2024

The global battle for technological leadership in the semiconductor industry

Semiconductor industry - government subsidies and private investment at a glance

Authors:
Maximilian Lautner, Florian Schupp

Management summary

Geopolitics is having an increasing impact on the semiconductor industry, which plays a key role in the modern economy. Semiconductors are essential to the electronic components used in smartphones, PCs and cars. The semiconductor industry is globally networked and highly dependent on technology. As a result, geopolitical tensions and changes in international relations have a direct impact on supply chains, production capacities and innovation strategies. National security concerns, trade restrictions, sanctions, subsidies and technological competition influence the dynamics of this industry.

“Geopolitical factors such as security concerns, trade restrictions, sanctions and subsidies have a significant impact on the development of the global semiconductor industry.”

A key issue is the concentration of semiconductor production in a small number of countries, particularly in East Asia. Here, Taiwan, China, Japan, South Korea and the USA dominate the production and innovation of semiconductors. Dependence on just a few regions bears the risk of supply bottlenecks and even the interruption of entire supply chains.

Competition for technological supremacy in the semiconductor industry is currently intensifying. Countries are investing heavily in research and development in order to become leaders in areas such as 5G, artificial intelligence and autonomous driving. This is leading to a race for innovation in which geopolitical influences are determining the direction of technological development. Governments are subsidizing companies to promote the domestic semiconductor industry and attract foreign semiconductor manufacturers.

“These developments are forcing companies to look at diversification strategies.”

In order to meet these challenges, it is therefore important for companies in the semiconductor industry to strive for a diversified supply chain to ensure the highest possible level of supply security. Close cooperation with international organizations, consortia and governments is of great importance in order to prevent trade conflicts and react flexibly to political changes.

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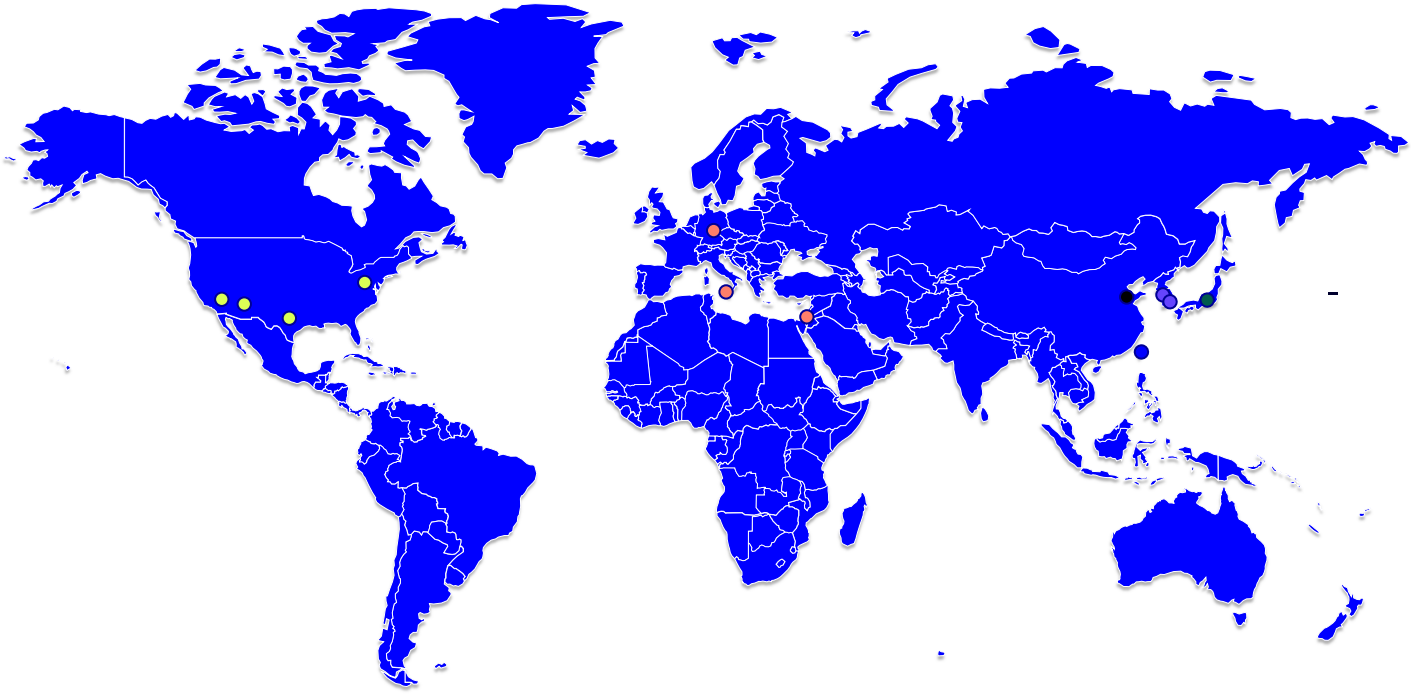
Private investments in the semiconductor industry



USA

Intel Arizona 20 Bn. USD
Intel Ohio 20 Bn. USD
Samsung Texas 17 Bn. USD
TSMC Arizona 12 Bn. USD

China

SMIC Beijing 7,5 Bn. USD

South Korea

Samsung Soul 230 Bn USD (planned until 2042)
SK HYNIX Soul 10,9 Bn USD

Taiwan

TSMC several plants each 10 Bn. USD

South Korea

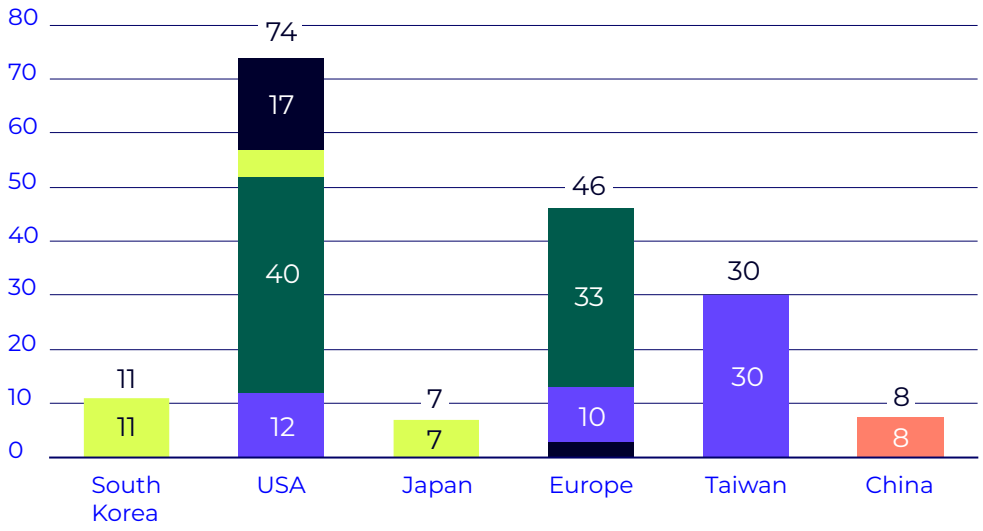
Intel Magdeburg 19 Bn USD
Intel Israel 14 Bn USD
TSMC Desden 10 Bn USD
STMicroelectronics Sicily 730 Mio. USD

Japan

Rapidus (Toyota, Sony, NTT, Soft-Bank, Kioxia, Denso, NEC, Mufg) 51,5 Bn USD

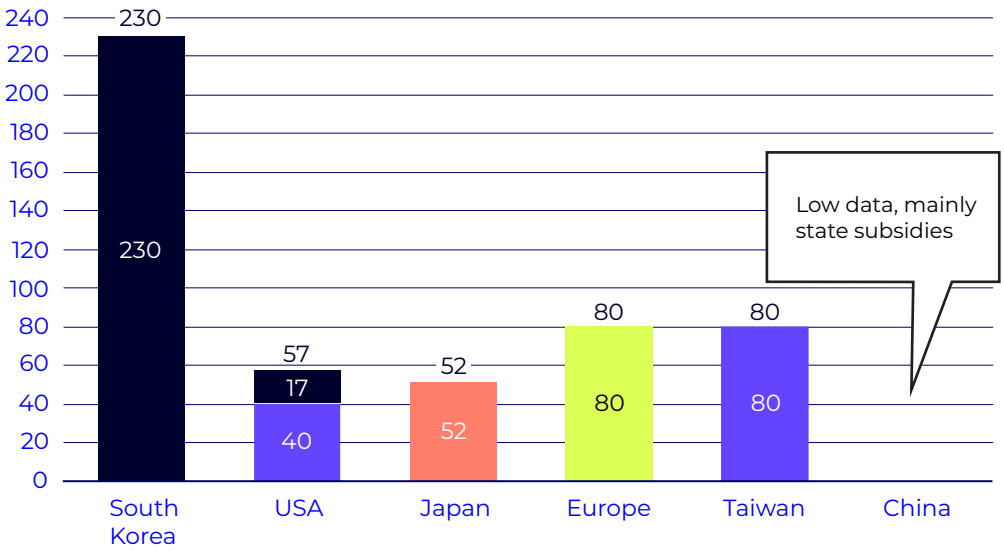
Overview of significant private investments in the semiconductor industry

Private investments in billion USD from 2020 - Jan. 2024



Samsung
SK Hynix
Intel
TSMC
Rapidus (Toyota, Sony, NEC...)
SMIC
Bosch
Sony

Planned private investments until 2042



Samsung
Intel
TSMC
Rapidus (Toyota, Sony, NEC...)

Europe

Development

The European semiconductor industry grew rapidly in the 1950s. Companies such as Philips (Netherlands), Siemens (Germany), SGS-Ates (Italy) and STC (United Kingdom) played an important role in the development and production of semiconductors. From the 1990s onwards, the European semiconductor industry came under increasing pressure from growing competition from the USA and Asia. Many European companies had to consolidate or reduce their activities due to intense competition. [1, 2, 3]

In order to remain competitive, European semiconductor companies are increasingly focusing on specialized areas and innovative technologies, such as the successful development of image sensors and power semiconductors by companies such as Infineon Technologies (Germany) and NXP Semiconductors (Netherlands). [1, 2, 3]

European Chips Act

Reduction of dependencies	Increase in production capacities	Promotion of research and innovation
The European Union is striving to reduce its dependence on imported semiconductors. This includes promoting the development and production of semiconductors in Europe to secure the availability of key technologies and avoid potential bottlenecks. [4, 5, 6]	It also aims to support the creation of local production capacities for semiconductors. This includes investments in modern semiconductor manufacturing technologies and infrastructure to establish competitive production facilities in Europe. [4, 5, 6]	The EU attaches great importance to promoting research and innovation in the semiconductor industry. This includes the funding of research projects, the development of new technologies and cooperation between industry, research institutions and universities to drive technological progress. [4, 5, 6]

The European Union (EU) is pursuing various goals with regard to geopolitics for the semiconductor industry to strengthen its strategic autonomy and competitiveness. The semiconductor industry is to be subsidized with a total of EUR **43 billion by 2030.** [4]

China

Development

In the 1960s, China began to develop its own semiconductor industry. At that time, China was largely dependent on imports for semiconductor technology. In the following decades, various state-owned companies were founded to promote the production of semiconductors. [16]

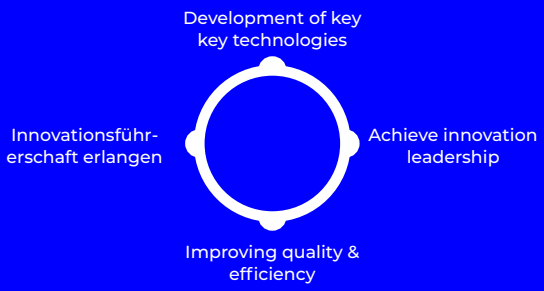
In the 1990s, joint ventures with foreign companies were increasingly entered into facilitate technology transfer and improve know-how in the Chinese semiconductor industry. This led to some progress, but China remained largely dependent on imports.[16]

From the 2000s onwards, China began to invest more heavily in the development of semiconductor technology and tried to catch up. Various national development plans were launched to promote the semiconductor industry. Large state-owned enterprises such as SMIC (Semiconductor Manufacturing International Corporation) were founded and received support to increase the production of semiconductors.[16]

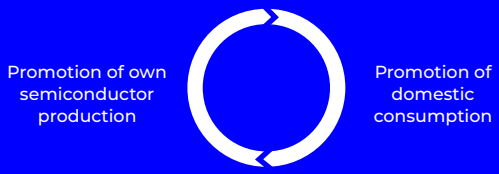
China's strategic orientation

The semiconductor market in China is one of the largest in the world and currently plays a crucial role in the global semiconductor industry. In recent years, China has made considerable efforts to develop its own semiconductor industry and reduce its dependence on foreign semiconductor products. Furthermore, China has a strong demand for semiconductors due to its wide range of applications in various industries such as consumer electronics, telecommunications, automotive, industrial automation and more, as well as the "Made in China 2025" strategy. [15, 16, 17, 18, 19] China is striving to become the global technology leader in the semiconductor sector. China is pursuing the "double cycle strategy" and the "Made in China 2025" strategy.

"Made in China 2025"



"Dual circulation-strategy"



The **"Made in China 2025"** strategy (set up in 2015) aims to transform China's economy from labor-intensive manufacturing to knowledge- and technology-based production. The objective is to reduce dependence on foreign technology and make China an innovation leader. The strategy is based on a combination of government investment, promotion of research and development, technology transfer, protection of intellectual property and support for domestic companies. The main objectives of the MIC 2025 strategy include increasing the domestic production of high-tech products, developing key technologies, improving the quality and efficiency of production, promoting innovation and strengthening the competitiveness of Chinese companies on the global market. [15, 16, 17, 18, 19]

The **"Dual Circulation Strategy"** is an economic development strategy introduced by the Chinese government in 2020 and aims to promote domestic economic growth and reduce China's dependence on external markets. The dual circulation strategy focuses on promoting domestic consumption, fostering innovation and technological progress and improving the competitiveness of domestic industries. This includes promoting consumer behavior, supporting small and medium-sized enterprises (SMEs) and strengthening the development of key industries. 15, 16, 17, 18, 19, 20

Taiwan

History

The Taiwanese government recognized the potential of semiconductor technology early on and began to take measures to promote the industry in the 1960s. In 1968, the government founded the Industrial Technology Research Institute (ITRI) to promote research and development in the semiconductor industry. The first semiconductor factories were built in Taiwan in the 1970s.[21]

In the 1980s and 1990s, the Taiwanese semiconductor industry experienced impressive growth. An important development was the foundation of the Taiwan Semiconductor Manufacturing Company (TSMC) in 1987. [22] TSMC was the first company that specialized itself in the contract manufacturing of semiconductors. Taiwan developed into an important supplier for international semiconductor companies and gained importance in the global electronics industry. The initial focus was on the production of memory chips and logic components. Companies such as TSMC, United Microelectronics Corporation (UMC) and MediaTek were the driving forces behind the success of the semiconductor industry in Taiwan. [22]

In the 2000s, Taiwan entered the production of more advanced semiconductors such as microprocessors and system-on-a-chip solutions. Taiwanese companies invested heavily in research and development to keep pace with technological advances.

Status Quo

Today, Taiwan is one of the largest semiconductor producers in the world. The country is home to some of the most important companies in the industry and has a strong supply chain ranging from semiconductor manufacturing to assembly and testing. The semiconductor industry in Taiwan is an important driver of the country's economy. It contributes significantly to export growth and job creation. Taiwanese companies continue to focus on innovation and technology development to consolidate and expand their position in the global semiconductor industry. [23, 24]

Taiwan has established itself as a leading provider of contract manufacturing services for semiconductors and wants to expand this leading position. The goal is to expand this position and attract more companies to outsource their semiconductor production. This implies that Taiwanese companies are constantly investing in research and development to develop innovative technologies and advanced semiconductor products. They want to break the boundaries of chip designs, manufacturing processes and materials to gain competitive advantages and lead the industry. [22] The Taiwanese semiconductor industry focuses on diversifying its product range. In addition to memory chips and logic devices, companies are striving to move into areas such as microprocessors, system-on-a-chip solutions, display panels, sensor technology and other semiconductor products. They are also striving for sustainable development. Companies are increasingly focusing on environmentally friendly production processes, energy efficiency and the use of renewable energies. The use of advanced technologies and environmentally friendly practices is intended to minimize resource consumption and environmental impact. [23, 24]

Taiwan is increasingly coming under geopolitical pressure from China and is therefore looking for opportunities for international cooperation in the semiconductor industry. Through partnerships, cooperation and the exchange of knowledge and resources, Taiwan wants to benefit from global networks and synergies. Cooperation with foreign companies, research institutions and governments such as Europe and the USA should help to strengthen the competitiveness of the Taiwanese semiconductor [23, 24]

Taiwan's semiconductor industry is currently undergoing a fundamental transformation. Leading global companies are looking for alternative production locations such as the USA, Europe and Southeast Asia as a result of the geopolitical risks caused by China. It can therefore be assumed that exports from Taiwan will decline in the long term. [20]

USA

History

In the 1990s and 2000s, the American semiconductor industry established itself as a technological leader with a global market share of 37% of semiconductor manufacturing. Companies such as Intel, AMD, IBM, Qualcomm and Nvidia played an important role in the development and production of advanced microprocessors, memory chips, graphics chips and other semiconductor products. In the 2000s, the American semiconductor industry came under increasing pressure from competitors from Asian countries such as Taiwan, South Korea and China. These countries invested heavily in the construction of modern production facilities and became increasingly important in the global semiconductor industry.[7]

This development led to a partial relocation of production and a decline in the USA's market share to around 12% today. In contrast, the share of semiconductors produced in Asia is currently around 75%. [7]

Geopolitical tensions between the US and China are having a major impact in the development of semiconductor supply chains. As semiconductor technologies are strategically important in the areas of security, defense, protection of critical infrastructure and communication, this initially led to major security concerns in the US. Since October 2022, the United States has therefore enforced a stricter trade embargo against China for certain semiconductor technologies. Since then, chips with a structure size of less than 16 NM may no longer be supplied to Chinese trading partners. Further sanctions relate to modern technologies for example, the Dutch equipment manufacturer ASML was prohibited to export to China.[8, 9, 10] The US aims to rebuild its technological leadership and innovative strength in the semiconductor industry:

„We will lead the production of high-performance chips“ Quote by Joe Biden. [11]

USA Chips & Science Act

Support of semiconductor production	Investment in research and development	Protecting the supply chain
The law allows grants and tax incentives to promote the construction, expansion or modernization of semiconductor factories in the US. The aim is to strengthen domestic production capacities and improve the competitiveness of the US semiconductor industry. [12, 13, 14]	The CHIPS Act supports semiconductor-related research and development activities, including investing in emerging technologies, promoting semiconductor education and training and strengthening partnerships between industry and academic institutions. [12, 13, 14]	Another important aspect of the Act is to improve the resilience and security of the semiconductor supply chain. This includes measures such as promoting partnerships between government and industry, creating stockpiles of critical semiconductor components and analyzing vulnerabilities in the supply chain. [12, 13, 14]

The American Chips & Science Act was signed into law by Joe Biden on August 9, 2022. The core of the CHIPS Act is to strengthen the production of semiconductors in the USA and reduce dependence on foreign suppliers. The planned government investment volume for research, development and manufacturing amounts to **USD 52 billion**.

Japan

History

The semiconductor industry in Japan began in the 1950s with the production of germanium diodes. Companies such as Sony and Toshiba started to play an early role in the production of semiconductor components and the spread of transistors and diodes in the Japanese electronics industry. In the 1960s, Japanese companies invested heavily in the research and development of integrated circuits (ICs). These were mainly produced by the companies Hitachi, Mitsubishi Electric and NEC. [25]

In the 1970s and 1980s, Japan was a key player in the manufacture of microprocessors and memory chips. The companies Fujitsu and Toshiba entered the market and supplied products for national and international demand. In the 1990s, Japan still accounted for around 50% of the global semiconductor market. Nowadays it is barely 10%. [26, 27]

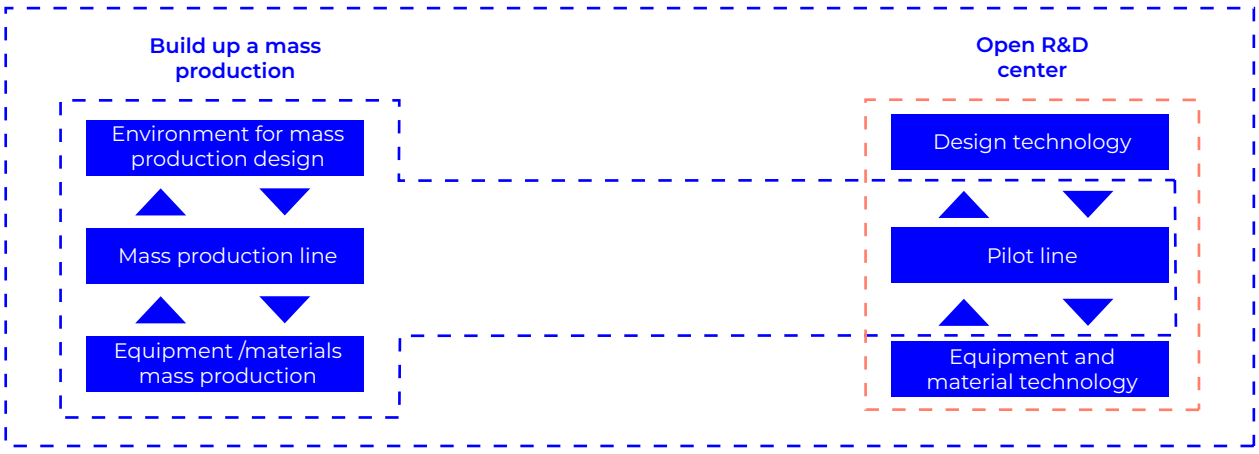
In the early 2000s, Japanese companies began outsourcing practices, specializing in certain aspects of semiconductor production while moving manufacturing overseas. In recent years, Asian countries, including China and South Korea, have increasingly invested in the semiconductor industry and have become major competitors for Japan. [28]

Status quo & the billion-euro project: Rapidus

Japan has a limited amount of expertise in the design and development of semiconductors, particularly advanced logic chips. The strength of Japanese companies has been the fact that they have continuously invested in the development of equipment and materials. One of the strengths of Japanese semiconductor value creation lies in materials for chip production, in the area of wafer fabrication, lithography or packaging. [29]

Shin-Etsu Chimcal and Sumco together have a global market share of around 60% in the production of silicon wafers. According to Electronic Device Industry News, the global share of Japanese companies in the production of photoresist was around 90%. Companies such as JSR, Tokyo Ohka Kogyo and Shin-Etsu are active in this sector. Shin-Etsu, for example, expanded its photoresist production in Taiwan in 2021 in order to meet demands from its main customers. [29, 30]

Furthermore, investments have been made in research and development in the semiconductor sector in cooperation with the USA since the beginning of 2022. The Rapidus consortium consisting of Toyota, Sony, NTT, SoftBank, Kioxia, Denso, NEC and MUFG Bank is investing particularly high amounts. This joint venture is expected to develop semiconductors in the 2 nanometer range by 2027. Rapidus has an investment volume of 50.7 billion dollars at its disposal. [26, 31]



Japan also provides state subsidies. These subsidies are intended to attract further companies to the semiconductor industry in Japan. A first project is in cooperation with the Taiwanese semiconductor manufacturer TSCM and Sony. The state subsidy for this new production facility amounts to 2.2 billion dollars. In total, the Japanese government is providing 8.9 billion dollars for these purposes. The aim of all these investments is for Japan to become independent of China and regain a larger share of global semiconductor production. [32, 33]

South Korea

History

The South Korean semiconductor industry was born in the 1960s when certain South Korean companies such as Korea Electronics (KE) began manufacturing diodes and other basic electronic components. In the following years, the South Korean government placed increased emphasis on promoting the semiconductor industry as part of its industrial development strategy. It provided financial support and tax incentives for companies investing in semiconductor manufacturing. [34]

In the 1980s, several of the leading semiconductor companies in South Korea were founded. This included Samsung Electronics, which opened its first memory chip factory in 1983, and Hyundai Electronics (now SK Hynix), which was founded in 1983. In the 1990s, South Korea made significant advances in semiconductor technology and began to establish itself as a major player in the production of memory chips. Samsung and SK Hynix became leading global manufacturers of DRAM and NAND flash memory chips. In the 2000s, South Korean semiconductor companies expanded their business activities to the global market and opened production facilities and sales offices in other countries. From the 2010s, South Korea consolidated its position as a technology leader in the semiconductor industry and achieved important milestones in the development of advanced process technologies such as 10nm, 7nm and 5nm chips. [35]

Status Quo

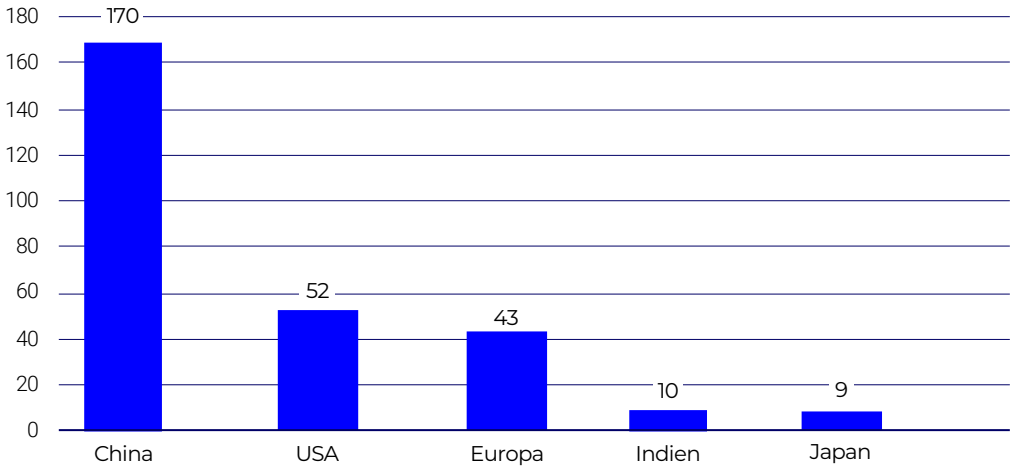
South Korea is the home of some of the world's leading semiconductor manufacturers such as Samsung Electronics and SK Hynix. These companies play a crucial role in the global market and are major suppliers of memory chips, NAND flash memory and other semiconductor components. As a result, South Korea has made significant technological advances in the semiconductor industry and has established itself as an innovation leader in areas such as the production of 5nm, 7nm and 10nm semiconductor technologies. As a result, South Korean companies are able to manufacture high-performance and energy-efficient semiconductor products. [36]

The focus so far has been on memory chips, but this is set to change. In May 2021, Samsung Electronics announced that it would increase its investments in the expansion of logic chip production and contract manufacturing to 145 billion dollars by 2030. [37]

South Korea's government and companies have made significant investments in research and development to secure their technological leadership and develop new innovative solutions. The focus on research and development has helped to strengthen the competitiveness of the South Korean semiconductor industry. The total investment is estimated at 550 trillion won, equivalent to around 392 billion euros by 2026. These investments are expected to come primarily from local companies, which will receive various benefits in return, such as tax exemptions, support for infrastructure such as water supply and energy generation, and deregulation of bureaucracy. [38]

Through international partnerships, South Korea is securing access to foreign markets and increasing its global presence. A national investment holding company with a budget of more than 18 billion euros is to make strategic investments, including in the fields of quantum computing and AI. [37]

Overview of planned government subsidies up to 2030 in USD



Summary and Outlook

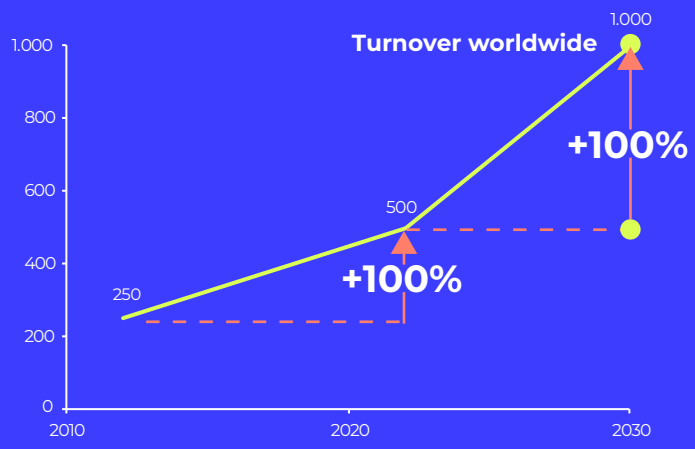
The semiconductor industry is becoming an increasingly important part of the global economy and technology development. In recent years, supply chains around the world and in the semiconductor industry have been exposed to high levels of pressure. The coronavirus pandemic and the Russian war of aggression in Ukraine led to bottlenecks and even the interruption of entire supply chains. The high complexity of multi-level supply chains in the semiconductor industry is forcing companies to reduce dependencies.

Countries such as the USA, China, South Korea, Taiwan and Europe are increasingly competing for technological supremacy in semiconductor manufacturing. Investment in research and development, the promotion of skilled workers and government support are currently important and necessary factors in maintaining or achieving a leading position. Government subsidies in the semiconductor sector are higher than ever before and appear to have no end in sight in the battle for global technology leadership. In addition to subsidies in trade policy, sanctions have a significant influence on the ongoing change in the semiconductor industry. The growing importance of semiconductors in critical infrastructures has made them an attractive target for cyber espionage and hacking attacks. Therefore, countries and nations are increasingly forced to take measures to protect their supply chains and technologies from such threats. Sanctions between the major powers have a significant impact on the semiconductor industry as they strongly influence the flow of raw materials, semi-finished products and technology transfer.

Especially geopolitical factors are having an increasing influence on the development of the semiconductor industry. Companies and countries must act flexible to be able to react appropriately to changes in political relations and the balance of economic power. The ability to secure technologies, diversify supply chains and seek cooperation is crucial to be successful in this constantly changing environment. The semiconductor industry will also come under increasing pressure to make its production processes more environmentally friendly. Countries and companies will strive towards more energy-efficient manufacturing technologies and recycling initiatives to minimize resource waste, but environmental and sustainability aspects currently play a subordinate role globally.

Key message:

- "The semiconductor industry is playing an increasing role in the global economy“
- "Geopolitical dynamics will have a significant impact on the semiconductor industry until 2030“
- "The ability of companies to diversify supply chains is essential to succeed in this ever-changing environment.“
- Forecasted sales development of the semiconductor industry until 2030 in Bn. USD:



P3 group

Point of contact regarding questions and annotations

Florian Schupp
Consultant
Florian.Schupp@p3-group.com

+49 152 09937 751

Maximilian Lautner
Senior Consultant
Maximilian.Lautner@p3-group.com

+49 151 57133 503

Mauritz Schwartz
Principal Operations
Mauritz.schwartz@p3-group.com

+ 49 163 75337 07

Disclaimer

Adress:
P3 Group GmbH
Heilbronner Str. 86
70191 Stuttgart
Germany

Website:
https://www.p3-group.com/semiconductor-management/

www.p3-group.com

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