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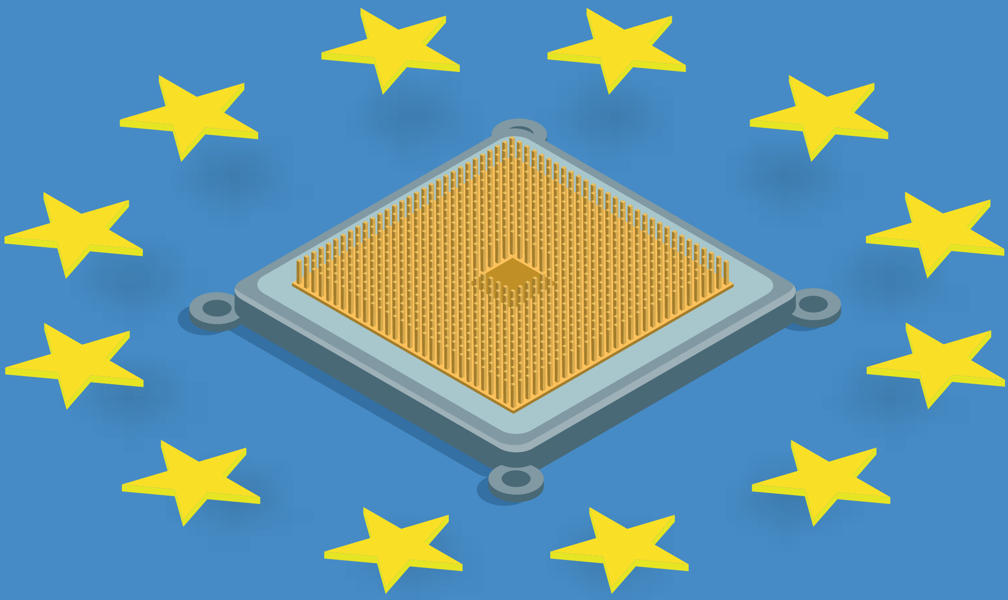
Semiconductors in Europe: the return of industrial policy



POLICY PAPER MARCH 2022

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Semiconductors in Europe:
the return of industrial policy

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There is no desire more natural
than the desire for knowledge

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INTRODUCTION

2022 is a decisive year for the European semiconductor industry, shaping Europe's semiconductor industry for the decade to come. The continent is currently undergoing a return of government intervention in the nanoelectronics sector, with the European Commission in the lead. Is Europe doing enough? The stakes are high. In semiconductor manufacturing, Europe's share of global production capacity has declined from 24% in 2000 to 8% in 2021. Europe needs to reverse this downward trajectory.

Complex as it is, the global semiconductor supply chain only involves a limited number of key players. Europe is in the top six, with three large IDMs (STMicroelectronics, Infineon, and NXP), the world's photolithography leader (ASML), a dynamic start-up scene, and leading research centers for nanoelectronics (IMEC, CEA-Leti, Fraunhofer). Yet, despite those strengths, Europe lacks world-leading fabless firms, and there is no foundry at the most advanced technological nodes in Europe, even if such a manufacturing process relies on a European technology – extreme ultraviolet (EUV) lithography.

Recent events have exposed the vulnerabilities of Europe's semiconductor sector. First, **geopolitical shocks can disrupt value chains.** Central to the US-China rivalry, semiconductors are a foundational technology essential to the race for digital transformation and the arms industry. Semiconductors are also a strategic commodity. The US and allies can restrict access to impose costs during phases of geopolitical confrontation – against Russia to counter its invasion of Ukraine, but also against Chinese companies involved in surveillance and military modernization programs. Second, **Europe is more restrictive than its competitors when providing public support for industrial production.** The European Union (EU) has a traditional preference for supporting fundamental research and innovation rather than industrial production and imposes stringent competition rules to ensure the integrity of the single market. At the same time, China, the United States, Japan, Taiwan, and the Republic of Korea are all engaged in considerable, if not massive, multi-level state actions to ensure the competitiveness of their national semiconductor ecosystem.

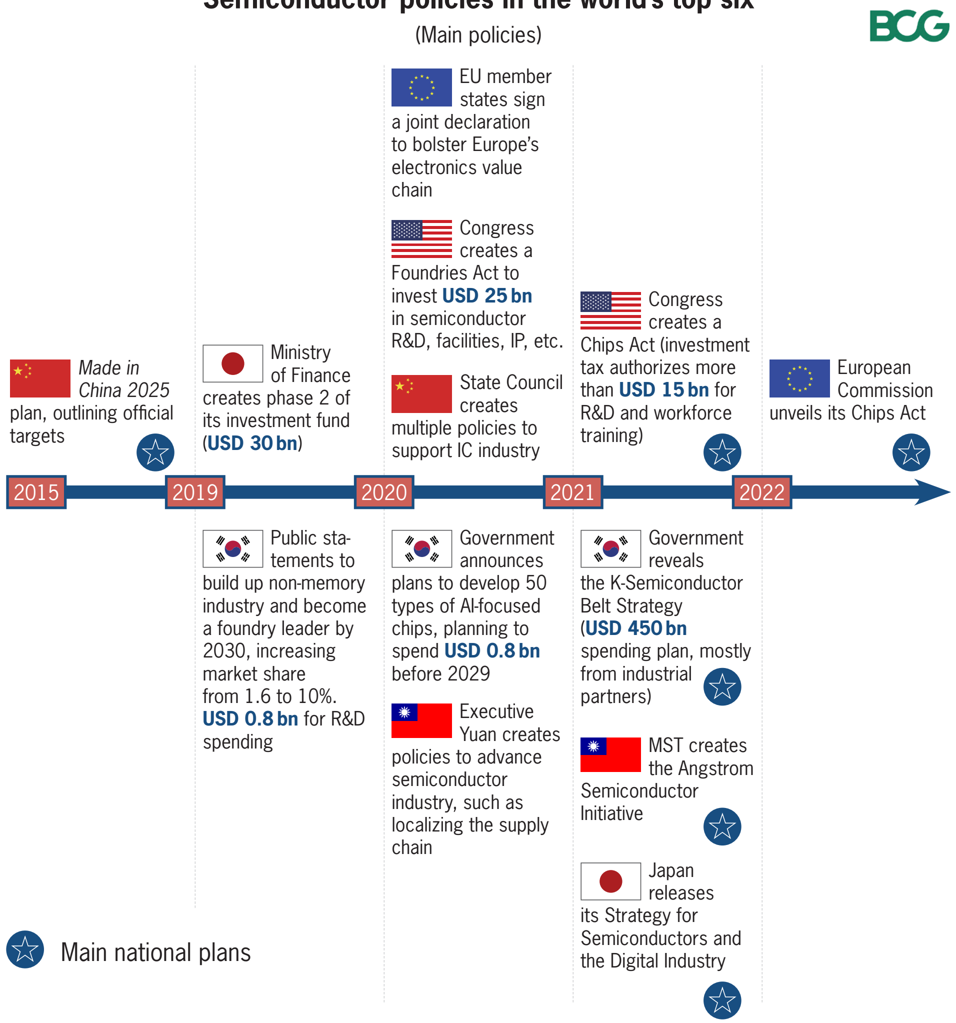
For the European Commission, in the words of President Ursula von der Leyen, the challenge of ensuring Europe's access to state-of-the-art technology is "a matter of competitiveness, but also a matter of tech sovereignty."[1] The Commission's draft

1 Ursula von der Leyen, "2021 State of the Union Address by President von der Leyen", Strasbourg, 15 September 2021, https://ec.europa.eu/commission/presscorner/detail/en/speech_21_4701

Chips Act, released in early February 2022, creates a specific competition regime for the semiconductor industry that allows State aid approval. In addition, a second Important Project of Common European Interest (IPCEI) – the EU's tool to mobilize funding for research, innovation, and pilot production lines – to support nanoelectronics is expected for mid-2022. The Chips Act and the second IPCEI considerably expand various existing budgetary instruments used by the EU and its Member States – including the exceptional recovery plan adopted in response to Covid-19.

Semiconductor policies in the world's top six

(Main policies)



Source : Lit research, BCG analysis.

This policy paper describes Europe's ongoing turn towards industrial policies for its semiconductor sector and places European decisions in a comparative perspective (see country files in the appendix). Adjusting to changing dynamics in global value chains means that the balance between market forces and government intervention is changing in Europe. **As multiple forces shape European decision-making, a guiding principle for the EU's current efforts should be the creation of a European semiconductor ecosystem beyond national divides and differentiating Europe in the global value chain.**

I

THE EUROPEAN SEMICONDUCTOR SECTOR IN PERSPECTIVE

1. The sources of Europe's turn towards industrial policy tools

The EU was built on a firm belief in an open European single market, with market forces guiding innovation and investment, enabling the optimal allocation of resources and avoiding waste. Industrial policy is not easily compatible with that faith. The EU's competition legislation is extremely strict with regards to State aid. It rests on the philosophy that Member States with larger resources should be prevented from outcompeting weaker ones by subsidizing whole sectors of their national economy.

Until the adoption of the Chips Act in February 2022, the EU's regional policy constituted the main exception to the State aid regime. Under that policy, less developed regions in the EU could see State aid approved for industrial production projects. In the semiconductor sector, this explains why GlobalFoundries settled in Dresden, the capital city of Saxony which was eligible for such aid. It also clarifies why GlobalFoundries did not invest further in Saxony later on, as the place was no longer eligible for the aid. Similarly, Intel's fab in Ireland received support from Europe's regional funds.

Regional policy thus played an important role in key foundry projects in Europe. Still, it did not benefit the existing clusters of competitiveness located in ineligible European regions, such as Grenoble or Eindhoven. State aid through the EU's regional policy helped to build the manufacturing capacity of the semiconductor industry, but they constitute an exception. **The overall approach had remained centered on general innovation instruments, with a narrow focus on supporting research, development and innovation, but not production.**

But China's rise has forced the EU to reflect on this restrictive approach regarding government intervention in industrial production and regarding unconditional openness of the EU's single market. As a result, the EU has adopted a toolbox of autonomous defensive instruments to address market distortions and asymmetries

in the EU-China trade and investment relationship. This toolbox includes investment screening, strengthened export controls, trade defense instruments, and soon a new approach to access Europe's public procurement market. It is part of a broader rethinking on regulating technology transfers and stems, based on the assessment that Europe's openness is being exploited through unfair and ill-intended practices. This defensive agenda is still a work in progress. However, it already has an important impact on the EU's international agenda. To make those measures effective, the EU now needs to enable information sharing and coordination with other industrialized democracies, especially the US and Japan (see *Technology transfers: the case for an EU-Japan-US cooperation framework*, Institut Montaigne, March 2022).

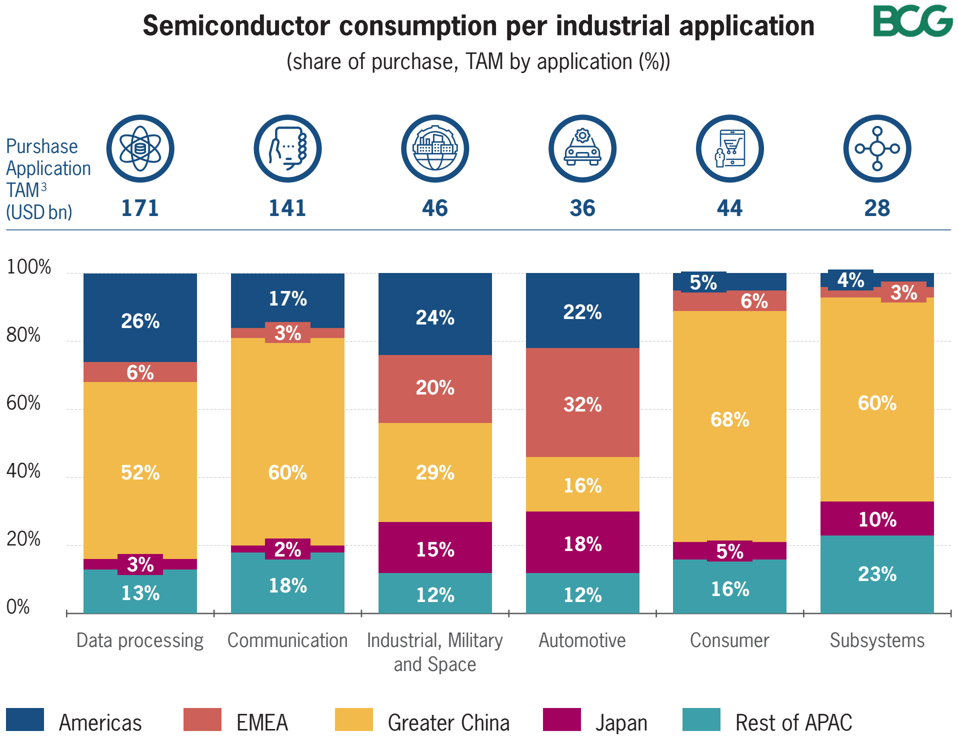
However, protecting European companies and research institutes from forced and intangible technology transfers is only one aspect of adjusting Europe's technology policies to an ever-changing international environment. The semiconductor industry is a revealing case of the limitations of defensive approaches. Responding to the exploitation of Europe's openness is essential, but the asymmetries and the market distortions created by China's model of state capitalism are not the sole challenge Europe's semiconductor industry faces. China has been the source of Europe's wake-up call, **but the real market leaders come from the US, Korea and Taiwan, while Japan also dominates niches in the supply chain – such as photoresist.**

European officials often use the shortages and the disruption of the semiconductor supply chain experienced since the end of 2020 to justify the EU action for Europe's semiconductor industry. In 2021, the shortage of supplies was estimated to cost the global automotive industry USD 210 billion in lost revenue[2]. As the world's leading importer of chips for its automotive industry, Europe has been particularly affected.

2 "Worsening Chip Woes to Cost Automakers $210 Billion in Sales", *Bloomberg*, 23 September 2021, https://www.bloomberg.com/news/articles/2021-09-23/worsening-chip-shortage-to-cost-automakers-210-billion-in-sales

Semiconductor consumption per industrial application

(share of purchase, TAM by application (%))



Source : Gartner Semiconductor Spending by Customer (April 2021).

The European Automobile Manufacturers' Association records a decrease of 2.4% in registrations of passenger cars in the EU in 2021 – the worst performance since 1990.[4] The shortage has also affected medical devices, video game consoles, entry-level smartphones, laptops, and smart appliances. The US Department of Commerce identified the need for additional fab capacity for some market segments as the main bottleneck in overcoming the current shortages, assessed to be lasting into 2023 for some products.[5]

How to explain shortages? Covid-19 has generated disruptions in supply chain segments by disorganizing purchase orders during lockdown periods. Moreover, geopolitics has aggravated the problem – Huawei alone spent USD 23 billion on stockpiling

3 Total available market, 2020.
4 "Chip crisis pushes European car sales to new low", *Euractiv*, 18 January 2022, https://www.euractiv.com/section/economy-jobs/news/chip-crisis-pushes-european-car-sales-to-new-low/
5 US Department of Commerce, "Results from Semiconductor Supply Chain Request for Information", 25 January 2022, https://www.commerce.gov/news/blog/2022/01/results-semiconductor-supply-chain-request-information

components in 2019 to anticipate future restrictions on technology transfers.[6] **But rising demand is a simple structural factor.** Indeed, there were already tensions in the equipment supply to manufacture 200 mm wafers as early as 2020.[7]

As a critical short-term issue for many industries, the shortages point to the existence of chokepoints, which raise the question of resilience in supply chains. What can companies and public authorities do to anticipate and prevent disruption of the procurement of components? **In Europe, the issue yields a new awareness of geopolitical risk in East Asia and US-China relations.** Ursula von der Leyen describes the fact that most of Europe's supplies come from outside Europe as a "dependency and uncertainty we simply cannot afford".[8] Thierry Breton looks at the other side of the coin, stressing that the EU's policies aim to "secure our supply chain in partnership with trusted players across the globe".[9] This logic is not limited to semiconductors **– nanoelectronics is one of five critical industrial sectors that have triggered an awakening in Europe regarding risks of disruptions and the need for supply chain resilience.[10]**

US policies to restrict Chinese access to foreign semiconductor technologies have created uncertainties and increased compliance costs for European companies. However, 2021 was an exceptional year for the semiconductor sector as US restrictions were imposed in a period of revenue growth, a lucky coincidence for many companies. For example, before the interruption of sales due to US restrictions, Huawei represented more than 10% of STMicroelectronics's revenue.[11] Yet, losing such an important customer has not prevented STMicroelectronics from ending 2021 with a solid 25% revenue growth.[12] In other words, costs are real, but they have been offset by an overall revenue growth throughout 2021.

6 "Huawei has spent billions on a two-year stockpile of American chips", *Techspot*, 31 May 2020, https://www.techspot.com/news/85439-huawei-has-spent-billions-2-year-stockpile-american.html
7 Mark Lapedus, "Demand Picks Up For 200mm", *Semiconductor Engineering*, 20 February 2020, https://semiengineering.com/demand-picks-up-for-200mm/
8 'State of the World' Special Address by President von der Leyen at the World Economic Forum, via videoconference, 20 January 2022, https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_22_443
9 "EU's Breton on Asia tour to foster digital cooperation, tackle chips shortages", *Euractiv*, 1 October 2021, https://www.euractiv.com/section/digital/news/eus-breton-on-asia-tour-to-foster-digital-cooperation-tackle-chips-shortages/
10 COMMISSION STAFF WORKING DOCUMENT, Strategic dependencies and capacities. Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery, 5 May 2021, https://eur-lex.europa.eu/legal-content/FR/TXT/?uri=CELEX:52021SC0352
11 "STMicro CEO says a Huawei ban would not threaten $12 billion revenue target", *Reuters*, 23 January 2020, https://www.reuters.com/article/us-stmicroelectronics-results-idUKKBN1ZM12Z
12 « L'explosion de la demande dope les performances de STMicroelectronics », *Les Échos*, 27 Janvier 2022, https://www.lesechos.fr/tech-medias/hightech/lexplosion-de-la-demande-dope-les-performances-de-stmicroelectronics-1382421

The Biden administration is continuing the restrictive policies initiated by the previous Trump administration, adding new Chinese companies to the entity list of the Department of Commerce, which requires export licenses and proceeds under a presumption of denial. In return, China has adjusted its industrial policies to reduce its vulnerabilities.[13] The European semiconductor supply chain is subject to serious risks of further disruptions due to these two opposite forces.

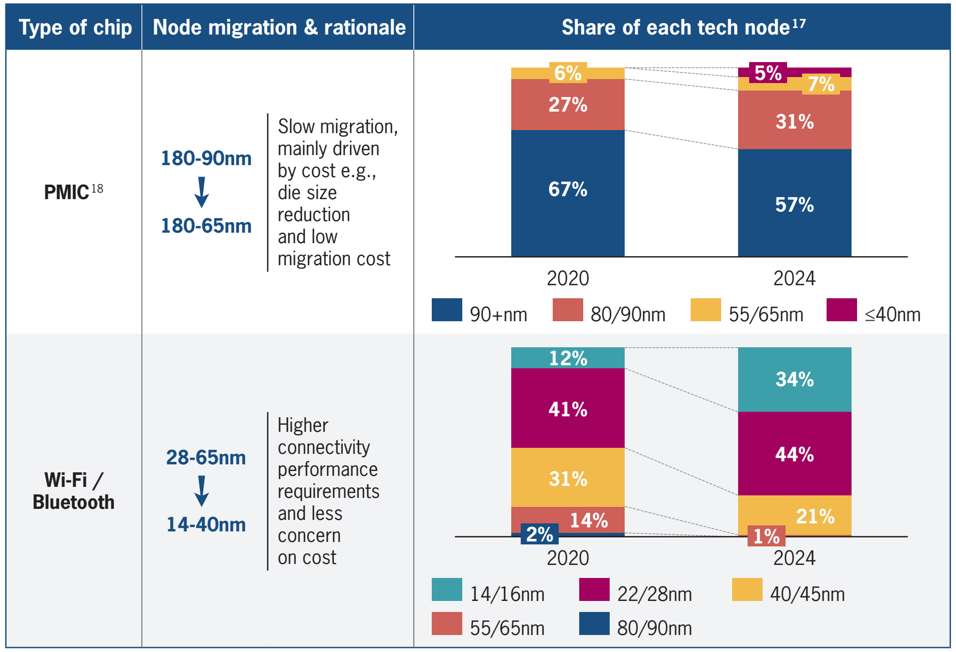
European officials often associate the resilience of Europe's access to semiconductor technology with other political agendas, such as European sovereignty and a geopolitical Europe. These associations are evident, but also misleading. They are evident because Europe's autonomy on the world stage will only be strengthened by industrial power and because European policies adjust to the geopolitics of technology. Resilience to blackmail and coercion has an obvious industrial policy angle – and it is a goal resulting from a geopolitical risk assessment. But they are also misleading. **The solution to ensuring access to trusted components is a matter of managing interdependence and limiting excessive dependence on foreign technology, components, and industrial production. However, this solution cannot be reached without trusted international partners.** The use of terms such as sovereignty and autonomy may suggest otherwise. In reality, no one in the European Commission or national governments aims at self-sufficiency. While strategic autonomy and building European sovereignty represent aspirational and motivational political goals, the pragmatic and realist guiding principle for public intervention in the semiconductor sector is to reduce vulnerabilities and cultivate existing strengths.

This strategic debate regarding the future of the EU should not obscure market logic. **Demand is the most important criterion to determine the correct public and private investment level for European companies to remain globally competitive.** Veterans in the industry acknowledge that assessing future demand is an extremely complex exercise. But the digital and green transformation of the continent requires a surge in semiconductor consumption. Kearney, for example, estimates that the total value of European semiconductor consumption will almost double, reaching nearly EUR 80 billion by 2030, from EUR 44 billion in 2020.[14]

13 See Institut Montaigne's previous report: Mathieu Duchâtel, *The Weak Links in China's Drive for Semiconductors*, January 2021, https://www.institutmontaigne.org/en/publications/weak-links-chinas-drive-semiconductors
14 "Europe's urgent need to invest in a leading-edge semiconductor ecosystem", Kearney, November 2021, https://www.kearney.com/communications-media-technology/article/?/a/europes-urgent-need-to-invest-in-a-leading-edge-semiconductor-ecosystem

The global equipment market expects a 12.9% compound annual growth rate (CAGR) up to 2030.[15] For the automotive industry, the CAGR of semiconductor consumption anticipates 18% expansion for 2021-2030.[16] Market demand has to be differentiated by categories of products and components. Clearly, semiconductors at advanced nodes (7 nm and below) will be in growing demand as their usage diffuses beyond the upscale digital devices to the automotive industry and other applications.

The automotive industry: towards smaller nodes



Source : Gartner Semiconductor Spending by Customer (April 2021).

Unlocking public and private investment so that Europe captures part of this growth makes sense beyond the political logics of supply chain resilience, European sovereignty, and strategic autonomy.

15 Allied Market Research, "Semiconductor Production Equipment Market by Product Type (Front End and Back End), Function (Integrated and OSD), Dimension (2D, 2.5D, and 3D) and Supply Chain Process (IDM, OSAT, and Foundry): Global Opportunity Analysis and Industry Forecast, 2021–2030", August 2021, https://www.alliedmarketresearch.com/semiconductor-production-equipment-market-A08267
16 "Automotive Semiconductor Market Worth $241.7 Billion by 2030", *Electronics B2B*, 18 February 2022, https://www.electronicsb2b.com/headlines/automotive-semiconductor-market-worth-241-7-billion-by-2030/
17 Share of each tech node considers other chip applications than only automotive.
18 Power management integrated circuit.

2. Strengths and weaknesses of Europe's semiconductor ecosystem

Europe has competitive strengths at the global scale:
- STMicroelectronics, Infineon, and NXP are among the world's leaders in sensors and power electronics design and manufacturing. They are key suppliers of Europe's automotive industry. Because of the importance of power electronics to support the European Green Deal, they play a critical role in the green transformation of the continent, extending way beyond the digital transformation of Europe.
- Europe has companies in the world's top 5 in semiconductor equipment (ASML), materials (BASF), and Electronic Design Automation (Siemens EDA, even if a large share of its intellectual property is American). It also has global leadership in the wafer fabrication process – FDSOI (Fully Depleted Silicon on Insulator) – that is crucial for reducing energy consumption.
- Europe is also a world-leading R&D center. CEA-Leti, IMEC and Fraunhofer are the origin of many industrial innovations in nanoelectronics. The close ties between those knowledge institutes and the European industry are a source of strength.
- Europe is a global leader in nano-optics, which have industrial applications in lithography, sensors, and imaging.
- And finally, Europe represents a massive market of equipment purchasers, especially in the automotive industry and aeronautics.

ASML's extreme ultraviolet (EUV) lithography deserves a particular mention: it is the European technology that has enabled logic manufacturing below the 7 nm node, using the FinFET process. Based on European R&D, emanating in particular from IMEC in Belgium, ASML's EUV machines are 95% built by a European chain of 48,000 suppliers. The machines include optical lithography developed by Zeiss, industrial lasers produced by Trumpf, and mirrors whose reflective coating is the outcome of research undertaken in the Fraunhofer Institute, all three of them in Germany. Zeiss's fab for EUV lithography optics received funding from the first Important Project of Common European Interest for nanoelectronics.[19] As of early 2022, ASML's EUV technology market is essentially in East Asia and the United States. Only Samsung, TSMC, and Intel use EUV in logic chip foundries and SK Hynix in memory foundries. Nevertheless, a market will emerge in Europe if Intel's plans to build a 7-nm fab come to reality.[20] Importantly, EUV machines are not licensed for export to China as a controlled dual-use good with possible applications to strengthen innovation in the arms industry.

19 "EUV Lithography, a European Joint Project", *Zeiss Magazine*, 20 October 2021, https://www.zeiss.com/semiconductor-manufacturing-technology/smt-magazine/euv-lithography-a-european-joint-project.html
20 "Intel installs first tools in Fab 34 in Ireland", *EENews Europe*, 24 January 2022, https://www.eenewseurope.com/news/intel-installs-first-tools-fab-34-ireland

Despite these strengths, it is important to note that the European semiconductor industry has missed the train of the early 2000s when horizontal segmentation separated IC design companies from contract foundries. Thus, large European companies operate as integrated device manufacturers (IDMs). **As a result, Europe lacks foundries at the most advanced nodes, and there are no large IC designers of the Broadcom/Nvidia/Qualcomm type and scale in Europe.** However, being an IDM does not necessarily mean that leadership is out of reach in IC design and advanced foundry processes. For example, Samsung and Intel are both IDMs, but with a specific contract foundry branch, newly established in 2021 in the case of Intel. But the division of labor between fabs and fabless players has been instrumental to the market domination of leading US companies (such as Broadcom, Qualcomm, Nvidia…) and of critical importance to TSMC as an exporter of chips at the most advanced nodes.

Today, leading European IDMs strengthen their production capacity to adjust to the rising demand, but none has plans to invest in a fab at an advanced node, leaving this market to TSMC, Samsung, and Intel. Infineon opened in 2021 its second fab for 300 mm wafer production in Villach, Austria.[21] STMicroelectronics has announced a capital expenditure budget of USD 3.4 billion for 2022 to prepare its new 300-mm wafer fab in Italy. The wafer fab is currently under construction, to reach volume production in 2023.[22] STMicroelectronics is also investing in a transition to 200 mm Silicon-Carbide wafers for its automotive and industrial customers.[23] **The most advanced process capacity in Europe is Intel's 14 nm capacity in its Leixlip fab in Ireland; however, it is not yet positioned for mass production and contract foundry business.[24]** Of all semiconductor companies currently operating in Europe, only Intel has expressed an intention to build a 7 nm fab, but on the condition of large-scale State aid. Intel's CEO Pat Gelsinger has allegedly requested EUR 8 billion of subsidies to build an advanced fab in continental Europe.[25] Many industrial players in Europe are agnostic, if not skeptical, regarding Intel's capacity to create a foundry business for 7 nm integrated circuits. Indeed, the process

21 Press Release, Infineon, "Infineon opens high-tech chip factory for power electronics on 300-millimeter thin wafers", 17 September 2021, https://www.infineon.com/cms/en/about-infineon/press/press-releases/2021/INFXX202109-098.html
22 "ST heads to $15bn sales, doubles spending", *EENews Europe*, 27 January 2022, https://www.eenewseurope.com/en/st-heads-to-15bn-sales-doubles-spending/
23 STMicroelectronics, Press Release, "STMicroelectronics Manufactures First 200mm Silicon Carbide Wafers", 27 July 2021, https://www.globenewswire.com/en/news-release/2021/07/27/2269487/0/en/STMicroelectronics-Manufactures-First-200mm-Silicon-Carbide-Wafers.html
24 Mark Lapedus, "Foundry War Begins", Semiconductor Engineering, 14 April 2021, https://semiengineering.com/foundry-wars-begin/
25 "Intel seeks $10 bln in subsidies for European chip plant", *Reuters*, 30 April 2021, https://www.reuters.com/technology/intel-seeks-8-bln-euros-subsidies-european-chip-plant-politico-2021-04-30/

of creating a contract foundry branch is extremely recent, and the company has encountered numerous problems in developing that technology for mass production.

The plans of the key European companies to increase their production capacity reflect their analysis of adjusting capital expenditure to projected market demand. For Europe, there is a larger question of the overall ecosystem for semiconductor production. **Given the scale of the investment required, an advanced fab would generate a virtuous cycle of innovation and the construction of a network of subcontractors.** Currently, the lack of a fab using EUV lithography in Europe explains that very few companies can design new products at the most advanced nodes. In other words, this is an obstacle to innovation. **Under the current status quo, the long-term competitiveness of Europe's industrial R&D is at risk.** Whereas demand for smartphones, data centers, IoT, electric vehicles, smart cities, autonomous driving, and AI will drive demand for chips at the most advanced nodes in the semiconductor industry.

In sum, Europe faces both supply chain risks and questions regarding the long-term competitiveness of its industry. When adjusting and strengthening its policy instruments, Europe's strengths need to be cultivated. At the same time, foundries at advanced nodes can strengthen the overall European semiconductor ecosystem. But such a level of private investment is unlikely to happen unless State aid enables reaching commercial viability.

II

UNPACKING EUROPEAN POLICY INSTRUMENTS

The European Commission has set the ambitious goal of increasing Europe's share of the global production of semiconductors to 20% by 2030.[26] Fulfilling this goal would constitute an impressive success of public intervention to reverse a decade-long trend of decline in a global environment characterized by a renewed investment of all of Europe's competitors in their semiconductor sector. In 2000, Europe's global market share was 24%. In 2021, it was less than 10%.[27] The global output of semiconductors is set to double by 2030. **Reaching the Commission's targets would mean quadrupling Europe's production during the same time frame, while no new fab has been built in the past 15 years and all other players have set equally ambitious targets.**

Europe's ambition in comparative perspective

BCG

China: Manufacture 40% of local demand by 2020 and 70% by 2025.

Japan: Increase annual revenue of Japanese companies from **USD 38 bn** in 2020 to **USD 112 bn** by 2030.

South Korea: "Build the **world's biggest** chipmaking base over the next decade".

Taiwan: Achieve **USD 170 bn** production value and break 1 nm technology node by 2030.

US: No official targets – general goal to **regain competitive positioning.**

EU: Cover **20% of international production** by 2030 in value.

26 European Commission, "Digital sovereignty: Commission kick-starts alliances for Semiconductors and industrial cloud technologies", Press Release, 19 July 2021, https://ec.europa.eu/commission/presscorner/detail/en/IP_21_3733
27 Semiconductor Industry Association, "China's Share of Global Chip Sales Now Surpasses Taiwan's, Closing in on Europe's and Japan's", 10 January 2022, https://www.semiconductors.org/chinas-share-of-global-chip-sales-now-surpasses-taiwan-closing-in-on-europe-and-japan/

The 20% target offers a vision for the future of the European industry. It has already been instrumental in **unlocking legal obstacles to the approval of State aid in Europe, a sine qua non condition for the private sector to resume investment in new fabs and not only in expanding existing facilities.** At the beginning of 2022, three new fab projects appear well-positioned to see the light if a package of State aid can be put together by a Member State and approved by the European Commission: TSMC for nodes from 10 to 40 nm, GlobalFoundries for FDSOI process, and Intel for 7 nm process technology. Moreover, the establishment of a new legal terminology – the "first-of-a-kind technology" – under European competition law and in the EU Chips Act opens the path to large-scale State aid for foundry projects.

The semiconductor sector provides a window into how European industrial policy instruments need reform to meet supply chain risks and international challenges to Europe's competitiveness. On the one hand, the EU Chips Act creates an exceptional competition regime that allows State aid for the semiconductor sector. On the other hand, the EU is refining other existing instruments to support research and innovation while anticipating and managing supply chain risks.

The EU's embrace of industrial policy tools raises two questions. First, what is the amount of public budget that the EU and Member States can mobilize to support the industry? In this regard, the Chips Act mentions 43 billion EUR.[28] However, one must unpack this amount due to the EU's budgetary constraints. Second, what can be done to fine-tune the existing and new European policy instruments to create an environment conducive to unlocking private capital? This is a crucial question for investment in manufacturing capacities and for scaling up emerging European companies, from start-ups to deep tech firms.

1. Overview

The EU adopted its budget for 2021-2027 in December 2020. It includes a multiannual financial framework (MFF) and Next Generation EU. At the beginning of 2022, three EU policy instruments are already in place and define the current state of public support for the European semiconductor industry:

- **The seven-year R&D and innovation program Horizon Europe's Cluster 4 (Digital, Industry, and Space)** has a EUR 15.349 billion budget. Following the release of the Chips Act, the Commission decided to reinforce that cluster at the expense of others.[29] DG Connect estimates that Horizon Europe will direct EUR 3.6 billion of public sector investment to projects in the semiconductor industry.[30] It represents 3.7% of Horizon Europe's EUR 95.5 billion budget. That said, this figure does not include the possibility of mobilizing funding from the European Innovation Council and the European Research Council to support semiconductor research.[31]
- **The EU EUR 750 billion "Next Generation EU" recovery package** allocates 20% of its total envelope to digital transformation.[32] How much of this allocated EUR 145 billion will fund projects from the European semiconductor industry is not yet known. Semiconductors are part of seven priorities, and not every EU Member State has players in that industry. When they do, semiconductors are not necessarily a digital transformation budget line priority. It is estimated that from the 20% of the recovery fund that Italy will spend on digital as part of its share of the recovery package – the largest in Europe – only 500 million will go to semiconductor projects.[33] Politico estimates governments have pledged around EUR 2.5 billion in direct funding for the chips sector in their recovery plans. This number does not include funding to be shared with other segments of the digital industry, such as A.I. and cloud technology, estimated at EUR 2.3 billion.[34] This estimated pledge represents 1.72% of the total amount dedicated to Europe's digital transformation.
- **The 2021-2027 Long-Term EU Budget** allocates EUR 33 billion to strategic investments in the "Single Market, Innovation and Digital" category.[35] The European Commission has not unpacked how much budget will be allocated to the semiconductor sector. A similar proportion between 1.5% and 4% would translate to a budget between EUR 495 million and EUR 1.32 billion.

Altogether, this suggests that the EU's budget will contribute between EUR 6.4 and EUR 7.2 billion to the Chips Act's EUR 43 billion goal. It is essential to keep in mind that the EU's budgetary support for the semiconductor industry will mainly operate within those three vehicles – and that margins are limited because

28 European Commission, Press Release, "Digital sovereignty: Commission proposes Chips Act to confront semiconductor shortages and strengthen Europe's technological leadership", 8 February 2022, https://ec.europa.eu/commission/presscorner/detail/en/ip_22_729

29 Author's interview with senior official from the European Commission, February 2022.
30 Author's interview with senior official from the European Commission, December 2021.
31 Publications Office of the European Union, "Horizon Europe, Budget", 4 May 2021, https://op.europa.eu/en/publication-detail/-/publication/1f107d76-acbe-11eb-9767-01aa75ed71a1
32 European Commission, "A European Initiative on Processors and semiconductor technologies", 7 December 2020, https://digital-strategy.ec.europa.eu/en/library/joint-declaration-processors-and-semiconductor-technologies
33 Author's interview with senior executive in the semiconductor industry, January 2022.
34 Laurens Cerelus, "Europe's microchips plan doesn't add up", *Politico*, 21 October 2021, https://www.politico.eu/article/europe-microchips-semiconductor-technology-plan-does-not-add-up/
35 Publication Offices of the European Union, DG Budget, European Commission, "The EU's 2021-2027 long-term budget & NextGenerationEU, Facts and figures", 29 April 2021,https://op.europa.eu/en/publication-detail/-/publication/d3e77637-a963-11eb-9585-01aa75ed71a1/language-en

they are found at the expense of other sectors. The EU's budget is far smaller than national budgets, but the share of investment in public expenditures is much larger. It is also important to underline that this is a budget for R&D and innovation, not industrial production.

The rest of the funding for the semiconductor industry will come from national governments and private investment. An additional accounting difficulty to break down between EU and national budgets is that national budgets will draw from their share of EU budgets. For example, national funding for semiconductor projects as part of the next IPCEI can incorporate digital transformation funds from Next Generation EU.

In sum, the EU has limited margins.

- National budgets remain central to any ambitious public policy projects as the EU budget alone is far from being sufficient.
- The future scale of Europe's policy support for the industry has yet to be determined. The scale will depend on the concrete modalities of national funding within the framework of two instruments: the next Important Project of Common European Interest and the European Chips Act.
- Even more importantly, public investment is no substitute for massive private investment.

2. Important Projects of Common European Interest

Important Projects of Common European Interest (IPCEI) are a regime of relaxed State aid rules. The EU created IPCEI in 2014 to support projects when they "contribute in a concrete, clear and identifiable manner to one or more Union objectives and [...] have a significant impact on competitiveness of the Union".[36] **IPCEIs have specific criteria to focus on state-of-the-art R&D projects and First Industrial Deployment, and explicitly exclude "regular upgrades without an innovative dimension of existing facilities" and the "development of newer versions of existing products".[37]** The European Commission must approve all IPCEIs under State aid law. They are an exceptional State aid regime under which Member States

36 Communication from the Commission, "Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest", 20 June 2014, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52014XC0620%2801%29
37 Ibidem, articles 21 and 22.

create packages of measures to support one industry, in compliance with the Treaty on the Functioning of the European Union (TFEU). As the article 107.3.b of the TFEU layed out, "aid to promote the execution of an important project of common European interest" is considered compatible with the internal market under some circumstances.

The Commission approved the first IPCEI on Microelectronics in December 2018.[38] France, Germany, Italy, and Austria joined to support the consortia of companies and research centers in five areas (energy-efficient chips, power electronics, smart sensors, advanced optical equipment, and compound materials).[39] Through the IPCEI, national governments provided support to several successful projects. In addition to Zeiss's lithography optics mentioned earlier in this policy paper, another example is Bosch's 300 mm wafer fab, inaugurated in June 2021 in Dresden. The Bosch fab is a good example of how IPCEI can facilitate industrial production in compliance with the strict financing criteria for industrial facilities. Through the IPCEI, the fab received EUR 200 million of State aid from the initial EUR 1 billion capex, but not directed at manufacturing capacities *per se*.[40] In France, the state committed EUR 886.5 million (including grants and loans) to support the companies and research institutes involved.[41] Furthermore, the French Nano 2022 plan, the fourth five-year plan for nanoelectronics, is in fact embedded into the IPCEI.

A second IPCEI on Microelectronics is currently in preparation for the first semester of 2022. The plan follows the revision of State aid rules under IPCEIs announced in November 2021 by the EU Commission's Executive Vice-President Margrethe Vestager, who is in charge of competition policy. **The revision aims at enhancing the pan-European nature of projects by creating the conditions for more Member States to join, as well as setting a new project approval criterion to also benefit other Member States within the EU.** The revision also seeks to facilitate SMEs' participation alongside larger companies that have benefited most from past IPCEIs. Finally, it clarifies the rules on First Industrial Deployment by mentioning the industrialization of R&D and innovation outcomes. It also adds an "infrastructure" category qualifying for State aid if projects are "of great importance for the environmental, climate, energy (including security of energy supply), transport, health, industrial or digital strategies of the Union or contribute significantly

38 Official website of the IPCEI on Microelectronics, https://www.ipcei-me.eu/
39 For a list of the companies involved in each consortium, see https://www.ipcei-me.eu/what-is/project-structure/
40 "Bosch powers up chip production in Dresden", *EENews Europe*, 7 June 2021, https://www.eenewseurope.com/news/bosch-powers-chip-production-dresden
41 Author's Interview with senior Finance Ministry official, December 2021.

to the internal market."[42] However, **the revised guidelines reiterate that IPCEI funding can only finance pilot production lines that industrialize innovation outcomes at an early stage when it comes to production facilities.**

While it is necessary to wait for the formal release of the plan, it is already clear that the number of Member States involved will far exceed the first IPCEI. According to the German Federal Ministry for Economic Affairs and Climate Action, which coordinates the initiative for participating Member States, 20 Member States and 90 companies had submitted initial projects by December 2021.[43] ZVEI, the German Association, expects EUR 4.5 billion of State aid in Germany, unlocking a total investment of EUR 15 billion in Germany alone.[44] Officials involved in the discussion suggest that two targets have emerged from considered projects: addressing capacity gaps in IC design and reinforcing the European ecosystem by focusing on its current strengths.[45] This point is not surprising, given that the November 2021 revisions do not change the main characteristics of IPCEIs. They remain an instrument to support research and innovation beyond the current state of the art. Also, the needs of participating European companies shape the actual content of the next IPCEI. **IPCEIs proceed bottom-up, not top-down.**

Large European companies in the lead of consortia will seek IPCEI funding to sharpen Europe's existing skills in microcontrollers and power semiconductors – their key strengths. When the second IPCEI discussion started in Europe in late 2020, some within the Commission believed that it could be the solution to Europe's financing needs to attract investment in an advanced fab. This is why Commissioner Thierry Breton specifically mentioned "a 2-nanometer fab" in his December 2020 speech, which still represents innovation beyond the current state-of-the-art. **Thus, 2 nm would qualify for State aid under IPCEI, while it is not the case for 7 nm technology, already mass-produced in Northeast Asia.[46]**

42 Communication from the Commission, "Criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest", 25 November 2021, https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6245
43 Federal Ministry for Economics and Climate Protection, Press Release, "32 Mikroelektronik-Projekte in den Startlöchern – Habeck: „Wir müssen Produktion von Halbleitern zurück nach Deutschland und Europa holen.", 20 December 2021, https://www.bmwi.de/Redaktion/DE/Pressemitteilungen/2021/12/20211220-32-mikroelektronik-projekte-in-den-startlochern.html
44 ZVEI, German Electro and Digital Industry Association, "Semiconductor Strategy for Germany and Europe", October 2021, https://www.zvei.org/en/press-media/publications/semiconductor-strategy-for-germany-and-europe-discussion-paper
45 Source: author's interview with European Commission officials, September 2021.
46 European Commission, "Member States join forces for a European initiative on processors and semiconductor technologies", 7 December 2020, https://digital-strategy.ec.europa.eu/en/news/member-states-join-forces-european-initiative-processors-and-semiconductor-technologies

In their interactions with the Commission and national governments, European companies strongly opposed using the second IPCEI to support the installation of an advanced foundry in Europe.[47] As a compromise, some industry actors have advocated for preparing a third IPCEI if an advanced foundry project was to see the light in Europe. One could indeed envision a third IPCEI supporting an R&D ecosystem around the construction of an advanced foundry project in a Member State. It would especially profit the network of subcontractors and diffuse benefits to other EU Member States.

The industry values IPCEI as a good instrument. There are problems, however. Bureaucratic complexity tends to limit the participation of SMEs because they cannot manage the application process, especially as leaders. This reality remains true despite the November 2021 revisions, although these revisions precisely sought to facilitate the participation of SMEs. Only the largest actors have the human resources and the knowledge of EU application processes to lead consortia. **Thus, it limits the positive impact on the larger ecosystem,** to the extent that some deep tech companies advocate quotas' imposition for SMEs' inclusion.[48] In addition, by definition, IPCEIs require the participation of at least four Member States in any project. **This rule disqualifies IPCEI as an instrument to support the growing needs of SMEs in the semiconductor sector.** All need to finance in-house innovation initiatives through other sources.

3. The EU Chips Act

The European Commission presented on February 8, 2022 its proposal for the Chips Act, a regulation that establishes a framework of measures for strengthening Europe's semiconductor ecosystem.[49] The proposed regulation, still to be approved by the European Council and the European Parliament, came with an explanatory communication from the Commission, outlining its political arguments.[50]

47 Author's interview with senior industry executive, September 2021.
48 Author's interview with senior industry executive, January 2022.
49 European Commission, "Proposal for a Regulation establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act)", 8 February 2022, https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation
50 European Commission, "Communication from the Commission: A Chips Act for Europe", 8 February 2022, https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation

The Act contains three main elements:
- A "Chips for Europe" program focusing on the existing strengths of Europe's semiconductor industry.
- An exceptional competition regime allowing State aid for "first-of-a-kind" manufacturing capacities.
- Supply chain risk-mitigating measures.

Importantly, while the regulation is expected to be adopted in 2023, the Commission has announced that it will consider compliance with criteria "set out in the proposed Chips Act with the expectation that such projects would apply for formal recognition once the Chips Act enters into force."[51]

3.1. Cultivating Europe's chips ecosystem

The first pillar of the Chips Act is the "Chips for Europe" Initiative. It explicitly aims at addressing several gaps in the European chips ecosystem:
- Design capacities, by focusing on Electronic Design Automation tools (IC design software) and RISC-V processor architecture.
- Production innovation, by supporting the development of pilot lines for FDSOI, leading edge nodes below 2 nm, 3D heterogeneous system integration and quantum chips.
- Industry's human resources needs, by training staff and developing an in-depth understanding of the ecosystem and value chain.

The Chips Act clarifies that the approved EU budget coming from Horizon Europe and the Digital Europe Program will finance those activities.[52] In addition, research, innovation, and production pilot lines are the types of activities supported by IPCEIs. **From that angle, the Chips for Europe Initiative is a statement of political intention that will serve as a loose guideline for companies and research centers seeking EU and national grants.** Tellingly, the initiative is planned for the current three-year budget cycle of the EU and not beyond.

The real novelty of the Chips for Europe Initiative is the creation of a Chips Fund. The Commission has recognized the "significant shortages in access to finance" faced by start-ups and SMEs in the European semiconductor sector.[53] In practice, the Chips Fund brings under the same umbrella various existing EU institutions and mechanisms:

51 *Ibid.*
52 Article 3.
53 *Ibid.*

- **InvestEU,** a mechanism inspired by the Juncker Plan, which backs the investment of its financial partners through an EU budget guarantee of EUR 26.2 billion for 2021-2027.
- **The European Investment Bank Group,** including both the European Investment Bank and the European Investment Fund, which provides loans and equity investment.
- **The European Innovation Council,** established in 2021 under Horizon Europe, which supports the industrialization phase of research and innovation.

How the Chip Fund will mobilize these various resources and attract investment from private equity funds is not yet clear. However, one thing is clear: in this part of the plan, the Commission directly responds to a demand emanating from the industry, especially from the start-up/deep tech ecosystem.

3.2. "First-of-a-kind": Europe's next foundries

When announcing the preparation of a Chips Act, Commissioner Thierry Breton made clear that the Act would aim to "support the development of European fabrication plants – 'mega fabs' – able to produce in high volume the most advanced (towards 2 nm and below) and energy-efficient semiconductors".[54] The Chips Act provides the EU the legal space to approve a State aid package for that purpose. But its scope of action is larger than a 2 nm mega fab.

The cornerstone of the Chips Act is the creation of an exceptional competition regime to meet the needs of the semiconductor sector. **The Act incorporates the new legal concept of "first-of-a-kind" facility, first announced by DG Competition in November 2021, as part of its revised policy guidelines for competition policy.** "The Commission may envisage approving public support to fill possible funding gaps in the semiconductor ecosystem for the establishment in particular of European first-of-a-kind facilities in the Union, based on Article 107(3) TFEU. Such aid would have to be subject to strong safeguards to ensure aid is necessary, appropriate and proportionate, undue competition distortions are minimized, and that benefits are shared widely and without discrimination across the European economy. All cases regarding supply of such a critical product must be rigorously examined based on their own respective merits."[55]

54 Thierry Breton, "How a European Chips Act will put Europe back in the tech race", Blog post, 15 September 2021, https://ec.europa.eu/commission/commissioners/2019-2024/breton/blog/how-european-chips-act-will-put-europe-back-tech-race_en
55 Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, DG Competition, *A competition policy fit for new challenges*, 18 November 2021, https://ec.europa.eu/transparency/documents-register/detail?ref=COM(2021)713&lang=en

The regulation project distinguishes between two types of "first-of-a-kind" facilities eligible for State aid. Integrated Production Facilities are "design and manufacturing facilities, including front-end or back-end." "Open EU Foundries" are "front-end or back-end, or both, manufacturing facilities in the Union that offer production capacity to unrelated undertakings." In other words, the former is closer to the IDM model, while the latter is closer to the contract foundry model, taking orders from design companies.[56]

The "first-of-a-kind" concept allows for approving State aid when a production facility goes "beyond the Union's state-of-the-art, for instance in terms of technology node, substrate material, such as silicon carbide and gallium nitride, and other product innovation that can offer better performance, process technology or energy and environmental performance". **Clearly, the scope of the notion goes beyond the political project of having an advanced fab producing 2 nm generation integrated circuits in Europe.** The criteria to determine whether a facility is "first-of-a-kind" could be the production node or the substrate. But could there be other elements to demonstrate the uniqueness of a manufacturing facility? It remains an uncertainty that will need to be fine-tuned.

The second central concept to the Chips Act is the "funding gap." It is the key criterion to obtain the Commission's approval for an industrial production project. Under the Act, "it may be justified to cover with public resources up to 100% of a proven funding gap, if such facilities would otherwise not exist in Europe".[57] **Once a Member State has established a package of State aid to support an industrial investment, it will have to demonstrate to the Commission that the project would not be commercially viable without State aid.** The gap is to be measured compared to the possibility of production outside Europe, not in another Member State within the EU. **But should it be measured against commercial viability or against the level of profitability of the investment had the company chosen a location in the United States or Northeast Asia?** This is a serious question for governments and companies. Importantly, the Member State will need to demonstrate that the investment is not principally motivated by the amount of State aid provided.[58] And the Member State has the explicit responsibility to "ensure that the most rapid treatment legally possible is given to these applications."[59]

56 Articles 10, 11, 12, Chips Act.
57 Communication from the Commission: A Chips Act for Europe.
58 Author's interview with senior Commission official, January 2022.
59 Article 14, China Act.

The Chips Act removes a major legal roadblock to enable the EU's approval of State aid. Under article 107 TFEU, State aid is incompatible with the internal market.[60] There are, of course, several exceptions, such as the IPCEI. Still, the amount of public aid needed for a major foundry project would have led to certain rejection by the Commission on the grounds that it would have distorted competition with the other Member States. Such an approach of relaxing restrictions for a specific industry had not been used since the 2011 framework on State aid for the shipbuilding industry, and it actually went further than previous schemes. Thus, it unlocks the possibility for significant national support to an advanced foundry project.

The "first-of-a-kind"/"funding gap" scheme, however, creates an issue of intra-European competition. **In the end, industrial projects will be located geographically in only one Member State – and the Member States with the largest budgets are frontrunners to attract private investment in foundries with State aid.** At the beginning of 2022, three projects are rumored to seek a State aid package: TSMC in Dresden, Intel in Magdeburg, Germany and GlobalFoundries, in an undisclosed location. Intel's foundry plan is the only fab that would bring 7 nm technology to Europe and seek production in volume. TSMC's would operate in nodes from 10 to 40 nm, focusing on customers in the automotive industry. GlobalFoundries positions itself on FDSOI (for Fully Depleted Silicon on Insulator), a technology developed in France by CEA-Leti, STMicroelectronics, and Soitec as an alternative to FinFET, which allows for ultra-low voltage and is already important for the automotive industry.[61] GlobalFoundries already produces 22 nm FDSOI chips in Dresden and has put the next 12 nm generation on hold – a fab would, in theory, qualify for state aid as a "first-of-a-kind" facility.[62] The history of GlobalFoundries in Germany would tend to favor Dresden as a production site. But the regulation on State aid makes clear that expansion of existing facilities does not qualify. The importance of Soitec as a producer of wafers for the FDSOI process and of STMicroelectronics and NXP as customers having externalized FDSOI chip manufacturing to GlobalFoundries, may be an argument in favor of a production site in Grenoble. In mid-March, Intel has announced a EUR 30 billion investment plan under the Chips Act scheme, including for the construction of an advanced fab in Magdeburg, Germany, becoming the first company to officially launch a process of approval of State aids.[63]

60 Consolidated version of the Treaty on the Functioning of the European Union – Part Three: Union Policies and Internal Actions – Title VII: Common Rules on Competition, Taxation and Approximation of Laws – Chapter 1: Rules on competition – Section 2: Aids granted by States – Article 107 (ex Article 87 TEC), Official Journal 115 , 9 May 2008, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:12008E107&from=EN
61 Ed Sperling, "FD-SOI Vs. FinFETs", *Semiengineering*, 16 April 2015, https://semiengineering.com/fd-soi-vs-finfets/
62 "Globalfoundries extends 22nm FDSOI; next node will wait", *EENews*, 24 September 2020, https://www.eenewsanalog.com/en/globalfoundries-extends-22nm-fdsoi-next-node-will-wait/
63 Intel pours EUR 30 bn into chip manufacturing in Europe", *Financial Times*, 15 March 2022, https://www.ft.com/content/3f7e4a87-f0c4-469a-b0cf-7bb3570e31f4

Germany is well-positioned to reinforce its place as a key European manufacturing hub for semiconductors; whether France will manage to attract a fab remains a question at the time of writing. **What is sure is that the Chips Act seeks to diffuse the benefits of foundry investment to the larger European ecosystem.** That is why IPCEIs use the criteria of "at least four Member States" and that of the "spillover effects". Indeed, Intel'‡s European plans include R&D investment in Paris Saclay, and an advanced packaging plant in Italy. In addition, the Chips Act underlines "positive contributions to cross-border cooperation and cohesion" as a factor of approbation of State aid. Although it is not a legal obligation, it creates political space for strategic negotiations between Member States, and between Member States and investors. Finally, it provides Member States with some leverage over investors, given their influence power over the approbation process.

3.3. Europe's supply chain security

Learning from the semiconductor shortages and the Covid-19 crisis, the Chips Act sets out measures to anticipate and respond to supply chain crises. Inspired by the Commission's management of Covid-19 vaccine procurement, it first creates a legal basis for "common purchasing" and "priority orders". It also institutes a European Semiconductor Board with representatives from the 27 Member States. This advisory body will be the main governance partner of the Commission to address and manage supply chain risks, and a lot will depend on its efficiency.

It seems clear that the Chips Act will improve the EU's overview of supply chain risks. Indeed, it requires "regular monitoring" and information sharing between the Commission and Member States (article 15). **If managed efficiently, this mechanism will ensure early warning to supply crises.** When a crisis stage is declared, the Commission can request precise information from companies to plan a proper response (article 17).

The most striking measure comes from the war-economy playbook and concerns "common purchasing" and "priority orders." In case of crisis, the Chips Act entitles the Commission to impose an obligation for Integrated Production Facilities and Open EU Foundries "to accept and prioritize an order of crisis-relevant products ('priority rated order'), [an] obligation [that] shall take precedence over any performance obligation under private or public law".[64] Article 21 of the proposed regulation makes clear that this obligation applies to "other undertakings" having benefited from public

64 *Ibid.*

support. In addition, the Chips Act establishes that the Commission can give itself a "mandate to act as a central purchasing body on behalf of the participating Member States for their public procurement." This measure considerably reinforces the possible role of the Commission in crisis management.

II

CONCLUSION AND POLICY RECOMMENDATIONS FOR NEXT STEPS: EUROPE'S ACTION IN COMPARATIVE PERSPECTIVE

Europe is unlikely to quadruple its production of semiconductors and increase its global market share from 10% to 20% by 2030. However, the reshuffle of the EU's policy instruments to support its semiconductor sector is remarkable. It represents an unmissable opportunity to increase Europe's competitiveness, global production share, and to manage supply chain risks. **Even if the target were not reached, visions have the merit to create political space and mobilize energies.**

The Chips Act and other instruments are now in place. **How to make those tools efficient? How can they be used to strengthen the foundation of a resilient and competitive semiconductor ecosystem in Europe in the next decade?** These questions are partly about organizing public action, and partly about positioning Europe in changing geopolitics. The transformation of the international security system, of which the Russian invasion of Ukraine is a brutal manifestation, creates serious risks for the future of Europe. To improve existing European policies, it is essential to integrate the volatility of the international security environment and the worst scenario of full bloc confrontation with revisionist and imperialistic authoritarian states.

Fine-tuning European tools needs to find inspiration in the practices of the other major players in the semiconductor industry. The United States, China, Taiwan, the Republic of Korea and Japan support their chips industry with various policy instruments. It includes **direct subsidies, tax exemptions, preferential customs and tariffs treatment, tax incentives to support innovation, investment funds, and regulatory action.**

The toolbox of public instruments to support IC industry

		China	Japan	South Korea	Taiwan	USA
Tax reduction	Corporate income tax exemption	✓		✓	✓	✓
	Preferential value-added tax	✓				N/A
	Preferential customs & import tariff treatment	✓		✓	✓	✓
	Tax incentives towards R&D or talents		✓		✓	✓
Direct subventions	Direct financial support	✓	✓	✓	✓	✓
	Creation of investment funds	✓		✓		
Regulatory support in chips	Policies supporting IP rights	✓	✓			
	Policies fostering international cooperation	✓				

Now that an exemption regime has been put in place for "first-of-a-kind" industrial projects in the EU, all these tools used by the other major players in the semiconductor industry are made available in Europe. Competition law makes no distinction between various forms of State aid. Subsidies, tax exemptions, preferential fiscal regimes, the cost of loans, tariffs and custom treatments are treated in the same basket, under article 107 of the TFUE, as "any aid granted by a Member State or through State resources in any form whatsoever which distorts or threatens to distort competition." **The key criterion is whether State aid distorts competition in the single market.**

To summarize, EU measures to support the European semiconductor ecosystem fall within four broad categories:

- An initiative to finance research, innovation, and prototype production (early-stage industrialization),
- An exemption regime for "first-of-a-kind" industrial projects,
- An ambition to meet SMEs, start-ups, and scale-ups financing needs through the Chips Fund,
- A package of supply chain resilience measures.

The following policy recommendations are focused on making those instruments effective, inspired by policy measures in place elsewhere. The supply chain resilience measures are the ones that require geopolitical positioning to reduce the impact of possible future international conflicts.

1. Financing Europe's semiconductor ecosystem

RECOMMENDATION NO. 1

Fine-tune guidance regarding "first-of-a-kind" facilities and "funding gap".

Competition law is unique to the European Union. Therefore, there are no best practices elsewhere that are immediately relevant.

The "first-of-a-kind" notion of the Chips Act expands the IPCEI special State aid regime to manufacturing, for large-scale industrial facilities that do not exist yet in Europe. Europe had to reform its competition law to approve the kind of State aid that the US and the Japanese governments are providing TSMC with for building fabs in Phoenix, Arizona and in Kumamoto, Kyushu Island.

"First-of-a-kind" and "funding gap" are the two legal creations relaxing existing constraints on State intervention. But despite this progress, Europe's capacity to act swiftly is still more constrained than the US Federal government's and Japan's. The EU will have to demonstrate bureaucratic efficiency and flexibility inside this legal framework. Therefore, the European Commission needs to make clear that:

- **"First-of-a-kind" will not be restricted to foundries at advanced nodes.**
- **"Funding gap" will be assessed against a criterion of relative profitability rather than simply commercial viability.**
- **All bureaucratic resources will be committed to reaching a swift decision to approve State aid.**

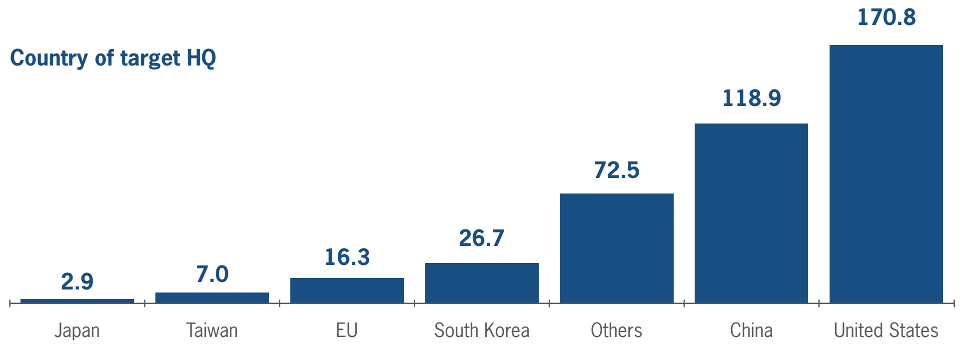
RECOMMENDATION NO. 2

Streamline the Chips Fund.

Europe suffers from a deficit of private investment in its semiconductor sector.

Private investment in the semiconductor industry

(Total transaction value (USD bn) – 2017-2022)



Note: investments include private placements, M&A, spin-off/split-offs or investor activism which happened between 2017 (January 1) and 2022 (January 18).

Source : IQ Capital (2017-2022), BCG analysis.

Mega fabs are only one side of Europe's financing problem, now addressed by the new competition law regarding State aid. The other side is Europe's urgent need for a better environment for private investment. Private capital needs to be available if semiconductor start-ups and deep tech are to scale up.

Regardless, this question needs to be put in the context of Europe's adoption of an Investment Screening Regulation and the strengthening of mechanisms to prevent foreign acquisitions in the semiconductor industry across Member States. **This strengthening is a welcome defensive move, but it risks aggravating Europe's financing problems if not complemented by a substantial European financing alternative for the companies that miss an opportunity to scale up with non-EU capital.** The Chips Fund represents an opportunity to change course. How can it be made an efficient instrument that meets the scaling needs of European companies?

The European Chips Fund needs to combine the capacities of the European Investment Bank and the European Investment Fund in terms of loans and equity shareholding with the involvement of private investors and funds. Furthermore, to increase the Fund's scale and to demonstrate its commitment to openness, **the Commission should consider creating a certification label for purely financial non-EU**

private equity funds that do not seek strategic control or access to technology.

China's National Integrated Circuit Industry Investment Fund, known as the Big Fund, deserves attention as a benchmark. Many companies consider the Chinese system as disregarding market realities and generating waste. The Big Fund is a central policy instrument that provides strategic guidance to the industry. In a first phase, it focused on scaling up Chinese champions to the next level. After China started facing import restrictions through tech transfers controls, its focus moved to supporting the development of semiconductor equipment. It has two characteristics that Europeans can consider:

- **The capacity to focus narrowly on a specific target in the value chain, which avoids spreading financial resources to the whole ecosystem.** Strategic guidance and the capacity to focus are major assets if the EU Chips Fund generates growth and added value for Europe. Taiwan and the US also provide examples of targeted support to parts of the supply chain.

Targeting public support to specific parts of the semiconductor supply chain

BCG

Country	Supply chain step supported	Main public instruments
China	Equipment and material	• 2nd phase of investment fund focused on upstream value chain (e.g., equipment, material) • Import tax waiver for key material and equipment • Additional VAT refund for semiconductor equipment
	Wafer fabrication	• 1st phase of investment fund focused ~67% of investment in manufacturing • Corporate tax reduction for manufacturing
Taiwan	Material	• Import tax waiver for material for companies in specific zones (e.g., industrial parks) • Royalties paid to foreign companies for products imported that have IP can be exempted from income tax
	Equipment	• Subsidies for purchase of leading-edge equipment and duty-free treatment for machines that local manufacturers cannot produce
US	Equipment	• 40% corporate tax deduction for semiconductor manufacturing equipment[65] • 100% reduction on equipment import costs
	Wafer fabrication	• 25% investment tax credit for investments in semiconductor manufacturing[66]

Source : Lit research, BCG analysis.

65 Announced on the Chips Act.
66 Currently in proposal stage.

- **The involvement of companies – in the case of China, state-owned enterprises, contributing to the financing of the Fund.** European private companies from sectors consuming semiconductors should invest in the Chips Fund in addition to their practice of shareholding through financial markets in semiconductor companies. This is particularly true of the automotive industry.

RECOMMENDATION NO. 3

Learn from best practices in tax reduction.

Tax incentives by country
(before the EU Chips Act)

BCG

Country	Main tax incentives deployed
China	• **70%** of tax reduction for IC design, equipment and software companies • **100%** tax exemption on several IC products, such as equipment parts, raw materials and other consumables • **100%** corporate tax waiver in the first years and up to **50%** of tax reduction for chip-related companies in the following years – duration of tax reduction increases for companies using more modern chips
Taiwan	• **15%** tax deduction on company's R&D expenditures • **30%** of corporate tax reduction for investments in smart machinery and 5G • **100%** reduction on import tariffs on machinery and equipment for companies in specific zones (e.g., industrial parks)
South Korea	• **50-100%** corporate tax reductions for semiconductor companies for the first five years • **40-50%** corporate tax deductions for semiconductor R&D investments and **10-20%** for semiconductor facility investments • **100%** subsidy on property tax
United States	• **40%** corporate tax deduction for semiconductor manufacturing equipment of facilities until 2024[67] • **50-70%** tax credit for qualified wages paid • **100%** reduction on equipment import costs • **25%** investment tax credit for investments in semiconductor manufacturing[68]
France	• **30%** of R&D tax incentive for operations relating to prototype designs of new products
Germany	• **25%** tax free subsidy in salaries and wages for certain R&D purposes
Netherlands	• **9%** corporate tax reductions for profits related to "innovation" • Reduction in wage tax for R&D activities

Source : Lit research, BCG analysis.

67 Announced on the Chips Act.
68 Currently in proposal stage.

South Korea, the United States and Taiwan have introduced tax deduction and reduction systems benefiting semiconductor companies, in particular for their investment in R&D and production equipment, property tax credit systems (Korea) or other fiscal aid measures (imports of equipment, qualified salaries, etc.). This public support has been bearing fruit. Some European Member States are taking similar measures: France offers research tax credit, and the Netherlands reduces corporate tax on profits linked to innovative projects. **Europe must review these different tax options to support European companies in their innovation and production efforts.** In addition, the EU could create guidelines to ensure a harmonization of best practices across Member States.

2. Nurturing the next generation of European human resources

RECOMMENDATION NO. 4

Nurture human capital through strengthened regional hubs.

The semiconductor industry is creating jobs across Europe, but the European toolbox to support human capital is so far less developed than its competitors. In 2022 alone, ASML seeks to hire approximately 3,000 staff in the Eindhoven area. However, the whole sector faces serious challenges in ensuring adequate access to human resources. **Industry insiders forecast that a shortage of human capital in microcontrollers is almost unavoidable.** The need is not exclusively for engineers, the industry needs skilled operators as well.

Human capital development: modes of state intervention

	China	Japan	South Korea	Taiwan	USA	EU
Industrial partnerships to boost talent training	✓		✓	✓		✓
Supporting colleges or educational programs focused on chips	✓		✓	✓ Direct government subsidies	✓ Direct government subsidies	✓
Attract foreign talent through direct incentives	✓			✓		

Source : Lit research, BCG analysis.

The Chips Act announces the creation of competence centers in each Member State to address "skills shortages", and perform various functions supporting the European industry. It is a welcome development, but one that is not deprived of risks. Spreading limited resources across Member States constitutes a particularly high risk, as it endangers the effective use of such limited resources. **Europe should concentrate resources in the existing European regional hubs such as Grenoble, Dresden and Eindhoven.** In addition, performing too many functions risks losing focus. The competence centers should focus on developing human capital across Europe in cooperation with leading academic and research centers.

In addition, the European Commission, together with relevant authorities in Member States, should:

- **Lead outreach programs to ensure the young generation's interest in engineering careers and understanding the potential of a career in the semiconductor industry.** It is, for example, about making sure that "people who are today 15 years old understand they have a possible career path in microcontrollers".[69]
- **Launch outreach programs to increase the attractiveness of local ecosystems such as Eindhoven, Grenoble, and Dresden,** in cooperation with the municipal governments. Eindhoven, Grenoble, and Dresden have not reached their full potential and are not "shining enough."[70] Being able to attract human capital from Europe and outside Europe is a major challenge, for which public policies have a responsibility to help.

69 Quote from an interview with a senior industry executive, Paris, December 2021.
70 Quote from an interview with a senior industry executive, Paris, December 2021.

- **Use of the Semiconductor Alliance to determine the scale of education efforts** needed by the industry and redesign curriculums to help the offer match the demand.[71]
- Encourage companies to directly fund PhD scholarships, like Taiwanese companies which use such schemes to recruit engineers in R&D teams at early career development stages.

Taiwan leveraging all levers to close talent gap in the semiconductor industry

Industrial partnerships to boost talent training	• TSMC offers **PhD scholarships** worth USD 18,000 per year for up to five years, with **mentoring and internship opportunities** • MediaTek also offers semiconductor-related **PhD scholarships**
Supporting colleges or educational programs focused on chips	• **Investment of USD 300 million** to start **4 new graduate school programs** for the semiconductor industry, with additional USD 40 million from TSMC. Impact on the investment will be of additional ~3,500 students per year
Attract foreign talent through direct incentives	• Foreign special professionals who meet criteria are eligible for a **50% deduction of total income tax** for amounts exceeding USD 100,000.

Source : Lit research, BCG analysis.

RECOMMENDATION NO. 5

Create a fast-track innovation facility.

Horizon Europe and IPCEI are good instruments, overall praised by industry and research centers. Nevertheless, they have two interlinked weaknesses: administrative complexity, and lack of reactiveness. The EU needs a special purpose fast-track innovation facility for the semiconductor industry to complement existing mechanisms. **Such a fast-track facility would be able to respond more directly to the innovation needs of the private sector.** Project selection could be jointly managed by the Semiconductor Board and the Semiconductor Alliance, to ensure the representation of both governments and the private sector. There would be no calls for projects or tenders, just an openness to listen to the financing needs of companies' R&D and innovation projects.

71 European Commission, "Alliance on Processors and Semiconductor technologies", July 2021, https://digital-strategy.ec.europa.eu/en/policies/alliance-processors-and-semiconductor-technologies

RECOMMENDATION NO. 6

Build clean rooms.

Clean rooms are where silicon wafers are manufactured into semiconductor chips – offering an environment free of any tiny particle that could derail the manufacturing process. The lack of available clean rooms can be a decisive factor for the delocalization of industrial production away from Europe. One example is Nil Technology, which produces optical elements and had to locate production in a clean room facility in Singapore for lack of better options in Europe. It is also important to ensure access to clean rooms as part of training future engineers and operators. Therefore, **European governments should strengthen the existing local nanoelectronics ecosystems by building clean rooms in research and education facilities as innovation incubators and options for early-stage industrialization.**

3. Towards an integrated European ecosystem

RECOMMENDATION NO. 7

Manage supply chain risks with allies and friends.

The Russian invasion of Ukraine has again placed semiconductors at the center of global power politics. Sanctions target Russian procurement of foreign semiconductor technology. At the time of writing, there is speculation that Russia could retaliate by cutting access to neon gases and palladium, raising the question of supply resilience for European companies again.

The Chips Act plans cooperation with the US, Japan, Singapore, South Korea, and Taiwan on standardization, talent development, and information exchange on chokepoints. **The European Union should expand the transatlantic Trade and Technology Council (TTC)'s working group on semiconductors to organize supply chain resilience with the United States and the East Asian states in question.** As an intermediary step before reaching a plurilateral semiconductor supply chain framework with allies and friends, the most desirable framework, **the**

EU should replicate the dispositions of TTC bilaterally with Japan, Singapore, South Korea, and Taiwan. To do so, the Commission should reinforce the technology security section of DG trade and place it in the leading position to conduct chokepoints reviews with the industry through the Semiconductor alliance.

The set outcome of these EU efforts should be to establish:
- **An EU early warning mechanism** that benefits from rapid information access from trusted sources in those countries;
- **A common list of vulnerabilities** that the EU can compile as a trusted partner to all parties.

Early warning is a common interest to all. For example, short of other geopolitical risks, the capacity to detect the signs of hostile Chinese orders on Taiwanese and South Korean foundries aiming to disrupt the US supplies, with Europe and Japan as collateral damage, is good risk management practice.

In addition to this defensive agenda focused on Europe's access resilience, recent episodes of sanctioning access to semiconductor technology also shows that **semiconductors are part of a Western counteroffensive playbook.** As such, the consolidation of supply chain cooperation with the US, Japan, Singapore, South Korea, and Taiwan will strengthen a collective capacity to retaliate against aggression.

RECOMMENDATION NO. 8

Think advanced nodes foundries as a flagship project for European technological power.

The European industry was initially extremely reluctant to consider large-scale State aid to attract foreign actors to build foundries in Europe. Their logic was one of European preference – their development projects should take priority. With the Chips Act, the European Commission is in position to do both.

In the current stage, political leadership at the EU level will be essential to overcome competition between the Member States seeking to attract investment since foundries will be ultimately located in one state only.

Political leadership needs to stress the notion of a European ecosystem. Regardless of the final location of foundries, they will spur innovation across Europe and will

aggregate a network of European subcontractors. A foundry will also strengthen the IC design level of European actors by creating virtuous circles of innovation.

RECOMMENDATION NO. 9

An efficient governance structure for supply chain management.

The Chips Act institutes the Semiconductor Board as the key governance structure complementing and supporting the efforts of the Commission. The Board is entirely geared towards the representation of EU Member States, as each will have a permanent representative. In addition, some Member States will send officials from their Economy Ministry, others from their Industry Ministry, or other branches of their government. The capacity of these officials to understand industrial and technological issues will be central to the efficiency of the Board as a governance structure.

Therefore, smooth cooperation with the EU's semiconductor alliance is essential. The industry representation is currently too diverse and not sufficiently centralized. For example, plenty of data is available across various associations to conduct supply chain vulnerability reviews. **The semiconductor alliance has a role to play in centralizing data monitoring together with the Board.** It needs to be a strong and organized counterpart to the Board to ensure smooth public-private cooperation.

APPENDIX

COUNTRY FILES

Country summary: China

Recent and historical policies

- 2012: Ministry of Finance creates incentives for enterprise income tax policies
- 2014: Ministry of Finance creates the phase 1 of its investment fund (**USD 20 bn**)
- 2014: Ministry of Industry and Information Technology creates guidelines for National IC industry development
- 2015: Made in China 2025 plan, outlining official targets
- 2018: Ministry of Finance renews incentive taxes policies and creates new ones
- 2019: Ministry of Finance creates phase 2 of its investment fund (**USD 30 bn**)
- 2020: State Council creates multiple policies
- 2021: Ministry of Finance creates import duty exemptions

Official targets

- Manufacture **40%** of the semiconductors it consumes by 2020 and **70%** by 2025 (Made in China 2025).

Estimated public funding

- **~USD 120-150 bn** investment funds from central and local governments (since 2014)

Public instruments

✓ Corporate income tax exemption
✓ Preferential value-added tax
✓ Preferential customs and import tariff treatment
✓ Tax incentives towards R&D or talents
✓ Direct financial support
✓ Creation of investment funds
✓ Policies supporting IP rights
✓ Policies fostering international cooperation

Market context

- Market size: **~USD 24 bn** (2020)
- Global market share: **~5%** (stronger presence in OSAT with **~20%**)
- Global demand share: **~23%**
- Market growth: **19%** CAGR (2020-25)

Key players

- IC Design: HiSilicon – Huawei
- Manufacturing: SMIC, Huahong
- Packaging, test & assembly: JCET, TongFu Micro
- International foundries: TSMC, UMC (Taiwan), Samsung, SK Hynix (South Korea)

Source : Lit research, BCG analysis.

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Country summary: Japan

Recent and historical policies

- 1986: US-Japan trade agreement where Japan agrees to end dumping of semiconductors in world markets and secure 20% of internal market to foreign producers
- 2001: ASPLA project is funded by the government with **USD 270 million,** aiming to share the manufacturing processes of each disjointed company
- 2001: Asuka and HALKCA project created with a total of **USD 240 million** to develop the semi-conductor manufacturing process
- 2003: NEDO is incorporated as an agency to foster tech development, including in electronics (total budget of **USD 1.4 bn** in 2020)
- 2009: Elpida project created by government and private sector to rescue semiconductor industry with **USD 1.1 bn,** but project bankrupted
- 2021: Japan releases its Strategy for Semiconductors and the Digital Industry

Official targets

- Increase sales of semiconductors by Japanese companies from 4.5 trillion yen (**USD 38 bn**) in 2020 to 13 trillion yen (**USD 112 bn**) in 2030

Estimated public funding

- Approved 617 billion yen (**USD 5 bn**) budget for fiscal year 2021, but no statement about budget for future support

Public instruments

- Corporate income tax exemption
- Preferential value-added tax
- Preferential customs and import tariff treatment

✓ Tax incentives towards R&D or talents
✓ Direct financial support

- Creation of investment funds

✓ Policies supporting IP rights

- Policies fostering international cooperation

Market context

- Market size: **~USD 44 bn** (2020)
- Global market share: **~10%**
- Global demand share: **~5%**
- Market growth: **3%** CAGR (2020-25)

Key players

- IDM: KIOXIA, Sony, Renesas Electronics, Rohm, Toshiba, Nichia, Mitsubishi Electric
- Fabless: Socionext, MegaChips, Panasonic
- International foundries: TSMC (Taiwan)

Source : Lit research, BCG analysis.

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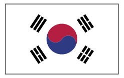
Country summary: South Korea



Recent and historical policies

- 2006: Government creates projects to support the IC industry, focused on equipment internalization and tech development
- 2007: Creation of the system IC 2010 strategy with a **USD 480 million** budget
- 2008: 577 Initiative, targeting 5% GDP to R&D expenses, in areas such as electronics, with gov. spending **USD 12 bn** by 2012
- 2011: System IC 2015 strategy with a **USD 250 million** budget, including the creation of a growth fund
- 2019: Trade war between Japan and South Korea, with Japan blocking raw material export to Korea
- 2019: Public statements to build up non-memory industry and become a foundry leader by 2030, increasing market share from 1.6 to 10%. **USD 0.8 bn** to R&D spending
- 2020: Plans to develop 50 types of AI-focused chips, planning to spend **USD 0.8 bn** before 2029
- 2021: Government reveals the K-semiconductor Belt Strategy with a **USD 450 bn** spending plan, mostly from industrial partners

Official targets

- No official target, but government statements to **"build the world's biggest chipmaking base over the next decade"** and **"become a semiconductor powerhouse in 2030"**

Estimated public funding

- Estimates on **USD 55-65 bn** in tax incentives in the K-Belt plan. Additionally, in plan, gov. committed to give **USD 1.1 bn** to R&D and **USD 0.8 bn** in loans

Public instruments

✓ Corporate income tax exemption
• Preferential value-added tax
✓ Preferential customs and import tariff treatment
• Tax incentives towards R&D or talents
✓ Direct financial support
✓ Creation of investment funds
• Policies supporting IP rights
• Policies fostering international cooperation

Market context

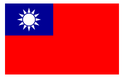
- Market size: **~USD 87 bn** (2020)
- Global market share: **~20%**
- Global demand share: **~2%**
- Market growth: **7%** CAGR (2020-25)

Key players

- IDM: Samsung Electronics, SK Hynix, Magnachip Semiconductor
- Fabless: Silicon Works, Seoul Semiconductor

Source : Lit research, BCG analysis.

Country summary: Taiwan



Recent and historical policies

- 2003: National Science Council creates the National Si-Soft Project targeting in launching a new wave of companies
- 2011: Ministry of Science and Technology (MST) creates the National Program for Intelligent Electronics with a budget of **USD 430 million** over 5 years
- 2018: MST creates the Semiconductor Moonshot Project with funding of **USD 130 million**
- 2020: Executive Yuan creates policies to advance semiconductor industry, such as localizing the supply chain
- 2021: MST creates the Angstrom Semiconductor Initiative to explore disruptive breakthroughs

Official targets

- Achieve **USD 170 bn** production value by 2030
- Break 1 nm technology node in 2030

Estimated public funding

- No data available for total public support
- Total funding for the Semiconductor Moonshot Project: **USD 130 million** (2018-21)

Public instruments

✓ Corporate income tax exemption
• Preferential value-added tax
✓ Preferential customs and import tariff treatment
✓ Tax incentives towards R&D or talents
✓ Direct financial support
• Creation of investment funds
• Policies supporting IP rights
• Policies fostering international cooperation

Market context

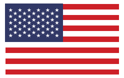
- Market size: **~USD 33 bn** (2020)
- Global market share: **~8%**
- Global demand share: **<1%**
- Market growth: **8%** CAGR (2020-25)

Key players

- IC Design: MediaTek, Novatek, Realtek, Himax
- Manufacturing: TSMC, UMC, VIS
- Packaging, test & assembly: ASE, Powertech Technology, King Yuan

Source : Lit research, BCG analysis.

Country summary: United States



Recent and historical policies

- 2018: Congress enacts the National Quantum Initiative Act
- 2018: DARPA creates a **USD 1.5 bn** program to address obstacles to Morre's Law
- 2018: creation of a public-private partnership between DARPA and Semiconductor Research Corporation
- 2019: NSTC publishes a report to support the future computing strategy (including semiconductors)
- 2020: Congress creates a Foundries Act to invest **USD 25 bn** in semiconductor R&D, facilities, IP, etc.
- 2020: Executive Yuan creates policies to advance semi-conductor industry, such as localizing the supply chain
- 2021: Congress proposes a 25% tax credit for investments in semiconductor manufacturing

Official targets

- No official targets available – primary motivation for state to regain competitive positioning in the sector

Estimated public funding

- **~USD 77 bn** investment funds from national governments (since 2020)

Public instruments

✓ Corporate income tax exemption
N/A Preferential value-added tax
✓ Preferential customs and import tariff treatment
✓ Tax incentives towards R&D or talents
✓ Direct financial support
- Creation of investment funds
- Policies supporting IP rights
- Policies fostering international cooperation

Market context

- Market size: **~USD 208 bn** (2020)
- Global market share: **~47%**
- Global demand share: **~15%**
- Market growth: **4%** CAGR (2020-25)

Key players

- IDM: Intel, Micron Technology, Broadcom, Texas Instruments
- Fabless: Qualcomm, NVIDIA, Apple, AMD, Xilinx
- International foundries: TSMC (Taiwan), Samsung (Korea), UMC (Taiwan)
- Distributors: Arrow Electronics, Avnet, Future Electronics, Digi-Key

Source : Lit research, BCG analysis.

BCG

ACKNOWLEDGMENTS

This policy paper builds on research interviews conducted with senior executives in the private sector and officials in European national governments and in the European Commission. The interviews were conducted between June 2021 and March 2022. The author is grateful to his interlocutors for their time and willingness to share ideas and insights.

He is particularly thankful to **Éric Baissus, Wouter Baljon, Frédérique Le Grevès, Riccardo Masucci, Takaaki Nihira, Jean Schmitt** and **Takuya Yamazaki** for inspiring and rewarding conversations conversations, and to **François Candelon, Maxime Courtaux** and **Gabriel Nahas** from the Boston Consulting Group, for excellent cooperation on data and comparative analysis.

The author gratefully acknowledges the invaluable support of his colleagues in the Asia Program at Institut Montaigne. **Joseph Dellatte, François Godement, Clément Plessis** and **Viviana Zhu** provided many helpful comments on earlier drafts of this report. **Claire Lemoine** has brilliantly coordinated all the research activities linked to this project and the phases of edition and publication. Finally, the author is indebted to the Institute's Communication Department for their assistance at different stages of this project. The author remains solely responsible for the conclusions and the recommendations of the policy paper.

The opinions expressed in this policy paper are not necessarily those of the above-mentioned persons or of the institutions that they represent.

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Imprimé en France
Dépôt légal : mars 2022
ISSN : 1771-6756

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THERE IS NO DESIRE MORE NATURAL THAN THE DESIRE FOR KNOWLEDGE

Semiconductors in Europe: the return of industrial policy

Europe is currently undergoing a return of government intervention in the nanoelectronics sector, with the European Commission in the lead. The stakes are high for the European semiconductor industry, which in the past decade has been losing market shares internationally. The industry faces two main vulnerabilities: one comes from the unpredictability of geopolitical shocks that can disrupt value chains, endangering Europe's tech sovereignty; the second stems from the massive State aid granted by the United States, China, Japan, South Korea and Taiwan in support of their national chips sector, raising important issues for Europe's competitiveness.

The Commission has set the ambitious goal to double Europe's share of the global production of semiconductors by 2030. In volume, this implies quadrupling European production. To reach that goal, the EU is adopting policy measures which contrast with its traditional belief in the benefits of a single open market and of free trade: the brand-new Chips Act and IPCEIs allow for increased public support and direct State aid for "first-of-a-kind" production facilities. Will it be enough?

This policy paper describes Europe's embrace of industrial policies for its semiconductor sector, dives into these new industrial policy tools and places European decisions in a comparative perspective. The author provides nine policy recommendations in favor of a European semiconductor ecosystem that would endow Europe with a differentiated position in the global value chain without jeopardizing its existing strengths.

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ISSN 1771-6756
MARCH 2022