
TAIWAN AND THE GLOBAL SEMICONDUCTOR SUPPLY CHAIN

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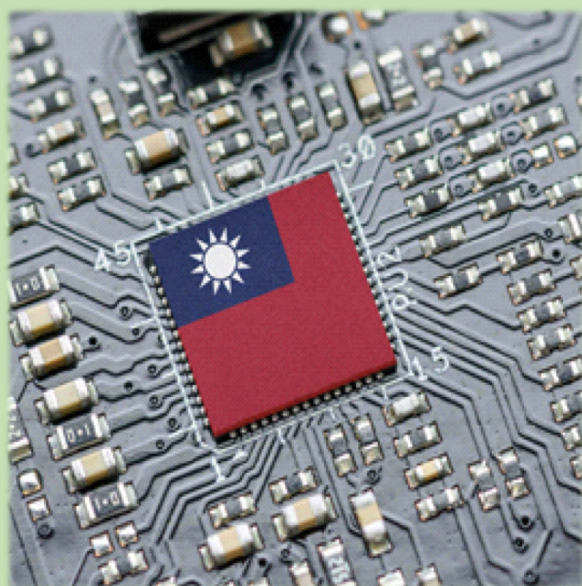
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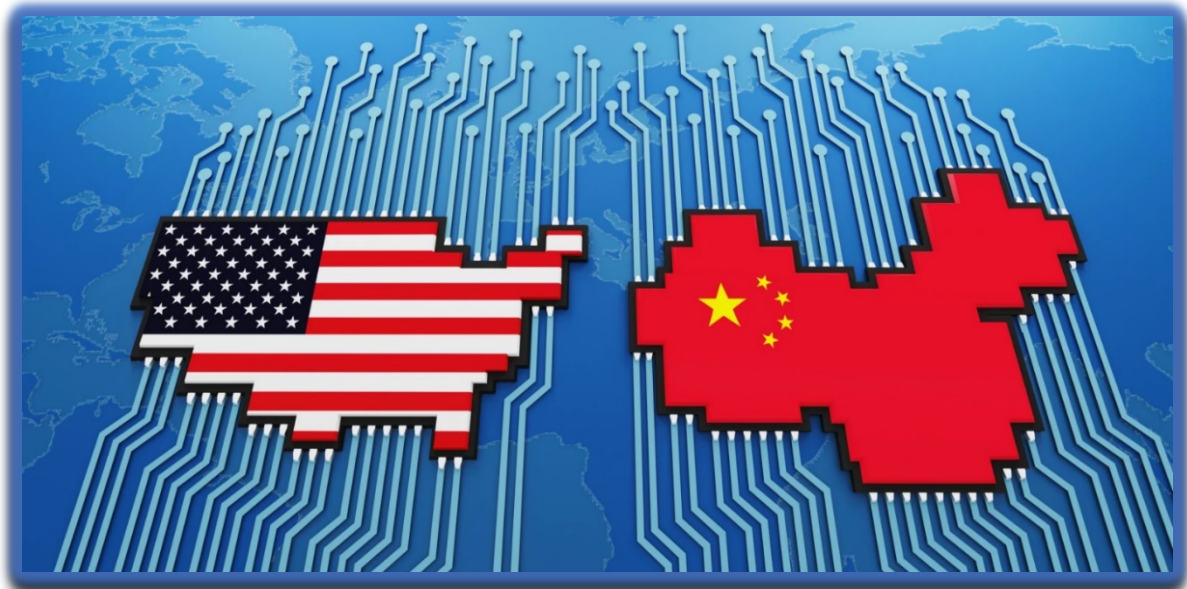
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IN THE SPOTLIGHT

U.S. – China Conflict over Semiconductors

- Chips are the new oil — the power behind all modern technology, and increasingly seen as the biggest geopolitical prize.
- The most advanced chips—and the technology to manufacture them—are produced in supply chains controlled by countries like Japan, the Netherlands, South Korea, Taiwan and the U.S.A.
- The U.S.A. and China have entered a phase of competition for advantage over semiconductor technology.
- Tit-for-tat U.S.-China trade restrictions.



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OVERVIEW

Semiconductors, or chips, are seen as key to national security for many countries and a sign of technological prowess. Moreover, as a vital and limited resource, chips have been likened to the modern world's equivalent of oil. Today, military, economic, and geopolitical strength is intricately tied to chips, a connection that has only intensified with the rise of artificial intelligence (AI). Similar to the centrality of oil in the past century, chips now occupy a central role in geopolitics, great-power rivalries, and trade, notably between the U.S.A. and China.

The semiconductor supply chain is composed of chip design and fabrication, as well as assembly, test, and packaging (ATP) stages to prepare chips for final integration in electronic devices. The semiconductor industry relies on a wide network of materials, chemicals, gases, and manufacturing equipment suppliers. As a result, the global semiconductor supply chain is complex and spans the globe.

The critical role of semiconductors in manufacturing was brought to the foreground when the COVID-19 pandemic and shifts in patterns of supply and demand led to a global chip shortage. In addition, the war in Ukraine has called attention to the importance of semiconductors to both national security and the conduct of modern warfare, as Russia has reportedly been struggling to restock precision-guided munitions that use foreign-made computer chips and guidance systems to help them hit targets.¹

Given the confluence of extreme global dependency in the semiconductor supply chain, a geopolitical context that is growing increasingly challenging by the day, and the role of semiconductors in enabling the essential technologies that drive economic growth and national security, it comes as little surprise that semiconductors lie at the heart of the tech war between the U.S.A. and China.

U.S.A.

The United States is presently the global leader in semiconductor revenue. In 2021, U.S. companies accounted for 46% (US\$ 258 billion) of the global chip sales (US\$ 556 billion). Semiconductors are the fourth largest U.S. export; and the industry directly employs 277,000 Americans and indirectly accounts for 1.6 million additional jobs.² However, the global share of semiconductors manufactured in the United States has declined from 37% in 1990 to about 10% in 2022.³

¹ Jack Detsch, “Pentagon Deputy: Russia’s Defense Industry ‘Will Feel’ Pain of Ukraine War”, Foreign Policy, May 25, 2022.

² Semiconductor Industry Association, 2022 Factbook, May 2022.

https://www.semiconductors.org/wpcontent/uploads/2022/05/SIA-2022-Factbook_May-2022.pdf

³ The White House, Fact Sheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China, August 9, 2022.

- (4) Grow a diverse semiconductor workforce and build strong communities that participate in the prosperity of the semiconductor industry.⁷

Correspondingly, DOC aims to reach the following goals by 2030 in order to advance U.S. economic and national security:

- (1) make the U.S.A. home to at least two, new large-scale clusters of leading-edge logic chip fabs,
- (2) make the U.S.A. home to multiple, high-volume advanced packaging facilities,
- (3) produce high-volume leading-edge memory chips, and
- (4) increase production capacity for current-generation and mature-node chips, especially for critical domestic industries.⁸

According to U.S. Secretary of Commerce Gina Raimondo, the CHIPS Act will ensure that the world's most advanced chips are manufactured on American soil by attracting investments, building up a robust semiconductor supplier and R&D ecosystem for innovating new process technologies, and drawing talented individuals to join the ecosystem.⁹

Incentives

Of the US\$ 52.7 billion fund, a vast majority – US\$ 50 billion – goes to the DOC, where US\$ 39 billion is allocated for the CHIPS Program Office to provide incentives for investment in facilities and equipment in the United States, and US\$ 11 billion to the CHIPS Research and Development Office to develop a robust domestic R&D ecosystem. The other US\$ 2.7 billion of the CHIPS related funding goes to the Defense Department (DOD), the Department of State (DOS) and the National Science Foundation (see Figure 1 for details).¹⁰

⁷ The U.S. Department of Commerce, Press Release: “A Strategy for the Chips for America Fund”, September 6, 2022.

⁸ The U.S. Department of Commerce, Press Release: “Biden-Harris Administration Launches First CHIPS for America Funding Opportunity”, February 28, 2023.

⁹ The U.S. Department of Commerce, “Remarks by U.S. Secretary of Commerce Gina Raimondo: The CHIPS Act and a Long-term Vision for America’s Technological Leadership”, February 23, 2023.

¹⁰ U.S. Senate Committee on Commerce, Science and Transportation, Press Release: “CHIPS and Science Act of 2022: Division A Summary - CHIPS and ORAN Investment”, July 29, 2022.

Figure 1: CHIPS and Science Act provides \$52.7 billion for U.S. semiconductor research, development, and manufacturing

Semiconductor Manufacturing and Research & Development
<p>US\$ 39 Billion Manufacturing Incentives:</p> <ul style="list-style-type: none"> • Build, expand, or modernize domestic facilities and equipment for semiconductor fabrication, assembly, testing, advanced packaging, or research and development, including US\$ 2 billion specifically for mature semiconductors.
<p>US\$ 11 Billion for Research and Development (R&D):</p> <ul style="list-style-type: none"> • DOC National Semiconductor Technology Center (NSTC): <ul style="list-style-type: none"> ○ A public-private partnership to conduct advanced semiconductor manufacturing R&D and prototyping; invest in new technologies; and expand workforce training and development opportunities. • DOC National Advanced Packaging Manufacturing Program: <ul style="list-style-type: none"> ○ A Federal R&D program to strengthen advanced assembly, test, and packaging (ATP) capabilities, in coordination with the NSTC. • DOC Manufacturing USA Semiconductor Institute: <ul style="list-style-type: none"> ○ A partnership between government, industry, and academia to research virtualization of semiconductor machinery, develop ATP capabilities, and design and disseminate training. • DOC Microelectronics Metrology R&D: <ul style="list-style-type: none"> ○ A National Institute of Standards and Technology (NIST) research program to advance measurement science, standards, material characterization, instrumentation, testing, and manufacturing capabilities. • DOC Economic Development Administration (EDA)'s Tech Hub Program <ul style="list-style-type: none"> ○ Designation of Tech Hubs in regions across the country to drive regional innovation and job creation. ○ Award of Strategy Development Grants (SDG) to help communities significantly increase local coordination and planning activities.
Defense, Technology Security and Workforce Development
<ul style="list-style-type: none"> • CHIPS for America Defense Fund: <ul style="list-style-type: none"> ○ US\$ 2 billion for the DOD to implement the Microelectronics Commons, a national network for onshore, university-based prototyping, lab-to-fab transition of semiconductor technologies—including DOD-unique applications—and semiconductor workforce training. • CHIPS for America International Technology Security and Innovation Fund: <ul style="list-style-type: none"> ○ US\$ 500 million for the Department of State, in coordination with the U.S. Agency for International Development, the Export-Import Bank, and the U.S. International Development Finance Corporation, to support international information and communications technology security and semiconductor supply chain activities, including supporting the development and adoption of secure and trusted telecommunications technologies, semiconductors, and other emerging technologies. • CHIPS for America Workforce and Education Fund: <ul style="list-style-type: none"> ○ US\$ 200 million to kick start development of the domestic semiconductor workforce, which faces near-term labor shortages, by leveraging activities of the National Science Foundation.

Source: US Department of Commerce, CHIPS and Science Act of 2022: Division A Summary - CHIPS and ORAN Investment, July 2022, and U.S. Economic Development Administration's Press Release: "Biden-Harris Administration Designates 31 Tech Hubs Across America", October 23, 2023.

Additionally, the CHIPS Act provides a 25% investment tax credit for qualified investments in buildings and other eligible depreciable tangible property for advanced manufacturing facilities that have a primary purpose of manufacturing semiconductors or semiconductor manufacturing equipment. The tax credit is available for projects that start construction between January 1, 2023, and December 31, 2026.¹¹ Distribution of the tax credit portion of the CHIPS Act—projected to cost US\$ 24 billion—will be straightforward. Semiconductor firms that build new plants or extend existing plants, including foreign-owned firms such as TSMC and Samsung, can claim a tax credit equal to 25% of the cost for plant and equipment placed in service after December 31, 2022 or for which construction starts before January 1, 2027.¹²

Guardrails

According to the Department of Commerce, the CHIPS guardrails are intended to ensure that recipients of CHIPS funding do not compromise U.S. national security.¹³ To that end, the U.S. government aims to ensure that any entity receiving CHIPS Act funding enters into an agreement that it will not engage in any “significant transaction” to facilitate a “material expansion of semiconductor manufacturing” in foreign countries of concern for ten years. These countries of concern are defined in the legislation as China, North Korea, Russia, and Iran. This prohibition also applies to a recipient’s “affiliated group”, that is, an entity that has 80% common ownership with the covered entity as defined in 26 USC 1504(a).

The statute classifies semiconductors as critical to national security and places limits on the expansion and new construction of legacy facilities in foreign countries of concern. Under the rules, legacy semiconductor” means (1) a digital or analog chip of the 28-nanometer generation or older; (2) a DRAM memory device with a half-pitch greater than 18 nanometers or a NAND flash memory device that is less than 128 layers and does not use emerging memory technologies; or (3) any other device designated by DOC. The

¹¹ The White House, Fact Sheet: CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China, August 9, 2021.

¹² 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.

¹³ The U.S. Department of Commerce, Press Release: “Commerce Department Outlines Proposed National Security Guardrails for CHIPS for America Incentives Program”, March 21, 2023.

Advanced Fab criteria above), absent evidence of knowledge of a violation by those persons.

Export Controls

Alongside the provisions in the statute, the Department of Commerce's Bureau of Industry and Security (BIS) issued additional Export Administration Regulations (EAR) on the semiconductor industry on October 7, 2022.¹⁸ Critical changes were made to the EAR in two areas to address U.S. national security and foreign policy concerns. First, BIS imposes additional export controls on certain advanced computing semiconductor chips, transactions for supercomputer end-uses, and transactions involving certain entities on the Entity List. Second, BIS adopts additional controls on certain semiconductor manufacturing items and on transactions for certain integrated circuit end use.

The export controls by BIS are aimed at restricting China's ability to obtain advanced computing chips, develop and maintain supercomputers, and manufacture advanced semiconductors. These items and capabilities are used by China to produce advanced military systems, improve the speed and accuracy of its military decision making, planning, and logistics, as well as of its autonomous military systems. Further, if BIS is prevented by the actions of foreign government from making compliance determinations, it will impact a company's access to U.S. technology through addition to the Entity List.¹⁹

The heaviest restrictions are centered on the tightening of restrictions on high performance computing chips, semiconductor manufacturing equipment, and supercomputing items. In addition to cutting-edge chips with U.S.-origin technology that meet the compute performance thresholds in a further October 17, 2023, controls²⁰, there will also be a gray zone that will be monitored for chips that could still be used for military aims even if they might not meet the thresholds for trade limitations. One of the new rules, for

¹⁸ Bureau of Industry and Security, Department of Commerce, "Implementation of Additional Export Controls: Certain Advanced Computing and Semiconductor Manufacturing Items; Supercomputer and Semiconductor End Use; Entity List Modification", Federal Register / Vol. 87, No. 197, October 13, 2022.

¹⁹ Bureau of Industry and Security, U.S. Department of Commerce, 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.

²⁰ Bureau of Industry and Security, U.S. Department of Commerce, Press Release: "Commerce Strengthens Restrictions on Advanced Computing Semiconductors, Semiconductor Manufacturing Equipment, and Supercomputing Items to Countries of Concern", October 17, 2023.

example, prevents the workaround of simply purchasing a larger number of smaller datacenter AI chips which, if combined, would be equally powerful as restricted chips.

The new rules are expected to impact Santa Clara, California-based Nvidia, a major supplier of chips and computing systems for artificial intelligence (AI). Nvidia had previously been allowed to ship slower lines of AI chips to China and the restrictions were supposed to be introduced 30 days from October 17, 2023. In a statement to the U.S. Securities and Exchange Commission (SEC) dated October 24, 2023, however, Nvidia said the curbs were "effective immediately". The new licensing requirement covers integrated circuits exceeding certain performance thresholds (including but not limited to Nvidia's A100, A800, H100, H800, L40, L40S, and RTX 4090 AI chips), any system that incorporates one or more of the covered integrated circuits (including but not limited to NVIDIA DGX and HGX systems), and includes future NVIDIA integrated circuits, boards, or systems classified with Export Control Classification Numbers (ECCN) 3A090 or 4A090, achieving certain total processing performance and/or performance density.²¹

In addition, chip exports to companies headquartered in Macao or the other 21 other countries for which the U.S.A. maintains an arms embargo can be restricted to prevent countries of concern from circumventing the controls and providing chips to China. Similarly, controls are imposed on additional types of semiconductor manufacturing equipment, and license requirements for semiconductor manufacturing equipment will apply to additional countries beyond China and Macau, to anywhere under a U.S. arms embargo.

According to BIS, there are over 600 Chinese entities on its Entity List for activities contrary to U.S. national security and foreign policy interests, and specifically for acquiring and attempting to acquire U.S.-origin items in support of China's military modernization efforts.²² The final rule of October 17, 2023, adds 13 entities, determined by the U.S. Government to be acting contrary to the national security or foreign policy interests of the United States, to the Entity List under the destination of China. Among the entities added to the U.S. trade blacklist are two Chinese start-ups – Moore Threads Technology Co and

²¹ Nvidia Corporation, U.S. Securities and Exchange Commission (SEC) filing dated October 24, 2023.

²² The Entity List compiled by the U.S. Department of Commerce's Bureau of Industry and Security can be found at <https://www.bis.doc.gov/index.php/policy-guidance/lists-of-parties-of-concern/entity-list>

Biren Intelligent Technology – which are founded by former Nvidia employees in China and aim to compete with the US AI chip giant.²³

Trade Initiatives and Alliances

While the guardrails will encourage leading firms, such as TSMC, Intel, Micron, Samsung, and SK Hynix to expand capacity in the United States rather than China, the CHIPS Act was also accompanied by trade policy initiatives and partnerships enlisting allies to deny advanced chips and chip-making machinery to China and Russia. Key initiatives by the Biden administration include the ‘Chip 4’ (or ‘Fab 4’) alliance, the US-EU Trade and Technology Council (TTC), the U.S.A.-Japan-Netherlands Alliance, and partnerships with Vietnam and India.

- **‘Chip 4’ Alliance**

The CHIPS Act of itself will not offer the U.S.A. a complete supply chain. Supporting America’s efforts to create a more secure and resilient global semiconductor supply chain is the ‘Chip 4’ alliance comprising Taiwan, Japan and South Korea. Proposed by U.S. President Biden in March 2022, each country in the alliance plays a unique and critical role in the supply chain: The United States dominates advanced chip design, Japan supplies essential materials and equipment, and both South Korea and Taiwan are major players in semiconductor manufacturing.²⁴

On February 16, 2023, the Chips 4 Alliance held a videoconference where Taiwan proposed for the countries to exchange information on different parts of the supply chain in order to have an “early warning and mutual reminder” system to ensure a stable supply chain for chip manufacturers.²⁵ Taiwan and South Korea are to focus on manufacturing, Japan on materials, and the U.S. on its role as a major market. However, the group did not discuss export controls, and no company was present at the meeting.²⁶

²³ Bureau of Industry and Security, U.S. Department of Commerce, “Entity List Additions”, Federal Register, October 19, 2023.

²⁴ Arjun Gargeyas, “The Chip 4 Alliance Might Work on Paper, But Problems Will Persist”, The Diplomat, August 25, 2022.

²⁵ Central News Agency, ‘Fab 4’ discuss supply chain early warning system’, February 25, 2023.

²⁶ Pablo E. Carrillo, Ludmilla L. Kasulke, Camilo Daza Manga, Rong Qin of Squire Patton Boggs (US) LLP, Chips Chatter: February 22-March 3, 2023, National Law Review, March 6, 2023.

- **US-EU Trade and Technology Council**

Founded in June 2021 by Presidents Biden of the U.S.A., Ursula von der Leyen of the European Commission, and Charles Michel of the European Council, the US-EU Trade and Technology Council (TTC), aims to secure critical technology supply chains, strengthen technological and industrial leadership, and “encourage compatible standards and regulations based on shared democratic values.”²⁷ At the fourth Ministerial meeting of the TTC on May 31, 2023, they discussed the impact of non-market economic policies on the global supply of semiconductors, particularly in legacy chips. It was agreed that the United States and the European Union, in cooperation with like-minded partners, will exchange information and market intelligence related to non-market policies and practices and explore cooperative measures to address those policies and their distortionary effects.²⁸

- **U.S.A.-Japan-Netherlands Alliance**

U.S. partnerships with like-minded partners and its allies are essential in tackling the China challenge and the wider ramifications of the regulations in the tech sector against China. In January 2023, the Netherlands and Japan reached a deal with the U.S.A. aimed at cutting off China from the most advanced chips that could be used in sophisticated weaponry and machines.²⁹

In July 2023, Japan officially banned the sale of 23 types of semiconductor equipment to China. Japan’s restrictions are far more extensive than the U.S.A.’s, hindering China’s production of advanced chips as well as basic chips used in technologies such as cars and smartphones.³⁰

On September 1, 2023, the Netherlands Standing Committee on Foreign Trade and Development Cooperation announced it is set to begin curbing its semiconductor technology exports to China. This new regulation would

²⁷ European Commission, EU-US Trade and Technology Council, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/stronger-europe-world/eu-us-trade-and-technology-council_en

²⁸ The White House, Press release: “U.S.-EU Joint Statement of the Trade and Technology Council”, May 31, 2023.

²⁹ Leo Lewis and Kana Inagaki, “Japan to restrict semiconductor equipment exports as China chip war intensifies”, Financial Times, March 31, 2023.

³⁰ Si Ma, “Japan’s chip-equipment export curbs slammed”, China Daily, May 24, 2023.

prevent the Dutch ASML from exporting advanced chip manufacturing technologies without obtaining government-approved licenses beforehand.³¹

Additionally, after the tightened U.S. rules on October 17, 2023, ASML can still ship its less advanced NXT:1980Di machine to Chinese facilities that make older chips, but it is not allowed to sell to fabs that produce semiconductors near the cutting edge. This export rule has been imposed after China's Semiconductor Manufacturing International Corp (SMIC) reportedly used ASML's DUV lithography and its own N+2 processing technology to make 7nm chips for Huawei.³²

The new measures will limit the ability of Chinese companies to make the most advanced types of semiconductors. The Netherlands and Japan hold the only three companies that supply the world with deep ultraviolet (DUV) lithography systems – the only chip making equipment that China can use since the Netherlands already banned the sale of extreme ultraviolet (EUV) lithography systems to China in 2019. The coordinated restrictions, if enforced effectively, could spell the end of the supply of chip manufacturing equipment to China.

- **Partnership with India**

On January 31, 2023, India and the United States announced the joint initiative on Critical and Emerging Technology (iCET), which committed the two countries to expand strategic technology partnerships and defense industrial cooperation between their nations' businesses, academic institutions, and government agencies. An initial assessment by the Semiconductor Industry Association (SIA) and the India Electronics Semiconductor Association (IESA) that is authored by the Information Technology and Innovation Foundation (ITIF) finds that India brings significant strengths, and both sides are looking at near-term industry opportunities and ways to facilitate the longer-term

³¹ Ting-Fang Cheng and Lauly Li, "Netherlands' chip tool export controls take effect: 4 things to know", Nikkei Asia, August 31, 2023.

³² Cagan Koc and Diederik Baazil, "Controversial chip in Huawei phone produced on ASML machine", American Journal of Transportation, October 25, 2023.

Additionally, Micron announced a US\$ 40 billion investment in memory chip manufacturing, which alone will bring the U.S. market share of memory chip production from less than 2% to up to 10% over the next decade.³⁷

Qualcomm and GlobalFoundries also announced a new partnership that includes US\$ 4.2 billion to manufacture chips in an expansion of GlobalFoundries' upstate New York facility. Qualcomm, the leading fabless semiconductor company in the world, announced plans to increase semiconductor production in the U.S.A. by up to 50 % over the next five years.³⁸

Investments

The DOC has received more than 460 statements of interest from companies for projects across 42 states interested in receiving CHIPS funding to invest across the semiconductor value chain from manufacturing to supply chains to commercial R&D.³⁹ According to a senior DOC official, President Biden's 'Investing in America' agenda has already attracted more than US\$ 231 billion in new announcements of private investment in semiconductor manufacturing and supply chains.⁴⁰

Research and Development

- **National Semiconductor Technology Center**

The Department of Commerce is partnering with the Department of Defense, the Department of Energy, and the National Science Foundation to establish the National Semiconductor Technology Center (NSTC), a critical part of the CHIPS research and development program that will support U.S. leadership in semiconductor innovation, cut down on the time and cost of

³⁷ Micron, Press release: "Micron Announces \$40 Billion Investment in Leading-Edge Memory Manufacturing in the US", August 9, 2022.

³⁸ The White House, Fact Sheet: "CHIPS and Science Act Will Lower Costs, Create Jobs, Strengthen Supply Chains, and Counter China", August 9, 2022.

³⁹ The White House, Fact Sheet: "One Year after the CHIPS and Science Act, Biden-Harris Administration Marks Historic Progress in Bringing Semiconductor Supply Chains Home, Supporting Innovation, and Protecting National Security", August 9, 2023.

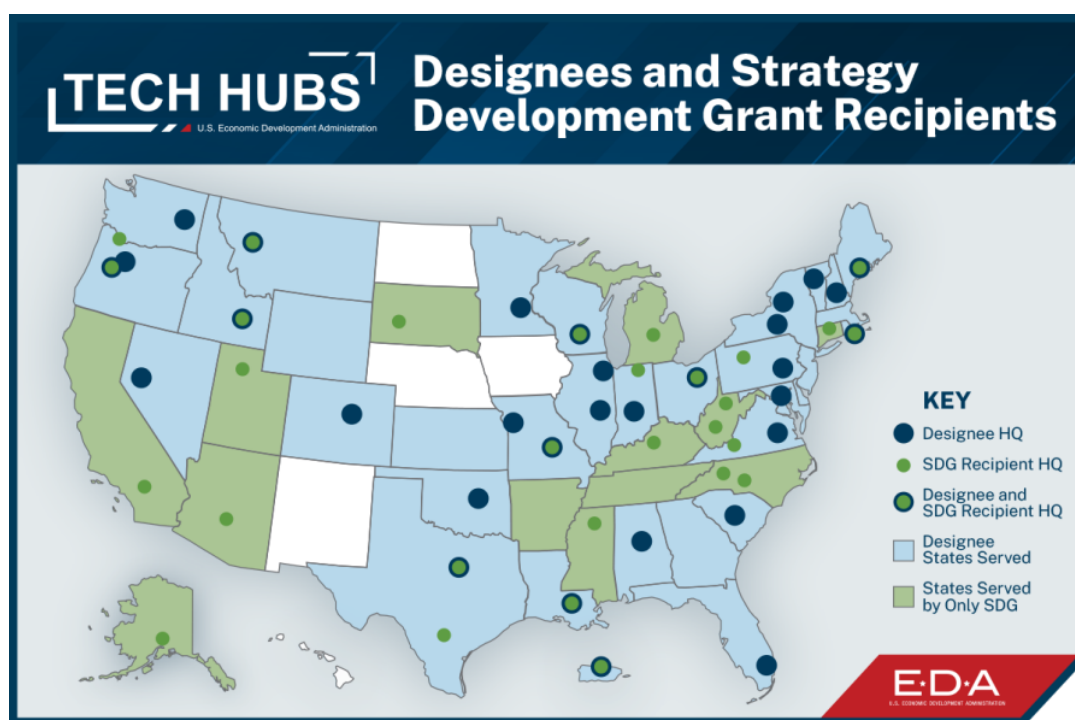
⁴⁰ U.S. Department of State, FPC Briefing: "Update from the CHIPS Program Office on Funding Opportunities", September 29, 2023.

commercializing new technologies, and develop the semiconductor workforce.⁴¹

- Regional Technology and Innovation Hubs (Tech Hubs)

On October 23, 2023, President Biden announced the designation of 31 Tech Hubs, as well as recipients of 29 Tech Hubs Strategy Development Grants under phase one of the Regional Technology and Innovation Hubs (Tech Hubs) program (see Figure 3). Scattered across 32 states and Puerto Rico, the program encompasses a broad spectrum of technological arenas including semiconductors, clean energy, biotechnology, and quantum computing, among others.⁴²

Figure 3: Tech Hubs Designees and Strategy Development Grant Recipients



Source: U.S. Economic Development Administration, Regional Technology and Innovation Hubs (Tech Hubs)

⁴¹ The White House, Fact Sheet: “One Year after the CHIPS and Science Act, Biden-Harris Administration Marks Historic Progress in Bringing Semiconductor Supply Chains Home, Supporting Innovation, and Protecting National Security”, August 9, 2023.

⁴² The White House, Fact Sheet: “Biden-Harris Administration Announces 31 Regional Tech Hubs to Spur American Innovation, Strengthen Manufacturing, and Create Good-Paying Jobs in Every Region of the Country”, October 23, 2023.

In Phase 2 of the Tech Hubs program, the 31 hubs will have the opportunity to compete for the US\$ 500 million of implementation funding administered by the Economic Development Administration (EDA).

The Tech Hubs Program will invest directly in regions with the assets, resources, capacity, and potential to transform into globally competitive innovation centers in approximately 10 years, and help create jobs for American workers at all skill levels, equitably and inclusively.⁴³

Workforce

At least 50 community colleges have already announced new or expanded semiconductor workforce programs. In July, the White House launched the first of its five Workforce Hubs, in Columbus, Ohio, where Columbus State Community College announced a new partnership with Intel which will create a new semiconductor technician credentialing course.

The National Science Foundation is also investing in the American semiconductor workforce through new initiatives focused on the manufacturing workforce, supporting researchers, and curriculum development. This includes partnerships with major semiconductor and technology companies.⁴⁴

CHINA

The unravelling competition in semiconductors between the U.S.A. and China is likely to impact the world for two key reasons. First, chips have become integral to various aspects of everyday life and the global economy. Second, the rivalry involves the world's two largest economies and their allies and partners, all of whom are likely to feel the effect given the technological and commercial interdependencies. Notably, the semiconductor industry ecosystems in both countries will experience immediate impacts.

⁴³ U.S. Economic Development Administration, Department of Commerce, "Regional Technology and Innovation Hubs (Tech Hubs)" <https://www.eda.gov/funding/programs/regional-technology-and-innovation-hubs>

⁴⁴ Ibid.

The CHIPS Act restrictions are not only applied to all companies within China, but are also applied across jurisdictions. It does not just enforce the ban over exports coming out of the U.S.A., but also over any company in the world looking to sell these advanced chips, as well as the equipment, software or blueprints needed to produce the chips, if they contain U.S. technology.

The restrictions attempt to constrain Beijing's emerging technology development in two ways. First, they limit China's access to advanced semiconductors necessary for data-intensive artificial intelligence (AI) models, supercomputers and hypersonic missiles. Second, the measures curtail China's ability to create these cutting-edge chips by preventing China from using U.S.-built semiconductor design and manufacturing equipment, including the electronic design automation (EDA) software required to design advanced semiconductors. As the world's largest importer of chips and chipmaking equipment, the CHIPS Act restrictions deal China a major blow.

Not surprisingly, China is responding in kind, imposing export and investment restrictions on U.S. companies. This is on top of the ongoing rivalry that has also fueled a subsidy race as both countries seek to shore up to their respective capabilities in semiconductors.

WTO Dispute Complaint

On December 15, 2022, China issued a lawsuit within the World Trade Organization against the U.S.A.'s semiconductor export controls against them that were levied on October 7, 2022. China claims that measures at issue are inconsistent with multiple provisions of the WTO's General Agreement on Tariffs and Trade 1994, the Agreement on Trade-Related Investment Measures, the Agreement on Trade-Related Intellectual Property Rights, and the General Agreement on Trade in Services.⁴⁵

Micron Chip Ban

On May 21, 2023, China banned the use of American Micron's chips in critical infrastructure projects, which Beijing said posed network security risks

⁴⁵ World Trade Organization, "China initiates WTO dispute complaint targeting US semiconductor chip measures", December 15, 2022.

that could affect "national security". China began an investigation into Micron in late March, five months after the US unveiled sweeping curbs aimed at cutting off Beijing's access to high-end chips, chipmaking equipment and software used to design semiconductors.⁴⁶

Restrictions on Exports of Gallium and Germanium

In the aftermath of an announcement by the Netherlands that it would support the United States' chip controls with its own equipment curbs, China imposed restrictions on exports of gallium and germanium, two rare metals used in semiconductor manufacturing, citing national security in August 2023. Germanium is used in critical applications such as thermal imaging cameras, solar panels, and fiber optics for telecommunications while gallium is crucial for manufacturing the gallium arsenide chemical compound, which can make radio frequency chips for mobile phones and satellite communication. Exporters of gallium and germanium will need to get a license to ship the metals out of China. China produces about 98% of the world's gallium, and controls 68% of global refined germanium production in various countries, mainly in southeast Asia, according to the U.S. Geological Survey. So far, China's controls appear to have had little impact. Even if Chinese gallium and germanium supplies suffer a bottleneck, analysts suggest that other sources of the metals may be able to ramp up production to compensate.⁴⁷

Huawei Mate 60 Pro

Despite ongoing U.S. sanctions, Huawei subtly introduced a new 5G-capable smartphone, the Mate 60 Pro in September 2023. Industry observers were surprised that the phone's 5G processor was manufactured by China's domestic company Semiconductor Manufacturing International Corporation (SMIC). This component exceeded the expectations of many experts regarding the company's production capabilities and sent U.S. lawmakers scurrying to try to understand if SMIC had violated U.S. sanctions to make the chip.

US Commerce Secretary Gina Raimondo was quoted as saying that reports of a chip breakthrough by Huawei Technologies Co. are "incredibly

⁴⁶ David Lawder, "US 'won't tolerate' China's ban on Micron chips, commerce secretary says," Reuters, May 28, 2023.

⁴⁷ Rahul Rao, "No Signs Yet of Gallium or Germanium Shortage", IEEE Spectrum, October 10, 2023.

disturbing” and emphasized that her department needs more ways to enforce its export-control regime.⁴⁸ Although Raimondo said during House testimony in September that she sees no evidence China can develop advanced 7-nanometer chips at scale, she still faced intense political pressure from Republicans in Congress to tighten controls. The additional refinements to the U.S. CHIPS controls on October 7 and 17, 2023, are thus seen as a response to close the loophole in curbs on advanced chips (see Annex for more details).

Graphite Restrictions

On October 20, 2023, China’s Ministry of Commerce and the General Administration of Customs jointly announced that as of December 1, 2023, Chinese exporters will be required to apply for permits to ship two types of the material, namely, “artificial graphite materials and related products with high purity (purity>99.9%), high strength (flexural strength>30Mpa) and high density (density>1.73g/cubic centimeter)”, as well as “natural flake graphite and its products, including spheroidized graphite and expanded graphite”.⁴⁹

China is the world's top graphite producer and exporter while the U.S.A. heavily relies on imports. Besides the U.S.A., Korea, Japan, and India are also major importers of Chinese graphite. As the Chinese government’s export control of graphite follows at the heels of the U.S. government’s decision to widen its restrictions on Chinese companies' access to semiconductors, many see the Chinese graphite restrictions as a retaliatory action, albeit aimed at the electric vehicle (EV) battery manufacturing this time.

Although China is the current top graphite producer, it is not the sole option for obtaining a sufficient supply. According to the United States Geological Survey, Turkey (27.3%) and Brazil (22.4%) account for half of the world’s natural graphite resources, while China is third, with 16%. Moreover, the new Chinese restrictions are set to incentivize anode manufacturers outside of China to seek alternative sources for raw materials. In the case of the U.S.A., Canada and Mexico are set to continue ramping up their own

⁴⁸ Mackenzie Hawkins and Jamie Tarabay, “Raimondo Says Huawei Chip Shows Need for ‘Different Tools’”, Bloomberg, October 5, 2023.

⁴⁹ The State Council Information Office, The People’s Republic of China, “China announces export control on certain graphite materials, products”, October 20, 2023.

domestic capacity to satisfy its demand.⁵⁰ South Korea, another major importer of Chinese graphite, also said that it is prepared to look for alternative sources of graphite if China’s newly strengthened export controls on the key material used in electric-vehicle batteries cause a severe shortage.⁵¹

IMPLICATIONS

Given both China and the U.S.A.’s global importance, many countries will inevitably be impacted. Re-shoring and ring-fencing of some critical manufacturing will be unavoidable. In February 2022 the European Commission proposed its own Chips Act, promising to mobilize over EU€ 43 billion (US\$ 45.78 billion) to double the EU’s share of semiconductor production (rising from the current figure of 10% to 20%).⁵²

Businesses, including multinationals that have adopted “in-China-for-China” business models, where components are manufactured in China for its domestic market, will need to adjust to a world of increasingly fragmented and localized value chains. Sweeping U.S. regulations announced in October last year cast uncertainty over foreign chipmakers in China, including TSMC, Samsung and SK Hynix. All three firms secured one-year waivers at the time, which allowed them to import vital equipment, but were able to secure permanent authorization in October this year to continue operating their chip manufacturing facilities in China.⁵³

Certain strategic value chains, too, may restructure and diversify out of China. One example is Micron, which has testing and packaging facilities in China. It has already started construction on a US\$ 2.75 billion assembly and test facility in India.⁵⁴

Additionally, as U.S. export controls against China’s advanced chip sector forces it to refocus on older chip technologies, contract chip suppliers or

⁵⁰ Emily Benson and Thibault Denamiel, “China’s New Graphite Restrictions”, Center for Strategic and International Studies, October 23, 2023.

⁵¹ Sam Kim, “Korea to Seek Alternative Graphite Source if Shortage Hits”, Bloomberg, October 20, 2023.

⁵² Enrique Feás, “The US-China technology war and its effects on Europe”, Elcano Royal Institute, February 28, 2023.

⁵³ Lisa Wang, “US extends a waiver for TSMC’s gear in China”, Taipei Times, October 14, 2023.

⁵⁴ Katie Tarasov, “How Micron is building the biggest chip fab in U.S. history despite a China ban and smartphone slump”, CNBC, October 23, 2023.

foundries focusing on supplying mature technologies in other countries are likely to be hit. According to Taiwan media reports, Taiwan's contract chip suppliers such as United Microelectronics Corp (UMC), Vanguard International Semiconductor Corp and Powerchip Semiconductor Manufacturing Corp, are seeing a constant drop in prices for chips made using mature technology nodes as their customers, mostly chip designers, are calling for price cuts after their Chinese competitors slashed prices to clear inventory and vie for a larger portion of orders. Some analysts have said that chip prices have plummeted about 50% over the past two years.⁵⁵

Overall, the unilateral enforcement of restrictions in the U.S. CHIPS Act to preserve its technological and innovation leadership and protect its national security have the effect of strengthening China's determination to innovate, achieve self-reliance in chips, and wean itself off of foreign semiconductor firms. For businesses, it is particularly important for the U.S.A. and China to provide an environment where they can invest in a predictable manner, but the tit-for-tat responses by the U.S. and China will affect future relations with and investments in China by U.S. and foreign semiconductor companies. As both countries compete for global technological and economic leadership, various countries are watching the dynamics closely to see how the situation plays out, while at the same time framing and adjusting their own response to the opportunities and challenges that arise.

⁵⁵ Taipei Times, Editorial: "Surviving the Chinese chip drive", September 19, 2023.

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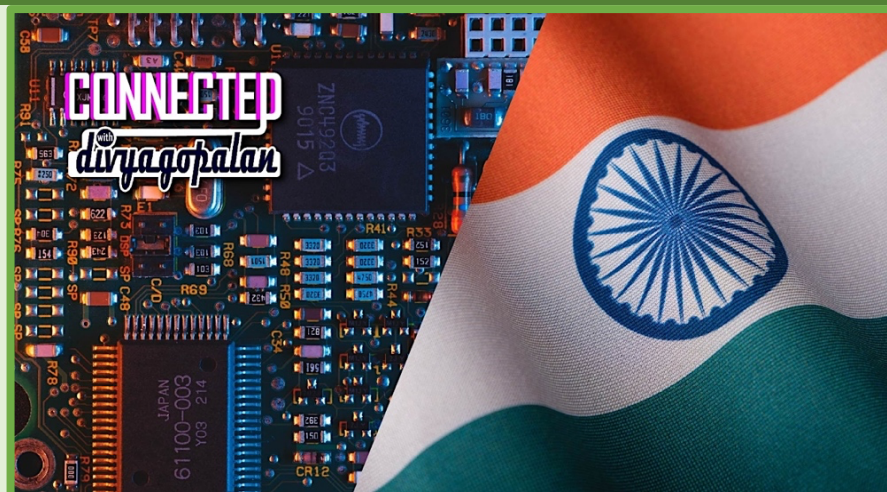


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Semiconductors are the new gold and Taiwan currently dominates 90% of the world's most advanced microchips. That leaves others like India scrambling for Taiwan's supply while trying to kick-start production at home. Is India up to the task and will its newfound friendship with Taiwan help achieve this goal? In this episode, we hear from Vrinda Kapoor, a tech entrepreneur at the forefront of India's semiconductor mission.

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With over three decades as a financial journalist, Owen Lin brings a deep understanding of Taiwan's semiconductor industry. His latest work "Chip Island" not only contains riveting insights from past interviews but also provides astute analysis of global trends, underscoring the pivotal role TSMC is poised to play on the world stage. Our guests: Owen Lin, Author of "Chip Island" and former deputy editor-in-chief of Business Today

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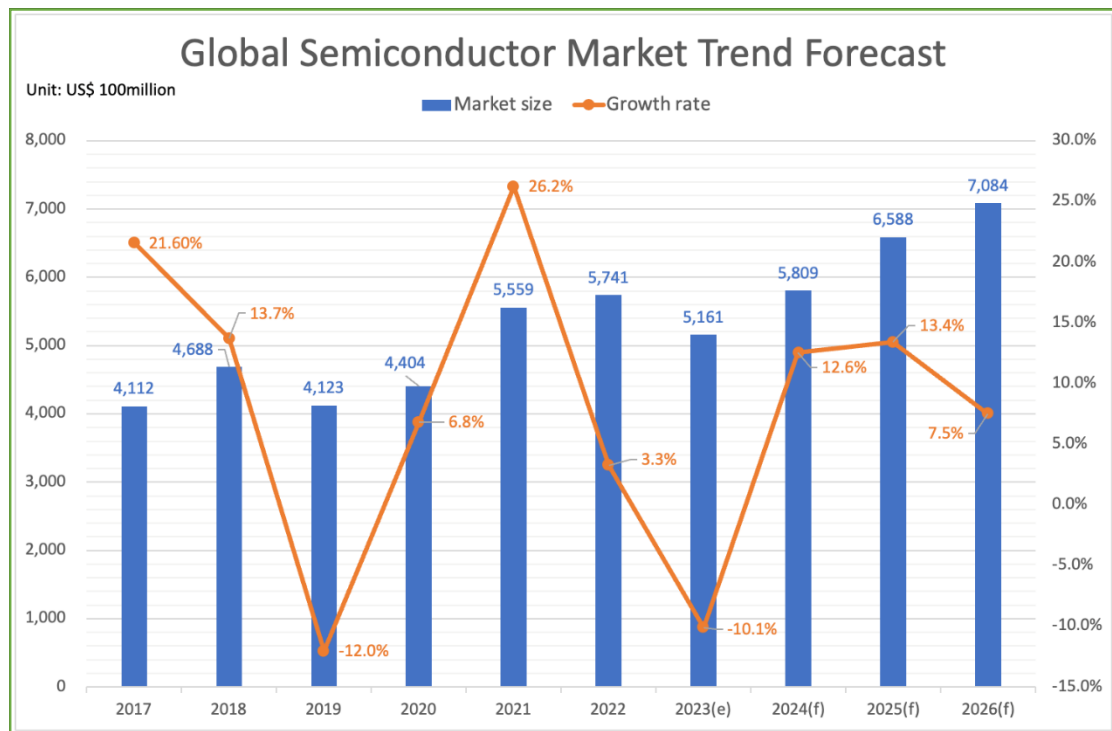


China's new restrictions on the export of two rare minerals critical for semiconductor manufacturing, gallium and germanium, will go into effect in August. It's the latest salvo in escalating trade tensions between the U.S. and China. On this episode of Zoom In Zoom Out, TaiwanPlus speaks to Jason Hsu, visiting fellow at Yale University's Paul Tsai China Center. We discuss the implications for the global chip industry and where Taiwan fits into the larger picture.

SEMICONDUCTOR STATISTICS AT A GLANCE

GLOBAL TRENDS

Figure 4: Global Semiconductor Market Trend Forecast: 2017-2026



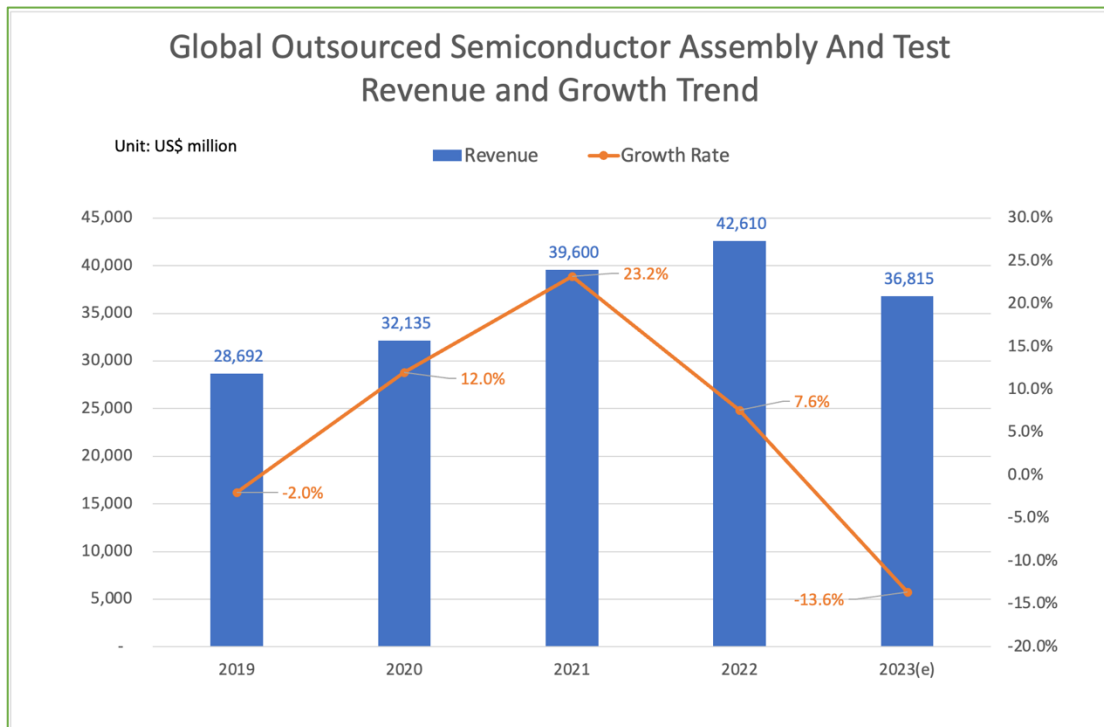
Note: According to the forecast of the WSTS released in July 2023.

Source: Paul Jiang, "Global Economy and Semiconductor Market Trends in the Second Quarter of 2023," IEK, ITRI. September 18, 2023, p. 9.

After observing a modest growth of 3.3% in the year 2022, the global semiconductor market is projected to reach US\$ 516.1 billion in 2023, indicating a decrease of 10.1%. The WSTS has adjusted its growth projections downwards in response to increasing inflation and weakening demand in end markets, particularly those relying on consumer spending.

Looking ahead to 2024, a robust recovery of the global semiconductor market is anticipated. The global semiconductor market is forecasted to surge by 12.6%, amounting to US\$580.9 billion. This upward trend is expected to continue in 2025 and 2026 as the global semiconductor market is projected to reach US\$ 658.8 billion and US\$ 708.4 billion respectively (see Figure 4).

Figure 5: Global Outsourced Semiconductor Assembly And Test (OSAT) Revenue and Growth Trend: 2019-2023



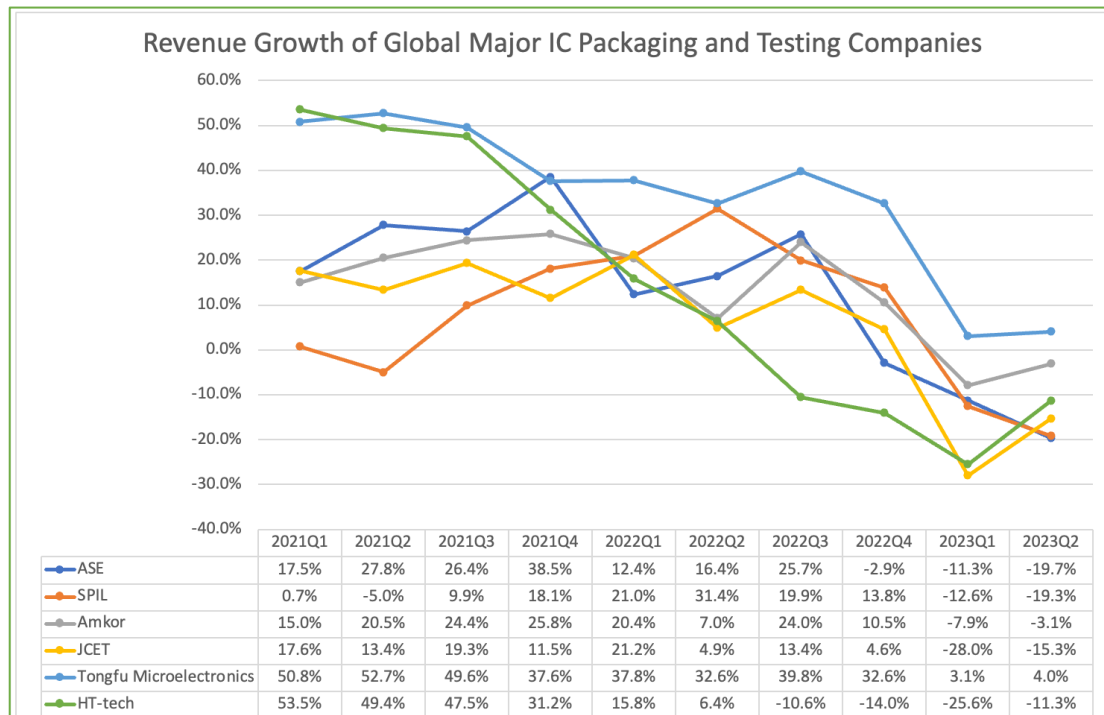
Source: Yunnice Chang, "Current Situation and Prospects of IC Packaging and Testing Industry in Worldwide in the Second Quarter of 2023," IEK, ITRI, October 2, 2023, p. 1.

In 2021, the global outsourced semiconductor assembly and testing (OSAT) industry faced unprecedented challenges due to the COVID-19 pandemic. COVID-19 lockdowns and disruptions to the global semiconductor supply chain resulted in a shortage of semiconductor packaging and testing production capacity, driving up prices. As a result, the OSAT market size was valued at US\$ 39.6 billion in 2021, with the annual growth rate reaching a peak of 23.2%.

Although 2022 saw the easing of the global semiconductor supply chain disruptions, end-user demand fell due to inflationary pressures. The annual rate of growth slowed to 7.6%, with a corresponding output value of US\$ 42.6 billion.

2023 sees the fading of the pandemic dividend. Global inflation continues to put a squeeze on consumer spending. It is estimated that the global IC packaging and testing industry's output value will decline to US\$ 36.8 billion in 2023. This represents a decline of 13.6%, a steep fall compared to the annual growth rate seen in the past few years (see Figure 5).

Figure 6: Revenue Growth of Global Major IC Packaging and Testing Companies: 2021Q1 to 2023Q2



Source: Yunnice Chang, "Current Situation and Prospects of IC Packaging and Testing Industry in Worldwide in the Second Quarter of 2023," IEK, ITRI, October 2, 2023, p. 3.

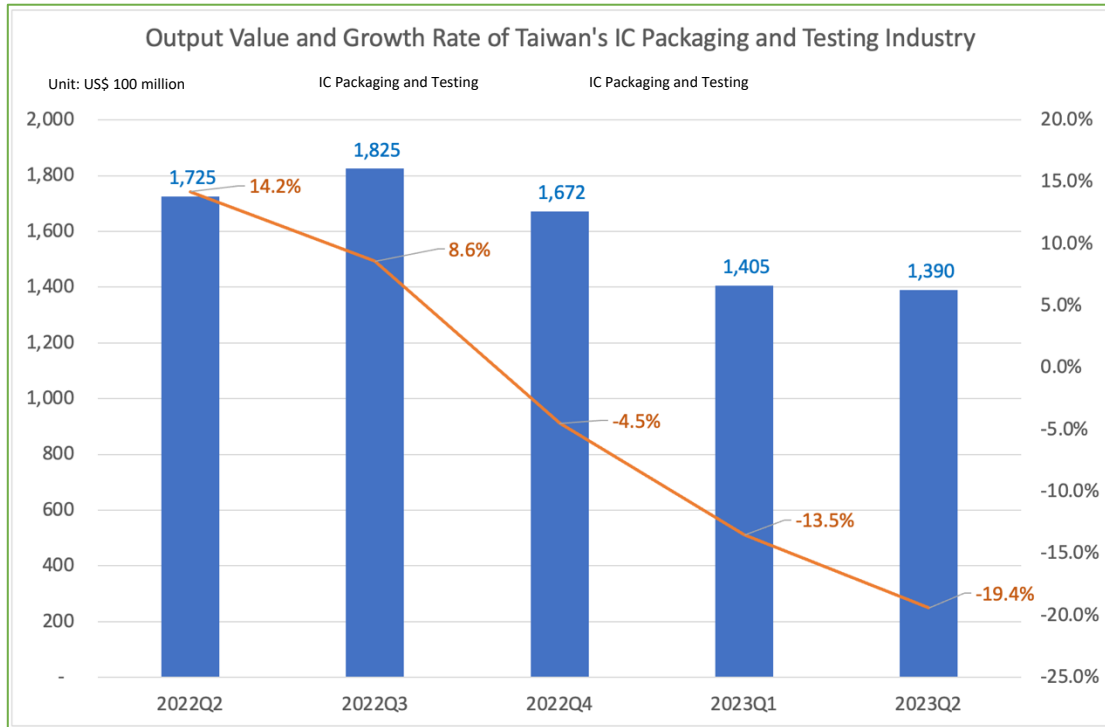
Figure 6 shows the revenue growth momentum of global benchmark packaging and testing manufacturers from the first quarter of 2021 to the second quarter of 2023.

ASE and SPIL are the leaders of Taiwan's IC packaging and testing industry, accounting for about 54% share of the global packaging and testing foundry market. The U.S.A., where Amkor is a dominant player in the IC packaging and testing industry, accounts for about 16% share of the global packaging and testing foundry market.

China's top three packaging and testing factories, namely, JCET, Tongfu Microelectronics and HT-tech have squeezed into the ranks of the world's top ten in terms of market share since 2016. China's packaging and testing foundries account for about 23% share of the global market.

TAIWAN TRENDS

Figure 7: Output Value and Growth Rate of Taiwan's IC Packaging and Testing Industry: 2022Q2 to 2023Q2



Source: Yunnin Chang, "Current Situation and Prospects of IC Packaging and Testing Industry in Taiwan in the Second Quarter of 2023," IEK, ITRI, September 27, 2023, pp. 1-2.

Figure 7 shows the overall output value and growth rate of Taiwan's IC packaging and testing industry from the second quarter of 2022 to the second quarter of 2023. In the second quarter of 2022, the growth rate of Taiwan's IC packaging and testing industry stood at a high of 14.2%. This can be attributed to the continued demand for high-end applications such as 5G, artificial intelligence (AI), and automotive electronics has brought strong impetus to the chip market.

As the overall economic situation gradually slowed down in the second half of 2022, the annual growth rate of Taiwan's IC packaging and testing industry shrank to 8.6% in the third quarter and to negative territory thereafter. Although the output value increased from NT\$ 172.5 billion (US\$ 5.3 billion) in the second quarter to a peak of NT\$ 182.5 billion (US\$ 5.69 billion) in the third quarter of 2022, the annual growth rate shrank in the same quarter.

From the third quarter of 2022 to the second quarter of 2023, both the output value and growth rate continue to fall as buying sentiment did not improve, resulting in a further slowdown in the growth of the semiconductor market. Taiwan's IC packaging and testing industry saw an annual growth rate of -13.5% in the first quarter and -19.4% in the second quarter of 2023.

Table 1: Output Value and Growth Rate of Taiwan's IC Packaging and Testing Industry: 2022Q2 to 2023Q2

Unit: NTD 100 million

	2022Q2	2022Q3	2022Q4	2023Q1	2023Q2
	Output Value				
IC Packaging	1,150	1,270	1,140	940	927
IC Testing	575	555	532	465	463
IC Packaging and Testing	1,725	1,825	1,672	1,405	1,390
	Annual Growth Rate				
IC Packaging	12.7%	10.4%	-5.0%	-14.5%	-19.4%
IC Testing	17.3%	4.7%	-3.3%	-11.4%	-19.5%
IC Packaging and Testing	14.2%	8.6%	-4.5%	-13.5%	-19.4%

Source: Yunnice Chang, "Current Situation and Prospects of IC Packaging and Testing Industry in Taiwan in the Second Quarter of 2023," IEK, ITRI, September 27, 2023, pp. 1-2.

Table 1 shows the output and growth statistics of Taiwan's sub-industries of the IC packaging and testing industry from the second quarter of 2022 to the second quarter of 2023.

The output value of the IC packaging industry saw its peak at NT\$ 127 billion (US\$ 3.9 billion) in the third quarter of 2022, with an annual growth rate of 12.7% in the second quarter of 2022 and a lower annual growth rate of 10.4% in the third quarter of 2022. Its output value fell to NT\$ 114 billion (US\$ 3.53 billion) in the fourth quarter of 2022 and has been falling thereafter.

The output value of the IC testing industry reached a high of NT\$ 57.5 billion (US\$ 1.78 billion) in the second quarter of 2022, with an annual growth rate of 17.3%. It dipped to NT\$ 55.5 billion (US\$ 1.72 billion) in the third quarter of 2022, registering a lower annual growth rate of 4.7%.

Overall, the IC packaging and testing industry saw its output value reach a high of NT\$ 182.5 billion (US\$ 5.66 billion) in the third quarter of 2022. However, the industry's output value has been falling since, and it registered negative annual growth rate from the fourth quarter of 2022 onwards.

make high-end semiconductors rather than mid-end ones.⁵⁹ Meanwhile, U.S., Dutch, and Japanese companies and other western nations continue to ship less advanced tools to China, in addition to key chemicals, gases and chip packaging equipment.⁶⁰

U.S. Commerce Secretary Gina Raimondo said during a House hearing that the U.S.A. has no evidence China can make advanced 7 nm chips “at scale.”⁶¹ There are also experts who downplay Huawei's breakthrough and share Secretary Raimondo’s doubt that Huawei can produce advanced chips at large scale. According to Ray Yang, a consulting director of Taiwan's Industrial Technology Research Institute (ITRI), Taiwan Semiconductor Manufacturing Company (TSMC), the world's leading chipmaker, holds various patents in mass production while "SMIC lags far behind in this area."⁶²

Other than the Kirin 9000s 7 nm processor discovery, TechInsights also revealed that while most of Mate 60 Pro’s parts were sourced domestically, there were with two SK Hynix chips – a DRAM and a NAND chip. According to Guan Quan, a professor at the School of Economics of Renmin University of China, if Huawei can no longer use SK Hynix chips in its new mobile phones in the future, it will need some time to find new suppliers.⁶³

⁵⁹ Toby Sterling, “Another ASML tool hit by US export curbs, China at 46% of sales”, Reuters, October 18, 2023.

⁶⁰ Chris Miller, “What the most ‘Chinese’ smartphone yet tells us about politics”, Financial Times, September 21, 2023.

⁶¹ Mackenzie Hawkins, “No Evidence That China Can Make Advanced Chips ‘at Scale,’ US Says”, Bloomberg, September 19, 2023.

⁶² Yuchen Li, “US-China tech war: Is Huawei's new chip a threat?”, DW, September 25, 2023.

⁶³ Jeff Pao, “Korean chips deflate Huawei phone’s purity bubble”, Asia Times, September 12, 2023.