JAPANESE SEMICONDUCTOR INDUSTRY'S COLLABORATION WITH TAIWAN SEMICONDUCTOR MANUFACTURING

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EAI Background Brief No. 1670

Date of Publication: 29 September 2022

Executive Summary

1. On 17 December 2021, Japan granted administrative approval to Taiwan Semiconductor Manufacturing Co Ltd (TSMC) to build a US$7 billion semiconductor chip-manufacturing foundry in Japan. This is a collaboration between the Sony Group and the world's number one Taiwanese chipmaker.

2. Sony and TSMC are complementary collaborators. Japan is weaker in front-end processes like forming circuit patterns on wafers but is superior in backend processes like cutting wafers into chips, linking chips to electrodes and packaging them in polymers. TSMC leads in logic semiconductors production, chip advancement, R&D and production technology.

3. The TSMC plant will be based in western Japan's Kumamoto prefecture. The joint venture will be boosted by a collaboration with Japanese academic institutions, especially after TSMC Chairman Mark Liu and Makoto Gonokami (then president of the University of Tokyo) inked an agreement in 2019.

4. The TSMC-Sony subsidiary in Kumamoto is named Japan Advanced Semiconductor Manufacturing, Inc. It will provide foundry service with 22/28-nanometre capability.

5. While sub-sectors of Japan's electronics industry like appliances and home computers had not been as competitive as before, other Japanese industries including car manufacturing, self-driving applications, electrification technologies and smart factories continue to generate strong demand for semiconductor chips.

6. Japan's Ministry of Economy, Trade and Industry has formulated a Strategy for Semiconductors and the Digital Industry in June 2021 that "will be conducted as a national project". Many analysts are watching whether the Japanese semiconductor industry will be revitalised through its R&D hub and cooperation with TSMC.

7. In February 2021, TSMC (along with other companies in the tie-up) announced that it will establish a Tsukuba research centre northeast of Tokyo to develop 3D chip integration technology that reaches beyond miniaturisation limits as a back-end process for Japan to revive its fortunes in the chipmaking sector.

8. Japan will subsidise TSMC's semiconductor R&D in Tsukuba with 19 billion yen (more than 50% of the project expenditure of 37 billion yen). The collaboration will include 20 other Japanese chipmakers (including Hitachi High-Tech and Asahi Kasei).

9. This joint venture has taken off due to not only mutual commercial interest but also support and approval by Japanese and Taiwanese authorities. Japan and Taiwan continue to enjoy cordial ties and trust, in part, due to a "special relationship" forged by their relatively benign colonial experience, and conceivably by the fear of a rising and more assertive China.

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Japanese Semi-conductor Industry: A Global Dominance Lost

1.1 In 1988, Japanese chip manufacturers dominated more than 50% of the global market. However, by 2019, their market share of chips fell to only a paltry 10%[1] (see Appendix 1 for Japan's share in the global chip market, Appendix 2 on Japan and the percentage of global semiconductor manufacturing capacity by location, and Appendix 3 for Japan's Share of Global IC wafer capacity and fabrication location).

1.2 Japanese semiconductor industry declined from the 1990s when the global market for chips was driven by personal computers. At the time, Japanese producers did not capitalise on this trend as their niche product was memory chips (DRAM) instead of microprocessors and logic Large Scale Integration (LSI) chips which the United States was far more competitive.[2]

1.3 In the 1970s, the Japanese government formulated an industrial policy called Vertical Large-Scale Integration (VLSI) Project to stay ahead in chips manufacturing. This move was however fiercely criticised by the United States as a collusive "system of government-private adhesion" or "Japan Inc." The United States deemed Japanese state-industry cooperation to be against free market principles and imposed restrictions on the export of Japanese-made chips to the US

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1 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy" dated 5 June 2021 in *The Asahi Shimbun* [downloaded on 5 June 2021], available at https://www.asahi.com/ajw/articles/14365786.

2 Semiconductor Industry News, "Episode 20 Rise and Fall of Japanese Semiconductors" dated 9 January 2008 in the Semiconductor History Museum of Japan (SHMJ) Sangyo Times Co. Ltd. [downloaded on 1 January 2021], available at https://www.shmj.or.jp/makimoto/en/pdf/makimoto_E_01_20.pdf, p. 3.

market. This resulted in the loss of economies of scale and what the Japanese called "15 years in blank" of the chip industry.[3]

1.4 Freed from such criticisms and restrictions, US, European and the other Asian semiconductor companies started their own large-scale public and private collaborative projects in the 1980s, resulting in the establishment of the United States' SEMATECH firm in 1987 which became the major player in the industry.[4]

1.5 While market restrictions/access on Japanese semi-conductor industries to US domestic market had crippled Japanese semiconductor companies, it would be too simplistic to attribute the decline of Japanese semi-conductor industry to foreign pressure (*gaiastsu*) alone. The lack of collaboration between Japanese industry stakeholders, running chip production as a division of electronics companies rather than specialised foundries, an overreliance on a handful of large companies for supply and the inability to meet foreign competition in an era of free trade agreements were also factors.

1.6 In contrast, South Korea and Taiwan made great strides in the global microchip competition. South Korean and Taiwanese semiconductor companies rose quickly due to their entrepreneurship, strong investments in the industry (including R&D) and access to capital markets, with Korean chaebols and Taiwanese semiconductor conglomerates linked to supportive economic ministries respectively.

1.7 The emergence of the South Korean semiconductor sector is based on the "corporatist state" with state-partnered chaebols utilising their structural dominance to mobilise and lead stakeholders in the sector, and resources allocated to develop their industries.[5] South Korean microchip companies hence succeeded in the Dynamic Random Access Memory (DRAM) sub-sector through the institutional alignment of the government (and its policies) with chaebol conglomerates in the

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[3] Ibid.

[4] Ibid.

[5] Kim, S Ran, "The Korean System of Innovation and the Semiconductor Industry: a Governance Perspective" dated December 1996 in OCED website [downloaded in December 1996], available at https://www.oecd.org/korea/2098646.pdf, p. 3.

private sector.[6] This arrangement harnessed free market opportunities in growth areas such as the chips industry in the 1980s (further boosted by the provision of state subsidies to develop the industry).[7]

1.8 Consequently, South Korea quickly became a global hub for making DRAM chips. The most successful of the chaebols, Samsung, rose to the position of the seventh largest chipmaker internationally by 1993 and attained the global market's leading position in Metal Oxide Semiconductor (MOS) memory chips and its DRAM segment.[8] From near zero global market share in memory chips in 1984, Samsung captured 1.4% in 1986, 5.6% in 1988, 10.2% by 1993 to finally become the world's largest 1M DRAMs and 4M DRAMs maker in 1994 (making up 13% market share in each of these two sub-sectors).[9]

1.9 The Taiwanese chip story is one of entrepreneurship with United Microelectronics Corp (UMC) founded in 1979 and Taiwan Semiconductor Manufacturing Co Ltd (TSMC) in 1987. The two enjoyed state assistance, access to the capital markets' provision of equities and R&D support through the Industrial Technology Research Institute and the Electronic Research and Service Organisation (ERSO).[10] In the 1990s or so, TSMC revolutionised the semiconductor sector by contracting custom wafers production to chip designers to empower chip designers to focus on imprinting the integrated circuits on the wafers to create microchips, resulting in the success of fabless microchip firms.[11] The Taiwanese has spearheaded a new model in the global semiconductor industry.

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6 Ibid.

7 Ibid.

8 Ibid., p. 4.

9 Ibid.

10 Windham, Patrick, "Securing the Future: Regional and National Programs to Support the Semiconductor Industry Panel IV The Taiwanese Approach Introduction" dated 2003 in National Academies Press Washington DC [downloaded on 1 January 2022], available at https://nap.nationalacademies.org/read/10677/chapter/9, pp. 149-150.

11 Ibid.

1.10 From the 1990s, a new horizontal business model has emerged in the chips industry, pioneered by TSMC's fabless business model that designed and developed chips within the company while outsourcing manufacturing.[12] For example, UMC started off designing and making integrated circuits but, in the mid-1990s, founder Robert Tsao converted it into a contract manufacturer like TSMC to facilitate its entry into high-end chips (a sector that made UMC competitive like TSMC).[13]

1.11 In contrast, Japan lagged behind these industrial trends. It was slow in forging collaborations between universities, national laboratories and industry, unlike Silicon Valley where researchers in Stanford/UC Berkeley developed cutting-edge semiconductor chips, facilitated by Semiconductor Research Corp. established in 1982 for industry-academia collaboration.[14] Japan's Semiconductor Technology Academic Research Centre that was set up in 2005 fell behind its peers by more than two decades.[15]

1.12 Japan operated its semiconductor businesses as divisions of its major electronics manufacturers, unlike US chipmakers which are specialised firms (like Intel, Texas Instruments and Micron) and Europeans chipmakers which are autonomous firms like Siemens (Germany), Phillips (Holland) and Thomson (France). Only a handful of Japanese companies managed to carry out such restructuring like the merger between Mitsubishi's system LSI divisions and Renesas Technology.[16]

1.13 Japan was largely dependent on these handful of domestic companies and foreign sources for its advanced chips. The vulnerability of domestic chip supply and overreliance on a few large companies became distinctive when a major fire razed

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12 Semiconductor Industry News, "Episode 20 Rise and Fall of Japanese Semiconductors", p. 3.

13 Windham, Patrick, "Securing the Future: Regional and National Programs to Support the Semiconductor Industry Panel IV The Taiwanese Approach Introduction" dated 2003 in National Academies Press Washington DC [downloaded on 1 January 2022], available at https://nap.nationalacademies.org/read/10677/chapter/9, pp. 149-150.

14 Semiconductor Industry News, "Episode 20 Rise and Fall of Japanese Semiconductors", p. 5.

15 Ibid.

16 Ibid.

important Japanese chipmaker Renesas Electronics Corp's foundry in March 2021, reducing its supply of chips to Japanese manufacturers.[17]

1.14 Domestic chipmakers were dealt a further blow by US-Japanese agreements. While Japan managed chipmaking as a domestic strategic priority until the 1970s, the US-Japan Semiconductor Agreement 1986 increased the market share of foreign-made chips in the Japanese domestic market from 10% to 20%.[18] After this Agreement, the Japanese government issued administrative guidance to Japanese semiconductor users "to use foreign made semiconductors as much as possible, instead of Japanese made products", resulting in today's (over) dependence on foreign-made chips.[19]

1.15 The attention given to economic security in the Biden era may mean formulating careful plans to construct a production/supply network with allied, friendly and like-minded nations through a division of labour to capitalise on each other's comparative advantages.[20] Given that South Korea and Taiwan have surged ahead in chips production (while Japan had fallen behind for decades, it still retains strengths in some end-user industries) and the United States continues to design cutting-edge new chips, this affords the United States the possibility of creating a new production ecology.

1.16 In this production ecology, the US network of allies and partners can specialise in different areas of the semiconductor industry (both in terms of production and applied technologies). If the United States were to form tight cooperation and tech-sharing between like-minded nations (and their chipmaking firms), it would depend on the willingness of the United States, European Union, South Korea, Taiwan and other like-minded democratic governments to multilaterally share technologies with

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17 Kyodo News Agency, "Low-quality semiconductors likely circulating across Japanese market" dated 28 August 2021 in *Kyodo News* [downloaded on 28 August 2021], available at https://english.kyodonews.net/news/2021/08/13043f22ed32-low-quality-semiconductors-likely-circulating-across-japanese-market.html.

18 Semiconductor Industry News, "Episode 20 Rise and Fall of Japanese Semiconductors", p. 5.

19 Ibid.

20 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy" dated 5 June 2021 in *The Asahi Shimbun* [downloaded on 5 June 2021], available at https://www.asahi.com/ajw/articles/14365786.

each other in semiconductor research, design, development and manufacturing while making such specialised sharing more cost-effective[21] (see Appendix 4 for Japan's share in chip research up to 2020). In such an ecology, Japan may become an end chip consumer and less of a major producer.

Japanese Tie-up with Taiwanese TSMC: Why Was Taiwan Agreeable?

2.1 The Taiwanese investment commission of the Ministry of Economic Affairs announced that the TSMC was given administrative approval on 17 December 2021 to build a US$7 billion semiconductor chip-manufacturing foundry in Japan in collaboration with the Sony Group.[22] Named Japan Advanced Semiconductor Manufacturing, Inc. (JASM), the fab started in 2022 with production initiation by end 2024, generating approximately 1,500 high-tech professional jobs producing 45,000 12-inch wafers.

2.2 Sony Semiconductor Solutions is a minority shareholder in this venture with an investment of about US$0.5 billion, or less than 20% equity stake in JASM.[23] According to *Nikkei*, the new TSMC-Sony Japanese chipmaking foundry will help Japan regain its place in the international semiconductor industry.[24]

2.3 Reasons for the collaboration include first, the need to capitalise on the expertise complementarity between the two. Sony is the world's top image sensor firm (the 'eye of electronic devices') with a global market share of 47.6% in 2020, a large

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[21] Goto, Shihoko, "Can Semiconductors be Japan's New Auto Industry?" dated 27 July 2021 in the Wilson Centre Asia Programme [downloaded on 27 July 2021], available at https://www.wilsoncenter.org/blog-post/can-semiconductors-be-japans-new-auto-industry.

[22] Shen, Meg, "Taiwan govt OKs Taiwan Semiconductor's new chip plant in Japan" dated 20 December 2021 in Reuters [downloaded on 20 December 2021], available at https://www.reuters.com/technology/taiwan-govt-oks-taiwan-semiconductors-new-chip-plant-japan-2021-12-20/.

[23] TSMC and Sony Semiconductor Solutions, "TSMC to Build Specialty Technology Fab in Japan with Sony Semiconductor Solutions as Minority Shareholder" dated 9 November 2021 in TSMC [downloaded on 9 November 2021], available at https://pr.tsmc.com/japanese/news/2880.

[24] Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant" dated 12 October 2021 [downloaded on 12 October 2021], available at https://asia.nikkei.com/Business/Tech/Semiconductors/Japan-s-wooing-of-TSMC-pays-off-with-7bn-chip-plant.

segment of which serves TSMC.[25] Japan has strong back-end processes (cutting wafers, chip linkages to electrodes and polymer packaging), while TSMC leads in logic semiconductor production, R&D, circuit patterns on wafers and production tech.[26]

2.4 TSMC has a historical presence in Japan's semiconductor ecosystem since setting up its Japan subsidiary in 1997, establishing the Japan Design Centre in 2019 to service its global clientele and collaborating with Japan's 3DIC Research and Development Centre in Ibaraki in the field of advanced packaging technology.[27] Japan is internationally competitive in making semiconductor materials, parts, equipment and NAND flash memories.[28] Japan's strengths are also found in integrating chips into end-product technologies.

2.5 The Japanese auto industry is a major beneficiary as a huge chip end-user. Moreover, Japanese companies can improve consumer lifestyles and mass standards of living using chips in end products and/or to address climate change through producing chip-based environmental technologies.[29]

2.6 Financially, Japan is also capable. Following on the heels of TSMC establishing a fab foundry in Japan in October 2021, Japan set up a fund for domestic semiconductor investments, with TSMC as the first recipient of subsidies[30] (see Appendix 5 for investments made by major chipmakers, including Japan, in microchip production from 2021 to 2030).

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25 Kim, Eun-jin, "TSMC to Build Semiconductor R&D Center in Japan" dated 2 June 2021 in BusinessKorea [downloaded on 2 June 2021], available at http://www.businesskorea.co.kr/news/articleView.html?idxno=68617.

26 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

27 TSMC and Sony Semiconductor Solutions, "TSMC to Build Specialty Technology Fab in Japan with Sony Semiconductor Solutions as Minority Shareholder".

28 Kim, Eun-jin, "TSMC to Build Semiconductor R&D Center in Japan".

29 Goto, Shihoko, "Can Semiconductors be Japan's New Auto Industry?"

30 Lu, Misha, "Japan Considers a Semiconductor Fund to Support TSMC and Chip Industry Revival" dated 20 October 2021 in Tech Taiwan [downloaded on 20 October 2021], available at https://techtaiwan.com/20211020/tsmc-japan-fund/.

2.7 To avoid flouting World Trade Organisation regulations or protests from South Korea, Prime Minister Kishida emphasised that TSMC will strictly follow Japanese subsidy conditionality for its foundry in Japan (which prioritises the sale of chips to Japanese clients) or risk punitive return of subsidies.[31] The fund will eventually attract R&D investments from international makers of logic devices like TSMC and mass-produce them in a cutting-edge foundry within Japan.[32]

2.8 The second is the existing memorandum of understanding signed between scientific institutions in both countries. The TSMC plant is based in western Japan's Kumamoto prefecture, strengthened further by the existing collaboration with Japanese academic institutions, especially after TSMC Chairman Mark Liu and Gonokami Makoto (then president of the University of Tokyo) inked an agreement in 2019.[33] JASM initially manufactured 22/28-nanometre chips in its foundry to meet robust international market demand for specialty technologies.[34]

2.9 The University of Tokyo and TSMC will also collaborate on making advanced chips for AI (artificial intelligence) applications using TSMC prototyping service. The University of Tokyo will utilise TSMC's chip design platform, while both exchanged materials science/physics/chemistry experts; as former University of Tokyo President Gonokami declared: "We are pleased that we decided to pursue international cooperation at an unprecedented richness and depth".[35]

2.10 The third is the pre-existing strong market demand for chips produced by the TSMC-Sony tie-up. The semiconductor industry previously reduced its production during the COVID-19 pandemic but industrial demand has quickly recovered for chips needed in a wide spectrum of consumer products driven by international consumer

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31 Ibid.

32 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy" dated 5 June 2021 in *The Asahi Shimbun* [downloaded on 5 June 2021], available at https://www.asahi.com/ajw/articles/14365786.

33 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

34 TSMC and Sony Semiconductor Solutions, "TSMC to Build Specialty Technology Fab in Japan with Sony Semiconductor Solutions as Minority Shareholder"

35 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

demand.[36] The COVID-19 pandemic further demonstrates the systemic weaknesses of global economic integration and supply chain networks, compelling many governments around the world (including Japan) to show the political will to reconstruct supply resilience and competitiveness between like-minded nations and pragmatic approaches.[37] Besides post-pandemic pent-up demand, the advent of the Industry 4.0 digital economy will also boost demand for semiconductor devices and chip components of digital products.

2.11 Dr CC Wei, chief executive officer of TSMC, had this to say of the significance of the digital revolution in the tie-up: "The digital transformation of more and more aspects of human lives is creating incredible opportunities for our customers, and they rely on our specialty processes that bridge digital life and real life. We are pleased to have the support of a leading player and our long-time customer, Sony, to supply the market with an all-new fab in Japan, and also are excited at the opportunity to bring more Japanese talent into TSMC's global family".[38]

2.12 Notably, economic factors are the key drivers of collaboration between Japan and Taiwan in chipmaking. As microchips are also strategic dual-use technologies, interchangeably usable by both the civilian and military sectors, some wonder if Taiwanese-Japanese collaboration in semiconductors production and application may be a consequence of geopolitics, domestic politics, and close informal ties between Taiwan and Japan despite a lack of official relations.

2.13 Given that many Japanese manufacturing firms were brought to a standstill by the pandemic, collaborating with TSMC is a pragmatic move to overcome the weaknesses of existing supply chains. Geopolitically, while the collaboration is not targeted at any third countries, some are genuinely worried about the severe ongoing tensions between the United States and China and its impact on global supply chains.

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[36] Kyodo News Agency, "Low-quality semiconductors likely circulating across Japanese market".

[37] Goto, Shihoko, "Can Semiconductors be Japan's New Auto Industry?"

[38] TSMC and Sony Semiconductor Solutions, "TSMC to Build Specialty Technology Fab in Japan with Sony Semiconductor Solutions as Minority Shareholder".

2.14 Tokyo is not alone in trying to be less reliant on foreign-originated chips by attracting TSMC plants. The United States has singled out semiconductor chips as an economic (and broader) security asset along with large-power batteries, pharmaceutical and critical minerals. To add to its core expertise in its world-class logic chipmaking plant (Intel Corp.), the United States has managed to attract TSMC to build a foundry in the United States as well.[39]

2.15 For TSMC, building a plant in Arizona and another in Kumamoto may diversify its production sites to manage any supply chain disruptions. The United States and Japan are also Taiwan's strongest strategic partners, with the United States its traditional security guarantor (Washington is committed to help Taipei defend itself under the 1974 Taiwan Relations Act). Both allies also signed the 1996 US-Japan Defence Guidelines which commits Tokyo to assist Washington in "situations in areas surrounding Japan" interpreted as providing security contingencies in the Taiwan Strait and Korean peninsula.

2.16 Arguably, Japan and Taiwan have a "special relationship" based on a relatively benign colonial experience since Tokyo took control of the island after it won the First Sino-Japanese War (1894-95). Japan has been Taiwan's major economic partner since the postwar era of the four tiger economies when Japan transferred its knowhow, investments and technologies to the tiger economies, in what some economists call the "flying geese model". These reasons make the United States and Japan acceptable candidates for receiving sensitive microchip investments from Taiwan, particularly in the eyes of Taiwanese politico-economic interest groups.

2.17 For Japan, Taiwan is also an acceptable partner as the most advanced chipmaker in the world; Japan will benefit much from acquiring chipmaking knowledge from Taiwan. Since the tech decoupling days from the era of President Trump to the Biden administration's Indo-Pacific Economic Framework (IPEF), Japan is acutely sensitised to the views of the US alliance network on the strategic nature of microchip technologies in the China-US rivalry; working with Taiwan can thus align with those sensitivities.

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[39] Goto, Shihoko, "Can Semiconductors be Japan's New Auto Industry?"

2.18 There were also communications at the political party levels between Taiwan and Japan. On 24 December 2021, in an online meeting, two senior parliamentarians each from the ruling parties of Taiwan's Democratic Progressive Party (DPP) and Japan's Liberal Democratic Party concurred on organising "all round cooperation" on semiconductors and implement regular dialogues between the two.[40]

2.19 However, at this talk, Head of the DPP international department Lo Chih-cheng (also a senior DPP parliamentarian) categorically indicated that military issues were not part of these talks.[41] Both sides agreed that resilient supply chains in semiconductors were very important, given that both industries in Taiwan and Japan's industries faced semiconductor shortfalls, along with other global players (a point reinforced by DPP lawmaker Chiu Chih-wei in speaking to the mass media).[42]

2.20 As relations with South Korea under President Yoon have improved rapidly, Japan can also work with the Yoon administration in this sector and end the economic boycotts between them (which also involves chemical cleaning agents related to the semiconductor industry). When President Biden visited South Korea in May 2022, he visited the Samsung Electronics Pyeongtaek Campus which is said to be a model for Samsung's Texas plant. Before President Biden flew off from South Korea to Tokyo for the IPEF, President Yoon committed to a new Samsung Texas plant investment for making high-tech products like chips.

2.21 It is unclear if the United States may nudge its Korean and Japanese allies and their chipmakers to exercise caution when exporting advanced chips to American economic and strategic rivals in the world. It remains to be seen how Biden and subsequent administrations will control the gateway to such technologies. If China-US confrontation deepens, Japan must also pragmatically manage the risks of an overconcentration of chip production in Taiwan in the scenario of Chinese military

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40 *The Asahi Shimbun*, "Taiwan, Japan eye 'all round cooperation' on chips" dated 24 December 2021 in REUTERS [24 December 2021], available at https://www.asahi.com/ajw/articles/14509712.

41 Ibid.

42 Ibid.

pressure and blockade on the "renegade" island if it flirts with de jure independence.[43]

2.22 Chip production is an agenda item between 13 pioneering IPEF members who intend to hammer out details of microchip production chains in the 12 to 18 months starting from 23 May 2022.

No Concerns That TSMC's Technology Might Be Stolen, Reversed Engineered or Becoming a Strategic Civilian-Military Spinoff

3.1 TSMC's 28nm Japanese fab focuses on specialty technologies.[44] TSMC's Kumamoto foundry is manufacturing 20-nanometre chips (a more than 10-year-old technology) and nowhere near three nm advanced chips.[45] The Taiwanese Ministry of Economic Affairs' investment commission revealed: "The technology that will be used in TSMC's new plant in Japan is lagging behind what has been applied in Taiwan for at least one generation or more. There should be no doubts about high-end technology outflow".[46]

3.2 Simply put, there are no cutting-edge technologies to be copied as this was conventional decades-old technology that is helpful to meet Japanese chip users' shortfall. It may not be a cutting-edge dual-use technology for the military-industrial complex, but these Japan-made TSMC chips are good enough for Japan's auto industry and consumer products.

3.3 Japan has placed semiconductors as a priority sector for investments in addition to meeting high demand and supply shortage through more domestic production. Former Economy Minister Amari Akira argued that Japan should lower advanced chips costs, increase use of cutting-edge chips and tap into Japan's existing strength

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43 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy".

44 Lu, Misha, "Japan Considers a Semiconductor Fund to Support TSMC and Chip Industry Revival".

45 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

46 Shen, Meg, "Taiwan govt OKs Taiwan Semiconductor's new chip plant in Japan".

as a hub for technological application of chips rather than focus on research and development of cutting-edge chips.[47]

3.4 Apparently, this Japanese-Taiwanese joint venture is a civilian tie-up with no dual-use intentions or a strategic civilian-military spinoff. The tie-up is driven by demand for semiconductor chips that Japan's other manufacturing industries are reliant on. While the sub-sectors of Japan's electronics industry like appliances and home computers have not been as competitive as they had been in the past, other Japanese industries continue to generate strong demand for semiconductor chips, including car manufacturing, self-driving applications and electrification technologies and smart factories.[48] Most importantly, the foundry would meet the increasing shortfall for semiconductor chips in car manufacturing and other industrial sectors, filling in the infrastructure and supply that Japan had phased out before.[49]

3.5 The global shortage of chips is so acute that Japanese companies are resorting to using low-quality semiconductors like imitation chips, altering the brand of chip manufacturers to a major branded producer, and disposing chips from decade-old recycled electronics equipment and sub-quality chips that should have been discarded during quality control inspections.[50] Due to global shortage, more Japanese manufacturers that required chips turned to unconventional supply chains like trading companies distributing defunct semiconductors, prompting electronics assembling companies to use Oki Engineering's (subsidiary of Oki Electric Industry Co.) chip verification service from June 2021 to carry out semiconductor quality checks/authentication from such supply routes.[51]

3.6 Japan Patent Office discovered such chips amongst Korean, Chinese and Southeast Asian products sold online are acquired by specialised trading firms supplying assemblers. Takamori Kei (general manager, Oki Engineering reliability solution

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47 Goto, Shihoko, "Can Semiconductors be Japan's New Auto Industry?"

48 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

49 Ibid.

50 Kyodo News Agency, "Low-quality semiconductors likely circulating across Japanese market".

51 Ibid.

division) explained: "It is highly likely that the number of imitations will increase, as there are no signs of the chip shortage issue being resolved for the time being".[52]

3.7 Now found across Japan's industries (30% of chips found in Japan as belonging to Oki Engineering Co. in a survey of more than 100 companies), there are worries amongst Japanese manufacturers they may lead to an increase in defective products in an international chip crunch.[53] Defective or imitation semiconductors found in electronic facial massagers, blood-pressure gauges, dashboard cameras and e-cigarettes broke down before use or malfunctioned, resulting in fire or smoke emissions.[54]

Prospects of a Semiconductor Partnership?

4.1 Japan's industry players, bureaucracy and intellectuals opined that Japan does not have a logic semiconductors advanced production line, making it over-reliant on foreign sources and, if it continues to backslide on leading-edge fabrication processes, the domestic knowhow, talent and other legacy technologies in the chip industry may decline, forcing Japanese hardware and material producers to move overseas.[55]

4.2 Higashi Tetsuro, chairperson of the executive board of TIA chip innovation group in Tokyo that brings together industry, government and academia officials warned: "Japan is losing its base for advanced logic semiconductors…It's imperative that we have the manufacturing processes along with the talent and development engineers to support them. We are formulating a strategy that sees it taking 10 years to build up front-end processes".[56]

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52 Ibid.

53 Ibid.

54 Ibid.

55 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

56 Ibid.

4.3 All is not lost in other sectors. Japan continues to possess world-class technologies for making equipment to fabricate semiconductor devices as well as manufacturing chip materials and memory devices; many are therefore urging the Japanese government to aid these peripheral industries as well.[57]

4.4 Japan's Ministry of Economy, Trade and Industry (METI) has formulated a Strategy for Semiconductors and the Digital Industry in June 2021 that "will be conducted as a national project that extends beyond general private-sector support"; many are watching if Japan's industry players, state and intellectuals can revive Japan's semiconductor industry through its R&D hub, TSMC and the foundry.[58] Whether the state (especially METI) can successfully support TSMC venture or other national semiconductor national projects remains to be seen, given the lag between Japan and others.

4.5 The Japanese government convened the 2021 Semiconductor-Digital Industry Strategy Review Meeting to formulate measures for building semiconductor/digital infrastructures to produce high-tech semiconductors and fill the gaps in the Japanese semiconductor industry.[59] Appointed to the Kishida Cabinet as minister for economic security (a new ministry) on 4 October 2021, Kobayashi Takayuki declared that TSMC's new fab in Japan is a pioneer in Japan's revival of its declining semiconductor industry, a thought that METI Hagiuda Kōichi shared.[60]

4.6 Other than the Cabinet and government, lawmakers are also lobbying for more help for the semiconductor industry. Spurred by the American, European and Chinese initiatives to dish out subsidies to their domestic semiconductor manufacturers, a ruling Liberal Democratic Party faction of legislators lobbied for more state expenditure to support Japan's declining chip industry with the same level of subsidies as those provided by foreign governments through a resolution.[61]

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57 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy".

58 Eiguchi, Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

59 Kim, Eun-jin, "TSMC to Build Semiconductor R&D Center in Japan".

60 Lu, Misha, "Japan Considers a Semiconductor Fund to Support TSMC and Chip Industry Revival".

61 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy".

4.7 The TSMC Japanese foundry costs TSMC one trillion yen (US$8.8 billion) with 50% paid by the Japanese government, a figure well within the expectations of a government expert panel's recommendation headed by Higashi Tetsuro, former chairperson of Tokyo Electron in June 2021 for fiscal year budgeting in 2021 to prevent any further backsliding of Japan's chipmaking sector.[62] Japanese foundry engineers and companies in the supply chain would be participating hands-on in the production process and the Kumamoto plant is crucial to providing a technological base for producing advanced logic chips in Japan.[63]

4.8 Prospects of further tie-ups for this collaboration are positive. In February 2021, TSMC (along with other companies in the tie-up) announced it will construct a Tsukuba research centre northeast of Tokyo to develop 3D chip integration technology that reaches beyond miniaturisation limits as a back-end process for Japan to revive its fortunes in the chipmaking sector.[64]

4.9 The semiconductor R&D base in Tsukuba Japan will enjoy 19 billion yen (more than 50% of the project expenditure of 37 billion yen) of state subsidies for activities like semiconductor packaging while approximately 20 Japanese chipmakers (including Hitachi High-Tech and Asahi Kasei) will be involved in collaborations with TSMC.[65] On 4 June 2021, METI formulated a strategy to revive the domestic chip industry, including a blueprint for making domestic programmable logic devices and customisable computer chips.[66]

4.10 Indeed, Japan has high hopes and the financial resources to rejuvenate its erstwhile cutting-edge semiconductor industry. While the success of this endeavour is uncertain given the capabilities and ambitions of American, European, Chinese and Korean chipmakers, Japanese state and industry have a higher probability of success by forging an alliance with Taiwanese TSMC.

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62 Lu, Misha, "Japan Considers a Semiconductor Fund to Support TSMC and Chip Industry Revival".

63 Eiguchi Ryosuke, "Japan's wooing of TSMC pays off with $7bn chip plant".

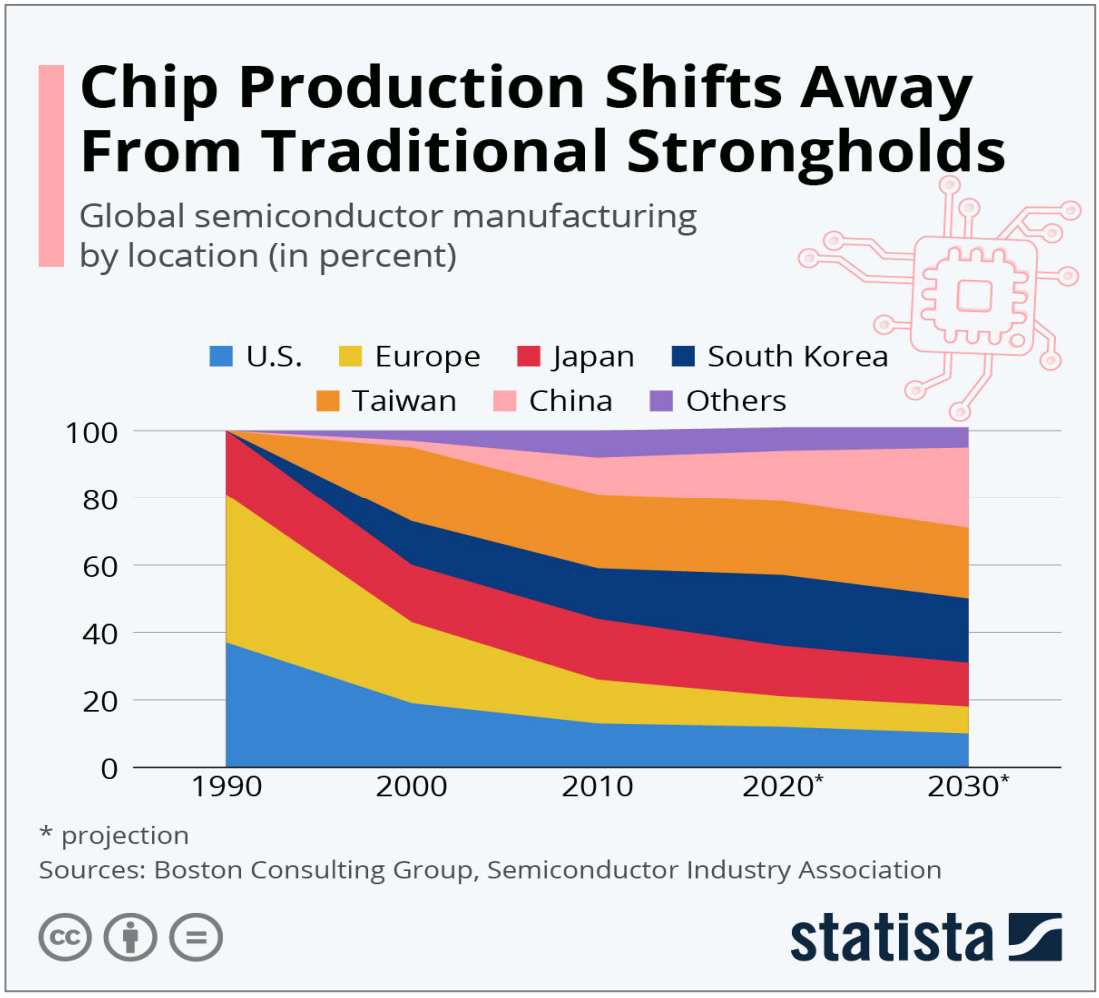
64 Ibid.

65 Kim, Eun-jin, "TSMC to Build Semiconductor R&D Center in Japan".

66 *The Asahi Shimbun*, "EDITORIAL: Move to revive chip industry must be based on sound strategy".

APPENDIX 1

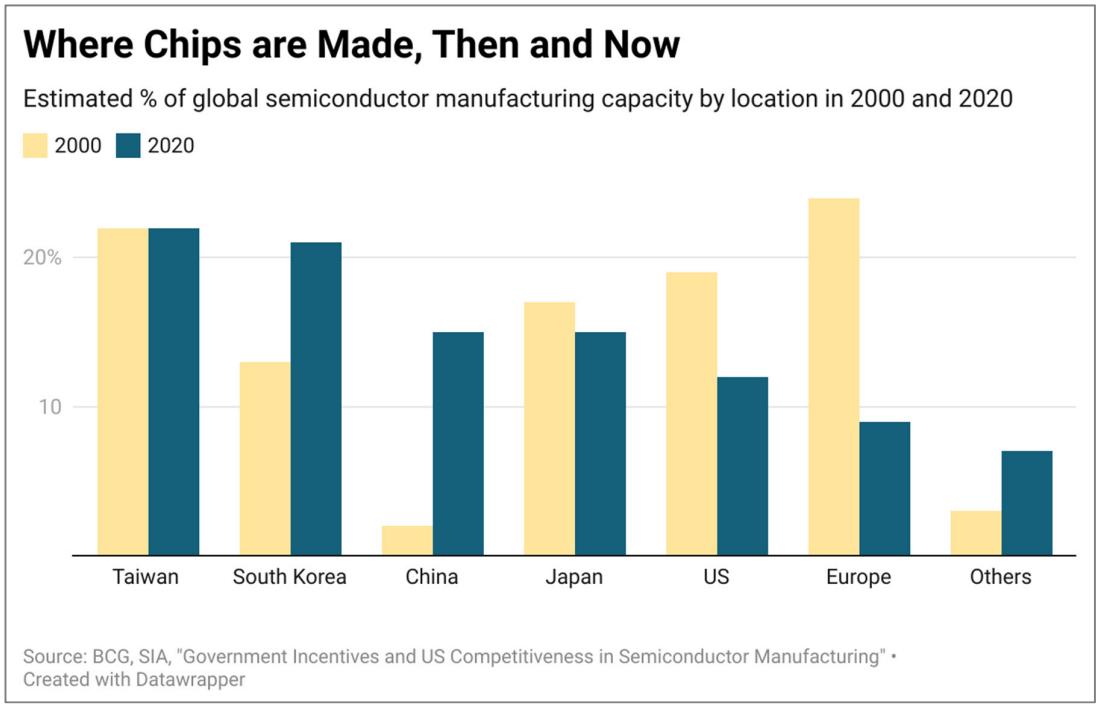
GLOBAL CHIP PRODUCTION AND JAPANESE SHARE (%)



Source: Boston Consulting Group, Semiconductor Industry Association and Katherine Buchholz, "Chip Production Shifts Away From Traditional Strongholds" dated 17 August 2021, downloaded on 17 August 2021, available at https://www.statista.com/chart/25552/semiconductor-manufacturing-by-location.

APPENDIX 2

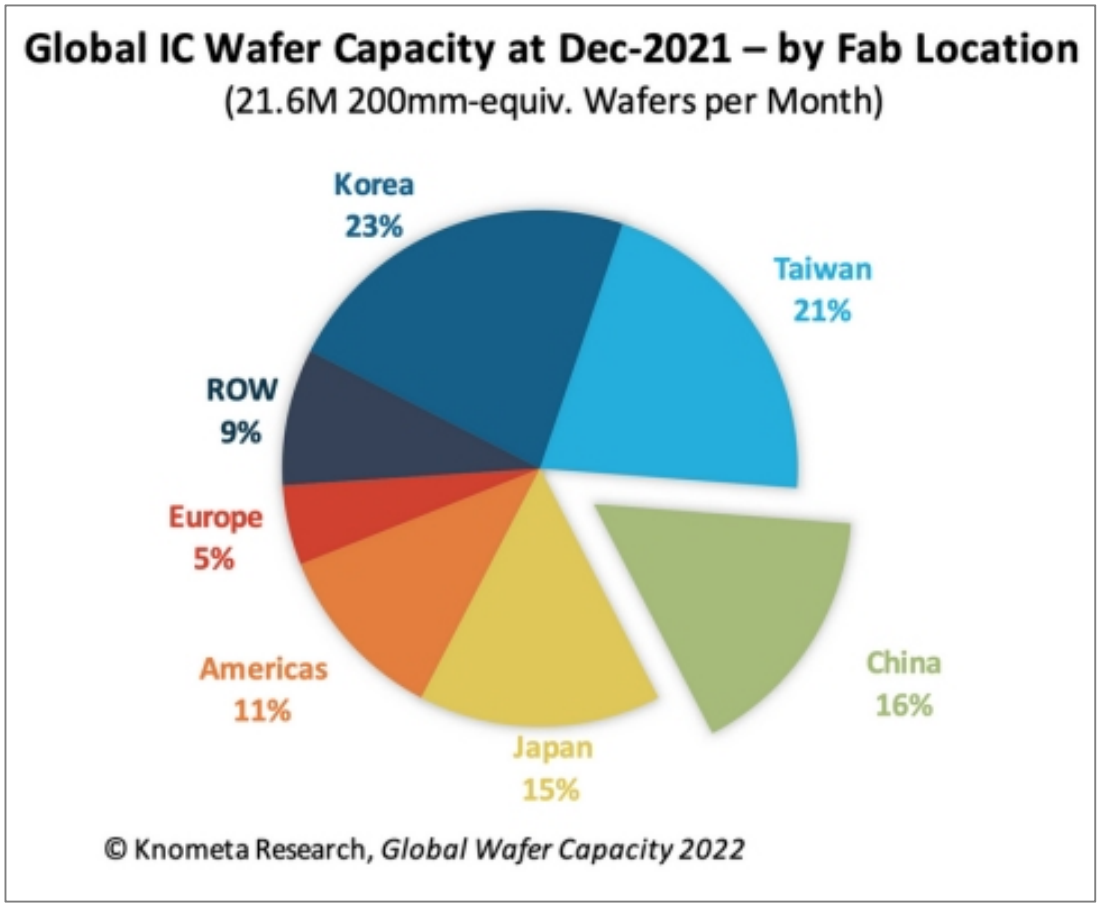
JAPAN AND GLOBAL SEMICONDUCTOR MANUFACTURING CAPACITY BY LOCATION: COMPARING 2000 AND 2020 (%)



Source: Letzing, John, "What's the 'bullwhip effect' and how can we avoid crises like the global chip shortage?" dated 12 May 2021 in the World Economic Forum (WEF), downloaded on 12 May 2021, available at https://www.weforum.org/agenda/2021/05/what-s-the-bullwhip-effect-and-how-can-we-avoid-crises-like-the-global-chip-shortage/.

APPENDIX 3

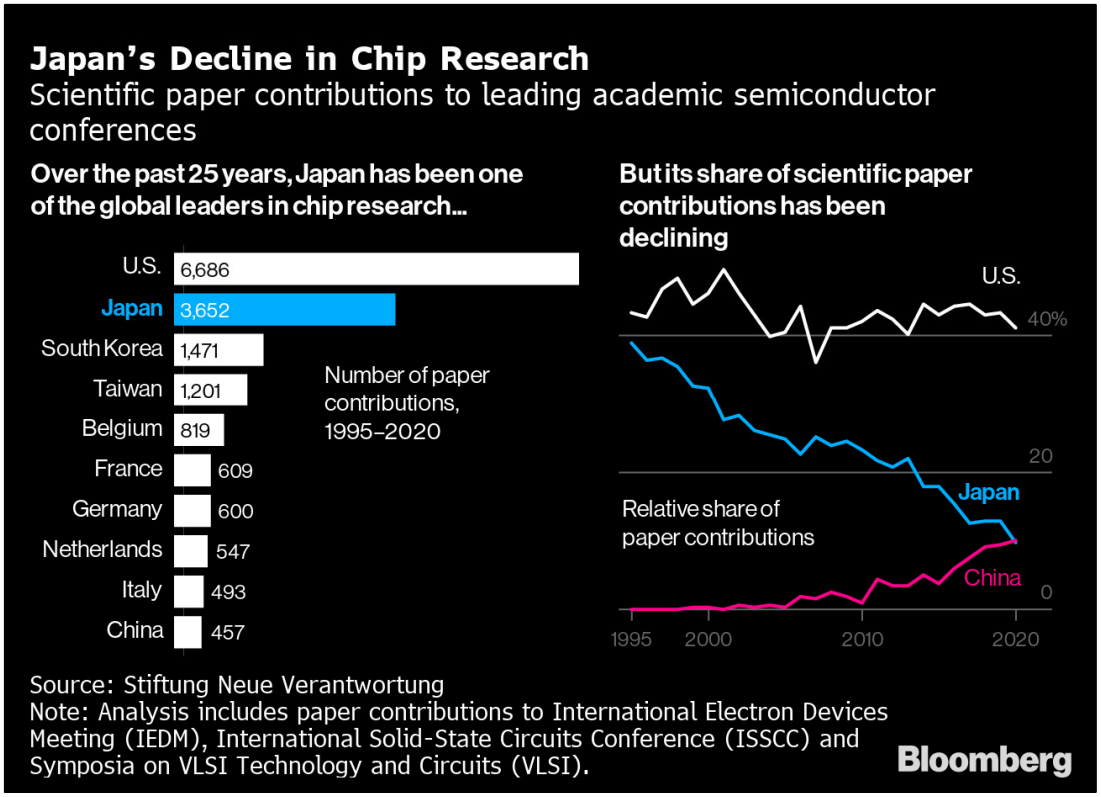
JAPAN'S SHARE OF GLOBAL IC WAFER CAPACITY
(fabrication location)



Source: Knometa Research, "China's share of global wafer capacity continues to climb" dated 21 February 2022 in Knometa Research/Design-reuse.com/Global Wafer Capacity 2022 Report, downloaded on 21 February 2022, available at https://www.design-reuse.com/news/51465/global-ic-wafer-capacity-2021.html.

APPENDIX 4

JAPANESE CHIP RESEARCH
(comparison with other major players)



Source: Stiftung Neue Verantwortung, "Japan's Decline in Chip Research" dated 22 July 2021 in Bloomberg/Image Sensors World [downloaded on 22 July 2021], available at http://image-sensors-world.blogspot.com/2021/07/more-about-sony-tsmc-fab-in-japan.html.

APPENDIX 5

INVESTMENTS BY MAJOR INDUSTRY PLAYERS OF MICROCHIP PRODUCTION (2021-2030)

Major investments by top chipmakers

Company	Investment	Locations
TSMC *(Taiwan)*	• $100 billion plus $7 billion *(Japan fabrication plant)* through 2023	Taiwan, U.S., China, Japan
Intel *(U.S)*	• $20 billion for new foundry plants • Additional 80 billion euro *($90 billion)* planned in Europe for the next ten years • $7.1 billion chip packaging plant in Malaysia	U.S., Europe, Malaysia
Samsung *(South Korea)*	• $151.1 billion to expand non-memory chips *(Including $17 billion for a new foundry plant in U.S.)* through 2030	U.S., South Korea
SMIC *(China)*	• Nearly $19 billion investment to triple production capacity for 12-inch wafers • $7.6 billion for a new Beijing plant • $2.35 billion to expand a new Shenzhen factory starting 2022 • $8.87 billion to build a new Shanghai plant	China

Source: Bain, company announcements, Counterpoint Research

Source: Bain and Counterpoint Research, "Major investments by top chipmakers" dated 15 December 2021 in KrAsia and *Nikkei Asia*, downloaded on 15 December 2021, available at https://kr-asia.com/chipmakers-nightmare-will-shortages-give-way-to-a-supply-glut.

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Best regards,
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