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EUROPE'S POSITION IN THE GLOBAL SEMICONDUCTOR ECOSYSTEM



INTRODUCTION

Semiconductors, also known as integrated circuits, chips, or microchips, are components used to process, store, and transmit information in almost every modern electronic device, from consumer devices, such as smartphones, to cars, medical equipment, and data centers. This fact justifies the growing political and strategic attention devoted to this industry - an industry which has come to represent the backbone of contemporary digital economy, and is now increasingly recognised as a pillar to technological power, military capability, and geopolitical influence (Duran Morenilla, 2024; Poitiers & Weil, 2021). One must highlight, however, that what has truly amplified the sector's relevance is the intensifying competition between the United States and China, for whom leadership in advanced chips has become central to broader economic and security objectives.

Within this global landscape, the European Union occupies an ambivalent position. On the one hand, Europe remains home to indispensable capabilities, namely world-leading research institutions and firms that dominate specialised segments such as advanced lithography equipment (Kleinhans, 2024; Ciani & Nardo, 2022). On the other hand, the EU has experienced a gradual erosion of its capacity to manufacture cutting-edge chips, leaving it more and more exposed to supply disruptions and strategic dependency (Huggins et al., 2023). The vulnerabilities of Europe's position became clear during the global chip shortage that began in 2020, which severely disrupted European manufacturing, particularly the automotive sector. As Europe's industries proved to be deeply dependent on external suppliers, the geopolitical consequences of semiconductor interdependence became undeniable. Besides, the complexity, capital intensity, and geographical contraction of the global semiconductor value chain (Cerutti & Nardo, 2023) further intensify these risks, especially as the US-China competition crescively spills over into export controls, investment restriction, and techno- nationalist policies.



Considering this context, the EU has sought to reposition itself through several initiatives, most strikingly through the European Chips Act, a policy framework intended to enhance resilience, secure supply, and support Europe's relevance in this industry. Yet the ECA's emphasis on achieving a 20% global market share in semiconductor manufacturing has been widely questioned. Given the exorbitant costs of advanced fabrication, Asia's sectorial dominance, and the expensive subsidies deployed by the United States and East Asian governments, there is no clear evidence that pursuing volume-based semiconductor autonomy is economically viable (Hancké & Garcia Calvo, 2022; Kleinhans, 2024).

This article seeks to argue that Europe's long-term success will depend less on replicating foreign industrial models and more on leveraging the strategic assets it already possesses. Rather than pursuing full autonomy, which could represent an objective that is financially unrealistic and even unnecessary, the EU would benefit more if it strengthened its position by managing said interdependence.



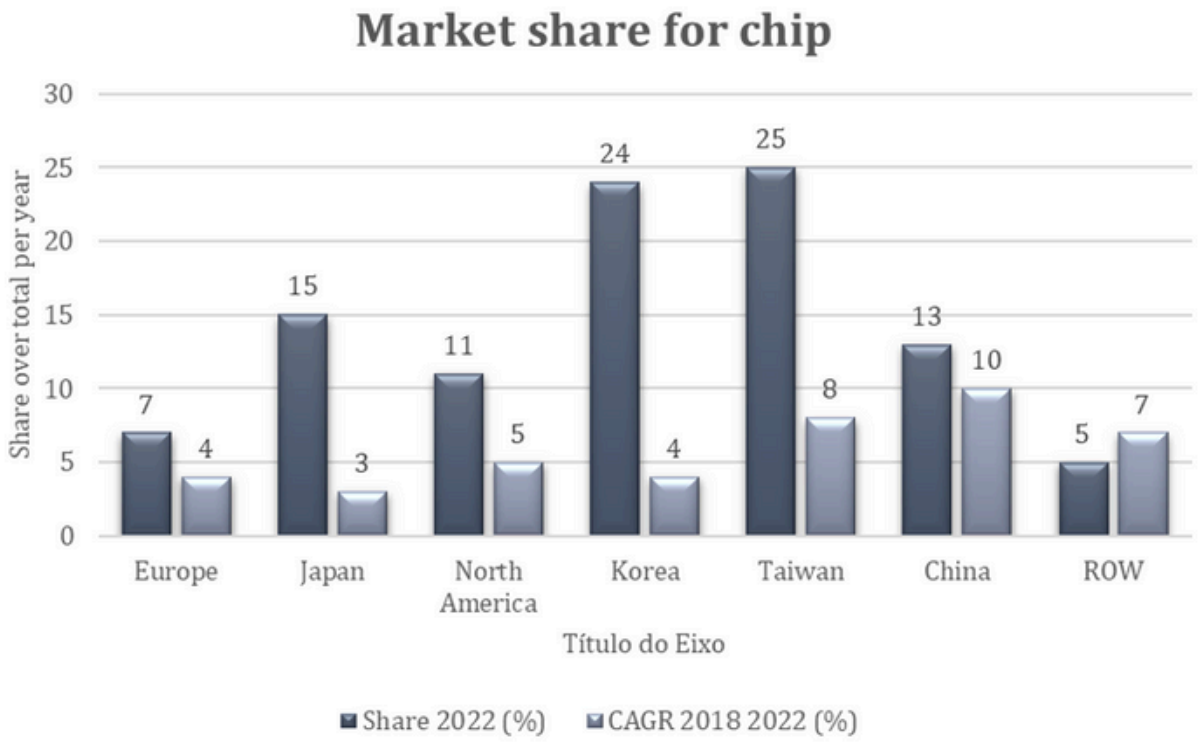
Indeed, Europe's control over essential upstream technologiesoffers a unique advantage that can be used to shape global supply chains and secure reliable access to advanced chips (Kleinhans, 2024; Cerutti & Nardo, 2023).

The analysis that follows, thus, studies Europe's structural position in the semiconductor ecosystem, tracing the roots of its relative decline, and critically evaluating whether the ECA provides a viable pathway toward sustainable resilience.

EUROPE'S DECLINE AND VULNERABILITIES IN SEMICONDUCTOR MANUFACTURING

Europe's relative decline in semiconductor manufacturing capacity can be said to be the result of long-term structural shortcomings, rather than a sudden or cyclical shift. The EU's share in the global semiconductor trade fell from roughly 22% in 1978 to about 9% in 2017 (Poitiers & Weil, 2021) and approximately 7% in 2022 (Cerutti & Nardo, 2023) (Figure 1). Wihtout substancial policy intervention, there are forecasts which suggest that these numbers could drop below 5% (Ejdys & Szpilko, 2023). This track clearly indicates a deeper failure to invest at the scale and speed required to keep pace with technological advances in the sector (Poitiers & Weil, 2021).

Figure 1: Market share for chip: (physical) production (in square inches of wafers) by region

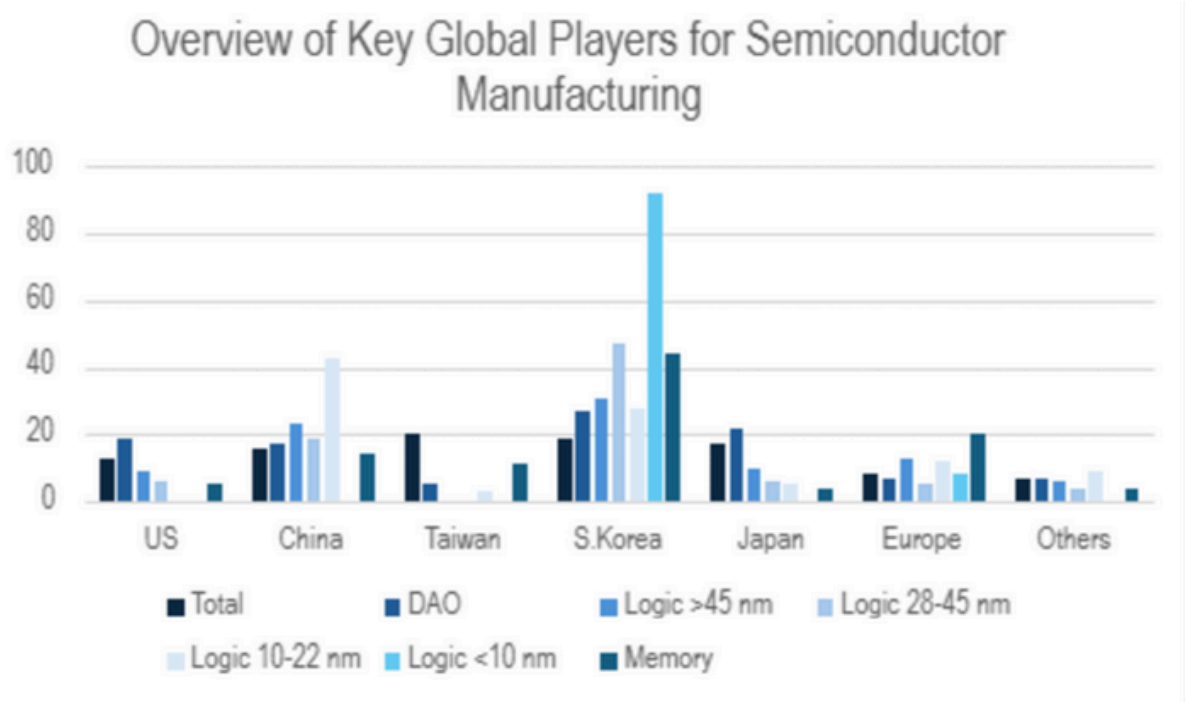


Source: Cerutti & Nardo (2023), JRC Technical Report, p. 14

It is relevant to note that the continent's capacity remains concentrated in mature nodes, which reflects its historical focus on older, high-volume products, rather than leading-edge chips.

Europe has effectively no presence in cutting-edge manufacturing below 10nm and none at all in the 2-5 nm range, as of 2021 (Poitiers & Weil, 2021) (Figure 2).

Figure 2: Overview of key global players for semiconductor manufacturing (Wafer fabrication capacity). Detail by country (%) and chip type.

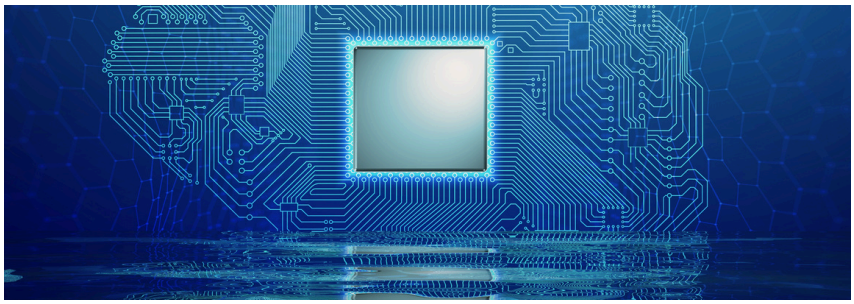


Source: Cerutti & Nardo (2023), JRC Technical Report, p. 34

Advanced logic-chip production is overwhelmingly concentrated in East Asia, where Taiwan's TSMC controls 85% of the global foundry market for nodes between 5 and 10 nm, while South Korea's Samsung accounts for the remaining 15% (Ciani & Nardo, 2022). Europe is also net importer of integrated circuits, and nearly 80% of the inputs required by European semiconductor firms originate outside the EU, primarily from the US, followed by Taiwan, China, South Korea, and Japan (Ciani & Nardo, 2022; Cerutti & Nardo, 2023). All of this comes to leave Europe in a position that is highly exposed to geopolitical and supply-chain risks.

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Foreign control over capital and ownership also enforces Europe's fragile position. Between 2015 and 2021, US firms accounted for more than half of minority-stake acquisitions, and around a quarter of mergers and acquisitions in the European industry (Ciani & Nardo, 2022). When it comes to costs, Europe also faces a structural disadvantage, considering that operating an advanced fabrication plant in the EU, over a ten-year period, is estimated to be about 33% more expensive than in South Korea and 63% more expensive that in mainland China (Hancké & Garcia Calvo, 2022; Johnston & Huggins, 2023).





EUROPE'S STRATEGIC CAPABILITIES

Indeed, the interesting combination of long-term investment, limited access to cutting-edge manufacturing, heavy dependence on foreign capital, and higher operation costs has turned Europe into a relatively fragile actor in the global semiconductor value chain. However, despite its relative decline, Europe still retains critical capabilities and, in some cases, even monopolistics positions in key upstream segments of the semiconductor value chain (Ciani & Nardo, 2022).

One of the most prominent levers is the European dominance in manufacturing equipment. The Dutch company ASML Holding holds a global monopoly in extreme ultraviolet lithography machines, which are indispensable for producing cutting-edge chips with nodes below 14 nm (Poitiers & Weil, 2021; Duran Morenilla, 2024). ASML alone accounted for over 12% of total EU semiconductor sector revenues in 2020 (Ciani & Nardo, 2022). Its supply chain is highly complex, relying on critical components from German firms such as Zeiss and Trumpf . Overall, European-owned companies represented 27% of global revenue in the semiconductor equipment segment in 2020, only behind the United States (Ciani & Nardo, 2022; Cerutti & Nardo, 2023).

Europe also maintains a strong position in materials and specialized inputs. European investors control major suppliers of chemicals and gases, accounting for 34% of the global market in this segment in 2020 (Ciani & Nardo, 2022). Besides. Europe reveals strentgh in high-value niches such as power electronics and, discrete, analog, and optoelectronic components, where firms like Infineon and STMicroelectronics are central suppliers to automotive and industrial customers (Ciani & Nardo, 2022; Huggins et al., 2022).

Another key advantage which Europe holds lies in its research and development base. Leading institutions such as IMEC in Belgium, which works closely with ASML, have been fundamental in pushing forwards EUV lithography and shortening innovation cycles (Cerutti & Nardo, 2023; Hancké & Garcia Calvo, 2022). In parallel, regional clusters, such as Silicon Saxony, in Germany, DSP Valley, in Belgium, Eindhoven, in the Netherlands, and Minalogic, in France, exemplify high levels of cooperation between firms and research centers, thus supporting the development of emerging technologies, including AI and quantum chips (Huggins et al., 2023).

Taken together, these capabilities suggest that Europe's most credible approach is to pursue "path creation" through innovation, new chip architectures, and deep-tech capabilities, rather than simply attempting to extend already existing mass-production paths in segments which are already dominated by Asia (Huggins et al., 2022). By concentrating on these specific strengths, Europe can use its position to influence global supply chains and retain influence in this increasingly competitive and geopolitically tense industry (Ciani & Nardo, 2022; Cerutti & Nardo, 2023).

EUROPE'S RESPONSE AND CRITIQUE OF THE EUROPEAN CHIPS ACT

In response to the continent's structural vulnerabilities and its semiconductor sector's decline, the European Commission proposed the European Chips Act in February of 2022, which came into effect in September of 2023. The ECA aims to mobilize over 43 billion € in public and private investment, and, as stated in the 2030 Digital Compass, to double Europe's share of
global chip production to 20% by 2030. The Act's central objective includes not only expanding high-volume manufacturing but also developing the ability to produce cutting-edge chips in the 2-5 nm range. However, the ECA has faced substantial criticism. It has been described as a reactive policy, mostly driven by the chip shortages experienced during the Covid-19 pandemic, and at times characterized as a "collection of ideas and initiatives" rather than a coherent long-term strategy (Kleinhans, 2024). Several concerns are highlighted. First, the economic feasibility of replicating high-volume chip production in Europe is a questionable matter. This is because, as stated previously, semiconductor manufacturing is capital-intensive, and operational costs in Europe are significantly higher compared to other regions. Besides, the total ECA budget can be considered modest when put next to other global investments - for instance, the US CHIPS and Science Act allocated 52.7 billion $ in grants and 24 billion $ in tax credits; South Kora plans to invest 450 billion $ until 2042; and Taiwan's TSMC alone budgeted 100 billion $ over three years (Cerutti & Nardo, 2023). Trying to compete in this global subsidy race means risking ineffiency and potentional misallocation of public funds (García-Herrero & Weil, 2022).

Second, even if Europe were to achieve the 20% target, this would not automatically ensure supply security or global competitiveness. The continent would remain dependent on external actor for advanced technologies, as well as critical materials, wafers, and back-end assembly, testing and packaging (Kleinhans, 2024; Ejdys & Szpilko, 2023). This means that resilience in the European semiconductor sector should therefore rely more critically on long-term investment in STEM talent, R&D, and innovation (Ejdys & Szpilko, 2023).



The European Chips Act has, nonetheless, attracted notable foreign direct investment, as exemplified by Intel's 33 billion € investment plan for two chip-making plants in Magdeburg, Germany, supported by roughly 10 billion € in government subsidies (Duran Morenilla, 2024; Stünkel & Nordin, 2022).

Yet, structural challenges persist. The EU's fragmented industrial ecosystem and stricter state aid regulations make it difficult to channel funding towards companies rather than universities or research institutes, limiting the potential of commercializing European innovations (Huggins et al., 2023). Additionally, the lack of coherent coordination among member states risks undermining the ECA's effectiveness. It becomes increasingly apparent that Europe should leverage its existing strengths instead of just trying to mimic US' and Chinese strategies focused on mass production. Prioritizing investment in R&D, chip design, software, and high-value niches, where European firms are already global leaders, offers a more realistic path to increasing value creation (Huggins et al., 2023; Kleinhans, 2024).

GEOPOLITICS AND INTERDEPENDENCE

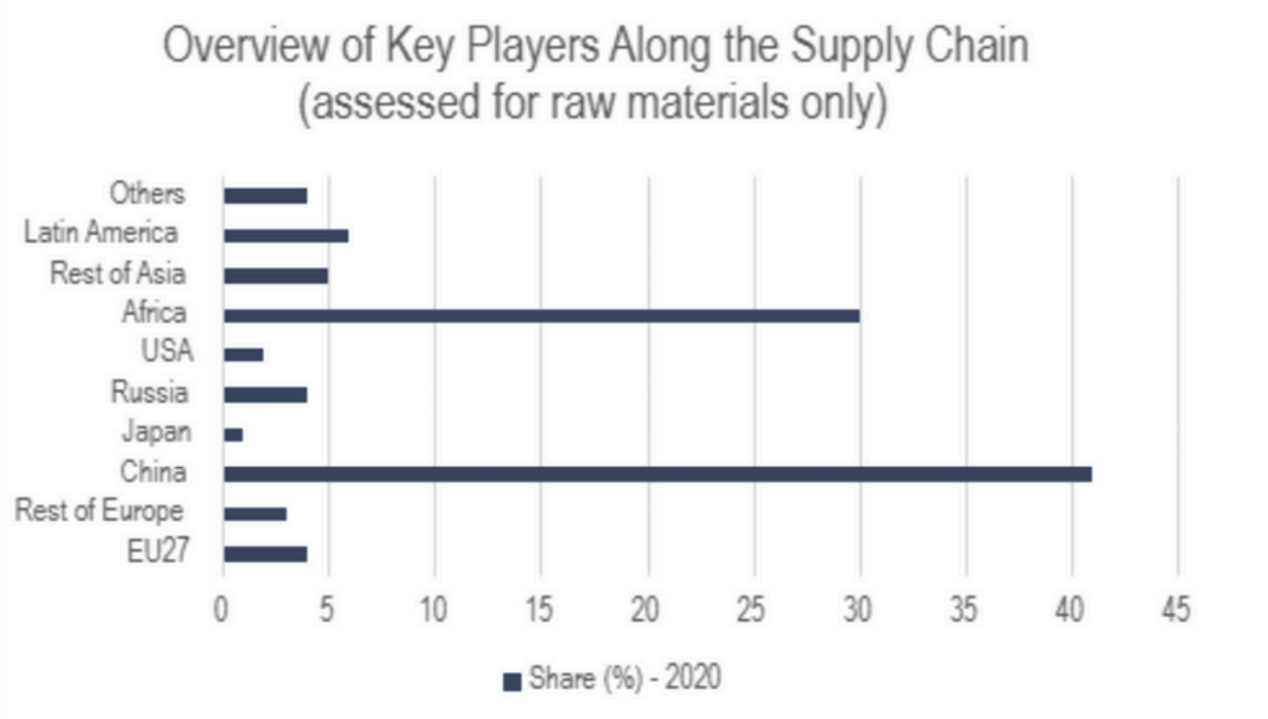


Europe's position in the semiconductor ecosystem cannot be separated from the dynamics of the US-China rivalry, which strongly shapes the environment in which the EU operates (Cerutti & Nardo, 2023).

Considering this information, it is important to understand that Europe's pursuit of strategic autonomy must not be summarized as autarky, or self-sufficiency. Replicating the entire global semiconductor value chain within Europe would be extremely expensive and economically inefficient (Cerutti & Nardo, 2023; Huggins et al., 2022). Instead, European strategy is and should be progressively centred on leveraging the EU's monopolistic position in critical upstream equipment (above all, ASML's technologies). This is mandatory in order to exert influence across the broader value chain. Protecting these assets from foreign acquisition or technology transfer remains a core priority (Hyggins et al., 2022).

Europe is also not a member of the US-led "Chip 4 Alliance", which brings together the United States, Japan, South Korea and Taiwan. Even so, the EU has the possibility of deepening cooperation with Taiwan, which has expressed its intention to remain a "trusted chip partner" for Europe (Stünkel & Nordin, 2022). Given Europe's reliance on Taiwan for advanced semiconductor manufacturing, this partnership will require public funding mechanisms or formal alliance to relieve geopolitical and natural-distaster risks in the Taiwan Strait (García- Herrero & Weil, 2022). All of the described challenges are further aggravated by Europe's dependence on critical raw material. China supplies around 41% of the raw materials essential to digital technologies (Cerutti & Nardo, 2023) (Figure 3).

Figure 3: Digital technologies: an overview of key players along the supply chain (assessed for raw materials only)..



Source: Cerutti & Nardo (2023), JRC Technical Report, p. 39

ANALYST'S TAKE

The reality of the matter is that Europe's position in the semiconductor system is defined by a structural paradox. The EU has seen its high-volume and high-end manufacturing capacity erode, while remaining deeply dependent on the US for financing and key suppliers, and on Asia for advanced foundry capabilities. Yet, it retains irreplaceable strengths in upstream segments, especially considering ASML's global monopoly in lithography and specialized technological know-how. The European Chips Act acknowledges the strategic importance of the sector, but its focus on achieving a 20% global production share has been criticised as unrealistic given global concentration and competing subsidy regimes. A more credible path thus lies in reinforcing Europe's comparative advantages, while improving the commercialisation capacity of its innovation clusters. Rather than pursuing costly self-sufficience, Europe's security of supply will depend on managing interdependence, or, in other words, by protecting its indispensable assets and using them as strategic leverage, while maintaing cooperation with partners such as Taiwan. The semiconductor industry reflects a fragmented and geopolitically tense reality, and Europe's competitiveness will depend, not on replicating the entire value chain, but on ensuring that the global ecosystem continues to rely on European technology at critical checkpoints.





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