South Korea

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South Korea is a major player in the global semiconductor industry and is home to some of the world's largest chip suppliers. Semiconductors are also very important for the South Korean economy, forming its most valuable export product.[1] South Korea's semiconductor sector has always been shaped by international politics. During the 1980s, an economic dispute between Japan and the United States resulted in less favourable conditions for Japanese semiconductor companies, providing an opportunity for South Korean companies to increase their market share, especially in the segment of memory chips.[2] Nowadays, South Korea finds itself wedged between the United States and China, which are both applying political pressure on Seoul to align itself with their country's interests, including in the semiconductor industry.

The size of South Korea's semiconductor sector, combined with its susceptibility to political forces, make its industry indispensable for Dutch semiconductor interests in Asia in light of (geo)political developments. This chapter therefore discusses the policies of the South Korean government regarding the sector, provides an overview of the industry in the country, lays out connections with the Dutch sector, and maps Seoul's geopolitical positioning and relevant relations with other countries in the region. The chapter concludes with a discussion of the implications of these political and economic developments and regional relations for the Dutch semiconductor sector.

1. Government policies

In recent years, the South Korean government has invested heavily in the semiconductor industry. This is in part to keep up with government support in other countries, but also to tackle a series of challenges that specifically face the industry in South Korea, such as its concentration on memory chip production and consequently its weaker position in system chips and other segments of the value chain (these challenges are discussed in more detail below).

[1] OEC, „Integrated Circuits in South Korea" (visited 08 february 2023), https://oec.world/en/profile/bilateral-product/integrated-circuits/reporter/kor.
[2] S.R. Kim, „The Korean system of innovation and the semiconductor industry: a governance perspective", December 1996, https://www.oecd.org/korea/2098646.pdf.

One of the first signs of renewed broad government support for the sector came in 2019, when Seoul presented its System Semiconductor Vision and Strategy, which aligned with Samsung's plans to invest in system chips' production capabilities. The aim of the strategy is to achieve a 10 per cent share of the global design (fabless) market, to become a world leader in the foundry segment and to increase the number of employees in the segment of system chips by 27,000 new jobs by 2030.[3] In order to realise this, South Korea's government established several initiatives, such as the so-called 'Alliance 2.0', in which over 20 companies coordinate on technology planning, R&D, and local supply and demand for system chips. South Korea's government also announced several funds to finance its ambitions in these segments of the industry, such as 859 million USD for an R&D fund.[4]

This initial strategy was followed by more policy initiatives. For example, in 2020, Seoul announced a strategy to develop further South Korea's AI semiconductor industry. The aim of this plan is to realise a 20 per cent global market share in this segment by 2030 through public–private collaboration.[5] And in 2021, the so-called 'K-Semiconductor Strategy' was presented, which consists of a plan to create a 'K-Semiconductor Belt' connecting several regions with semiconductor activities into the world's largest chip-making ecosystem.[6] In 2022, it became clear that the South Korean government's goal is to grow the country's non-memory chip global market share from 3 per cent to 10 per cent by 2030.[7]

To support these aims, South Korea's government announced tax reductions for semiconductor R&D and facility investments, as well as other benefits regarding permits and water and energy supplies.[8] The private sector, under the leadership of Samsung and SK Hynix, has committed to investing over 400 billion USD in the next ten years in semiconductor research and production as part of the government's blueprint.[9] These policy plans were established in several acts passed in the South Korean Parliament, although some of the government's commitments appear to have been watered down, resulting in criticism from multiple sides.[10]

[3] Baek Byung-yeul, 'Korea will become non-memory chip powerhouse by 2030', *The Korea Times*, 30 April 2019, https://www.koreatimes.co.kr/www/tech/2022/06/133_268069.html.
[4] Ha-yan Choi, "Moon announces system semiconductor "vision and strategy" to match Samsung investment", *Hankyoreh,* 1 May 2019, https://english.hani.co.kr/arti/english_edition/e_business/892289.html.
[5] Eun-jin Kim, "South Korea Aiming to Become AI Semiconductor Industry Powerhouse", *BusinessKorea*, 13 October 2022, http://www.businesskorea.co.kr/news/articleView.html?idxno=53036.
[6] KBS World, ""K-Semiconductor Belt Strategy" to establish the world's largest supply network by 2030", 17 May 2021, http://world.kbs.co.kr/service/contents_view.htm?board_seq=403357.
[7] Suk-yee Jung, "South Korea to Make Huge Investment in Semiconductor Industry", *BusinessKorea,* 22 July 2022, http://www.businesskorea.co.kr/news/articleView.html?idxno=97099.
[8] Young-bae Kim, "S. Korea vows to build world's largest semiconductor belt", *Hankyoreh*, 14 May 2021, https://english.hani.co.kr/arti/english_edition/e_business/995284.html.
[9] Sohee Kim and Kim Sam, "South Korea joins global chipmaking race with $450 billion spending plan", *Fortune*, 14 May 2021, https://fortune.com/2021/05/13/south-korea-chip-semiconductor-samsung-hynix/.
[10] He-rim Joh, "'Half-baked' chips act falls short of drastic corporate tax cuts", *The Korea Herald*, 25 December 2022,

Furthermore, in 2022 South Korea's government earmarked almost 700 million USD for R&D regarding important materials and parts, including for the semiconductor industry.[11] This followed the earlier 'Materials, Parts and Equipment 2.0 Strategy', which was presented in 2020 and similarly consisted of large investments (4.2 billion USD) to develop technologies in these sectors. The aim of these plans is to reduce foreign dependencies. While the focus was initially on countering reliance on Japan, the policy also targets key items imported from around the world, in part because of the problems that COVID-19 caused in global supply chains.[12]

Finally, in order to train more skilled personnel for the semiconductor sector, the South Korean government announced in 2022 that it will invest public funds in educating and training 150,000 semiconductor engineers in the coming years. More than 700 million USD will be allocated by 2029 towards education and research projects. Limits on student numbers will be removed for semiconductor-related departments, special training sessions for non-engineering majors will be organised and joint research centres are to be established.[13] Furthermore, a special semiconductor academy will open in April 2023.[14] Agreement was also reached by the government, research institutions and semiconductor companies to work together to overcome issues regarding training new personnel.[15]

2. Industry overview

Strengths and weaknesses of the South Korean semiconductor industry

The South Korean semiconductor industry is especially strong in the segment of memory chips. Memory chips are used to store information, while system chips (also known as logic chips) process data to perform tasks and therefore function as the brains of electronic devices. Memory chips generally require less cutting-edge technology and production methods to manufacture and depend

https://www.koreaherald.com/view.php?ud=20221225000069; Suk-Hyun Ko and Eun-Jee Park, "Korea chips act all but useless, critics argue", *Korea JoongAng Daily*, 26 Dember 2022, https://koreajoongangdaily.joins.com/2022/12/26/business/industry/Kchips-Act/20221226185044592.html.

[11] Yonhap News Agency, "S. Korea earmarks 841 bln won for key materials, parts development", 3 February 2021, https://en.yna.co.kr/view/AEN20220203003100320.

[12] Ho-Jeong Lee, "2.0 strategy for 3 key materials to cost trillions of won", *Korea JoongAng Daily*, 9 July 2020, https://koreajoongangdaily.joins.com/2020/07/09/business/economy/material-and-parts-MOTIE-Minister-Sung-Yunmo/20200709180200380.html.

[13] Ho-Jeong Lee, "Korea to amass a chip army with huge spending of public funds", *Korea JoongAng Daily*, 19 July 2022, https://koreajoongangdaily.joins.com/2022/07/19/business/economy/Semiconductor-training-talents-Korean-government/20220719190204828.html; Eun-byel Im, "Korea to lift school limits in chip expert push", *The Korea Herald,* 19 July 2022, https://www.koreaherald.com/view.php?ud=20220719000584.

[14] Ho-Jeong Lee, "Chip U established to train Korea's chip army", *Korea JoongAng Daily*, 1 December 2022, https://koreajoongangdaily.joins.com/2022/12/01/business/economy/semiconductor-Korea-academy/20221201182703788.html.

[15] Dong-joon Kwon, "Samsung Electronics planning large framework for customized on-site 'training for semiconductor professionals'", *Korea IT News*, 7 September 2022, https://english.etnews.com/20220907200001.

more on economies of scale compared to advanced system chips. South Korea managed in part to gain a strong position in the global market for memory chips during the 1980s because of its lower production costs compared to, then, memory chip powerhouse Japan.

According to the national investment promotion agency of the South Korean government, South Korea accounts for 18 per cent of global semiconductor production and 57 per cent of the global output for memory chips (in 2020).[16] These exports were worth 99 billion USD, of which memory chips accounted for 64 billion USD, which made South Korea the third largest exporter of chips in the world in 2020.[17]

Chips are, in turn, also of vital importance to the South Korean economy. Semiconductors are South Korea's most important export product: the industry accounted for 18 per cent of total exports in 2019.[18] In 2018, the semiconductor industry produced almost 6 per cent of the country's GDP.[19] Furthermore, about 177,000 people work in the industry in South Korea, which the government expects to grow to over 300,000 in the coming ten years.[20]

However, the South Korean semiconductor industry is recently facing a series of challenges. While the country holds a leading position in the global market for memory chips, its role in the production of system chips, chip design (fabless), equipment and materials is much less strong. This is problematic, because most of the added value in the supply chain takes place at the design level.[21] The market for memory chips is also relatively volatile and recently seems to be losing ground to that of system chips, which are becoming increasingly important as enablers of new technologies such as AI, smart devices, and the Internet of Things.[22] Furthermore, increased competition from Chinese memory chip manufacturers is also challenging the South Korean memory chip industry.[23] Finally, South Korea's

[16] Invest Korea, "Semiconductor", (visited 8 February 2022), https://www.investkorea.org/ik-en/cntnts/i-312/web.do.
[17] OEC, „Integrated Circuits in South Korea"; Invest Korea, "Semiconductor".
[18] Seul-gi Jun, "Overreliance on semiconductors drives S. Korea's economic recovery", *Hankyoreh*, 23 April 2021, https://english.hani.co.kr/arti/english_edition/e_business/992372.html.
[19] Malichanh Chiemsisoulath and Wanwisa May Vorranikulkij, "Revival of Korea's Semiconductor Exports is In Sight", *Amro Asia*, 23 April 2020, https://www.amro-asia.org/revival-of-koreas-semiconductor-exports-is-in-sight/.
[20] Ho-Jeong Lee, "Korea to amass a chip army".
[21] George Calhoun, "Which Companies Add The Most Value In The Semiconductor Industry? (Part 1)", *Forbes,* 30 September 2021, https://www.forbes.com/sites/georgecalhoun/2021/09/30/the-semiconductor-scoreboard-part-1-the-basic-value-chain-and-the-value-added/?sh=724049d738ab.
[22] The Economist, "Why some chipmakers are hurting much more than others", 29 September 2022, https://www.economist.com/business/2022/09/29/why-some-chipmakers-are-hurting-much-more-than-others; Trefis Team, "Why Samsung Plans To Double Down On The $170 Billion Logic Chip Market", *Forbes*, 22 January 2020, https://www.forbes.com/sites/greatspeculations/2020/01/22/why-samsung-plans-to-double-down-on-the-170-billion-logic-chip-market/?sh=5a1c00e140b6.
[23] Samsung, "역동적 혁신성장을 위한 삼성의 미래 준비", 24 May 2022, https://news.samsung.com/kr/%ec%97%ad%eb%8f%99%ec%a0%81-%ed%98%81%ec%8b%a0%ec%84%b1%ec%9e%a5-%ec%9c%84%ed%95%9c-%ec%82%bc%ec%84%b1%ec%9d%98-%eb%af%b8%eb%9e%98%ec%a4%80%eb%b9%84-5%eb%85%84%ea%b0%84-450%ec%a1%b0-%ed%88%ac.

focus on memory chips has created precarious dependencies in other market segments, such as in semiconductor equipment and materials.[24]

Apart from the disadvantages that stem from the concentration on memory chips, other issues are also challenging the industry. For example, South Korean semiconductor companies invest relatively little in R&D when compared to companies from the United States, China, Japan and Taiwan.[25] Moreover, a lack of skilled personnel challenges the development of South Korea's semiconductor industry. According to a survey by the Korea Enterprises Federation, 45 per cent of companies in the sector are understaffed.[26] The Korea Semiconductor Industry Association expects the sector to face a shortage of at least 30,000 workers in the coming ten years.[27]

Major players

While there are many companies operating in the South Korean semiconductor industry, two of them are dominating the sector: SK Hynix; and Samsung Electronics. These two companies both have extensive production and R&D facilities, and together with SK Square (the investor arm of SK Group, of which SK Hynix is a subsidiary) they are the only South Korean companies in the top 100 of semiconductor companies worldwide, based on market capitalisation.[28] Other noteworthy South Korean companies in the industry are LG Chem (a supplier of processed chemicals), SK Siltron (a wafer supplier) and DB Hitek (foundry).

SK Hynix is a public company that specialises in the production of memory chips. It belongs to the IDM segment of the value chain, as it both designs and manufactures semiconductors. Apart from manufacturing its own chips, SK Hynix also has a foundry division, SK Hynix System IC, which was separated from the memory chip division in 2017. In 2022, SK Hynix increased its foundry capacity by acquiring an existing foundry in South Korea.[29] According to the company, strengthening its foundry capabilities serves to enhance its competitiveness in the system semiconductor segment, although its foundries are not focused on producing the most cutting-edge system semiconductors.[30] SK Hynix,

[24] Hyun-bin Kim, "Korea highly dependent on foreign chip equipment: KITA", *The Korea Times*, 3 November 2022, https://www.koreatimes.co.kr/www/tech/2022/11/419_339135.html.
[25] Eun-jin Kim, "R&D Investment-to-Sales Ratio Lower in South Korean Semiconductor Companies", *BusinessKorea,* 26 July 2022, http://www.businesskorea.co.kr/news/articleView.html?idxno=97259.
[26] Suk-yee Jung, "Manpower Shortage Serious in 4 Key Industries", *BusinessKorea*, 9 November 2022, http://www.businesskorea.co.kr/news/articleView.html?idxno=103717.
[27] Man-Su Choe, Ji-Eun Jeong and Ye-Rin Choi, "Why Korean chipmakers struggle with talent shortages", *The Korea Economic Daily*, 10 June 2022, https://www.kedglobal.com/the-deep-dive/newsView/ked202206100004.
[28] Eun-jin Kim, "Only 3 Korean Semiconductor Companies Make It to Global Top 100", *BusinessKorea*, 25 October 2022, http://www.businesskorea.co.kr/news/articleView.html?idxno=102779#:~:text=24%20that%20the%20global%20top,%2C%20Taiwan%20and%20Japan%2C%20respectively.
[29] Ji-hyoung Son, "SK hynix completes Key Foundry acquisition", *The Korea Herald*, 2 August 2022, https://m.koreaherald.com/view.php?ud=20220802000647.
[30] Su-Bin Lee, "SK Hynix in $492 million Key Foundry deal, doubles foundry capacity", *The Korea Economic Daily*, 29 October 2021, https://www.kedglobal.com/semiconductors/newsView/ked202110290013.

together with other companies of the SK Group, also develops AI chips (which are manufactured by the Taiwan Semiconductor Manufacturing Company, TSMC).[31]

Samsung's semiconductor division is one of the largest in the world and, similar to SK Hynix, is especially strong in the memory chip market. However, Samsung is also among the leading companies in the foundry segment of the industry, where it produces advanced system chips. Samsung is one of only three companies (the others being TSMC and Intel) that can manufacture the most advanced system semiconductors.[32] According to Samsung's website, its foundry business is recording an annual growth of approximately 20 per cent and the company invests 'aggressively' in this business by constructing additional production lines with EUV machines for the mass production of 5nm chips. Samsung aims to become the world's number one foundry by 2030, while currently still being a distant second after Taiwan's TSMC.[33] Samsung also hopes to challenge the position of the Taiwanese company by its investments in 3nm production capabilities, while new R&D facilities are also being built.[34] Samsung furthermore has a fabless division that specialises in system semiconductor design.[35] It is an important supplier of memory and advanced system semiconductors in the global market. However, since Samsung is also an end user of semiconductors (for example, for its smartphones), many of the chips it produces are for its own use as well.

Both SK Hynix's efforts to increase its capacities in the foundry business and system semiconductor segment, as well as Samsung's investments in its foundry and design divisions, are in line with the above-mentioned plans presented by the Seoul government to widen South Korea's focus in the industry.[36]

Connections with Dutch players

South Korea is an important industry for the Dutch semiconductor sector. It is one of the largest suppliers of semiconductors and among the few that can produce the most advanced chips, but it does not have a strong equipment sector. The importance of connections between companies in both

[31] Byung-wook Kim, "[CES 2022] SK to launch Sapeon Inc. for AI chip supremacy", *The Korea Herald,* 10 January 2022, https://www.koreaherald.com/view.php?ud=20220109000087.
[32] The Economist, "Chipmaking is being redesigned. Effects will be far-reaching", 23 January 2021, https://www.economist.com/business/2021/01/23/chipmaking-is-being-redesigned-effects-will-be-far-reaching.
[33] Samsung, "Foundry", (visited 8 February 2023), https://semiconductor.samsung.com/about-us/business-area/foundry/; Jeong-Soo Hwang, "Samsung to make 3 nm chips for Nvidia, Qualcomm, IBM, Baidu", 22 November 2022, https://www.kedglobal.com/korean-chipmakers/newsView/ked202211220027.
[34] Samsung, "Samsung Begins Chip Production Using 3nm Process Technology With GAA Architecture", 30 June 2022, https://news.samsung.com/global/samsung-begins-chip-production-using-3nm-process-technology-with-gaa-architecture; Samsung, "Samsung Electronics Breaks Ground on New Semiconductor R&D Complex in Giheung, Korea", 19 August 2022, https://news.samsung.com/global/samsung-electronics-breaks-ground-on-new-semiconductor-rd-complex-in-giheung-korea.
[35] Samsung, "The dream of artificial intelligence realized with system LSI" (visited 8 February 2023), https://semiconductor.samsung.com/about-us/business-area/system-lsi/.
[36] Samsung, "Samsung Electronics to Boost Investment in Logic Chip Businesses to KRW 171 Trillion by 2030", 13 May 2021, https://news.samsung.com/global/samsung-electronics-to-boost-investment-in-logic-chip-businesses-to-krw-171-trillion-by-2030.

countries was underlined when South Korean President Yoon Suk Yeol and Dutch Prime Minister Mark Rutte agreed to strengthen cooperation in high-tech areas (including semiconductors) and elevated diplomatic relations between South Korea and the Netherlands to the level of 'strategic partnership' in November 2022.[37]

For Dutch equipment manufacturer ASML, South Korea was its second largest sales market in 2021, just behind Taiwan. That year, total sales to South Korea reached more than 6.2 billion euros, representing one-third of total net sales.[38] To support its sales in South Korea, ASML has a local sales and customer support office. Moreover, the company also operates a repair and service centre, a research lab at Hangyang University, a manufacturing and refurbishment location in Pyeongtaek, and an office and cleanroom facility in Hwasung.[39] According to its website, over 1,400 people work for ASML in South Korea.[40] New facilities are also being built in South Korea, including training and repair centres.[41] In 2021, ASML reported that it did not have noteworthy R&D activities in South Korea.[42]

Dutch equipment manufacturer ASMI is also very active in South Korea. The country, with important customers such as Samsung and SK Hynix, represents the second largest sales market for ASMI and is also home to several important suppliers. ASMI operates a manufacturing and R&D facility in Dongtan, which it is looking to enlarge. The number of ASMI employees in South Korea in 2021 was 392, representing 12 per cent of ASMI's total number of employees. ASMI also collaborates with academic institutions in South Korea on research projects.[43]

Dutch chipmaker NXP has two sales and support locations in South Korea (in Seoul and Gyeonggi-do).[44] This is unsurprising, considering that among NXP's ten largest original equipment manufacturer (OEM) end customers, three are South Korean: Samsung; LGE; and Harman Auto (a Samsung subsidiary). Nonetheless, NXP's revenue in South Korea in 2021 was relatively limited: 467 million USD (only 4 per cent of its global revenue).[45]

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[37] Government of the Netherlands, "Joint Statement on the Establishment of a Strategic Partnership between the Government of the Republic of Korea and the Government of the Kingdom of the Netherlands", 23 November 2022, https://www.government.nl/documents/diplomatic-statements/2022/11/17/joint-statement-on-the-establishment-of-a-strategic-partnership-between-the-government-of-the-republic-of-korea-and-the-government-of-the-kingdom-of-the-netherlands.
[38] ASML, "Annual Report 2021" (visited 8 February 2023), https://www.asml.com/en/investors/annual-report/2021.
[39] ASML, "Annual Report 2021"; for the website of the lab at Hanyang University, see: http://asmllab.hanyang.ac.kr/kor/page/index.php
[40] ASML, "Working in South Korea" (visited 8 February 2023), https://www.asml.com/en/careers/working-at-asml/south-korea.
[41] Hyeong-woo Kan, "ASML to strengthen foothold in Korea: CEO", 15 November 2022, https://www.koreaherald.com/view.php?ud=20221115000589.
[42] ASML, "Annual Report 2021".
[43] ASMI, "Growth through Innovation. Annual Report 2021" (visited 8 February 2023), https://www.asm.com/Downloads/2021_ASMI_Annual_Report.pdf.
[44] NXP, "NXP in Korea" (visited 8 February 2023), https://www.nxp.com/company/about-nxp/worldwide-locations/korea:KOREA.
[45] NXP, "Annual Report 2021", (visited 8 February 2023), https://www.nxp.com/docs/en/supporting-information/2021-IFRS-STATUTORY-ANNUAL-REPORT.pdf.

Smaller Dutch companies also have connections with South Korea. Equipment manufacturer BESI, for example, operates a sales office in Seoul and aims to increase its penetration of the Korean market. BESI's revenue in 2021 in South Korea was 64 million euros (8.5 per cent of its total revenue).[46] Furthermore, Nearfield Instruments opened a subsidiary in South Korea in 2021 in order to support the introduction of its machines at Samsung, which in 2017 had invested in the Dutch company to develop further its equipment.[47] In 2021, Nearfield received further investment from a South Korean investor (Eugene Investment & Securities Co.).[48] In addition, Dutch biochemical company Corbion has an office in Seoul to support its sales to South Korean semiconductor companies, which increasingly value the use of bio-based chemicals.[49]

3. International positioning and connections

Geopolitical developments

South Korea finds itself, even more than many other countries, wedged between the technology ambitions of the United States and China. Both the US and China are pressuring Seoul to align with their country's interests, but South Korea is traditionally quite successful in avoiding picking one side over the other in the US–China rivalry. This is crucial, as Seoul relies on the United States for its security in the face of North Korean threats, while South Korea's economy is very dependent on China, as 30 per cent of South Korean exports are shipped to China or Hong Kong.[50]

However, this balancing act has become increasingly difficult to perform now that the rivalry between the two superpowers is intensifying. Recently, the South Korean government opted to align itself further with the US in the area of security, deploying an advanced American missile-interceptor defence system (named THAAD) and increasing its military cooperation both with Washington and Tokyo. China opposes these moves and considers them as running counter to its own security interests.

[46] BESI, "Annual Report 2021" (visited 8 February 2023), https://www.besi.com/fileadmin/data/Investor_Relations/_Semi__Annual_Reports/Annual_Report_2021.pdf.
[47] Innovation Industries, "Innovation Industries And Samsung Ventures Investment Corporation Invest In TNO Spin-Off Nearfield Instruments B.V.", 5 September 2017, https://www.innovationindustries.com/news/innovation-industries-and-samsung-ventures-investment-corporation-invest-in-tno-spin-off-nearfield-instruments-b-v; Paul van Gerven, "Nearfield Instruments richt Koreaanse dochter op", *High-Tech Systems*, 28 June 2021, https://hightechsystems.nl/artikel/nearfield-instruments-richt-koreaanse-dochter-op/.
[48] Computable, "12 mln voor chipmeettechniek Nearfield Instruments", 3 August 2021, https://www.computable.nl/artikel/nieuws/technologie/7224084/5182002/12-mln-voor-chipmeettechniek-nearfield-instruments.html.
[49] Corbion, "Contact Asia" (visited 8 February), https://www.corbion.com/en/About-Us/Our-company/Our-global-presence/Asia.
[50] The New York Times, "'Yankees, Go Home!': Seoul Gets Squeezed Between the U.S. and China", *19 October 2022,* https://www.nytimes.com/2022/10/19/world/asia/korea-china-us-thaad-missiles.html; WITS (World Bank), "Korea, Rep. Trade" (visited 8 February 2023), https://wits.worldbank.org/CountrySnapshot/en/KOR.

In response to THAAD, Beijing retaliated by restricting Chinese tourism to South Korea, as well as South Korean exports to China.[51]

As competition between China and the United States is increasingly tense in the area of technology, South Korea's semiconductor industry is particularly affected. First, President Biden is trying to convince Seoul to join his proposed initiative to increase coordination and collaboration between US allies in the semiconductor sector. The programme, dubbed the 'Chips 4 Alliance', is widely interpreted as not only serving to secure the supply of chips to the United States, but also as countering China's growing power in the industry.[52] Japan and Taiwan have also been invited to join this grouping and appear relatively open to joining forces with the US, while South Korea has expressed wariness.

Seoul's caution is understandable, since China strongly opposes the alliance (to which it was not invited) and is urging South Korea not to join. Chinese state media outlet *Global Times* has called the alliance a 'semiconductor barrier' against China and has stated that if South Korea joins the initiative, this would be equivalent to 'committing commercial suicide'.[53] Such language has to be taken seriously in Seoul, considering that almost 60 per cent of South Korean chips are exported to China.[54] In August 2022, South Korean Foreign Minister Park assured his Chinese counterpart that when South Korea meets with the United States on semiconductors, it is not intended to isolate any specific country.[55] Nonetheless, in December 2022, South Korean media outlets reported that South Korea was seriously considering joining the initiative.[56]

Another issue facing South Korea's semiconductor industry is the fact that the new US Chips Act (see chapter 3) restricts the operations of South Korean semiconductor companies in China. The Chips Act prohibits shipments to China of certain advanced semiconductor-related products that contain US technology or involve US personnel. This also applies to the Chinese facilities of foreign companies. Because of the Chips Act, South Korean companies such as Samsung and SK Hynix, which have extensive production facilities in China, need permission from the United States to ship some of the equipment used at their Chinese microchip fabrication plants (known as fabs). For now, both companies have received a one-year waiver regarding the restrictions.[57]

[51] The New York Times, "'Yankees, Go Home!'".
[52] Arjun Gargeyas, „The Chip 4 Alliance Might Work on Paper"; Financial Times, „US struggles to mobilise its East Asian 'Chip 4' alliance".
[53] Global Times, "S.Korea should have courage to say 'no' to US coercion: Global Times editorial", 21 July 2022, https://www.globaltimes.cn/page/202207/1271044.shtml.
[54] He-rim Jo, "Minister confirms South Korea's participation in US-led chip alliance", *The Korea Herald*, 18 December 2022, https://www.koreaherald.com/view.php?ud=20221218000120.
[55] Esther Chung, "Park tries to assuage Wang on chips in Qingdao", *Korea JoongAng Daily,* 10 August 2022, https://koreajoongangdaily.joins.com/2022/08/10/national/diplomacy/korea-china-semiconductor/20220810170408001.html.
[56] He-rim Jo, "Minister confirms South Korea's participation in US-led chip alliance".
[57] Reuters, "Samsung gets one-year exemption from new U.S. chip restrictions on China – WSJ", 13 October 2022, https://www.reuters.com/technology/samsung-gets-one-year-exemption-new-us-chip-restrictions-china-wsj-2022-10-13/.

Despite this waiver, Samsung and SK Hynix are unable to bring all the equipment they want to their facilities in China. For example, the US regulations still require licences for the export of certain equipment from other companies, such as ASML, to entities in China.[58] This potentially obstructs SK Hynix's plans to upgrade one of its Chinese manufacturing sites with ASML's advanced EUV machines. How the US restrictions will unfold in practice is still unclear, although Washington is lobbying the Dutch government to block also the shipment to China of less advanced equipment (such as ASML's deep ultraviolet (DUV) machines).[59]

Another effect of the US Chips Act is that it offers large incentives for major semiconductor manufacturers around the world, including in South Korea, to invest in the United States. Samsung, for example, might benefit from these provisions with its investments in a semiconductor plant in Texas.[60] However, what complicates the situation is that a recipient of such benefits under the Chips Act is not allowed to expand its semiconductor manufacturing capabilities in China for ten years. This might pose problems for Samsung with its large facilities in China.[61]

Relevant political relations with other countries in the region

Japan is an important player for South Korea in the semiconductor sector and the two countries appear to complement one another. While South Korea is strong in chip manufacturing, Japan is strong in the equipment and advanced materials segments of the value chain. However, political relations between the two countries sometimes stand in the way of this complementary relationship.

In 2019, a trade dispute flared up when Tokyo strengthened export restrictions on certain high-tech goods to South Korea and downgraded South Korea's status as a trade partner in response to a ruling by South Korea's Supreme Court on compensations for Japanese activities during Japan's occupation of the Korean peninsula (1910–1945).[62] Among the restricted goods are three materials that are critical for semiconductor production and for which Japan has a dominant position in the global market.[63] This gave rise to an effort by South Korea to invest in domestic production of these items,

[58] Alexandra Alper and Karen Freifeld, "Exclusive: Samsung, SK Hynix to be spared brunt of China chip crackdown by U.S.", *Reuters*, 7 October 2022.
[59] Robyn Mak, "Chip dilemma will buy Beijing precious time", *Reuters*, 19 December 2022, https://www.reuters.com/breakingviews/chip-dilemma-will-buy-beijing-precious-time-2022-12-19/; Eun-jee Park and Ho-Jeong Lee, "U.S. grants waiver to SK hynix for tech transfers to China", *Korea JoongAng Daily* 12 October 2022, https://koreajoongangdaily.joins.com/2022/10/12/business/tech/Korea-US-export-control/20221012180226419.html.
[60] Eun-jin Kim, "Tax Cuts in the U.S. and Korea to Give Momentum to Samsung's Future Investment", *BusinessKorea*, 4 January 2023, http://www.businesskorea.co.kr/news/articleView.html?idxno=107165.
[61] Jae Chang and Andy Hong, "CHIPS Act: Outlook and Implications for South Korea", 24 August 2022, *KEI*, https://keia.org/the-peninsula/chips-act-outlook-and-implications-for-south-korea/.
[62] Ian Bremmer, "Why the Japan-South Korea Trade War Is Worrying for the World", *Time*, 3 October 2019, https://time.com/5691631/japan-south-korea-trade-war/.
[63] The Korea Herald, "S. Korea earmarks W841b for key materials, parts development", 3 February 2022, https://www.koreaherald.com/view.php?ud=20220203000584.

in order to decrease its dependence on Japan. In some cases, import dependencies on Japan did lessen, while some Japanese companies expanded their production capacity in South Korea in order to circumvent the restrictions.[64] However, South Korean companies continue to import most of the materials from Japan on a large scale. Samsung, for example, remains a crucial customer for Japanese material suppliers.[65]

In 2022, Tokyo and Seoul began an effort to improve their diplomatic ties under their new leaderships.[66] Apart from advanced materials, the connections with Japan are also strong in the area of equipment. In 2021, South Korean imports of such equipment from Japan grew to $6.3 billion USD worth, making it the top import by value.[67] In 2020, 26 per cent of the semiconductor equipment used by Samsung and other South Korean companies was supplied by Japanese businesses.[68]

China is another country with which the South Korean semiconductor industry has many connections. First, Chinese memory chip manufacturers are increasingly competing with those from South Korea.[69] Second, South Korea is very reliant on China as a sales market for semiconductors: almost 60 per cent of South Korean chips are exported to China, representing about 40 per cent of the total value of South Korean semiconductor exports in 2021.[70] Third, Samsung and SK Hynix both have very large manufacturing plants in China. 40 per cent of Samsung's NAND flash memory chip production takes place at its plant in Xi'an, which equals 10 per cent of global output.[71] SK Hynix produces 50 per cent of its dynamic random-access memory (DRAM) chips in Wuxi, representing 15 per cent of the world's production.[72]

Taiwan is mainly a competitor of the South Koreans' semiconductor industry. TSMC is, together with Intel in the United States, the only company with the capacity to compete with Samsung in the area of advanced chips. Considering that the South Korean industry is aiming to reduce its focus on the

[64] Eun-Jee Park and Young-min Kim, "Japanese firms start making photoresists in Korea", *Korea JoongAng Daily,* 2 July 2020, https://koreajoongangdaily.joins.com/2020/07/02/business/industry/photoresist-TOK-EUV/20200702200000423.html; Korea JoongAng Daily, "Korea significantly reduces dependence on Japan", 1 July 2021, https://koreajoongangdaily.joins.com/2021/07/01/business/economy/Japan-Trade-war-Ministry-of-Trade/20210701152200453.html.
[65] Hosokawa Kotaro, "South Korea struggles to decouple from Japan in key chipmaking materials", *Nikkei Asia*, 28 June 2022, South Korea struggles to decouple from Japan in key chipmaking materials - Nikkei Asia.
[66] Alastair Gale and Timothy W. Martin, "Japan and South Korea Seek Diplomatic Reset With Change of Leadership in Seoul", 26 April 2022, https://www.wsj.com/articles/japan-and-south-korea-seek-diplomatic-reset-with-change-of-leadership-in-seoul-11650966395.
[67] Hosokawa Kotaro, "South Korea struggles".
[68] Eun-jin Kim, "South Korea Still Heavily Dependent on Semiconductor Equipment from Japan", *BusinessKorea*, 7 September 2020, http://www.businesskorea.co.kr/news/articleView.html?idxno=51363.
[69] Samsung, "역동적 혁신성장을 위한 삼성의 미래 준비".
[70] He-rim Jo, "Minister confirms South Korea's participation in US-led chip alliance"; Ji-Eun Jeong, "Korean chip exports to China rise thirteenfold in 21 years", *The Korean Economic Daily*, https://www.kedglobal.com/economy/newsView/ked202208220014.
[71] Eun-jee Park and Ho-Jeong Lee, "U.S. grants waiver to SK hynix for tech transfers to China".
[72] Che Pan, "Tech war: SK Hynix executive says Korean chip maker may sell China fab under 'extreme' US pressure", *SCMP*, 26 October 2022, https://www.scmp.com/tech/tech-war/article/3197331/tech-war-sk-hynix-executive-says-korean-chip-maker-may-sell-china-fab-under-extreme-us-pressure.

memory chip market and grow in the more-advanced chip and foundry segments, competition with TSMC might very well only increase. The competition between Taiwan's TSMC and South Korea's Samsung and SK Hynix can also be affected by the geopolitical considerations of other companies. For example, when important foundry clients are looking to reduce their reliance on one company, they could therefore opt to become a customer of both Samsung and TSMC.[73]

Samsung also has plans to increase its presence in **Singapore**, where it has entered a joint venture with German company Siltronic to construct a new 2 billion euro 300nm manufacturing facility in the city-state by the end of 2024.[74] In **India**, Samsung has plans to expand semiconductor R&D facilities.[75]

4. Implications for the Dutch semiconductor sector

South Korea is an important semiconductor industry for the Netherlands. Samsung and SK Hynix are among the largest customers of equipment manufacturers such as ASMI and ASML. South Korea is also an important sales market for NXP, while ASML and ASMI collaborate with South Korean academic institutions. These connections are affected by geopolitical pressures, domestic government policies and regional relations in the following ways.

The South Korean government, together with the private sector, has committed itself to serious investments in the semiconductor sector, in particular in non-memory segments such as system chips and the foundry business. This could provide opportunities for Dutch equipment manufacturers to supply the new plants with much-needed equipment. Furthermore, although some memory chip manufacturers also make use of EUV machines, this technology is essential for producing the most advanced system chips. South Korea's turn towards system chips and the foundry business means that demand for this ASML technology could grow even further. This can also benefit other Dutch actors in these segments, now that South Korean companies will be looking for R&D partners.

Another potentially beneficial development for the Netherlands is South Korea's aim to decrease its dependence on Japan because of the two countries' highly political trade dispute, which exposed South Korea's reliance on Japan for certain semiconductor-related goods. Seoul is already diversifying

[73] Eun-jin Kim, "Samsung and TSMC Competing to Secure Foundry Customers", *BusinessKorea,* 1 December 2022, http://www.businesskorea.co.kr/news/articleView.html?idxno=105184.
[74] Sharon See, 'Global Chipmakers' Investments in Singapore', *The Business Times*, 22 July 2022, https://www.businesstimes.com.sg/government-economy/global-chipmakers-investments-in-singapore.
[75] Samsung, "Samsung Strengthens its India Commitment, Plans to Hire around 1,000 Engineers from IITs & Top Engineering Institutes to Work on Cutting-Edge Technologies like AI, ML, IoT & Deep Learning", 30 November 2022, https://news.samsung.com/in/samsung-strengthens-its-india-commitment-plans-to-hire-around-1000-engineers-from-iits-top-engineering-institutes-to-work-on-cutting-edge-technologies-like-ai-ml-iot-deep-learning.

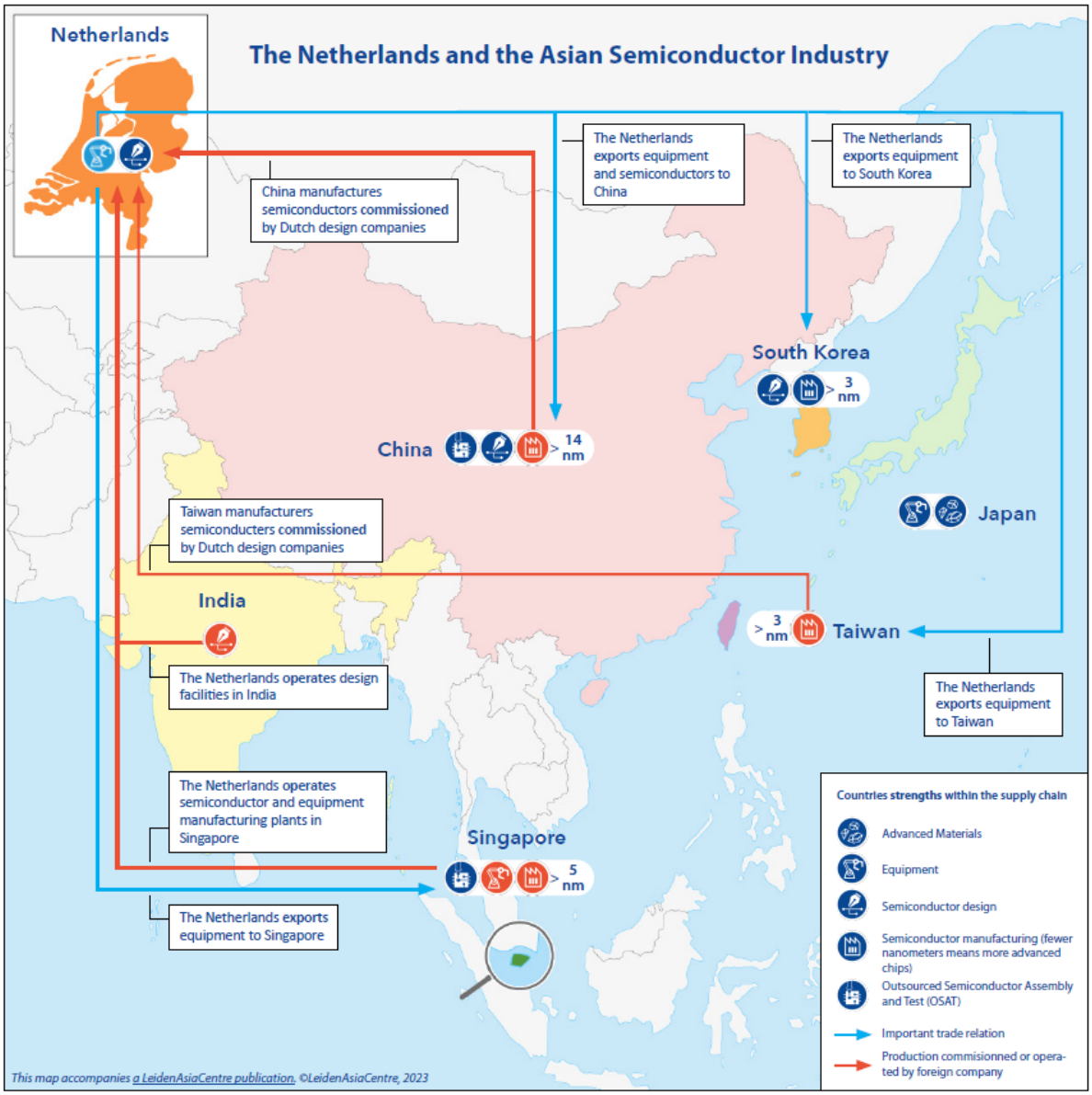
its supplies of many materials.[76] Its diversification strategy away from Japan could provide opportunities for Dutch equipment makers, since Japan is also strong in this segment of the supply chain. Furthermore, South Korea's government and private sector are investing in domestic production capabilities for materials and equipment in order to overcome dependency on Japan. This, similarly, provides opportunities for Dutch companies, which can collaborate with South Korean partners on R&D or on joint ventures in these segments.

However, the political developments that affect the South Korean semiconductor industry also have potentially negative effects for Dutch players in this sector. The fact that SK Hynix and Samsung are no longer able to expand their facilities in China without having to consider restrictions by the United States could damage Dutch equipment suppliers. Obviously, it is unfortunate for ASML that some of their biggest non-Chinese customers have large facilities in China. On the other hand, if Washington manages to persuade these companies to open plants in the United States instead, this could make up for the potential losses of these equipment suppliers.

Another potential negative effect for the Netherlands is that South Korea's investments in domestic production of semiconductor equipment in order to lessen foreign dependencies could, in the long run, mean more competition from South Korea in the equipment market. However, Dutch equipment manufacturers argue that they will continue to invest in order to stay ahead of any competition and continue to lead this segment of the industry.

[76] Joyce Lee and Hyunjoo Jin, "South Korea government, Samsung team up for self-sufficiency after Japan export curbs on chip material", *Reuters*, 14 September 2020, https://www.reuters.com/article/us-southkorea-japan-chip-analysis-idUSKBN26501U.

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