

# A Comparative Study on The Development of Chip Industry Between the Two Countries Under the Background of Sino-US Conflict

Mengdi Sun \*

Chengdu Jincheng University, Chengdu, Sichuan, China

\* Corresponding author: Mengdi Sun (Email: 2803356849@qq.com)

**Abstract:** Since the United States officially launched a trade war against China in 2018, the contradiction between China and the United States has gradually expanded, covering many fields such as science and technology, finance, geopolitics and ideology. On August 9, 2022, the then President of the United States signed the "Chip and Science Act" to safeguard the security of the national semiconductor supply chain and promote the return of manufacturing. China's chip industry will be seriously affected in the short term, but in the long run, this will encourage China to accelerate the pace of localization. From the current perspective, there is a huge gap between China and the United States in many aspects, and it is difficult to catch up with or even surpass the United States in the short term.

**Keywords:** Sino-US conflict, Chip industry, Semiconductor industry chain.

## 1. Introduction

The Sino-US trade dispute has become a central issue in the international political and economic field, which has a profound impact on the global economic landscape. Chen Jiyong (2018) and Kwan (2020) revealed the root causes of Sino-US trade frictions. Zhang Huaxin et al. (2019) and Guo Hongfu et al. (2019) discussed the causes of the contradictions from different perspectives, and put forward corresponding countermeasures and policy recommendations for China. Cui, Sun, Melnikiene et al. (2019) investigated the specific impact of globalization on local society and the possible long-term social changes.

One of the cores of modern science and technology is the chip industry, which is closely related to international development and national security. Taylor (2023) and Meiksin (2022) describe the development trend of the global chip market. Xue Lan et al. (2022) and Shi Jiuling et al. (2024) studied the impact of the chip bill on the global chip industry competition pattern in China. Luo & Van Assche's (2023) focused on how the bill aggravated the technological competition between China and the United States, highlighting the increasing uncertainty of technological geopolitics. In the field of semiconductors, China has put forward policies such as 'Made in China 2025', '14th Five-Year Plan' and national funds, which will help promote the progress of China's semiconductor industry, highlighting the importance of structural adjustment and promoting innovation. It promotes the anti-corruption work of the chip industry and highlights China's great attention to the chip industry.

Under the combined influence of global economy, scientific and technological progress and geopolitical pattern, countries are gradually paying attention to the adjustment of global supply chain structure. Baldwin & Freeman (2022) conducted research on the uncertainties inherent in global supply chains, especially the challenges posed in the context of the Sino-US trade conflict and its potential impact on the global economy. In the process of promoting supply chain

reshaping, a variety of policy tools have been designed, such as near overseas contracting, the Indo-Pacific economic framework, 'risk reduction' policies, regional integration, etc., which have played a crucial role.

## 2. Comparative Analysis of The Chip Industry Between the Two Countries

### 2.1. Advantages of Industry Development in China and the United States

#### 2.1.1. Advantages of the United States

Adequate research funding is a major advantage in the development of the U. S. chip industry; good scientific research environment, with the world's advanced laboratory mature scientific research innovation and market transformation mechanism.

In 2017, the US government's total investment in research and development reached USD 496 billion, mainly from the National Science Foundation (NSF), the National Institutes of Health (NIH) and the Department of New Energy (DOE). The research focuses mainly on the fields of life science, physics, chemistry, computer science, material science, mathematics and so on. Among them, basic research and innovative technology account for 70 % of the investment proportion.

#### 2.1.2. Advantages of China

China's chip industry has significant advantages in one of the world's largest unified markets and the world's most complete manufacturing industry chain. The huge population forms a huge amount of information, covering a wide range of vertical areas.

China's medium-sized families are large, and the level of urbanization is still about 18 percentage points lower than that of developed countries. The consumption rate of residents is less than 30 %, which is lower than the world average. The total number of workers in China is 96 million, of which the employed population reaches 740 million. It is estimated that by 2023, the number of college graduates will reach 10.47 million. People pursue high-quality life. In addition, as a global production center, China has established a sound

industrial structure and corresponding scale. China is currently unique in having all industrial categories in the United Nations Industrial Classification. Over the past decade, manufacturing value added has been leading the world.

## **2.2. Comparative Analysis of the Chip Industry**

In the industry, the chip industry is often referred to as the semiconductor industry. Generally speaking, the core of the chip industry chain is divided into chip design, chip manufacturing and chip packaging / testing. In addition, semiconductor equipment and semiconductor raw material suppliers are located in the upstream of the industrial chain, while chip demand customers are located in the downstream of the industrial chain. A wide range of applications include automotive electronics, consumer electronics, medical, industrial, military and so on.

### **2.2.1. Semiconductor Material**

The semiconductor silicon wafer manufacturing industry has a high degree of technical challenges, a long R & D cycle, a large amount of financial support, and a cumbersome customer certification process. The global market concentration is quite high. The top five manufacturers in this field include Japan's Shin-Etsu Chemical, Japan's Shenggao, Global Wafer, Germany's Siltronic and South Korea's SK Silicon Dragon, which together account for more than 90 % of the market share. Compared with the major international semiconductor silicon wafer suppliers, there is a certain gap in the technical level of semiconductor silicon wafer enterprises in mainland China, the market share is also small, and the technical process and yield control are still significantly different from the international advanced level. In the field of semiconductor production, the application of photoresist is difficult and growing rapidly. Lithography and etching technology play a vital role in the production of integrated circuits, accounting for 40-50 % and 30 % of the chip manufacturing time and cost. For a long time, foreign companies have monopolized the photoresist market, especially Japanese companies control 70 % -90 % of the global market share.

### **2.2.2. Semiconductor Device**

The manufacturing process of semiconductor equipment includes front-end equipment and back-end equipment. In the total investment of semiconductor equipment, the proportion of front-end equipment is more than 80 %, and the proportion of etching equipment, thin film deposition equipment and lithography equipment is 22 %, 22 % and 17 % respectively. In the global market competition, China's semiconductor equipment is accelerating technological upgrading.

This technology determines the important size parameters of the chip. As the most challenging equipment in chip manufacturing, the performance of lithography machine directly affects the whole production process. However, there is a clear gap between China and the international advanced level in lithography technology. The industry mainly relies on imported technology, the manufacturing level is limited, and the market competition is extremely fierce. In particular, the extreme ultraviolet (EUV) lithography machine is mastered by a few companies around the world, which is an important equipment that affects the production of high-end chips. Considering the difficulty of developing EUV lithography machines, China still faces technical challenges in this field.

China has shown a comparative advantage in the field of

semiconductor manufacturing equipment. Etching equipment, as an important part, plays a key role in domestic substitution. As one of the three elements of semiconductor manufacturing, etching machine has a high degree of technical value and market demand. However, globally, American and Japanese manufacturers have dominated the etching equipment market, among which Fanlin Research, Tokyo Electronics (TEL) and Applied Materials (AMAT) have long dominated, with a total market share of nearly 90 %. The market share of China's mainland engraving equipment suppliers is limited. The market share of China Micro and North China Huachuang is about 1 %, which shows that domestic etching equipment has great potential in replacing imports.

## **3. The Specific Impact of The Sino-US Trade Conflict on The Two Countries**

### **3.1. Impact on the United States**

#### **3.1.1. The talent gap continues to expand**

According to the report of the Semiconductor Industry Association (SIA), by 2030, the United States will need 3.85 million workers with technical expertise, including skilled technicians, highly educated engineers and computer scientists. It is expected that 1.4 million jobs will be unfilled. For the U.S. semiconductor industry, 114,800 jobs will be added in the field of chip manufacturing and design, of which about 58 % (67,000 people) may have a talent shortage. Worker shortages are evident throughout the supply chain, from engineers promoting engineering design and materials research to technicians operating and maintaining plant equipment. The progress of the U.S. economy and chip industry lies in the importance of making up for the talent gap. If the shortage of human resources is not solved in time, it may bring more serious competitive pressure to the United States in the manufacturing and chip design fields.

#### **3.1.2. Inflationary Pressure Further Intensified**

After China imposed tariffs on the United States, the tariff rate of goods imported from the United States increased significantly. Because of their fierce price competition and meager profits in the international market, Chinese exporters have not chosen to cut prices sharply so as not to harm their own interests. However, Chinese exporters did not experience large-scale price cuts, and ultimately passed the tariff costs on to American consumers.

The inflation rate in the United States has been high in recent years, and there is a risk of secondary inflation. It may lead to increased inflation in the United States and hinder economic growth and employment.

### **3.2. The Influence on China**

#### **3.2.1. Increased Geopolitical Risks**

The United States has taken restrictive measures to curb China's technology transfer. The national security review system for foreign investment has been further strengthened by the United States, so China is no longer inclined to acquire technology by acquiring American companies. At the same time, restrictions on the business of U.S. companies and some high-tech companies in China have become increasingly stringent [1]. The blockade of semiconductor devices and the formulation of a series of related control policies have become a common initiative of the United States and its allies. In March and June 2023, Japan and the Netherlands

announced regulations on the export of semiconductor equipment.

### **3.2.2. Chip Semiconductor Talent Shortage**

According to data and analysis, China's integrated circuit industry faces many challenges in talent training and development. By 2023, the entire industry will need about 766,500 talents, but there is a gap of about 200,000 between talent supply and demand. The progress of China's semiconductor industry will be restricted by the lack of chip semiconductor talents [2].

### **3.2.3. Accelerate the Localization Process**

China has exposed the shortcomings of the autonomy of the semiconductor industry in the Sino-US trade friction. At the same time, the separation between China and the United States has revitalized the American semiconductor industry chain and promoted the process of domestic substitution. The Chinese government and enterprises work together to strengthen scientific and technological accumulation and innovation strength, increase investment in R & D and introduce talents, and promote the expansion and independent control process of domestic chip manufacturers.

## **4. Conclusion**

### **4.1. Industrial Scale and Market Position**

The US semiconductor industry has long been a global leader, with a huge industrial chain layout, covering top companies in chip design, wafer manufacturing, packaging and testing. American companies, such as Intel, NVIDIA, Qualcomm and other companies, maintain technological advantages in the field of CPU, GPU, and communication chips, and occupy a leading position in the global market share. China has the largest integrated circuit consumer market in the world, and the demand for semiconductor products continues to increase, which promotes the rapid growth of the domestic semiconductor industry. However, compared with the United States, China's semiconductor industry started late. Although significant progress has been made in recent years, it still faces challenges in the field of core technology and high-end chips. Some well-known enterprises, such as Ziguang Zhanrui, domestic integrated circuit enterprises, Wuhan Xinxin, have emerged in some specific fields, but in general, domestic enterprises still have considerable room for growth in the global market.

### **4.2. Technological Innovation Capability and R & D Investment**

The United States' R & D investment in the semiconductor field is among the highest in the world, and its innovation achievements cover many fields, including material science and process technology. For example, the United States has always been at the forefront of advanced process nodes, such as 5nm and below chip manufacturing processes. In terms of technological innovation, the United States has adopted a combination of industry, university and research to establish an efficient system. In order to catch up with the international advanced level, the Chinese government and enterprises have increased R & D investment, and actively enhance the level of independent innovation. As a supporting measure, relevant departments have also introduced a number of incentive policies to support enterprises and scientific research institutions to make important breakthroughs in scientific research and technological research.

### **4.3. Supply Chain Security and Industrial Ecological Construction**

The semiconductor industry in the United States has formed a complete ecosystem, including raw material supply, production equipment, EDA tool software, IP core and other important links, with high self-sufficiency rate. In addition, the United States has also established a wide range of international cooperation networks with countries to ensure the stability and security of global supply chains. China is also actively trying to promote the construction of independent and controllable semiconductor industry chain. On the other hand, the introduction of cutting-edge technology at home and abroad includes acquisition and cooperation. In terms of local supplier training is also accelerating, especially in the packaging test, materials and other relatively weak links have made some progress. However, in the face of international technology constraints, China needs to address supply chain challenges and establish a more comprehensive local alternative.

### **4.4. Policy Environment and Strategic Layout**

The United States has always attached importance to the development of the semiconductor industry, through the formulation of laws, providing tax incentives, funding research and other ways to support the development of the industry. Recently, the United States has proposed a series of new initiatives, including the promotion of the "CHIPS Act," which aims to enhance local chip manufacturing capabilities to safeguard national security and economic interests. The Chinese government also regards the semiconductor industry as one of the key areas, and has put forward relevant policies such as 'Made in China 2025' and 'The 14 th Five-Year Plan', which clarifies the development direction and objectives of the industry. In addition, with the establishment of the national integrated circuit industry investment fund and other measures, efforts to promote the semiconductor industry technology research and development and capacity expansion. In addition, in terms of strengthening the protection of intellectual property rights, China is also constantly improving relevant laws and regulations and optimizing the industrial development environment.

In general, there are obvious differences in the development stage, technical level and industrial ecology of the semiconductor industry between China and the United States, which also highlights China's determination and strategy to catch up. In terms of technological innovation and industrial policy, both countries regard semiconductors as the backbone of strategic emerging industries, which will profoundly affect the global technology and economic landscape in the future. We must realize that both China and the United States will be hurt by trade disruptions, especially if bilateral trade breaks down. Only a deep understanding, when bilateral trade is in trouble, trade sanctions can not fundamentally solve the U.S. trade imbalance [3]. Because of the differences in social systems and ideologies between the two countries, their national policy choices are different. As the world's two largest economies, China and the United States cooperate with each other in various fields will help promote the harmonious development of the world. The two sides must strengthen cooperation, strengthen strategic mutual trust and enhance mutual understanding. Especially for the choice of China's peaceful rise, the process of developing democratic politics and the growth of military

power, the United States especially needs to deepen its understanding of a harmonious world [4].

## References

- [1] Kwan, Chi Hung. (2019). The China-US Trade War: Deep-Rooted Causes, Shifting Focus and Uncertain Prospects. *Asian Economic Policy Review*, aepr.12284.
- [2] Shi Peipei, Xu Xuhua, Liu Yushu. (2023) Research on the national unified market construction of chip semiconductor industry. *International economic cooperation*, (02): 12-21 + 90.
- [3] Lianbiao Cui, Yi Sun, Rasa Melnikiene, Malin Song & Jianlei Mo. (2019) Exploring the impacts of Sino-US trade disruptions with a multi-regional CGE model, *EconomicResearch-Ekonomska Istrazivanja*, 32:1,4015-4032.
- [4] Jianfei, L. (2009). Sino-US Relations and Building a Harmonious World. *Journal of Contemporary China*, 18(60), 479-490.