Japan

Alexandre F. Gomes (Institute for International Relations 'Clingendael') and Maaike Okano-Heijmans (Institute for International Relations 'Clingendael')

This country chapter is part of the report "Dutch semiconductor interests in Asia. The politicisation of the Asian semiconductor industry", which you can read here.

Since its creation in the 1960s to today, the Japanese semiconductor industry has gone from a gradually rising industry to global leadership, into decline and – most recently – towards renewed growth. The Japanese government has played a significant role in each of these phases, both through domestic industrial policies for growth and through concessions to the United States that led to the sector's decline. Today, Japanese government involvement is largely driven by economic security concerns and, more specifically, by a desire to ensure the secure and stable supply of semiconductors and the materials needed for their production. The Japanese government has labelled semiconductors as a critical component for the development of new leading-edge technologies.

This chapter presents the state of play and latest trends of the Japanese semiconductor industry, as well as key government policies. It reflects on implications for the Dutch semiconductor sector and government, and highlights opportunities and challenges for collaboration. The analysis suggests that the Netherlands and Europe can learn from Japan's clarity about strategic objectives, which serves as a powerful driver for Japanese stakeholders in the semiconductor sector and beyond to act proactively and jointly.

A brief history

In the late 1980s, Japan was the world leader in the semiconductor industry, transcending American firms in both the quality of chips and size of its industry. This was the result of almost three decades of gradual rise of the sector, facilitated by the Japanese government's effort and money, as well as considerable investments by major industry players at the beginning of the 1970s. In 1980, the general manager of one of the United States' biggest information technology companies Hewlett-Packard, Richard W. Anderson, shook the American industry by saying that the best American chips had a failure rate more than ten times higher than that of Japanese firms. By 1986, Japan surpassed the United States

as the biggest semiconductor supplier in the world, to reach its peak in 1988, with over 50 per cent of the global market share.[1]

The US and Japan Semiconductor Agreement of 1986 heralded the fall of the Japanese semiconductor sector. The agreement followed years of US–Japan trade friction, which had erupted as US policymakers and industry players came to see Japan as an unfair competitor, claiming that Tokyo subsidised exports of chips and consumer electronics and based its growth on unfair trade practices. US policymakers thus acted upon the threat of having its own semiconductor industry disappear. Afraid of losing access to the important US market, Japanese government officials succumbed to the agreement, which would ultimately be responsible for the decline of its semiconductor industry. Furthermore, the Japanese industry failed to move from vertical integration to horizontal firms, specialised in particular aspects of the supply chain. In the years that followed, Japan's market share gradually declined to a global market share of below 10 per cent today,[2] with a market worth of approximately 595 billion USD in 2021.[3]

Semiconductors are of vital importance for Japan's manufacturing, automotive and electronics industries, and for achieving the government's vision of a green and digital Society 5.0 more broadly.[4] This also explains why the Japanese government labelled semiconductors as a 'critical component for the development of new leading-edge technologies'.[5]

Facing this reality, and with the growing geopolitical and supply chain challenges that have emerged over recent years, the Japanese government has tried to reinvest and relaunch the industry since the 2000s, without success. Recently, it placed semiconductors back at the core of its industrial policy, with a dedicated national strategy to revamp the industry being presented in June 2021. The Japanese government now considers the semiconductor industry to be within the realm of economic and national security.

[1] William Sposato, 'Japan Bets Big on Bringing Semiconductor Manufacturing Home', *Foreign Policy*, 9 January 2023, last accessed 30/01/2023, https://foreignpolicy.com/2023/01/09/japan-semiconductor-chip-manufacturing-china/.
[2] US International Trade Administration, 'Japan - Country Commercial Guide', last accessed 30 January 2023, https://www.trade.gov/country-commercial-guides/japan-semiconductors.
[3] Gartner Press Release, 'Gartner Says Worldwide Semiconductor Revenue Grew 26% in 2021', *Gartner*, last accessed 30 January 2023, https://www.gartner.com/en/newsroom/press-releases/2022-04-14-gartner-says-worldwide-semiconductor-revenue-grew-26-percent-in-2021.
[4] Society 5.0 is an aspirational model for a human-centred Japanese society, which 'balances economic advancement with the resolution of social problems by a system that highly integrates cyberspace and physical space'. See: https://www8.cao.go.jp/cstp/english/society5_0/index.html.
[5] Tim Kelly and Elaine Lies, 'Japan to invest $500 million to manufacture advanced chips', *Euronews*, last accessed 30 January 2023, https://www.euronews.com/next/2022/11/11/japan-semiconductors.

1. The role of government

Economic security as a driver of government involvement

Japan's industrial policies in the initial growth period of the semiconductor industry revolved mainly around funding for R&D. This fostered public–private technology research cooperation and information-sharing between rival companies that nurtured innovation. A key initiative was the establishment of the Very Large-Scale Integrated (VLSI) project, a research consortium that ran from 1976 until 1980.[6] Fujitsu, Hitachi, Mitsubishi Electric, NEC and Toshiba were the associated companies that had a playground to cooperate in R&D projects, with about half of the funds coming from the Japanese government. Perhaps the most notable result was the creation of the electron beam lithography (EBL) technique, which fundamentally changed the ability to manufacture chips at scale.

As Japanese enterprises failed to move from vertical integration to horizontal business models in the 1990s and early 2000s, the Japanese government sought to push the industry in that direction in several ways. Among its initiatives was the replication of the VLSI model to convince companies to work together on specialised products, such as the creation of smaller and more advanced semiconductors. These initiatives ultimately failed, in part because of the lack of private capital to invest in R&D.

Government involvement was revamped only in the early 2020s. Japan's Ministry of Economy, Trade and Industry (METI) released a new National Strategy for Semiconductors and the Digital Industry[7] in 2021. This strategy considers the semiconductor industry to be a matter of economic and national security, alongside energy and food. The new government of Prime Minister Fumio Kishida that took office in October 2021 put economic security at the centre of its agenda. As evidenced also by the 2022 Economic Security Promotion Bill, Japan is committed to supporting and investing in the semiconductor sector in order to revive and strengthen it.[8]

Towards strategic autonomy and strategic indispensability

Japan's semiconductor strategy acknowledges the ongoing conflict between the United States and China for 'technological hegemony'. Set against that backdrop, the Japanese government established the goals of achieving: (1) strategic autonomy; and (2) strategic indispensability.[9] Strategic autonomy

[6] Hideki Uno, 'Japan's Semiconductor Industrial Policy from the 1970s to Today', *Center for Strategic & International* Studies, last accessed 30 January 2023, https://www.csis.org/blogs/perspectives-innovation/japans-semiconductor-industrial-policy-1970s-today.
[7] Ministry of Economy of Trade and Innovation, 'The Strategy for Semiconductors and the Digital Industry (Summary)', 4 June 2021, last accessed 30 January 2023, https://www.meti.go.jp/english/press/2021/pdf/0604_005a.pdf.
[8] Minister Yasutoshi Nishimura, 'Press Conference by Minister Nishimura (Excerpt)', last accessed 30 January 2023, https://www.meti.go.jp/english/speeches/press_conferences/2022/1014001.html.
[9] Amari Akira and Tanaka Akihiko, 'The Urgent Need to Establish 'Strategic Autonomy' and 'Strategic Indispensability': economic security strategy for a digital transformation society', last accessed 30 January 2023, https://www.japanpolicyforum.jp/diplomacy/pt20211013080925116 42.html. The official translation of the strategy refers to being

relates to the ability to reduce vulnerabilities in key infrastructures and supply chains, while strategic indispensability is about improving technology and industrial competitiveness by strengthening R&D, as well as preventing technology leaks. The combination of the two goals cements the importance given by the Japanese government to playing a greater role in the global supply chain.

The pillar of strategic autonomy includes two key elements. First, to bring more production onshore, since Japan currently imports more than 60 per cent of its semiconductors.[10] The path to meet that goal includes 'establishing joint-venture factories with overseas foundries'. As elaborated below, Taiwan's TSMC plays a key role herein. Furthermore, the Japanese government is also looking for chances to collaborate with trusted foreign partners to strengthen its supply chain of rare-earth materials. Key objectives are to find innovative solutions to diversify this supply chain, and to invest in R&D to develop new materials in laboratories, which could help to reduce dependency on the outside. Japan currently depends on China for about 60 per cent of the rare-earth materials it uses.[11]

The second pillar of Japan's semiconductor strategy is that of strategic indispensability. This includes the 'identification of targets and leaders' in different areas of semiconductor specialisation, with the aim to enable further focus and differentiation within the overall supply chain, namely in the fields of memory, sensors, power and microcomputers.[12] The Japanese government also prioritises the ability to produce more high-end chips, since the production of chips smaller than 40nm is currently very limited. This move will require extensive investments in upgrading domestic foundries, as well as working with international trusted partners to work on next-generation microchips.[13]

Japan's vision for Society 5.0

The 2021 Japanese National Strategy for Semiconductors not only has a national security outlook. Overarching it is the fact that the Japanese government wants the semiconductor industry to support, design and develop more and more solutions tailored for the twin transitions of digital and green. These, in turn, are logical major levers to realise Society 5.0, a blueprint released by the Japanese government in December 2015 that presents an aspirational model for society that Japan should pursue. It ought to be a human-centered 'super-smart society', beyond the information age, where the innovations of the

'strategically independent' and 'strategically essential'. In this chapter, for clarity of all readers, we use respectively 'strategic autonomy' and 'strategic indispensability', which is the most commonly used terminology in literature.

[10] Takashi Tsuji, Tomohiro Ebuchi and Kosuke Takeuch, 'Japan puts all chips on the table to lure semiconductor makers', *Nikkei*, 3 June 2021, last accessed 30 January 2023, https://asia.nikkei.com/Business/Tech/Semiconductors/Japan-puts-all-chips-on-the-table-to-lure-semiconductor-makers.

[11] Ministry of Economy of Trade and Innovation, 'Japan's new international resource strategy to secure rare metals', 31 July 2020, last accessed 30 January 2023, https://www.enecho.meti.go.jp/en/category/special/article/detail_158.html.

[12] Ministry of Economy of Trade and Innovation, 'The Strategy for Semiconductors and the Digital Industry (Summary)', 4 June 2021, last accessed 30 January 2023, https://www.meti.go.jp/english/press/2021/pdf/0604_005a.pdf.

[13] Mariko Togashi, 'Japan prioritises semiconductor industry in bid to enhance economic security', 30 March 2022, last accessed 30 January 2023, https://www.iiss.org/blogs/analysis/2022/03/japan-prioritises-semiconductor-industry-in-bid-to-enhance-economic-security.

fourth industrial revolution are fully integrated and used in favour of the people and industry, in a sustainable manner.[14] The government wants Japan to be relatively independent when it comes to supporting businesses to develop the technologies and applications that 5G, AI and quantum computing are expected to bring about, or green-related technologies and products like electric vehicles or clean sources of energy. Having a clean supply chain of chips, free of disruptions and external threats, is regarded as central for achieving this.

METI has several funds and mechanisms to support the implementation of this strategy, including funds from the annual budget of the New Energy and Industrial Technology Development Organisation (NEDO), which were 1.3 billion USD in 2022, and from the 16.3 billion USD Green Innovation fund, among others.[15] The Japanese government's political commitment is clear, for it has gone as far as to state that it is available for 'establishing a system for special measures to treat them [strategic digital industry sectors] beyond normal industrial policy'.[16]

Rapidus

A major step in Japan's semiconductor industrial policy came with the launch in November 2022 of the Rapidus Corporation. Supported by roughly 485 million USD in subsidies, Rapidus (Latin for 'speed') brings together a group of companies to drive Japan's revival into semiconductor supremacy – and to strengthen the country's strategic autonomy as well as strategic indispensability. The new semiconductor producer includes eight major Japanese players: Toyota; Sony; Kioxia; NEC; Tokyo Electron; Denso; NTT; and SoftBank. The US giant IBM, whose research on 2-nanometre (nm) technology will be used by the consortium, will also be part of the project.[17] Strikingly, the consortium thus includes both players in the semiconductor industry itself, as well as key buyers of the chips: Japan's key manufacturers of automotive, electronics and telecommunications equipment.

This venture aims to produce 2nm chips domestically by 2027. This is an ambitious objective, since the market leaders TSMC and Samsung are aiming to produce chips of the same range only by 2025.[18] Table 1 below shows the scope of the players involved.

[14] The Government of Japan, 'Realising Society 5.0', last update June 2020, last accessed 30 January 2023, https://www.japan.go.jp/abenomics/_userdata/abenomics/pdf/society_5.0.pdf.
[15] Ministry of Economy of Trade and Innovation, 'Basic Policies for Green Innovation Fund (Summary)', 12 March 2021, last accessed 30 January 2023, https://www.meti.go.jp/english/press/2021/pdf/0312_002a.pdf.
[16] Ministry of Economy of Trade and Innovation, 'The Strategy for Semiconductors and the Digital Industry (Summary)', 4 June 2021, last accessed 30 January 2023, https://www.meti.go.jp/english/press/2021/pdf/0604_005a.pdf.
[17] IBM Newsroom, 'IBM and Rapidus Form Strategic Partnership to Build Advanced Semiconductor Technology and Ecosystem in Japan', 12 December 2022, last accessed 30 January 2023, https://newsroom.ibm.com/2022-12-12-IBM-and-Rapidus-Form-Strategic-Partnership-to-Build-Advanced-Semiconductor-Technology-and-Ecosystem-in-Japan.
[18] Marco Vlot, 'Japan zet vol in op ontwikkeling geavanceerde halfgeleiders', *Het Financieele Dagblad*, 11 November 2022, last accessed 30 January 2023, https://fd.nl/bedrijfsleven/1457656/japanse-zet-vol-in-op-ontwikkeling-geavanceerde-halfgeleiders-onk2ca8sg0yw.

Table 1: Companies that are part of Rapidus

Automotive	Telecommunications	Technology and Electronics	Others
Toyota	NTT	Sony	Kioxia (memory)
Denso	SoftBank	NEC	MUFG (banking)

One key difference with earlier efforts by the Japanese government to boost the semiconductor sector is the engagement also with foreign companies. Whereas earlier efforts were 'Japan-only', Rapidus partners with foreign companies. Besides IBM, the Belgian R&D organisation Imec has set up a strategic partnership to research beyond 2nm technologies in Japan.[19] Ties with Dutch semiconductor giant ASML are likely to be informal, although the Dutch company is expected to be engaged as Rapidus' supplier.

Promoting technological development and stimulating innovation

While Japan's METI is in charge of guiding, making policy and monitoring the progress of Japan's semiconductor industry strategy, two national agencies stand out in helping the industry to implement that strategy. First, the New Energy and Industrial Technology Development Organisation (NEDO) is a national agency responsible for promoting technological development and stimulating innovation. NEDO bridges the gap between Japan's national government, including METI, and the private sector, universities and public research institutes. It allocates funding and supports with project management and planning, and informs the government about progress made in the industry, allowing for well-informed policymaking by the METI.

Another agency that is relevant to Japan's semiconductor industry is the National Institute of Advanced Industrial Science and Technology (AIST). Since its creation in 2001, the AIST seeks to support the creation and development of technologies that may be useful to society at large, and to close the gap between research and industrialisation by creating consortiums around specific themes. In 2021, the AIST set up a consortium with Tokyo Electron, SCREEN and Canon to develop semiconductor equipment. Several other companies, including Intel and TSMC, as well as universities, are sponsoring or have access to the results of the pilot project. Also sponsored by the AIST is the Japan 3D IC R&D Centre.[20]

[19] Imec Press Release, 'Imec and Rapidus sign Memorandum of Cooperation to collaborate on advanced semiconductor technology', *Imec*, 6 December 2022, last accessed 30 January 2023, https://www.imec-int.com/en/press/imec-and-rapidus-sign-memorandum-cooperation-collaborate-advanced-semiconductor-technologies.

[20] TSMC, 'TSMC Japan 3DIC R&D Center Completes Clean Room Construction in AIST Tsukuba Center', 24 June 2022, last accessed 30 January 2023, https://pr.tsmc.com/system/files/newspdf/attachment/43c4fd19dc5cdd233b76395ad558ee56950651b6/0624_TSMC%20Japan%203DIC%20RD%20Center%20Completes%20Clean%20Room_%28E%29_final_wmn.pdf.

where TSMC will work with local companies and partners to develop new packaging techniques. Launched in March 2021 and opened in June 2022, in the Tsukuba Centre of the AIST, it will be used to explore three-dimensional packaging of integrated circuits (composed by semiconductors and peripheral circuits).

2. Overview of the industry in Japan

Today's competitive disadvantage of Japan's semiconductor industry *vis-à-vis* Taiwanese, Korean, Chinese or US firms triggered not only the recent push in terms of public and private investment, but also in strategic partnerships within Japan and abroad. Factories and plants need to be revamped to meet state-of-the-art standards, knowledge needs to be updated and captured from abroad, and funds need to be channelled to achieve a broad improvement.

The fact that the semiconductor industry has been placed at the heart of the Japanese economic security agenda pressures Japan's industry to perform and deliver quick results. At the same time, it means that public funds and, eventually, a more beneficial legislative framework may be made available for the industry to achieve progress that would otherwise be impossible to accomplish. Japan's funding seems small, however, in comparison to that of other countries. The US Chips Act provisions about 280 billion USD over the coming ten years, while South Korea's figure is about 260 billion USD, and the European Chips Act allocates 43 billion euros to the semiconductor industry until 2030. So far, the numbers put forward by the Japanese government in concrete projects have not surpassed 10 billion USD.

To summarise, the Japanese semiconductor industry benefits from three favourable conditions. First, the political and economic support offered by the Japanese government makes it easier for industry players to apply for funds that can help to achieve their goals. Second, the openness of both Japanese government and industry leaders to learn from and build meaningful relationships with companies from other countries may work as an accelerator of knowledge transfer. Third, Japan can draw inspiration from the VLSI project, which helped the country climb the industry's ladder 40 years ago.

Key players in the industry

The segment of the semiconductor industry that is of particular interest to the Netherlands in relation to Japan is lithography, where the Dutch firm ASML is a world leader thanks to its monopoly on extreme ultraviolet (EUV) machines. By the mid-1990s, Japan's Canon and Nikon together had almost three-quarters of global market share, 45 per cent and 25 per cent, respectively. However, these Japanese companies would be overtaken by ASML, which was founded in 1984 but by 1995 had a global market

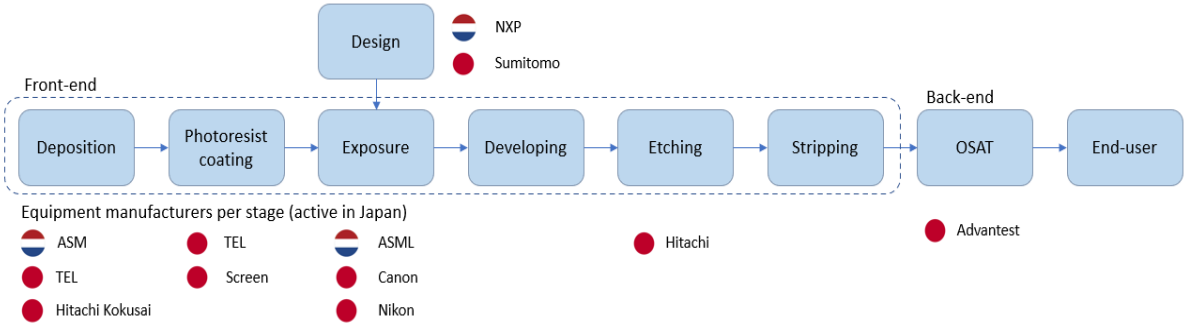
share of 25 per cent. By 2002, that number had risen already to 50 per cent of global market share.[21] ASML has made huge leaps forward with TwinScan and immersion lithography since then, and in 2010 it started selling EUV machines – which are by far the most advanced in the market and solely sold by ASML. In Japan, ASML has seven offices with more than 250 employees focused on customer service and support, responsible for delivering, installing and maintaining the lithography machines for more than ten clients.

Canon is trying to leapfrog with a new technology called nano-imprinting lithography, which could, at least in theory, compete with ASML's EUV machines. Canon is now building a 345 million USD lithography equipment plant in Tochigi prefecture, Japan, to start operating in 2025.[22] This will be the first such plant built in Japan in over 20 years and, with it, Canon is aiming to double its current production capacity with deep ultraviolet (DUV) machines and to research nano-imprinting lithography. Kioxia and Dai Nippon Printing are supporting Canon in this development. Importantly also for Japan's green ambitions, with this new imprinting technology, Canon expects to reduce manufacturing costs by 40 per cent and power consumption by about 90 per cent in comparison to EUV technology. If successful, Canon may be able to reduce ASML's current strategic advantage of possessing EUV machines.

In addition to ASML, two other big Dutch companies have customer support offices in Japan: ASM International (ASMI); and NXP. ASMI works in wafer-processing technology, including single-wafer epitaxy and atomic layer deposition (ALD), and is among the market leaders in the latter. It has five offices in Japan to support its clients. In Japan, ASMI faces competition from Tokyo Electron (also known as TEL) and Hitachi Kokusai, besides the US firms Applied Materials and LAM Research. The other big Dutch company, NXP, operates in the global radiofrequency market, especially focused on the automotive industry, as well as in defence and communications applications and near-field communication (NFC) chips. NXP's main competitors are the Japanese firm Sumitomo Electric Devices Innovations and the US company Advanced Materials. Meanwhile, BESI, another important Dutch player, operates at the other end of the supply chain, namely on assembly and packaging technology. Its main competitors are ASM Pacific Technology (Hong Kong) and Kulicke & Soffa (a US company based in Singapore), but BESI has no presence in Japan yet. Figure 2 below presents the main Dutch and Japanese players in the industry.

[21] ASML Press Release, 'ASML named world leader in stepper market', 1 May 2003, last accessed 30 January 2023, https://www.asml.com/en/news/press-releases/2003/asml-named-world-leader-in-stepper-market.
[22] Nikkei, 'Canon to build $345m plant for chipmaking equipment in Japan', *Nikkei*, 4 October 2022, last accessed 30 January 2023, https://asia.nikkei.com/Business/Tech/Semiconductors/Canon-to-build-345m-plant-for-chipmaking-equipment-in-Japan.

Figure 2: Biggest Dutch companies operating in Japan and their main competitors



Source: authors' compilation

The presence of ASML, ASMI and NXP is well-recognised in Japan, and places the Netherlands as a reference point for the Japanese industry. Furthermore, there is an ecosystem of Dutch companies working with Japanese counterparts, both on their own and via the three aforementioned big companies. While these bigger companies have been well established in Japan for several years and are comfortable with the business environment, small and medium-sized enterprises normally need support from the local Dutch Embassy and from the Dutch Innovation Attachés' network, in order to have a smoother entry in the Japanese market.

As well as industry connections, research collaboration exists between Japanese and Dutch organisations. For example, the Dutch independent research organisation of applied science, TNO, has links with its Japanese counterpart, AIST. Moreover, several Dutch and Japanese universities cooperate with each other, including the Tokyo Institute of Technology and the Universities of Kyoto, Osaka and Nagoya in Japan, as well as the Dutch Technical University of Delft and Leiden University.

3. Japan's international positioning and connections

Japan's 2022 National Security Strategy labels China as the 'the greatest strategic challenge in ensuring the peace and security' of Japan and of the international community.[23] Clearly, Japan aligns much more with many of the United States' and European Union's values and the United States and Taiwan are highest on the list of foreign partners with which Japan wants to cooperate.[24]

[23] The Government of Japan, 'National Security Strategy of Japan (Provisional Translation)', December 2022, last accessed 30 January 2023, https://www.cas.go.jp/jp/siryou/221216anzenhoshou/nss-e.pdf.
[24] Ko Fujioka And Ryuto Imao, 'Japan to spend $2.4bn on joint chip research hub with U.S'., *Nikkei*, 6 November 2022, last accessed 30 January 2022, https://asia.nikkei.com/Business/Electronics/Japan-to-spend-2.4bn-on-joint-chip-research-hub-with-U.S.

Japan and the Netherlands have been caught in the great-power competition between the United States and China. American officials have placed pressure on both Japan and the Netherlands to limit sectorial exports to China, both in terms of material and knowledge.[25] The position both countries hold by leading the global market in lithography machines, which ultimately hold the key to unlocking the potential to manufacture chips at even greater scale, with lower costs and higher precision, has made US Presidents and high officials intervene regularly over the past few years. In 2018, the Trump administration began a campaign with ASML and the Dutch government to limit exports of lithography machines to China.[26] More recently, since new export controls were put in place in the United States in October 2022, US representatives have repeatedly asked their allies to follow suit.[27]

Relations with countries in the region

Japan cooperates with partners and allies in several multilateral and bilateral fora. Within the Quadrilateral Security Dialogue (also known as the Quad), Japan engages with the United States, India and Australia. Primarily driven by military cooperation, this forum – initiated in 2007 by then Japanese Prime Minister Shinzo Abe – shows Japan's eagerness to cooperate with these countries. India and Australia, in particular, share a common understanding with Japan of the position of China in the Indo-Pacific and the threats and opportunities associated therein. This common view is further put in practice by another forum proposed by Japan and including the three countries: the Supply Chain Resilience Initiative (SCRI). Launched in April 2021, the SCRI seeks to enhance their collaboration in face of the geopolitical tensions growing in the region and the need to balance Chinese power, a concern that grew in the face of overdependency on China during the COVID-19 pandemic. Japan has also held 2+2 Ministerial Dialogues with the three other members of the Quad.

Led by the United States, the Indo-Pacific Economic Framework (IPEF) was launched in May 2022 in Tokyo, to further engage the United States with countries in the region. Japanese Prime Minister Kishida's in-person attendance signalled the Japanese government's political support for the initiative. Among the key themes to be addressed in this forum are supply-chain security and clean energy, decarbonisation and infrastructure, intrinsically linked to the availability of semiconductors.[28] Besides

[25] Rintaro Tobita, 'US calls out Japan and Netherlands over China chip curbs', *Nikkei*, 6 November 2022, last accessed 30 January 2023, https://asia.nikkei.com/Business/Electronics/U.S.-calls-out-Japan-and-Netherlands-over-China-chip-curbs.
[26] Alexandra Alper, Toby Sterling and Stephen Nellis, 'Trump administration pressed Dutch hard to cancel China chip-equipment sale', *Reuters*, 6 January 2020, last accessed 30 January 2023, https://www.reuters.com/article/us-asml-holding-usa-china-insight-idUSKBN1Z50HN.
[27] Reuters, 'US consults with Japan, Netherlands on chip restrictions as China pushes back', *Reuters,* 13 December 2022, last accessed 30 January 2023, https://www.reuters.com/technology/japan-netherlands-join-us-china-chip-curbs-bloomberg-news-2022-12-12/.
[28] Office of the United States Trade Representative, 'Indo-Pacific Economic Framework for Prosperity (IPEF)', last accessed 30 January 2023, https://ustr.gov/trade-agreements/agreements-under-negotiation/indo-pacific-economic-framework-prosperity-ipef.

the Quad members, other countries in the region, such as Malaysia, New Zealand, Vietnam and South Korea, are also involved.

Historically, Japan's relationship with South Korea has not been particularly smooth. South Korea benefited greatly from the 1986 US–Japan Semiconductors Agreement, which allowed it to surpass Japan in the production of, among others, DRAM components, in which it currently holds a global market share above 70 per cent.[29] In July 2019, Japan's export controls on three chemicals used to manufacture semiconductors and display screens shook the relationship between the two countries further. This decision was a response to a South Korean court's decision to request reparations from Japanese companies that had used South Korean forced labour during the Second World War.[30] Nonetheless, the geopolitical context may create the conditions to enhance cooperation between the two countries, namely in the face of the security concerns that both countries share in relation to China and North Korea. A South Korean government that is more open to cooperating with Japan, particularly in the fields of economic security, including semiconductors, took office in May 2022, which may help to improve the bilateral relationship.[31]

Another related thematic forum, which was proposed by the United States in March 2022, is the Chip 4 Alliance that also includes Japan, South Korea and Taiwan. Its goal is to increase self-sufficient semiconductor supply chains among these four countries. The selection of countries has strategic reasoning: together, they cover all the major areas of the semiconductor value chain, from design to chip production, testing, assembly and packaging. However, it is still unclear whether this forum will succeed in its objectives, because of the three Asian countries' reluctance to collaborate. First, for historical reasons Japan and South Korea may not wish to enter into this cooperation. Furthermore, both countries are reluctant to be included in the same alliance as Taiwan, as they fear China may interpret the partnership as a challenge to its 'One China' policy and regional tensions arise as a consequence. Finally, since China is the three Asian countries' leading trading partner, it is still unclear whether they are willing to risk their commercial relationships.[32]

[29] Invest Korea, 'No. 1 Memory Semiconductor Industry in the World, Second Largest Semiconductor Producing Country', last accessed 30 January 2023, https://www.investkorea.org/ik-en/cntnts/i-312/web.do#:~:text=Korea's%20global%20semiconductor%20market%20share,%25%20and%20NAND%20at%2044.9%25.
[30] CNBC, 'South Korea downgrades Japan trade status as dispute deepens', *CNBC*, last accessed 30 January 2023, https://www.cnbc.com/2019/09/18/south-korea-downgrades-japan-trade-status-as-dispute-deepens.html.
[31] Gyu-Pan Kim, 'Japan's Semiconductor Strategy and Implications for Korea', *Korea Institute for International Economic Policy*, 1 September 2022, last accessed 30 January 2023, https://www.kiep.go.kr/gallery.es?mid=a20308000000&bid=0008&list_no=10310&act=view.
[32] *Financial Times*, 'US struggles to mobilise its East Asian "Chip 4" alliance', *Financial* Times, last accessed 30 January 2023, https://www.ft.com/content/98f22615-ee7e-4431-ab98-fb6e3f9de032.

Regarding Taiwan, one of the legacies of Shinzo Abe was the transformation of Japanese ties with the island.[33] Japan is currently dedicated to improving its relationship further, including by capturing foreign direct investment from TSMC to achieve its aim of strategic autonomy. In 2022, TSMC was invited to build a semiconductor plant in Kumamoto, Japan. Japan's METI will subsidise this undertaking with an estimated sum of 3.5 billion USD, corresponding to about 40 per cent of the total estimated cost of 8.5 billion USD.[34] A joint venture called Japan Advanced Semiconductor Manufacturing (JASM), led by the Taiwanese company in which Sony and Denso also participate, has been formed to carry out the project.[35] In line with its strategy to have valuable international partnerships, Japan is wanting to learn from Taiwanese companies.

The only country in the region where collaboration with Japan is not to be expected is China. Although reluctantly, the Japanese government aligned in January 2023 with the export controls mechanism imposed by the United States on China in October 2022.[36] Although the relationship between Japan and China has been troublesome, also because of geopolitical disagreements and territorial disputes in the East China Sea, both countries do have a strong mutual economic dependency. China is both the biggest importer from and exporter to Japan, and Japan largely relies on China for rare-earth materials, which are vital for the semiconductor industry. In 2010, Japan imported more than 80 per cent of its rare-earth materials from China, a figure reduced to about 60 per cent in 2019 and targeted to decrease to below 50 per cent in 2025.[37]

Japan's biggest strengths in the semiconductor supply chain reside in the production of silicon wafers, manufacturing equipment and advanced material fields. First, Shin-Etsu Chemical and Sumco lead in the global market of silicon wafer production, where Japan holds more than 50 per cent of global market share. Second, Japan has about 75 per cent of global market share in producing equipment for wafers, handling and marking, above 40 per cent in etching and cleaning, and about 50 per cent in testing. When it comes to advanced materials, Japanese companies hold up to 90 per cent market share in both photoresist and special chemicals, about 70 per cent in etching gasses and above 50 per cent in photomask. Japan stands out, therefore, as a key player in the global semiconductor supply

[33] David Sacks, 'Shinzo Abe Transformed Japan's Relationship With Taiwan to Counter Threats from China', 13 July 2022, last accessed 30 January 2023, https://www.cfr.org/blog/shinzo-abe-transformed-japans-relationship-taiwan-counter-threats-china.
[34] Nikkei, 'Japan to subsidise TSMC's Kumamoto plant by up to $3.5bn', *Nikkei,* 17 June 2022, last accessed 30 January 2023, https://asia.nikkei.com/Business/Tech/Semiconductors/Japan-to-subsidise-TSMC-s-Kumamoto-plant-by-up-to-3.5bn.
[35] Nikkei, 'Japan to subsidise TSMC's Kumamoto plant by up to $3.5bn', *Nikkei,* 17 June 2022, last accessed 30 January 2023, https://asia.nikkei.com/Business/Tech/Semiconductors/TSMC-lifts-Japan-chip-plant-investment-with-Denso-following-Sony.
[36] Nikkei, 'US secures deal with Netherlands, Japan on China chip export limit: Bloomberg', *Nikkei,* 28 January 2023, last accessed 30 January 2023, https://asia.nikkei.com/Business/Tech/Semiconductors/U.S.-secures-deal-with-Netherlands-Japan-on-China-chip-export-limit-Bloomberg.
[37] Ryosuke Hanafusa, 'Japan to pour investment into non-China rare-earth projects', *Nikkei*, 15 February 2020, last accessed 30 January 2023, https://asia.nikkei.com/Politics/International-relations/Japan-to-pour-investment-into-non-China-rare-earth-projects.

chain. As such, Japanese exports in the sector are mostly consumed by the four greatest powerhouses on semiconductor development and end-user and commercial devices production: the United States; Taiwan; China; and South Korea.

4. Implications for the Netherlands

In the Netherlands, innovation and business have been left to the market, in a typical bottom–up approach where the government does not interfere. Japan, on the other hand, is known for its strategic partnerships between public and private sectors, including between competitors in specific sectors, to meet specific national goals. The current times are pushing all governments into new territories, and perceptions on trade and industrial policy are changing. In Europe, the Netherlands induced a paradigm shift from free markets to more closed-economy thinking.[38] European Union (EU) member states aim for so-called open strategic autonomy and aim to identify and reduce one-sided strategic dependencies *vis-à-vis* unreliable partners, especially those outside the European framework of values.

Japan and the EU and its member states seem to be on the same page in their approach to China. This assessment is based on both their analysis of geopolitical risks, as well as the pressure imposed by the United States upon their governments to slow down China's progress on technology. In this context, the Netherlands can exchange best practices with Japan on how to promote Europe's own capabilities and competitiveness, namely by promoting R&D and innovation, building strong relationships between the public and private sectors, and creating consortia tailored to specific themes. As the Rapidus project shows, Japan is thinking strategically about how these consortia could be set up. Both the Japanese government and its private-sector actors see the urgency of acting together, also because they are closer to the heart of the US–China competition, and they are focusing on themes where they are strongest, such as automotive and electronics – thus including the partners that they think can best work together. In fact, one potential medium- or long-term consequence of the current focus in the semiconductor industry in Japan is the risk, even if very small, that the Japanese lithography industry may reduce its gap with the Dutch. The strategic investments made by the Japanese government may be the last opportunity for Nikon and Canon to catch up with ASML.

When it comes to collaboration between the Dutch and Japanese semiconductor industries, a characteristic to keep in mind is the lack of complementarity between them. The major Dutch semiconductor companies have offices in Japan to serve clients, as well as counterparts with which

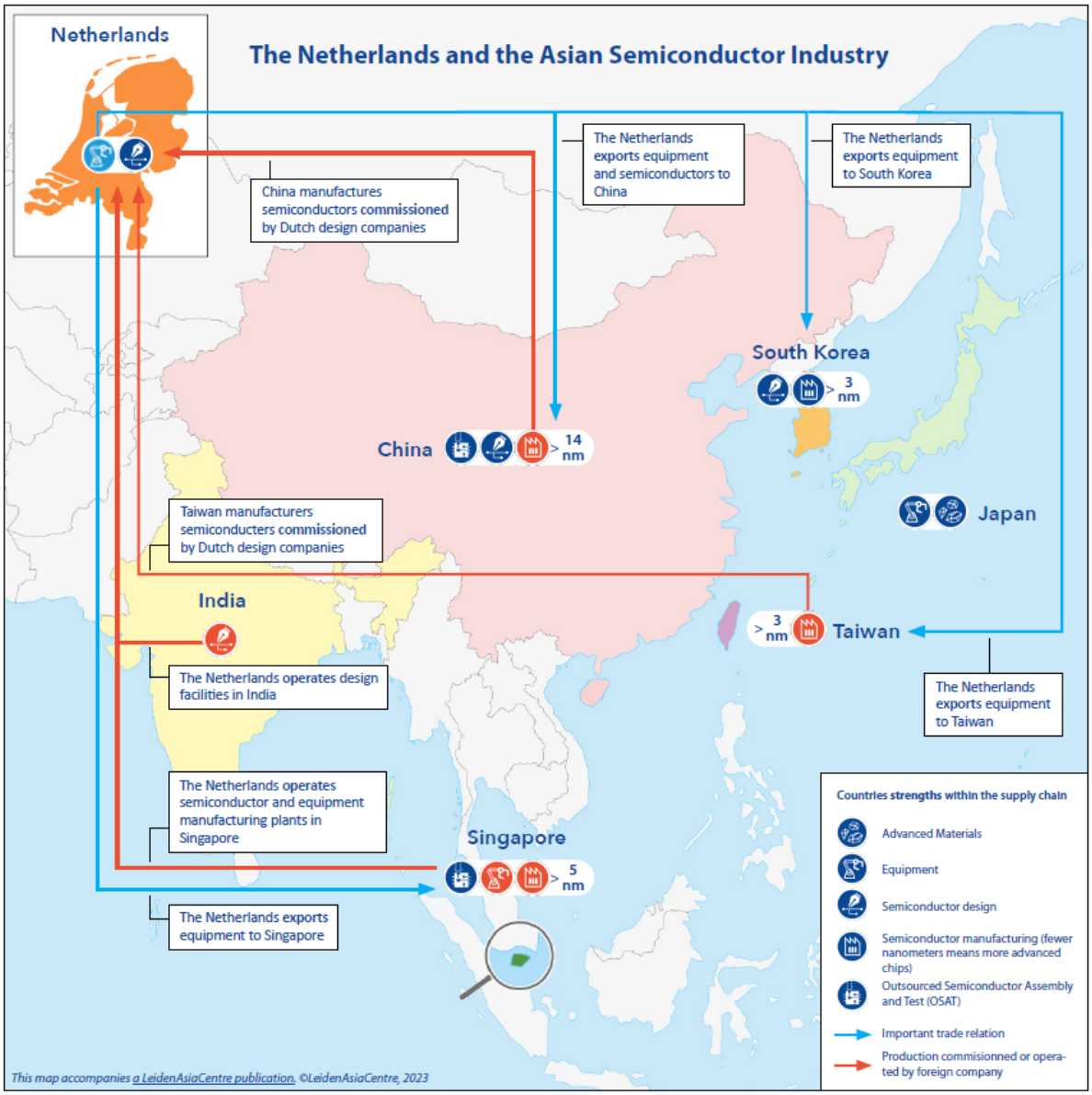
[38] Maaike Okano-Heijmans, 'Open strategic autonomy: the digital dimension', *Clingendael*, 23 December 2023, last accesses 30 January 2023, https://www.clingendael.org/publication/open-strategic-autonomy-digital-dimension.

they compete, even if at different scales. The Netherlands should also work on finding new opportunities for its small and medium-sized enterprises working in the sector and wanting to invest in Japan. Furthermore, it is worth mentioning that the broad strategic goals are similar in both countries: the twin transitions of green and digital are background themes for both governments; and their allies and trusted partners are essentially the same. Another common theme with Japan – and if not in the Netherlands specifically, then at least in Europe at large – is demography. Japan has the oldest population in the world and needs quickly to step up digitalisation of the country, with which the Netherlands might help Japan.

Moreover, a broader presence of Dutch companies in the Japanese market might be a means for them to establish meaningful business relationships and to learn more in technology fields led by Japan, such as photonics, sensors and power chips (used for industrial equipment and in the automotive sector). Furthermore, Japan can help the Netherlands with technology transfer, and in valorising research – that is, turning research into products that can be commercialised, something that the Dutch often fail to do. Finally, and most importantly, in order to push all these agendas, more bilateral involvement between both governments is required, since both countries are already well connected at the business level. The December 2022 SEMICON conference in Tokyo is a good example of this business-level connection: the Netherlands was represented by twelve companies – compared to three from Germany and one from the Czech Republic – three times as many as at the 2021 conference.

The Japanese government is investing heavily in semiconductors, because they are considered of paramount importance to Japan's economic security. Japan's actions are the logical outcome of a vision of what the government wants future society to look like: so-called 'Society 5.0'. By coherently placing its main industries – such as automotive, robotics and electronics – at the centre of this approach, Japan is seeking to achieve a diversity of policy objectives: securing earning potential; contributing to the digital and green transitions; and responding to its social and demographic challenges. In short, Japan is actively pursuing its goal to live in the Society 5.0 to which it aspires. This clarity about strategic objectives is the primary driver for Japanese stakeholders to act proactively and jointly. The EU and the Netherlands should also invest in such strategic clarity, which can deliver better policies at home and jointly with partners, including Japan.

Map of Dutch semiconductor interests in Asia



For an interactive version of this map, visit: https://leidenasiacentre.nl/map-of-dutch-semiconductor-interests-in-asia