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The European Chips Act: Europe's Quest for Semiconductor Autonomy

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Executive Summary

The European Chips Act (ECA) is a legislative proposal, unveiled on 8 February 2022, which seeks to address the root issues that lay underneath the semiconductor shortage arising from the covid-19 pandemic and bolster Europe's position as a technological frontrunner. Europe currently assumes a pivotal role in chip design; however, most of the value chain remains concentrated in East Asia and North America. The European Commission has identified the current state of chip production as excessively vulnerable to supply disruptions, especially it remains susceptible to potential geopolitical tensions between the United States and the Chinese Communist Party. Consequently, the ECA aims to rectify these vulnerabilities by formulating strategic countermeasures against future semiconductor shortages, while reinforcing domestic chip design and production capacities. These concerted efforts are set to ensure a steadfast supply of chips for Europe and pave the way for the continent's future technological development and market dominance.

1. Introduction

The covid-19 pandemic caused significant disruption in the global semiconductor market and lead to severe supply shortages worldwide. As semiconductors play a critical role in the functioning of electronic devices, the scarcity of this component highlighted current vulnerabilities in the supply chain. Semiconductors or Integrated Circuits (IC), are the fourth most traded good in the world and are an essential component of the future digital economy.[1] The industry may hit $1 trillion in revenue by 2030, and is growing at about 6% annually[2].

In response to these developments, the European Commission (EC) proposed the **European Chips Act (ECA)** as its flagship solution. The ECA aims to strengthen the EU's semiconductor R&D capabilities, decrease its vulnerabilities to supply shortages, and **increase the EU's global production market share up to 20% by 2030**[3]**.**

The years following 2020, across the globe the economies and logistics were impacted by the pandemic, and the semiconductor manufacturing processes worldwide were disrupted. The sudden surge in demand for consumer electronics, remote work equipment, and medical devices further aggravated the chips shortages. Most of the microchip value chain is currently concentrated in East Asia and key steps in the design and manufacturing are nearly monopolized by a small number of highly specialized companies that bottleneck the entire process when the supply chain is under heavy pressure.

The EU introduced the European Chips Act in recognition of the strategic and geopolitical importance of microchips for economic independence. This legislation seeks to enhance the EU's supply chain resilience, reduce dependency on foreign sources, and mitigate geopolitical risks (especially regarding the Chinese-US tensions).

The ECA is a comprehensive initiative to revitalize the EU semiconductor sector. By investing in R&D, fostering collaboration, and establishing robust manufacturing facilities within the EU, the act aims to create a self-reliant ecosystem capable of meeting growing chips demands and minimizing possible supply chain shortages. This research paper analyzes the latest semiconductor shortage, explores the Act's provisions, and assess its potential to position Europe as a major player in the global semiconductor market. Through this analysis, a better understanding of the EU's efforts and the implications for the semiconductor industry will be achieved.

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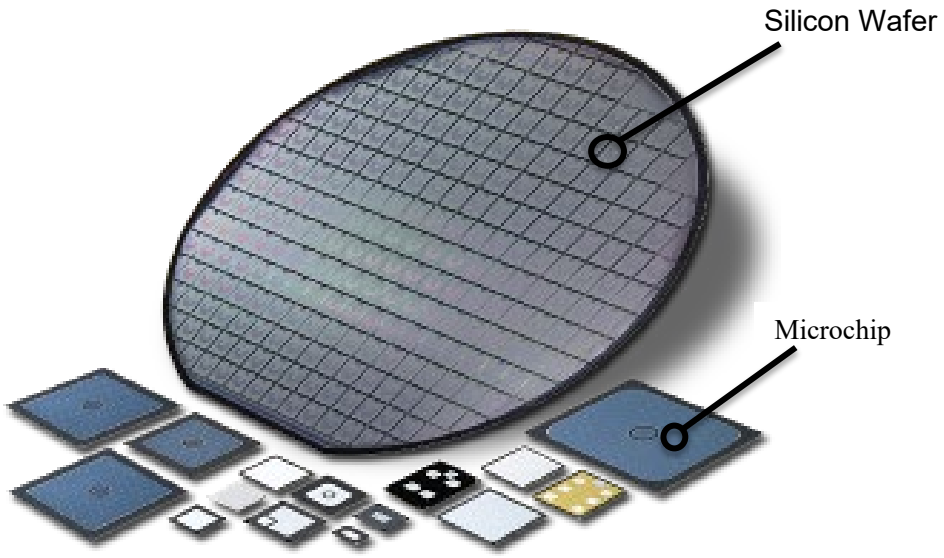
[1] Wallach, O. (14 December, 2021). *Visualizing the Global Semiconductor Supply Chain*. Visual Capitalist.
[2] Ramachandran, K., Bish, J., Steward, D., & Lee, P. (3 November, 2022). *A new dawn for European chips*. Deloitte Insights.
[3] *European Chips Act*. European Commission.

2. Production Process of Semiconductors

Semiconductor microchips are vital elements of every electronic device. They function as the brain of the device and are responsible for processing information and managing all the device's actions. As its name suggests, a semiconductor chip is made of semiconducting materials like silicon. A semiconductor is a material with an electrical conductivity value between conductors, such as copper, and with insulators or nonconductors, such as glass. Eight crucial steps are involved in manufacturing semiconductor microchips:

1. **Wafer manufacturing:** Purification and polishing of pure silicon wafers.
2. **Photoresist coating:** Wafers are covered with a light-sensitive coating called 'resist'.
3. **Lithography:** Wafers are exposed to ultraviolet light to print a blueprint pattern.
4. **Etch:** Removal of the degraded resist to reveal the intended pattern. There are two types of etching: 'wet' and 'dry'. Dry etching uses gases, and wet etching uses chemical baths to wash the wafer.
5. **Deposition and ion implantation:** A thin layer is coated by showering with electrically charged positive or negative ions to adjust the electrical conducting properties of the wafer.
6. **Metal wiring:** A thin metal layer is coated to enable electricity to flow.
7. **EDS:** Testing to ensure flawless semiconductor chips.
8. **Packaging:** To produce chips from a wafer, it is sliced and diced with a diamond saw into individual chips. Some wafers can contain thousands of chips, while others contain just a few dozen. The chip die is then placed on a 'substrate' that uses metal foils to direct the input and output signals[4][5].

[4] Timings, J. (6 October, 2021). *6 crucial steps in semiconductor manufacturing*. ASML.
[5] Das, S. (9 November, 2022). Semiconductor Manufacturing Process – Steps, Technology, Flow. *Electronics Tutorial | The Best Electronics Tutorial Website*.

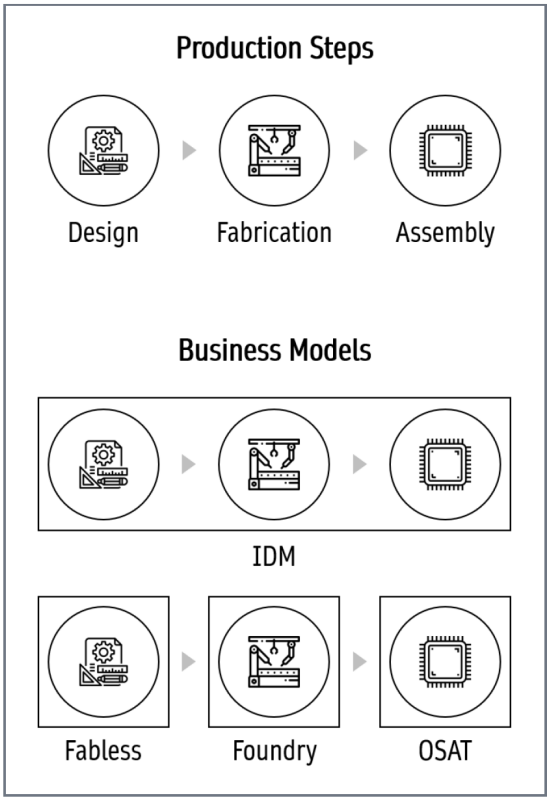


*Silicon wafer and different types of chips. *Source:* ***IXYS Power Semiconductors***

Nevertheless, the semiconductor manufacturing chain is not an integrated, nor a uniform industry. The global semiconductor value chain is globalized, and a few highly specialized companies have consolidated a sector of the industry. These companies operate under the *foundry model* (also known as *fabless design)*. The foundry model outsources stages of production to specialized companies. Historically, the entire process was performed by **integrated device manufacturers (IDM)[6],** such as Samsung and Intel. However, due to the intricacies and capital-intensive nature of semiconductor manufacturing, smaller companies may find it challenging to compete with large IDMs. Instead, companies prefer to specialize in one or two of the production steps. These specialized companies often solidify their market dominance with substantial unique intellectual property, proprietary manufacturing techniques, and enjoy strong relationships with customers and suppliers.

The key phases of the *foundry model* can be categorized as:
Fabless (R&D) → Raw Materials → Foundry (front-end fabrication) → OSAT[7]

[6] *Integrated Device Manufacturer (IDM)*. Semiconductor Engineering.
[7] OSAT = back-end packaging & testing



Source: Baisakova, N., & Kleinhas, J.-P. (2020). The Global Semiconductor Value Chain: A Technology Primer for Policy Makers. Stiftung Neue Verantwortung.

ICs have become increasingly complex to manufacture due to their exponential increase in intricacy and proportional decrease in size. Technologic developments and the growing demand for semiconductors have led to an increasing degree of specialization throughout the various phases of semiconductor manufacturing. For instance, in 2022, IBM announced the creation of the smallest microchip in the world, a 2-nanometer (nm) chip technology with 50 billion transistors, each the size of roughly five atoms[8].

As a result of increasing sophistication, a few highly specialized companies have emerged as key players in specific production phases, often giving them near-monopolies or significant market influence in those areas.

These specialized companies excel in segments of the semiconductor value chain, such as design, fabrication, packaging, and testing. Some companies possess advanced expertise, dedicated infrastructure, well established customer relations, and substantial investments in research and development, allowing them to maintain a competitive advantage and provide cutting-edge products.

The **US and Europe** excel at providing services for **research and design**. **Semiconductor companies specializing exclusively in design are better known as *fabless***. **The US is the current leader in chip R&D**, with fabless companies like **Qualcomm, Broadcom, and Nvidia leading the sector**. These North-American fabless companies dominate due to their access to a great pool of engineering talent from top-tier universities and access to investment capital. **Europe is also strong on the research sector**. The **Arm** company in the UK is strong in chip intellectual property cores. There is also companies with strong fundamental research, with research centers such as **IMEC** in Belgium, **CEA-Leti** in France, **TNO** in the Netherlands, and **Fraunhofer** in Germany[9].

[8] Mullich, J. (10 November, 2022). *IBM Two-Nanometer Chip: The 200 Best Inventions of 2022*. Time.
[9] Slijkerman, J. F. (8 February, 2022). *EU Chips Act to boost Europe's technological prowess and strengthen economy*. ING Think.

The **raw materials** used in production are mainly provided by **Germany, Japan, South Korea, and the USA**. Although **the main material is silicon** (one of the most abundant natural resources on the planet), the silicon required for wafers is extremely pure, and the four nations previously mentioned are the only ones capable of supplying a large quantity of the material.[10] Moreover, chemicals are also needed during the creation of the wafer. The necessary chemicals is mostly **dominated by the Japanese providers like Shin-Etsu, Sumitomo Chemicals, and Mitsui Chemicals**. **European companies such as BASF, Linde, and Merck KGaA are also important chemical suppliers**[11]**.**

The **manufacturing process** from silicon wafers to microchips, better known as **'front-end',** is performed by IDMs or by specialized companies called '**foundries'**. Foundries and IDMs process the silicon wafers in factories, known as 'wafer-fabrication-plants', **'fabs'** or **'mega-fabs'.** The foundries use the finished designs provided by the fabless companies together with the raw materials, manufacturing equipment, and chemicals to produce multiple chips out of a silicon wafer. Currently the manufacturing process is rapidly increasing in complexity and in expenditure, a trend that is being exacerbated by Moore's Law. **Moore's Law is an observation that claims that the number of transistors in an IC doubles roughly every two years, explains the increasing complexity of the foundry phase.** This observation was first described by Gordon E. Moore, the co-founder of Intel, in 1965, and for half a century it has held true[12]. The chip's sophistication and power are correlated with its number of transistors; therefore, the smaller the transistors, the more that can be squeezed on a single chip.

Front-end manufacturing is centered in East Asia. Four East Asian countries (**China, Japan, South Korea, and Taiwan) represented 73% of the total chip manufacturing in 2020**[13]**. The Taiwanese foundry company TSMC holds around 50% of the foundry market share**, making it the world's main chip producer[14]. **TSMC accounts for more than 90% of the global output of chips smaller than 10nm**, according to industry estimates[15]. Moreover, TSMC and Samsung are the only foundries capable of producing cutting-edge chips with 7nm nodes and smaller that sell to third-party clients. These dynamics have been especially magnified during the last decade due to the industry's great complexity and capital-intensive requirements. **In**

[10] Heaven, D. (n.d.). *The humble mineral that transformed the world*. BBC.
[11] Baisakova, N., & Kleinhas, J.-P. (2020). *The Global Semiconductor Value Chain: A Technology Primer for Policy Makers*. Stiftung Neue Verantwortung.
[12] Roser, M., Ritchie, H., & Mathieu, E. (2023, March 28). *What is Moore's Law?* Our World in Data.
[13] Ramachandran, K., Bish, J., Steward, D., & Lee, P. (3 November, 2022). *A new dawn for European chips*. Deloitte Insights.
[14] Ibid
[15] Lee, Y., Shirouzu, N., & Lague, D. (27 December, 2021). *Taiwan chip industry emerges as battlefront in U.S.-China showdown.* Reuters.

2019, only five foundries produced 53% of the global wafer capacity, while in 2009, the top five only represented 36%[16].

Furthermore, foundries require high-end ***semiconductor manufacturing equipment* (SME)** during the front-end process. The SME is integral for important phases of production like lithography and deposition. The largest SME vendors worldwide are **Applied Materials (AMAT), Lam Research (LAM), and KLA** in the **United States**; **ASML** in **Europe;** and **Tokyo Electron (TEL) in Japan**[17]**.** In the niche sector of lithography and photolithography equipment, the Dutch SME company ASML enjoys a near monopoly, especially on the latest generation EUV lithography, primordial to produce chips smaller than 7nm[18].

Finally, after the 'front-end' manufacturing process is finished, the wafers are implemented with integrated circuits. The wafers are **cut into single chips**, **tested,** and **packaged**. This 'back-end' process is conducted by **outsourced semiconductor assembly & test (OSAT)** companies that specialize in assembling, packaging, and testing chips. A handful of OSAT companies have consolidated a large margin of the 'back-end' market. Out of the total of 150 OSAT companies, just 10 can be considered mid to large, and Taiwan is also a key actor[19]. **Taiwan-based OSATs provide about 50% of the world's IC packaging and test services**[20]**.** The Taiwanese **ASE Group** is also the market leader in assembly and testing services, capturing 30% of the global OSAT market in 2021[21].

The near-monopolies or significant market influence of these foundry model companies can enormously impact the dynamics of the semiconductor value chain. Their control over critical production phases gives them considerable bargaining power, allowing them to influence pricing, terms, and technological advancements. Additionally, their strong positions may pose entry barriers for new players, which limits market competition and diversity.

[16] Baisakova, N., & Kleinhas, J.-P. (2020). *The Global Semiconductor Value Chain: A Technology Primer for Policy Makers*. Stiftung Neue Verantwortung.
[17] Baisakova, N., & Kleinhas, J.-P. (2020). *The Global Semiconductor Value Chain: A Technology Primer for Policy Makers*. Stiftung Neue Verantwortung. P. 16
[18] How ASML became chipmaking's biggest monopoly. (29 February, 2020). *The Economist*.
[19] Wallach, O. (14 December, 2021). *Visualizing The Global Semiconductor Supply Chain*. Visual Capitalist.
[20] LaPedus, M. (18 February, 2016). *Consolidation Hits OSAT Biz*. Semiconductor Engineering.
[21] Wallach, O. (14 December, 2021). *Visualizing the Global Semiconductor Supply Chain*. Visual Capitalist.

3. Motivations for New Legislation in Europe

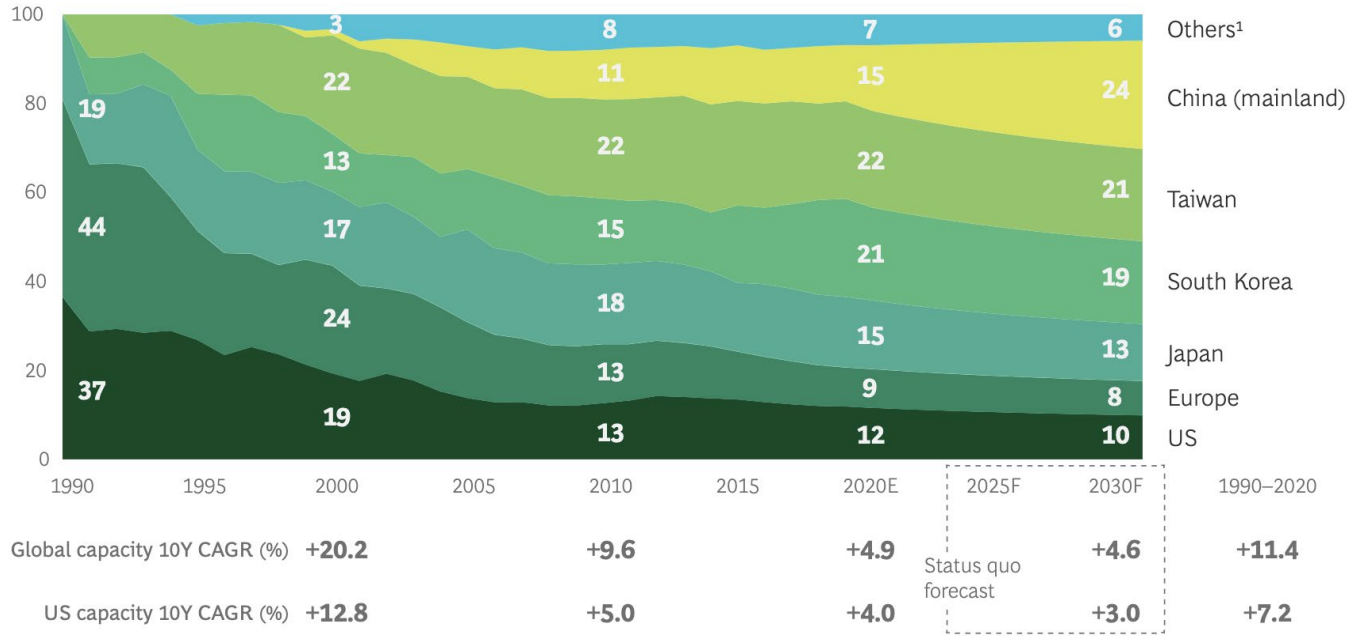
Europe's minor role

Historically, Europe has played a key role in the production of semiconductors, especially centered around R&D and semiconductor manufacturing equipment, but that privileged positions has been slowly diminishing. **'The share of the EU in manufacturing capacity has dropped from around a quarter at the start of the century to below 10% now.'** [22] Europe does not represent at the moment a significant percentage of the foundry nor OSAT phases of chips production, while East Asian nations like Taiwan, South Korea, and Japan have become industry leaders. For instance, South Korea and Taiwan combined represent 81% of IC foundry manufacturing, and Taiwan alone accounts for 63% of global foundry capacity by non-IDMs[23]. As previously mentioned, TMSC and Samsung also enjoy a complete monopoly of high-end chips.

Semiconductors are mostly used to produce digital hardware, which the EU imports mainly as final goods. Overall, Europe produces only 10% of the world's chips[24], primarily focused on industrial and automotive applications. European firms remain competitive in specialized areas such as SME sensors, lithographic equipment, power and radio frequency chips, and are focused on material innovation rather than size reductions[25]. So far, Europe has no capacity to produce cutting-edge chips smaller than 10nm, and only plays a minor role in computer chip design, accounting for only 2% of the market for IC designs outside of IDM companies[26].

[22] '*Note: This percentage of European manufacturing capacity excludes capacities below 5kwpm or less than 8'*. Slijkerman, J. F. (8 February, 2022). *EU Chips Act to boost Europe's technological prowess and strengthen economy*. ING Think.
[23] Ramachandran, K., Bish, J., Steward, D., & Lee, P. (3 November, 2022). *A new dawn for European chips*. Deloitte Insights.
[24] *European Chips Act*. European Commission.
[25] Poitiers, N., & Weil, P. (9 March, 2023). *Is the EU Chips Act the right approach?* Bruegel | The Brussels-Based Economic Think Tank.
[26] García-Herrero, A., & Poitiers, N. (17 October, 2022). *Europe's promised semiconductor subsidies need to be better targeted*. Bruegel | The Brussels-Based Economic Think Tank.

Global manufacturing capacity by location (%)



Sources: VLSI Research projection; SEMI second-quarter 2020 update; BCG analysis.

Note: All values shown in 8" equivalents; excludes capacity below 5 kwpm or less than 8".

[1] Includes Israel, Singapore, and the rest of the world.

Extracted from: Varas, A; Varadarajan, R; Goodrich, J; Yinung, F; (September 2020), Government Incentives and US Competitiveness in Semiconductor Manufacturing, Semiconductor Industry Association SIA.

The current chip production reflects the demand that was projected a few years ago before the demand surge during the pandemic. However, the semiconductor industry is not as flexible as other industries, and the factories require time to adapt production to sudden demand changes. New foundries and mega-fabs can take years to build and require billions of investment. Shifting manufacturing between different types of wafers to satisfy shifting demands can take months or even years to take place. Companies were investing in new mega-fabs before the covid pandemic, but a significant increase in manufacturing capacity by the private sector alone takes time to materialize.

Governments worldwide are also seeking to gain market share and reduce their dependence on foreign chip manufacturers, with total government subsidies for the chip industry amounting to 0.9% of the 2020 global GDP[27]. A catalyst for this new global attitude was the policy **Made in China 2025** – China's landmark industrial policy strategy. Introduced in 2015, the policy created two major funds that offer hundreds of millions in subsidies to

[27] García-Herrero, A., & Poitiers, N. (17 October, 2022). *Europe's promised semiconductor subsidies need to be better targeted*. Bruegel | The Brussels-Based Economic Think Tank.

Chinese tech companies. Beijing's goal is to end China's dependence on imported technologies, like semiconductors. This explains why China is encouraging Chinese firms to invest so heavily in international companies that lead in advanced technological sectors – and especially semiconductor companies. The value of Chinese acquisitions of American companies peaked at over $45 billion in 2016[28]. However, although China has given vast subsidies to its national industry for years, it has been unable to end its dependence on foreign supply and R&D providers. Apparently, Beijing poorly planned the targeting of its funding, and so it increased its mega-fab capacity, but they remain highly reliant on importing key technologies that Japan and the United States almost completely control[29]. Therefore, Chinese foundry companies were left dependent on imports. For example, Huawei's cutting-edge chips 'now face extinction as Huawei became the target of a series of devastating sanctions that targeted China's inability to independently build the necessary electronic design automation and nanometer lithography machines which were necessary to turn these advanced chip designs into products.'[30]

Nonetheless, other states are also heavily investing in the sector. The US in 2022 announced the **US CHIPS and Science Act,** which included subsidies of $52 billion for its domestic chip industry, and India in 2021 announced a plan to attract chipmakers with $10 billions of investment[31].

The EU already attempted to carry out an ambitious industrial policy to strengthen the domestic IC manufacturing in 2013. The European Commission proposed the **New European Industrial Strategy for Electronics**, a plan to better target support to **mobilize €100 billion in new private investments for chip manufacturing**. The proposal's main objective was very similar to the one set by the European Chips Act of 2022, namely, to double Europe's chips manufacturing global share[32]. The European Commission Vice President at the time, Neelie Kroes, claimed in 2013 'I want to double our chip production to around 20% of global production. I want Europe to produce more chips than the United States produces domestically. It's a realistic goal if we channel our investments properly.'[33]

[28] McBride, J; Chatzky, A; *Is 'Made in China 2025' a Threat to Global Trade?* (13 May, 2019) Council on Foreign Relations.
[29] Ji, E. *Great Leap Nowhere: The Challenges of China's Semiconductor Industry.* (23 February, 2023) War on the Rocks
[30] Ibid
[31] Poitiers, N., & Weil, P. (9 March, 2023). *Is the EU Chips Act the right approach?* Bruegel | The Brussels-Based Economic Think Tank.
[32] *Commission proposes New European Industrial Strategy for Electronics*. (23 May, 2013). European Commission - European Commission.
[33] *EU launches new industry strategy and commits to European microelectronics*. (2013, May 27). Silicon Europe.

But this policy failed almost completely, and the European global share today still remains below the 10% after ten years. The shortcomings of the New European Industrial Strategy for Electronics highlights the EU's historic inability to successfully carry out long-term industrial policy and especially Brussels' lack of technical understanding of the microchip industry. While the EU has struggled for ten years to develop its own 'mega-fabs' and foundries, the industry giants are investing in North America and East Asia.

The global microchip shortage

The 2020-2022 microchip supply shortage significantly impacted the global economy. While major economies like the US and China experienced strong economic recovery post-2020, Europe lagged behind with slow economic growth. The region has been particularly hard-hit by supply constraints related to semiconductor shortages and issues related to the Russo-Ukrainian conflict.

The chip shortage can be traced back to the second quarter of 2020. Strong demand for work-from-home technology and competition among automakers for increasing semiconductor capacity in automobiles created a complex situation of high demand and limited supply in Asian foundries[34]. Every passing quarter during the covid-19 pandemic further exacerbated the shortage, causing disruptions in the supply chain due to the lockdown of foundries and the refocusing of IC production towards digital devices rather than industrial or automobile chips. In November 2020, Korean chipmaker SK Hynix's factories in Chongqing, China, were closed after reporting new covid-19 cases among factory workers (who were then quarantined).[35] Later in mid-2021, the Taiwanese government locked down thousands of workers from TSMC mega-fabs due to the pandemic, and this measure combined with the severe drought that the island was suffering at the time, virtually halted wafer production by the company[36]. Assembly and testing operations in South and Southeast Asia, particularly in Malaysia, which performs labor-intensive tasks like chip packaging and testing, were also adversely affected by the covid-19 Delta variant, leading to additional bottlenecks in the supply chain[37].

[34] *How Long Will the Chip Shortage Last?* (18 April, 2023). J.P. Morgan.
[35] China halts operation at Korean chip plant after worker tests positive for coronavirus. (29 November, 2020). *Reuters*.
[36] Cheung, E. (11 June, 2021). *The chipmaking factory of the world is battling Covid and the climate crisis | CNN Business*. CNN.
[37] *How Long Will the Chip Shortage Last?* (18 April, 2023). J.P. Morgan.

The waves of covid-19 outbreaks and environmental crises resulted in temporary closures and reduced the production capabilities for many Asian mega-fabs. This process was joined by the prioritization of producing digital device chips rather than other types due to the high demand, which in turn affected the industrial and automotive industries. **The global production of vehicles decreased by around 18 million in 2021**, with the European automotive industry being hit especially hard by the shortages[38]. The chip shortage led to a drastic reduction in the global median inventory of semiconductor products, dropping from 40 days in 2019 to less than 5 days in 2021[39]. The automotive industry in Europe was particularly impacted, with new car sales declining by 11.9% between January and August. The shortage of semiconductors, essential for vehicle production, costed the European automotive industry nearly **€100 billion between 2021 and 2022.**[40]

Nevertheless, Europe is regaining economic momentum in 2023, and **the continent, despite the current energy crisis, is expected to show a strong economic growth rate this year**. According to the head of European automotive research at J.P Morgan, Jose Asumendi, '2023 should mark a strong earnings year for the automotive industry, with less volatile raw material costs and a more stable supply chain.' [41] He later added that there are signs of improvement on the continent with a projected year-over-year growth rate of 5%, which signals the end of the microchip shortage in Europe. This positive outlook is supported by strong growth in January and February, indicating a return of supply chain stability after constraints over the past three years.[42][43] 'We're nearing the end of the supply crunch after more semiconductor capacity comes online in 2022. Looking ahead, we don't predict any major constraints', concluded Sandeep Deshpande, head of European technology research at J.P. Morgan.[44]

After facing unexpected supply shortages during the last three years, the European Commission is committed into addressing the chip supply challenges and enhancing domestic competitiveness. The EU proposed the ECA to alleviate recent shortages and tackle

[38] *Chip shortage costs European car industry €100 billion*. (n.d.). The Brussels Times. Retrieved 22 May, 2023.
[39] *Results from Semiconductor Supply Chain Request for Information*. (25 January, 2022). U.S. Department of Commerce.
[40] *Chip shortage costs European car industry €100 billion*. (n.d.). The Brussels Times. Retrieved 22 May, 2023.
[41] *How Long Will the Chip Shortage Last?* (18 April, 2023). J.P.Morgan.
[42] Ibid
[43] *Supply chain issues and autos: When will the chip shortage end?* (2023, April 18). J.P.Morgan.
[44] Ibid

the broader issue of European interdependence and lack of competitiveness in high-end technologies. The EU strives to match the capital that China and the US have already invested in this sector. The estimated total support provided in 2020 by various countries and regions, including the **US, China, Japan, South Korea, and the EU**, amounts to **$721 billion**, indicating the start of a global subsidy race in high-tech[45]. On top of that, **the market share of semiconductors of sizes below 10nm in automobiles is expected to grow from 2% today to 10% in 2030[46].** Therefore, it makes sense for a continent heavily centered around the automotive industry to invest in high-tech mega-fabs. Europe understands the strategic benefits of nurturing a strong domestic foundry and OSAT industries, which is motivating law makers in Brussels to push the EU's industrial policy towards strategic autonomy.

America has also been taking steps to strengthen its domestic chip manufacturing. Thanks to the ***CHIPS and Science Act,*** semiconductor companies have been attracted to invest in American industry. Thanks to the subsidies offered by the US, Washington has attracted semiconductor companies to open new fabs in their country. For instance, TSMC is building two mega-fabs with an investment of $40 billion in Phoenix, Arizona[47], Samsung is building with $25 billion another mega-fabs in Austin, Texas[48], and the US Department of Commerce and ASML announced a joint $200 million investment to expand the ASML facility in Connecticut, aiming to ensure domestic capacity for fabricating advanced chips and create jobs[49].

4. Structure of the Chips Act

Although the semiconductor industry is a crucial player in our modern economy, it represents a just small part of the larger digital industry. Nonetheless, the gigantic new semiconductor industrial policies like *Made in China 2025, the European Chips Act, and US CHIPS and Science Act* are the symptoms of a larger economic trend that is becoming a staple of the post-2020 world economy.

After the global economy suffered the ruinous effects of the covid-19 pandemic, the US-China trade war, and lastly, the Russo-Ukrainian War; policy-makers realized that national economies can no longer rely on the globalized system that has taken shape in recent

[45] Poitiers, N., & Weil, P. (9 March, 2023). *Is the EU Chips Act the right approach?* Bruegel | The Brussels-Based Economic Think Tank.
[46] Slijkerman, J. F. (8 February, 2022). *EU Chips Act to boost Europe's technological prowess and strengthen economy*. ING Think.
[47] Wang, L. (2023, March 28). *TSMC wins approval to invest US$3.5bn in Arizona—Taipei Times*.
[48] Alper, A., Nellis, S., & Yang, H. (2023, March 16). Exclusive: Samsung's new Texas chip plant cost rises above $25 billion. *Reuters*.
[49] *Deputy Secretary Don Graves joins Dutch semiconductor equipment company ASML to announce $200 million semiconductor investment in Connecticut*. (31 May, 2022). U.S. Department of Commerce.

decades. Potential geopolitical tensions or new supply chain disruptions are too unpredictable. The European economy wants to escape its dependence on a handful of foreign semiconductor suppliers. The goal of the ECA is to achieve semiconductor 'strategic autonomy' by strengthening the manufacturing capacity in the Union, stimulating the European R+D ecosystem, and diminishing European vulnerabilities by supporting scale-up and innovation across the whole value chain.

The **European Chips Act (ECA) was initially proposed by the European Commission on the 2nd of February 2022**[50]**. A public consultation was hosted between the 14th of March and the 9th of May**[51]**, and the act was finally approved by the European Parliament and Council of Ministers on the 18th of April 2023**[52]**.**

As the ECA was not in the original work plan of the Commission, the proposed expenditure for the ECA will not increase the annual spending of the EU, it will instead redirect pre-existing capital pooled from the **Horizon Europe Program** and the **Digital Europe Program** (the EU's flagship research programs)[53]. The ECA plans to mobilize more than **€43 billion of policy-driven investments into six specific objectives located under the Digital Europe Program until 2030**[54]. These funds will also be broadly matched by long-term private investment.

Moreover, the proposal creates **an advisory role** for the **Alliance on Processors and Semiconductor Technologies**[55]**.** This alliance strengthens cooperation amongst stakeholders and state actors in the EU to deliver more secure and competitive solutions in processor and semiconductor technologies[56]. The role of the alliance inside the ECA is to identify and help address gaps in the production of microchips and the technology developments needed for companies to thrive. The alliance aims to help strengthen the competitiveness of companies, increase Europe's digital sovereignty and address the demand for the next generation of secure, energy-efficient, powerful chips and processors. Furthermore, the European Semiconductor Board, composed of representatives of the Member States and chaired by a representative of the Commission, will also advise the Commission[57].

To prop up the domestic semiconductor industry, the European Chips Act will enhance Europe's competitiveness and digital sovereignty in the field of semiconductor technologies

[50] *The European Chips Act*. (n.d.). The European Chips Act.
[51] *Initiative details*. (n.d.). European Commission. Retrieved 8 July, 2023.
[52] *The European Chips Act*. (n.d.). The European Chips Act.
[53] European Commission, *European Chips Act*. 2022/0032 (COD), 2022. page 76
[54] *European Chips Act*. (n.d.). European Commission. Retrieved 12 May, 2023.
[55] European Commission, *European Chips Act*. 2022/0032 (COD), 2022. page 6
[56] *Alliance on Processors and Semiconductor technologies | Shaping Europe's digital future*. (2023, June 15). European Commission.
[57] Parliament, E. (n.d.). *European Chips Act (semi-conductors) | Legislative Train Schedule*. European Parliament. Retrieved 5 July, 2023.

by strengthening the semiconductor manufacturing ecosystem and ensure the availability of cutting-edge and next-generation semiconductor and quantum technologies. As the bloc's Swedish presidency concluded: 'The Chips Act will boost the European ecosystem for semiconductors and play a vital part in strengthening the EU's global competitiveness.'[58]

Through the ECA, the European Union aims to double its global manufacturing market share from the current 10% up to 20% in 2030[59]**.** This is an ambitious goal because Europe will have to quadruple its current production to meet this target[60]. For the short term, the proposal mentions that **€8.638 billion in current prices** has been allocated for the implementation of the program for the period 1 January 2021 to 31 December 2027[61].

The architecture of the Chips Act is divided into three pillars:

1. **Chips for Europe Initiative:** policies for research, development, and innovation of chips and fabless industries.
2. **Facilitate new state aid exemptions for cutting-edge foundries.**
3. Measures to **monitor the supply chain** and **intervene effectively in supply-chain crises**

First pillar

The first pillar is also known as the **'Chips for Europe Initiative**' and aims to, to bridge the gap between 'the fab and the lab'. The initiative plans to support large-scale technological capacity building, and innovation and research across the EU IC value chain. It combines existing cross-border R&D programs like the Important Project of Common European Interests, chips-related Horizon Europe projects, Digital Europe, and the Key Digital Technologies Joint Undertaking[62]. The Chips for Europe Initiative will **'reinforce Europe's technological leadership by facilitating the transfer of knowledge from the lab to the fab, bridging the gap between research and innovation and industrial activities, and by promoting the industrialization of innovative technologies by European businesses.'**[63]

EU funding will support the Chips for Europe Initiative with a total of up to €3.3 billion. The funding has multiple sources, including €1.65 billion via Horizon Europe and €1.65 billion via

[58] *EU strikes €43 billion deal to boost semiconductor chip production*. (April 19, 2023). Euronews.
[59] Union, E. (19 April, 2023). Commission welcomes political agreement on the European Chips Act. *The European Sting - Critical News & Insights on European Politics, Economy, Foreign Affairs, Business & Technology - Europeansting.com*.
[60] *EU strikes €43 billion deal to boost semiconductor chip production*. (19 April, 2023). Euronews.
[61] European Commission, *European Chips Act*. 2022/0032 (COD), 2022. page 59
[62] European Commission, *European Chips Act*. 2022/0032 (COD), 2022. page 11
[63] Union, E. (April 19, 2023). Commission welcomes political agreement on the European Chips Act. *The European Sting - Critical News & Insights on European Politics, Economy, Foreign Affairs, Business & Technology - Europeansting.Com*.

Digital Europe. Out of this total amount, the Chips Joint Undertaking will implement €2.875 billion, €125 million through InvestEU, plus another €125 million from InvestEU itself, and €300 million through the European Innovation Council[64]. The rest is being leveraged through the Chips Fund, which raises funds from the European Investment Bank and EU finance. The EU Council pushed to slash €400 million off the €3.3 billion budget, while MEPs wanted to maintain at least the original budget. The EU Parliament prevailed in its stance, although according to a joint statement draft by EURACTIV, the Commission is still investigating from where to take the last €50 million[65].

Second pillar

The focus of the second pillar is on enhancing the EU's **security of supply by attracting investments and improving foundry and OSAT production capacities.** This will be achieved by establishing integrated production facilities and open 'first-of-a-kind' EU foundries located in the Union, and by contributing to the resilience of the European supply ecosystem. Although **the proposal does not directly state the total budget** for the second pillar, the German MEP Henrike Hahn tweeted that the deal allocated large funds to 'support large-scale technological capacity building and innovation across the EU in the semiconductor sector'.[66]

State aid can be allocated to these pioneering mega-fabs in accordance with the provisions outlined in the Treaty on the Functioning of the European Union[67]. Moreover, Member States are expected to extend administrative assistance to mega-fabs, and encompassing the expeditious handling of administrative applications. These mega-fabs function as comprehensive manufacturing hubs, offering their production capabilities to various industrial entities. The ECA aims to develop mega-fabs with manufacturing capacities for high-tech wafers and create first-of-a-kind semiconductors, including the production of chips smaller than 2nm. The underlying objective is to foster both public and private investments in chip manufacturing facilities and their associated suppliers[68].

[64] (February 08, 2022). *REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act).* 2022/0032 (COD) European Commission. page 59
[65] Bertuzzi, L. (2023, April 19). *EU institutions reach agreement on European Chips Act*. EURACTIV.
[66] *EU strikes €43 billion deal to boost semiconductor chip production*. (19 April, 2023). Euronews.
[67] Article 107(3)(c) Consolidated version of the Treaty on European Union [2012] OJ C326/13.
[68] Union, E. (April 19, 2023). Commission welcomes political agreement on the European Chips Act. *The European Sting - Critical News & Insights on European Politics, Economy, Foreign Affairs, Business & Technology - Europeansting.Com*.

Third pillar

The third pillar centers around **coordinating Member States and the Commission to monitor the supply of semiconductors and effectively respond to shortages**. It establishes a mechanism to effectively anticipate and address semiconductor shortages in the future. **The Commission has the authority to oblige companies to provide information on production capabilities and capacities**. Additionally, the pillar includes **emergency measures to ensure the security of supply chains, such as joint procurement of chips** by the European Commission and the activation of a crisis stage. The aim is to facilitate coordinated monitoring, crisis response protocols, and the availability of crisis-relevant products.

5. Opinions about the European Chips Act

During the formulation of the proposal, a long debate ensued on the domestic and continental levels. Although there was no great opposition to strengthening the EU's 'open strategic autonomy', there were important divisions between the MEPs and stakeholders on the proposal's scale and priorities.

Overall, European corporations fully support the EU initiative, although some stakeholders did propose minor revisions and amendments. For example, the chief lobbyist for the German corporations Volkswagen, BMW, and Mercedes-Benz, Hildegard Müller, he argued at a German auto industry association: 'Securing the existing global supply chain (of chips) is of central importance and an additional strategic share of the global market can strengthen the negotiating position in the event of new shortages.'[69] For most European companies, the option to purchase high-tech chips from European suppliers reduces the risks of global supply shortages and significantly diminishes the manufacturing costs of tech devices such as automobiles.

The *Spanish Industrial Association of Semiconductors* (AESEMI) also supported the proposal during a public consultation: 'AESEMI's general assessment of the **Chips Act package is eminently positive**, given that it **provides the sector with its own regulatory framework and specific mechanisms for dealing with supply crisis situations**, as well as creating specific structures to guide and channel large investments.' [70] However, it calls on

[69] Cerulus, L., & Posaner, J. (8 February, 2022). Europe has a chips plan – here are 6 things that could kill it. *POLITICO*.
[70] Gabarrón González, A. (2022). *Response to the Public Hearing process on the Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures to strengthen the European Semiconductor Ecosystem (Chips Act)* (No. F3257511;). AESEMI. p.22

widening beyond 2nm chips: 'devoting the bulk of the budget in the European industrial framework to the 2nm nodes would not be the most advisable thing to do, since in order to meet the objectives of guaranteeing supply, the budget should be focused on providing supply with mature technologies, which are those that are eminently used in the Community's industrial fabric.'[71] Taking into consideration that many European industries, including the automotive industry, still rely on larger integrated circuits; they consider relevant to diversify the production of different sizes of chips.

Source: *Infineon breaks ground on 5-billion-euro semiconductor plant in Germany*. (2023, May 3). Autocar Professional.

The *German Chambers of Industry and Commerce* (DIHK) also supported the ECA during the public consultation and stated: '**There is widespread support in German industry for the European Commission to address the EU's highly concentrated dependence on semiconductor production from a few countries**, especially against the background of increasing geopolitical tensions.'[72] Yet, the DIHK remained concerned that the growing trend of EU intervention 'in entrepreneurial activities in times of crisis, such as export bans, which should be viewed critically from a business perspective.'[73]

Meanwhile, the American company, Hewlett Packard Enterprise, proposed going beyond mere semiconductor manufacturing and covering the entire value chain: 'We believe

[71] Ibid
[72] *Proposal of the European Commission for a European Chip Act* (No. F3257484). (2022). DIHK. p.1
[73] Ibid

that a more global approach must be incorporated in the Chips Act proposal to ensure that the entire value chain is seen as a driver of growth, and receives the following preferential treatment, not solely the chips manufacturers.'[74]

The major sources of criticism were focused on the ability of the EU economy to fully extricate its supply chains from East Asian suppliers, and especially from China. EU officials have recognized the immense difficulties involved in untangling supply chains away from China and other Asian countries. EU trade commissioner, Valdis Dombrovskis, told industry figures that decoupling from the PRC was not a realistic option currently. 'The EU should continue engaging with China with pragmatism and without naivety. Our trading relationship needs more balance and reciprocity.'[75] Meanwhile, an economic analysis by Deloitte questioned the capacity of the EU to decouple from importing Asian chips: 'Given the scale of growth in the semiconductor industry and the pace at which new factories can be built**, Europe could remain a net importer of semis as of 2030, despite the best efforts of the EU Chips Act.'**[76] In anticipation to these questions about European self-reliance, the president of the European Commission, Ursula Von der Leyen, clarified that the European Chips Act aims to make the EU more self-reliant: but not completely self-sufficient. As she later explained: 'It should be clear that no country – and not even any continent – can be entirely self-sufficient.'[77]

The construction of 'mega-fabs' is a very complex and costly endeavor that requires years of investment before foundries even begin manufacturing. Some skeptics also questioned whether the major investments included in the proposal for cutting-edge semiconductor tech would benefit the current European demand for microchips. The Dutch financial corporation ING commented: 'It is estimated that **90% of European chip demand until the end of this decade will be for chips over 10nm**. Therefore, the priority should be to strengthen the current ecosystem.'[78] Most European companies mainly import semiconductors to produce industrial and automotive products, and therefore they mostly rely on chip nodes larger than 10nm and not smaller chip nodes.

Nevertheless, the ECA strongly emphasizes on developing local European mega-fabs with larger than 5nm chips mega-fab plants. But for European companies: 'it is relatively unattractive to set up a fab that produces larger than 5nm chips in Europe. In Asia, companies profit from economies of scale, industrial clustering, and government subsidies. Incentives

[74] European Chips Act package, *Hewlett Packard Enterprise (HPE)*
[75] Murray, M. (11 October, 2022). Decoupling from China not an option for EU firms—Dombrovskis. *Reuters*.
[76] Ramachandran, K., Bish, J., Steward, D., & Lee, P. (3 November, 2022). *A new dawn for European chips*. Deloitte Insights.
[77] Ramachandran, K., Bish, J., Steward, D., & Lee, P. (3 November, 2022). *A new dawn for European chips*. Deloitte Insights.
[78] Slijkerman, J. F. (8 February, 2022). *EU Chips Act to boost Europe's technological prowess and strengthen economy*. ING Think.

are therefore required to balance the relatively high-cost base in Europe.'[79] Although Europe currently has little need for the most complex chips technologies, the general consensus is that over time the demand for chip nodes smaller than 5nm will increase (including for car production). BMW's CEO Oliver Zipse argues that once **artificial intelligence technology takes off, the demand for smaller chips will increase**[80]**.** Even Margrethe Vestager (Executive Vice President of the European Commission for A Europe Fit for the Digital Age and European Commissioner for Competition) highlighted the strong emphasis of the ECA on future demand for semiconductors: **'The European Chips Act is not about solving our current shortage. We need to anticipate crises that are on the horizon.'**[81]

The European political environment is strongly focused on achieving an 'open strategic autonomy' of semiconductors, with a special focus on becoming market competitors in the future. The EU Commissioner for the Internal Market, Thierry Breton, described in September 2022 very well the *zeitgeist* in Brussels: 'In **technology**, we have recognized that **a global race is taking place and that our capacity to take our destiny into our own hands boils down essentially to the mastery of tomorrow's technologies**. Breakthrough digital, dual, and green technologies are becoming essential drivers of our resilience. Data, chips, quantum, hydrogen, batteries – these are key transformative technologies that we need to invest in for the real industrial revolution to happen.'[82]

EU leaders remain heavily invested in the project of strategic autonomy for the European economy, and it is unlikely that a major political shift will change this policy direction. Spain is the current member state to take presidency of the EU Council for the second half of 2023. The Spanish prime minister, Pedro Sánchez, has already announced that he plans to continue the roadmap for decoupling from foreign suppliers. On the presentation of the Spanish presidency on the 15th of June, Mr. Sánchez declared: 'we want new investments that will encourage strategic industries and technologies in Europe that boost innovation and industrial policy. However, we also want to encourage investments that allow us to expand and diversify our commercial relationships with third parties and strengthen our supply chain.'[83]

[79] Ibid
[80] Cerulus, L., & Posaner, J. (8 February, 2022). Europe has a chips plan – Here are 6 things that could kill it. *POLITICO*.
[81] Ibid
[82] Vasquez, M. (6 January, 2023). *EU Chips Act, the debate goes on - Geopolitics: Remaining open for business*. Aeneas.
[83] *Pedro Sánchez presenta las prioridades de la Presidencia española del Consejo de la Unión Europea*. (15 June, 2023). La Moncloa.

6. Conclusions

Although the European Chips Act was a reactive measure for the supply shortages that began in 2020, it is probable that the EC would have implemented a similar industrial policy eventually. For most governments, the greatest lesson drawn from the covid-19 pandemic and the Ukrainian War is the need to transition away from a globalized economic system with high dependence on foreign imports and towards a new economic model that is more self-reliant and less vulnerable to global supply chain disruptions.

Given the growing importance of semiconductor technology in most industries, it is only natural that the EU would have aimed to strengthen the domestic chips industry. The EC already attempted in 2013 to increase Europe's chip market share to 20% with the New European Industrial Strategy for Electronics with mixed results. The developments that followed the second quarter of 2020 simply accelerated a trend that was already gestating in the background. Nonetheless, chip supply issues also contributed to ensuring that the ECA was also focused on lowering supply chain risks and increasing European digital sovereignty.

However, the major difference between 2013 and 2020 is that the EU is no longer the only major government working to expand its semiconductor industry, there are more players involved now. Major states like the US, China, and India have reached a similar conclusion to the EU- in the case of China since 2015. With the Chips Act, the EU is joining a perilous game with the major economies. They are all competing to increase their market share through state interventions, a fragile scenario that is on edge of becoming a subsidy race for semiconductor supremacy.

It is true that Brussels has learned from its mistakes from the New European Industrial Strategy for Electronics in 2013, and the EC is now more self-confident and assertive in implementing EU-wide policies. However, the competition for semiconductor dominance is fiercer today than in 2013, and a subsidy race can easily derail.

Moreover, the willingness to invest large sums of capital does not guarantee that a foundry or OSAT industry will flourish. In order to develop a semiconductor industry, which is increasingly sophisticated, requires from ground-based innovation (rather than duplication or imitation); hiring from a very limited pool of highly skilled workers; and smartly targeting investment. A prime example is China, which has subsidized in large quantities its domestic chips industry since 2015, but remains dependent on foreign technologies. The reality of

semiconductor manufacturing is that for any one country, no matter how advanced or wealthy, the goal of semiconductor autonomy is beyond reach.

Nevertheless, the decision to launch the ECA demonstrates a strong commitment by Brussels towards reclaiming its former position in the global market and achieving 'strategic autonomy' – despite the probable impossibility of achieving total self-sufficiency. In contrast with many other legislative initiatives, the ECA has gained overwhelming approval from politicians and private stakeholders. It is not yet clear whether the implementation of the Chips Act will be successful or which subsidies the EU will prioritize. The proposal focuses on satisfying the current demands for less sophisticated semiconductors, as well as enabling Europe to exploit the digital economy's growing demand for high-tech microchips.

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7. Bibliography

- *Alliance on Processors and Semiconductor technologies | Shaping Europe's digital future*. (2023, June 15). European Commission. https://digital-strategy.ec.europa.eu/en/policies/alliance-processors-and-semiconductor-technologies
- Alper, A., Nellis, S., & Yang, H. (2023, March 16). Exclusive: Samsung's new Texas chip plant cost rises above $25 billion. *Reuters*. https://www.reuters.com/technology/samsungs-new-texas-chip-plant-cost-rises-above-25-billion-sources-2023-03-15/
- *ASML EUV lithography systems*. (n.d.). ASML. Retrieved 30 May 2023, from https://www.asml.com/en/products/euv-lithography-systems
- *Automotive Innovation Outlook | J.P. Morgan Research*. (2023, May 23). J.P.Morgan. https://www.jpmorgan.com/insights/technology/electric-vehicles/automotive-innovation
- Baisakova, N., & Kleinhas, J.-P. (2020). *The Global Semiconductor Value Chain: A Technology Primer for Policy Makers*. Stiftung Neue Verantwortung. https://www.stiftung-nv.de/de/publikation/global-semiconductor-value-chain-technology-primer-policy-makers
- Bertuzzi, L. (2023, April 19). *EU institutions reach agreement on European Chips Act*. EURACTIV. https://www.euractiv.com/section/industrial-strategy/news/eu-institutions-reach-agreement-on-european-chips-act/

- Cerulus, L., & Posaner, J. (2022, February 8). Europe has a chips plan—Here are 6 things that could kill it. *POLITICO*. https://www.politico.eu/article/european-union-chips-industrial-policy-european-chips-act-semiconductors/
- Cheung, E. (2021, June 11). *The chipmaking factory of the world is battling Covid and the climate crisis | CNN Business*. CNN. https://www.cnn.com/2021/06/10/tech/taiwan-chip-shortage-covid-climate-crisis-intl-hnk/index.html
- China halts operation at Korean chip plant after worker tests positive for coronavirus. (2020, November 29). *Reuters*. https://www.reuters.com/article/us-health-coronavirus-china-cases-idINKBN289019
- *Commission proposes New European Industrial Strategy for Electronics*. (2013, May 23). [Text]. European Commission - European Commission. https://ec.europa.eu/commission/presscorner/detail/en/IP_13_455
- Das, S. (2022, November 9). Semiconductor Manufacturing Process—Steps, Technology, Flow. *Electronics Tutorial | The Best Electronics Tutorial Website*. https://www.electronicsandyou.com/blog/semiconductor-manufacturing-process-steps-and-technology-used.html
- *Deputy Secretary Don Graves joins Dutch Semiconductor Equipment Company ASML to Announce $200 Million Semiconductor Investment in Connecticut*. (2022, May 31). U.S. Department of Commerce. https://www.commerce.gov/news/press-releases/2022/05/deputy-secretary-don-graves-joins-dutch-semiconductor-equipment-company
- *EU launches new industry strategy and commits to European microelectronics*. (2013, May 27). Silicon Europe. https://www.silicon-europe.eu/nc/news/news/news-detail/archive/2013/may/article/eu-launches-new-industry-strategy-and-commits-to-european-microelectronics-1/27/
- *EU strikes €43 billion deal to boost semiconductor chip production*. (2023, April 19). Euronews. https://www.euronews.com/next/2023/04/19/eu-strikes-deal-to-boost-semiconductor-chip-production

- *European Chips Act*. (n.d.). European Commission. Retrieved 12 May 2023, from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-chips-act_en
- *European Chips Survey | Shaping Europe's digital future*. (2022, August 4). https://digital-strategy.ec.europa.eu/en/library/european-chips-survey
- *European Commission—Have your say*. (2022a, May 9). [Text]. European Commission - Have Your Say. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13405-European-Chips-Act-package/feedback_en?p_id=29086370
- *European Commission—Have your say*. (2022b, May 9). [Text]. European Commission - Have Your Say. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13405-European-Chips-Act-package/feedback_en?p_id=29086370
- Fitri, A. (2022, November 28). The European Chips Act has already failed. *Tech Monitor*. https://techmonitor.ai/technology/silicon/the-european-chips-act-will-not-restore-the-continents-semiconductor-industry-to-its-former-glory
- Gabarrón González, A. (2022). *Response to the Public Hearing process on the Proposal for a Regulation of the European Parliament and of the Council establishing a framework of measures to strengthen the European Semiconductor Ecosystem (Chips Act)* (F3257511; p. 22). AESEMI.
- García-Herrero, A., & Poitiers, N. (2022, October 17). *Europe's promised semiconductor subsidies need to be better targeted*. Bruegel | The Brussels-Based Economic Think Tank. https://www.bruegel.org/blog-post/europes-promised-semiconductor-subsidies-need-be-better-targeted
- Hayes, A. (2023, March 29). *Semiconductors: What Is the Supply Chain? Why Is it Important?* Investopedia. https://www.investopedia.com/semiconductors-supply-chain-7367716
- Heaven, D. (n.d.). *The humble mineral that transformed the world*. BBC. Retrieved 31 May 2023, from https://www.bbc.com/future/bespoke/made-on-earth/how-the-chip-changed-everything/
- How ASML became chipmaking's biggest monopoly. (2020, February 29). *The Economist*. https://www.economist.com/business/2020/02/29/how-asml-became-chipmakings-biggest-monopoly

- *How Long Will the Chip Shortage Last?* (2023, April 18). J.P.Morgan. https://www.jpmorgan.com/insights/research/supply-chain-chip-shortage
- *Initiative details*. (n.d.). European Commission. Retrieved 8 July 2023, from https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13405-European-Chips-Act-package_en
- *Integrated Device Manufacturer (IDM)*. (n.d.). Semiconductor Engineering. Retrieved 7 August 2023, from https://semiengineering.com/knowledge_centers/manufacturing/integrated-device-manufacturer-idm/
- Ji, E. (2023, February 24). *Great Leap Nowhere: The Challenges of China's Semiconductor Industry*. War on the Rocks. https://warontherocks.com/2023/02/great-leap-nowhere-the-challenges-of-chinas-semiconductor-industry/
- Lalmand, E. (n.d.). *Chip shortage costs European car industry €100 billion*. The Brussels Times. Retrieved 22 May 2023, from https://www.brusselstimes.com/292061/chip-shortage-costs-european-car-industry-e100-billion
- LaPedus, M. (2016, February 18). *Consolidation Hits OSAT Biz*. Semiconductor Engineering. https://semiengineering.com/consolidation-hits-osat-biz/
- LaPedus, M. (2020, June 22). *China Speeds Up Advanced Chip Development*. Semiconductor Engineering. https://semiengineering.com/china-speeds-up-advanced-chip-development/
- Lee, Y., Shirouzu, N., & Lague, D. (2021, December 27). Taiwan chip industry emerges as battlefront in U.S.-China showdown. *Reuters*. https://www.reuters.com/investigates/special-report/taiwan-china-chips/
- McBride, J., & Chatzky, A. (2019, May 13). *Is 'Made in China 2025' a Threat to Global Trade?* Council on Foreign Relations. https://www.cfr.org/backgrounder/made-china-2025-threat-global-trade
- Mullich, J. (2022, November 10). *IBM Two-Nanometer Chip: The 200 Best Inventions of 2022*. Time. https://time.com/collection/best-inventions-2022/6228819/ibm-two-nanometer-chip/
- Murray, M. (2022, October 11). Decoupling from China not an option for EU firms—Dombrovskis. *Reuters*. https://www.reuters.com/markets/decoupling-china-not-an-option-eu-firms-dombrovskis-2022-10-11/

- Parliament, E. (n.d.-a). *European Chips Act (semi-conductors) | Legislative Train Schedule*. European Parliament. Retrieved 12 May 2023, from https://www.europarl.europa.eu/legislative-train/theme-a-europe-fit-for-the-digital-age/file-european-chips-act-(semiconductors)
- Parliament, E. (n.d.-b). *European Chips Act (semi-conductors) | Legislative Train Schedule*. European Parliament. Retrieved 5 July 2023, from https://www.europarl.europa.eu/legislative-train/theme-a-europe-fit-for-the-digital-age/file-european-chips-act-(semiconductors)
- *Pedro Sánchez presenta las prioridades de la Presidencia española del Consejo de la Unión Europea*. (2023, June 15). La Moncloa. https://www.lamoncloa.gob.es/presidente/actividades/paginas/2023/150623-prioridades-presidencia-ue.aspx
- Poitiers, N., & Weil, P. (2023, March 9). *Is the EU Chips Act the right approach?* Bruegel | The Brussels-Based Economic Think Tank. https://www.bruegel.org/blog-post/eu-chips-act-right-approach
- *Proposal of the European Commission for a European Chip Act* (F3257484). (2022). DIHK. https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13405-European-Chips-Act-package/F3257484_en
- Ramachandran, K., Bish, J., Steward, D., & Lee, P. (2022, November 3). *A new dawn for European chips*. Deloitte Insights. https://www2.deloitte.com/uk/en/insights/industry/technology/semiconductor-chip-shortage-supply-chain.html
- *Results from Semiconductor Supply Chain Request for Information*. (2022, January 25). U.S. Department of Commerce. https://www.commerce.gov/news/blog/2022/01/results-semiconductor-supply-chain-request-information
- Roser, M., Ritchie, H., & Mathieu, E. (2023, March 28). *What is Moore's Law?* Our World in Data. https://ourworldindata.org/moores-law

- *Semiconductor Manufacturing by Country 2023*. (n.d.). Retrieved 31 May 2023, from https://worldpopulationreview.com/country-rankings/semiconductor-manufacturing-by-country
- Sevastopulo, D., & Hille, K. (2022, October 24). TSMC: The Taiwanese chipmaker caught up in the tech cold war. *Financial Times*. https://www.ft.com/content/bae9756a-3bce-4595-b6c9-8082fd735aa0
- Slijkerman, J. F. (2022, February 8). *EU Chips Act to boost Europe's technological prowess and strengthen economy*. ING Think. https://think.ing.com/articles/eu-chips-act-to-strengthen-europes-economy/
- *Supply chain issues and autos: When will the chip shortage end?* (2023, April 18). J.P.Morgan. https://www.jpmorgan.com/insights/current-events/supply-chain/supply-chain-chip-shortage
- Tarasov, K. (2022, March 23). *Inside ASML, the company advanced chipmakers use for EUV lithography*. CNBC. https://www.cnbc.com/2022/03/23/inside-asml-the-company-advanced-chipmakers-use-for-euv-lithography.html
- *The Ecosystem: EU Chips Act starts to shape innovation landscape | Science|Business*. (n.d.). Retrieved 19 May 2023, from https://sciencebusiness.net/news/Digital/The-Ecosystem-EU-Chips-Act-starts-to-shape-innovation-landscape
- *The European Chips Act*. (n.d.). The European Chips Act. Retrieved 8 July 2023, from https://www.european-chips-act.com/
- *The Tech Cold War's 'Most Complicated Machine' That's Out of China's Reach—The New York Times*. (n.d.). Retrieved 31 May 2023, from https://www.nytimes.com/2021/07/04/technology/tech-cold-war-chips.html
- Timings, J. (2021, October 6). *6 crucial steps in semiconductor manufacturing*. ASML. https://www.asml.com/en/news/stories/2021/semiconductor-manufacturing-process-steps
- Timmers, P. (2022, August 9). How Europe aims to achieve strategic autonomy for semiconductors. *Brookings*. https://www.brookings.edu/techstream/how-europe-aims-to-achieve-strategic-autonomy-for-semiconductors/
- Union, E. (2023, April 19). Commission welcomes political agreement on the European Chips Act. *The European Sting - Critical News & Insights on European Politics, Economy, Foreign*

Affairs, Business & Technology - Europeansting.Com. https://europeansting.com/2023/04/19/commission-welcomes-political-agreement-on-the-european-chips-act/

- Vasquez, M. (2023a, January 6). *EU Chips Act, the debate goes on- Geopolitics: Remaining open for business*. Aeneas. https://aeneas-office.org/2023/01/06/eu-chips-act-the-debate-goes-on-geopolitics-remaining-open-for-business/
- Vasquez, M. (2023b, January 9). *EU Chips Act- The debate goes on- Resources: Enabling the Chips Act goals*. Aeneas. https://aeneas-office.org/2023/01/09/eu-chips-act-the-debate-goes-on-resources-enabling-the-chips-act-goals/
- Wallach, O. (2021, December 14). *Visualizing The Global Semiconductor Supply Chain*. Visual Capitalist. https://www.visualcapitalist.com/sp/visualizing-the-global-semiconductor-supply-chain/
- Wang, L. (2023, March 28). *TSMC wins approval to invest US$3.5bn in Arizona—Taipei Times*. Taipei Times. https://www.taipeitimes.com/News/biz/archives/2023/03/28/2003796823