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Chips: EU's Ambition in a Transatlantic Technology Bridge

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ABSTRACT

Semiconductors are vital building blocks of digital technologies. In line with its aspiration for strategic autonomy, the EU has recognised vulnerabilities in its chip supply chain, which heavily relies on foreign firms. The intricate relationship between economic security and open trade underlies the EU's quest to bolster its domestic capacity while enhancing connections with key global partners. Despite the challenges of finding a policy balance, fostering transatlantic cooperation in the semiconductor domains remains a key ambition. To cultivate a more balanced and effective partnership with the US, the EU should capitalise on its comparative advantages to amplify and fortify its strategic positioning in the global supply chain.

keywords

European Union | Transatlantic relations | Industrial policy | Semiconductors

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by Nicola Bilotta*

Introduction

Global economic competition is increasingly also a technological challenge. Since semiconductors (also referred to as chips) are a vital component for the technological transformation of the economy, their design, research and production automatically becomes a strategic contest. The growing reliance on semiconductors in the global economy reflects an unstoppable trend that, in the near future, will see demand grow exponentially, driven primarily by the requirements of the automotive sector (and especially electric vehicles), computing and data storage technologies, and the wireless communications sector.[1] The semiconductor market is estimated to reach approximately 650 billion US dollars in 2023 and is projected to reach over 1.8 trillion US dollars by 2032.[2]

Amidst cyclical shocks caused by external factors (such as the Covid-induced supply crunch) and geopolitical competition, chip production chains have shown structural vulnerabilities.[3] It has been estimated that a chip passes through 70 national borders before reaching the end consumer. This complex

[1] Ondrej Burkacky, Julia Dragon and Nikolaus Lehmann, "The Semiconductor Decade: A Trillion-Dollar Industry", in *McKinsey Articles*, April 2022, https://www.mckinsey.com/industries/semiconductors/our-insights/the-semiconductor-decade-a-trillion-dollar-industry.

[2] Precedence Research, *Semiconductor Market*, June 2023, https://www.precedenceresearch.com/semiconductor-market.

[3] Economist, "Why Is There a Shortage of Semiconductors?", in *The Economist*, 25 February 2021, https://www.economist.com/the-economist-explains/2021/02/25/why-is-there-a-shortage-of-semiconductors.

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journey highlights the semiconductor supply chain's deeply interconnected and globalised nature. Moreover, the diversification of demand for different types of semiconductors will require production adjustments to meet the technical requirements of different industrial sectors, increasing challenges within the current production chain.

At a global level, both China and the United States have recently taken steps to localise strategic parts of the digital supply chain within their borders, so as to "decouple" their deeply connected manufacturing systems to enhance industrial self-reliance. This is reflected in China launching the "Made in China 2025" initiative in 2015 and the US unveiling the "CHIPS and Science Act" in 2022, both targeting substantial advancements in domestic semiconductor production and research.

The recent semiconductor shortages have highlighted the European Union's reliance on a restricted pool of suppliers outside its borders, specifically Taiwan and Southeast Asia for chip manufacturing and the US for their design. In line with the aspiration for strategic autonomy and the objective of reducing trade risks, the EU has initiated an ambitious plan through 2023, the European Chips Act, to enhance domestic production throughout the entire semiconductor value chain.

However, challenges remain on how the EU will proceed from the legislation to the implementation of the plan. A critical and undeniable element is that the EU cannot be self-sufficient in semiconductor production. In addition to investments within its borders, the EU should prioritise coordination with like-minded partners to strategically allocate funds to boost domestic capacity as well as leverage complementariness with its global partners.

1. EU weakness in the semiconductor value chain

Nearly 80 per cent of suppliers to European companies in the semiconductor industry are based outside the EU. This limited capacity affects the EU's ability to meet its semiconductor needs independently, especially during global supply chain disruptions caused by geopolitical tensions, natural disasters, or global events such as pandemics. Moreover, EU-based suppliers to the chips industry serve predominantly international clients, with only 37 per cent of their customer base located in the EU.[4]

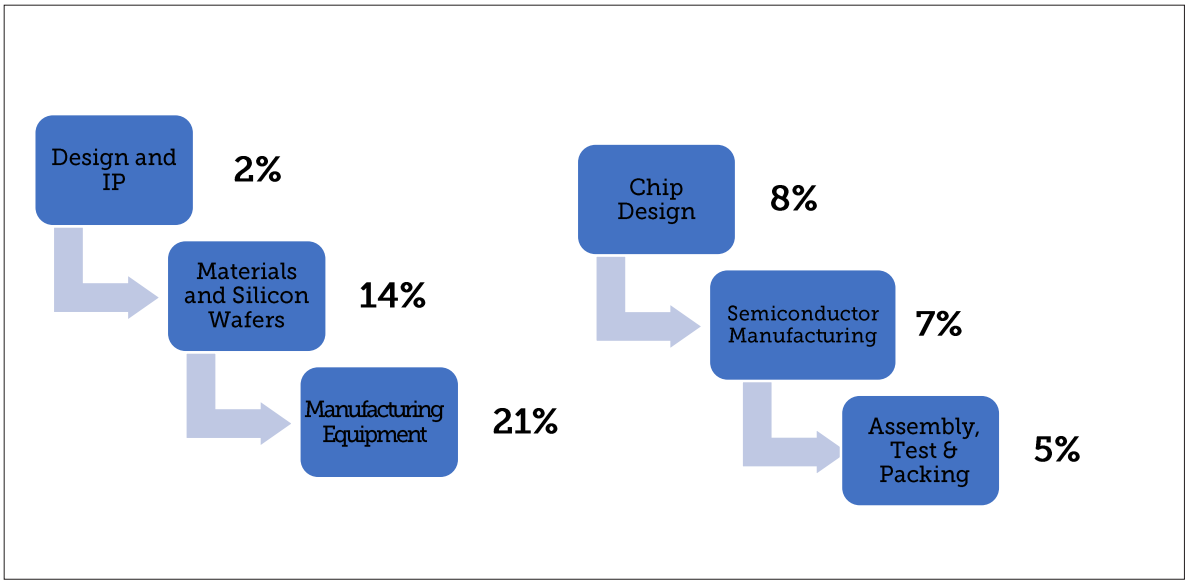
To better assess the EU's standing in the semiconductor market, it is key to segmentise the supply chain of semiconductors into phases: (1) research and design, (2) equipment and machinery, (3) manufacturing in fabs, (4) assembling,

[4] Andrea Ciani and Michela Nardo, "The Position of the EU in the Semiconductor Value Chain: Evidence on Trade, Foreign Acquisitions, and Ownership", in *JRC Working Papers in Economics and Finance*, No. 2022/3, https://joint-research-centre.ec.europa.eu/node/8286_en.

IAI PAPERS 24 | 06 - FEBRUARY 2024 ISSN 2610-9603 | ISBN 978-88-9368-320-3

testing and packing. All chips are produced in fabrication plants, commonly known as 'fabs'. Integrated device manufacturers (IDMs) are companies that own fabs and handle both chip design and manufacturing. Similarly, assembling and testing are performed either by the integrated device manufacturer or by an outsourced semiconductor assembly and test (OSAT) provider.

Figure 1 | EU market share in the chips global supply chain



Source: Jordan Bish et al., "A New Dawn for European Chips", in *Deloitte Insights*, 3 November 2022, https://www2.deloitte.com/xe/en/insights/industry/technology/semiconductor-chip-shortage-supply-chain.html.

Despite the semiconductor value chain being highly concentrated, it is simultaneously fragmented, with only a few countries maintaining leadership in specific segments.

First, the US leads globally in semiconductor design. It owns about 85 per cent of the electronic design automation tools, which are crucial for advanced chip design. However, while dominant in design, the US has lost a significant advantage in production. In the 1990s, the US produced around 37 per cent of semiconductors sold in global markets, but this figure has now dropped to less than 10 per cent. Taiwan is now the global leader in semiconductor manufacturing, particularly for advanced chips, producing 92 per cent worldwide. In the EU, the most significant semiconductor imports fall into two categories: the diodes, transistors and similar semiconductor devices, 60 per cent of which are purchased from China, and the electronic integrated circuits such as processors, memories and amplifiers, of which 20 per cent come from Taiwan, 12 per cent from China and just under 10 per cent from the US.[5]

[5] Ibid.

IAI PAPERS 24 | 06 - FEBRUARY 2024
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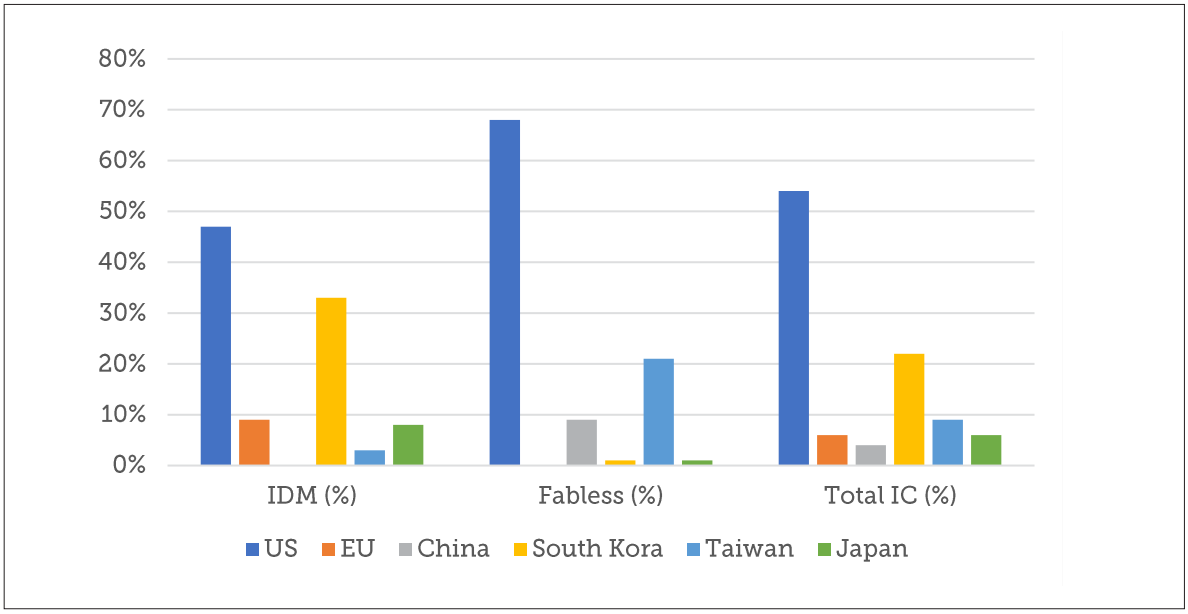
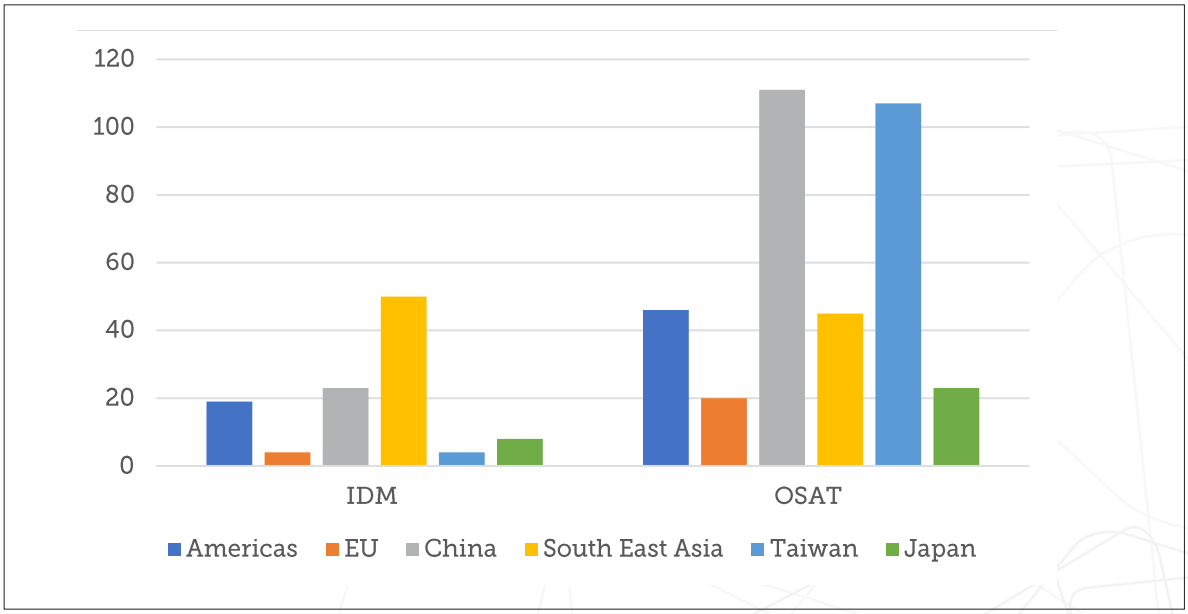
Figure 2 | 2021 Worldwide chips company market share by headquarters location (not including foundries)



Source: Jordan Bish et al., "A New Dawn for European Chips", cit.

Figure 3 | Worldwide test and facilities



Source: Jordan Bish et al., "A New Dawn for European Chips", cit.

The supply chain complexity in semiconductor manufacturing is further exacerbated by the control over raw materials. China dominates in the two rare metals used in semiconductor manufacturing. Beijing controls the refined

IAI PAPERS 24 | 06 - FEBRUARY 2024 ISSN 2610-9603 | ISBN 978-88-9368-320-3

germanium market with a 68 per cent share and the gallium market with 98 per cent. These figures highlight a significant geopolitical challenge, as the concentration of raw material processing in Beijing's hands heightens the risk of disruptions due to geopolitical competition or trade disputes.

The EU has a strong position in the market for machinery required for semiconductor manufacturing. Despite three American companies collectively holding a 40 per cent market share, the EU is a net exporter of semiconductor manufacturing machinery, led by companies such as ASML (Netherlands) and Rhode & Schwarz and Trumpf (Germany). The EU exports machines for the production of chips and integrated circuits primarily to Taiwan, and machines for the production of boules and wafers mainly to China.

Saliently, the semiconductor production landscape is characterised by national specialisations and a significant concentration within the private sector, creating strong dependencies and bottlenecks.

Another trend that could indirectly increase the EU's weakness in the global supply chain of chips is that large foreign technology multinationals are likely to play an increasingly significant role in the semiconductor sector, with strategic implications throughout the value chain. Driven by the increasing need for chips tailored to specific applications, many tech giants have announced the intention to internalise certain chip production stages, although for the time being, they only focus on the research and design phases rather than on manufacturing.[6] Custom-designed chips – meaning the production of chips based on the specific orders of the buyer – allow tech giants to harness the potential of the latest-generation chips by optimising the interaction between hardware and software while simultaneously amortising costs throughout the supply chain. As most tech giants are not EU players, they will prioritise production strategies based on economic efficiency or the national interest of their country of origin when planning their investments in the manufacturing of chips, further marginalising the EU's role in the global semiconductor landscape.

2. The European Chips Act

Concerns about the EU's gradual loss of technological and political influence have prompted the introduction of the European Chips Act, effective from September 2023. The legislative initiative aims to double the European share of global production capacity, in terms of value, from the current 10 per cent to 20 per cent

[6] For example, since November 2020, Apple has begun replacing Intel processors with in-house processors in iMacs and iPads. Similarly, the Chinese company Baidu has recently launched its own chips, known as "Kunlun 2", designed to enhance analytical and computational capabilities. This trend involves a large number of tech giants that have already initiated or are planning similar initiatives, such as Google, Meta or Tesla.

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by 2030. To meet the ambitious goals set by the Act, the EU should mobilise up to 15 billion euros in public and private investments, in addition to another 30 billion allocated by other European programmes, such as Next Generation EU or Horizon Europe. These funds are specifically earmarked to foster research and enhance semiconductor manufacturing capabilities within the EU.

The European Chips Act is grounded on four main pillars designed to foster innovation, ensure supply security and coordinate efforts across the EU. The first pillar involves the establishment of the Chips for Europe Initiative which, with a budget of 3.3 billion euros in EU funds matched by member states, aims at easing knowledge transfer, financing innovative technologies and conducting support activities – such as setting up advanced pilot production lines, developing a cloud-based design platform, developing quantum chips and creating a Chips Fund for financing.

The second pillar introduces two crucial concepts to define the conditions under which public funding can be provided for new facilities in Europe. The first is the concept of "first of its kind" facilities, indicating structures capable of advancing European capacity in production or technology. The second key concept is the "funding gap", which refers to the financial shortfall. To obtain approval for public funding, the government of an EU member country must demonstrate the project's lack of feasibility or profitability without public support. The goal is to balance the need to allocate state aid in a strategic sector without distorting the competitive framework that regulates the EU's single market. To mitigate potential internal distortions, the legal framework requires that new facilities must have effects, known as "spillover effects", on the entire value chain of European semiconductors.

The third pillar of the European Chips Act has instituted a coordination mechanism connecting member states and the European Commission. This mechanism aims to enhance collaboration among member states, monitor semiconductor supplies, estimate demand, anticipate shortages and, when needed, activate a crisis stage. As an initial measure, a semiconductor alert system was established on 18 April 2023, enabling stakeholders to report disruptions in the semiconductor supply chain.

Finally, the European Chips Act targets the issue of skills shortage. With an estimated requirement to educate or retrain over 250,000 individuals across Europe, the shortage is acutely felt in specialised fields like electrical engineering and computer science, where the number of graduates currently falls short of industry needs.[7] This talent gap could present a significant challenge for Europe, not only in terms of meeting immediate workforce demands but also in sustaining the long-term growth and global competitiveness of its semiconductor industry. The urgency of this issue is compounded by the rapid evolution and increasing complexity of semiconductor technologies, requiring a workforce that is not only

[7] European Commission, *A Chips Act for Europe* (SWD/2022/147), 11 May 2022, https://digital-strategy.ec.europa.eu/en/node/10953.

IAI PAPERS 24 | 06 - FEBRUARY 2024 ISSN 2610-9603 | ISBN 978-88-9368-320-3

larger in number but also equipped with advanced and up-to-date skills.

The Act proposes two main policy actions. First, it establishes the European Chips Skills Academy which will design ad-tailored training programmes based on the needs and demand of the local chips industry. Second, it plans the launch of a network of "competence centres" to foster spillover effects across EU member states.

While the European Chips Act sets an ambitious plan, the EU – like any other country or bloc – cannot be self-sufficient in the value chain of semiconductors. The EU would need an estimated upfront investment of more than 300 billion US dollars to replicate the whole supply chain. Additional annual costs as high as the profits of the semiconductor value chain would be necessary to maintain this self-sufficiency. Such additional investments would cause an increase in semiconductor prices estimated to range between 35 and 65 per cent.[8]

The implementation of the European Chips Act still poses questions and key challenges. These challenges pertain not only to the underlying strategy of the EU but also constitute a pivotal factor in determining the metrics for assessing the success (or failure) of such strategy.

A critical choice is to strategically prioritise which generation of chips the EU should focus on. While investing in advanced chips is beneficial for the latest technology applications like data centres or artificial intelligence (AI) applications, crucial EU industrial clusters – such as the automotive or the healthcare industry – require mostly trailing semiconductors. Moreover, establishing factories to produce advanced chips involves greater sunk capital investments and operating costs. The struggle is to balance short- and medium-term needs with long-term ambition based on the EU's future consumption projections.

A second strategic consideration is the segment of the supply chain to which the EU should give precedence. Being aware that it cannot be self-sufficient, the EU could decide to prioritise the segments in which it is the most dependant on third countries[9] – such as design, design tools and IP, semiconductor manufacturing and assembly, test and packaging – or it could target the phases that imply more value added. Provided the complexity of the supply chain, if the EU focuses on building new fabs, it risks maintaining a significant dependency on Asia for the back-end processing. Finally, it could invest in the segments in which it is already at the frontier – such as machinery production – to consolidate its comparative advantage and positioning in global markets.

[8] Isabella Cerutti and Michela Nardo, "Semiconductors in the EU. State of Play Future Trends and Vulnerabilites of the Semiconductor Supply Chain", in *JRC Technical Reports*, No. 133850 (2023), https://doi.org/10.2760/038299.

[9] Jan-Peter Kleinhans, "The Lack of Semiconductor Manufacturing in Europe", in *Stiftung Neue Verantwortung Policy Briefs*, April 2021, https://www.stiftung-nv.de/en/node/3045.

ISSN 2610-9603 | ISBN 978-88-9368-320-3

Similarly, the EU should strategically assess and direct its investments in forming a skilled labour force. As a key fundamental underlying dimension, the talent gap requires a long-term strategy. The EU should consider how to best leverage its comparative advantage in the skilled workforce, given that it produces the largest number of STEM (science, technology, engineering and maths) advanced-level graduates globally.[10] Forming specialised workers is already a challenge, but the EU needs to also prioritise a strategy to address its systemic weakness in retaining and attracting talents. Furthermore, the complexity of the value chain requires specific skills for each production segment which would, again, pose questions on how to strategically allocate efforts and investments.

3. Neither one can make it alone

Transatlantic cooperation in the field of semiconductors has proved challenging. Divergent approaches to digital development between the US and the EU have led to divisions and recent tensions. However, trade tensions between the US and China, as well as the conflict in Ukraine, are pushing Washington and Brussels to strengthen their cooperation in response to growing multipolar competition. In the digital and technology field, a notable initiative was the creation of the EU-US Trade and Technology Council (TTC) in 2021 by the Biden Administration and the European Commission. The TTC was greeted with great enthusiasm as an opportunity to revive transatlantic cooperation on strategically central issues. It is important to clarify that the TTC's goal is not to establish a free trade agreement but rather to encourage ongoing dialogue between the two sides of the Atlantic to address common challenges and propose coordinated actions and responses.

One of the TTC's primary challenges has been to better align restrictions imposed by the US on China's civilian and military technology sectors, particularly targeting semiconductor sales and technology. In this context, semiconductors are a crucial component in a broader game. In 2018, the Trump Administration began imposing restrictions on the sale of semiconductors and machinery containing US design or production to selected Chinese companies, particularly telecommunications giants Huawei and ZTE. These restrictions were also applied to third-party manufacturers, including allies like Taiwan and South Korea, if the production was intended for Huawei.

With Joe Biden, this type of restrictions has taken on a systemic dimension. In October 2022, the US government introduced a new set of stringent export controls on advanced semiconductors with US design or production going to China. This move has aimed to slow the development of the Chinese market for advanced chips through market control, which becomes highly effective only when similar

[10] Johan Aurik et al., "Europe's Urgent Need to Invest in a Leading-Edge Semiconductor Ecosystem", in *Kearney Reports*, February 2022, https://www.kearney.com/industry/technology/article/-/insights/europes-urgent-need-to-invest-in-a-leading-edge-semiconductor-ecosystem.

ISSN 2610-9603 | ISBN 978-88-9368-320-3

measures are being implemented also by other states. As a result, the US has been pressuring its European allies to follow a similar approach.

The imposition of progressively stringent unilateral restrictions is not widely supported in Europe. As China is one of their largest markets, EU firms are concerned that implementing US-style export controls could slow European semiconductor capacity.[11] However, because some European companies are global leaders in the manufacturing of semiconductor machinery, transatlantic coordination is crucial to make restrictions effective. On this matter, EU member states and the EU institutions have acted in a scattered fashion, and the lack of a unified approach has hindered their collective bargaining power.

As early as 2019, the White House had begun pressuring the Dutch government to prohibit ASML from selling its latest machinery models to China. With the much larger restrictions adopted by Biden, ASML is also expected to halt the export of older models to the Chinese market, leading to a sales loss of around 10 to 15 per cent and potential commercial repercussions for the whole EU.[12] The Dutch government took the decision to push ASML to restrict sales to China in coordination with the US and Japan without liaising with its EU counterparts. As pointed out by the Dutch Minister of Trade, Liesje Schreinemacher, export control is a national competence.[13] The Belgium Prime Minister De Croo, commenting on the Dutch decision, stated that the US was bullying the Hague to align with its trade restrictions.[14]

With the US ever keener to leverage export control against China, from 5G technology to chips, the EU needs to scale up its coordination mechanism beyond the current scheme on dual-use items. Otherwise, it risks following US choices even passively and indirectly when its strategic interests are not aligned with those of the US. As a first step to prevent that from happening, in June 2023 the EU Commission launched a "European Economic Security Strategy".[15] While its main objective is to improve the EU's responsiveness to potential dependency risks, a further goal is to increase EU internal coordination to consolidate its international influence.[16] It remains to be seen if member states will be willing to coordinate and implement common actions in areas where competence and security are

[11] Cristina Gallardo, "European Chip Startups Plan Future without China", in *Sifted*, 8 January 2024, https://sifted.eu/articles/european-chip-startups-plan-future-without-china.

[12] ASML, *Statement Regarding Partial Revocation Export License*, 1 January 2024, https://www.asml.com/en/news/press-releases/2023/statement-regarding-partial-revocation-export-license.

[13] Pieter Haeck, "EU Sidelined in US-Dutch Deal to Block Chips Exports to China" in *Politico*, 31 January 2023, https://www.politico.eu/?p=2557152.

[14] Andy Bounds, "Belgium Accuses US of 'Aggressive' Push to Lure European Business", in *Financial Times*, 10 January 2023, https://www.ft.com/content/16816444-1694-4530-84bb-ac289d6776dd.

[15] European Commission, *European Economic Security Strategy* (JOIN/2023/20), 20 June 2023, https://eur-lex.europa.eu/legal-content/en/TXT/?uri=celex:52023JC0020.

[16] Tobias Gehrke, "A Maker, Not a Taker: Why Europe Needs an Economic Security Mechanism," in *ECFR Commentaries*, 9 November 2023, https://ecfr.eu/?p=114469.

IAI PAPERS 24 | 06 - FEBRUARY 2024 ISSN 2610-9603 | ISBN 978-88-9368-320-3

still national. The fate of this heavily politicised strategy might either solidify or crumble with the European election in June.

Another priority on the transatlantic agenda concerns greater coordination on semiconductor industrial policies. At the May 2022 TTC ministerial meeting, the US and the EU agreed on a set of principles to establish a rapid alert system for semiconductor value chain disruptions and information-sharing to coordinate not only export controls but also public subsidy policies. After launching a two-month pilot project, consisting of bi-weekly meetings between US government agencies and the European Commission, during the third TTC ministerial in December 2022, the intention to formally establish a rapid alert mechanism was announced – and this was finalised at the fourth TTC ministerial in May 2023.

The May ministerial also included a reference to the willingness to increase transparency in coordinating public policies supporting the semiconductor industry. However, specific details regarding the methods and functions of this new form of cooperation are still lacking. At the current stage, a shared and complementary strategy to maximise investment plans does not exist. The risk that the US and the EU may engage in a subsidy race rather than developing virtuous synergies is evidenced by the Inflation Reduction Act (IRA), adopted by the US Congress in August 2022.[17] Despite its name, the IRA is most of all a massive investment plan in green technologies, and its provisions discriminate against European competitors.

The ambitions for semiconductor cooperation clash with a backdrop of tense transatlantic trade relations that have led to an intensification of reciprocal trade barriers. If the US and the EU do not seriously begin to discuss a new trade policy agenda, every effort regarding chips is likely to produce unsatisfactory results. The key issue is the lack of political will to develop a shared and strategically complementary industrial vision.[18]

Again, the fate of US-EU cooperation on chips is just a small piece of a larger puzzle which depends on the results of the election on both sides of the Atlantic.

4. From concept to application for a balanced EU-US cooperation

It should not come as a surprise that supplier-customer linkages for companies show that European companies have the highest number of linkages with US firms in the domain of chips, stressing again the centrality of transatlantic cooperation. In 2020, in the EU there were 4,406 firms operating in the chips sector, of which

[17] Andy Bounds, "Belgium Accuses US of 'Aggressive' Push to Lure European Business", cit.

[18] Sujai Shivakumar, Charles Wessner and Thomas Howell, "Opportunities and Pitfalls for U.S.-EU Collaboration on Semiconductor Value Chain Resilience", in *CSIS Commentaries*, 7 July 2022, https://www.csis.org/node/66070.

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41 per cent were foreign owned and 59 per cent held by EU investors. Between 2015 and 2021, non-EU investors allocated more than 33 billion euros in EU firms manufacturing electronic components. US investors play a predominant role in investments in this sector, accounting for over 54 per cent of minority deals and nearly 27 per cent of mergers and acquisitions (M&A). Investors with ultimate ownership in China (21 per cent), Japan (12 per cent) and Switzerland (9 per cent) trail US investors in the ranking of M&A deals. Similarly, firms specialised in the supply machines and other inputs to chip manufacturers reveal a significant interest from foreign investors with the total cumulative investment in these firms surpassing 60 billion euros.[19]

To foster a more balanced and efficient partnership with the US, the EU should leverage its comparative advantages to scale up and consolidate its strategic positioning in the global supply chain through three policy objectives.

First, transatlantic cooperation should go beyond the implementation of export control. It should aim at fostering complementarities while pursuing reciprocal trade concessions to incentivise economic efficiencies and enable firms, from both sides, to exploit a larger scale.[20] In this context, establishing a joint public-private partnership backed research and innovation framework in semiconductor technologies could be an additional critical policy objective for EU-US cooperation. This initiative would focus on collaborative R&D efforts aimed at developing next-generation semiconductor technologies, including advanced materials, chip design and manufacturing processes.

Such a framework also includes exchange programmes for researchers, shared intellectual property agreements and joint funding for university and private sector research projects. For example, to leap forward in operational cooperation on semiconductors, a transatlantic consortium could be established to develop a full chip production chain in Europe.[21] Alternatively, synergies could be developed between the US National Science Foundation and the Horizon Europe programme, two major initiatives supporting research, to fund and develop joint research projects.[22]

Second, enhancing transatlantic cooperation also means securing and managing the raw materials crucial to the semiconductor value chain. The EU and the US should jointly focus on ensuring a stable and sustainable supply of essential raw

[19] Andrea Ciani and Michela Nardo, "The Position of the EU in the Semiconductor Value Chain", cit.

[20] Sarah Kreps and Paul Timmers, "Bringing Economics Back into EU and U.S. Chips Policy", in *Brookings Commentaries*, 20 December 2022, https://www.brookings.edu/?p=1656532.

[21] Tyson Barker, "The Hidden G2 for Democratic Tech Governance is the EU-US Relationship. A Starter Kit", in *DGAP Analyses*, No. 2 (June 2021), https://dgap.org/en/node/35372.

[22] Daniel S. Hamilton and Joseph P. Quinlan, *The Transatlantic Economy 2022. Annual Survey of Jobs, Trade and Investment between the United States and Europe*, Washington, Foreign Policy Institute, Johns Hopkins University SAIS/Transatlantic Leadership Network, 2022, https://transatlanticrelations.org/?p=4224.

IAI PAPERS 24 | 06 - FEBRUARY 2024 ISSN 2610-9603 | ISBN 978-88-9368-320-3

materials like silicon, rare earth elements and other critical minerals that are pivotal for chip manufacturing. This cooperative effort could involve joint investments in mining and processing facilities, both within and outside their borders, and the development of recycling technologies to reduce reliance on virgin raw materials.[23] Additionally, establishing shared standards and practices for ethical sourcing and environmental protection in raw material extraction can further strengthen this aspect of the supply chain.

Finally, the EU must invest more political capital in trying to diversify its value chain to ultimately de-risk its existing dependency on third countries. The complexity and fragmentation of the semiconductor value chain require a system of alliances with coordinated industrial policies to mitigate the risks caused by external shocks. The Digital Partnerships with Japan, South Korea and Singapore and the recent MoU signed with India are the right steps in this direction. The latter, for instance, aims to foster opportunities for collaborative R&D projects and innovation and ensure a level playing field in the sector.

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[23] Virgin raw material is anything extracted directly from nature without processing.

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