

**TAIWAN SEMICONDUCTOR
MANUFACTURING COMPANY:
A CRITICAL CHIP IN THE
COMPETITION FOR
GLOBAL POWER**

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Executive Summary

1. Taiwan Semiconductor Manufacturing Company (TSMC) is the pioneer in the “pure-play foundry” business and the world’s most important semiconductor chip manufacturer. It captures over half of the global market share in contract chipmaking and over 90% of global advanced chip production.
2. Semiconductor chips are important for current and future technologies. Given its crucial role in global industrial development, semiconductor chips are now called “a new oil”.
3. TSMC started chip fabrication in the 1980s through technology transfer from the United States. The company gradually expanded its business thanks to the continuously improving technology and its unique business model that offers customised chipmaking for branded companies.
4. The greater trade and investment liberalisation over the past few decades has deepened the global division of labour in the semiconductor industry. The company invested most of its chip fabrication in Taiwan for its comparative advantage in manufacturing.
5. TSMC’s business growth has made the world’s and Taiwan’s economies heavily reliant on the company. TSMC took a lion’s share of Taiwan’s exports of integrated circuits (IC). IC accounts for 40% of Taiwan’s exports, much higher than Singapore’s 26%, Malaysia’s 26%, South Korea’s 19%, and China and Hong Kong’s 11%.
6. TSMC’s dominance in global chip production has highlighted Taiwan’s importance in the US-China power competition. It gives China more reason to seek unification with Taiwan to achieve a breakthrough in its semiconductor technology, a scenario the United States would not allow to happen.

7. The United States has restricted exports of high technology products to the country, including to Huawei. The loss of Huawei did not hamper TSMC's business growth in the last few years.
8. To avoid an over-reliance on TSMC and the growing military tension in the Taiwan Strait, "production efficiency" through the global division of labour in the semiconductor industry is de-emphasised today. Several countries have been encouraged to relocate chip production back home for "national security".
9. Given its small economic size, Taiwan is not able to engage in the competition for subsidising semiconductor companies' development. In the long run, these factors will restrain TSMC's expansion of production on the island.
10. TSMC's production efficiency, manufacturing strength and technological superiority are unlikely to be replaced anytime soon despite the growing competition. China's potential military invasion and the world's heavy reliance on "made in Taiwan" chips will continue to place the democratic island at the centre of the global political economy in the foreseeable future.

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CHIANG Min-Hua*

Dominance in the Global Foundry Business

- 1.1 The chip shortage¹ during the COVID pandemic has turned the spotlight on the world's most important chipmaker, Taiwan Semiconductor Manufacturing Company (TSMC). Several big car manufacturers, including Ford, Toyota and Volkswagen, requested TSMC's help through diplomatic channels, to increase chip supply to them.²
- 1.2 Founded in 1987,³ TSMC is the pioneer in the "pure-play foundry business", which focuses only on manufacturing customers' chips without involving in chip design.⁴ With its unique business model and improving technology, TSMC is now the global leading Integrated Circuit (IC) manufacturer with cutting-edge technology.
- 1.3 The robust global demand for chips has provided a conducive external environment for TSMC's sales growth over the last few decades. The global sales revenue of

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¹ "Chips", "semiconductor chips" and "IC" are used interchangeably in this brief.

² "U.S. thanks Taiwan for help resolving auto chip shortage in key trade meeting", *CNBC*, 5 February 2021, <<https://www.cnbc.com/2021/02/05/us-thanks-taiwan-for-help-resolving-auto-chip-shortage-in-key-trade-meeting.html>> (accessed 4 July 2022). Michael Nienaber, "Germany urges Taiwan to help ease auto chip shortage", *Reuters*, 24 January 2021, <<https://www.reuters.com/article/us-taiwan-autos-chips-idUSKBN29T04V>> (accessed 4 July 2022).

³ Taiwan started to develop its IC technology through technology transfer from Radio Corporation of America (RCA, a US electronic firm) to Industrial Technology Research Institute (ITRI) in the 1970s. TSMC was co-founded by Taiwan's government, Philip Electronics NV and other private investors. TSMC Annual Report, 1994, p. 5 <https://investor.tsmc.com/sites/ir/annual-report/1994/annual1994_0.pdf> (accessed 1 July 2022). Morris Chung, who had studied and worked in the United States for almost four decades, was recruited by the Taiwanese government and became the first Chief Executive Officer of TSMC.

⁴ Unlike Samsung and Intel which design and manufacture IC, TSMC's "pure foundry business" focuses on manufacturing IC. TSMC website, <<https://www.tsmc.com/english/dedicatedFoundry>> (accessed 2 July 2022).

semiconductor chips has skyrocketed more than 10 times, from US\$55 billion in 1991 to US\$556 billion in 2021.⁵

- 1.4 The IC's wide application in several industrial goods explains its strong global demand. The development of Information and Communication Technology (ICT) goods is the most important driver. In 2020, 61% of IC was used in computers and communication equipment, followed by consumer products (12%), industrial products (12%) and automotive parts (12%).⁶
- 1.5 TSMC's strength in making the most advanced chips allows it to become a key supplier for the most developed ICT products. In the first quarter of 2022, TSMC accounted for 70% of global chip production for making smartphones. Samsung accounted for another 30%.⁷
- 1.6 Taiwan's high-quality but affordable engineers helped TSMC develop its manufacturing strength. ⁸ The high fixed cost of building a foundry plant and high level of expertise required have prevented many competitors from entering the semiconductor market in the past few decades.
- 1.7 TSMC's global market share in the foundry business is expected to reach nearly 55% in 2022, far ahead of any semiconductor companies in South Korea, China and the United States. TSMC's large global market share also made Taiwan the most critical IC producer in the world, accounting for nearly 60% of global foundry revenue (Figure 1).

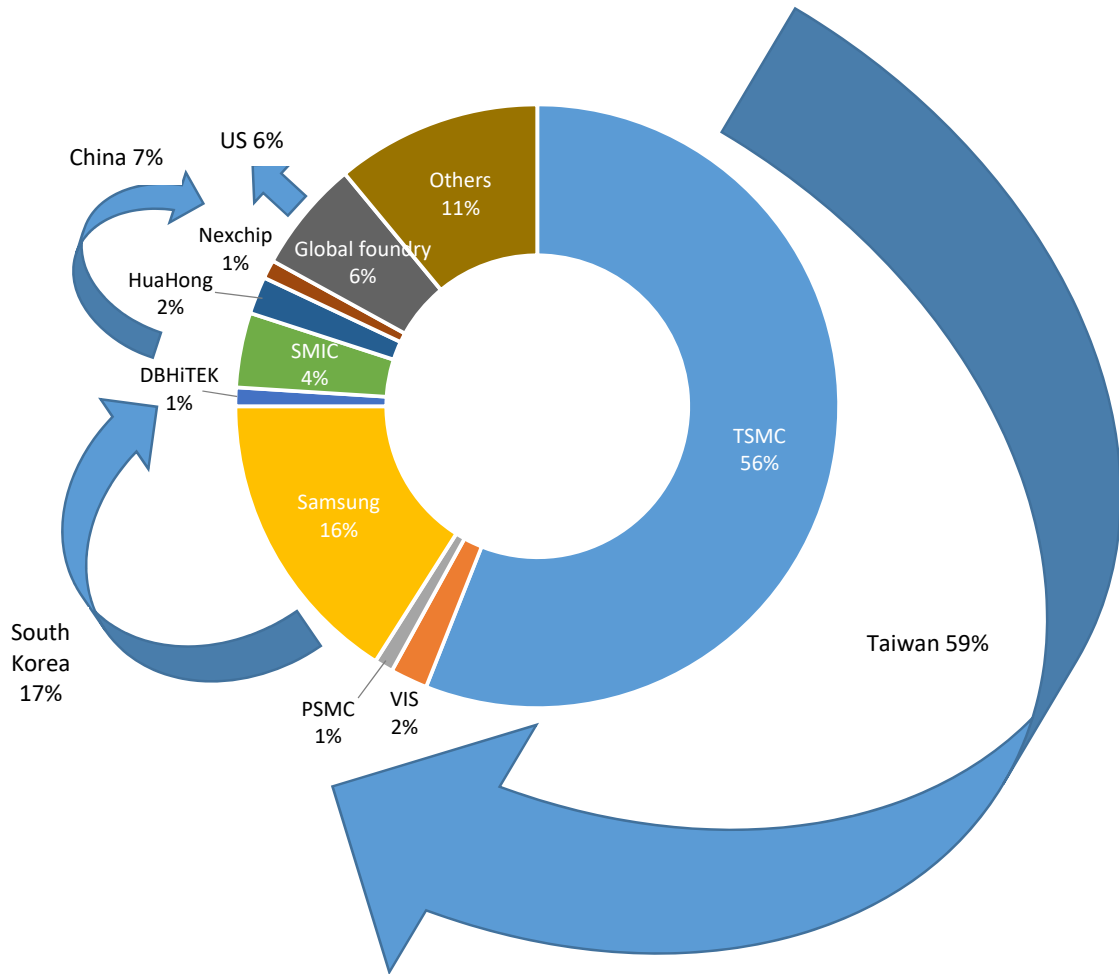
⁵ Data source: CEIC Data.

⁶ "2021 Factbook", Semiconductor Industry Association, <<https://www.semiconductors.org/wp-content/uploads/2021/05/2021-SIA-Factbook-FINAL1.pdf>> (accessed 28 April 2022).

⁷ Parv Sharma, "TSMC captures 70% share of the smartphone AP/SoC and base band shipments in Q1 2022", *Counterpoints*, 5 July 2022, <<https://www.counterpointresearch.com/tsmc-captures-70-share-smartphone-apsoc-baseband-shipments-q1-2022/>> (accessed 16 August 2022).

⁸ Engineering has been the most preferred course for most Taiwanese students. In 2018 for example, more than 40% of university students in Taiwan majored in engineering-related subjects. "Employment Affects Students choosing Major", <<https://hs.1111.com.tw/collegeWind.aspx>> (accessed 1 July 2022).

FIGURE 1 FOUNDRY REVENUE BY MARKET SHARE IN 2022



Source: "TSMC, Taiwan to increase foundry market share in 2022", 25 April 2022, <<https://www.eenewsanalog.com/en/tsmc-taiwan-to-increase-foundry-market-share-in-2022/>> (accessed 15 June 2022).

1.8 TSMC’s success has drawn Intel’s attention to join the chipmaking business. By building its new facility in Ohio, USA, Intel has pledged to become a leading chip manufacturer by 2025.⁹ Intel was previously a more well-known producer of microprocessors for use in mostly personal computers (PCs).¹⁰

⁹ Katie Schoolove, “How Intel plans to catch Samsung and TSMC and regain its dominance in the chip market”, *CNBC*, 6 November 2022 <<https://www.cnbc.com/2021/11/06/how-intel-plans-to-catch-up-to-samsung-and-tsmc-with-44-billion-of-new-global-chip-fabs.html>> (accessed 1 July 2022).

¹⁰ Matthew Gooding, “Can Anything Stop TSMC?”, *TechMonitor*, 1 February 2022 <<https://techmonitor.ai/technology/silicon/tsmc-problems-chip-semiconductor-intel>> (accessed July 1 2022).

- 1.9 Samsung is the most important competitor for TSMC so far. The company announced in June that it has begun to produce 3nm semiconductor chips before TSMC does in the latter half of the year. TSMC’s business is less likely to be affected as it takes time for Samsung to prove it has the same cost-efficiency level as TSMC’s most advanced N3 process before it can gain new orders.¹¹
- 1.10 Apart from commercial usage, TSMC’s chips are also widely used by the US Department of Defence (DOD) in its F-35 fighters and a wide range of “military-grade” devices. It is uncertain the extent of the US DOD’s reliance on TSMC for manufacturing chips. It is, however, an important reason for the US government to pressure TSMC to relocate chip production to the United States.¹²
- 1.11 TSMC is likely to remain a leading chipmaker in the next few years thanks to the strong global demand for chips, its large and solid customer base, and its technological superiority that will take other companies several years to catch up.
- 1.12 TSMC’s dominance in the global semiconductor industry has increased Taiwan’s visibility in the growing US-China geopolitical tension. Great power competition in the near future could centre around the control of Taiwan, an island that possesses 90% of TSMC’s manufacturing capacity.¹³

Globalisation Reinforced TSMC’s Manufacturing Muscle

- 2.1 Greater trade and investment liberalisation in the past few decades has facilitated the circulation of chips between countries. Taiwan’s comparative advantage in manufacturing has helped bolster TSMC’s production capacity in the development of the global division of labour.

¹¹ Sohee Kim, “Samsung Is First to Start Mass Production of 3-Nanometer Chips”, Bloomberg, 29 June 2022 <<https://www.bloomberg.com/news/articles/2022-06-30/samsung-is-first-to-start-mass-production-of-3nm-chips>> (accessed 1 July 2022).

¹² Sujai Shivakumar and Charles Wessner, “Semiconductor and National Defense: What Are the Stakes?”, Centre for Strategic and International Studies, 8 June 2022, <<https://www.csis.org/analysis/semiconductors-and-national-defense-what-are-stakes>> (accessed 19 August 2022).

¹³ “Ministry of Economic Affairs: 90% of TSMC’s advanced manufacturing production is in Taiwan”, *Central News Agency*, 22 April 2021, <<https://www.cna.com.tw/news/afe/202104220366.aspx>> (accessed 22 July 2022, in Chinese).

- 2.2 The division of labour in the semiconductor industry across different countries started with American semiconductor firms' relocation of production to developing countries in Asia in the 1960s. US companies exported unfinished IC to their counterparts in Asia for final assembly and packaging.¹⁴
- 2.3 The US-Japanese Semiconductor Trade Agreement in 1986 was critical for enticing Japanese firms to invest in the United States. The 1992 European programme encouraged both American and Japanese firms to expand their business presence in Europe.¹⁵
- 2.4 China's economic opening has attracted global investors' attention. In addition to China's cheap labour cost, the Chinese government's policy of directing FDI towards high-technology and capital-intensive sectors have also encouraged the relocation of chip production to the country since the 1990s.
- 2.5 The conclusion of the International Technology Agreement (ITA) under the World Trade Organisation (WTO) in 1996 brought semiconductor-related tariffs close to zero in many countries, including Taiwan. There are currently 74 participants in ITA, representing 97% of world trade in information technology (IT) products.¹⁶
- 2.6 Under ITA 2, the signatories agreed to eliminate more tariffs on 201 information technology products not included in the original 1996 ITA by January 2024.¹⁷
- 2.7 Decades of investment relocation have entrenched geographical shifts of global semiconductor chip production to Asia, a region with a comparative advantage in

¹⁴ David B Yoffie, "Foreign Direct Investment", in Kenneth A Froot (ed.), *Foreign Direct Investment*, University of Chicago Press, 1993, p. 204.

¹⁵ Yoffie, *op.cit.*, "Foreign Direct Investment", 1993, pp. 197-230.

¹⁶ The WTO's Information Technology Agreement (ITA), World Trade Organisation, <https://www.wto.org/english/news_e/brief_ita_e.htm>, (accessed 6 August 2022).

¹⁷ Michaela D Platzer, John F Sargent Jr And Karen M Sutter, "Semiconductors: U.S. Industrial, Global Competition and Federal Policy", CRS Report, 26 October 2020 <https://crsreports.congress.gov/product/pdf/R/R46581> (accessed 2 May 2022).

manufacturing production. Today nearly 80% of semiconductor foundries and assembly and test operations are concentrated in Asia,¹⁸ particularly in China.¹⁹

- 2.8 Chinese semiconductor firms only accounted for 6% of total IC sold inside China.²⁰ Chips made by Chinese companies only accounted for less than 7% of global semiconductor chip sales.
- 2.9 TSMC opened its first wafer production factory in the Washington state of the United States in 1998. It built up an 8-inch fab in Shanghai in 2004 and 12-inch Gigafabs in Nanjing in 2016 to provide chips to customers in China. The overall overseas investment only accounted for 10% of TSMC's total production. Most of TSMC's chip production, especially the one with cutting-edge technology, remains in Taiwan.
- 2.10 As such, Taiwan dominates cutting-edge logic production (below 10nm),²¹ accounting for 92% of the global market share in 2019.²² By comparison, the United States accounted for a greater share (43%) in 10-22 nm logic production. The logic production in China was mostly at a lower level of technology intensity (between 28 and 45 nm and >45nm) (Figure 2).
- 2.11 Taiwan's strength in manufacturing chips is evidenced by its enormous trade surplus in IC (Figure 3). In comparison, China has the largest trade deficit in IC. Being a

¹⁸ "2020 State of the US Semiconductor Industry", Semiconductor Industry Association, <https://www.semiconductors.org/wp-content/uploads/2020/07/2020-SIA-State-of-the-Industry-Report-FINAL-1.pdf> (accessed 28 April 2022).

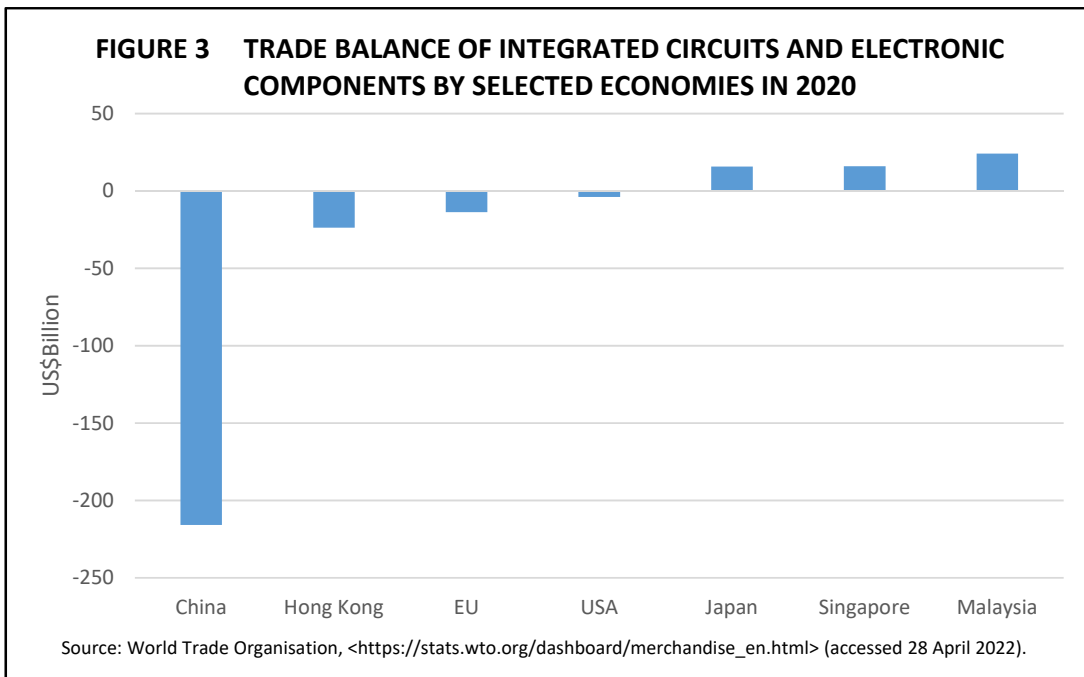
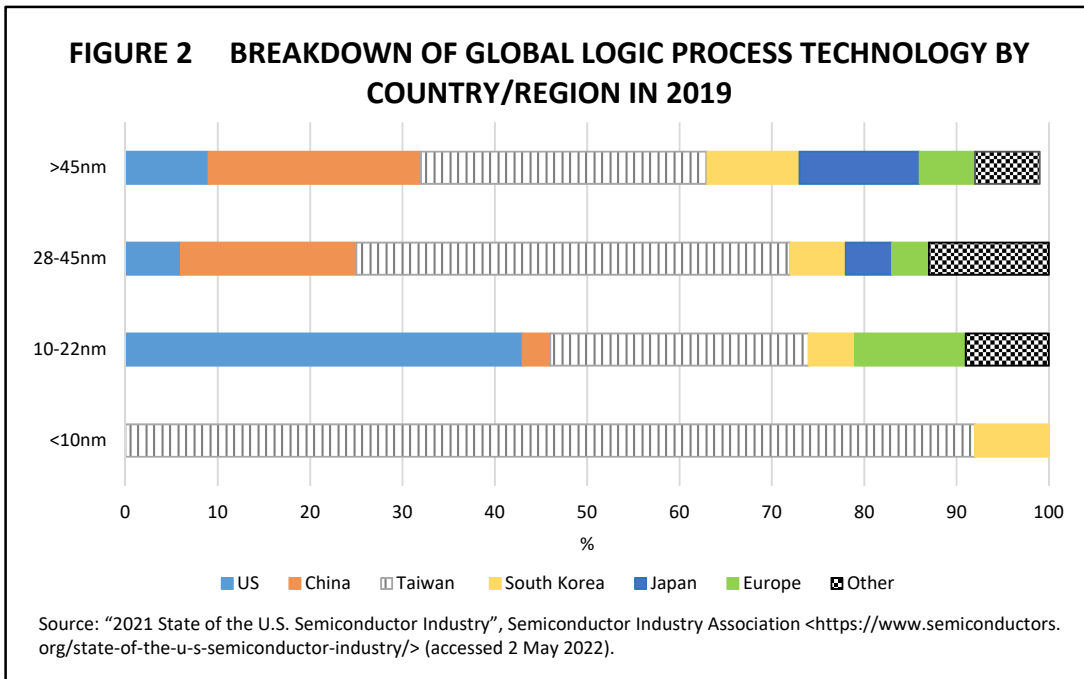
¹⁹ "China's semiconductor ambitions take a hit after Huawei's HiSilicon drops out of Global Top 25 Chip Vendor Rankings", Yahoo News, 15 April 2022, <https://www.yahoo.com/video/chinas-semiconductor-ambitions-hit-huaweis-093000508.html?guccounter=1> (accessed 2 May 2022).

²⁰ Wei Sheng, "China made 6% of chips it used in 2020: report", Technode, 19 February 2021 <https://technode.com/2021/02/19/china-made-6-of-chips-it-used-in-2020-report/> (accessed 2 May 2022).

²¹ Nanometres (NM) are the size of the transistor gate length. One nanometre is a billionth of a metre. the smaller the nanometre, the more advanced the technology. Michaela D Platzter, John F Sargent Jr and Karen M Sutter, "Semiconductors: U.S. Industry, Global Competition and Federal Policy", CRS Report, 26 October 2020 <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://crsreports.congress.gov/product/pdf/R/R46581> (accessed 21 June 2022).

²² 2021 State of the US Semiconductor Industry, Semiconductor Industry Association, <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.semiconductors.org/wp-content/uploads/2021/09/2021-SIA-State-of-the-Industry-Report.pdf> (accessed 21 June 2022).

global factory for assembling ICT goods, China has a strong demand for advanced chips, especially from Taiwan and South Korea.



2.12 China has been making efforts to advance its level of technology by forcing technology transfer from foreign firms, acquiring technology through Chinese

investment in the United States, cyber espionage,²³ theft,²⁴ or hiring skilled workers from Taiwan with huge remuneration.²⁵ It has however failed following several semiconductor companies' bankruptcies in recent years.²⁶

Unique Role in the Global Semiconductor's Eco System

- 3.1 In general, semiconductor production can be divided into three stages, including design, manufacturing (including manufacturing wafers and making semiconductors on the substrate wafer), packaging and testing.
- 3.2 The semiconductor industry was dominated by several companies in the United States and Japan before the 1990s. US trade restrictions against Japanese chips in the 1980s and Japanese semiconductor companies' failure to adapt to the more specialised chip production model have resulted in their declining semiconductor business.²⁷ Japanese semiconductor companies' business failure has provided conditions for Taiwanese and South Korean firms to emerge.
- 3.3 By outsourcing chip manufacturing to foundry companies (such as Samsung and TSMC), the semiconductor companies in the United States do not need to build their

²³ In order to access the Chinese market, foreign firms have to acquiesce to Chinese firms' joint venture requirements such as transferring technology to their Chinese counterparts. Sean O'Connor, "How Chinese companies facilitates technology transfer from the United States", US-China Economic and Security Review Commission, Staff Research Report, 6 May 2019, <<https://www.uscc.gov/sites/default/files/Research/How%20Chinese%20Companies%20Facilitate%20Tech%20Transfer%20from%20the%20US.pdf>> (accessed 20 August 2022).

²⁴ Gina Keating, "California jury finds SMIC stole trade secrets", Reuters, 3 November 2009, <<https://www.reuters.com/article/us-smic-lawsuit-idUSTRE5A26CA20091103>> (accessed 29 July 2022); Paul Alcorn, "China's SMIC shipping 7nm chips, reportedly copied TSMC's tech", Tom's Hardware, 21 July 2022, <<https://www.tomshardware.com/news/china-chipmaker-smics-7nm-process-is-reportedly-copied-from-tsmc-tech>> (accessed 29 July 2022).

²⁵ Ibid.

²⁶ Yoko Kubota, "Two Chinese startups tried to catch up to makers of advanced computer chips and failed", *The Wall Street Journal*, 10 January 2022, <<https://www.wsj.com/articles/two-chinese-startups-tried-to-catch-up-to-makers-of-advanced-computer-chipsand-failed-11641724382>> (accessed 16 August 2022); Peng Qinjin, Zhang Erchi and Manyun Zou, "Tsinghua Unigroup submits debt restructuring plan to court", *Nikkei Asia*, 15 December 2021, <<https://asia.nikkei.com/Spotlight/Caixin/Tsinghua-Unigroup-submits-debt-restructuring-plan-to-court>> (accessed 16 August 2022).

²⁷ Hideki Uno, "Japan's semiconductor industrial policy from the 1970s to today", Centre for Strategic and International Studies, September 2022, <<https://www.csis.org/blogs/perspectives-innovation/japans-semiconductor-industrial-policy-1970s-today>> (accessed 21 September 2022).

own expansive foundry plants. Instead, they were able to focus on designing chips and conducting R&D activities, the so-called fabless model (such as Broadcom and Qualcomm) (Table 1).

- 3.4 Apart from the United States, Japan and the Netherlands are also important semiconductor equipment suppliers in the world (Table 1). Japan is particularly dominant in supplying materials for making semiconductor chips.²⁸
- 3.5 Unlike TSMC, some semiconductor companies do not specialise in a single stage of the production process but are involved in the whole semiconductor value chain, from the initial design, manufacturing and sales, such as Intel and Samsung,²⁹ the so-called integrated device manufacturer (IDM) (Table 1).
- 3.6 Although TSMC's total revenue is less than Samsung's,³⁰ its market capitalisation (nearly US\$400 billion as of July 2022) is higher than Samsung's (US\$295 billion)³¹ and is the highest among companies in the global semiconductor industry.³² The bigger market capitalisation means the investors have greater confidence in the company's profit-earning prospect.
- 3.7 TSMC's level of technology is similar to Samsung's. However, unlike Samsung, TSMC does not compete with its customers (eg. Apple). The clear division of labour between TSMC and its customers helped to build mutual trust and contributed to their sustained partnership.

²⁸ Julian Ryall, "Japan strengthens hold on semiconductor raw materials amid global chip shortage", *South China Morning Post*, 28 September 2021, <<https://www.scmp.com/week-asia/politics/article/3150323/japan-strengthens-hold-semiconductor-raw-materials-amid-global>> (accessed 8 August 2022).

²⁹ Samsung is doing both foundry and IDM.

³⁰ "Top 20 semiconductor companies by revenue recorded healthy growth, says GlobalDATA", Global Data, 8 July 2021, <<https://www.globaldata.com/top-20-semiconductor-companies-revenue-recorded-healthy-growth-says-globaldata/>> (accessed 4 July 2022).

³¹ "Largest companies by market cap", <<https://companiesmarketcap.com/>> accessed 4 July 2022).

³² TSMC ranked as the world's 11th most valuable company and the most valuable in Asia in January 2022 according to S&P Global Market Intelligence data. "TSMC Overtakes Chinese Tech Giants to Become Asia's Most Valuable Stock", *The Wall Street Journal*, 25 January 2022, <<https://www.wsj.com/articles/tsmc-overtakes-chinese-tech-giants-to-become-asias-most-valuable-stock-11643105547>> (accessed 21 June 2022).

TABLE 1 GLOBAL SEMICONDUCTOR INDUSTRY’S ECO SYSTEM

	US		Europe		Asia	
	Company	Revenue (US\$ billion)	Company	Revenue (US\$ billion)	Company	Revenue (US\$ billion)
Chip design software	Synopsis	3				
	Cadence	2				
Equipment And materials	Applied Materials	15	ASML (the Netherlands)	13	Tokyo Electron (Japan)	10
	Lam Research	10			Shin-Etsu Chemical (Japan)	14
	KLA	5			Sumco (Japan)	3
Fabless	Broadcom	23	STMicro (Switzerland)	10	MediaTek (Taiwan)	8
	Qualcomm	20	Infineon (Germany)	9		
	Texas Instruments	14				
	Nvidia	11				
	AMD	7				
Foundry					Samsung Electronics CO. (South Korea)	56
					TSMC (Taiwan)	35
					UMC (Taiwan)	5
					SMIC (China)	3
IDM	Intel	72	NXP (the Netherlands)	9	Samsung Electronics CO. (South Korea)	56
	Micron Technology	20	ST Micro (Switzerland)	10	SK Hynix (South Korea)	23
			Infineon (Germany)	9		

Source: Alan Crawford, Jarrell Dillard, Helene Fouquet and Isabel Reynolds, “The World is Dangerously Dependent on Taiwan for Semiconductors”, Bloomberg, 25 January 2021, <<https://www.bloomberg.com/news/features/2021-01-25/the-world-is-dangerously-dependent-on-taiwan-for-semiconductors?sref=InMWfBxD>> (accessed 16 June 2022); Financial Information, MediaTek <<https://corp.mediatek.com/investor-relations/financial-information>> (accessed 16 June 2022); Monthly Sales Revenue, UMC <https://www.umc.com/en/IR_Financial/monthly_sales_revenue?param1=2019> (accessed 16 June 2022); MarketCap <<https://companiesmarketcap.com/shin-etsu-chemical/revenue/>> (accessed 8 August 2022).

Note: Revenue is in 2019.

3.8 In contrast, Samsung is competing with Apple for final consumption products (eg. smartphones and tablets), reducing Apple’s trust and willingness to outsource the production of the most critical chips to its business rival.

- 3.9 Through its “chipmaking only” business model, TSMC has won greater orders, especially from several big, branded companies. Producing chips for big, branded companies in large quantities also helped TSMC to reach a greater production scale.
- 3.10 In 2021, 44% of TSMC’s revenue came from selling chips to smartphone makers, followed by high-performance computing (37%), internet of things (8%), automotive (4%), digital consumer electronics (4%) and others (3%).³³ Apple alone contributed 26% of TSMC’s total revenue in 2020.³⁴
- 3.11 Personal connection is TSMC’s other advantage. AMD and Nvidia in the United States are TSMC’s second and third most important customers, accounting for 15% of TSMC’s sales revenue in 2020. The CEOs of AMD and Nvidia are both Taiwanese Americans.³⁵
- 3.12 Although most final assembly of the semiconductors occurs in China, no Chinese companies were on the list of top semiconductor companies by revenue due mainly to their inferior technology. For example, founded in 2000, China’s largest semiconductor foundry company-Semiconductor Manufacturing International Corporation (SMIC), is still several generations behind Samsung and TSMC.³⁶

Limited Impact from the US-China Geopolitical Confrontation

- 4.1 The rise of Chinese-branded ICT products (eg. Huawei and Xiaomi) increased China’s demand for advanced IC from TSMC. Hence, China’s share in TSMC’s

³³ *TSMC Quarterly Management Report*, 13 January 2022, <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://investor.tsmc.com/chinese/encrypt/files/encrypt_file/reports/2022-01/f7c72d6d88b224476ab812fc3ba28169ec091a86/4Q21ManagementReport.pdf> (accessed 21 June 2022).

³⁴ Alan Friedman, “New report explains why TSMC favors Apple; intel seeks to recapture process node leadership”, *Phone Arena*, 18 December 2021, <https://www.phonearena.com/news/apple-accounts-for-quarter-of-tsmc-top-line_id137277> (accessed 29 August 2022).

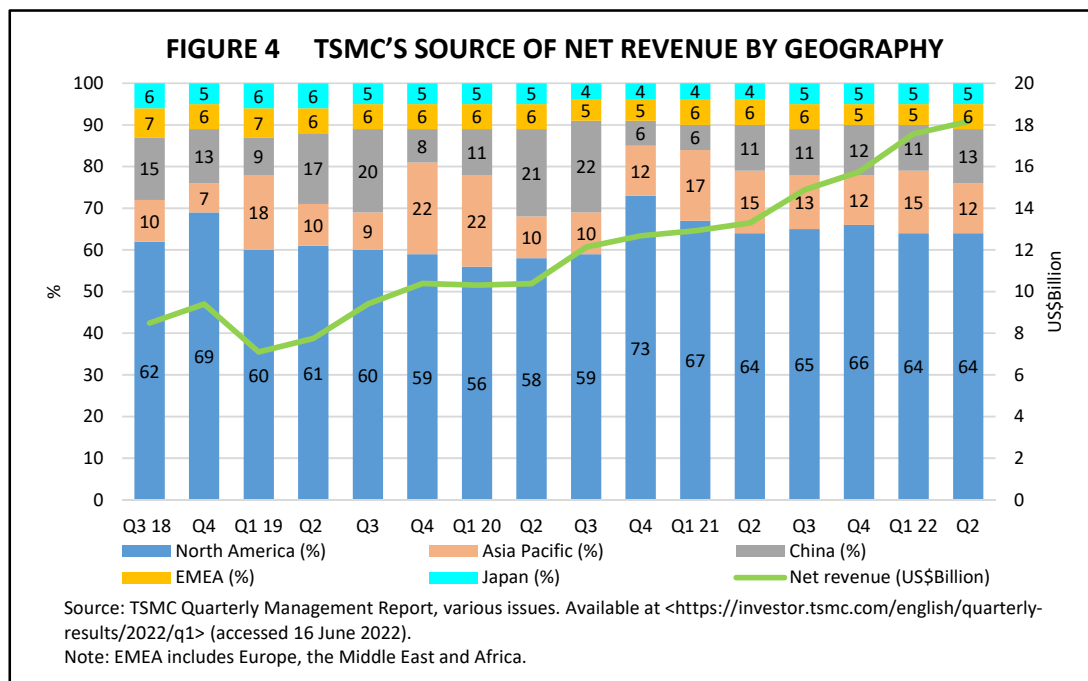
³⁵ “TSMC’s decision revealed the dilemma in global semiconductor industry”, *Common Wealth Magazine*, 17 April 2022, <<https://www.cw.com.tw/article/5120813>> (accessed 2 August 2022, in Chinese).

³⁶ Arjun Kharpal, “China’s Biggest Chipmaker SMIC Posts Record Revenue Despite U.S. Sanctions”, *CNBC*, 11 February 2022, <<https://www.cnb.com/2022/02/11/chinese-chipmaker-smic-posts-record-revenue-despite-us-sanctions.html#:~:text=SMIC%20is%20China's%20largest%20foundry,technology%20is%20several%20generations%20behind>> (accessed 29 April 2022).

revenue increased from merely 3% in 2010 to 17% in 2020. North America’s share declined from 68% to 62% during the same period.³⁷

4.2 When US-China tension escalated, TSMC was requested by the United States not to sell its advanced chips to Huawei. Huawei’s close relationship with the Chinese government was considered a threat to US national security as the Chinese government might acquire chips from TSMC through Huawei to advance its military development.

4.3 The US ban on TSMC’s sales to Huawei resulted in China’s declining shares in TSMC’s revenue from 22% in Q3 2020 to 13% in Q2 2022. However, TSMC’s total revenue has not been impacted and continued to grow over the last few years (Figure 4).



4.4 Unlike TSMC’s thriving business, Huawei’s falling revenue, due to the lack of chips from TSMC to assemble into its most advanced devices,³⁸ shows China’s

³⁷ Data source: TSMC Quarterly Management Report, various years.

³⁸ Evelyn Cheng, “Huawei’s first quarter revenue trembles by nearly 14% as smartphone sales plunge”, CNBC News, 28 April 2022, <<https://www.cnbc.com/2022/04/28/huaweis-first-quarter-revenue-tumbles-as-smartphone-sales-plunge.html>> (accessed 1 August 2022).

vulnerability in the global supply chain network. This refuted some of the conventional arguments about Taiwan's economic dependence on China. Indeed, like other countries, China relies on Taiwan's semiconductor chips for producing its high-technology products.

- 4.5 ZTE, the second largest telecommunication company in China, benefitted from Huawei's declining smartphone business. Although ZTE has not been banned by the United States from purchasing advanced chips, its small global market share (0.7% in 2021)³⁹ suggests limited chip demand for TSMC.
- 4.6 A few months after it prohibited the sale of chips to Huawei in 2020, the United States placed restrictions on sales to SMIC. Suppliers for certain equipment to SMIC were required to apply for an export licence.⁴⁰ The ban was further extended to the sale of Dutch-made chip manufacturing technology from ASML.⁴¹
- 4.7 In 2022, the United States has extended the export restriction to 14 nm chipmaking machines to SMIC and other foreign chipmakers in China.⁴² A specific electronic design automation (EDA) software for making an advanced chip is also banned from exporting to China.⁴³
- 4.8 TSMC could benefit from geopolitical tensions between China and the United States. Due to the US ban on chipmaking machine exports to China, it will take a

³⁹ Lauly Li And Cheng Ting-Fang, "China's ZTE boosts chip capabilities amid Huawei's crackdown woes", *Nikkei Asia*, 9 February 2022, <<https://asia.nikkei.com/Business/China-tech/China-s-ZTE-boosts-chip-capabilities-amid-Huawei-s-crackdown-woes>> (accessed 21 September 2022).

⁴⁰ Josh Horwitz, Karen Freifeld and Alexandra Alper, "The US stepped up its tech war against China, placing sanctions on its biggest chip", *Business Insider*, 28 September 2020 <<https://www.businessinsider.com/china-chipmaker-smic-us-sanctions-2020-9>> (accessed 6 August 2022).

⁴¹ Alexandra Alper, Toby Sterling and Stephen Nellis, "Trump administration pressed Dutch hard to cancel China chip-equipment sale: source", *Reuters*, 20 January 2020 <<https://www.reuters.com/article/us-asml-holding-usa-china-insight/trump-administration-pressed-dutch-hard-to-cancel-china-chip-equipment-sale-sources-idUSKBN1Z50HN>> (accessed 6 August 2022).

⁴² Debby Wu, Ian King and Jenny Leonard, "US quietly tightens grip on exports of chipmaking gear to China", *Bloomberg*, 29 July 2022, <<https://www.bloomberg.com/news/articles/2022-07-29/us-pushes-expansion-of-china-chip-ban-key-suppliers-say?sref=InMWfBxD>> (accessed 15 August 2022).

⁴³ "The US bars China from accessing advanced chipmaking EDA software", *Technode*, 15 August 2022 <<https://technode.com/2022/08/15/the-us-barrs-china-from-accessing-advanced-chipmaking-eda-software/>> (accessed August 2022).

much longer time for Chinese semiconductor firms (eg. SMIC) to catch up with TSMC's level of technology.

- 4.9 SMIC might be able to produce 7-nm with its existing technology, but without the use of EUV lithography, barred by the United States, the chips will be more costly to make and their quality will be questionable.⁴⁴
- 4.10 The most daunting challenge so far following the US-China geopolitical tension is probably TSMC's new business operation in the United States. TSMC was forced by the Trump administration to build a factory in Arizona, a site with higher labour cost.
- 4.11 TSMC has encountered tremendous difficulties in recruiting local engineers in the United States.⁴⁵ Unlike Intel, TSMC is not a globally well-known name that can appeal to young American talent.
- 4.12 The disruption of the supply chain network due to the prolonged pandemic crisis is another factor for the higher-than-expected production cost of building a new factory in the United States.⁴⁶ The inflation rate in the United States jumped by nearly 7% in June 2022 from one year prior.⁴⁷
- 4.13 In the face of an uncertain business environment, TSMC plans to invest more in Taiwan by expanding its production from Hsinchu Science Park (HSP) to the middle

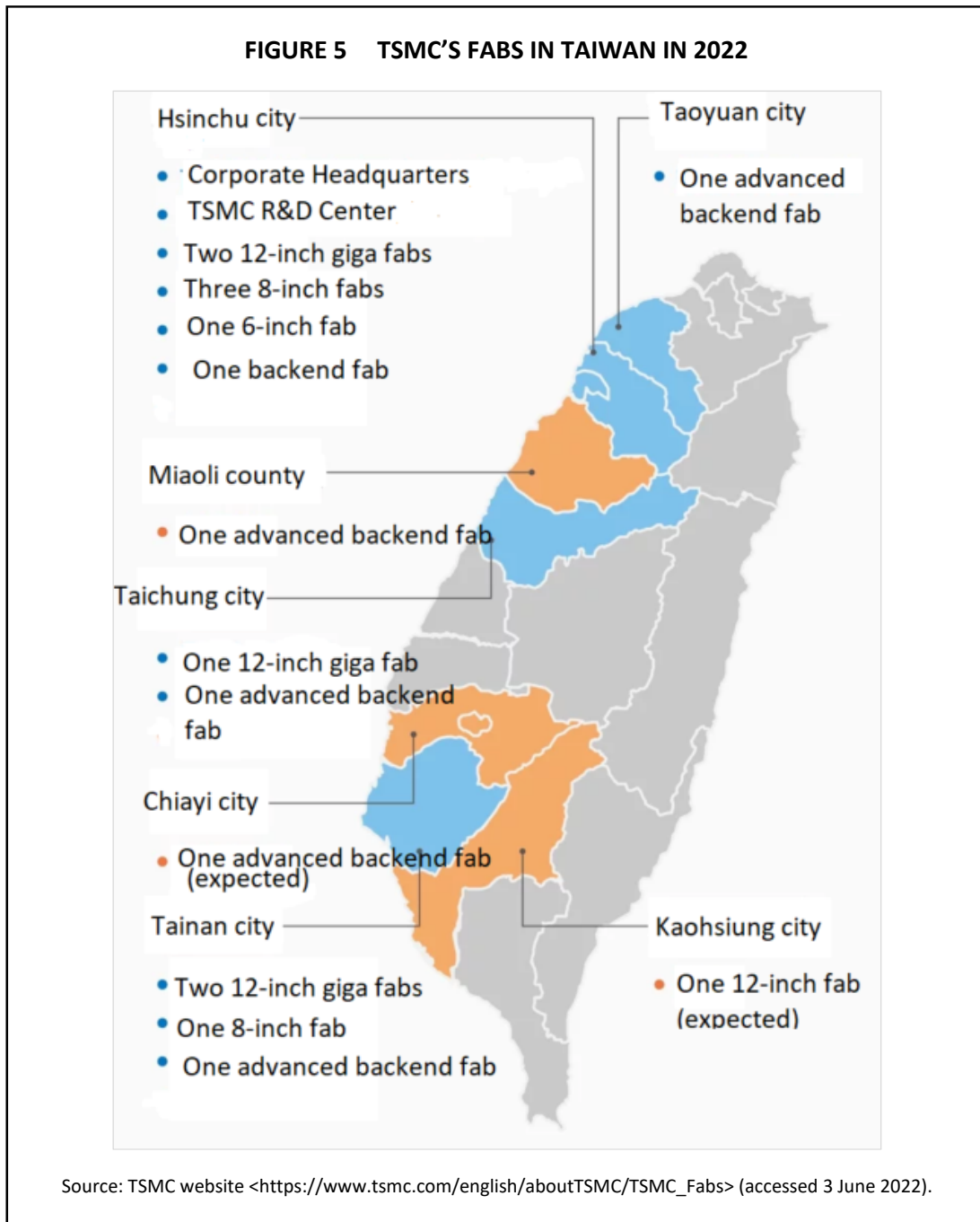
⁴⁴ "SMIC loses second senior executive", *Taipei Times*, 13 November 2021, <<https://www.taipetimes.com/News/biz/archives/2021/11/13/2003767776>> (accessed 8 August 2022).

⁴⁵ Yifan Yu, Cheng Ting-Fang and Lauly Li, "From somebody to nobody: TSMC faces uphill battle in US talent war", *Financial Times*, 5 June 2022, <<https://www.ft.com/content/a369987e-1113-45ed-98b1-3dbf01f457ec>> (accessed 22 July 2022).

⁴⁶ "US factory cost higher than expected: TSMC president said the cost is not the only consideration", *Economic Daily News*, 14 July 2022, <https://money.udn.com/money/story/12806/6461288?from=edn_previous_story> (accessed 22 July 2022, in Chinese).

⁴⁷ Christopher Rugaber, "Inflation and wages data suggests US prices will keep climbing", *Associated Press*, 29 July 2022, <<https://apnews.com/article/inflation-economy-consumer-spending-prices-1c912833f8e24c6ca151f0d5d89332f7>> (accessed 1 August 2022).

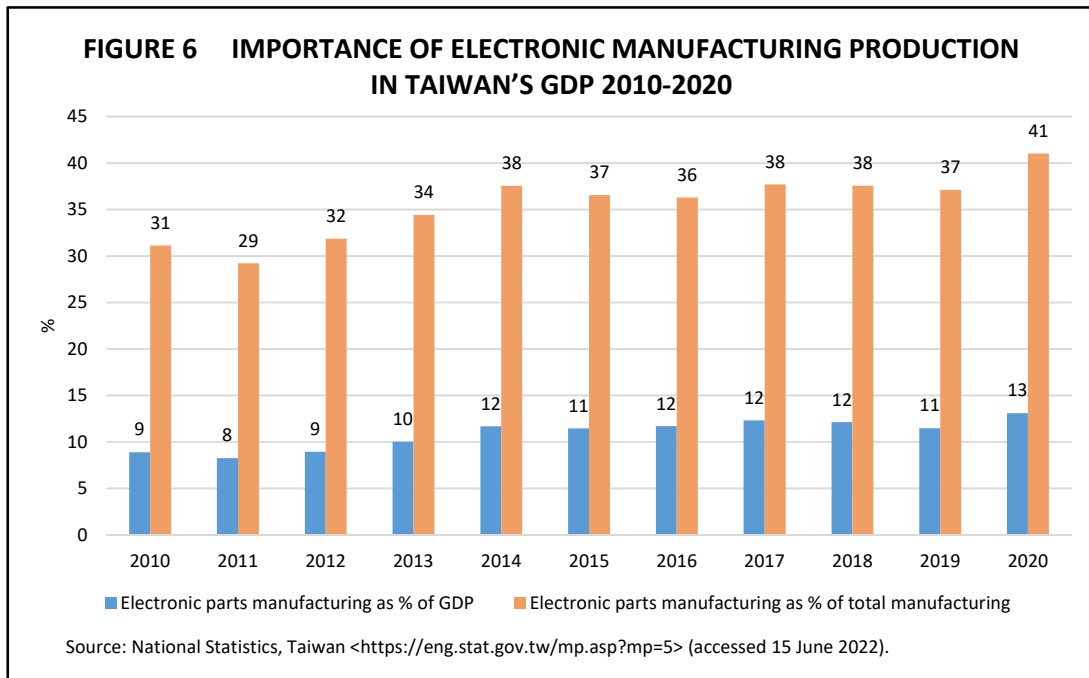
and southern parts of Taiwan (Figure 5). Its US\$120 billion investment in Taiwan is 10 times greater than its investment in Arizona (US\$12 billion).⁴⁸



⁴⁸ Atkinson, "TSMC invested US\$120 billion in Taiwan", *Tech News*, 15 June 2022, <<https://technews.tw/2022/06/15/tsmc-invests-120-billion-in-construction-in-taiwan/>> (accessed 23 July 2022, in Chinese).

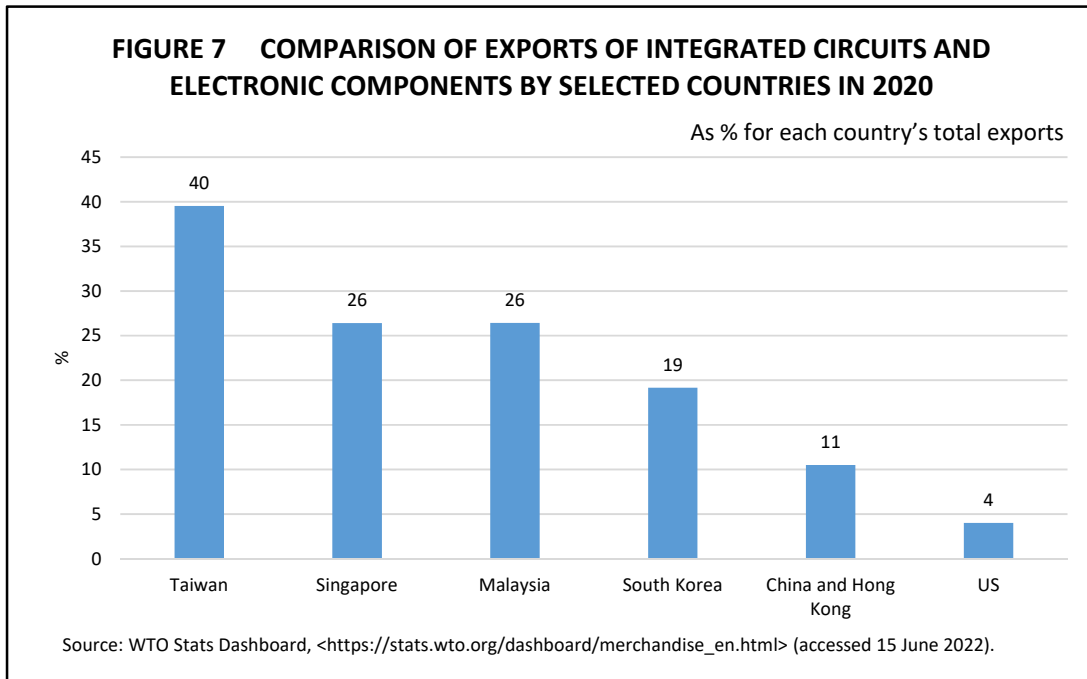
Too Big to Fail?

- 5.1 Not only the world but also Taiwan is heavily reliant on TSMC. It is Taiwan's largest company in terms of market capitalisation. Its net revenue accounted for about 7% of Taiwan's GDP and 11% of Taiwan's total exports in 2021.⁴⁹
- 5.2 TSMC's business expansion has contributed to Taiwan's growing reliance on IC production over the past decade. Total electronic manufacturing production accounted for 41% of Taiwan's total manufacturing production in 2020, from 31% 10 years ago (Figure 6).



- 5.3 Taiwan's reliance on IC is particularly strong when compared with other important IC manufacturers in the world. According to WTO statistics, 40% of Taiwan's exports are IC in 2020, higher than Malaysia (26%), Singapore (26%), South Korea (19%), China and Hong Kong (11%), and the United States (3%) (Figure 7).

⁴⁹ "Quarter Management Report Q4 2021", TSMC, 12 January 2022, <https://investor.tsmc.com/chinese/encrypt/files/encrypt_file/reports/2022-01/f7c72d6d88b224476ab812fc3ba28169ec091a86/4Q21ManagementReport.pdf> (accessed 24 July 2022); National Statistics, Taiwan <[https://statdb.dgbas.gov.tw/pxweb/Dialog/varval.asp?ma=NA8101A1A&ti=%B0%EA%A5%C1%A9%D2%B1o%B2%CE%ADp%B1%A5%CE%B8%EA%AE%C6\(2008SNA\)-%A6~&path=../PXfile/NationalIncome/&lang=9&strList=L](https://statdb.dgbas.gov.tw/pxweb/Dialog/varval.asp?ma=NA8101A1A&ti=%B0%EA%A5%C1%A9%D2%B1o%B2%CE%ADp%B1%A5%CE%B8%EA%AE%C6(2008SNA)-%A6~&path=../PXfile/NationalIncome/&lang=9&strList=L)> (accessed 24 July 2022).



5.4 TSMC is also a key driving force of Taiwan's industrial upgrading and innovation. TSMC spent US\$15 billion on R&D annually.⁵⁰ In 2020, the company accounted for over 20% of R&D expenditure made by all the manufacturers in Taiwan.⁵¹

5.5 The increasing IC exports and capital expenditures in the semiconductor industry, of which TSMC contributed a significant portion, has pushed up Taiwan's notable economic growth at a time when most countries in the world have been suffering from the pandemic crisis in the last few years.

5.6 Despite TSMC's significance in Taiwan's economy, its total employment (around 65,439 workers) accounted for only 0.6% of total employment and 2% of manufacturing employment in 2021.⁵²

⁵⁰ "Why TSMC is important for Taiwan?", *NOW News*, 5 May 2020, <<https://www.nownews.com/news/5004349>> (accessed 28 July 2022, in Chinese).

⁵¹ "Three most important semiconductor companies invested heavily in R&D", *Business Next*, 5 May 2021, <<https://www.bnext.com.tw/article/62688/semi-ministry-of-economic-affairs-bulletin-min>> (accessed 28 July 2022, in Chinese).

⁵² TSMC Annual Report 2021, <<https://investor.tsmc.com/chinese/annual-reports>> (accessed 28 July 2022); National Statistics, Taiwan, <<https://www.stat.gov.tw/ct.asp?xItem=47781&CtNode=4944&mp=4>> (accessed 28 July 2022).

- 5.7 The higher wages in TSMC and other semiconductor companies could have widened the income gap. Employment in electronic parts manufacturing accounted for 8% of total employment in Taiwan. However, the total monthly wage per person in electronic parts manufacturing was nearly 1.5 times greater than the average wage in all the manufacturing and service sectors.⁵³
- 5.8 Taiwan's heavy reliance on IC could be a factor for its exclusion from the various free trade agreements (FTAs). Without other FTAs to diversify its industrial development, Taiwan can only rely on ITA for expanding its exports and its overall economy.
- 5.9 The Taiwanese government is aware of its over-reliance on TSMC. To encourage other companies to develop their R&D, the government plans to update its "Statue for Industrial Innovation" in 2022 to include tax deductions for companies with expenditure on R&D and the purchase of capital equipment.⁵⁴
- 5.10 TSMC's importance surpasses that of the Taiwan government in the international arena. Apart from the United States, other countries such as Japan,⁵⁵ South Korea and European Union have also invited TSMC to set up factories and research centres in their territories. The strong global demand for chips will continue to extend TSMC's international partnership and cooperation with other countries.
- 5.11 In Japan, TSMC has teamed up with SONY to build a chip plant in the western prefecture of Kumamoto. The chips produced by TSMC-SONY joint venture are expected to be used in SONY's image sensors and electrical cars produced in Japan. However, the most advanced chips will still be manufactured in Taiwan.⁵⁶

⁵³ Data source: National Statistics, Taiwan, <https://earnings.dgbas.gov.tw/query_payroll_C.aspx> (accessed 1 August 2022).

⁵⁴ "MOEA plans to roll out tax deduction plan for encouraging companies' expenditure on R&D", *United Daily*, 17 June 2022, <<https://udn.com/news/story/7240/6394304>> (accessed 28 July 2022, in Chinese).

⁵⁵ "Japan plans to invite TSMC to build joint chip plant: Yomiuri", Reuters, 18 July 2020 <<https://www.reuters.com/article/us-japan-tsmc-idUSKCN24K03B>> (accessed 20 October 2022).

⁵⁶ Hideaki Ryugen, "Can TSMC give new spark to Japan's Silicon Island", *Nikkei Asia*, 16 December 2022, <<https://asia.nikkei.com/Business/Tech/Semiconductors/Can-TSMC-give-new-spark-to-Japan-s-Silicon-Island>> (accessed 21 September 2022).

- 5.12 TSMC's significance in the global economy and industrial development, and the US-China competition in high technology might benefit the Taiwan government in its bid to secure arms sales from the United States, boost bilateral economic ties and promote inclusion in the regional security alliance in the future.

CHIPS Act and Afterwards

- 6.1 Semiconductor chips are not only important for the current industries but also important for future technologies, including in the areas of artificial intelligence (AI), quantum computing and advanced wireless networks such as 5G. Given its key role in global industrial development, semiconductor chips are now called "a new oil".⁵⁷
- 6.2 Due to chips' significance in a variety of industries, the US economy will be severely impacted if there is any production disruption in Asia. Although the United States dominates upstream chip production (eg. design and equipment supply), only 11% of chip fabrication is done in the United States.⁵⁸
- 6.3 To avoid the potential impact from Asia's production disruption, the CHIPS and Science Act of 2022 was enacted in August 2022 to encourage chip fabrication in the United States. Several important semiconductor companies, including TSMC, Samsung, Micro, Qualcomm and GlobalFoundries would benefit from the United States' CHIPS and Science Act of 2022.⁵⁹
- 6.4 The CHIPS and Science Act of 2022 in the United States also bars semiconductor companies, including TSMC, that receive subsidies to invest in China in the next 10

⁵⁷ Kevin Stankiewicz, "Intel CEO says semiconductors are like oil-making more in US can avoid global crisis", CNBC, 23 March 2022, <<https://www.cnbc.com/2022/03/23/intel-ceo-making-semiconductors-in-us-is-more-important-than-oil-reserves.html>> (accessed 4 July 2022).

⁵⁸ Michaela D Platzer, John F Sargent Jr and Karen M Sutter, "Semiconductors: U.S. Industrial, Global Competition and Federal Policy", CRS Report, 26 October 2020 <https://crsreports.congress.gov/product/pdf/R/R46581> (accessed 2 May 2022).

⁵⁹ "Fact Sheet: CHIPS and Science Act will lower costs, create jobs, strengthen supply chains, and counter China", Statement and Release, The White House, 9 August 2022, <<https://www.whitehouse.gov/briefing-room/statements-releases/2022/08/09/fact-sheet-chips-and-science-act-will-lower-costs-create-jobs-strengthen-supply-chains-and-counter-china/>> (accessed 16 August 2022).

years.⁶⁰ While this is likely to squeeze China's market share in global chip production in the future, it does not seem to harm China's current chip fabrication with inferior technology intensity.

- 6.5 Enforcing advanced chip production in America might increase US competition with its allies in cutting-edge chip fabrication, notably Taiwan and South Korea. Exporting advanced chips is vital for these two economies.
- 6.6 Apart from the United States, several countries also started to subsidise chip production at home. For example, a European Initiative on Processor and Semiconductor Technologies,⁶¹ European Chip Act⁶² and South Korea's K-Semiconductor Belt⁶³ also aimed to increase local advanced IC production.
- 6.7 Given its small economic size, Taiwan is not able to engage in the competition for subsidising semiconductor companies' development. In addition, Taiwan's limited land size will restrain TSMC's expansion of production on the island in the long run.
- 6.8 China might want to take over TSMC by force. The consequence of a war in the Taiwan Strait will not only impact the supply chain network but also the global financial market. TSMC is the top Taiwanese company in the world in terms of

⁶⁰ Debby Wu, Daniel Flatley and Jenny Leonard, "US stop TSMC, Intel from adding advanced chips abs in China", Bloomberg, 1 August 2022, <<https://www.bloomberg.com/news/articles/2022-08-02/us-to-stop-tsmc-intel-from-adding-advanced-chip-fabs-in-china?sref=InMWfBxD>> (accessed 4 August 2022); Katie Schoolove, "How Intel Plans to Catch Samsung and TSMC and Regain its Dominance in the Chip Market", CNBC, 6 November 2021, <<https://www.cnbc.com/2021/11/06/how-intel-plans-to-catch-up-to-samsung-and-tsmc-with-44-billion-of-new-global-chip-fabs.html>> (accessed 4 August 2022).

⁶¹ "Declaration A European Initiative on Processors and Semiconductor Technologies", <https://www.eusemiconductors.eu/sites/default/files/uploads/20201209_EuropeanInitiativeonProcessorsandsemiconductortechnologies.pdf> (accessed 18 May 2022).

⁶² "European Chip Act", European Commission, <<https://digital-strategy.ec.europa.eu/en/policies/european-chips-act2022>> (accessed 18 May 2022).

⁶³ "K-Semiconductor Belt Strategy to Establish the World's Largest Supply Network by 2030", KBS World, 17 May 2021, <http://world.kbs.co.kr/service/contents_view.htm?board_seq=4033572022> (accessed 18 May 2022).

market capitalisation and overseas institutions and individuals accounted for nearly 80% of TSMC's shares.⁶⁴

- 6.9 Despite its large global market share, TSMC's reliance on US companies for the technology and chipmaking equipment implies that it will not have strong bargaining power. The technology reliance has resulted in TSMC's losing control of its future business development amid the growing complexity of geopolitical tension (eg. being banned from selling chips to Huawei).
- 6.10 The US-China de-coupling in the semiconductor industry is emerging. Apart from the CHIPS Act and other existing export restrictions, the United States is also trying to secure the supply of advanced chips through "chip-4", namely Taiwan, South Korea, Japan and the United States.⁶⁵
- 6.11 Taiwan's over-reliance on exporting chips might affect its economic prospect if chips can be produced in foreign countries, instead of being procured from Taiwan. TSMC's long-term profit might be affected if it continues to be forced to relocate chip production to countries with lower production efficiency than in Taiwan.

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⁶⁴ Taiwan and Singapore governments are the two largest state holders, accounting for a respective 6% and 3% of total TSMC shares. *TSMC annual report*, 2021, <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://investor.tsmc.com/sites/ir/annual-report/2021/2021_Annual%20Report%20_C.pdf> (accessed 12 August 2022).

⁶⁵ "S.Korea expresses intent to join preliminary chip4 meeting", *The Korea Herald*, 8 August 2022, <<https://www.koreaherald.com/view.php?ud=20220808000140>> (accessed 8 August 2022).