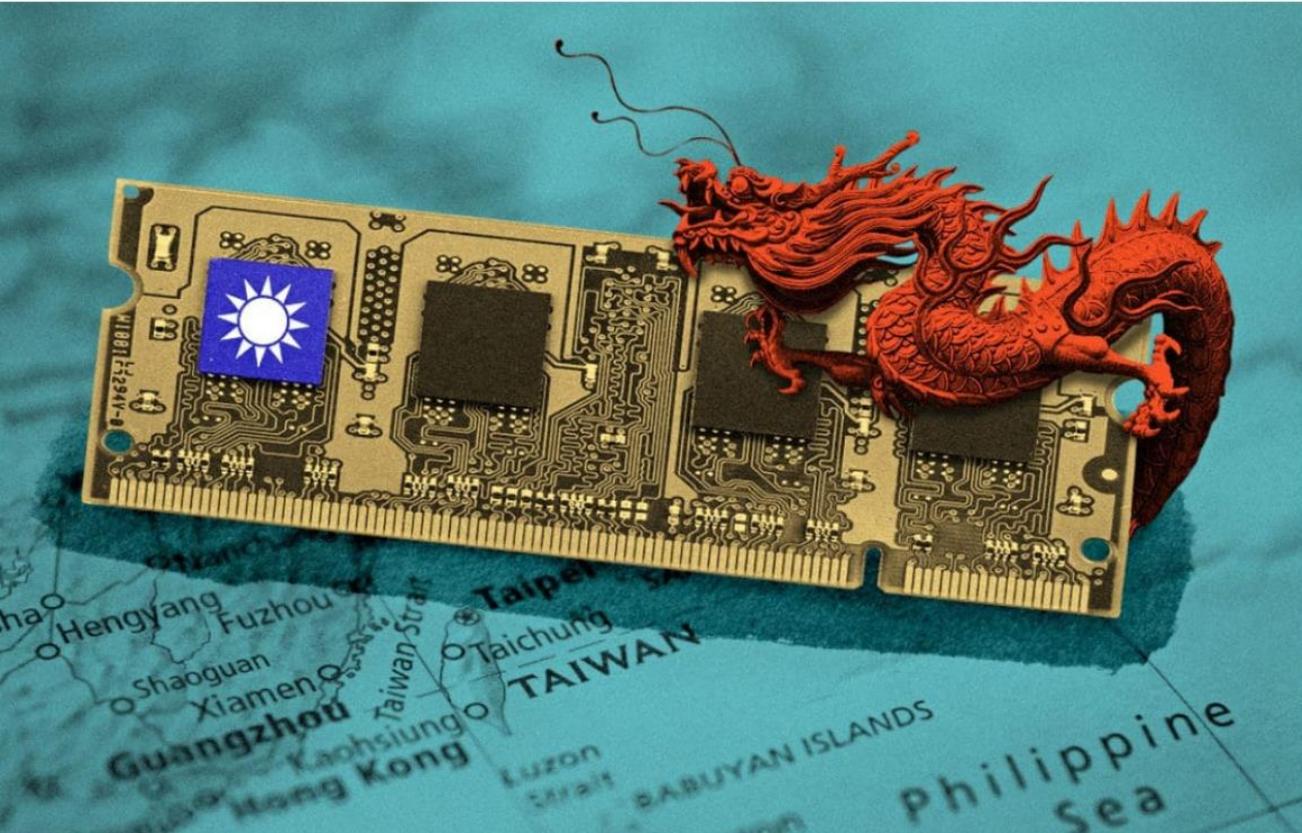


BACKBONE OF TECHNOLOGICAL DEVELOPMENTS: CHIPS - COMPETITION AND SUSTAINABILITY

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The chip industry is one of the cornerstones of modern technology and the global economy. Devices ranging from smartphones to cars, from F-35 jets to personal computers, rely on these tiny chips for functionality. Therefore, chip production and supply are at the center of international politics and economic power balances. We are living in an age where we are gradually moving away from oil and gaining momentum with electrification and digitization. In this process, our dependence on another critical element, chips, is increasing. States have recognized the importance of controlling chip production to gain a competitive advantage in the race for technological dominance. Mastery of chip technology has become not only crucial in shaping the future of technology but also a leverage point in the broader geopolitical landscape and a highly vulnerable point of weakness. This analysis delves into the impact of the chip industry on global competition and its future direction, focusing on how competition and sustainability will be shaped. These dynamics are factors that influence both technological innovations and international relations, and these interactions are fundamental elements that will determine the future of global technology and economic policies.

Competition Dynamics: New Battlefield for Major Players

In the increasingly unstable and chaotic environment of global technology and international trade, the competition between the United States (US) and China in the context of the chip industry is crucial. Historically, the US has been a leader in chip design technology with an ecosystem of companies such as Intel and GlobalFoundries. Traditionally, Washington had only restricted the export of cutting-edge chips for military applications to China. However, in its efforts to lead in chip technologies, the US has taken steps to restrict the sale of advanced chip technologies to Chinese companies, regardless of whether they are for civilian or military purposes and has supported the local chip industry with the \$280 billion CHIPS and Science Act.¹

With these steps, the US has pushed China towards localization by adopting blockade

strategies instead of “free trade,” and subsequently, China, recognizing the strategic importance of chips, has embarked on an ambitious mission to develop its domestic chip capabilities. Under initiatives such as “Made in China 2025,” China has allocated significant resources to chip research, production, and skill development. Following this initiative, concerns have arisen that China’s military and economic power is growing faster than expected, and there are concerns that the US is using its commercial technologies for this purpose.²

In addition to the CHIPS Act, which is one of the concrete steps of US-China chip competition, there are also US sanctions, and it is observed that the US is forcing allies such as Japan, South Korea, and the Netherlands to impose sanctions on China. In particular, Advanced Semiconductor Materials Lithography (ASML), the most valuable company in the Netherlands and a chip-producing machine supplier, has been

¹ The White House Facts Sheet, 2022

² Lawfare Media, 2024

prevented from providing maintenance and repair services for chip production equipment to Chinese customers. Such restrictions aim to limit China's acquisition and production capabilities of advanced chips, especially products or technologies used for supercomputing and artificial intelligence training.

In response, China continues its efforts to localize every stage of its production as an alternative path in chip competition. Many critics have argued that China has lagged behind in chip production from the most advanced technologies for years. This is because until very recently, China believed it could purchase this equipment from other countries. However, now, due to US sanctions, China, which is forced to follow the localization path, is interpreted as eventually being successful. When that time comes, it is likely that the decisions of states such as the US, Japan, Korea, and the Netherlands to regret will come when they lose their Chinese customers completely. Indeed, it is observed that allies who do not want to lose the Chinese market are resisting US pressure. On the other hand, South Korea emerges unexpectedly as the one suffering from US pressure.³ With more than a 20% decline in chip exports to China⁴, South Korea faces the harsh realities of conflicting with US hegemony in global trade dynamics. It brings to mind Henry Kissinger's saying, "Being an enemy of the United States is dangerous, but being its friend is deadly."

Indeed, China's localization strategy has become more apparent with Huawei's work on lithography equipment, the most critical stage in chip technology. These machines are the ones that produce chips,

and Huawei is building a massive R&D center in Shanghai, China. This development signals that China has entered the most critical period in modern Chinese history. China aims to gain originality and leadership in chips by breaking free from American pressure in line with its technological goals. If successful, these developments will render US sanctions against China's chip industry essentially insignificant and provide a high-quality and reliable chip production alternative when any sanctioned country builds capacity for its advanced lithography machines.

As the chip industry, which demonstrates spillover effects with the rapid development of technology, interacts with tensions and daily developments between the US and China, the small island nation of Taiwan, which is truly the leader of the chip sector, can not be considered separately from this situation.

Taiwan's Role in the Chip Industry

A single company called Taiwan Semiconductor Manufacturing Company (TSMC) dominates the chip market by producing the most advanced chips in the world. Taiwan's near-monopoly position in the advanced chip sector, especially considering the geopolitical tensions around Taiwan, destabilizes the global supply security by putting the situation at risk⁵. Those aware of Taiwan's international importance in the chip industry have called for an open defense commitment to Taiwan, and top US leaders have confirmed their military defense commitments to Taiwan.⁶ The geopolitical chessboard around Taiwan's dominance

³ Bloomberg, 2024

⁴ 동아일보, 2024

⁵ Sacks, D. (2023)

⁶ Sam Meredith. (2022)

position in the chip market reflects the interaction between technological competition, strategic interests, and broader international relations.

The stable migration of advanced capacity to Taiwan has created both a market and a political decision, creating both pressure and vulnerability.⁷ Although China's desire for reunification with Taiwan has long been a desire predating the chip industry, it has become a significant point of discussion in the context of technological dependence. Despite the challenges China faces in replicating Taiwan's success in advanced chip production, especially necessary for artificial intelligence, Beijing is believed to abandon peaceful commitments to Taiwan and resort to the use of military force. The motivation behind this military power could be to seize chip factories to address domestic chip production shortcomings.⁸

However, some experts argue that the magnitude of China's dependence on chips produced in Taiwan reduces the likelihood of an attack on Taiwan because the destruction or incapacitation of factories in Taiwan could potentially devastate the Chinese economy.⁹ TSMC President Mark Liu mentioned in an interview that in a scenario of a possible Chinese occupation, TSMC facilities would become "dysfunctional" due to their dependency on real-time connections with the outside world and could see the physical destruction of TSMC facilities as a potential deterrent.¹⁰ However, he also stated that this approach would incur significant costs for the global chip industry. TSMC's critical role raises concerns about the sustainability of the sector.

In response to these potential threats, the US continues to insist on TSMC establishing a factory in the US. As a result of this insistence, TSMC has announced that it will produce its most sophisticated chips in Arizona, USA, starting in 2028.¹¹ The US's all these efforts are to minimize the potential impact of a possible invasion of Taiwan. Just as in 1941 when the Soviets moved 1,500 factories from west to east during the Nazi occupation, the US, considering the possibility of war, may have embarked on such an initiative to continue its technological development and protect its most valuable ally according to its interests.

Sustainability and the Chip Industry

The chip industry presents a paradox in terms of its impact on the climate crisis, with both positive and negative aspects. Achieving global climate goals and reaching targets for a sustainable future will depend on chips. Chips are essential components, especially for technologies such as electric vehicles, solar panel arrays, and wind turbines.

On the other hand, chip production is a process that requires significant energy and water consumption. The rapid spread of chips to all sectors of the economy leads to concerning environmental impacts. Factors such as pollution in manufacturing facilities, depletion of raw materials, electricity consumption during use, and accumulation of electronic waste are some of these factors.¹² These factories can consume millions of liters of water per day, putting significant pressure on water resources. Additionally, chip factories'

⁷ Martin, B, et al. (2023)

⁸ Sacks, D. (2023)

⁹ Sacks, D. (2023)

¹⁰ CNN Interview with Mark Liu, mentioned in "On GPS: Can China afford to attack Taiwan?".

¹¹ OODA Analyst (2024)

¹² Aurélie Villard. (2015)

energy consumption is quite high, with much of this energy typically coming from fossil fuels, increasing carbon emissions. Indeed, TSMC's electricity consumption is expected to increase by 267% by 2030, an amount of electricity equivalent to that consumed by approximately a quarter of Taiwan's population, or 5.8 million people.¹³ TSMC also used 63 million tons of water for production in 2019.¹⁴

The amount of waste generated by these factories is also significant; hazardous wastes contain chemicals that can harm the environment. By 2030, it is estimated that 86 million tons of carbon dioxide equivalent emissions will spread globally.

When it comes to sustainability, climate crisis comes to mind first. However, another crucial point to consider when examining the chip industry from a sustainability perspective is the sustainability of supply chains. The COVID-19 pandemic has clearly demonstrated how fragile supply chains can be. In this context, diversifying and localizing supply chains for the chip industry have become important parts of sustainability strategies. During the pandemic, fully assembled automobiles had to wait for chip deliveries. Chip manufacturers prioritized home office technologies, putting the automotive sector on the back burner. This situation particularly highlights the importance of sustainable supply chain management. The pandemic has shown how vulnerable supply chains can be in various sectors and the risks of over-dependence on a single product. Indeed, comparing this new dependence on chips with the dependence on oil is possible. Steps taken to move away from the environmentally harmful and geopolitically charged use of oil have

merely reshaped with dependence on chips.

Future Perspectives and Strategies

It is evident that the future will be shaped by innovations in chip technologies. Technologies such as artificial intelligence, big data, and the Internet of Things (IoT) are opening up new doors in chip design and production. However, these innovations require high supply security and environmental compliance. Strategic investments and international collaborations will be crucial in this new era. In particular, high-tech competition between the US and China will continue to play a decisive role in the global chip market. US policies restricting technology exports to China and China's efforts to increase domestic production capacities outline the contours of this competition.

The Taiwan issue stands out as a critical milestone in the technology war between the US and China. Taiwan controls a significant portion of global chip production, increasing the island's strategic importance. China's view of Taiwan as a strategic target and the risk of potential military intervention could throw global chip supply into significant uncertainty. The US policy of supporting Taiwan aims to balance this uncertainty and thus aims to ensure both regional security and the stability of the global chip supply.

In this context, the focus of future strategies should be on ensuring supply security and minimizing environmental impacts. Various innovative solutions should continue to be developed to reduce environmental impacts. Additionally,

¹³ Green Peace. (2023)

¹⁴ Padraig Belton. (2021)

efforts should focus on developing next-generation chips with high energy efficiency to reduce energy consumption and encourage the use of more sustainable materials. Innovative chip production techniques that consume less energy and produce less waste will be crucial in achieving sustainability goals. Moreover, encouraging international cooperation and technology sharing can bridge the technological gap between different countries and support a more balanced distribution of global power.

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