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Fishing for Chips

Assessing the EU Chips Act

Niclas Frederic POITIERS

Pauline WEIL

Key Takeaways

- Drawing lessons from the ongoing shortages in chip supply, the United States, China and the European Union are adopting industrial policies in the semiconductor sector in search for supply chain security and economic and technological competitiveness.
- The EU Chips Act in particular represents a notable shift from a long-held opposition to industrial subsidies seen as detrimental to international competition.
- The proposal will support R&D in Europe, provide a legal basis for EU member states to use subsidize domestic semiconductor manufacturing, and facilitate trade measures to intervene in the supply chain in times of crisis.
- This new global subsidy race to build foundries carries the risks of channeling billions in public funds into unprofitable investments, due to the complexity of semiconductor production and risks of overcapacity in certain segments.
- To avoid that, cooperation with like-minded partners of the EU, especially the US, appears necessary but still needs to be worked out.

Introduction

Bottlenecks in the semiconductor value chain, exposed by pandemic-induced shortages and sanctions, have created concerns over the sustainability of the chip supply. In this context, governments are increasingly eager to ensure the security of their chip supply and gain geopolitical leverage in the sector. China has offered massive subsidies to reduce its reliance on imported chips, whereas the US used its control of key technologies to keep China from achieving this goal. Last year, the US government also proposed massive support to increase US stronghold in the industry.

The European Chips Act proposed by the European Commission in February 2022 is the European Union's (EU) response to the challenges in the industry. It calls for massive investments by European governments and private companies and marks an embrace of hands-on industrial policies in the EU. In this policy brief, we explain the background to this policy and discuss its merits to achieve EU policy goals.

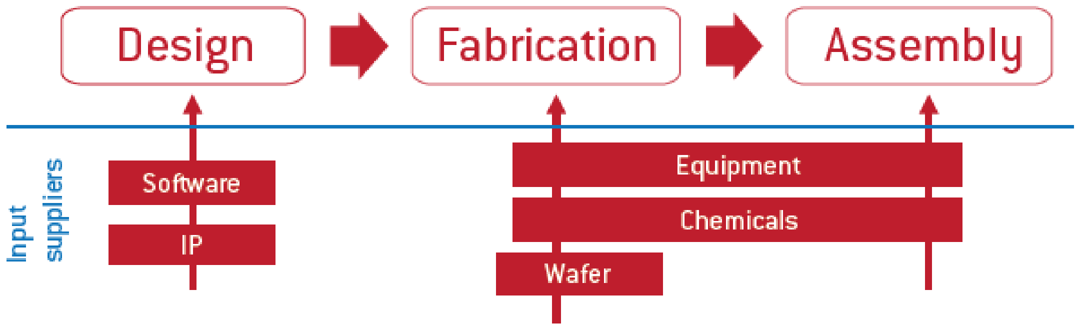
Chips Supply Chain: Bottlenecks and Asian Gravity Center

Chips, or semiconductors, are made of a semiconductor material (most often silicon) onto which a circuit is designed and electronic components embedded. These define the nature, mainly either logic or memory, and features of the chip. The production of chips can be broken down into three steps: design (specifying the layout and features), fabrication (i.e., manufacturing in foundries), and assembly (i.e., testing and packaging of chips before they can be put into hardware) (Figure 1). Two main business models co-exist in the industry. Integrated design manufacturers (IDM), such as Intel, both design and fabricate chips. In the 'pure foundry' model, ("fabless") design firms and foundries collaborate. The leading 'pure foundry' is the Taiwanese firm TSMC. The South Korean firm Samsung operates in both business models. The assembly of chips usually takes place in standalone firms.

The industry is characterized by fast-paced innovation, relying on expensive research and development (R&D), and very high capital and operational expenditures. As a result, the production of chips has concentrated around a small number of firms. Fabrication, as the most capital intensive, is the most concentrated segment. Five foundries represent over 80% of the global 'pure foundry' market and only two firms can fabricate the latest generations of chips used for high-end computers and smartphones: TSMC and Samsung.

America's Intel holds a third place but has been lagging a generation behind.[1,2]

Figure 1: Semiconductor production steps



Source: authors.

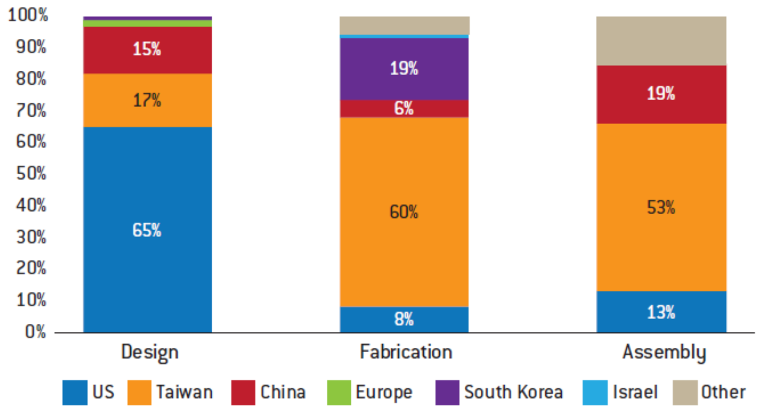
Design is comparatively cheaper for new entrants, so new players managed to grow market shares more easily than for fabrication. The US is currently the leader in the segment, with firms like Qualcomm, Broadcom, Nvidia and AMD. The US firms Cadence Design Systems, Mentor and Synopsys control the market for the software used for chip design. This dominance enables the US to enact wide ranging trade sanctions.[3]

Assembly is comparatively the most labor-intensive step. Taiwanese companies such as ASE Group dominate the market with an overall market share of 53%, while Chinese companies gained significantly over the last decade[4] and now account for almost a fifth of the market (see Figure 2).

Recently, collaboration between fabless designers and pure foundries is how the most innovative and cutting-edge chips have been produced. Major technology companies including Apple, Tesla or Alibaba are increasingly investing in capacities to design their own semiconductors and are turning to the state-of-the-art foundries of TSMC or Samsung for fabrication. As such, TSMC and Samsung represent the biggest bottlenecks of the industry. Big tech players tend to turn to standalone foundries rather than IDM, as the latter is integrated with potential competitors.

1. P. McGee, "Intel to Step Up Chip Manufacturing with $20bn Plants", *Financial Times,* March 24, 2022, available at: www.ft.com. The *Final Report by the US National Security Commission on Artificial Intelligence* from March 2021 does not expect Intel to be able to compete with TMSC or Samsung on cutting-edge chips in the medium term, available at: www.nscai.gov.
2. N. Poitiers and P. Weil, "A New Direction for Europe's Half-Hearted Semiconductor Strategy", *Policy Contribution*, No. 17, Bruegel, July 2021, available at: www.bruegel.org.
3. See K. Hille and K. Stacey, "TSMC Falls into Line with US Export Controls on Huawei", *Financial Times*, June 9, 2020, available at: www.ft.com.
4. J.-P. Kleinhans and N. Baisakova, *The Global Semiconductor Value Chain: A Technology Primer for Policy Makers*, Stiftung Neue Verantwortung, 2020, available at: www.stiftung-nv.de.

Figure 2: Firms' market share of semiconductor production steps by headquarter location, pure foundry business model, 2019



Source: Bruegel based on IC Insights, Seeking Alpha and Stiftung Neue Verantwortung.

The sector is geographically centered on Asia: in 2019, the region accounted for 80% of production capacity.[5] This concentration can be explained by the 'gravitational' pull of producers towards consumers of chips, as the biggest user of chips is the information and communication technology (ICT) industry. The high levels of coordination and integration needed in the ecosystem have favored chips manufacturers based in Asia, close to its main users. China alone manufactures around 90 percent of smartphones, 67 percent of smart televisions and 65 percent of personal computers. It is the biggest importer of chips:[6] they replaced oil as China's largest import – representing $380 billion in 2021.[7]

Europe on the other hand is only a minor consumer and producer, accounting for only 9% of global trade in semiconductors.[8] European foundries such as ST Microelectronics and Infineon have focused on trailing-edge chips, used for example in industrial and automotive applications. However, the EU plays an important role in upstream parts of the value chain: the world's leading chip R&D centre, IMEC, is Belgium, while the Dutch firm ASML has a monopoly on high-end chip manufacturing machines. Riber (France) is also an important machinery producer. Germany's Aixtron provides important chemicals to fabrication. Many critical components to the machinery are also coming from the EU, including from the German companies Zeiss and Trumpf.

5. J. Sargent and K. Sutter, "Semiconductors, CHIPS for America, and Appropriations in the U.S. Innovation and Competition Act (S. 1260)", *In Focus,* Congressional Research Service, January 2022, available at: https://crsreports.congress.gov.

6. C. Bown, "How the United States Marched the Semiconductor Industry into Its Trade War with China", *Working Paper* 20-16, Peterson Institute for International Economics, 2020.

7. "China Stockpiles Chips, Chip-Making Machines to Resist U.S.", *Bloomberg News*, February 2, 2021, available at: www.bloomberg.com.

8. N. Poitiers and P. Weil, "A New Direction for Europe's Half-Hearted Semiconductor Strategy", *op. cit.*

The Economic and Strategic Importance of Chips

Since the 1990s, the industry is characterized by boom-and-bust cycles of demand and prices because the cyclicality of demand clashes with the rigidity of production. Given their complexity and specificity, computer chips are generally produced in cooperation between the producer and consumer. It is not possible to quickly adapt production lines to a different type or quantity of chips (production can take up to several months).[9] Increasing fabrication capacity is also a cumbersome process: new foundries take years to build and the construction of a high-end one can cost more than $10 billion.[10] In some cases, firms invested billions of dollars in new facilities but ultimately failed to master the technologies.[11]

The current chip shortage induced by the pandemic was felt for all types of chips, but it is especially the shortage of trailing-edge chips which brought the automotive industry to a halt that was most felt in Europe.[12] Some in the industry expect this shortage to expand into 2024.[13]

The chips industry is characterized by boom-and-bust cycles, while production lines a hard to adapt

On the other hand, there have been times of overcapacity as some end markets get saturated. As companies and governments around the world are investing hundreds of billions of dollars in reaction to the current shortage, there is a real overcapacity risk for some types of chips and hoped returns on these investments might not materialize.[14]

Recently, shortages have put chips in the spotlight but prior to that they were already a geopolitical concern. Retaining supremacy in the semiconductor industry has been an outspoken US policy goal since the 1980s.[15] Their role in military applications, their ubiquity as well as the existing concentration and bottlenecks in the industry have made chips sanctions a powerful tool to apply economic and political pressure. Sanctions were first imposed by the US on Chinese tech companies, especially Huawei, depriving them of their supply of high-end chips. Other bottlenecks have been used to impede a Chinese

9. A. Duthoit, "A 2020 Semiconductor Slump Will Send Shockwaves Across the Global Electronics Industry", *The View*, October 30, 2019, Euler Hermes Allianz Economic Research.

10. For example, "Samsung's Expect Its New Foundry In Texas To Costs USD 17bn", available at: www.samsung.com.

11. For example, A. Shilov and I. Cutress, "GlobalFoundries Stops All 7nm Development: Opt to Focus on Specialized Processes", Anantech, available at: www.anandtech.com.

12. J.-P. Kleinhans and J. Hess, "Understanding the Global Chip Shortages", *Policy Brief,* Stiftung Neue Verantwortung, November 2021, available at: www.stiftung-nv.de.

13. See K. Stankiewicz, "Intel CEO Now Expects Chip Shortage to Last into 2024", *CNBC*, April 29, 2022, available at: www.cnbc.com.

14. See A. García-Herrero "Global Chip Shortage May Soon Turn into an Oversupply Crisis", *Nikkei Asia*, February 24, 2022, available at: asia.nikkei.com.

15. See C. Miller, "A Semiconducted Trade War", *Foreign Policy*, July 1, 2019, available at: https://foreignpolicy.com.

catch-up: After strong pressure by the US, the Dutch government has imposed an export ban on the sale of the last generation of ASML machines to Chinese companies. More recently, the US, the EU, the United Kingdom, Japan, Taiwan, and Canada have imposed a chip embargo on Russia, cutting Russian industries from the supply of an important input.[16] These sanctions have reportedly already disrupted some of Russia's production of precision guided missiles and tanks.[17]

These sanctions get their teeth from the monopolistic position of Western technologies in the supply chain, as all high-end chips are produced using US intellectual property – namely the software for design or the design of US based-firms. Reportedly, despite an ambiguous stance of the Chinese government towards Russia's invasion of Ukraine and a declaredly hostile stance towards Western sanctions, Chinese companies have remained reluctant to circumvent US sanctions on Russia.[18]

Without access to the technology, a catch-up by China to the chip frontier will be all but impossible in the foreseeable future.[19]

Designing an EU Chip Strategy

The shortage was acutely felt by the automotive sector, which accounts for 6% of jobs and 7% of GDP20 in the EU. This has served to justify a shift away from a traditional stance of restricted state aid to expanding subsidies beyond the established scope of the EU's industrial subsidy framework (the Important Projects of Common European Interest, IPCEI).[21] The EU Chips Act, proposed by the Commission in February 2022, aims to increase EU chip production to 20% of the global market, with an emphasis on the latest generation. The proposal currently consists of three pillars:

- supporting R&D in Europe and bringing innovation 'from the lab to the fab';
- providing the legal basis for EU member states to use subsidies to lure cutting-edge manufacturers;
- a framework with trade measures to intervene in the supply chain in times of emergency.

16. M. Grzegorczyk, J. S. Marcus, N. Poitiers and P. Weil, "The Decoupling of Russia: High-Tech Goods and Components", *Bruegel Blog*, March 2022, available at: www.bruegel.org.
17. See J. Ponciano, "Russia May Be Showing It's Running Low on Precision-Guided Munitions", *Forbes*, March 1, 2022, available at: www.forbes.com; K. Freifeld, "U.S. Official Says Export Curbs on Russia Hit Car Production and Tank Building", Reuters, March 30, 2022, available at: www.reuters.com.
18. See I. Deng *et al.*, "Ukraine Invasion: Chinese Tech Firms Face Dilemma over Western Sanctions on Russia", *South China Morning Post*, March 1, 2022, available at: www.scmp.com.
19. For a discussion see C. Thomas, "Lagging But Motivated: The State of China's Semiconductor Industry", *Tech Stream*, Brookings, January 2021, available at: www.brookings.edu.
20. D. Brown, M. Flickenschild, C. Mazzi, *et al.*, 'The Future of the EU Automotive Sector", Study Requested by the ITRE committee, European Parliament, PE 695.457, October 2021, available at: www.europarl.europa.eu.
21. N. Poitiers and P. Weil, "Opaque and Ill-Defined: The Problems with Europe's IPCEI Subsidy Framework", *Bruegel Blog*, January 26, 2022, available at: www.bruegel.org.

The first pillar of the Chips Act aims to expand the EU high tech ecosystem and intends to bring the EU's strength in fundamental research to foster industrial innovation. To support R&D, it plans to provide infrastructures and intellectual property (IP) that would be available to European SMEs and start-ups. It also includes funding, framed under the umbrella of the 'Chips for Europe' initiative, which combines several existing chips research projects under Horizon Europe, Digital Europe, and the Key Digital Technologies Joint Undertaking. It boasts a headline number of €11bn, from which less than €4bn comes from the EU itself, most of which was already earmarked for chips research under these existing initiatives. Some additional European Investment Bank (EIB) funding has been earmarked as financial assistance to be offered to start-ups. Finally, EU countries are encouraged to coordinate and subsidize research and innovation projects by private companies through a new IPCEI. Funds from governments and firms, channeled through IPCEIs are probably how the Commission anticipates the rest of the €11bn will be funded.

Now, most of the EU ambitions focus on foundries. To increase EU-based manufacturing, the Commission sets up a new exemption to allow EU countries to provide (otherwise prohibited) subsidies to companies to build high-end foundries without strict curtailments of subsidized amounts.[22] These investments would induce the biggest spending, as a new high-tech foundry can cost above $10 billion. This marks the biggest shift in terms of EU industrial policy as the Commission is encouraging EU countries to use state-aid for investments, via a rule specifically created for just one use-case. Under the rules set out for IPCEI projects, only research, development and innovation projects using novel technologies can be financed under the condition that they would not be financeable by the private sector alone. The foundry investments would not qualify for this as they use cutting-edge yet proven technology, so the second pillar of the Chips Act creates a foundry-specific European 'first-of-a-kind' rule for which it is sufficient that the technology is not present within the EU itself. The first project benefiting from this rule was already announced: a new Intel foundry in Magdeburg (Germany). The planned investment is €17bn, 40% of which will be funded by the German government.[23]

> The Commission is encouraging EU countries to use state-aid for investments

To secure a sustainable chips supply to EU industries, the third pillar of the Chips Act is meant to provide emergency measures for crisis situations. It includes:

- a monitoring mechanism to identify a supply crisis;
- a requirement for foundries that have benefited from subsidies to supply EU industries first;

22. The European Chips Act communication and respective regulations are available at: https://ec.europa.eu.
23. See "6,8 Milliarden Euro für Intel-Ansiedlung", *Zeit Online,* June 3, 2022, available at: www.zeit.de.

- export controls;
- and joint procurement of chips by the Commission on behalf of other actors.

A 'European Semiconductor Expert Group' with EU countries representatives would monitor the supply chain to identify potential shortages. If a crisis is foreseen, the third pillar would provide the Commission with the power to purchase chips on behalf of the EU and require foundries that benefited from EU subsidies to prioritize EU customers. It includes a proposal that would allow the Commission to curb exports from the EU if deemed appropriate, echoing measures used for vaccines during the Covid crisis.

Since the Commission has limited fiscal policy leverage, it mostly takes on a steering role for this industrial policy. Within the limits of the Commission's competences and budget, the Chips Act encourages EU countries to use subsidies and allows the application of new trade restrictions. As such, it marks a significant evolution of the EU's position on industrial and trade policy.[24]

Running an International Subsidy Race

Since 2014, China has a strategy to reach goals of increasing chip manufacturing capacity and catching up with the latest technology, with an investment program estimated to reach $150 billion in state aid over ten years.[25] Since 2020, both the US and the EU have introduced their own programs to support their domestic chip manufacturing capacity. The US CHIPS Act, introduced in 2020 (but not passed yet), foresees $52 billion in public investments over 5 years, an amount that the European Chips Act (not passed yet either) tries to match with its $48 billion headline figure (both in EU investments and leveraged equity support).[26]

> Support for the chips industry globally could amount to 0.9% of global GDP

Adding up estimates of announced support by the US, China, Japan, South Korea and the EU, amounts to $721 billion, or 0.9% of 2020 global GDP.[27] The result is a subsidy race over the location of foundries of just a few companies. As a result, taxpayers are bearing high shares of the costs for constructing privately owned manufacturing plants. These subsidies come on top of massive investments by the industry itself: TSMC and Samsung are in a bidding war for

24. For a discussion see N. Poitiers and P. Weil, "Is The EU Chips Act the Right Approach?", *Bruegel Blog*, June 2, 2022, available at: www.bruegel.org.
25. "Measuring Distortions In International Markets: The Semiconductor Value Chain", *OECD Trade Policy Papers,* No. 234, Paris: OECD Publishing, 2019
26. The investment target for the EU Chips Act is €43bn, which at the exchange rate at the time corresponded to USD 48bn. How the European Commission came to this headline number remains unclear.
27. European Commission, "European Chips Act", 2022, available at: https://ec.europa.eu.

high-end fabrication market shares, with TSMC alone investing over $30 billion a year.[28]

Given its dependency on imports and their strategic importance, it is hardly surprising that China has tried for a long time to reduce its reliance on foreign chip technology. What is more surprising is the embracing of such industrial policies by the US and the EU, because they are not targets of export restrictions in the sector. Especially for the EU, the Chips Act represent a notable shift from a long-held opposition to industrial subsidies seen as detrimental to international competition. Chips are thus becoming a symptom and cause of major shifts in industrial and trade policymaking.

Since the beginnings of the industry, in the 1950s, government interventions (R&D funding, university research programs, tax incentives, public procurement, protectionist policies…) played an important role to support the development of high technology ecosystems and the advent of chip champions in the United States, Japan, South Korea, Taiwan and China.[29] Government support has historically been a prerequisite but, given high competitiveness, not a guarantee for moving up the value chain in the semiconductor industry as the Chinese example illustrates.

The new investment programs introduced by the US CHIPS Act and the EU Chips Act are focused mainly on increasing chip manufacturing capacity, with emphasis on cutting-edge foundries so far only located in South Korea and Taiwan. Building homegrown foundries is intended to mitigate economic and political risks by easing the bottlenecks around Taiwan, especially, but also South Korea. For the US and China, this focus on the most complex technical step of production reflects the competition to respectively retain and gain technology supremacy. Europe's goals are not as clear, stating both economic and strategic rationales. Given the currently low demand for chips in the EU, and especially of the cutting-edge production pursued by the EU Chips Act, intent to gain leverage in a strategic and growing industry is the more convincing driver. The Chips Act thus exemplifies the European Commission's ambitions to become a geopolitical actor defending EU strategic autonomy or "digital sovereignty".[30]

Outlook for the Chips Industry

The global subsidy race to build foundries carries the risks of channeling billions in public funds into unprofitable investments. Building state-of-the-art foundries requires mastering very complex technologies. Focusing the lion's share of public funding on this, governments may be overlooking support needed to increase know-how and foster the broader high-tech ecosystem. And there have been several cases of failed investments to

28. See "TSMC To Invest $100 Billion Over 3 Years To Meet Chip Demand", *Reuters*, April 1, 2021, available at: www.reuters.com.

29. N. Poitiers et P. Weil, "A New Direction for Europe's Half-Hearted Semiconductor Strategy", *op. cit.*

30. From the regulation proposal to the Parliament and the Council from the Commission to establish the Chips Act, European Commission, "European Chips Act", 2022, available at: https://ec.europa.eu.

build such high-end foundries. An example is Tsinghua Unigroup (China), which benefited from government support for investments that the OECD estimated at $100 billion.[31] However, Tsinghua Unigroup defaulted on several bond repayments, amounting to $3.6 billion by January 2021 and continues to struggle to generate positive cash flows and remains highly indebted.[32]

Further, overcapacity has been a problem in the past, and the large subsidies offered create very high incentives for firms to build new foundries. This risk is probably much higher in some segments of the chip industry. For instance, the prices for memory chips have fallen amid the shortage.[33] Overall, supply and demand mismatches are to be expected in a sector where supply cannot be adapted quickly, but demand for high tech goods is cyclical.

What is more, countries have so far focused on subsidies and protectionist tools, rather than coordination. For the EU, the creation of protectionist tools such as export controls creates a beggar-thy-neighbor precedent in a sector where it is reliant on global value chains. Export restrictions were not responsible for the shortages and if such policies were used, they would likely have aggravated the crisis. While there is a political usage of sanctions and export restraints, this has not targeted the EU but China and Russia instead, and the key parts of the technology are controlled by 'like-minded' partners of the EU. It is also questionable if such export controls or joint procurements would be able to help in times of crisis, as production lines cannot easily be switched or capacity increased. The EU Chips Act targets the increase of production capacity for high-end chips, that, as opposed to low-end ones such as sensors, are not a commodity that the government could just negotiate on behalf of EU industries or reallocated between companies.

The strategy could be better adapted to the EU's strengths and needs

Some coordination on chip supply chain is planned by the US and the EU, through the Trade and Technology Council (TTC), and the US has approached Taiwan, South Korea and Japan to form a semiconductor alliance.[34, 35] Overall, the shape of such cooperation remains to be worked out. The intent of such cooperation also appears tilted in favor of containing China's technological capacities rather than international supply chain management. These countries share the aim of diversifying the value chain and

31. "Measuring Distortions in International Markets: The Semiconductor Value Chain", *op. cit.*
32. See J. Horwitz, "Analysis: China's Would-Be Chip Darling Tsinghua Unigroup Bedevilled by Debt and Bad Bet", Reuters, January 20, 2021, available at: www.reuters.com.
33. See S. Kim, "Hynix Profit More than Doubles After Strong Server Memory Demand", *Bloomberg*, April 26, 2022, available at: www.bloomberg.com.
34. European Commission, "EU-US Trade and Technology Council: Strengthening Our Renewed Partnership in Turbulent Times", May 16, 2022, available at: https://ec.europa.eu.
35. See ANI, "US Plans Semiconductor Alliance with Taiwan, South Korea, and Japan", *Business Standard*, March 29, 2022, available at: www.business-standard.com.

increasing its resilience, however currently all of them try to compete for the same subsegment of the market. If the EU and its partners were to coordinate on their industrial subsidies instead of competing, they would be able to achieve much more with the same investments.

Beyond coordinating with partners, the EU's interests would be better served with a chips strategy better adapted to the EU's strengths and needs. Given low domestic demand especially in the cutting-edge segment, a focus on upstream parts of the value chain such as chip design and R&D would be more fitting. While there is a need to mitigate political risks in high-end supply chains, in an industry where technical complexity means that no country can be self-sufficient and the EU relies on functioning supply chains, chip-specific export controls are more likely to do harm than good. Therefore, integrating export controls within a broader trade strategy would make the EU a more reliable and consistent partner. This could be achieved through the ambitious anti-coercion instrument that remains under negotiation. Lastly, the EU should also signal engagement and cooperation as well as protectionist tools if it wants to retain a position of free trade defender.

***Niclas Frederic Poitiers**, Research Fellow at Bruegel and **Pauline Weil**, Research Analyst at Bruegel.*

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27 rue de la Procession
75740 Paris cedex 15 – France

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