Chips: The Battle for Technological Supremacy

During the Cold War (1947-1991), the United Sates and the former Soviet Union (USSR) competed not only for ideological, economic and political supremacy, but also for technological superiority in order to expand their influence and power across the world. Both nations aimed to demonstrate to the world which socio-economic system was superior and which country was at the forefront of technological development.

Undoubtedly, one of the main areas of competition was the space race, which ran parallel to the arms race. The Soviet Union achieved the historic feat of sending the first man to space in 1961 while the United States claimed the milestone of landing the first humans on the moon in 1969. This superpower rivalry persisted until the collapse of the Soviet Union in 1991, which ultimately led to US hegemony in the international system.

As a result, the space race between the US and the USSR accelerated the development of new technologies, including rocketry, satellite communication, robotics, computing, material science, Earth observation, medicine, and many others.

In particular, computer technology reached a major turning point in 1971 with the introduction of Intel's microprocessor 4004. This groundbreaking chip contained 2,300 transistors within an area smaller than a penny, making it the first commercially available microprocessor used in calculators. This development ushered in the era of computer chips, paving the way for the emergence of personal computers, tablets, smartphones such as iPhones, cloud computing and artificial intelligence (AI).

50 years later, in 2021, the US-based company Cerebras unveiled the Wafer Scale Engine 2 (WSE-2), which is currently the largest and most powerful single computer chip ever designed. It contains 2.6 trillion transistors embedded in an area nearly the size of an iPad. Manufactured by Taiwan Semiconductor Manufacturing Company (TSMC), the WSE-2 is specifically designed for AI applications that require an enormous amount of computing power for machine learning, deep learning and training of neural networks.

As we enter an era of increasing automation and widespread use of AI applications, the semiconductor industry (encompassing chip design, manufacturing, assembly, fabrication equipment, etc.) has emerged as the center arena of technological competition between the US and China. This is because the semiconductor industry plays a critical role in the fabrication of chips, which are essential components of virtually all electronic devices and machines, from computers and smartphones to advanced missiles systems and fighter jets.

Given the pivotal importance of the semiconductor industry, it has become a matter of national security for both geopolitical rivals. And similar to the US-USSR space competition, it has become a core sector for the US and China to project their power and influence among nations across the world.

As we know, chips are tiny flat pieces of semiconducting material containing transistors, capacitors, and resistors. These components are printed on a silicon wafer and interconnected to form integrated circuits (IC) to perform specific functions. They are the brain of computing devices, and the most known categories are as follows:

1) Central Processing Unit (CPU) chips, which are responsible for arithmetic, logic and memory functions.
2) Graphic Processing Unit (GPU) chips to perform visual display functions such as images, videos, animations.
3) Neural Processing Unit (NPU) chips, which are specifically designed for artificial intelligence applications such as ChatGPT, a large language model designed to provide more elaborated responses to queries posed by human beings. NPUs are the key to fostering more autonomous and intelligent software that can enable the next generation of robots and the so-called Internet of Things (IoT).

Apart from the US and China, there are also other important countries and regions that play a significant role in the global semiconductor industry. South Korea, Taiwan, Japan, and European countries including Germany, Netherlands, Switzerland and UK all have a strong presence in the global semiconductor supply chain. But it is important to point out that US companies have historically been at the forefront in the design and manufacturing of semiconductors.

However, in the mid-1980s, Japanese companies emerged as dominant players in the semiconductor industry, overtaking US companies. This shift in the semiconductor market dominance led to friction with the US government. The US complained of dumping and unfair trade practices by Japanese companies caused by a restricted market access for US goods as well as the managed undervaluation of the yen, making Japanese goods cheaper in world markets.

Consequently, the US, Japan, Germany, France and UK signed the Plaza Accord in 1985. This accord aimed to decrease the value of the dollar against major currencies, including the Japanese yen. Furthermore, the US and Japan negotiated a Semiconductor Trade Agreement to increase US access to the Japanese semiconductor market and control Japanese exports to the US, thereby addressing the trade imbalance that favored Japan.

As a result of these financial and trade agreements, Japanese products became more costly, while US semiconductors regained ground in the global market. Along with the appreciation of the yen, the emergence of new, cheaper semiconductor manufacturers from countries like South Korea and Taiwan, and Japan’s sluggish response to technological changes in the semiconductor sector contributed to the decline of the Japanese semiconductor industry. From having a global market share of over 50% in 1988, Japan’s share has fallen to below 10% today.

Following China’s accession to the World Trade Organization (WTO) in 2001, the Chinese economy commenced its integration into the global trade system. This move led to the adoption of market principles (albeit with Chinese characteristics) and increased trade and investment with members of the WTO. Through this economic integration, China gained entry to foreign markets, foreign investment and joint ventures that facilitated the transfer of technology and expertise across various sector of the economy, including the semiconductor industry.

Therefore, it was not a coincidence that most of the Chinese semiconductor companies gained momentum after China's entry to the WTO. Today, we observe Chinese powerhouses such as Semiconductor Manufacturing International Corp (SMIC), HiSilicon (Huawei), Yangtze Memory Technologies Co. (YMTC), Hua Hong Semiconductor, UNISOC (Tsinghua Unigroup), and other Chinese companies rapidly advancing and positioning themselves as significant players in the global semiconductor market over a period of more than 20 years.

The Chinese "catch up" in the semiconductor industry, as well as other technological sectors, undoubtedly relied on sustained support and oversight from the Chinese Communist Party (CCP). This CCP-led support became more apparent in 2015 when China introduced the "Made in China 2025" development plan. The plan aimed to attain technological superiority and self-reliance in 10 strategic sectors of the economy, including artificial intelligence.

Although Japan represented a serious challenge to the US supremacy in the semiconductor sector in the mid-1980s, it was an economic and commercial competition, managed by two countries that share similar values such as a rule-based international order, a democratic system of government, and an open market economy subject to internal and international regulations.

However, the challenge posed by China in the semiconductor industry goes beyond the sphere of economic and commercial competition. For the US, China represents an existential challenge driven by ideological considerations, reflected in a competition between China's state-controlled techno-capitalism and the US-led free market system. This challenge is boosted by China's growing economic and technological power with deep implication for US national security, similar to the challenge posed by the USSR during the Cold War. In a nutshell, China has become *the strategic rival* of the US.

The China challenge led the Trump administration (2016-2020) to shift the US-China relationship from engagement and cooperation to confrontation. Thus, in 2018, the US imposed tariffs on various Chinese goods, alleging unfair trade practices, similar to the allegations against Japan in the mid-1980s. In 2019, the Trump administration banned US companies from doing business with the Chinese telecom giant, Huawei Technologies, citing national security concerns over alleged Huawei's connections with the Chinese military. In 2020, the top Chinese chipmaker, Semiconductor Manufacturing International Corporation (SMIC), was included in the US Entity List and banned from doing business with US semiconductor companies on the same national security grounds.

The Biden administration has not only upheld the Trump's hardline trade policy towards China but has also broadened export restrictions to include 36 Chinese semiconductor companies and entities as of today. The export restrictions seek to limit, in China, the development of advanced node semiconductors, semiconductor production equipment, advanced computing capabilities and supercomputers. Additionally, the restrictions limit semiconductor expertise or consulting services provided by US citizens to Chinese companies. Foreign companies exporting to or manufacturing advanced semiconductors in China using US technology are also subject to these restrictions.

According to the US Under Secretary of Commerce for Industry and Security, Alan Estevez, the new export controls are designed to "prevent sensitive technologies with military applications from being acquired by the People's Republic of China's military, intelligence, and security services"**.**

Furthermore, in August 2022, the Biden Administration signed the CHIPS and Science Act of 2022, which provide over US$50 billion in financial incentives and tax breaks to bolster US semiconductor manufacturing, supply chains, national security, research and development as well as workforce training. The CHIPS Act and Science is the US government's industrial policy response to the "Made in China 2025" development plan, which aims to make China a global leader in key technology sectors, including semiconductors.

Moreover, in March 2022, the US put forward a proposal to establish the Chip-4 alliance with the world's leading semiconductor producers, namely Taiwan, South Korea and Japan, with the aim of creating a a stable and resilient semiconductor supply chain and countering the rise of China's semiconductor industry. In February of this year, senior officials of the Chip-4 countries had their first working group meeting to discuss ways to strengthen the semiconductor supply chain, following a global chip shortage caused by the COVID-19 pandemic.

Regarding the US semiconductor export restrictions to China, South Korean, Japan and Taiwan are navigating a challenging landscape as China is a critical market for their semiconductor products. The US has adopted a case-by-case approach dealing with these countries, providing them with temporary export licenses to China. However, the sale of semiconductor manufacturing equipment containing US components that could enable Chinese firms to produce advanced semiconductors smaller than 14 nanometers is restricted due to national security concerns. The development of artificial intelligence heavily relies on chips that are 14 nanometers or smaller, and currently, Taiwan' TSMC, South Korea's Samsung and US' Intel are manufacturing 3-nanometers chips.

In addition, Japan and the Netherlands, which are top global players in semiconductor manufacturing equipment and materials, has also imposed export restrictions on semiconductors without naming any particular country; however, it is not a secret that both countries have been urged by the US government to restrict exports to China of key components of advanced semiconductor technology.

Undoubtedly, the US semiconductor export restrictions has temporary slowed down China's drive to achieve technological superiority, but at the same time, they have also pushed China to accelerate the domestic design and fabrication of semiconductors and reduce dependence on foreign chipmakers. It is worth noting that China has already produced 14-nanometers chips and is close to produce 7-nanometers chips. Some experts argue that it might take 5 to 10 years for China to build its own state-of-the-art semiconductor ecosystem.

Indeed, in the face of US sanctions, China has initiated a restructuring process to achieve self-sufficiency in the semiconductor industry. This will not be an automatic decoupling process, but rather a national mission to build its own semiconductor ecosystem while still utilizing western-made mature semiconductors (older chipmaking architecture). In this regard, Liu He, a top economic adviser to the Chinese president, Xi Jinping, recently declared to top industry representatives that the approach to the semiconductor industry must be a "whole nation" effort, leveraging both *state and market power*.

Therefore, it is not a surprise that Huawei Technologies, one of the most influential tech companies of China, is quietly spearheading efforts to build a domestic supply chain after being hit hard by the US sanctions. As the supply of US advanced semiconductor was cut off, Huawei turned to domestic suppliers and has even engaged in chip production itself. Prior to the export restrictions, Huawei had already positioned itself as a top global player in 5G networks and competed with tech giants such as Apple and Samsung.

Additionally, in response to US export restrictions, the Cyberspace Administration of China recently launched a cybersecurity review of the US semiconductor company Micron Technology, citing the need to "safeguard key information infrastructure supply chain security" and "prevent cyberspace security risks due to problematic products". Micron Technology is the largest US memory chipmaker, and China's actions towards it are seen as a warning signal to other key players in the semiconductor global supply chain, including South Korea, Taiwan, Japan, and the Netherlands, all of which are heavily dependent on the Chinese semiconductor market.

I believe that the Cold War 2.0 is already here and is being staged at the cyberspace. The US-China technological confrontation, aggravated by China's strategic friendship with Russia, has initiated a technological decoupling and political fragmentation of the globalization process with profound consequences for the architecture of the international system in the XXI century.

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Notes

My articles are food for thought and mainly addressed to relatives, friends, acquaintances and general public to reflect and generate discussion on current issues.

I also wish to point out that, although I am not the owner of the truth, I am entitled to my opinions as long as the rule of law exists and freedom of expression is guaranteed.