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# *Semiconductor Culture in the Global Economy*

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***Abstract:*** The use of technology in multiple industries has contributed to the growth of the global economy. As a core part of today's technology, the impact derived from semiconductors is two-sided. While the general public is focused on the advantages of semiconductors, the political-cultural-national tensions it creates are missing. Semiconductor culture is a combination of technology and politics in the context of economic development. The historical semiconductor battles between countries and the current semiconductor battles confirm this view. This paper reviews the Japan-US semiconductor war in the last century, the Japan-South Korea semiconductor war in this century, and the US-China semiconductor war in the last few years. This paper aims to use the semiconductor cases to demonstrate the adverse effects of semiconductor culture in the global economy. Finally, it concludes that semiconductor culture can strain political relations between nations.

***Keywords:*** semiconductor, Japan, US, South Korea, China

## 1. Introduction

Technology is not only a driver of globalization but also a contributor. Economic globalization stimulates competition among countries worldwide, which compels governments to implement market-oriented policies both domestically and internationally [1]. Robert Solow, the winner of the 1981 Nobel Prize in Economics, showed that GDP growth could not be explained simply by the growth of factors of production. Equally important is the growth of productivity, for which advances in knowledge and technology are responsible [2]. Therefore, in order to enhance the competitiveness and leadership of their economies in the global marketplace as well as improve the welfare of their people, it has become more critical for a country to have the ability to upgrade its industries and advanced technologies. Today only a few developed countries control advanced technologies' core design, development, and production. However, the global technology innovation landscape has changed substantially, as several developing countries have also begun to invest significant resources and funds into research and development of new technologies and to develop their own technological innovation capabilities. And the primary way these countries have done this, in addition to increasing their R&D efforts, is by acquiring overseas companies to acquire advanced technological capabilities to improve their global competitiveness. China's Huawei, for example, formed joint ventures with 3Com, Siemens and Symantec and acquired IBM's personal computer division, Medion [3].

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In addition, the semiconductor industry has become one of the key components of the global economy, and topics related to semiconductor technology have been very popular in recent years. The semiconductor industry is at the heart of next-generation information technology and the cornerstone of the modern digital economy, and is critical to long-term economic growth, the creation of new jobs and national security. Today, semiconductors are found in virtually every electronic device, including cell phones, computers, automobiles, home appliances and weapons systems. As a result, the chips produced by semiconductor companies are significant, and emerging and new technologies such as artificial intelligence, quantum computing and 5G all require chips as a critical backbone. Since the 1950s, the semiconductor chip industry has been at the forefront of global technological innovation and is one of the main targets of competition and rivalry among the world's major economies. While semiconductor technology has been the focus of attention since the latter half of the last century, in recent years it has once again become a hot topic due to the rise of 5G technology in China. The United States, Japan and South Korea, three developed countries that have been world leaders in the semiconductor industry, and now China, with the rise of its semiconductor technology, are beginning to join the fierce competition in the global semiconductor industry. The rise of technology has indeed boosted national and corporate technology research efforts and facilitated global technology development. However, it has also created tensions between countries.

## 2. Semiconductor War

Technology wars have been taking place since the last century, with the Japan-US technology war at the end of the last century, the Japan-Korea technology war in this century, and the US-China technology war in recent years. In these leading countries, technology policy-type government initiatives are triggered when national political or economic interests are threatened, and the threat may be related to the control of a particular technology [4]. The occurrence of technology wars adversely affects not only the trade of countries involved in technology wars, but also other countries that depend on the technology of these countries. In particular, the United States and China, as the world's largest developed and developing countries, have large economies and intensive trade activities. The forced decoupling of technology between these two countries could require their respective trading partners to "take sides," ultimately creating two competing industrial chain systems and leading to the fragmentation of the global economy [5].

### 2.1. Japan-US Semiconductor War

The Japan-US semiconductor war in the 1980s turned Japan from a dominant player in the world semiconductor market to a participant. In the mid to late 1970s, Japan's semiconductor industry, which had shown rapid growth, was overtaken by Japan's lower production costs and technological advantages in 1983, when the US had bet heavily on the semiconductor industry. Japanese semiconductor products began to crowd the US market, leading to a growing US trade deficit with Japan and intense friction between Japan and the U.S. around the development of high-tech industries. Abel suggests that technology can inspire respect for a country and cause fear, anger, or resentment. In order to prevent the US from imposing anti-dumping duties, in 1986, the Japanese and US governments reached a semiconductor agreement that limited the price floor for Japanese semiconductor products in overseas markets [6]. However, because the Japanese market has not achieved the requirements of the agreement, the Reagan administration levied a 100 percent tariff on 300 million dollars' worth of imports from Japan in April 1987, including products from primary semiconductor consumer industries such as computers and televisions. Then the semiconductor agreement was renewed for five years in 1991 [7]. At the same time, the US government and

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domestic semiconductor companies worked together to promote the standardization of semiconductor production equipment and increase the production capacity of US semiconductor companies. In addition, measures have been taken to curb Japan's participation in global technological innovation by tightening control over semiconductor technology and restricting Japanese high-tech companies' access to U.S. technology. As a result, Japan lost the memory chip field, and the Japanese semiconductor industry has been on a downward spiral ever since. In 2021, Japan accounted for 9% of the global semiconductor market, while the US accounted for 46% [8]. Japan and the United States, from 1970 to 1993, the main reason for the increased frequency of conflict was the economic growth factor, especially the growth of semiconductors [9]. This demonstrates the friction that semiconductor culture brings while promoting global technological innovation.

## 2.2. Japan-South Korea Semiconductor War

The Japan-South Korea semiconductor war affected Japan-South Korea's economy and increased tensions between the two countries. In the early 1980s, Korea's semiconductor industry was still mainly assembled for foreign companies. Nevertheless, the Korean semiconductor industry proliferated in the following years, with an average annual growth rate of 25.5%. And against Japan's failed semiconductor war with the United States, Korea began to rise rapidly in the semiconductor market, which the United States helped. For example, in the world DRAM chip market in 1992, Korea's largest semiconductor company, Samsung, held 13.6% of the market share, which reached 25% in 1993. In addition, wafers, the primary raw material for making semiconductor devices, accounted for only 4.5 percent of Korea's semiconductor exports in 1984 but rose to 42.3 percent by 1992 [10]. These changes also announced that the South Korean semiconductor industry began to compete with leading international companies in developed countries [11]. The semiconductor dispute between Japan and South Korea began in July 2019 when Japan's Ministry of Economy, Trade and Industry (METI) declared that it was restricting exports to South Korea of certain chemicals and materials critical to semiconductor production, including fluorinated polyimide, photoresists and high-purity hydrogen fluoride, in order to protect national security. In addition, in August, the Japanese government announced that it was deleting South Korea from its "white list" of trustworthy trading partners. In revenge, South Korea also removed Japan from the "white list" [12]. South Korea's semiconductor industry has gradually taken a leading position globally since its development. Two companies, in particular, Samsung Electronics, the world's No. 1 semiconductor company in 2018 [13], and SK Hynix are boosting their market share in the global semiconductor market, which have been in the top 10 in global semiconductor sales for the past decade and account for about 75% of the global DRAM market [14]. In addition, as an export-oriented country, the semiconductor industry has become the backbone of Korea, with semiconductors ranking first in the export category since the 1990s [15].

Despite Japan's gradual departure from the semiconductor manufactured goods sector, Japan continues to dominate the global semiconductor materials market. So, the export restrictions on semiconductor raw materials adopted by Japan have hit Korea very hard, creating uncertainty not only for Japan-Korea relations but also affecting electronics producers and the automotive industry worldwide [16]. For example, China imports chips from South Korea, and Samsung produces car chips for Audi. Furthermore, Samsung Electronics' third-quarter 2019 earnings report showed that operating profit fell to 7.7 trillion won from 12.8 trillion won in the second quarter, down 39.8% sequentially, while SK Hynix's operating profit fell to 410 billion won from 631.6 billion won, down 35.1% sequentially. Although the easing of export restrictions a few months later, imports of hydrogen fluoride declined from $33.7 million in the first half of 2019 to only $1.6 million in the second half of the year after the easing of exports. Meanwhile, the massive boycott of Japanese

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products by the South Korean public also caused economic losses to Japan. For instance, Japanese beer, which accounted for 25% of South Korea's total beer imports in 2018, suddenly dropped 97% in August 2019 and 49.2% for the year [16]. Toyota car sales declined 36.7% in 2019. The number of South Korean tourists to Japan also dropped by more than 60% in the later part of this year of the year [17]. The poll also shows that the proportion of South Koreans who have a favorable view of Japan has fallen to an all-time low of nearly single digits. Therefore, the Japan-South Korea dispute showed that the dispute caused by the semiconductor not only has an impact on the semiconductor industry but also on other goods, to the detriment of the economies of South Korea and Japan and maybe even other countries, which brings tensions between nations.

### 2.3. US-China Semiconductor War

In recent decades, semiconductor technology has been one of the key factors that triggered the tensest relationships between the United States and China. Unlike the U.S.-Japan technology war and the Japan-Korea technology war, the U.S.-China technology war has a much more significant and broader impact on the global economy. The United States and China, as the world's two largest economies and consumer markets, are highly intertwined and dependent on each other and have a pivotal role in global development. However, with the start of the technology war, the U.S.-China relationship gradually decouples. The reason for this is mainly the rise of China in emerging high-tech fields, such as artificial intelligence technology and 5G technology, which are at the forefront of the world, and the U.S. sees it as affecting its global leadership position [18]. China has released the "Made in China 2025" plan, which aims to dominate new economic sectors such as robotics and artificial intelligence, and to have domestic production of chips to meet most of the domestic demand. Nevertheless, this has caused panic in the United States because China's semiconductor industry is growing too quickly. In recent years, China has become the world's largest semiconductor market, its semiconductor demand accounts for about 60% of the world, but the supply of only 13% of the world [19]. However, the U.S. government considers Chinese semiconductor technology by the risk of affecting national security, so the U.S. government has successively introduced relevant policies to restrict Chinese semiconductors from entering the market. For example, in 2018, Chinese high-tech companies such as Huawei and ZTE were included in the list of entities that prohibited U.S. companies, companies that have used U.S. technology, from providing semiconductor-related parts to Huawei [7]. Although Chinese companies are currently stepping up their efforts to develop domestic chips, these measures implemented by the U.S. government have indeed slowed down the development of Chinese semiconductors. With the disappearance of consensus in the global economy, the global economy may gradually diverge under the decoupling of China and the U.S. in the field of technology.

## 3. Conclusions

Science and technology should be the main enabler of human technological progress. However, in the era of globalization, the competition among countries in science and technology has become more critical and intense. Political overtones accompany the development of modern technology, and when a country is leading in economic power and high-tech capabilities, it may face greater global competitive pressure. Semiconductor culture is essentially a contributor to the global economy, but also a disruptor.

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