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Geopolitics of Semiconductors

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Executive Summary

- Semiconductors or chips are tiny pieces of silicones that power almost every electronic device we use today. From consumer-grade fridges to the most advanced fighter jets, semiconductors play an indispensable role in today's global economic, technological, and military sectors.
- The strategic competition between the United States and China has put pressure on the global supply chains of semiconductors, gradually turning chip production into another geopolitical tension that could bifurcate electronic device production and flow into 'red' and 'blue' camps.
- This article examines the geopolitics of semiconductors. First, it explains the nature of the existing global supply chains of semiconductors. Then, it analyses why chips have been at the centre of the US-China strategic competition and what the US and China have been doing in their respective effort to compete in this realm. Last, it examines the risks and consequences of an armed conflict across the Taiwan Strait.

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- បន្ទះឈីប គឺជាបំណែកតូចៗនៃសារធាតុស៊ីលីកូន ដែលផ្តល់ថាមពលដល់ស្ទើរតែគ្រប់ឧបករណ៍អេឡិចត្រូនិចដែលយើងប្រើប្រាស់សព្វថ្ងៃ។ ចាប់ពីទូរទឹកកក្នុងផ្ទះ រហូតដល់យន្តហោះចម្បាំងដែលទំនើបបំផុត បន្ទះឈីបដើរតួនាទីមិនអាចខ្វះបានក្នុងវិស័យសេដ្ឋកិច្ច បច្ចេកវិទ្យា និងយោធាក្នុងសកលលោកនាពេលបច្ចុប្បន្ននេះ។
- ការប្រកួតប្រជែងយុទ្ធសាស្ត្ររវាងសហរដ្ឋអាមេរិក និងចិន បានដាក់សម្ពាធទៅលើខ្សែសង្វាក់ផ្គត់ផ្គង់សកលនៃបន្ទះឈីប ដោយធ្វើឱ្យការផលិតបន្ទះឈីបទៅជាភាពតានតឹងផ្នែកភូមិសាស្ត្រនយោបាយមួយផ្សេងទៀត ដែលអាចមានសក្តានុពលធ្វើឱ្យផលិតកម្ម និងលំហូរនៃឧបករណ៍អេឡិចត្រូនិកបែកខ្ញែកជាពីរ ពោលគឺប្រភពផលិតកម្ម "ក្រហម" និង "ខៀវ" ។
- អត្ថបទនេះពិនិត្យមើលលើភូមិសាស្ត្រនយោបាយនៃបន្ទះឈីប។ ជាដំបូង អត្ថបទនេះធ្វើការពន្យល់ពីលក្ខណៈនៃខ្សែសង្វាក់ផ្គត់ផ្គង់នៃបន្ទះឈីបសកលសព្វថ្ងៃ។ បន្ទាប់មក ធ្វើការវិភាគ

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ថាហេតុអ្វីបានជាបន្ទះឈីបស្ថិតនៅចំណុចកណ្តាលនៃការប្រកួតប្រជែងយុទ្ធសាស្ត្ររវាងសហរដ្ឋអាមេរិក និងចិន និងសកម្មភាពអ្វីខ្លះដែលសហរដ្ឋអាមេរិក និងចិន បានកំពុងធ្វើនៅក្នុងកិច្ចខិតខំប្រឹងប្រែងរៀងៗខ្លួន ដើម្បីប្រកួតប្រជែងនៅក្នុងវិស័យនេះ។ ជាចុងក្រោយ អត្ថបទនេះពិនិត្យមើលលើហានិភ័យ និងផលវិបាកនៃជម្លោះប្រដាប់អាវុធនៅច្រកសមុទ្រតៃវ៉ាន់។

Introduction

Semiconductors or chips are tiny pieces of silicones that power almost every electronic device we use today. From consumer-grade fridges to the most advanced fighter jets, semiconductors play an indispensable role in today's global economic, technological, military, and industrial sectors. However, despite its small size, producing semiconductors requires one of the most capital-intensive and complicated manufacturing processes, requiring billions of dollars in investment, years of technical know-how, closely guarded intellectual property, constant innovation, and investment in human capital.

The current strategic competition between the US and China has posed significant pressure on the global supply chains of semiconductors, gradually turning chip production into yet another area of geopolitical tension that could potentially bifurcate the production and flow of electronic devices into 'red' and 'blue' camps. Simply put, the US-China tension over semiconductors is a cocktail mixed between geopolitics, economic interests, national security, mutual dependence, and technological contest.

This article examines the geopolitics of semiconductors. First, it explains the nature of the existing global supply chains of semiconductors. Then, it analyses why chips have been at the centre of the US-China strategic competition and what the US and China have been doing in their respective effort to compete in this realm. Last, it examines the risks and consequences of an armed conflict across the Taiwan Strait.

Global Supply Chains of Semiconductors: An Overview

Semiconductors or chips are small pieces of silicones embedded with millions or billions of transistors that make electronic devices such as smartphones, cars, planes, game consoles, Internet-of-Things (IoT), smart weapons, and autonomous vehicles functional. They are the "foundational technology" and the "new oil" on which the global economy runs (CSIS 2021; Draper 2021). They also power advanced technologies found in AI, quantum computing, and advanced weaponry.

Due to its capital-intensive nature and fierce competition, only a handful of companies make chips, classified into three groups. The first group is **Fabless**, referring to companies that design but do not produce their own chips. Apple, Nvidia, and Qualcomm are prime examples of fabless companies. The second group is **Integrated Device Manufacturers** (IDM), which are companies that design, produce, and install chips directly in their electronic devices. Samsung (South Korea) and Intel (US) are globally known IDMs. The last group is **Foundry**, which are companies specialised in manufacturing highly advanced, tiny logic chips such as processors required in smartphones. Foundries deploy state-of-the-art fabrication plants that require billions of dollars in investment to build, operate, and maintain. For these reasons, the foundry business is currently dominated by Taiwan Semiconductor Manufacturing Company (TSMC), which controls over 55% of the global advanced chip market (Lee and Kleinhans 2020).

In 2020 alone, TSMC accounted for 90% of all advanced semiconductors, making it the "linchpin" of the global chip supply (Klinger-Vidra and Kuo 2021). Moreover, TSMC and Samsung are the only two foundries producing the most advanced and smallest chips of 3 nm. TSMC has emerged as the most eminent manufacturer, producing 5-nanometer and 3-nanometer chips. According to Stokes (2021), the semiconductor market is a "fully baked cake" spanning continents and requiring raw materials, tools, software, technical specialities, and human capital from various countries. While China is the largest maker of silicone, the core material needed, Taiwan owns the most advanced chip fabs in the industry and is significantly ahead of Samsung and Intel (USGS 2020).

That said, to produce advanced 5-nm or smaller chips, TSMC must import extreme ultraviolet (EUV) lithography technology from the Dutch firm ASML and other hardware and software from US companies such as Applied Materials, KLA, and Synopsys (Bown 2021; Horwitz and Jin 2020). That means even though the US consumes 60% of TSMC's chips and is extremely dependent on Taiwan for chips, it has great leverage over TSMC's manufacturing and ties with China (Blank 2020).

Since chip production is highly transnational, any disruption to any supplier of elements could bottleneck the global supply chains, which have been strained due to the COVID-19 pandemic. Moreover, no country has achieved "strategic autonomy" or "technological sovereignty" in the semiconductor industry (Kleinhans and Baisakova 2020). The whole market relies on several different players, including Taiwan, China, the US, Japan, South Korea, and Europe. For these reasons, the semiconductor industry is highly vulnerable to shortage and disruption caused by export control imposed by the key actors involved.

Semiconductors amid US-China Strategic Competition

The Trump administration has imposed trade sanctions on Huawei due to the allegation that the company allows the Communist Party of China to spy on its customers. In May 2020, Donald Trump banned TSMC from supplying its chips to Huawei (McGregor 2021). This decision has severely disrupted Huawei's steady supply of chips for its smart device manufacturing and forced Beijing to speed up its plan to achieve semiconductor independence. Trump later required foreign companies using American software to apply for an export license when selling chips to Huawei, leading to another severe blow to China's technological advancement and triggering a tech war between Washington and Beijing (Keane 2020).

In addition to supply halting, TSMC announced its plan to build a $12 billion fab in Arizona to move its supply of advanced chips closer to major US military manufacturers. Later, Joe Biden upheld Trump's policies of banning Chinese tech companies from doing business with US firms by expanding the number of blacklisted firms. Most recently, he signed the bipartisan Secure Equipment Act of 2021 into law, prohibiting Huawei from obtaining equipment licenses from the US Federal Communications Commission (FCC) (Shepardson 2021). These decisions are part of the US attempt to cut China off the global supply chains of critical tech components.

There are four reasons why the US has pressured TSMC to cut off its chip supplies to China. First, the US is concerned about securing a steady flow of TSMC advanced logic chips for its high-tech defence equipment like the F-35 fighter jets (CRS 2020; Lee 2021). Second, the US is worried about China's increasing chipmaking capacities and its constant appeal to TSMC to move its advanced plants to the mainland. Third, the US is uneasy about the alleged IP thefts by Chinese engineers working at TSMC plants. An injection of malicious code into US-bound

chips could pose grave threats to the US's national security. Last, the chip industry is China's strategic vulnerability in which the US has the upper hand due to its leading technological prowess and leverage over TSMC. By cutting China off TSMC's supply, the US has used TSMC as a geostrategic instrument as part of its broader strategy to counter China to prolong, if not alter, the maturity of China's chip sector and undermine its overall technological advancement.

To avoid overreliance on US chip supplies, China has invested heavily in the chip industry for several years. In 2019, China captured only 5% of the global chip sale, whereas the US accounted for 47% or $412 billion (CRS 2020). According to the Semiconductor Industry Association (2021), China accounted for 36% of global electronics production and only 7.6% of all semiconductor sales in 2021.

In June 2014, China revealed a major initiative entitled "Guidelines to Promote National Integrated Circuit Industry Development" to create a leading chip industry by 2030 (CRS 2021). This document aims to meet 70% of the country's demand for chips by 2025. In this same vein, China unveiled the "National Integrated Circuit Industry Investment Fund" (also known as the "Big Fund") with a $21 billion investment from the national government. In 2015, Beijing released its "Made in China 2025" plan to push domestic firms further and become 70% self-reliant in chips in the next ten years (SIA 2021). Moreover, between 2014 and 2030, the Big Fund invests at least $150 billion to fund domestic production, overseas acquisitions, and purchases of chipmaking equipment (CRS 2021). In addition to the initiatives above, in its 14th Five-Year Plan (2021–2025), China identifies semiconductors as a key priority in its whole-of-government approach to "achieve technological self-reliance" (SIA 2021). It also announced a ten-year tax exemption for chip producers.

Overall, Beijing has played a central role in subsidising local firms, giving out tax preferences, posing trade barriers, attracting foreign talents, and forging ties with foreign labs (CRS 2021). According to a 2019 study by OECD, four state-backed firms in China received $4.85 billion in below-market loans from 2014 to 2018, while 43% of the $51 billion registered capital in the local chip sector is owed by the Chinese government (SIA 2021). Nevertheless, Kleinhans and Baisakova (2020) found that China still played a minimal role in the value chain of the chip industry, with little progress in chip design and assembly, whereas the US dominated the whole sector along with its allies such as Japan, South Korea, and Europe.

The Biden administration has adopted several key steps to decrease America's reliance on foreign-made chips and foster local production. In February 2021, Biden signed executive order 14017 to direct a 100-day whole-of-government review by different agencies on critical supply chains, including chips. In addition, the Biden administration encouraged its allies to work more closely to boost production, close the supply gap, and address China's role in the chip value chain. Later, the US Senate passed the "US Innovation and Competition Act of 2021", which earmarks $52 billion for federal financing for domestic chip production, research, and development.

In addition, two other legislations are being processed. The first one is the "Facilitating American-Built Semiconductors (FABS) Act", which, if passed, would offer an investment tax credit to local chip producers. The second one is the "Creating Helpful Incentives to Produce Semiconductors for America Act" (also known as the CHIPS for America Act), which would provide income tax credits and other incentives for domestic chipmakers to purchase

equipment and invest in new facilities. Multilaterally, the US has rallied its fellow Quad members to foster a more resilient supply of chips.

Semiconductors and Cross-Strait Tension

The US's pressure on TSMC to cut off supplies to China of advanced chips has complicated the tense relationship between Washington and Beijing and between Beijing and Taipei. Given TSMC's critical role in the global chip supply chain, Chinese firms Huawei and ZTE have been immensely impacted by Washington's export control on chips and related technologies. Although Beijing has not resorted to military means to force TSMC to sell chips to its companies, it is worth examining the fear of a military conflict over semiconductors.

President Xi Jinping has repeatedly made clear that the issue of reunification of Taiwan is a "historic mission" that must be fulfilled to achieve the "national rejuvenation" of the Chinese nation (Sacks 2021). With the US ramping up its blockade of TSMC chips to China, political and business leaders have carefully examined a possible armed conflict between Beijing and Washington over TSMC. However, any military action against Taiwan by China would not address the country's long-term shortcomings in the chip sector but may instead provoke an armed response from the US.

For the US, the stakes over a possible Chinese takeover of TSMC could not be any higher due to its reliance on TSMC for advanced chips that power its high-tech and defence industries. Since 1979, the US has adopted the policy of "strategic ambiguity" towards Taiwan, which has worked out well for Washington because it has deterred Taiwan from proclaiming independence from China and warned Beijing about serious repercussions for any military action on its part against Taipei. However, due to their worsening ties, some have begun questioning the viability of "strategic ambiguity" and proposed a new policy called "strategic clarity", in which the US makes it clear to China that any military action against Taiwan or TSMC would certainly invite a military response from the US (Haass and Sacks 2020).

Conclusion

In summary, semiconductors have been at the front and centre of the ongoing geopolitical competition between the US and China due to their indispensable roles in the global military, technological, and economic sectors. For Washington, maintaining a steady and trusted supply of advanced chips from TSMC is crucial for its national security and military prowess. In contrast, China has experienced major disruptions to its chip supplies since the Trump administration. Therefore, it has stepped up its national efforts to foster sovereignty in producing and supplying advanced chips. As a result, further escalations between the two rivals are possible due to the strategic role of semiconductors in their military and non-military industries.

The opinions expressed are the author's own and do not reflect the views of the Asian Vision Institute.

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