiconductor manufacturing, leaving it behind leaders like Taiwan and the U.S.A. Notably, TSMC is set to mass-produce 2nm chips in 2025, maintaining its technological edge at approximately three generations ahead of China.

Taiwanese semiconductor companies, including MediaTek, TSMC, UMC, and PSMC, have significantly influenced China's semiconductor industry through investments, technological expertise, talent development, and supply chain integration. MediaTek leads the 5G chipset market in China, collaborating with major Chinese brands and driving innovation in flagship smartphones. TSMC operates key fabs in China, supporting local chip design companies while maintaining global trade compliance. UMC and Powerchip also contribute through partnerships and manufacturing facilities, focusing on mature nodes and display driver ICs.

Despite the significant presence of Taiwanese semiconductor companies in China, rising geopolitical tensions and China's push for localization and semiconductor self-sufficiency are likely to reshape the future trajectory of these companies' operations in the region. For example, while TSMC's business in China remains substantial, its revenue growth from other regions — particularly the United States and allied markets — has been outpacing its growth in China.

As TSMC strengthens its alignment with Western strategic interests, opportunities for technology transfer, joint R&D collaboration, and talent exchange between Taiwan's semiconductor ecosystem and China are expected to diminish. This dynamic could further slow China's progress toward developing the technological expertise required for advanced-node manufacturing. Moreover, persistent U.S. export restrictions on critical semiconductor technologies continue to hinder China's ability to bridge this gap. As a result, these factors may drive a reconfiguration of global supply chains, deepening China's isolation from the most advanced segments of the semiconductor industry.

With regards to IC trade, while Taiwan is working to diversify its IC export markets, China (including Hong Kong) remains its largest destination, accounting for 54.3% of Taiwan's IC exports in 2023. Foxconn plays a pivotal role in this trade relationship, relying on TSMC chips for manufacturing products for global brands due to China's limited capacity to produce advanced chips domestically. However, geopolitical tensions may force future adjustments in this supply chain linkage.

At the same time, Taiwan's IC exports to other markets are growing. Singapore's share rose to 12.7% in 2023, while Japan's share increased to 9.4%, indicating strengthening semiconductor ties with both countries. The rise in the "Others" category to 11.6% suggests Taiwan's broader diversification efforts.

On the import side, Taiwan sources ICs from a diverse range of countries. In 2023, China and South Korea each contributed around 23% of Taiwan's IC imports, with Japan, the U.S., and Singapore also significant suppliers.

In summary, Taiwan continues to play an important role in China's semiconductor supply chain, providing technological expertise and essential manufacturing capacity. However, as geopolitical tensions intensify and China accelerates its efforts toward semiconductor self-sufficiency, Taiwanese semiconductor companies are actively diversifying their operations. At the same time, Taiwan is broadening its trade relationships in the semiconductor sector to mitigate risks and lessen over-reliance on specific markets.

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2025/2/5
Taiwan Talks

Trump Eyes 100% Tariffs on Taiwan's Chips

While U.S. allies Canada and Mexico have for the time being averted a massive trade war with Donald Trump, Taiwan is still bracing for a possible 100% tariff on its chips. Can Taipei strike a deal with Washington and what impact could all this have on the new U.S.-Taiwan relationship?

Guests:

- Wen Lii, Taiwan Presidential Office Spokesperson
- Ronan Fu, Academia Sinica Institute of Political Science Assistant Research Fellow

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