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Global chip dependencies: Supply chain vulnerabilities and prospects for Indian offshoring

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Introduction

The notion of economic 'decoupling' has emerged as one of the key buzzwords in analyses of the increasingly fragile relations between the US and China in recent years. Decoupling is frequently discussed in terms of reducing American manufacturing operations in China to reverse the offshoring of jobs and protect US civil and military infrastructure (Black & Morrison, 2021). A key component of the broader discourse surrounding decoupling is a discussion on how long-term chip supply chain resilience can be ensured. The chip/semiconductor sector is a highly globalized industry that involves both chip design capacities, in which the American private sector remains key, as well as the process of chip manufacturing. Chip manufacturing and especially the manufacturing of advanced chips is dominated by a small number of key firms in East Asia and in Taiwan in particular. As such, Chinese aggression toward Taiwan (for instance in the form of an invasion or a naval blockade) would significantly disrupt manufacturing output, decreasing the availability of chips for both consumer goods as well as more advanced, partially AI-dependent technology systems.

In Washington, China's emerging role as a more central part of global chip supply chains over the course of the 21st century has evoked concerns about losing the technological supremacy the US has enjoyed over the past decades. If State-linked Chinese firms manage to design and manufacture chips that can rival those developed by the US, policymakers in Washington fear, China will be capable of rivaling the military-technological dominance that has defined US military power since the late 1970s (Miller, 2022). While chips are currently used in a variety of everyday items and appliances, the use of more advanced chips is crucial for the development of AI technology, supercomputers, and cutting-edge military software and hardware, including hypersonic missiles (Harris, 2023). Under the Trump administration, the US began imposing significant sanctions on leading Chinese technology firms such as Huawei and ZTE, targeting the Chinese access to US-linked chip technology and equipment. The Biden government has maintained and expanded this sanctions regime through a series of executive actions and the 2022 CHIPS and Science Act. The 2022 sanctions have included measures that prevent US companies and citizens from working with Chinese chip companies and make it harder for Chinese commercial companies to access components required for the manufacturing of advanced chips (Sheehan, 2022). The CHIPS Act also seeks to strengthen domestic chip manufacturing in the US via a total investment pledge of 52.7 billion US$ (Kannan & Feldgoise, 2022). Chip technology and the industry's link to Taiwan has become a defining part of contemporary China-US relations.

The attempt to 'offshore' chip manufacturing and reduce the dependence on Taiwan-based manufacturing has not been isolated to the US, with India also seeking to play an increasingly important role in the industry. Japan, France, Germany, and Spain have launched a series of investment incentives for chip manufacturers to set up manufacturing plants, known as 'fabs', in their countries (Data Center Knowledge, 2023). In February 2022, the European

Union passed the European Chips Act, which has a total value of 45 billion US$ (Cota, 2022). The Indian equivalent is the India Semiconductor Mission (ISM), launched in late 2021. With a total investment volume of 30 billion US$, the ISM seeks to establish India as a key hub for chip manufacturing, design, and packaging (Ministry of Electronics & IT, Government of India, 2022). Through the ISM, India aims to emerge as an alternative in the increasingly competitive offshoring market.

This paper retraces the supply chain trajectories that have led to the contemporary reliance on Taiwanese manufacturing and some key equipment firms before exploring the prospects of India's attempt to establish itself as an offshoring destination. After briefly discussing how East Asia has emerged as a key space for chip manufacturing, the paper examines how increased geopolitical tensions have led to the development of sanctions regimes by the US vis-à-vis China and acceleration of offshoring incentives. The paper then zeroes in on the ISM, discussing both the progress made by the ISM as well as its challenges.

Asia, Taiwan, and supply chain vulnerabilities

Taiwan's centrality in the chip industry is a result of the offshoring drive toward East Asia that came to dominate chip manufacturing throughout the 1960s. In 1963, the US company Fairchild was the first to set up manufacturing operations in Hong Kong, where labor costs were significantly lower than in the US (Miller, 2022). The chip design divisions, however, remained based in the US. Other US tech firms such as Motorola and Texas Industrials (TI) promptly followed suit, establishing fabs in places such as Malaysia, Singapore, South Korea, and Taiwan. This outsourcing of manufacturing diffused the chip-making process, with design remaining in the US but production occurring primarily in Asia. In the context of the US' war in Vietnam and the associated fears of communist contagion throughout wider East Asia, the establishment of US manufacturing and assembly operations provided employment for populations in urban centers, promoting economic development and reducing the appeal of leftist movements. Although driven by the private sector, the linking of the US chip industry and the economies of the US' East Asian allies and partners thus emerged as an economic-developmental component of the broader American Cold War strategy for the region.

Taiwan's role in the chip assembly process is the outcome of this outsourcing process. Taipei had sought to become a part of the broader chip supply chain as early as the early 1960s to generate jobs for the Taiwanese population, acquire leading technologies, and deepen its economic-political relationship with and the United States amid continued fears of a Chinese invasion of the island (Miller, 2020, p. 163). In 1968, TI representatives visited Taiwan to discuss the construction of fabs on the island, with the first fab becoming operative a year later. For Taiwanese policymakers, growing US investment and an integration into the chip supply chain created economic advantages and strategic leverage due to the growth of US vested economic interests in Taiwan, which may raise Washington's willingness to deter potential Chinese aggression down the line.

Taiwan emerged as the central node in the global manufacturing network in the mid-1980s through the founding of the Taiwan Semiconductor Manufacturing Company (TSMC). After 1968, Taiwan had developed into a key chip assembly hub but was not part of the more advanced design process. Moreover, other Asian economies provided similar assembly capacities. The launch of China's Reform Era in the late 1970s also led to growing chip

assembly capacities in China, where labor costs were lower than in Taiwan. In short, Taiwan had no distinct competitive advantage and ran the risk of falling into the middle-income trap. The middle-income trap describes a scenario in which a middle-income country *"can no longer compete internationally in standardized, labor-intensive goods because wages are relatively too high, but it can also not compete in higher value-added activities on a broad enough scale because productivity is relatively too low"*, leading to *"slow growth, stagnant or falling wages, and a growing informal economy"* (Paus, 2017). In 1985, the Taiwanese government hired Morris Chang, who had previously worked at TI, to chair and lead the Taiwanese Industrial Technology Research Institute. Supported by Taiwanese private but especially public funding, Chang founded TSMC as part of his new role. Instead of designing and manufacturing chips, Chang's vision for TSMC was to solely operate as a manufacturer for chips designed by other companies (Miller, 2022, p. 166). During his career in the industry, Chang estimated that the growing demand for ever-smaller transistors would exponentially increase the private sector costs for manufacturing and R&D, in the process pricing out companies with little capitalization. Further, fabless firms relied on companies such as Intel to manufacture their chips, with Intel itself being involved in both chip design and manufacturing and therefore being a de facto competitor for fabless firms. By having TSMC operating as a chip *"foundry"* that would solely manufacture chips and provide this service to smaller designers, TSMC thus provided an out for smaller companies and, crucially, did not compete with other firms in the design process.

Taiwan's contemporary centrality in global chip supply chains is the result of the foundry model, through which TSMC revolutionized the manufacturing networks in the industry. To acquire the intellectual property and technology required for the development of lithography equipment, TSMC entered a partnership with the Dutch manufacturer Phillips, which had a separate division called ASML that was solely focused on developing and perfecting cutting-edge lithography equipment. The partnership with ASML allowed TSMC to perfect the manufacturing process, reducing production costs while making manufacturing more efficient than its competitors. By solely focusing on manufacturing and eliminating the need for firms to have their own fabs, TSMC created market access for fabless startups which had previously relied on their design competitors (most notably Intel) for access to manufacturing. TSMC thus became the central and market-neutral node in global chip manufacturing, allowing it to coordinate between chip designers and set industry standards without directly competing in chip design.

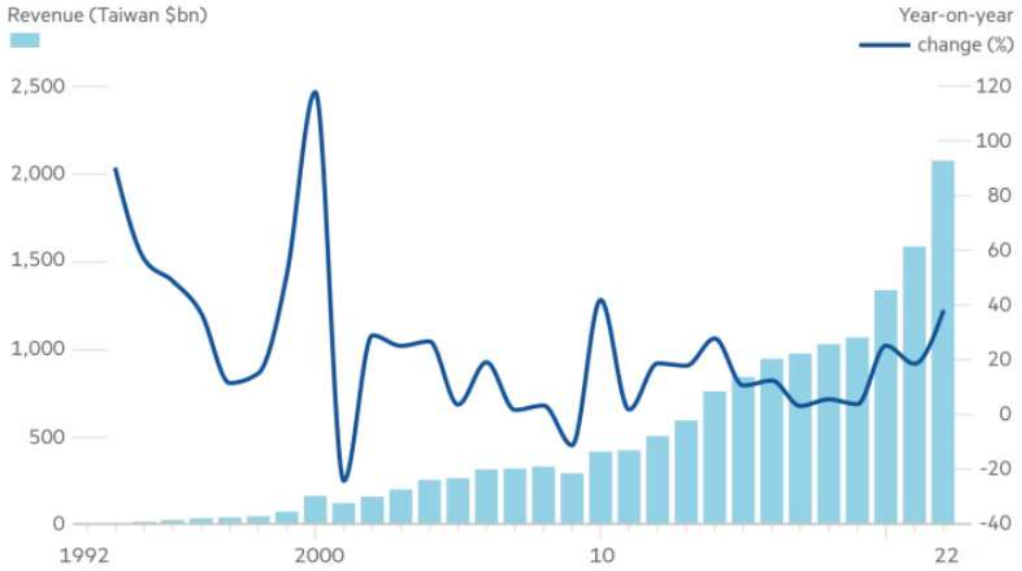
The birth of TSMC indicates the confluence of economic and broader strategic considerations that had become apparent in the 1960s. The Taiwanese government provided 48% of the start-up capital and pressured the Taiwanese business community to invest in TSMC (Miller, 2022, p. 167). As such, TSMC has always been partially a State project rather than a purely private entity that competes on the market solely for economic profit. The State-linked nature of TSMC illustrates that TSMC had a clear economic dimension (i.e., avoiding the middle-income trap by bolstering the role of Taiwanese manufacturing in added-value sectors) and a strategic one (i.e., make Taiwan more central to the globalized chip production network).

The case of Samsung illustrates the structural market advantages of TSMC's 'neutral' foundry model. South Korea emerged as a major chip manufacturer in the 1980s due to the support from US companies, which sought to reduce their dependence on Japanese manufacturers, and industrial policy akin to that in Taiwan. Government policy focused on the provision of cheap capital and loans from State-linked banks, effectively replicating the model

the Japanese government had developed to accelerate industrial development in the 1950s (Kim & Kim, 2006). US companies signing joint ventures with Korean firms gave Korean firms access to leading technology and allowed companies such as Samsung to outcompete Japanese manufacturers due to lower production costs (Sposato, 2023). Today, Samsung is the second-largest global foundry by revenue, making up 17.3% of the global market share (compared to 52.9% for TSMC) (Kharpal, 2022). Unlike TSMC, however, Samsung also produces its own products and designs its own chips. This makes manufacturing via the Samsung foundries less appealing for fabless firms given that Samsung is effectively a design competitor whereas TSMC merely focuses on the manufacturing process. Despite being the second-largest foundry firm in the world, Samsung can subsequently not immediately compete with TSMC for production dominance.

TSMC's foundry model has bestowed TSMC and Taiwan with a crucial importance for chip supply chains, creating severe dependencies on Taiwanese manufacturing. By avoiding an "integrated" approach that combines chip design and manufacturing, TSMC has emerged as an ever-more central component of the chip industry (Miller, 2022, p. 233) and now controls more than 50% of the global market share in chip manufacturing (Data Center Knowledge, 2023). TSMC's exponentially increasing revenues in the 21st century (see Figure 1) reflect the firm's rapid rise.

Figure 1: TSMC's revenues, 1992-2022

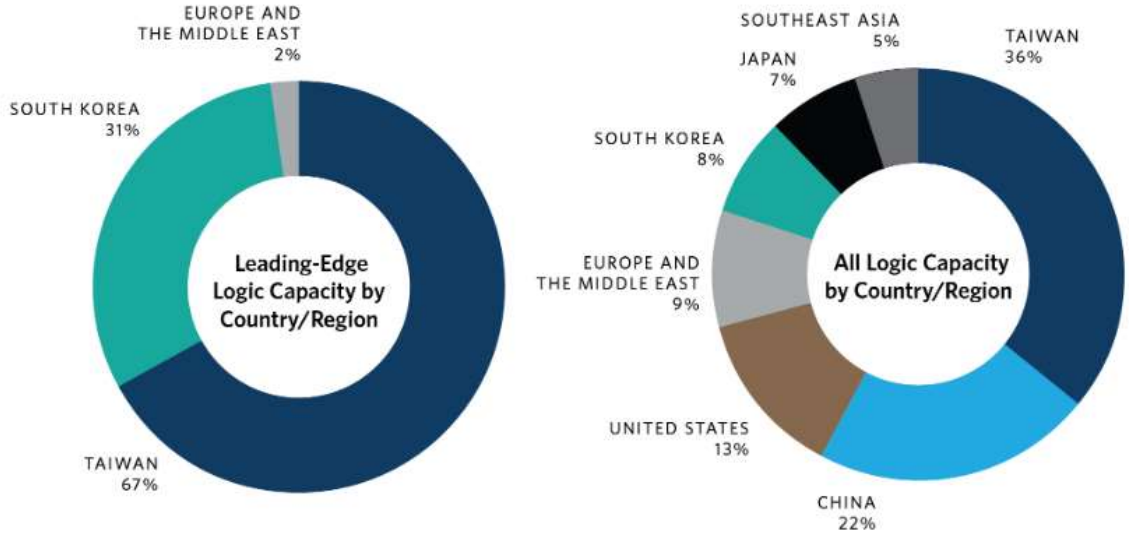


Source: Hille & Sevastopulo (2022).

Through a strong focus on R&D and continued investment in developing cutting-edge manufacturing processes, TSMC has maintained technological leadership in chip manufacturing, especially in the most advanced form of chips (such as 5nm and 7nm node technologies). Taiwan's integration into the chip industry from the 1960s onwards has also translated into a highly skilled workforce and a favorable business environment, allowing TSMC to attract and retain top industry talent. TSMC's existence as a government-backed venture also translates into continued political and regulatory support.

Beyond Taiwan, East Asia as a whole remains crucial for global chip supply chains. South Korean firms single-handedly produce 35% of NAND flash memory chips (Miller, 2022, p. 207), which retain stored data even when the power on the device is turned off, making them crucial for portable devices (Kingston Technology, n.d.). South Korean firms also manufacture 31% of cutting-edge logic chips, with 67% of the market being controlled by Taiwan (Kannan & Feldgoise, 2022). In the market for more basic logic chips, Taiwan accounts for 36% of the global production while China has now come to occupy a market share of 22%. (see Figure 2).

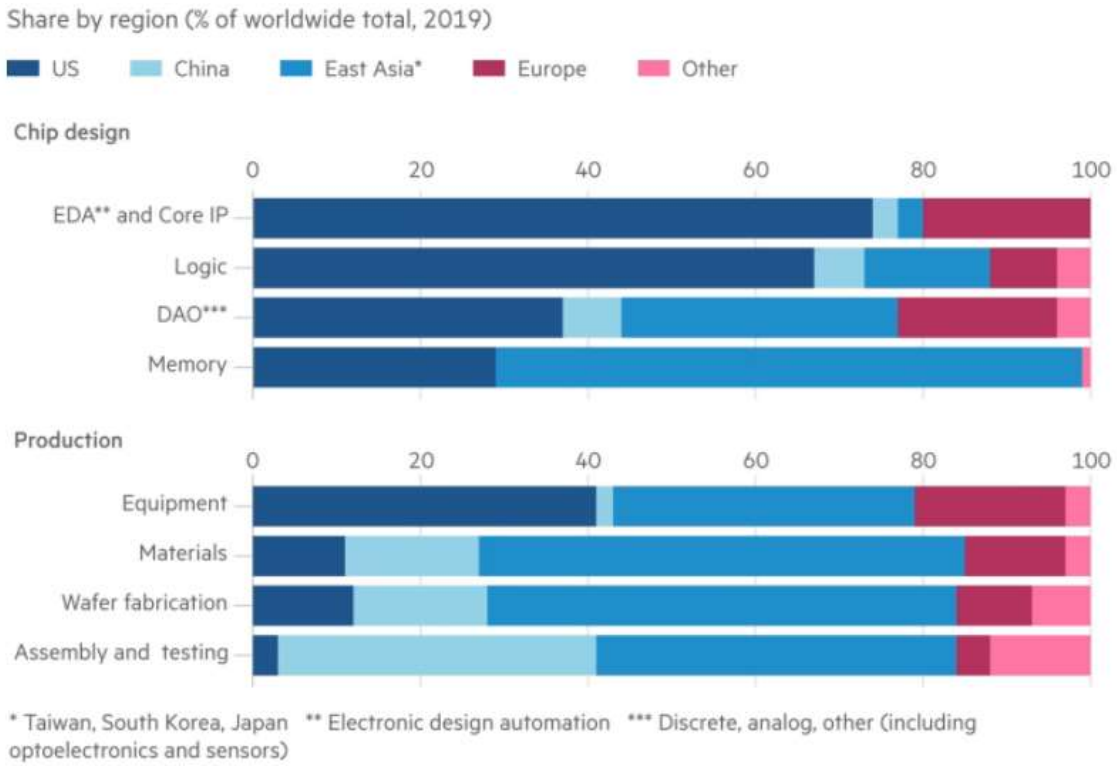
Figure 2: Logic chip fabrication capacity by country (2021)



Source: Kannan & Feldgoise (2022).

The industry's globalized nature is reflected by the focus of different countries and different regions on different components of the supply chain. While East Asian countries are key for manufacturing, the design process remains heavily shaped by leading American private sector firms (see Figure 3).

Figure 3: Globalized supply and value chains in chip design and manufacturing



Source: Hille & Sevastopulo (2022).

Going forward, TSCM's role as a leading manufacturer looks near unassailable. On the one hand, this is the result of TSMC's unique business model, which reduces the motivation of fabless firms to have chips manufactured by competitors such as Samsung. This model has also allowed TSMC to operate with an efficiency that other firms may simply be incapable of replicating. On the other hand, TSMC's foundry model cannot simply be emulated due to the variety of companies involved in the supply of technology and equipment to TSMC. There is also a more obvious cost element: building an advanced logic foundry is now estimated to cost at least 20 billion US$, massively restricting the number of firms that can finance advanced fabs (Miller, 2022, p. 208). Furthermore, even the successful completion of an foundry would create no guarantee that this foundry could compete with TSMC in the long run. While the dependence on one firm for chip manufacturing creates severe economic vulnerabilities for the global economy and tech industry, TSMC's role as a market leader is unlikely to change anytime soon.

Supply chain resilience, sanctions, and offshoring

The dependence on TSMC creates severe dependencies for economies worldwide. Choke points also exist at other points in the supply chain: ASML, for instance, now enjoys a de facto monopoly on the manufacturing of cutting-edge lithography equipment that is required for the printing of silicon wafers (Tarasov, 2022). As such, a disruption to ASML supply chains would create ripple effects that would impact TSMC and, thus, (temporarily) reduce the manufacturing of chips. While negatively affecting the availability of consumer goods, supply chain disruptions in advanced chip manufacturing would also reduce the access to more advanced technologies, including medical devices, missile launch platforms, and supercomputers (Hsu, 2022). In defense industries, advanced chips are also required for the

development of more sophisticated missiles, lasers, and air defense systems as well as the integration of AI into combat decision-making processes (Demarai, 2022). In short, a supply disruption would likely have severe global economic effects.

Supply chain disruptions and growing geopolitical tensions in Asia and elsewhere have driven a growing emphasis on enhancing the resilience of key supply chains, including in the chip industry. The market shocks caused by the China-US trade war, COVID-19, and the Russian invasion of Ukraine have led to supply chain security and resilience being made a growing policy priority throughout the world (Ghiretti, 2023). Tensions surrounding Taiwan play a key role in this: a recent analysis suggested that a hypothetical blockade of Taiwan by China would cost the global economy 2.5 trillion US$ annually due to the disruption in the chip supply chains (Powers-Rigg, 2023). Today, the chip industry and national chip policies have become increasingly shaped by a competitive logic that aims to reduce the exposure to supply chain shocks. In the US, this is linked with a drive to directly outcompete China, which has partially involved the policy alignment of US partners in Asia and Europe. The ambition to counter China is based on a two-pronged strategy: (1) sanctions designed to cut off China's access to high-end technology and manufacturing and (2) offshoring manufacturing to reduce vulnerabilities in times of heightened strategic competition surrounding Taiwan.

US Sanctions

For the US, sanctions have formed the primary policy tool to combat what the US has described as China's endemic violation of intellectual property rights (IPR) and the use of industrial policy to establish unfair market advantages for Chinese tech firms. Leading chip firms have long expressed concerns regarding China's subsidization of domestic firms, its forcing of joint ventures to acquire foreign technologies, and its weaponization of trade linkages as a means of gaining economic concessions and accessing technologies from foreign companies (Ghiretti, 2023). In a time of growing geopolitical tensions, these enduring concerns have obtained an increasingly strategic dimension. A key part of this is the erosion of the belief that economic interdependence could be a pathway for regulating Chinese behavior (Shoebridge, 2018).

Washington's sanctions regime was initially launched under the Trump administration. In 2016, Beijing had announced that it would spend 150 billion US$ until 2026 to develop a chip manufacturing sector capable of producing advanced chips (Demarais, 2022). When the US transitioned from an Obama to a Trump government, the new administration took a significantly more hostile approach toward the growing market share of Chinese technology companies. In 2017, the US began rolling out sanctions against the telecommunications company ZTE, forcing ZTE to pay an 892 million US$ penalty for delivering communication equipment to Iran in violation of US sanctions on Tehran (Freifeld, 2022). The main target of the Trumpian sanction package, however, was Huawei, which was positioned to become a key provider of global 5G technology, stoking fears that Huawei equipment could be utilized to spy on the US and its allies. The initial sanctions against Huawei were later extended by including Huawei on the FDPR (Foreign Direct Product Rule) of the Commerce Department's Entity List, which restricts Huawei from buying US products (such as chips) without a preapproved license (Sheehan, 2022). In practice, this meant that any firm using US technology in their chip production would also have to apply for a license to be able to sell to Huawei. With one stroke, the US had capitalized on the centrality of US technology in different parts of the supply chain, effectively eliminating Huawei's access to advanced chips (Miller, 2022). As it lacked the capacity to design and manufacture chips domestically, Huawei had to put its plans for 5G expansion on ice and lost significant market shares. Sanctions against Huawei had

indicated that US dominance in key choke points could be leveraged to hurt leading Chinese firms.

The Trump administration afterwards widened sanctions, a process that was continued by the Biden government. In effect, the US has been pursuing an approach of "low-grade economic warfare" since 2018 via a series of tariffs, export controls, investment blocks, and visa limits (Bateman, 2022). This has included policies that prevent US venture capital firms from contracting with US government agencies if they have previously taken up Chinese investments (Iyengar & Detsch, 2023). The 2022 CHIPS Act has included measures to specifically reduce the access of Chinese firms to graphics processing units (GPUs) required for AI development, supercomputing, and the construction of sophisticated data centers (Scharre, 2023). Further, sanctions have targeted China's access to key technologies in parts of the chip supply chain. This includes measures that prevent US companies and citizens from working with Chinese companies and measures limiting China's access to advanced manufacturing equipment (Sheehan, 2022). This is partially done by exerting pressure on non-US firms such as ASML to limit the Chinese purchase of lithography equipment (Demarais, 2022). American, Dutch, and Japanese firms control over 90% of the equipment market for advanced chip technologies, meaning that comprehensive policy coordination can significantly undermine China's efforts to construct high-end fabs (Scharre, 2023). These tech sanctions follow a logic comparable to that of financial sanctions:

> *"Like financial sanctions, these export regulations seek to force countries and companies to choose sides between the United States and the sanctioned country—in this case China. The United States is betting that the world's largest microchip producers, such as South Korea's Samsung or Taiwan's MediaTek and TSMC, will side with it and stop working with Chinese companies. Alternatively, these foreign firms could maintain ties to China, but this would come at a high price: Using U.S. technology to design or manufacture microchips for Chinese firms has become impossible"* (Demarais, 2022).

In effect, the sanctions have excluded China from an innovation and manufacturing infrastructure that remains dominated by US and US-linked companies (Sposato, 2023). The main choke point is the ban on US-designed chip software and manufacturing equipment. Eliminating China's access to US-linked hardware and software, which is present in effectively all parts of the chip supply chain, forces China to manufacture high-end chips at home, for which China currently lacks the capacity and will likely do so for the foreseeable future due to the sanctions (Allen, 2022). In practice, this leverages China's lack of capacity to design and manufacture advanced chips, which has kept Chinese firms dependent on R&D done abroad. In sanctioning technologies required at lower parts of the supply chain, the sanctions also raise the economic costs for China to establish the infrastructure required for advanced domestic manufacturing.

The sanctions' focus on eliminating China's access to high-end, AI-capable chips is particularly worth noting. For the time being, the sanctions put an end to China's ability to use TSMC-manufactured chips to develop a new class of hypersonic missiles and more advanced AI technology (Hsu, 2022). It is notable that the CHIPS Act does not just target the defense-industrial base but also the commercial sector. This is the result of China's emphasis on civil-military fusion, leading commercial companies to acquire advanced chips and then reselling them to the armed forces via shell companies (Sheehan, 2022). By targeting the commercial sector, these sanctions thus also limit the access of the Chinese military to AI-powered

technology, indicating the extent to which AI is viewed as crucial for maintaining long-term military dominance (Allen, 2022). This once again highlights the confluence of economic and broader strategic considerations, in this case in terms of limiting the R&D capacity of the Chinese defense industry.

The sanctions imposed on Russia following its invasion of Ukraine in February 2022 showcase the devastating short-term effects of a sudden stop in access to advanced chips for a modern military. The Russian military is heavily dependent on microelectronics designed and manufactured in Western Europe, Taiwan, and the US (Byrne et al., 2022). In the aftermath of the Russian attack, key microelectronics supplier countries imposed export controls on Moscow (Sheftalovich & Cerulus, 2022). This has led to the Russian military using less-advanced domestic products, degrading the quality of the Russian weaponry (Byrne et al., 2022). While the sanctions have not crippled Russia's overall ability to fight, they have reduced Moscow's capacity to fight an effective war against a Ukrainian army armed with high-tech, Western equipment.

Some voices in the US have expressed concerns that the 2022 sanctions are not stringent enough. One key domestic stakeholder in regulating the restriction of US products and technologies to Chinese firms is the Committee on Foreign Investment in the United States (CFIUS), which has been ordered to restrict Chinese access to technologies in sectors that do not necessarily have an immediate military application, including AI, quantum computing, and biotechnology (Iyengar & Detsch, 2023). CFIUS is constituted by representatives of several departments, including the US Treasury and the US Commerce, Defense, and State Departments, making interagency cooperation key for an efficient functioning of CFIUS. Under the Trump administration, the number of chip-related clearances granted by CFIUS to Chinese firms had already dropped by 33% compared to the Obama years (King & Wood Mallesons, 2023). Yet, the potential of inadequate coordination and the frequently blurry distinction between emerging and critical technologies has sustained concerns that the often-voluntary CFIUS reviews are inadequate to prevent Chinese firms from obtaining US-designed chip technologies (Iyengar & Detsch, 2023). The political support for sanctions in Washington and the concern that a largely unprecedented sanctions regime may prove insufficient indicates the degree to which anti-China policies have become a bipartisan position in the US and the extent to which a zero-sum logic has come to dominate US policymaking.

Others, however, have suggested that imposing sanctions now hurts the US' long-term interests by accelerating the indigenization drive of the Chinese chip industry. In response to American sanctions, Beijing has ramped up its institutional and financial support for technological self-sufficiency (Groenewegen-Lau & Laha, 2023). This includes an effort to optimize and align every step of the R&D process, shifting from a more decentralized innovation approach to one that openly emphasizes the pursuit of specific strategic objectives.

Over time, China is likely to gain access to other sources of manufacturing equipment as other countries may not share Washington's zero-sum logic and remain dependent on access to the Chinese consumer market (Sheehan, 2022). Non-US companies thus retain a strong incentive to work towards less-US-centric supply chains to circumvent sanctions and retain access to the Chinese market (Scharre, 2023). Sanctions subsequently run the risk of focusing China's market conduct on generating supply chains that are less dependent on choke points controlled by the US and its allies. Besides using most of its long-term leverage in the technology competition now and creating a greater incentive for Beijing to increase the indigenization of the industry, the US also risks creating competitive disadvantages for US

firms by limiting access to funds and talent, alienating partners through unilateral policies, and intensifying hostilities in the bilateral relationship with China (Bateman, 2023). There is naturally no way of accurately predicting if China does manage to catch up with the US-controlled industry and, if so, in what time. Yet, the potential surrender of Washington's main strategic advantage, its centrality in key parts of the supply chain, has worried some analysts and policymakers.

The US-driven sanctions policy constitutes a key part of the effort to push back against Chinese trade and tech practices. Crucially, they reflect the perception that only an exceptional sanctions regime can limit China's emergence as a key tech competitor in the face of corporate espionage, State-driven subsidies, and the reselling of US chips by shell companies to defense-industrial actors in China (Allen, 2022). The sanctions can prevent China from acquiring advanced technologies that could be used for military purposes and restrict China's access to advanced semiconductor technology by limiting the space for intellectual property theft. Yet, China's role as a key buyer of chips and chip technology could also disrupt supply chains and lead to higher consumer prices. Furthermore, the sanctions could undermine US interests in the long run by accelerating the push for indigenization.

Increased self-sufficiency and offshoring

The dependence on Taiwan-based manufacturing has driven the attempt by several countries to enhance their domestic manufacturing capacity, a process described as offshoring. In effect, the US and other countries seek to boost domestic chip manufacturing and reduce their dependence on Taiwan for multiple reasons. The most immediate motivation is enhancing supply chain resilience. Furthermore, countries may also seek to grow their own chip capabilities to remain competitive in a high added value industry. Finally, growing the domestic chip manufacturing sector can create jobs and stimulate economic growth. While having a highly domestic element, the offshoring of chip manufacturing is situated in and a result of broader geopolitical tensions in East Asia and subsequent supply chain vulnerabilities.

The arguably biggest push to boost domestic manufacturing of advanced chips has taken place in China. As discussed above, China has reacted to the sanctions launched by the Trump administration by heightening its push for technological self-sufficiency. This includes the 'Made in China 2025' program, which aims to boost the global market share of Chinese companies focused on *"automotive[s], aviation, machinery, robotics, high-tech maritime and railway equipment, energy-saving vehicles, medical devices and information technology"* (Wübbeke et al., 2016, p. 6). As part of Made in China 2025, Beijing aims to reduce the share of imported chips from 85% to 30% by 2025 (Miller, 2022, p. 250). China has heavily subsidized the development of a competitive domestic design and manufacturing sector since the start of the Reform Era in the late 1970s. Under Xi, State institutions have sought to reassert control over a corruption-marred sector that has largely failed to develop high-end chips (Macklin, 2022). In the pursuit of self-sufficiency, a reflection of the competitive logic applied to technology development in Beijing, China has now come to favor a more centralized development model (Groenewegen-Lau & Laha, 2023). In effect, self-sufficiency seeks to limit the leverage the US currently holds over key parts of the production and innovation supply chain. While this process has been transpiring throughout the 21st century, the sanctions have ramped up the urgency to achieve self-sufficiency.

Washington's offshoring push has significantly accelerated under the Biden administration as part of the CHIPS Act. While US firms continue to dominate the design market and are key for equipment development, their share of global manufacturing output remains limited. From a global market share of 37% in 1990, American manufacturers now only account for 12% of the global chip manufacturing output (Hille & Sevastopulo, 2022). The CHIPS Act seeks to address this through a stimulus package to reshore chip manufacturing to the US, valued at a total of 53 billion US$ (Scharre, 2023). While clearly geared to improving supply chain resilience and preventing chips from being sabotaged in the manufacturing process, the CHIPS Act also has a clear emphasis on boosting the competitiveness of US firms and creating jobs at home (Kannan & Feldgoise, 2022). TSMC is also working towards the construction of a fab in Arizona worth 12 billion US$, with the fab planned to start operating by 2026 (Hioe, 2023). Attracting investments from leading chip firms to set up manufacturing operations manifest key components in the US' broader offshoring policy.

Countries like Japan have followed suit in an attempt to attract investments from leading manufacturing firms. Japanese firms had lost the market shares they generated during the 1960s and 1970s to the more competitively priced Taiwanese and South Korean chips in the 1980s, eroding Japan's leading industrial role in the sector and contributing to Japan's 'lost decade' in the 1990s (Eguchi, 2022). Japan has now launched a large-scale industrial investment program that seeks to reshore some chip manufacturing to Japan via the construction of a TSMC fab worth 8.6 billion US$ (Sposato, 2023). 40% of this plant will be financed by Japan's Ministry of Economy, Trade, and Industry while also involving investment from the Japanese private sector, most notably Sony.

In countries concerned about a potential Chinese invasion or blockade of Taiwan, sanctions and offshoring are part or broader focus on enhancing their economic security. Geopolitical volatility and other supply chain disruptions have created a focus on enhanced resilience to secure long-term national interests. As economic security has become increasingly incorporated into conventional understandings of national security, however, balancing national security objectives and safeguarding an open economy are in an increasingly uneasy tension (Ghiretti, 2023). Moreover, this understanding of economic security is mostly not institutionalized in national bureaucracies with the notable exception of Japan, which now has a designated Minister of Economic Security. In Tokyo, policymakers understand economic security as being driven by the reshoring and diversification of supply chains as well as the promoted growth of critically important industries, especially those that may need government funding on top of private capital (Adler, 2023). The TSMC fab in Japan, co-financed by the government and Sony, exemplifies modern economic security making in the country. Ghiretti (2023) also notes that the linking of national and economic security creates tensions between unilateral and multilateral policymaking as countries may seek to prioritize national objectives over aims shared with their partners. Countries other than the US, for instance, may not seek to outcompete and contain China in quite the same way as Washington, which could create tensions further down the road.

Offshoring is also viewed critically in Taiwan as it reduces Taipei's strategic leverage that comes as the result of its centrality in global chip supply chains. For Taiwan, the chip industry and TSMC foster a degree of security that ensures continued US support for Taiwan in the face of an increasingly capable Chinese military, with Taiwan's centrality for chips forming a 'silicon shield' for Taiwan (Cronin, 2022). Now, the targeting of the Chinese commercial sector creates losses for Taiwanese. More crucially, Taiwan's aim of maintaining the 'silicon shield' clashes with the US' attempts to reduce its dependence on Taiwan-based

manufacturing. Offshoring attempts by the US have thus been criticized by Taiwanese manufacturers and politicians as *"hollowing out"* Taiwanese security (Powers-Riggs, 2023). Despite claims by TSMC and the Taiwanese government that TSMC's most advanced processes will be retained in Taiwan, the construction of the Arizona fab has been heavily criticized by parts of the Taiwanese opposition (Hioe, 2023). Attempts to increase self-sufficiency, including by offshoring, invariably come at the expense of the 'silicon shield', both by pushing industry indigenization in China (which reduces China's dependence on Taiwanese manufacturers, decreasing the cost of eventual supply chain disruptions for Beijing) and reducing the strategic dependence of Western partners (viewed as crucial to ensure support in times of increased tensions with China) (Powers-Riggs, 2023). For Taiwan, offshoring thus creates a higher degree of strategic exposure.

However, the financial and technological challenges associated with offshoring and supply chain indigenization render an achievement of complete self-sufficiency a highly unrealistic prospect. As discussed above, the construction of one advanced logic foundry is believed to cost up to 20 billion US$. The costs of a fully localized supply chain, even on a regional rather than national level, is believed to require an initial investment of 1.2 trillion US$, followed up by annual costs of 125 billion US$ (Hille & Sevastopulo, 2022). As such, the notion that China, the US, or any other country could become entirely independent from TSMC and Taiwan is unrealistic due to the gargantuan investments and public-private partnerships that would be required for complete self-sufficiency. As such, TSMC's role in global supply chains may change to a degree through increased offshoring. Even from a medium-term perspective, however, it appears unlikely that the chip industry can eliminate its reliance on Taiwan and TSMC.

The push toward enhanced self-sufficiency and offshoring reflects the increasingly competitive logic that China and the US have come to apply in their perspectives on the chip industry. Access to chips and the geostrategic role of Taiwan in the chip supply chain have become more and more influential in shaping policy discussions on the international relations of the wider Indo-Pacific. Yet, the prospects of offshoring are limited for the time being both because of TSCM's specific expertise and the costs associated with enhanced self-sufficiency. Self-sufficiency is therefore likely to increase but remain incomplete.

India's offshoring prospects

As part of the broader attempt to reduce dependence on Taiwan-based chip manufacturing, India has sought to emerge as a key location for chip manufacturing. The India Semiconductor Mission (ISM) provides the framework for this drive and is part of the broader 'Make in India' program of the Modi administration, which seeks to improve the competitiveness of India's manufacturing sector, especially in high added value sectors (Anand et al., 2015). Indian firms are already highly integrated in some parts of the supply chain, with designers in Bangalore playing a key part in the broader design ecosystem. The ISM, which came into force in December 2021, includes a series of policy components that seek to facilitate the development of a competitive manufacturing sector in India. These policy measures include:

1. The creation of chip manufacturing clusters to provide infrastructure, power, and water facilities to manufacturing companies. Clusters include fabs for display chips, compound chips, silicon photonics and sensors, assembly hubs, testing, and marking and packaging (ATMP) facilities (Rajagopalan, 2022).

2. The provision of financial assistance via subsidies, grants, tax breaks, and loans to manufacturing companies seeking to establish operations in India.
3. The creation of training and skilling facilities that provide training for engineers and technicians working in the manufacturing of advanced chips.
4. The encouragement of indigenous R&D via the provision of funding and infrastructure for educational facilities working on chip design and broader chip technology.
5. The creation of adequate policy frameworks ensuring the protection of IPR of chip manufacturers.
6. Provide financial assistance to chip startups, especially in areas that have become highly integrated into the wider sector (i.e., Bangalore).

Several states, including Karnataka, Telangana, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Odisha, Tripura, Punjab, and some Union Territories have already announced an interest in setting up manufacturing facilities, with decision being made based on the existing infrastructure and the investment incentives offered by individual states (Rajagopalan, 2022). The ISM ultimately provides the broader framework through which India seeks to emerge as a more attractive investment destination for companies aiming to reduce their dependence on Taiwan-based manufacturing.

Coordination on chip policies between India and its emerging partners also plays a key role in the Quad's efforts to develop more resilient supply chains. All members of the Quad (Australia, India, Japan, and the US) converge in their concerns regarding Chinese economic coercion and the potential market effects of an attack on Taiwan. As such, the Quad has made coordination of chip policy a priority (Nikkei Asia, 2021). This is driven by the underlying complementarity between all partners in different parts of the supply chain: the American private sector continues to lead advanced chip design, Japan has over time specialized in the mass production of silicon wafers and other manufacturing materials, Australia can deliver key minerals, and India can capitalize on its labor pool and its role in chip design (Gargeyas, 2022). Through enhanced cooperation and policy coordination between its partners, the Quad thus seeks to boost the capacity of individual members and its collective capability.

India enjoys some competitive advantage that creates the potential to play a significant role in the reshoring of chip manufacturing. India is home to a large pool of skilled engineers, many of whom are employed in the information technology sector and have gained experience working in market-leading companies abroad. The comparatively low labor costs make production in India attractive for multinationals that seek to diversify away from investment environments characterized by rising (or at least higher) labor expenses. As discussed, India already has a chip ecosystem in place, particularly in terms of chip design. This ecosystem can be developed further by leveraging the existing infrastructure and knowledge. India's role as an emerging manufacturer also does not make it an immediate competitor for more established and advanced manufacturing hubs, primarily in South Korea and Taiwan, making the establishment of joint ventures more attractive for firms from these countries. Lastly, the ISM fosters a favorable policy framework for investment in the sector. Indeed, the announcements that Apple supplier Foxconn is increasing its production capacity at a factory in Chennai and that the Taiwanese firm Pegatron has launched assembling the latest iPhone 14 model in India indicates the growing attractiveness of India-based manufacturing (Agarwal, 2022).

However, the Indian manufacturing sector also faces some key restraints that must be addressed going forward. One key factor is the general infrastructure gap, including the lack of specialized fabs, a partially insufficiently skilled workforce, and unreliable power supply that would significantly challenge the operation of any advanced fabs. This makes Indian manufacturing more costly, undermining the competitiveness of chips produced in India. Further, India only has limited indigenous access to a range of raw materials, including chemicals and rare earth metals. The need to import these materials again decreases the competitiveness of Indian products. Despite the ISM, India's regulatory environment remains difficult to navigate, especially on a state level. This can make it more difficult for companies to establish and operate manufacturing facilities as multiple government agencies are involved in the process of granting permits and approvals, adding to manufacturing becoming more time-consuming and expensive. As mentioned above, establishing more indigenized supply chains is also a highly costly endeavor that Indian firms may currently lack the capital for. Lastly, chip manufacturing requires a strong network of suppliers, customers, and partners. Despite the growth of the technology sector, India may currently not possess the same developed ecosystem as other countries, limiting its competitive advantage.

There are several steps and broader infrastructure investments India can undertake to boost its competitiveness in the chip manufacturing process. India could seek to streamline and simplify regulations to make them more transparent and predictable for international investors and chip manufacturers, for instance by reducing the number of permits and licenses, improving the coordination of policy measures between the national government and state administrations, and ensuring the adequate safeguarding of IPR. As part of the provision of financial incentives under the ISM, India could consider the creation of special economic zones (SEZs) to provide further tax incentives allowing for the duty-free import of necessary capital goods to stimulate investment from abroad. India should also bolster its investment in the development of a skilled workforce and more competitive R&D initiatives, including in collaboration with institutions of higher education and targeted collaboration with private sector entities.

Much of India's potential success is likely going to hinge on the more structural transformations the Indian economy is required to undergo to emerge as a leading global manufacturer. As part of a broader structural transition in the Indian economy, India must increase its investment in physical infrastructure such as roads, railways, ports, and airports. The Indian economy has also been plagued by a growing number of power outages in the past years due to partial coal shortages and rising temperatures putting additional stress on electricity grids (Biswas, 2022). The larger unreliability of the Indian power grid has been estimated to cost the Indian economy around 4% of GDP per annum (World Bank, 2018), reducing the degree to which manufacturing plants can operate effectively (Singh, 2022). Consistent access to reliable power is particularly crucial in the chip sector, where even minute distortions or supply shortages can lead to delayed, halted, or faulty production. Questions concerning energy systems and energy use in India are tied into broader socioeconomic domestic considerations. The reliability of its physical infrastructure and energy supply will be some of the key variables Indian policy must address in the coming years if India is to become a more influential manufacturing space, both for chips and other industries.

India has taken some important steps to establish Indian firms and manufacturing as a more central node in the global network of chip design and manufacturing. The ISM provides a useful initial framework through which to pursue these broader ambitions.

Conclusion

Today, chips are at the forefront of the geopolitical competition between China and the United States. Beyond consumer-oriented chips, especially advanced chips remain key for the development of advanced AI and supercomputing capacities that shape, among other things, cutting-edge military technology. Asian manufacturers play a decisive role in the manufacturing of chips due to the globalization drive that has dominated chip manufacturing since the 1960s. Taiwanese manufacturers and TSMC in particular, have come to play an utterly decisive role in this process, tying the island into the US' border security and economic interests in the Indo-Pacific and contributing to continued support for Taiwan in Washington.

Competition between China and the US, however, has come to complicate this dynamic. In both Beijing and Washington, a war-like logic has come to dominate technological policymaking, viewing technology transfers and competition in almost entirely zero-sum terms. Especially in DC, this leaves very little space for compromise going forward. As the 2022 sanctions package indicates, the intent of US policymakers is no longer focused on involving China in technology supply chains to a limited extent but to effectively destroy any prospect China may have had in catching up with the American chip capacities. Whether these sanctions will be effective in the long run remains to be seen. It is notable, however, that a strong anti-China position has become a bipartisan consensus in the United States. Further, China has thus far not leveraged its role as the most influential actor in the supply chain for critical minerals (such as lithium, nickel, cobalt, and manganese) that are essential for a serious push toward renewable energy due to the centrality of lithium-ion batteries (Lu & Scott, 2023). While China's ability to effectively resist American chip sanctions is currently limited, Beijing can widen the scope of this broader technological contest to areas in which US leverage is less pronounced. This raises broader questions as to how geopolitical tensions in East Asia may be alleviated going forward considering the fundamental divergence of China and the US on issues such as security, technology, human rights, and the broader political order of the region.

While the offshoring that is linked to these tensions threatens to weaken Taiwan's 'silicon shield', it presents other countries with novel opportunities to modify their role in global supply and value chains. India's ISM provides a useful framework for the broader governmental approach toward the industry but structural challenges facing India's economy today restrain the scope of its effectiveness. Introducing India as a more central global manufacturing agent will require more significant structural transformations that necessitate immense investments and continued political intent. That said, the degree to which offshoring is now pushed is likely to boost the Indian chip industry to some extent, even if India cannot currently compete with more advanced manufacturing destinations.

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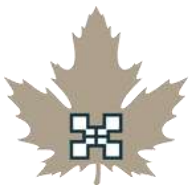

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