SECTION ONE:

GLOBAL CHANGES IN THE WAKE OF THE TECHNOLOGICAL STRUGGLE BETWEEN THE UNITED STATES AND CHINA

Globalization has been an irrefutable axiom since World War II. It is one of the most significant phenomena that has occurred in history, and it is difficult to imagine today how individuals and countries could survive without international partnership and movement of goods. However, since the outbreak of the COVID-19 pandemic and the supply chain crisis following it, cracks have emerged in the principles of global trade. One expression of these cracks is the technological struggle taking place between the United States and China.

In October 2022, the United States publicized the CHIPS Act.[1] The law includes a budgetary investment of $278.2 billion over ten years to accelerate technological research and development, and to ensure that the United States remains the strongest economic power in the world. Out of this total, a direct investment of $52 billion is planned, by subsidizing the establishment of semiconductor manufacturing plants in US territory, a field in which China has been trying to achieve a global advantage for a decade.

Many in the world see this legislative process, which includes severe trade restriction regulations vis-à-vis China, as the beginning of a new era in global trade relations. It is considered unprecedented in scope and implications and is seen as a significant step up in the technological struggle between the United States and China,[2] because it entails breaking the principle of "free trade" that had been in place and allows room for government intervention and the entry of political considerations. In this section, we will attempt to explain the change taking place in the global system. To this end, we will present the history of economic relations between the United States and China and discuss the circumstances that have led the United States to change its approach and the global implications of this technological struggle.

The Beginning of 21st Century Globalization: How Was the Global Free Market Born?

The global trade with which we are familiar today first began in the peace talks following World War II. While World War II left most of the world's countries battered, including the pre-war European great powers, the United States finished the war as the big winner, militarily, economically, industrially, and technologically. If not for the United States, its advanced military capabilities, and its strong manufacturing industry, it is doubtful that some European countries would have succeeded in rehabilitating themselves and their economies in the decades after the war.

The United States had an ideological and economic interest to strengthen the European countries that fought against Nazi Germany, as well as Japan, South Korea, and other countries in Eastern Asia, and to ensure that this kind of war would not happen again.[3] Therefore, even before the war had finished, along with Britain, and in cooperation with the Soviet Union and China (then under the rule of the Kuomintang), it pushed for the establishment of the United Nations, which replaced the League of Nations. Alongside it came the International Monetary Fund, the World Bank, and the General Agreement on Tariffs and Trade (GATT), which served as the basis for the establishment of the World Trade Organization 50 years later. These institutions expressed the aspirations of the United States to manage a "global market of goods" and heralded the beginning of modern globalization and intercontinental free trade.[4] The world enjoyed the surplus production of the United States, and the scope of American exports in the food, military equipment, and industrial equipment industries grew significantly during these years. The United States won the confidence of other countries as the strongest and most stable economic hegemon in the world and also became the most important financial center, with the American dollar quickly becoming the strongest and most stable currency in the world. It provided the world with a dramatic improvement in production technologies, and most of the countries

that traded with the United States enjoyed economic growth and the fruits of the research and development that enabled technological progress.

In the years following World War II, like the European countries, China was a battered and bruised country. Not only World War II, but a span of over 100 years, beginning with the First Opium War, contributed to this complex scenario. Throughout this period, wars, rebellions, Japanese occupation, and overall instability placed China in challenging circumstances, while the internal struggles between the Kuomintang forces and the communist forces exacerbated the situation. These struggles reached their peak immediately after the war and culminated in 1949, when Mao Zedong, the leader of the Communist Party, succeeded in taking control of China with the help of the Soviet Union, while the Kuomintang, which the United States supported, retreated to the island of Taiwan. China under Mao was a communist country with an extremely centralized rule; starting in 1953, China instituted five-year economic plans, on the theme of growth and instilling society with culture and values according to the communist vision and worldview of Mao. Mao's actions accelerated China's progress and led to numerous scientific and military achievements. Despite this economic leap, China's economic situation still remained poor, partly because it did not maintain trade relations with the developed countries of the world, and due to the Cultural Revolution.

After Mao's death, Deng Xiaoping, Mao's deputy, ruled China and instituted a strategy that was called the "Four Modernizations," focusing on agriculture, industry, science and technology, and defense. This model was later recorded as China's fast industrial revolution, which amazed the world in the ability to separate between a communist approach to politics and a capitalist approach to the economy, and between authoritarian rule that encouraged initiatives and an economy that ostensibly advocated for the principles of the free market. Meanwhile, China also began a series of reforms, addressing issues such as legal and judicial issues to regulate new economic measures (for example, regarding private ownership) as well as increasing openness to the

world. The combination of the modernizations, the reforms, the openness, and the "state capitalism"/"socialism with Chinese characteristics" enabled China to import knowledge and capabilities from advanced countries and to overcome a decades-long scientific-technological (and also infrastructural) gap in order to try to match the level of the world's industrial leaders. But at this stage, at the beginning of the 1970s, China's portion of total global exports was less than one percent.[5]

In 1971, US President Richard Nixon announced the cancellation of the gold standard as the basis for the dollar. The decision was made as an effort to address inflation and the growth of the US trade deficit, which stemmed from the enormous expenses of the Vietnam War. Another reason for abandoning the gold standard was the desire to reduce the ability of foreign countries to burden the American financial system by trading dollars for American gold. This American act had far-reaching consequences that shaped the global economy and created a new foundation for global trade. The "Nixon shock," as it was called, was one of the steps that led to another shock—Secretary of State Kissinger opened a channel between the United States and China, and Nixon visited China in 1972, which ultimately led to the normalization of relations between the two countries in 1979. At that time, the United States experienced a sharp rise in investment in education, and as a result, the percentage of educated people grew and the supply of manufacturing workers in the United States declined. During this period, the United States continued to suffer from the economic consequences of the fighting in Vietnam, and the chair of the Federal Reserve raised the interest rate in a way that eroded exports and the profitability of investing in manufacturing plants in US territory. The American manufacturing industry was transformed—the vehicle and goods industries moved to Asia, but the technology, electronics, and computers sector continued to develop in US territory.

Starting in 1986, China held talks to join the General Agreement on Tariffs and Trade but did not receive the members' agreement. Western criticism of

China further increased following the events at Tiananmen Square in 1989, in which armed soldiers shot at protestors who sought to carry out democratic reforms in China. In 1991, the fall of the Soviet Union's Iron Curtain caused profound global change, which was also evidenced in the way the United States managed global trade. For China, this was an opportunity to strengthen its production systems and to improve its standing in global trade. By the year 2000, China had progressed and became the largest exporters of household consumption, particularly in the textile industry.

In April 1999, US President Clinton hosted Chinese Premier Zhu Rongji at the White House to discuss the future of economic and diplomatic relations and China's request to join the World Trade Organization (WTO). Clinton invited Zhu to dinner at the private residence wing to coordinate positions, with each having a clear interest in the partnership succeeding. Zhu wanted US support for acceptance in the WTO, while Clinton wanted to significantly increase the exposure of US goods to the Chinese market and to remove the difficulties that American exporters faced in trading with China. The understandings between the two led to the biggest bilateral trade agreement that the United States has ever signed.[6] President Clinton believed that the agreement would enable open and increased American exports to the country that made up a fifth of the world's population. Associates of the president voiced serious criticism of his willingness to advance China's accession to the WTO while China continued to violate basic human rights. Ultimately the economic consideration triumphed; Clinton believed that China was vital for global trade and willing to make concessions.[7]

After its acceptance into the WTO in November 2001, China committed to advancing reforms, including the removal of customs barriers, intellectual property regulations, transparency, and even changing laws that were incompatible with the rules of the free market. The WTO, for its part, was committed to allowing China to take part in joint initiatives, including in areas defined as sensitive, such as technologies and banking.[8] Even though

at this stage China engaged in limited trade with international technology companies, it continued to import production components and technologies that would serve the economy even more.

China's accession to the WTO heralded a new economic era in relations with the United States. The volume of goods that the United States imported from China increased from $100 billion in 2001 to $500 billion in 2021. A study conducted in 2019 showed that the purchasing power of the average American family increased by $1,500 per year between the years 2000 and 2007, thanks to imports from China, which lowered the costs of goods,[9] with China moving to third place in American export destinations, after Canada and Mexico. In the first few years after the agreement, exports to China provided two million jobs in the United States. Within less than a decade, China climbed to second place in the volume of global trade (after the United States) and took on a central role in the global supply chain—Chinese factories produced goods for the United States using equipment and components that were imported from it. President Clinton's dream was almost completely fulfilled.

Shattering the Illusion: China Plays the Whole Field and Strives for "Technological Superiority"

Since 2003, the United States has expressed doubts regarding the way that China has fulfilled its part of the trade agreements. The United States has levelled serious accusations against China regarding exploitation of workers and continued violation of human rights. In addition, it has accused China of violating intellectual property rights and the unfair use of government support, which undermines competition in the free market.[10]

The US administration attempted to settle the disputes with China via the WTO's mediation mechanism. President George Bush took minor steps, which included imposing tariffs on a variety of Chinese goods that were abnormally subsidized by the regime. Bush needed cooperation from China in the global war on terror, so he refrained from more stringent measures and

settled for a dialogue initiated in 2006, in which the United States expressed its concerns.

In 2009, President Barack Obama continued the discussions that President Bush had begun in the framework of the bilateral US–China Strategic and Economic Dialogue. During Obama's presidency, the United States took more stringent steps and waged an ongoing struggle via restrictions that were imposed by the WTO, and through a new oversight mechanism, the Committee on Foreign Investment in the United States (CFIUS). In 2011, China won in a hearing that took place at the WTO about the subsidies that it granted, which determined that it was not violating the free market regulations. Nevertheless, President Obama for the first time blocked two Chinese acquisition deals at the recommendation of CFIUS, based on national security considerations.[11] In 2015, the Trans-Pacific Partnership Agreement (TPP) was signed, through which the United States hoped to curb China's trade violations and to contain its fast pace of advancement. However, China's ambitions for global leadership were deeply embedded in its worldview, and thus it found ways to circumvent the restrictions and barriers that the United States imposed on it.

In March 2016, the Chinese government revealed the Communist Party's thirteenth five-year plan under the heading "Innovation-Oriented Nation." The 80-chapter plan aimed to recalibrate the Chinese republic—growth and prosperity via a modern, technological, and state-of-the-art manufacturing industry. There were concerns in China of economic stagnation that would threaten the desired growth targets (6.5% per year between 2016 and 2020 in order to double the GDP), in part because the heavy industries and cheap products would ultimately become a burden and drive away the educated population. China hoped to streamline industry and to provide employment to educated university students, partly so that it could compete with the United States for scientific and technological leadership in the 21st century.

The thirteenth five-year plan especially emphasized China's being fully open to the global technology market as a necessary condition for innovation.

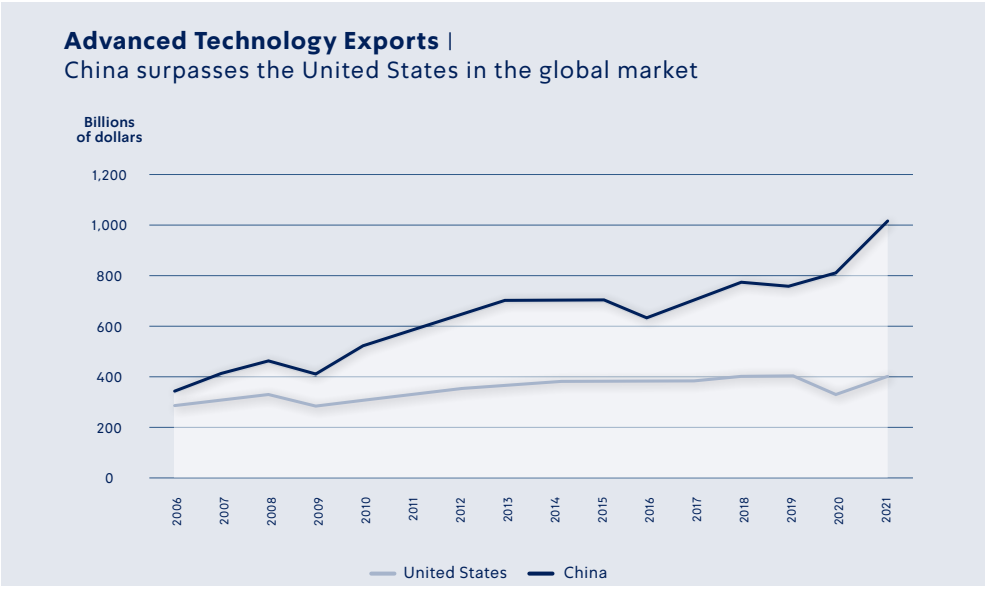
In order to encourage educated citizens to take part in the change, the plan continued the line of its predecessors and attributed supreme importance to resolving China's environmental crisis while directing dedicated resources to improving citizen welfare in this respect (10 out of the plan's 25 objectives were related to the environment). In addition, China continued the line in which it would remove restrictions on citizens, such as changing the *hukou* system in which citizens must work in the place where they are registered. The removal of barriers was supposed to increase citizens' motivation to fulfill their economic potential.

Similar to the five-year plans instituted by the Communist Party in the past, the State Council set measurable targets to meet between 2015 and 2020.[12] These included the aspiration to progress from 18th place to 15th place in the Global Innovation Index,[13] and to increase the investment in research and development within five years from 2.1% to 2.5% of the GDP (for comparison, in the United States in 2014, 2.8% of the GDP was allocated to research and development, which was $489 billion. China aspired to double these amounts).[14] In addition, China stated its intention to double the number of patents registered in its name and the workforce invested in research and development in all fields. In the plan, China set a GDP per capita target of $17,910 for 2020 (compared to $12,985 in 2015, the year the plan was published), and allocated subsidies and participation in tuition, in order to encourage residents to learn scientific disciplines related to math, physics, chemistry, and biology. Figure 1 shows that the volume of China's advanced technology exports, as defined by the OECD, is 2.5 times that of the United States.

Alongside the short-term targets, long-term targets in the field of innovation in technological production were also presented in the plan. According to the original timetable in the plan, China, as mentioned above, would be defined as an innovation-oriented nation in 2020. By 2030 it would be the world leader of technological production industries, and by 2050 it would be recognized

as the world leader in science and technology research and development. These competitive targets are incorporated in a plan known as "Made in China 2025." The plan's name hints at the clear intentions of the Communist Party, favoring openness to the global market that China ultimately will lead.

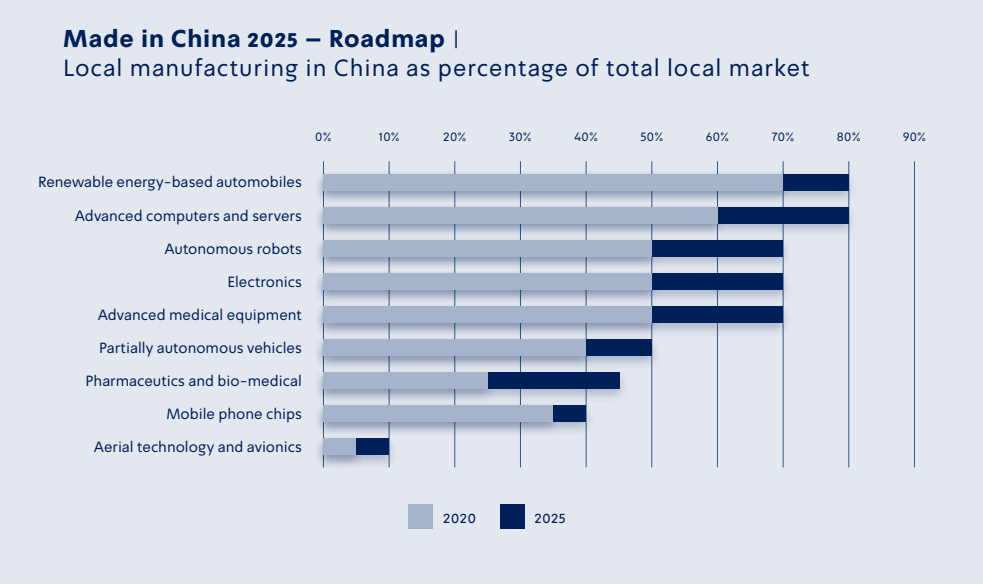
FIGURE 1. ADVANCED TECHNOLOGY EXPORTS



Source: Based on data of the OECD.

The Chinese Academy of Engineering detailed the goals of the plan, including the industries at the center of national attention. Figure 2 highlights the fact that the entire plan relies on advanced technology that China does not have, first and foremost advanced chips, thus increasing the need for imports from Taiwan and the West, especially the United States.

FIGURE 2. MADE IN CHINA 2025 – ROADMAP



Source: Institute for Security & Development Policy, "Made in China 2025."

To achieve the objectives, China needed to remove some of the political restrictions in a way that would encourage the private sector to increase investments with free market characteristics. The government approved an investment plan to encourage global tech giants to establish chip production plants in China at a total cost of around $80 billion.[15] According to the plan, the China Development Bank would invest over half the amount; a new national fund for investing in the chip industry would provide $20 billion, while innovation and production funds as well as taxes for the purpose of developing advanced robotics, particularly from the Beijing and Shenzhen districts, would cover the rest of the budget. In January 2023, China announced the establishment of a unified procurement platform for all chip companies in China to strengthen their bargaining power vis-à-vis the competition in the West.[16]

"Internet Plus," a plan parallel to "Made in China 2025," also appears in the thirteenth five-year plan. The project aimed to strengthen communications infrastructure and cloud computing to advance innovation, most of which operates on the Internet of Things (IoT). China wanted to encourage the exposure of local communications companies to the world, and the government decided that it would provide regulatory assistance and push for private companies in China to support global technology. For the internet infrastructure to support big data, China allocated $135.2 billion in the plan, in addition to $180 billion that would be allocated solely toward upgrading infrastructure.[17]

The Beginning of the "Trade War" and the Outbreak of the COVID-19 Pandemic

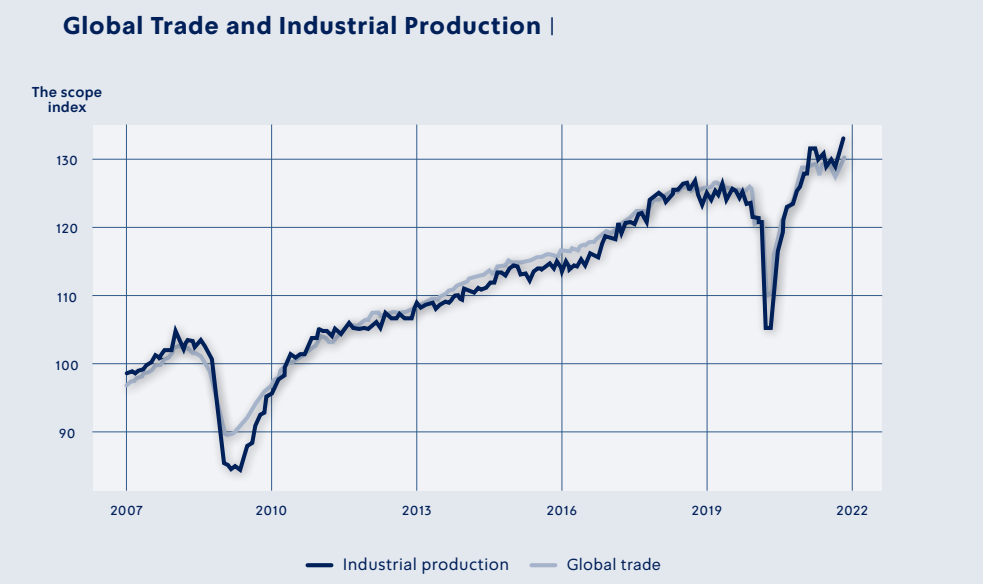
In the middle of the thirteenth five-year plan, Donald Trump was elected president of the United States and entered the White House in January 2017. Trump sharply criticized China's actions as part of his election campaign ("the rape of the American economy"),[18] and studies show that these messages received considerable American support. Trump accused the Chinese government of a customs policy, including subsidizing exports, which violated the rules of the free market and harmed the American economy. In the first few months of his presidency, the United States left the Trans-Pacific Partnership Agreement (against American interests), and imposed billions of dollars of tariffs on Chinese goods.[19] This was the opening shot of the "trade war" that continued throughout Trump's presidency.[20] In 2018, Trump announced government initiatives that aimed to strengthen the partnership with Asian countries other than China, in both the military sphere and the economic sphere. Trump attempted to advance negotiations in 2019 and signed an agreement ("Phase One") with China that aimed to address intellectual property violations, to "rebalance" trade between the countries, and to define fair rules for deals between American companies and China.

Another development that changed relations with China was the COVID-19 pandemic that spread throughout the world at the beginning of 2020. Global attitudes toward China worsened, as it was accused as having been the source of the coronavirus outbreak. To contain the severe health consequences of the disease, many countries imposed lockdowns, which significantly slowed the economy. For the first time in 70 years, the world was forced to cope with an almost complete stoppage of global trade and with considerable damage to supply chains.[21] The decline in the volume of goods in the first half of 2020 was similar in scope to that of the global economic crisis of 2008 and was indicative of China's centrality in the supply chain. The return to normalcy that characterized 2021 compensated for some of the losses that occurred. Nevertheless, great concern arose in the West given the risks of dependence on supply chains originating in Asia, particularly in China, which over the years had become a central supplier of vital goods and technologies. It is worth mentioning that these risks could also have materialized as a result of a stoppage of trade under other circumstances.

Figures 3 and 4 illustrate how the supply chain crisis that started during the COVID-19 pandemic has, in fact, continued until today, and despite the removal of restrictions, the global system is having difficulty addressing the increasing demand for goods in all sectors, particularly in the technology sector.

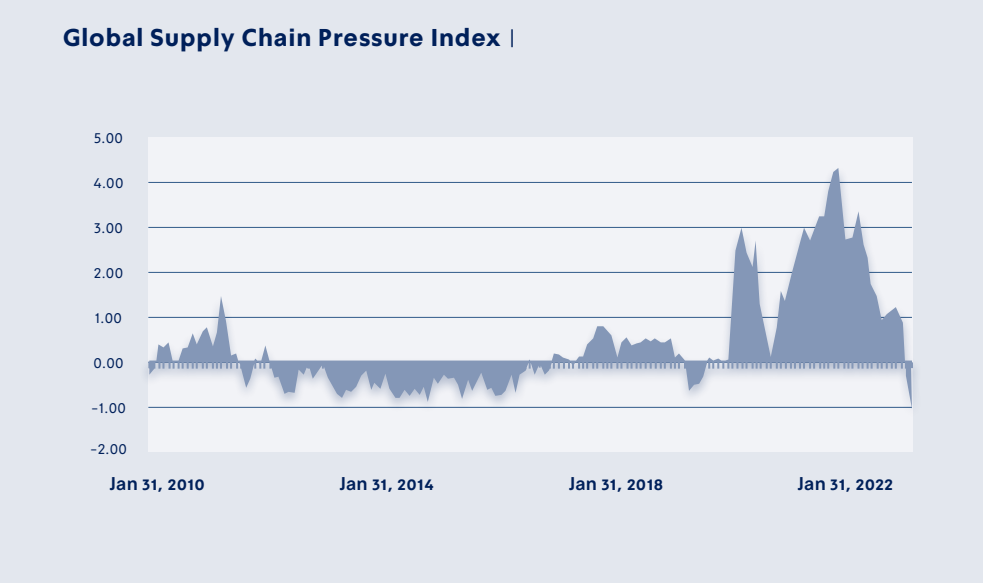
In 2022, most markets opened, but China maintained significant restrictions in its territory, and its markets did not return to full functioning. Even though the Communist Party continued to present optimistic growth and investment figures indicating progress according to the plan, the long lockdown that China imposed led to protests with tens of thousands of people participating, and in practice, like the rest of the world's countries, the pace of growth slowed.

FIGURE 3. GLOBAL TRADE AND INDUSTRIAL PRODUCTION



Source: OECD, "International Trade during the COVID-19 Pandemic: Big Shifts and Uncertainty," (March 10, 2022).

FIGURE 4. GLOBAL SUPPLY CHAIN PRESSURE INDEX



Source: "Global Supply Chain Pressure Index: May 2022 Update," *Liberty Street Economics.*

From Global Chip Crisis to the CHIPS Act: Industrial Policy for Preventing Chinese Superiority

The tech industry suffered serious harm from the supply chain crisis due to its being a global, decentralized industry that is distributed among countries according to comparative advantage. Research and development take place mainly in the West, while there are also smaller R&D centers in Asia. In contrast, most of the production of advanced technological components occurs in Asia, particularly in Taiwan and China. The decline in the activity of production plants and the export of these components was the last straw in the crisis that already occurred at the chip factories, which for a long time had been operating at maximum capacity. The demand for chips has increased throughout the past few years, but the process of producing them remains complex and expensive, and private investors are finding it difficult to bear the burden on their own. It has become clear that without hundreds of billions of dollars of government support, it is impossible to resolve the crisis. Furthermore, the COVID-19 pandemic, as mentioned above, exacerbated the chip crisis, making it difficult for the government and private entrepreneurs to give the issue the necessary attention and resources.

In China, a total investment (direct and indirect; governmental and private) of $150 billion led to only a limited achievement in the field of producing and assembling chips.[22] Even though China declared that by 2020 it would reduce its dependence on imports and provide 40% of demand via domestic factories, in practice in 2019 it succeeded in producing 16% of total domestic demand, and did not succeed in making the leap in the following years.[23] The main reason for this gap is that China still lacks production capabilities and a software environment that would allow it to make the desired advancement, and consequently it is dependent on the supply of equipment and components from the United States, Taiwan, and additional countries in Europe.

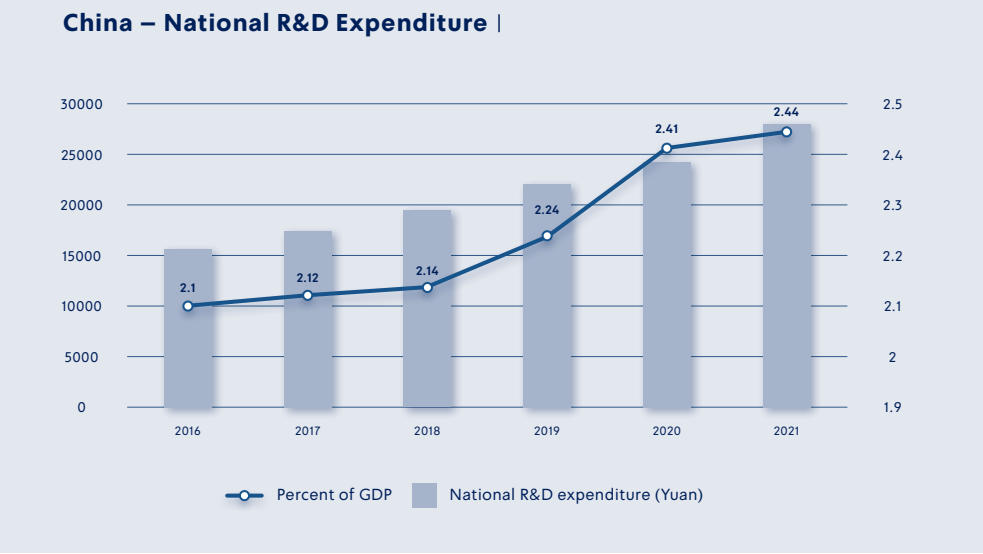
In 2021, the Chinese Communist Party's fourteenth five-year plan was published, under the slogan "Looking Forward to 2035." The plan continues

the approach of its predecessors in focusing on a modern society oriented toward technology and innovation but hints at a five-year delay on the path to global leadership, as a result of the consequences of the COVID-19 pandemic and the changes in trade policy vis-à-vis the United States. Because China did not meet its demand target (of producing 40% of total domestic demand for chips), the policy expressed in this plan still encourages continued investment in cutting-edge technologies in the field of producing chips for use in artificial intelligence,[24] as well as in research and development, totaling about half a trillion dollars.[25]

The supply chain crisis also demonstrated to the United States the risk posed to its national security when a sector in which its share of global production is only 12% is so vital to its stability.[26] In addition, the United States interpreted China's determination in the chips field as an arms' race whose winner would have the most advanced military capabilities. As a result, for the first time the US administration clearly saw the necessity of having a technology strategy that would improve American technological production capacity and exert significant pressure on China.[27]

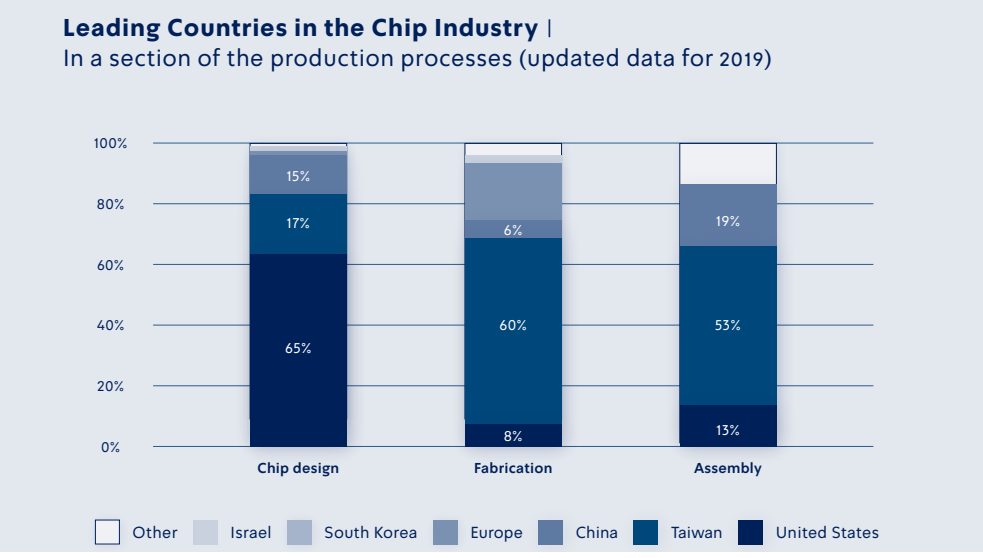
In November 2020, Joe Biden was elected US president, after having promised to bring the manufacturing industries back to the United States in response to the consequences of the COVID-19 pandemic and the disruption of supply chains. At the very beginning of his term, Biden advanced a technological legislative process that encouraged the establishment of production plants on American soil and imposed much more comprehensive export restrictions than his predecessors. The US administration's national security strategy, which was published in October 2022, highlighted the multidimensional competition with China and the need to prevent it from getting stronger and threatening global stability, particularly with respect to advanced technology and chips.[28]

FIGURE 5. CHINA – NATIONAL R&D EXPENDITURE



Source: National Bureau of Statistics of China, "China's R&D Expenditure Reached 2.79 Trillion Yuan in 2021," January 27, 2022.

FIGURE 6. LEADING COUNTRIES IN THE CHIP INDUSTRY



Source: Alicia García-Herrero and Pauline Weil, "Lessons for Europe from China's Quest for Semiconductor Self-Reliance," *Bruegel*, November 18, 2022.

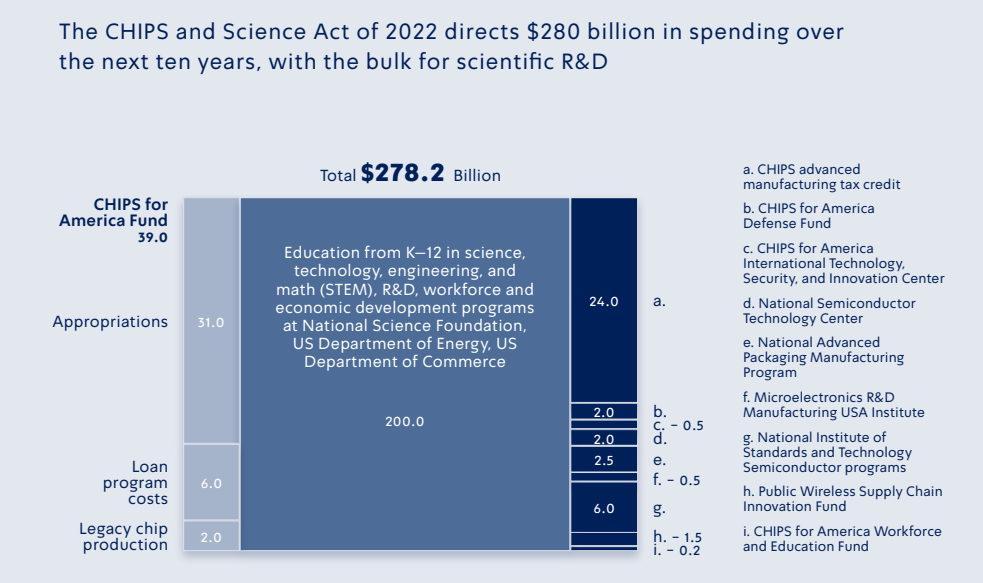
On August 9, 2022, President Biden signed the CHIPS and Science Act of 2022.[29] The law sets out industrial policy and a complete strategy regarding semiconductor industries,[30] and encompasses the logic, budget, and implementation of supervisory regulations on the export of artificial intelligence technologies. The law was passed in the House of Representatives and the Senate with broad support from both parties. Biden recruited a team of experts who set up a council that would guide the government's investments in the field of research and development. The message that the president has sought to convey to the American public is that the United States cannot maintain its standing without strengthening its manufacturing industry, first and foremost in the technology sector and in the field of semiconductors.

A document published by the White House stated that aside from the American aspiration to end the dependence on supply chains in Asia and to prevent the theft of intellectual property, the law would restore the prestige of the US manufacturing industry. It stated that in 2021 alone, the establishment of new production plants provided 642,000 new jobs. The administration indicated investment in education in this field as a central engine of growth for the entire American economy, which would increase the percentage of populations with low participation in this advanced market and reduce the social gaps.[31]

The total budget that the American government has allocated is estimated to be $278.2 billion over ten years (see Figure 7). This sum includes funding and regulatory support for all aspects necessary for achieving "technological superiority" in the field of chips and technological R&D. As part of the legislation, an investment fund of $39 billion was established for direct investment in companies that would develop and produce advanced chip technology; $2 billion was invested in production capabilities for older models of chips; $24 billion is to fund tax benefits up to a total of 25%. The remaining amount, about $200 billion, is invested in research and development, educational

institutions, and security and defense agencies that will ensure the future of the chip industry in the United States.[32]

FIGURE 7. FINANCING ACCORDING TO THE CHIPS AND SCIENCE ACT, 2022–2026



Source: Based on information from H.R. 4346, Chips and Science Act, 117th Congress.

In June 2023, the American Department of the Treasury announced the establishment of a team of experts that will choose the candidates for the Executive Committee of the National Semiconductor Technology Center. The Act gives the Executive Committee the authority to choose the companies and the projects that will receive government assistance. The team of experts is composed of key figures in the American high-tech industry, including Jason Matheny, president of the RAND Corporation; Donald J. Rosenberg, a policy and strategy research fellow at UCSD who previously served as general counsel for Qualcomm, IBM, and Apple; Brenda Darden Wilkerson, who serves as president of the organization for the integration of women and non-gendered or non-binary people in the technology industries; Janet Foutty, who served

as president and CEO of the strategy consulting company Deloitte; and John L. Hennessy, a professor of electrical engineering and computer science at Stanford University. The desire for the committee to express the diversity of voices in American society is intended to show the national and social purpose of the CHIPS Act as a strategic turning point for the manufacturing industries and the American labor market.[33]

Technology companies that express a desire to establish production plants on US soil and far away from China will receive generous government assistance. These companies will commit to not building advanced production plants in China, Iran, North Korea, or Russia nor exporting controlled technology to any of them. Companies that attempt to sell advanced chips intended for artificial intelligence and supercomputing to China will expose themselves to sanctions, requiring them to return the funding and to pay a fine. Since preventing deals may not be enough to curb China's advancement in the chip industry, the administration examined the ways China could achieve a comparative advantage in the field and proposed a comprehensive set of regulations that would block China's technological capabilities in both the short and long term.[34]

China is considered a leader in the use of artificial intelligence for the purpose of research, trade, and military technology. The Military-Civil Fusion (MCF) strategy ensures that every technology marketed in the business sector is available for military use in accordance with the needs of the party. As a result of the strong connection between the military and the business sector in China, chips and other components produced in the United States have been incorporated into Chinese military technologies. Although the United States attempted to prevent this use through sanctions, this policy failed in practice, and the Chinese military has continued to make use of the advanced technology for its purposes.[35] The current legislation is more comprehensive and does not allow China access to advanced chips for any purpose. Consequently, advanced chips that are used in artificial intelligence

technologies are completely prohibited for sale to any entity that operates in China, even if it is an American company whose activity in China is limited to the storage of information on servers.

In the United States, tech giants, AMD and Nvidia, account for the majority of exports of advanced chips for artificial intelligence to China. These companies received detailed explanatory letters that warned them of prohibited transactions according to the new legislation. In effect, the law expands the prohibition on chip deals according to the quality of the chip's performance and not according to the type of deal, the company selling it, or the customer. The sale of a chip whose performance is considered advanced, meaning its processing capability is higher than 300 terabytes per second and its data transfer rate is equal to or exceeds 600 gigabytes per second, is strictly prohibited. According to the administration, these chips could expose technological secrets and endanger national security; therefore, every deal will require reporting and federal approval. These conditions prevent the marketing of chips that were planned for large data servers or supercomputers that train artificial intelligence technologies; nonetheless, China is still permitted to continue to purchase chips intended for personal computers.

While the tech giants Nvidia and AMD are among the only companies in the world capable of designing the advanced chips described, several Chinese companies have made significant progress in adopting and independently applying this unique technology. The most significant comparative advantage of the American giants is the unique software environment marked by Nvidia, called CUDA. The company provides a complete product that makes it easier for the tech giants to carry out the complete process of developing the advanced chips, from the design stage to quality control processes in the production stage. For this reason, Nvidia currently controls 95% of advanced chip sales in China.[36] The prohibition on selling the software environment, in addition

to the chips themselves, ensures that the American company will maintain its comparative advantage and its profitability.

The trade restrictions will deny China access to the software environment for designing chips, such as CUDA, and to vital production components for advanced technology. The Department of Commerce has also designated the software environment known as EDA (Electronic Design Automation), which chip designers and developers use to turn the design into silicon on a chip, as a product that is prohibited from being exported to China, thus ensuring that this significant comparative advantage will remain at its disposal. Should a Chinese company try to use American software, whether by successfully stealing the product or by acquiring a license before the law came into effect, the company will not be able to send the design for production outside of China. This is a significant limitation, as China does not yet have advanced production systems necessary for assembling the advanced chips; therefore, it must export the design to factories abroad, and it is, in effect, dependent on them. Restricting China's access to the necessary software environment will inhibit its ability to design chips, while preventing the use of factories and production systems that rely on American technology will minimize the likelihood of China acquiring relevant production capability of advanced chips for the purposes of artificial intelligence.

Even without production systems, China could still gain access to the software environment and produce the chips using outdated equipment. The company Huawei has announced its intention to pursue this option via HilSilicon, its subsidiary for producing chips.[37] Nevertheless, the US administration believes that even the old equipment, which is based on American capabilities, will require support and maintenance that it does not intend to allow.[38] The legislation explicitly states that any company that supplies production components is prohibited from fulfilling contracts and providing service to Chinese manufacturing plants, while existing contracts with Chinese companies will be cancelled. Thus, even if China strives to

produce the chips on its own and needs American assistance, it is prohibited from receiving such support.

The administration is going as far as to not only deny China the ability to develop future technologies but also to erode its existing capabilities and to set China back a few steps. Similar to chip performance, production equipment is also classified by performance. It is customary to classify chips according to their geometric size, whereas the unit of measurement is the nanometer (billionth of a meter); one can understand that the most advanced chips are a size that is almost microscopic, and it is possible to squeeze an entire computer into a chip. The administration's efforts are currently focused on limiting China's ability to produce chips to a size of 16 nanometers, while the most advanced chips in the world are 3 nanometers and 2 nanometers are expected in the near future. The Chinese company SMIC currently is able to produce chips at a size of 14 nanometers, while the American actions could force it to produce larger chips. The company YMTC, which Apple is considering for producing chips for its devices, will also be limited to chips of 18 nanometers and could lose its business advantage. Even if these companies succeed in overcoming the difficulties, the lack of support from the United States will delay them by several years at least. Because China expected these restrictions, it has since completed large-scale purchases of chipmaking equipment in recent years, but it still lacks the comprehensive capabilities encompassed by the entire package described above.

The final layer of defense created by the United States in this context is preventing China from producing the essential equipment for making its own chips. The sale of American components used to produce the machines that manufacture the chips will also be prohibited. This equipment is considered especially advanced and complex to produce; therefore, exclusivity ensures that the United States has an advantage over all chip industries in the world. So far China has relied on the American technologies, and now it will be

prohibited from buying any component that serves the process of producing advanced chips.

At this stage it is still too early to assess China's readiness at coping with the significant restrictions that the United States has placed on it, but we can assume that China will remain determined, as reflected by the substantial investments in strengthening artificial intelligence that appear in the fourteenth five-year plan, especially the intention to develop an independent software environment. Regardless, China will continue to maintain a comparative advantage in older models of chips, components crucial for the proper functioning of household appliances (washing machines, computer or television screens), and it could make things difficult for countries that prevent its ambitions for global leadership in the field of artificial intelligence. While the current legislation also allocates funds for the production of the old chips, this is an issue that will require further examination as time goes on.

To ensure that China's access to advanced technology is limited, the United States will need to enlist its partners, particularly in Europe and Asia, who have their own advanced chip industries. For this exact reason, the legislation process was coordinated with the European Union and leading countries in the industry, and in the first few months after the legislation, the United States invested in publicity efforts and in enlisting partners to support the legislation and its consequences.

"Chip Coalitions": Interest-Based Alliances

The chip war is seen as a new kind of cold war.[39] In the period after the fall of the Soviet Union, globalization and the economic aspirations of countries sometimes acted as a deterrent to war, due to both the risks to trade and the costs of rehabilitation, which grew as countries developed. Most countries that take part in global trade have profited from mutual defense, although they have sometimes been forced to compromise on local interests. Countries that chose to isolate and to adhere to militant, anti-democratic agendas, such as

Iran and North Korea, have paid for this with the imposition of heavy sanctions. However, in recent years, given technological and cultural changes, and a certain erosion of values and interests, the question of the cost versus the benefit of dependence on others is being reconsidered. The Russia–Ukraine war undermined belief in the effectiveness of the mechanism of dependence on others, and in effect an increasing number of countries are concerned that this model exposes them to strategic risks that are not worth the economic benefit. History shows that conflicts between countries end with a balance between economic growth and national security interests. While there is no correct balance, the technological struggle between the United States and China and the decline in trade is putting globalization to the test.

The chip market is a global market that is not owned by any country. The supply chain is intercontinental and is sensitive to changes, from climate and demography to foreign relations and security. To succeed in producing a chip, many raw materials are needed, along with engineering capabilities and advanced production components. Raw materials for producing chips are found in China and other countries in Asia. While the United States has a substantial share in research and development, making it a focal point, the production of advanced equipment is done almost exclusively by the Dutch company ASML, and the chips themselves are manufactured and assembled in a variety of countries, led by companies in Taiwan (TSMC) and in Japan (KIOXA and others). Even though geopolitical challenges are pushing countries toward independence and exclusivity in the field of chips in the long run, global trade between countries with advanced chip factories or conditions conducive to the establishment of factories is necessary at this stage to fulfill the potential.

The legislation in the United States has created a reality in which each country (or, in fact, each company) is obliged to reexamine the partnerships in its supply chain in order to avoid American sanctions. Furthermore, the United States has turned to its partners in Asia and Europe and has attempted

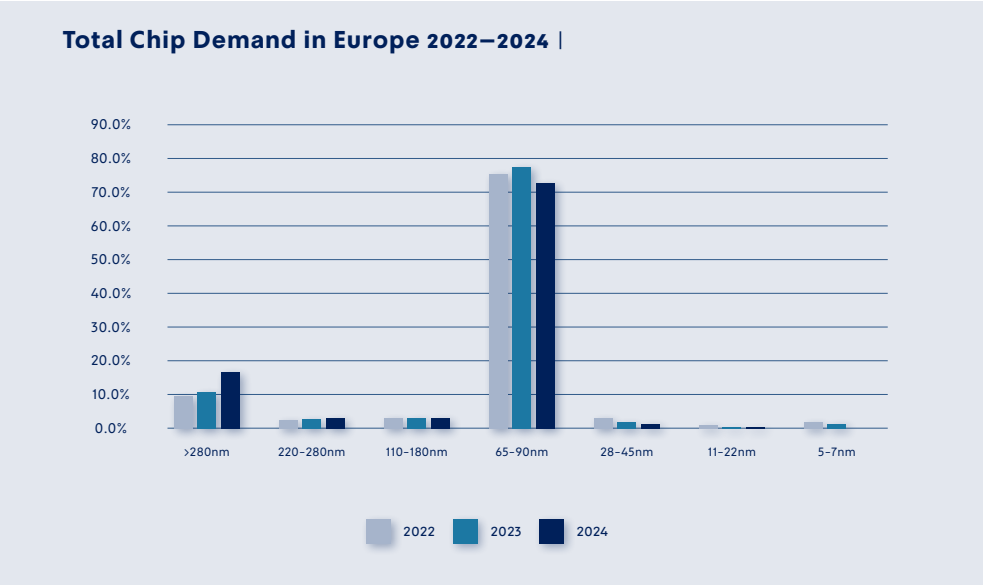
to convince them to join the struggle and adopt the policy restricting China's ability to research, develop, and produce advanced chips. This is a complicated demand given China's economic standing, its growing ties with the countries of Asia and Europe, and the high cost that these countries could pay not only economically but also in terms of national security.

In an era of post-globalization and a return to models based on alliances and coalitions, the United States has initiated several technology alliances. In the field of chips, the United States has invited the leading countries in the industry, Taiwan, Japan, and South Korea, to a four-way alliance of countries that produce the most advanced chips ("the Fab 4"), which is supposed to become one of the main axes in regulating and supervising the proliferation of chip technologies worldwide, especially with respect to China. Another alliance that has been proposed by the Atlantic Council will focus on the use of technology by democratic countries (Democratic Technology Alliance). These two alliances bring together two central motifs in the spirit of the lessons learned from the supply chain crisis and the struggle to prevent the proliferation of advanced technology, which could be used for destructive purposes in an uncontrolled manner. With the help of these alliances, the United States will strive to manage the global proliferation of the most advanced technologies, in part to prevent China from attaining the ability to independently produce the most advanced chips, as well as technologies that rely on these chips. In addition, an alliance of technologically advanced democratic countries would be able to define the accepted guidelines for the use and proliferation of all technologies. Without defining technologies as "good" or "bad," the broadest common denominator that defines the nature of their use is the regime that controls the technology. The basic assumption is that even if a democratic regime has countless weaknesses, it is more likely that it would use technology in a more responsible and moral manner than an undemocratic regime.

Taiwan, which relies on the United States for defense given the military threat from China, was the first to join the Fab 4 chip alliance. Soon after the publication of the law and the policy of restrictions against China, TSMC, the leading chip company in Taiwan, announced its intention to set up two advanced chip factories in Arizona with a total investment of $40 billion.[40] President Biden participated in the announcement ceremony that was held in Arizona together with the tech giants that are expected to acquire the advanced chips.[41] His speech demonstrated the seriousness of the administration's intentions and the expectation that other democratic partners join it. Since this announcement, the construction of the factories has advanced, and in August 2023 TSMC announced its intention to build another chip factory in Germany.[42]

In the past year, the European Union advanced its own efforts in the field of chips, and at the same time strengthened its coordination with the United States. A report by the European Commission on the EU's technology policy detailed the consequences of the global shortage of chips and the future demand for chips in the European Union.[43] The report showed that the demand for chips is expected to double between 2022 and 2030 and that in 2020 alone, a trillion chips were produced worldwide, and only 10% of them on European soil. The gap between the increasing demand in Europe and the supply and dependence on countries with which relations are unstable is not sustainable. The same report also published a survey of industry leaders in Europe, which revealed that the main consideration for choosing a location for a production plant is the availability of labor and supportive legislation. In addition, it stated that legislators need to invest in research, development, and production as well as in companies that would encourage new technological initiatives, since increasing demand for chips is no less important than increasing the supply, as both are crucial for encouraging economic growth and promoting the application of artificial intelligence for the benefit of citizens.

FIGURE 8. TOTAL CHIP DEMAND IN EUROPE (DIFFERENT SIZES) 2022–2024



Source: European Commission, European Chips Survey Report, July 2022.

The European Union's technological legislation was approved by the European Parliament in February 2023. As in the United States, the EU legislation aims to shorten supply chains and to promote the establishment of additional production plants in EU countries in a way that will double Europe's chip production to 20% of overall global production.[44] The European law does not contain severe trade restrictions against China, but it explicitly states that the European Union will be part of a supply chain that includes the United States, Japan, Korea, Singapore, and Taiwan. In the framework of the law, an additional €15 billion will initially be allocated to direct investment in companies that establish chip production plants on European soil. This investment joins technology and artificial intelligence development plans that were launched in 2021, which together amount to an overall investment of €43 billion in technology by 2030. Each country in the EU will publicly and

privately encourage additional investments in the chip industry, in accordance with its capabilities, as long as they serve the overall welfare of the EU's countries. The Netherlands and Germany, which are considered industry leaders in Europe, have both created an independent incentive policy that aims to ensure continued growth in the field.

In March 2022, Intel reported its intention to implement a plan to invest €80 billion in Europe in the coming decade.[45] The plan includes the establishment of two huge factories for producing chips (Mega-Fab) in Magdeburg, Germany, which will be responsible for producing the most advanced chips in the continent. Intel chose Germany after it was promised an incentive estimated at about 40% of the total setup costs (subject to the approval of the European Trade Council). Alongside the government benefits, Intel will benefit from advanced green energy infrastructure being installed in the region and water desalination infrastructure that is supposed to reduce the cost of the significant energy and water consumption of a chip factory of this kind.

As part of strengthening cooperation and trust with the United States, in December 2022, weeks after the publication of the American chip policy, a joint conference of the EU–US Trade and Technology Council (TTC) was held under the leadership of the foreign and trade ministers. In the closing announcement, the TTC stated that the increasing geopolitical challenges, in particular those originating from autocratic regimes that violate human rights, threaten both the shared values of the democratic countries and international trade.[46] The TTC emphasized that the Russian invasion of Ukraine alongside the COVID-19 pandemic and other factors that affected the global supply chains have led to the understanding that relying on areas of geopolitical tension as export centers expose the global economy to especially challenging risks. One of the prominent conclusions of the TTC is that there is no choice but to cooperate in the chip field, and to resolve the current crisis, alongside independent aspirations, a coordination mechanism based on transparency and trust is needed.

At the conclusion of the summit, it was decided that investment in technology would be based on shared democratic values, out of a desire to safeguard the citizens' future. The TTC emphasized the conflicting interests vis-à-vis China, which competes with the United States and Europe for technology and control of the global market. The TTC decided to establish a joint mechanism that would warn of supply chain disruptions and would fully reveal the amount of government support in the chip field in each country so that every country could independently assess future demand and the resulting risks. In addition, it was decided to establish ten work teams that will discuss, in part, economic growth, digital transformation, standardization, and international fair trade that will maintain regular supply. The work of these teams will create conditions and definitions for the safe and fair use of advanced technology, especially in the field of artificial intelligence, so that trade barriers will be removed, and global competition and innovation will be encouraged. Artificial intelligence and supercomputing were defined as necessary conditions for solving global problems, such as extreme climate change, agriculture, green energy, and coping with serious illnesses.

In January 2023, further progress was made, when the Netherlands and Japan signed a joint agreement with the United States in which they agreed to enforce the American restrictions on the export of chip technologies to China, which in practice would make it difficult for China to independently produce advanced chips.[47] The full details of the agreements between the countries have not yet been disclosed as of the date of this writing, but according to statements by figures involved in the negotiations, the restrictions that the governments of the Netherlands and Japan are preparing to impose on China apparently will be more limited than those of the United States and will not include restrictions on the employment of their citizens in Chinese companies and so on. Since the Netherlands and Japan are the world's leading countries for producing lithographic machines for manufacturing advanced chips, minimal export restrictions—meaning a prohibition on

the export of components developed in the United States or containing American technology—are sufficient for significantly impeding the Chinese companies and their commercial partners. For the companies in Japan and the Netherlands, this is a difficult decision that could harm their profitability, and therefore international cooperation and government intervention are a necessary condition for safeguarding the interests of these companies. According to economic forecasts, cooperation between the European Union and the United States will ensure incentives that will compensate for potential losses.[48] This is, in practice, a new economic framework that violates the principle of the free market that had been implemented until now in the chip industry.

India is also paving its way toward the American chip alliance. Under the auspices of the legislation, India and the United States have agreed on the establishment of a task force to examine India's potential in the global supply chain.[49] Today India is considered a leading country in research and development, and it is preparing to offer billions of dollars of incentives to companies that establish factories in its territory. From the perspective of the United States, India is an important ally in Asia, and it has a significant role in the struggle against China in the military sphere too.

The United Kingdom, which left the European Union, is also engaged in formulating government policy on chips, and like the European Union, it will probably align with the US policy. There were hints of this in the unusual government intervention in a deal to acquire the Newport Wafers chip production plan in southern Wales.[50] The government published an order that forced the factory to withdraw from the process of acquisition by the Chinese company Nexperia for £63 million, claiming that this was a transaction that could endanger British interests in the chips industry and as a result, could threaten national security. At the time of this writing, a legal battle is taking place between the Chinese company and the British government, and further developments could affect the future of the deal. We can assume that

the United Kingdom is closely coordinating and discussing the issue with its ally, the United States.[51]

In an effort to strengthen the local industry, the British government published an invitation to tender to encourage initiatives that will accelerate the UK chip industry.[52] It also appears that the United Kingdom will allocate £1 billion to invest in and subsidize companies engaged in semiconductors.[53] This is a tiny amount compared to the investment amounts of private British industrialists. The question at hand is to what extent the United Kingdom would agree to adopt as legislation the restrictions that the United States has imposed, and what incentives would it be able to provide to companies operating in its territory?

China is closely following the American actions and the emerging chip alliance. While it is not yet clear how it will respond, aside from the expected increased budgetary investment in the field, it seems that China is considering its next steps in the industry and trying to enlist partners that will enable it at least to maintain its current standing.[54] Because China is responsible for the production of the "old" chips that are located in most home appliances and are outside of the American sanctions, it is expected to maintain relations with the leading chip companies in the world in producing chips that are at least 28 nanometers in size.