China

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The Chinese semiconductor sector has grown rapidly in recent years and the country has become a major player in the global semiconductor industry. China has the world's largest market for semiconductors, turned itself into a major chips producer and is home to many leading semiconductor companies. This is the result of large investments and efforts made by China's private sector, but also very much by the Chinese government through investments in R&D, favourable policies for domestic companies, tax incentives, and the establishment of technology parks and incubators. China is also a very significant market and partner for Dutch semiconductor players.

Despite its extensive domestic production, China is still heavily dependent on imports for many types of semiconductors, particularly high-end chips. It is exactly this sore spot of dependency where the US is applying pressure since Washington began to actively frustrate the development of China's technological capabilities. China finds itself in a geopolitical competition with the US, and increasingly with Washington's allies, and there are few areas as affected as the semiconductor industry.

This chapter discusses the policies and role of the Chinese government in China's semiconductor industry. It then examines the makeup of the sector in China, its connections with the Netherlands, China's geopolitical positioning and the relevant relations with other countries in the region. Finally, the implications of the geo- and regional political situation for the interests of the Dutch semiconductor sector are analysed.

1. The role of the Government

The Chinese government actively works to develop China's semiconductor industry and reduce its dependence on foreign companies. The government provides funding for R&D, encourages the formation of domestic semiconductor companies, attracts foreign investment, promotes foreign technology transfer, secures its supply chain, protects Chinese intellectual property, and implements regulations and policies to control the export of certain semiconductor products.

The government's long term plans for the semiconductor industry can be distilled from the country's many and often overlapping industry plans. These plans are mostly drafted at the central-government level, but implemented at local-government level, for which local authorities draft their own roadmaps. Local governments sometimes have surprising leeway with the implementation and funding of these plans. The list below contains an overview of important government policies that directly or indirectly concern semiconductors. The most relevant are discussed in detail.

National Standardization Development Outline Action Plan[1] National Standardization Development Outline[2]	2021
14th Five-Year Plan for National Informatisation[3]	2021
14th Five Year Plan (2021-2025)[4]	2020
Notice of the State Council on Issuing Several Policies for Promoting the High-quality Development of the Integrated Circuit Industry and the Software Industry in the New Era[5]	2020
China Standards 2035[6]	2018
Made in China 2025[7]	2015
Guidelines to Promote National Integrated Circuit Industry Development[8]	2014

[1] Xinhua News Agency, „中共中央 国务院印发《国家标准化发展纲要》“, 10 October 2021, https://gkml.samr.gov.cn/nsjg/bzjss/202207/t20220708_348515.html.

[2] Xinhua News Agency, „中共中央 国务院印发《国家标准化发展纲要》“, 10 October 2021, http://www.gov.cn/zhengce/2021-10/10/content_5641727.htm.

[3] Rogier Creemers et al., "Translation: 14th Five-Year Plan for National Informatization – Dec. 2021", *DigiChina*, 24 January 2022, https://digichina.stanford.edu/work/translation-14th-five-year-plan-for-national-informatization-dec-2021/.

[4] Xinhua News Agency, "中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要", 13 March 2021, https://www.fujian.gov.cn/english/news/202108/t20210809_5665713.htm.

[5] State Council, "国务院关于印发新时期促进集成电路产业和 软件产业高质量发展若干政策的通知", 27 July 2020, http://www.gov.cn/zhengce/content/2020-08/04/content_5532370.htm.

[6] Chinanews.com, "国家标准委：正制定《中国标准 2035》", 10 January 2018, https://www.chinanews.com.cn/gn/2018/01-10/8420700.shtml.

[7] State Council, "国务院关于印发《中国制造 2025》的通知", 8 May 2015, http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm.

[8] Ministry of Industry and Information Technology, "工信部正式公布《国家集成电路产业发展推进纲要》", 26 June 2016, http://www.cac.gov.cn/2014-06/26/c_1111325916.htm.

The **14th version of the five year plan** of China's Communist Party calls for the digital transformation of China's society, making everything, from classrooms to courts, "smart". This transformation requires key digital technologies, according to the plan, including high-end semiconductors.[9] The **14th Five-Year Plan for National Informatisation** provides a more detailed blueprint of this digitalisation. Regarding semiconductors, the plan calls for an acceleration of key technological breakthroughs, and the development of key materials such as design tools and equipment. The plan furthermore calls for the cultivation of an advanced dedicated chip ecosystem and the strengthening of chip research.[10]

The **Notice of the State Council on Issuing Several Policies for Promoting the High-quality Development of the Integrated Circuit Industry and the Software Industry in the New Era** stems from 2020. This policy promotes the development of chips and software and includes detailed tax benefit policies for different kinds of chip projects. For example, the notice stipulates that companies with chip-projects for 28 nm chips or smaller are exempted from corporate income taxes for 10 years, while companies producing and designing chips are exempt from import duties on the equipment they use. The notice also includes directions on how different government levels should support the industry through investments and other forms of financing. Furthermore, it calls for standardisation efforts in the industry and sets out policies that encourage the development of R&D, skilled personnel and international cooperation.[11]

Made in China 2025 is both a strategic- and an industrial policy plan launched in 2015 to develop China's industry sector towards more advanced manufacturing. It focuses on 10 Key Industries, including Information Technology, Robotics and Green Energy & Vehicles, for which semiconductors are indispensable. The plan sets up various new development funds. According to research by the US Congress, MIC 2025 was linked to 1800 funds with a valuation of 426 billion USD in 2018.[12] Semiconductors are also specifically mentioned, and the plan calls for improving design capabilities, enriching intellectual property, improving the capabilities of the packaging and testing industry, and the formation of key manufacturing equipment supply capabilities. The goal of the plain is to produce

[9] Xinhua News Agency, "中华人民共和国国民经济和社会发展第十四个五年规划和 2035 年远景目标纲要", 13 March 2021, https://www.fujian.gov.cn/english/news/202108/t20210809_5665713.htm.
[10] Rogier Creemers et al., "Translation: 14th Five-Year Plan for National Informatization – Dec. 2021", *DigiChina*, 24 January 2022, https://digichina.stanford.edu/work/translation-14th-five-year-plan-for-national-informatization-dec-2021/.
[11] State Council, "国务院关于印发新时期促进集成电路产业和 软件产业高质量发展若干政策的通知", 27 July 2020, http://www.gov.cn/zhengce/content/2020-08/04/content_5532370.htm.
[12] Jie Lu and Yann Morell y Alcover, "China: Navigating the push towards technology leadership", https://insuranceaum.com/wp-content/uploads/2021/10/China-navigating-the-push-towards-technology-leadership_ROBECO.pdf, see note 7 at page 7.

40% of the Chinese semiconductor demand domestically by 2020, and 70% by 2025 (the latter goal was later changed to 80% by 2030). [13]

The **Guidelines to Promote National Integrated Circuit Industry Development** launched in 2014 to support the chip sector. It includes provisions for chip design, research in equipment and materials and the development of the packaging and testing industry. The guidelines also encourage chip companies to go public, calls for preferential tax policies, a national investment fund (this became the Big Fund, see below), and to boost overseas cooperation. The guidelines also include chapters on training and attracting talented personnel, including from abroad. [14] It is important here to also mention the Thousand Talents Program, which was a scheme to attract foreign researchers to work for Chinese companies, universities, and other R&D institutions. After receiving negative attention outside of China, the plan was eventually renamed and moved away from the spotlights, but still exists.[15]

Also worth mentioning is that strengthening the capabilities and self-reliance of China's defence sector is one of the reasons why the Chinese government actively invests in developing the domestic semiconductor industry and in reducing the dependence on foreign companies. The sector is a key supplier of the country's defence industry, with semiconductors being used in a variety of defence applications, such as communication systems, radar systems, and guidance systems. One of the strategies to strengthen China's defence is the practice of "civil-military fusion". This refers to the integration of civilian and military resources and technologies in order to improve the military's capabilities. This can include things like using civilian technologies in military equipment, or having military personnel work in civilian research and development. China's "civil-military fusion" policy also applies to the semiconductor industry.

Government Funds

In order to realise the ambitious plans of the Chinese government for the semiconductor sector in the country, many funds have been founded to direct financial support to the industry. These do not just hand out cash, but actually invest and hold shares in many different companies. The funds are often

[13] State Council, "国务院关于印发《中国制造 2025》的通知", 8 May 2015, http://www.gov.cn/zhengce/content/2015-05/19/content_9784.htm.

[14] Ministry of Industry and Information Technology, "工信部正式公布《国家集成电路产业发展推进纲要》", 26 June 2016, http://www.cac.gov.cn/2014-06/26/c_1111325916.htm.

[15] In 2019, the plan was renamed to: High-End Foreign Expert Recruitment Program, and merged with several other similar schemes. In 2022, the plan was renamed and reorganized once again. The current name is National Foreign Expert Project. Chinese R&D institutes are still recruiting, see for example this webpage of Wuxi University: "关于申报 2022 年度国家外国专家项目的通知", 18 March 2022, https://gjjy.cwxu.edu.cn/info/1124/1396.htm http://international.cumt.edu.cn/72/cb/c6289a619211/page.htm.

overseen by a semi-private entity, like a government-backed investment company. For the semiconductor industry, two national funds stand out.

The **China Integrated Circuit Industry Investment Fund (CICF) Phase II** is also known as the "Big Fund II" and controls 204 billion CNY (31.8 billion USD).[16] As the name indicates, it is a successor to an earlier fund that contained about half that amount for the 2014-2019 period. The new fund is managed by a subsidiary of the China Development Bank (CDB).[17] Main investors are the Ministry of Finance and various central and local state-owned funds and companies. Its investment field covers the entire industrial chain of integrated circuit design, manufacturing, packaging and testing. The aim of the fund is to help leading enterprises to grow, to accelerate investments in core equipment such as lithography machines, to ensure the security of the industrial chain and to create a supply system for the integrated circuit industry chain with a focus on upstream equipment and materials.[18] Secondly, the **Advanced Manufacturing Industry Investment Fund** was established to support the development goals of Made in China 2025 with an initial capital of €2,7 billion, which later grew to €6,85 billion.[19] The scope of the fund is wide, but it also invests in semiconductor companies.

Besides the national funds, there are numerous funds backed by local governments. Similar to the national level, investors in these funds include a mix of (other) local government investment funds, local private investment funds, local banks, and companies. It appears that nobody keeps track of the combined amount of money that is supposed to sit in these funds.

The ownership structure of companies in which such funds invest is often very vague, as these companies undergo seemingly endless changes of shareholders. There is a lot of reporting in Chinese media about these dealings, so it is not exactly a secret, but it is still unclear to what extent the government funds are actually involved. There also have been numerous allegations of corruption concerning the funds. [20] One of the main problems is that directors of the funds are often also directors

[16] In Chinese, the Phase II fund is most often referred to by the same name as the first: 国家集成电路产业投资基金股份有限公司, but sometimes as 国家集成电路产业投资基金**二期**股份有限公司二期; Eudora Wang, "China Closes $29B 'Big Fund II' To Catch Up In Global Semiconductor Race – CSJ", *China Money Network*, 26 July 2019, https://www.chinamoneynetwork.com/2019/07/26/china-closes-29b-big-fund-ii-to-catch-up-in-global-semiconductor-race-csj.

[17] Shunsuke Tabeta, "China launches graft probe into another chip 'Big Fund' exec", *Nikkei Asia*, 21 September 2022, https://www.cbinsights.com/investor/sino-ic-capital.

[18] East Money, "国家集成电路产业投资基金二期成立，这两只股将笑傲市场", 29 October 2019, https://caifuhao.eastmoney.com/news/20191028100453943581980.

[19] SASAC, "国投参与出资设立的先进制造产业投资基金成立", 12 June 2016, http://www.sasac.gov.cn/n2588025/n2588124/c3822803/content.html.

[20] Eduardo Jaramillo, "After a year of corruption scandals, China's national chip fund forges ahead", *The China Project*, 4 January 2023, https://thechinaproject.com/2023/01/04/after-a-year-of-corruption-scandals-chinas-national-chip-fund-forges-ahead/; Barry van Wyk, "Mayhem in China's semiconductor industry as 'chips madmen' are arrested", *The China Project*, 1 August 2022, https://thechinaproject.com/2022/08/01/chinas-microchip-great-leap-forward-has-also-ended-in-chaos/.

at other investment funds *and* hold positions at semiconductor companies. Another problem is that funds invest in companies that are themselves shareholders of the funds.

Government organisations

In China, industry associations (such as the Chinese Semiconductor Industry Association (CSIA)) are not independent entities, but approved, regulated, controlled and largely funded by the government. In the case of semiconductors, the main regulator/funder is the Ministry of Industry and Information Technology (MIIT). Another noteworthy organisation is the Advanced Semiconductor Innovation Alliance (CASA). This is an alliance of government entities, research institutes, universities, and state-owned companies, which appears to be an important player in China's military-civil fusion strategy.[21] Finally, the China Center for Information Industry Development (CCID) is a research institute under MIIT that consists of 18 research institutes, more than 20 holding companies, and several fully- or partially state owned companies.[22]

2. Industry overview

China is the world's largest market for semiconductors. Estimates about the share of the Chinese market vary, some stating that sales in China represent more than half of worldwide sales, others put the number around one third. In both cases, total sales in China amount to hundreds of billions USD.[23] In fact, China is the largest export destination for the four other main semiconductor producers (South Korea, Taiwan, US, Japan).[24] This large Chinese consumption stems from the fact that many consumer goods, which use a large amount of chips, are produced in China.[25]

At the same time, China also has become an important producer of chips and is investing heavily, just like many other countries, to expand this capacity. One of its plans is to build 31 fabs between 2020 and 2021.[26] According to the US Semiconductor Industry Association (SIA), Chinese semiconductor companies captured 9% of the global market in 2020.[27] At the same time, China exports by far the

[21] Emily Weinstein, "Don't Underestimate China's Military-Civil Fusion Efforts", *Foreign Policy*, 5 February 2021, https://foreignpolicy.com/2021/02/05/dont-underestimate-chinas-military-civil-fusion-efforts/.
[22] CCID, "About us" (visited 8 February 2023), http://en.ccidgroup.com/ABOUT/About_Us.htm.
[23] Mark Lapedus, "China Accelerates Foundry, Power Semi Efforts", *Semiconductor Engineering*, 22 November 2021, https://semiengineering.com/china-accelerates-foundry-power-semi-efforts/.
[24] Gary Clyde Hufbauer and Megan Hogan, "Major semiconductor producing countries rely on each other for different types of chips", 31 October 2022, https://www.piie.com/research/piie-charts/major-semiconductor-producing-countries-rely-each-other-different-types-chips#:~:text=Each%20of%20the%20five%20major,also%20a%20large%20chip%20importer.
[25] Gary Clyde Hufbauer and Megan Hogan, "CHIPS Act Will Spur US Production but Not Foreclose China", https://www.piie.com/sites/default/files/2022-10/pb22-13.pdf.
[26] Gary Clyde Hufbauer and Megan Hogan, "CHIPS Act Will Spur US Production but Not Foreclose China".
[27] SIA, "China's Share of Global Chip Sales Now Surpasses Taiwan's, Closing in on Europe's and Japan's", 10 January 2022, https://www.semiconductors.org/chinas-share-of-global-chip-sales-now-surpasses-taiwan-closing-in-on-europe-and-japan/.

most semiconductors.[28] However, different sources report different figures and numbers appear at odds with each other. This could be explained by the fact that many non-Chinese companies have manufacturing facilities in China from where the chips are shipped (see section "international connections"), which some appear to consider to be Chinese chips or exports, and others do not.

Despite the large exports, China continues to import a large share of its semiconductors from abroad. According to figures by private-sector market research, only 16% of the semiconductors used by Chinese companies in 2020 were produced domestically. The number is even 6% when foreign-owned chip manufacturing facilities in China are excluded. The Chinese authorities themselves claim that the share of domestic supply was around 30%. Both fall short of the target of the Made in China plan to produce 40% of demand domestically by 2020.[29]

What's more, China is especially strong in producing relatively inexpensive and less advanced semiconductors. This can be illustrated by the fact that the average chip exported from China costs 0.19 USD (in 2021). Japanese chips are even cheaper (0.13 USD), but semiconductors from Taiwan (0.32 USD), South Korea (1.08 USD) and the US (2.16 USD) are considerably more expensive.[30] Furthermore, the price of the average chip that China buys from the US costs 70 times more than the ones it sells to that country (4.28 USD compared to 0.06 USD). China is thus still very dependent on overseas suppliers for advanced semiconductors. As discussed above, China invests heavily in its capabilities to produce more advanced semiconductors, and its technologies are progressing. It is exactly this progress that Washington is looking to slow down with its new export restrictions and by preventing the shipment of advanced equipment to China.

Another area in which China is especially strong is the Outsourced Semiconductor Assembly and Test (OSAT) segment the value chain. The three top Chinese companies in this segment together represent over 35% of the global market share.[31]

China has made significant investments in semiconductor R&D in recent years. The country has established several national labs and research institutes focused on semiconductor technology, and has also provided funding and support for private companies working on semiconductor R&D.

[28] Gary Clyde Hufbauer and Megan Hogan, "CHIPS Act Will Spur US Production but Not Foreclose China".
[29] Shunsuke Tabeta, "'Made in China' chip drive falls far short of 70% self-sufficiency", *Nikkei Asia,* https://asia.nikkei.com/Business/Tech/Semiconductors/Made-in-China-chip-drive-falls-far-short-of-70-self-sufficiency.
[30] Gary Clyde Hufbauer and Megan Hogan, "CHIPS Act Will Spur US Production but Not Foreclose China".
[31] SIA, "China's Share of Global Chip Sales Now Surpasses Taiwan's, Closing in on Europe's and Japan's".

Main Chinese semiconductor companies and research institutes[32]

There are an estimated 15,000 Chinese companies registered as semiconductor enterprises spread out across the complete value chain.[33] The fortunes of chip companies rise and fall fast, depending on market conditions, government policies and US sanctions. The sector is very dynamic, with a continuous stream of new companies, mergers and acquisitions, name-changes, etc. Discussed below are the major Chinese semiconductor companies as of early 2023.

In the foundry business, **Semiconductor Manufacturing International Corporation (SMIC)** stands out as the largest Chinese player, and one of the largest globally. It is partially state-owned and on the Chinese Military Companies and Entity List of the US.[34] It has been hit heavily by US sanctions. Although the company can still buy ASML DUV machines, at least for now, the EUV machine it bought from ASML in 2018 was never delivered.[35] This seriously limits its ability to expand to high-end chip manufacturing. That does not stop SMIC from expanding its current business, such as its recently announced investments in a foundry for the production of 28 nm to 180 nm chips.[36] **Hejian Technology Corporation (HJTC)** is the second largest Chinese foundry after SMIC and was fully acquired by Taiwan's United Microelectronics Corporation (UMC), making it one of the very few Chinese chip makers with 100% overseas ownership. HJCT makes relatively basic chips, the most advanced is 110 nm, that are mainly used in consumer electronics and automotive applications.[37] **Hua Hong Semiconductor** is another important foundry.

Regarding design (fabless) companies, **HiSilicon** is among the major Chinese players. It is a subsidiary of **Huawei Technologies** and mainly designs and manufactures semiconductors for use in Huawei's products. Huawei has been subject to US sanctions since 2019 and is on the Entity List, which restricts the company's access to US technology. This also has a significant impact on HiSilicon, which relies heavily on US technology and equipment for its semiconductor and electronic device production. **Unisoc** (formerly known as Spreadtrum Communications) is another Chinese fabless semiconductor design company. Its main shareholder was bailed out by a consortium including the same company that runs a joint venture with NXP in China and bought Nexperia from NXP. Furthermore, US based

[32] Will HuntSaif M. Khan Dahlia Peterson, "China's Progress in Semiconductor Manufacturing Equipment", March 2021, https://cset.georgetown.edu/publication/chinas-progress-in-semiconductor-manufacturing-equipment/.
[33] SIA, "China's Share of Global Chip Sales Now Surpasses Taiwan's, Closing in on Europe's and Japan's".
[34] U.S. Department of Denfese, "Entities Indentified as Chinese Military Companies Operating in the United States in Accordance with Section 1260H of the William M. ("Mac") Thornberry National Defense Authorization Act for the Fiscal Year 2021 (Public Law 116-238)", (visited 8 February 2023), https://media.defense.gov/2022/Oct/05/2003091659/-1/-1/0/1260H%20COMPANIES.PDF.
[35] Anton Shilov, "Chinese SMIC Tapes Out First N+1 '7 nm' Chip, But Mass Production Uncertain", 18 December 2020, https://www.tomshardware.com/news/chinese-smic-tapes-out-first-n-7-nm-chip-but-mass-production-uncertain.
[36] Channel News Asia, "Chinese chip foundry SMIC to invest $7.5 billion in new fab in Tianjin", 26 August 2022, https://www.channelnewsasia.com/business/chinese-chip-foundry-smic-invest-75-billion-new-fab-tianjin-2902211.
[37] Evertiq, "UMC's Hejian subsidiary resumes production", 24 February 2022, https://evertiq.com/news/51458.

Omnivision was bought by Will Semiconductors in 2018.[38] Will Semiconductor has since adopted 'Omnivision' as their English name. Finally, **GigaDevice** is also a major fabless design company and designs memory chips.

In the IDM segment, **Yangtze Memory Technologies Corporation (YMTC)** is an important player. In recent years, YMTC has made significant technological progress and has begun mass production of its 3D NAND memory semiconductors. YMTC is on the US Entity List, which meant Apple had to cancel its plans to source memory chips from the company.[39] YMTC's CEO, who had a US passport, stepped down in 2022 after becoming vulnerable to US sanction concerning US personnel working for Chips chip firms. [40] Other major IDMs are **ChangXin Memory Technologies (CXMT)** and **Silan Microelectronics**.

Chinese semiconductor manufacturing equipment makers are increasingly able to produce basic equipment for the chip production chain. **Shanghai Microelectronics Equipment (SMEE)** has long been working on the development of 28nm and 20 nm DUV machines.[41] In November 2022, the company announced that it plans to officially mass-produce and commercialise 28nm lithography machine before the end of that year. This pleased Chinese media, after ASML had reportedly stated earlier that "even if they gave Chinese companies drawings, they could not make lithography machines."[42] **Naura Technology Group** is another important player in this segment that produces etchers, deposition equipment, atomic layer deposition equipment (ALD), and cleaning equipment.[43] Other noteworthy equipment producers are **Advanced Micro-Fabrication Equipment Inc. (AMEC), Sai MicroElectronics (SMEI)**, whose purchase of a German chip company was blocked, and **Piotech**.

In the OSAT segment, **JCET** is China's largest company, and among the largest in the world.

[38] Peter Clarke, "OmniVision bought quietly by China's Will Semiconductor", 24 May 2019, https://www.eenewseurope.com/en/omnivision-bought-quietly-by-chinas-will-semiconductor/.
[39] Cheng Ting-Fang, Lauly Li and Yifan Yu, "Apple freezes plan to use China's YMTC chips amid political pressure", *Nikkei Asia,* 17 October 2022, https://asia.nikkei.com/Business/Tech/Semiconductors/Apple-freezes-plan-to-use-China-s-YMTC-chips-amid-political-pressure.
[40] Jiaxing Li, "China's top memory chip maker YMTC replaces CEO amid risks of US sanctions after rumoured Apple deal", *SCMP*, 1 October 2022, https://www.scmp.com/tech/big-tech/article/3194519/chinas-top-memory-chip-maker-ymtc-replaces-ceo-amid-risks-us.
[41] Anton Shilov, "China's 28nm-Capable Chip Fabbing Tool on Track Amid Trade War", 6 December 2020, https://www.tomshardware.com/news/chinas-28nm-capable-chip-fabbing-tool-on-track-amid-trade-war.
[42] iMedia, "A bigger crisis is coming!The domestic 28nm lithography machine just showed the light, ASML immediately "zoomed in"", 5 Febuary 2023, https://min.news/en/tech/08acbf8bdb4973e8b7b9dca55bc92134.html.
[43] Naura, "Semiconductor", visited 8 February 2023, https://www.naura.com/en/index.php/product/product_list/834.html.

R&D

China invests actively in the R&D of its semiconductor industry, with the goal of becoming self-sufficient in the production of semiconductor devices and reducing its dependence on foreign companies. China also works on developing and protecting its own intellectual property in the and promotes foreign technology transfers. Many universities in China have established research centres focused on semiconductor technology which are often supported by government funding. Universities often also have strong industry partnerships, and companies in the semiconductor industry often collaborate with universities on R&D projects. Some of the key areas of focus for Chinese semiconductor research include advanced manufacturing technology, advanced materials such as new types of transistors, artificial intelligence and machine learning technologies (in which China is world leader), and Internet of Things (with a focus on developing chips that enable connected devices).[44]

Two general trends are furthermore noticeable. First, mergers and name-changes of research institutes have been common, but in recent years this seems to intensify. This may be caused by the desire to combine expertise to get more results, and by the desire to avoid possible US sanctions. However, even after an official merger, the original institutes often appear to continue to go their own way. Secondly, there appears to be a shift of R&D activities away from the centre (Beijing and Shanghai) to the provinces. Many provincial capitals are setting up new semiconductor research institutes, often in cooperation with local-state owned companies and local universities.

There are many semiconductor R&D centres in China, some of which are especially worth mentioning. The **School of Integrated Circuits (SIC)** is a new semiconductor research institute at Tsinghua University in Beijing that offers relevant degree programs. There are also several relevant research institutes that are part of the Chinese Academy of Sciences (CAS), such as the **Institute of Computing Technology (ICT), Institute of Microelectronics (IME)** and the **Institute of Semiconductors (SEMI)** that do research on semiconductor related topics. Finally, the **Shanghai Industrial Technology Research Institute (SITRI)** focuses on applied research and development in the fields of advanced manufacturing, materials, and information technology.

[44] Arjun Kharpal, "In battle with U.S., China to focus on 7 'frontier' technologies from chips to brain-computer fusion", *CNBC*, 5 March 2021, https://www.cnbc.com/2021/03/05/china-to-focus-on-frontier-tech-from-chips-to-quantum-computing.html.

Connections with the Netherlands

The relationship between China and the Netherlands in the semiconductor industry is relatively extensive. Major Dutch companies have a strong presence in China and are looking to expand their activities. Below are the most prominent of these companies.

In 2021, **ASML**'s sales in China amounted to €2.74 billion, accounting for 14.7% of ASML's total net sales.[45] That makes China ASML's third largest market worldwide after Taiwan and South Korea. ASML expects business in China to grow, notwithstanding US sanctions. In June 2022, the company announced it would expand its China workforce with 14% or 200 employees.[46] 3% of ASML's R&D employees operate in China. This is comparable to Taiwan and more than in other Asian countries. ASML also sponsors five scholarships in China (compared to 54 in Netherlands, 24 in Taiwan, 7 in the US (and on par with South Korea).[47]

Starting from 2018, the Trump administration pressured the Dutch government to block the shipment of the company's most advanced EUV machine that can make chips of 7nm and smaller to China. Under president Biden, this policy has continued. Washing fears that if China acquires the EUV machine, it will be able to produce the most advanced chips that would strengthen the Chinese military capabilities.[48] At least until recently, ASML was able to export the less advanced DUV machines to the country. In March 2021, Chinese chip maker SMIC announced that it had placed an order of 1.2 billion USD with ASML for DUV machines.[49] There is also an active market for used ASML machines. ASML refurbishes and resells such machines, but Chinese companies are trying to purchase used machines on the international market themselves as well. This process may gain importance if ASML further reduces sales of machinery to China in the future. Chinese companies may buy chip machines in third-countries, either under their own name or by using intermediaries.

In 2021, 38% of **NXP**'s revenue was earned in China, which makes it by far the largest market for NXP. The net value of the company's assets (properties, plants and equipment) in China was 387 million,

[45] South China Morning Post, "Tech war: broader ban on ASML sales to China will hurt firm's revenue and set back Beijing's domestic chip-making drive, analysts say", 19 July 2022, https://www.yahoo.com/lifestyle/tech-war-broader-ban-asml-093000858.html.
[46] South China Morning Post, "Chip-making tools firm ASML to hire 200 staff in China as Covid restrictions ease, including sanctions compliance role", 8 June 2022, https://www.scmp.com/tech/big-tech/article/3180830/chip-making-tools-firm-asml-hire-200-staff-china-covid-restrictions.
[47] ASML, "Annual Report 2021" (visited 8 February 2023), https://www.asml.com/en/investors/annual-report/2021 p. 138, 240.
[48] Alexandra Alper, Toby Sterling, Stephen Nellis, "Trump administration pressed Dutch hard to cancel China chip-equipment sale: sources", *Reuters*, 6 January 2020, https://www.reuters.com/article/us-asml-holding-usa-china-insight-idUSKBN1Z50HN.
[49] Wency Chen, "Chinese chipmaker SMIC inks deal worth USD 1.2 billion with ASML", 4 March 2021, https://kr-asia.com/chinese-chipmaker-smic-inks-deal-worth-usd-1-2-billion-with-asml.

up from 257 in 2020, 15% of total NXP worldwide assets and ranking third after the US and Singapore.[50] NXP's facility in Tianjin is one of their most important back-end facilities worldwide.[51]

NXP runs several joint ventures and joint research programs in China. Datang NXP Semiconductors is such a joint venture between NXP and Datang Telecom Technology (DTT) with NXP controlling 49% of shares.[52] DTT is a subsidiary of state-owned enterprise Datang Telecom Technology & Industry Group, which owns another company that supplies communications network equipment to the Chinese military and conducts research with the military, according to US research.[53] Another joint venture is NXP Qiangxin (Tianjin) IC Design, with NXP having 75% of the shares.[54] This joint venture runs a training platform for local colleges and universities.[55] Furthermore, WeEn is a joint venture between NXP and Beijing JianGuang Asset Management Co. Ltd (JAC Capital).[56] In April 2019, NXP also entered into an agreement with the Chinese Hawkeye Technology which, according to a report, is affiliated with Southeast University (SEU) that is involved in various defence research with the Chinese military.[57]

For **ASM International,** 16% of total revenue is earned in China. Its most recent annual report states that "Notably, the China region has become a significant growth area for new fab investments .This includes both domestic Chinese companies and foreign companies building fabs there for the local market. To better serve this growing market, we are continuing to increase our investment in people and support infrastructure in China."[58] Revenue in China in 2020 had increased 10 times compared to 2017, and the number of employees three times. According to its general manager in China, AMS's Atomic Layer Deposition (ALD) machines are used by nearly every Chinese chipmaker.[59]

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[50] NXP Annual Report 2021, visited 8 February 2023, https://investors.nxp.com/static-files/4c564920-493f-4653-ab69-8ee1101152a4
[51] https://investors.nxp.com/static-files/4c564920-493f-4653-ab69-8ee1101152a4, p.9.
[52] Bits & Chips, "NXP in Chinese power-joint venture", 20 February 2015, https://bits-chips.nl/artikel/nxp-in-chinese-power-joint-venture/.
[53] Bryan Krekel, Patton Adams and George Bakos, "Occupying the Information High Ground: Chinese Capabilities for Computer Network Operations and Cyber Espionage", 7 March 2021, https://www.uscc.gov/sites/default/files/Research/USCC_Report_Chinese_Capabilities_for_Computer_Network_Operations_and_Cyber_%20Espionage.pdf.
[54] 权易汇, "「优质股权」天津强芯半导体芯片设计有限公司混改推介项目", 3 March 2020, https://www.toutiao.com/article/6799577946815201796/?wid=1668003672360.
[55] TEDA, "深耕经开区 20 年 校企合作开创"育才"新模式 恩智浦强芯为泰达引育高端芯片人才超 200 名", 25 April 2022, https://www.teda.gov.cn/tedazt/contents/8999/179205.html.
[56] NXP, "NXP and JAC Capital Complete Bipolar Power JV Following Regulatory Approvals", 9 November 2015, https://www.nxp.com/company/about-nxp/nxp-and-jac-capital-complete-bipolar-power-jv-following-regulatory-approvals:NW-JAC-BIPOLAR-POWER-JV.
[57] Rita Liao, "Dutch chipmaker NXP makes China push by backing radar company Hawkeye", 17 April 2019, https://techcrunch.com/2019/04/17/nxp-backs-hawkeye-china/; ASPI Unitracker, "Southeast University", 12 November 2019, https://unitracker.aspi.org.au/universities/southeast-university/.
[58] ASMI, "Growth through Innovation. Annual Report 2021" (visited 8 February 2023), https://www.asm.com/Downloads/2021_ASMI_Annual_Report.pdf, p. 24.
[59] EE World, "荷兰另一全球 top10 半导体设备厂商 ASMI 中国市场营收三年增 10 倍", 11 April 2021, http://news.eeworld.com.cn/xfdz/ic532486.html.

BE Semiconductor Industries N.V. (Besi) revenue in China in 2021 was €282 million, nearly 38% of Besi's 2021 total revenue. To put that into perspective: China earns Besi almost the same revenue as the next six countries combined. Revenue growth in China was 86.7% in 2021.[60] BESI runs several factories that produce semiconductor equipment in China. Its plant in Leshan is its second-largest worldwide, producing 25% of its global production.[61] China is thus not only a very important market for BESI, but also a crucial location for production.

There are also several connections in other areas. For example, TU Delft opened a Beijing Research Center in cooperation with the Institute of Semiconductors in 2011.[62] There also have been Sino-Dutch semiconductor summer schools, such as between TU Delft and Tsinghua University from 2016-2019.[63] In 2015, TU Delft and the Beijing Shunyi Government (a district in Beijing) signed a "Strategic Cooperation" to set up a semiconductor joint innovation and entrepreneurship incubation centre.[64] The Chinese industry association CSIA has cooperated with Dutch counterpart Holland Semiconductors in the China-Netherlands Semiconductor Industry Cooperation Forum of 2018, during which the latter said it would invest 1 million USD to found a 'Sino-Dutch innovation centre'.[65] There are also certain noteworthy Dutch semiconductor companies that were acquired by Chinese parties, such as Nexperia and Ampleon (former divisions of NXP), Nowi (a company that develops energy-harvesting semiconductors) and Anteryon (a supplier for the semiconductor manufacturing industry).

3. International positioning and connections

Geopolitical positioning

The technological rivalry between the US and China is the major international political issue affecting the Chinese semiconductor industry. The conflict turned *geo*political when the US persuaded other countries to join its efforts to slow down China's development, specifically in the area of semiconductors. Washington has expressed concern that if China becomes technologically highly advanced and self-reliant in the area of semiconductors, it will use these capabilities to upgrade its

[60] Besi, "Annual Report 2021, visited 8 February 2023, https://view.publitas.com/cfreport/besi-annual-report-2021/page/155.
[61] Besi, "Investor Presentation", October 2022, https://www.besi.com/fileadmin/data/Investor_Relations/Investor_Presentations/Investor_Presentation_October_2022.pdf.
[62] Netherlands Innovation Network, "Opening ceremony TU Delft Beijing Research Center", 10 December 2011, https://netherlandsinnovation.nl/uncategorized/opening-ceremony-tu-delft-beijing-research-center/.
[63] TU Delft, "Sino-Dutch Summer School", visited 8 February 2023, https://www.tudelft.nl/en/eemcs/the-faculty/departments/quantum-computer-engineering/sino-dutch-summer-school.
[64] Ministry of Science and Technology, "荷兰代尔夫特理工大学中国研究院落户顺义第三代半导体联合创新基", 28 November 2016, https://www.most.gov.cn/dfkj/bj/zxdt/201611/t20161125_129192.html.
[65] Yuqing Ni, "荷兰半导体协会在华投资百万美元 建中荷创新中心", 12 March 2018, https://m.21jingji.com/article/20180312/herald/7b553eb50e62aa6a06203817ba759424.html, 1 million euro would make more sense, but the source-article clearly mentions USD.

military to a level that challenges the security interests of the US and its allies. Such concerns are fuelled by the Chinese government policies discussed above, which promote the self-sufficiency of China's semiconductor sector and civil-military fusion.

In response, the US has taken several steps, as also mentioned in chapter 3. Chinese companies and research centres which could threaten US security interests or undermine human rights, for example because Washington believes they have ties with China's security apparatus or military, are added to several US blacklists, such as the Entity List or the Military End User List.[66] This restricts or adds control mechanisms for the interactions that US companies can have with these Chinese actors.

The US also introduced stringent export restrictions regarding certain, often advanced, semiconductors and related goods in October 2022. In addition, Washington pressures its allies, notably the Dutch and Japanese government, to prevent the shipment of advanced semiconductor equipment to China, so that Chinese companies are not able to manufacture advanced semiconductors or acquire the necessary technology. After preventing ASML from shipping its most advanced semiconductor manufacturing equipment to China, the Dutch government, along with the government of Japan, appear to have given in to US demands to also restrict the export of less advanced machinery to China.[67] The US furthermore attempts to convince South Korea, Taiwan and Japan to join the so-called Chips 4 Alliance to coordinate on semiconductors and to counter China's development in the sector. See chapter 3 for more details on all of these policies.

Obviously, Beijing condemns these actions by the US and has initiated a dispute settlement case at the WTO over the measures.[68] Chinese state media state that the case demonstrates that China upholds multilateralism, while the US is disrupting global supply chains.[69]

Many Chinese actors, such as the Chinese industry association CSIA, try to put a positive spin on the restriction, stating they spur the founding of more Chinese semiconductor companies and lead to a wider use of Chinese-designed chips.[70] State-media in China also contend that the restriction only motivates Chinese companies to increase their technological capabilities.[71]

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[66] Other lists include: Unverified List (UVL), *the Commerce Control List (CCL), and the list of Chinese military companies.*
[67] Dee-Ann Durbin and Aamer Madhani, "Source: Dutch, Japanese join US limits on chip tech to China", *AP News*, 30 January 2023, *https://apnews.com/article/technology-district-of-columbia-netherlands-china-business-6801d6c5f65b0bc1df6186e2e89a6f7d.*
[68] WTO, "China initiates WTO dispute complaint targeting US semiconductor chip measures", 15 December 2022, https://www.wto.org/english/news_e/news22_e/ds615rfc_15dec22_e.htm.
[69] Si Ma and Zhihua Liu, "Chip suit aims to safeguard supply chains", *ChinaDaily*, 14 December 2022, https://global.chinadaily.com.cn/a/202212/14/WS639902eba31057c47eba43ad.html.
[70] Si Ma and Zhihua Liu, "Chip suit aims to safeguard supply chains".
[71] Si Ma, "US chip tech ban threatens supply chain", 7 October 2022, https://www.chinadaily.com.cn/a/202210/07/WS633f6176a310fd2b29e7b293.html.

Chinese companies are also trying to deal with the restrictions by, for example, setting up "Non-A lines", which are semiconductor manufacturing plants without any American equipment.[72] Some research centres and companies are also looking to develop technologies to manufacture advanced semiconductors (7nm generation and beyond) that do not require the restricted equipment.[73]

In the meantime, semiconductor imports have declined due to the US restrictions and slowing demand. Over the first 10 months of 2022, China imported 13.2% less semiconductors compared to the same period in 2021 (though higher prices meant the value of the imports went up 1.3%).[74] The value of Chinese semiconductor equipment imports in November 2022 was 40% less compared to a year earlier and the lowest number since May 2020.[75]

Finally, the tensions over Taiwan are another important (geo)political factor shaping the semiconductor industry. The potential consequences of a reunification of Taiwan with China by military force are considerable for the industry, considering that some of the world's largest foundries are Taiwanese and operate major manufacturing plants in both Taiwan and China. Concerns over these consequences have motivated governments and semiconductor industries around the world to strengthen their domestic capacities and diversify their international supply chains to rely less on Taiwan.[76]

China's relations with other countries in the region

Despite the problematic political relationship between **Taiwan** and China, the two are highly connected in the economic sphere and in the semiconductor industry specifically. Taiwan's TSMC, the largest foundry in the world, has production facilities in China and many of its customers are Chinese. Other major Taiwanese foundries, such as UMC and PSMC also have facilities, customers or joint ventures in China. However, the efforts of the Chinese government to develop its own semiconductor industry and reduce its dependence on foreign companies has resulted in more competition for these Taiwanese companies from Chinese businesses. Increased scrutiny of foreign companies by the

[72] David Manners, "Huawei leading China chip dream revival", *Electronics Weekly,* 7 December 2022, https://www.electronicsweekly.com/blogs/mannerisms/manufacturing-mannerisms/huawei-leading-china-revival-of-chip-aspirations-2022-12/.
[73] Anton Shilov, "SMIC Details Its N+1 Process Technology: 7nm Performance in China, March 23 2020, https://www.anandtech.com/show/15649/smic-details-its-n1-process-technology-7nm-performance-in-china.
[74] Ann Cao, "China's chip imports see biggest drop in 2022 with accelerated decline in October amid US restrictions and weak demand", *SCMP,* 7 November 2022, https://www.scmp.com/tech/tech-war/article/3198726/chinas-chip-imports-see-biggest-drop-2022-accelerated-decline-october-amid-us-restrictions-and-weak.
[75] Ailing Tan and James Mayger, "China's Imports of Chip-Making Gear Drop to Lowest Since Mid-2020", *Bloomberg,* 22 December 2022, https://www.bloomberg.com/news/articles/2022-12-22/china-s-imports-of-chip-making-gear-drop-to-lowest-since-mid-2020.
[76] Gregory Arcuri and Samantha Lu, "Taiwan's Semiconductor Dominance: Implications for Cross-Strait Relations and the Prospect of Forceful Unification", 22 March 2022, https://www.csis.org/blogs/perspectives-innovation/taiwans-semiconductor-dominance-implications-cross-strait-relations.

Chinese authorities also led to concerns about the business environment for Taiwanese enterprises in China. Recent US sanctions make it furthermore increasingly difficult for TSMC to operate in China, as it is unsure if the company can ship manufacturing equipment to its facilities in the country (for which it currently received a one-year waiver from the US).[77] TSMC may also be forced to cancel contracts with Chinese customers that are blacklisted by the US.

China and **South Korea** have a close economic relationship in the area of semiconductors. The Chinese market is very important to Korean semiconductor companies: almost 60% of their chips are sold to China or Hong Kong.[78] China also houses significant manufacturing plants operated by Samsung and SK Hynix which produce 40% of Samsung's NAND flash memory chips (10% of global output) and 50% of SK Hynix's DRAM chips (15% of global output).[79] Chinese companies also operate facilities in South Korea, such as OSAT company JCET.[80] South Korean and Chinese semiconductor manufacturers are also competing with one another in the production of memory semiconductors.

Political disputes between Seoul and Beijing are challenging the strong economic ties in the semiconductor sector. Most importantly, South Korea appears to align itself more closely with the US and its allies in opposition to China. Militarily, the adoption of a US defence system and closer coordination with Tokyo angered Beijing.[81] In the area of semiconductors, South Korea's expected participation in the US-initiated Chips 4 Alliance further aggravates China.[82] SK Hynix was also blocked by Washington from shipping an ASML EUV machine to China in order to upgrade one of its Chinese manufacturing plants.[83]

Singapore is trying to position itself as a non-aligned country in the US-China tech war and to serve as a meeting point between China and the rest of the world. However, its semiconductor sector is much more integrated with that of the US and its allies than with that of China. There are only two major Chinese presences in Singapore: Chinese OSAT company JCET and private equity fund Wise Road

[77] Che Pan, "TSMC gets one-year equipment waiver for mainland China chip plant, easing the blow from new US restrictions", *SCMP*, 13 October 2022, https://www.scmp.com/tech/tech-war/article/3195870/tsmc-gets-one-year-equipment-waiver-mainland-china-chip-plant-easing.
[78] 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.

[79] Che Pan, "Tech war: SK Hynix executive says Korean chip maker may sell China fab under 'extreme' US pressure", 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.
[80] JCET, "Company Information", visited 8 February 2023, https://www.jcetglobal.com/en/site/about.
[81] 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
[82] 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.
[83] Jan Fred van Wijnen en Stijn van Gils, "Koreaanse chipmaker SK Hynix mag zijn ASML-machines niet in China zetten", *FD*, 18 November 2021, https://fd.nl/tech-en-innovatie/1419763/koreaanse-chipmaker-sk-hynix-mag-zijn-asml-machines-niet-in-china-zetten.

Capital each acquired a Singaporean OSAT business.[84] Nonetheless, China is a very important export market for Singapore's semiconductor industry.[85]

Political relations with **Japan** have obviously historically been difficult, but the two countries are highly connected economically, including in the semiconductor industry. China is Japan's most important trade partner in terms of value and Japan depends on China for about 60% of the rare earth materials it uses (which are significant for the semiconductor sector).[86] China, at the same time, relies on Japan for advanced semiconductor materials and semiconductor equipment, two areas in which the latter country is relatively strong. China is also the most important export market for Japanese semiconductors.[87]

Despite these close economic connections, Beijing and Tokyo appear to drift away further apart politically, which is in part due to tensions in the semiconductor sector. Japan takes a relatively confrontational position among semiconductor countries in the Asian region and labels China "the greatest strategic challenge in ensuring peace and security".[88] The country also appears relatively willing to work with the US on preventing China from acquiring the most advanced semiconductors and equipment.[89]

4. Implications for the Netherlands

The Dutch semiconductor sector is highly connected with that of China. For most of the large semiconductor companies in the Netherlands, China is among their largest (if not the largest) export markets. What's more, some companies run joint ventures with Chinese parties, conduct R&D activities in China or operate manufacturing facilities in the country. Dutch universities and the industry association of the Netherlands also have connections with Chinese counterparts. Many of

[84] 'UTAC Completes Sale to Wise Road Capital', UTAC Group, August 12, 2020, https://www.utacgroup.com/wp-content/uploads/2020/08/WR-Yransaction-announcement.pdf; Business Wire, 'KLA-Tencor's New Singapore Facility Will Provide Base for Regional Expansion', *KLA Corporation*, May 16, 2008, https://ir.kla.com/news-events/press-releases/detail/327/kla-tencors-new-singapore-facility-will-provide-base-for.
[85] Nile Bowie, 'Singapore's Chip Revival Hinges on a Wobbly China', *Asia Times*, January 14, 2022, https://asiatimes.com/2022/01/singapores-chip-revival-hinges-on-a-wobbly-china/.
[86] 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
[87] Gary Clyde Hufbauer and Megan Hogan, "CHIPS Act Will Spur US Production but Not Foreclose China", https://www.piie.com/sites/default/files/2022-10/pb22-13.pdf, p12.
[88] 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
[89] Orange Wang, "Japanese official signals that Tokyo will join US in chip ban against China", *SCMP*, 6 January 2023, https://www.scmp.com/news/china/article/3205769/japanese-official-signals-tokyo-will-join-us-chip-ban-against-china.

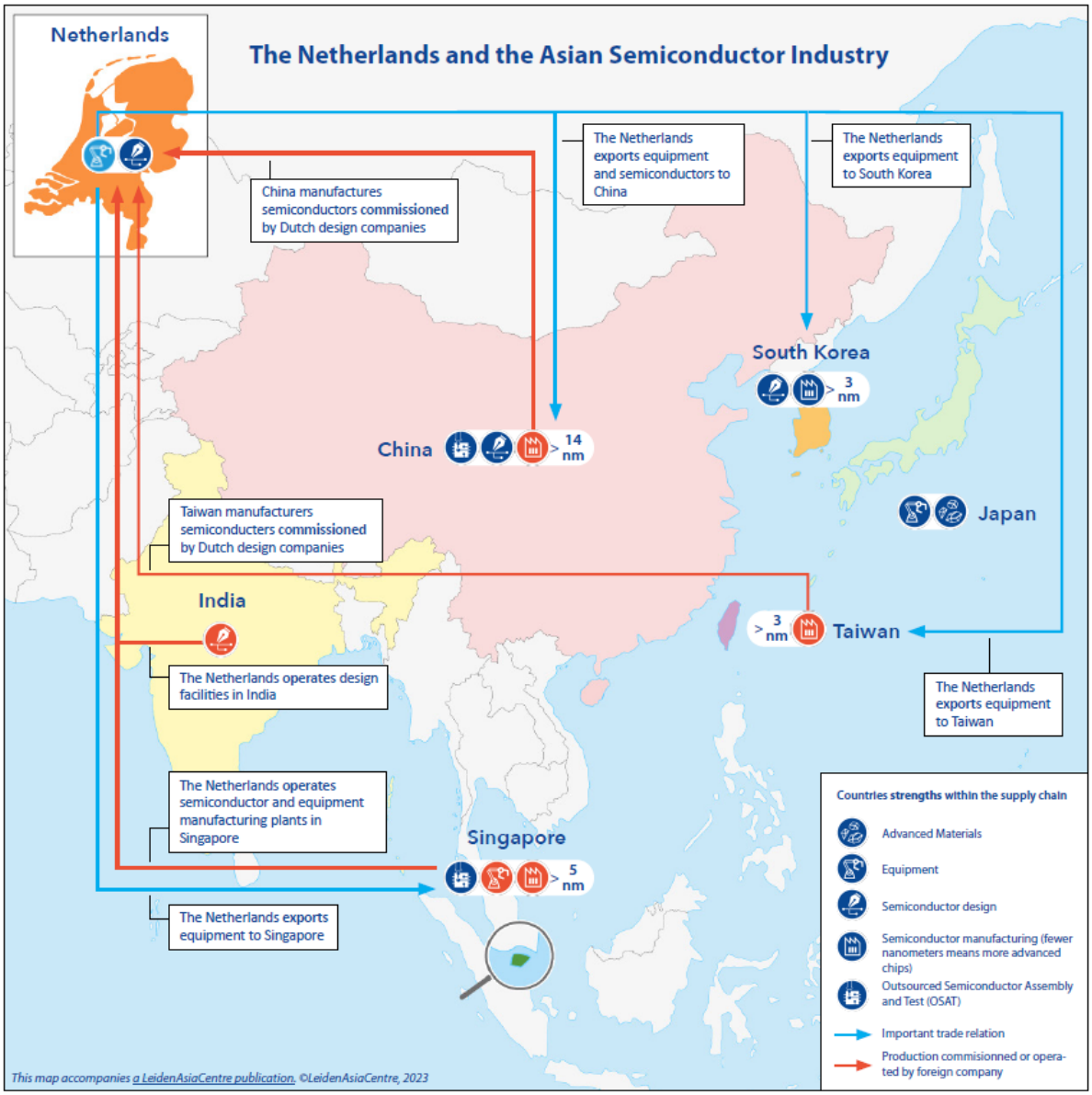
these relations are, or can be, affected by the political developments surrounding the Chinese semiconductor industry.

First of all, the actions by the US government that prevent companies in other countries from supplying advanced semiconductors and equipment to China have negative consequences for the Dutch industry. ASML is blocked from shipping its most advanced EUV machines to its Chinese customers, and it seems the same will apply to some of its less advanced equipment. Non-Chinese companies, such as South Korean company SK Hynix, are also not allowed to ship ASML's EUV machines to their Chinese facilities. This means that ASML loses an important market for its advanced equipment. The new US export restrictions introduced in October 2022 also impacts Dutch companies. For example, ASM International expects that 40% of its sales in China will be affected by the new restrictions.[90] The number of companies or organisations with whom Dutch semiconductor players can trade, start joint ventures or collaborate on R&D is also affected by the several blacklists drafted by the US.

China is motivated to invest extra funds and efforts to overcome the challenges of being cut-off from access to advanced semiconductors and semiconductor related goods. The need to develop alternative technologies is especially strong in the equipment sector. This could eventually result in Chinese competition for Dutch equipment companies. Within the Chinese market, the impact of this competition is relatively limited, considering that Dutch equipment companies are not able to export advanced goods to China. However, in the long run, if Chinese companies manage to develop alternatives, they could challenge Dutch equipment enterprises in the global market. China will be slowed-down, however, by the fact that international collaboration for many Chinese research centres and companies is complicated by US restrictions. What's more, Dutch equipment companies will contend that they will work hard to maintain their technological lead.

[90] Reuters, "ASMI expects Chinese sales to drop 40% on U.S. chip sanctions", 25 October 2022, https://www.reuters.com/technology/semiconductor-supplier-asmi-beats-its-q3-revenue-guidance-2022-10-25/.

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