Singapore

Sense Hofstede (University Lecturer, Leiden University)

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

Singapore's government has stressed the importance of light manufacturing with a strong electronics component ever since the current ruling party came to power shortly before the city-state's independence in 1965. The development plans of the legendary minister Goh Keng Swee and United Nations (UN) advisor Albert Winsemius already laid the groundwork for the further development of Singapore's manufacturing industry. The first semiconductor firms began offshoring production from the United States right from the start of the industry. Singapore was already one of their destinations in the 1960s.

Dutch presence has also always been there. Just as Philips featured in Winsemius's early plans, so the company played a role in expanding semiconductor manufacturing in Singapore. Today, the list of semiconductor industry companies with a presence in Singapore is a fairly comprehensive overview of the global industry. This is the result of conscious efforts by the city-state's government to attract foreign business. Goh and Winsemius's Economic Development Board (EDB) – itself originally inspired by Winsemius's directorate-general for industrialisation at the post-war Dutch Ministry of Economic Affairs – plays a central role in everything that occurs. [1]

Singapore maintains a foreign policy of neutrality that seeks balance by involving as many players as possible in the city-state. It is a member of the Non-Aligned Movement (NAM) and still claims developing-country status. This positions Singapore as a meeting place between different worlds as the technology war heats up, something that already busies the finance industry.[2] At the same time, Singapore has always maintained close security cooperation with the United States and the main semiconductor manufacturers in the city-state are American too. In the great-power technology struggle, Singapore serves as an interface to the OECD semiconductor chain for Chinese customers, more than as a base for Chinese manufacturers.

[1] Frans Stoelinga, *Albert Winsemius: De man die Nederland en Singapore rijk maakte* (Amsterdam: Boom, 2021), p. 176.
[2] Leo Lewis, 'Singapore Is Well-Positioned to Play Both Sides of Decoupling', *Financial Times*, 24 November 2022, https://www.ft.com/content/269b1a53-dd66-4446-8da8-f54d39403bfc.

1. Government

Singapore's political system is a modified Westminster parliamentary system with regular elections that have no chance of changing the government. The press is expected to assume a constructive rather than a critical role. The current ruling People's Action Party (PAP) has been in power since 1959 and the country attained independence in 1965. Economic policy is shaped by various long-term plans. Thanks to low tariffs and welcoming government agencies, Singapore has always been attractive to foreign companies.

The city-state's foreign policy aims to get as many countries and thus companies as possible to develop a stake in Singapore's welfare and continued independence. Domestically, Singapore's economy is dominated by government-linked companies (GLCs), many controlled by Temasek Holdings under Singapore's Ministry of Finance. The sovereign wealth fund GIC manages and invests the country's substantial reserves. Singapore's Ministry of Trade and Industry (MTI) and its Economic Development Board (EDB) play major roles in assisting and steering the development of industry.

Singapore's population of 5.5 million consists of only 3.5 million citizens. There are another 500,000 so-called 'permanent residents', foreign passport holders who have many rights and duties similar to those of citizens. The remaining 1.5 million residents are made up of foreign workers, students, dependents and 'talents'. The government's immigration policy aims to protect its own middle class through quotas, local hiring requirements, and by dividing immigrant labour into the two categories.

The foreign workers – sometimes referred to as guest workers – are heavily regulated and lowly paid labourers and domestic workers, who often stay in large dormitories on the edge of town. They help to keep Singapore's construction and manufacturing prices competitive.

At the higher end of the wage spectrum are the large numbers of 'foreign talents' or expatriates, who work in the increasingly hard-to-fill roles for technical and creative talent, as well as many of the managerial positions. It is the foreign talents who are the most vulnerable to middle-class unhappiness, which became clearest around the 2011 General Election.

Policy plans for the industry

Despite the large number of expatriates in management and the presence of many multinationals, the government ensures that they serve Singapore's goals through their reliance on government cooperation and subsidies, as well as the frequent need to work together with some of the many Temasek-owned GLCs that dominate the domestic economy.

Besides cheap foreign labour and the absence of a universal minimum wage, other ways in which Singapore's government keeps manufacturing affordable is through robotic automation to reduce labour intensity, as well as cooperation between government, industry and vocational education to increase the productivity of workers.[3]

The JTC Corporation, a statutory board under Singapore's Ministry of Trade and Industry that was originally founded in 1968 to develop the Jurong industrial estate, is now used as one of the tools for Singapore's government to steer industry. JTC has four wafer fab parks, totalling 391 hectares. These are home to fourteen global semiconductor companies, but also serve smaller players.[4]

The EDB is the main driver behind industrial plans. The 'Semiconductor Vision 2020' taskforce was a cooperation between the EDB and various companies from the industry to coordinate efforts for next generation manufacturing.[5] The EDB's 'Manufacturing 2030' plan aims to grow Singapore's manufacturing sector by 50 per cent of its 2021 value of 106 billion Singapore dollars (SGD) (or 80 billion USD) by 2030, while remaining approximately 20 per cent of gross domestic product (GDP).[6]

The aim is 'to anchor frontier investments from global companies with specialised capabilities to support [Singapore's] local manufacturing ecosystem'.[7] This includes the semiconductor industry.

One part of the recently launched Refreshed Industry Transformation Maps concerns advanced manufacturing. The Singapore government's plans project that by 2025 there will be 70,700 jobs in electronics manufacturing, while reducing the industry's carbon footprint.[8]

Singapore is an example of a country that not just supports research and development and innovation (R&D&I), but also provides investment incentives in the form of tax concessions.[9] The EDB's plans for

[3] James Lambert, 'Robots Have Made Singapore a Modern Manufacturing Success', *Nikkei Asia*, 24 October 2022, https://asia.nikkei.com/Opinion/Robots-have-made-Singapore-a-modern-manufacturing-success.
[4] Choo Yun Ting, 'How Has Singapore Been Cashing in on Semiconductor Chips', *The Straits Times*, 2 October 2022, https://www.straitstimes.com/tech/tech-news/how-has-singapore-been-cashing-in-on-semiconductor-chips.
[5] Alvin Tan, 'Speech by MOS Alvin Tan at SSIA Semiconductor Business Connect 2021', *Ministry of Trade and Industry, Singapore*, https://www.mti.gov.sg/Newsroom/Speeches/2021/07/Speech-by-MOS-Alvin-Tan-at-SSIA-Semiconductor-Business-Connect-2021.
[6] Singapore Economic Development Board, 'Singapore Seeking Frontier Firms for 'Manufacturing 2030'', Economic Development Board, Singapore, 2 February 2021, https://www.edb.gov.sg/en/business-insights/insights/singapore-seeking-frontier-firms-for-manufacturing-2030.html.
[7] Alvin Tan, 'Speech by MOS Alvin Tan at the SSIA Semiconductor Business Connect 2022', *Ministry of Trade and Industry, Singapore*, https://www.mti.gov.sg/Newsroom/Speeches/2022/05/Speech-by-MOS-Alvin-Tan-at-the-SSIA-Semiconductor-Business-Connect-2022.
[8] Elysia Tan, 'Investments into Semiconductor Centre, Industry Tie-Ups to Power Manufacturing Transformation', *The Business Times*, 18 October 2022, https://www.businesstimes.com.sg/government-economy/investments-into-semiconductor-centre-industry-tie-ups-to-power-manufacturing.
[9] OECD, 'Measuring Distortions in International Markets: The Semiconductor Value Chain', OECD Trade Policy Papers no. 234 (Paris: OECD Publishing, 12 December 2019), https://doi.org/10.1787/8fe4491d-en, p. 9.

the semiconductor industry focus on providing grants and placing 'bigger bets' on improving five areas:[10]

1. Heterogenous integration;
2. Millimetre wave and beyond;
3. Novel architectures for edge AI;
4. Wide bandgap semiconductors;
5. Piezoelectric microelectromechanical systems (MEMS).

These plans are now being implemented. One example is the recent Singaporean government announcement of an initial investment of 85 million USD to set up a National Gallium Nitride Technology Centre over the next five years. This 'boutique foundry' will serve as 'a shared resource and translation centre'.[11] Research is an important part of the Singapore government's approach and is mostly organised under the Institute of Microelectronics, founded in 1991, which is part of the Agency for Science, Technology and Research (A*STAR).

In education, efforts are made by stakeholders both to educate the workforce and to upgrade their skills for the future. The Singapore Institute of Technology has signed a memorandum of understanding with American semiconductor supplier Applied Materials for continuing education and training. Coordination with industry associations, as well as vocational schools (known as Institutes of Technical Education or ITEs) and polytechnics, is meant to ensure training before and during careers.[12]

Singapore is not only important as a manufacturing location, but also sits at the critical transportation choke point of the Strait of Malacca, where raw materials[13] and finished goods pass through. The Singapore Armed Forces (SAF) are active in multilateral anti-piracy missions in the region, which help to ensure the safety of maritime traffic. The SAF's new fourth service – the Digital and Intelligence Service – is worth following. Singapore's Army has long-standing ties with Israel and all men are obliged to serve two years of National Service. Singapore might take inspiration from Israel's success in harnessing tech talent for its conscripted soldiers, who often begin start-ups once discharged.

[10] Singapore Economic Development Board, 'The Growth and Advancement of Singapore's Semiconductor Industry' (Singapore: SEMI, October 2021), https://www.semi.org/sites/semi.org/files/2021-10/The-Growth-and-Advancement-of-Singapores-Semiconductor-Industry.pdf.
[11] Elysia Tan, 'Investments into Semiconductor Centre, Industry Tie-Ups to Power Manufacturing Transformation', *The Business Times*, 18 October 2022, https://www.businesstimes.com.sg/government-economy/investments-into-semiconductor-centre-industry-tie-ups-to-power-manufacturing.
[12] Alvin Tan, 'Speech by MOS Alvin Tan at the SSIA Semiconductor Business Connect 2022', *Ministry of Trade and Industry, Singapore*, https://www.mti.gov.sg/Newsroom/Speeches/2022/05/Speech-by-MOS-Alvin-Tan-at-the-SSIA-Semiconductor-Business-Connect-2022.
[13] Joris Teer and Mattia Bertolini, *Threats to the Supply of Critical Raw Materials for Semiconductors* (The Hague: The Hague Centre for Strategic Studies, 2022).

Singapore is not a member of the export control regime the Wassenaar Arrangement. As a rule, it only joins sanctions mandated by the UN Security Council. Singapore's measures taken against Russia following Russia's invasion of Ukraine in February 2022 are an exception. They include export controls on weapons and tools for offensive cyber operations.[14]

2. Overview of Singapore's local industry

Singapore was involved in overseas manufacturing right from the start,[15] although the situation has changed radically since then. It began with Singapore's first Prime Minister Lee Kuan Yew telling US President Richard Nixon that he needed exports to 'sop up unemployment' to prevent unrest as Singaporean government support brought in US firms Texas Instruments and National Semiconductors.[16] Now, the government's Refreshed Industry Transformation Maps call for robotisation as automation complements the use of highly productive locals and affordable foreign workers.

In 2021, manufacturing as a whole provided for 450,400 jobs in Singapore and produced 22 per cent of GDP.[17] Thanks to the above-mentioned robotisation plans, by now 60 per cent of the people working in manufacturing are highly skilled.[18] A substantial part of this is made up by the semiconductor industry. Semiconductors constituted 17 per cent of Singapore's exports in 2017.[19] In 2021, the semiconductor industry provided roughly 7 per cent of Singapore's GDP, making up 11 per cent of the global semiconductor market.[20]

Singapore is especially strong in semiconductor equipment manufacturing, of which it constitutes 20 per cent globally, and wafer capacity, of which it is 5 per cent.[21] The industry's focus in Singapore is assembly and testing, and non-edge manufacturing, with Singapore's proximity to Malaysia allowing companies to locate services and support for manufacturing there, nearby the easily accessible city-state.

[14] 'Sanctions and Restrictions against Russia in Response to Its Invasion of Ukraine', Ministry of Foreign Affairs of Singapore, 5 March 2022, https://www.mfa.gov.sg/Newsroom/Press-Statements-Transcripts-and-Photos/2022/03/20220305-sanctions.
[15] Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (London: Simon and Schuster, 2022), p. 54.
[16] Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (London: Simon and Schuster, 2022), p. 65.
[17] Ovais Subhani, 'S'pore Updates Industry Transformation Plans to Boost Production, Add 13,400 Jobs by 2025', *The Straits Times*, 18 October 2022, https://www.straitstimes.com/business/s-pore-updates-industry-transformation-plans-to-boost-production-add-13400-jobs-by-2025.
[18] James Lambert, 'Robots Have Made Singapore a Modern Manufacturing Success', *Nikkei Asia*, 24 October 2022, https://asia.nikkei.com/Opinion/Robots-have-made-Singapore-a-modern-manufacturing-success.
[19] Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (London: Simon and Schuster, 2022), p. 253.
[20] Choo Yun Ting, 'How Has Singapore Been Cashing in on Semiconductor Chips', *The Straits Times*, 2 October 2022, https://www.straitstimes.com/tech/tech-news/how-has-singapore-been-cashing-in-on-semiconductor-chips.
[21] Choo Yun Ting, 'How Has Singapore Been Cashing in on Semiconductor Chips', *The Straits Times*, 2 October 2022, https://www.straitstimes.com/tech/tech-news/how-has-singapore-been-cashing-in-on-semiconductor-chips.

Care must be taken, however, when interpreting the statistics. Beyond its small size and dependence on foreign trade causing big swings, Singapore's attractiveness as a welcoming and relatively neutral place to headquarter companies can also lead to confusion in the data, as illustrated by the noise resulting from the fact that US company Broadcom was domiciled there until 2018.[22]

Singapore does not have any major semiconductor firms of its own. Singapore's attempt to create its own foundry, called Chartered Semiconductor and modelled after Taiwan's TSMC,[23] ended with its takeover by US firm GlobalFoundries in 2010.[24] Instead, Singapore is home to players from all around the world. The two big manufacturing firms active in Singapore are Micron and GlobalFoundries. Singapore's semiconductor manufacturing equipment (SME) exports are largely attributable to Applied Materials, ASM International and KLA Corporation.[25]

Manufacturers

Government subsidies help **Micron** maintain and expand its fabs in Singapore.[26] Singapore state support for Micron and **Qualcomm** is important.[27] Singapore is home to Micron's non-US operational headquarters and three factories, as well as a test and assembly facility, critical for producing its NAND flash memory chips.[28]

GlobalFoundries announced in 2021 that it would invest 4 billion USD [3.8 billion euros] to expand its Tuas factory from 750,000 wafers a year to 1.2 million wafers by Q1 2023 and 1.5 million wafers in 2024. Its Singapore fab produces about one-third of GlobalFoundries' global revenue. EDB partners with GlobalFoundries to support the investment[29] and Qualcomm is an important customer.

When it was still a division of Philips, Dutch manufacturer **NXP Semiconductors** entered a joint venture with **TSMC** and EDB Investments in 1998 to create the **Systems on Silicon Manufacturing Company** (SSMC), which was expanded in 2007 with an R&D centre to work on NXP's specialised chips with

[22] OECD, 'Measuring Distortions in International Markets: The Semiconductor Value Chain', OECD Trade Policy Papers no. 234 (Paris: OECD Publishing, 12 December 2019), https://doi.org/10.1787/8fe4491d-en, p. 20.
[23] Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (London: Simon and Schuster, 2022), p. 178.
[24] Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (London: Simon and Schuster, 2022), p. 233.
[25] Andre Barbe and Will Hunt, 'Preserving the Chokepoints: Reducing the Risks of Offshoring among US Semiconductor Manufacturing Equipment Firms' (Washington, DC: Center for Security and Emerging Technology, May 2022), https://cset.georgetown.edu/publication/preserving-the-chokepoints/, p. 6.
[26] Chris Miller, *Chip War: The Fight for the World's Most Critical Technology* (London: Simon and Schuster, 2022), p. 207.
[27] OECD, 'Measuring Distortions in International Markets: The Semiconductor Value Chain', OECD Trade Policy Papers no. 234 (Paris: OECD Publishing, 12 December 2019), https://doi.org/10.1787/8fe4491d-en, p. 61.
[28] Choo Yun Ting, 'Semiconductor Giant Micron Aims to Invest over US$150b Globally over next Decade', *The Straits Times*, 20 October 2021, https://www.straitstimes.com/business/companies-markets/semiconductor-giant-micron-aims-to-invest-over-us150b-globally-over-next.
[29] Dylan Loh, 'GlobalFoundries Puts $4bn into Singapore Expansion', *Nikkei Asia*, 22 June 2021, https://asia.nikkei.com/Business/Tech/Semiconductors/GlobalFoundries-puts-4bn-into-Singapore-expansion.

automotive, near-field communication (NFC) and RF functions, and their manufacturing processes.[30] NXP and TSMC are now the only shareholders, in a roughly 61:39 per cent split. In 2018, SSMC expanded with a new 4,400 square metre facility, increasing its automotive and speciality chip manufacturing space by 34 per cent. With a total capital expenditure of 3 billion SGD since its founding, it is the largest 200mm plant in the region.[31]

NXP's Singapore office supports sales and technical support teams for South-East Asia and Australia, a global distribution centre and engineering support for Singapore.[32] *The Wall Steet Journal* reported in May 2022 that TSMC was in talks with the EDB over a possible plant in Singapore.[33]

Taiwanese foundry **Vanguard International Semiconductor (VIS)** purchased GlobalFoundries' 200mm MEMS fab with a capacity of 35,000 wafer starts per month in Tampines in eastern Singapore in 2019.[34] It is also considering a 300mm fab in Singapore, according to Taiwanese business press.[35] Meanwhile, Taiwan's **UMC** is to spend 5 billion USD [4.7 billion euros] on a new factory in Singapore for 22nm and 28nm chips, next to its existing Pasir Ris factory, producing 30,000 wafers per month.[36]

Germany's Siemens spin-off **Infineon** in 2020 announced a 27 million SGD investment over three years, with the aim of making Singapore its AI hub.[37] Its country office hosts its Development Centre Singapore, as well as its headquarters for the countries of the Association of South-East Asian Nations (ASEAN), India, South Korea and Oceania.[38]

[30] 'NXP in Singapore', NXP Semiconductors, accessed 27 December 2022, https://www.nxp.com/company/about-nxp/worldwide-locations/singapore:CAREERS_SINGAPORE_HOME.
[31] Janice Heng, 'Semiconductor Firm SSMC Opens New S$300m Facility', *The Business Times*, 27 November 2018, https://www.businesstimes.com.sg/startups-tech/technology/semiconductor-firm-ssmc-opens-new-s300m-facility.
[32] 'NXP in Singapore', NXP Semiconductors, accessed 27 December 2022, https://www.nxp.com/company/about-nxp/worldwide-locations/singapore:CAREERS_SINGAPORE_HOME.
[33] Yang Jie and Keith Zhai, 'TSMC Looks to Build Multibillion-Dollar Chip Plant in Singapore', *The Wall Street Journal*, 20 May 2022, https://www.wsj.com/articles/tsmc-looks-to-build-multibillion-dollar-chip-plant-in-singapore-11652958840.
[34] Peter Clarke, 'GloFo Sells MEMS Business, Fab to Taiwan's Vanguard', *eeNews Europe*, 31 January 2019, https://www.eenewseurope.com/en/glofo-sells-mems-business-fab-to-taiwans-vanguard/.
[35] Yin Hui-chung 尹慧中, '世界先進續考慮台灣、新加坡建 12 吋廠 但暫時沒有時間表' [VIS considers building 12-inch fab in Taiwan and Singapore, but for now has no time schedule], United Daily News, 6 January 2023, https://udn.com/news/story/7240/6891577.
[36] 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.
[37] 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.
[38] 'Infineon Singapore', Infineon Technologies, accessed 27 December 2022, https://www.infineon.com/cms/singapore/en/.

Outsourced semiconductor assembly and test (OSAT)

The US firm **KLA Corporation** opened its Advanced Packaging Development Centre in Singapore in 2015.[39] This follows upon the opening of its 17,400 square metre manufacturing site in 2008.[40]

Singapore's packaging and test services company STATS ChipPAC was taken over by **JCET** in 2015, an acquisition funded by China's National IC Fund,[41] a subsidiary of China's Semiconductor Manufacturing International Corporation (SMIC), and Bank of China loans.[42] This demonstrates the close involvement of Chinese state mechanisms. According to electronic component distributor Utmel, JCET had an OSAT market share of almost 11.96 per cent in 2020.[43]

Singapore-headquartered **UTAC** had a market share of 2.15 per cent in 2020, declining to tenth place,[44] down from seventh with 3 per cent market share in 2018.[45] UTAC had manufacturing locations in Singapore, China and Taiwan. In 2020 it was bought by Beijing-based private equity fund Wise Road Capital, except for its Taiwanese operations.[46] Taiwanese OSAT market leader **ASE** also has operations in Singapore.

The OSAT market dominance by Taiwanese and Chinese companies and the decline of Singapore during the 2009–2019 period[47] can perhaps be explained by the above takeovers, obscuring the importance of these companies' Singapore location in the statistics.

Wafer processing

Dutch multinational **ASM International** assembles and tests advanced deposition tools in Singapore. It moved most of its production to Singapore in 2007, with one big reason being Singaporean government support. It also considered the practical and geopolitical advantages of Singapore.[48] Its new manufacturing floor opened in 2020 and a second is planned to be ready at the start of 2023. This

[39] Amit Roy Choudhury, 'KLA-Tencor Opens New Facility in Singapore', *The Business Times*, 18 November 2015, https://www.businesstimes.com.sg/startups-tech/technology/kla-tencor-opens-new-facility-singapore.
[40] Business Wire, 'KLA-Tencor's New Singapore Facility Will Provide Base for Regional Expansion', *KLA Corporation*, 16 May 2008, https://ir.kla.com/news-events/press-releases/detail/327/kla-tencors-new-singapore-facility-will-provide-base-for.
[41] OECD, 'Measuring Distortions in International Markets: The Semiconductor Value Chain', OECD Trade Policy Papers no. 234 (Paris: OECD Publishing, 12 December 2019), https://doi.org/10.1787/8fe4491d-en, p. 44.
[42] OECD, 'Measuring Distortions in International Markets: The Semiconductor Value Chain', OECD Trade Policy Papers no. 234 (Paris: OECD Publishing, 12 December 2019), https://doi.org/10.1787/8fe4491d-en, p. 54.
[43] 'Top 10 OSAT (Outsourced Semiconductor Assembly and Test) Companies', *Utmel*, 10 January 2022, https://www.utmel.com/blog/categories/semiconductor/top-10-osat-outsourced-semiconductor-assembly-and-test-companies.
[44] 'Top 10 OSAT (Outsourced Semiconductor Assembly and Test) Companies', *Utmel*, 10 January 2022, https://www.utmel.com/blog/categories/semiconductor/top-10-osat-outsourced-semiconductor-assembly-and-test-companies.
[45] OECD, 'Measuring Distortions in International Markets: The Semiconductor Value Chain', OECD Trade Policy Papers no. 234 (Paris: OECD Publishing, 12 December 2019), https://doi.org/10.1787/8fe4491d-en, p. 22.
[46] 'UTAC Completes Sale to Wise Road Capital', UTAC Group, 12 August 2020, https://www.utacgroup.com/wp-content/uploads/2020/08/WR-Yransaction-announcement.pdf.
[47] Jan-Peter Kleinhans and Nurzat Baisakova, 'The Semiconductor Value Chain: A Technology Primer for Policy Makers' (Berlin: Stiftung Neue Verantwortung, October 2020), p. 20.
[48] Interview with a representative of ASMI.

will quadruple its Singapore yield and triple its global yield. Headcount has more than doubled to 850 people since late 2021.[49]

German publicly traded company **Siltronic** has entered a joint venture with **Samsung** for a new 2 billion euro 300mm manufacturing facility in Singapore by the end of 2024. It already produces 200mm and 300mm wafers in Singapore.[50]

The French firm **Soitec** is increasing its global capacity and investing 400 million euros to double its Pasir Ris factory in eastern Singapore to produce two-thirds of its global capacity there,[51] which should see the Singapore site produce two million energy-efficient wafers a year and double its workforce to more than 600 by 2026.[52]

As noted above, US firm **Applied Materials** works closely with the Singapore Institute of Technology for vocational training and with A*STAR for research. It states that half its global SME production takes place in Singapore.[53]

Semiconductor manufacturing equipment

Dutch SME giant **ASML** maintains an office in Singapore in light-industrial development New Tech Park, home to its field service engineers. Dutch SME parts supplier **BESI** maintains an office for support and sales in Singapore, while its regional manufacturing takes place in neighbouring Malaysia. Its office in the city-state is the Die Attach product group contact point for Asia.[54]

Design and contract manufacturing partner **VDL Enabling Technologies Group**, which is part of Dutch carmaker VDL, has a subsidiary in Singapore that works on system integration.[55] US firm Applied Materials is among its customers.[56]

[49] 'ASM International Unveils Expansion in Singapore to Meet Global Customer Demand for Advanced Semiconductors', *Yole Group*, 29 March 2022, https://www.yolegroup.com/industry-news/asm-international-unveils-expansion-in-singapore-to-meet-global-customer-demand-for-advanced-semiconductors/.
[50] 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.
[51] 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.
[52] Ovais Subhani, 'French Semiconductor Firm Soitec to Double Production and Manpower in Singapore', *The Straits Times*, 9 December 2022, https://www.straitstimes.com/business/french-semiconductor-firm-soitec-to-double-production-and-manpower-in-singapore.
[53] Andre Barbe and Will Hunt, 'Preserving the Chokepoints: Reducing the Risks of Offshoring among US Semiconductor Manufacturing Equipment Firms' (Washington, DC: Center for Security and Emerging Technology, May 2022), https://cset.georgetown.edu/publication/preserving-the-chokepoints/, p. 3.
[54] 'Company Overview', BESI, accessed December 27, 2022, https://www.besi.com/company/company-overview/.
[55] 'VDL ETG Singapore', VDL Enabling Technologies Group, accessed 27 December 2022, https://www.vdletg.com/en/het-bedrijf/locations/vdl-etg-singapore.
[56] 'VDL ETG Receives Supplier Excellence Award from Applied Materials', *VDL Enabling Technologies Group*, 16 December 2022, https://www.vdletg.com/en/news/vdl-etg-receives-supplier-excellence-award-from-applied-materials.

Small Dutch mechanotronics companies **DEMCON**, **Sioux Technologies** and **NTS** also maintain Singapore offices.

Industry association

The Singapore Semiconductor Industry Association (SSIA) has brought together companies working in the industry since its founding under the name MIDAS in 2005.[57] In recent years it has organised the annual Semiconductor Business Connect industry event. Given the dominance of foreign firms and the EDB, the SSIA is not as important in determining the direction of development as in countries with a stronger independent domestic manufacturing industry.

3. International posititioning and connections

Relevant geopolitical positioning

Singapore's foreign and economic policies have, from the start, stressed the need to involve as many different actors as possible. The aim is to get both foreign countries and multinational companies to have a stake in maintaining the city-state's independence. Singapore also does not want to miss out on the economic benefits. At the same time, welcoming all also serves to underwrite Singapore's neutrality.

Singapore was involved with the Non-Aligned Movement (NAM) during the Cold War and repeatedly says it does not want to choose between the United State and China,[58] as Prime Minister Lee Hsien Loong warns about the risks of a trade war or escalation.[59] Foreign Minister Vivian Balakrishnan openly worries about the erosion of the post-Second World War order that Singapore sees as an important underpinning of its prosperity.[60]

In practice, Singapore has close relations with the United States dating back to the Vietnam War. Although Singapore is not a formal treaty ally of the United States, unlike the Philippines or Thailand, it has one of the closest military relations with the United States in the region. One-quarter of Singapore's fleet of fighter jets is permanently in the United States. The US Navy has a logistical

[57] 'Singapore Semiconductor Industry Association', SEMI, accessed 5 January 2023, https://www.semi.org/en/resources/member-directory/singapore-semiconductor-industry-association.
[58] Chong Ja Ian, 'Other Countries Are Small Countries, and That's Just a Fact: Singapore's Efforts to Navigate US–China Strategic Rivalry', in *China-US Competition: Impact on Small and Middle Powers' Strategic Choices*, ed. Simona A. Grano and David Wei Feng Huang (Cham: Palgrave MacMillan, 2023), 307–38, https://doi.org/10.1007/978-3-031-15389-1.
[59] Lee Hsien Loong, 'The Endangered Asian Century: America, China, and the Perils of Confrontation', *Foreign Affairs* 99, no. 4 (4 June 2020): 52–58, https://www.foreignaffairs.com/articles/asia/2020-06-04/lee-hsien-loong-endangered-asian-century.
[60] Vivian Balakrishnan, 'Edited Transcript of Speech by Minister for Foreign Affairs Dr Vivian Balakrishnan: 'Staying Together in a Turbulent World' at Singapore Management University, 22 January 2020', *Ministry of Foreign Affairs of Singapore*, https://www.mfa.gov.sg/Newsroom/Press-Statements-Transcripts-and-Photos/2020/01/22012020-SGT.

support centre in Singapore and its 7th Fleet uses Changi Naval Base for maintenance. Paya Lebar Air Base is a regular host to US P-8 military reconnaissance planes.

Unrest in Hong Kong and the decreasing attractiveness of the whole of China because of political and pandemic reasons mean that Singapore's role as a meeting point between East and West is increasing. The inflow of Chinese capital and talent seeking a safe harbour brings opportunities and challenges for Singapore. Its role as a meeting point also applies to Singapore's semiconductor industry. There are some worries about its reliance on customers from China[61] if the Chinese economy worsens or if US extraterritorial restrictions expand. In the meantime, Singapore is positioning itself to 'play both sides of decoupling', even as its sovereign wealth funds are now tasked with taking geopolitical considerations into account.[62] Manufacturers' reliance on EDB support means that they will also have to deal with government stances.

The Singapore government's concern about the tech war between China and the United States is part of its wider concerns over competition.[63] This concern found clear expression in Foreign Minister Vivian Balakrishnan's call in November 2022 for a non-aligned movement for science, technology and supply chains to avoid being caught in the superpowers' fight.[64] It remains to be seen what practical implementation this will bring. Singapore appears to be well positioned to gain from supply chain diversification. As Cornell University's Sarah Kreps told CNBC: 'South Korea and Taiwan can't camouflage themselves, but countries like Vietnam, India and Singapore are positioning themselves as a third way, a neutral bridge between two titans'.[65]

Even though the city-state could serve as a place to interact with the Western world for Chinese businesses, they must deal with the fact that Singapore is aligned with the United States not only on security. The above list of companies demonstrates Singapore's de facto integration into the Euro-American semiconductor supply chain. The only significant Chinese presence is through OSAT company JCET.

If Singapore is forced to limit one of the two superpowers, it is most likely that China's presence will be squeezed. This would probably take a similar form to how Huawei did not end up partaking in

[61] Nile Bowie, 'Singapore's Chip Revival Hinges on a Wobbly China', *Asia Times*, 14 January 2022, https://asiatimes.com/2022/01/singapores-chip-revival-hinges-on-a-wobbly-china/.
[62] Leo Lewis, 'Singapore Is Well-Positioned to Play Both Sides of Decoupling', *Financial Times*, 24 November 2022, https://www.ft.com/content/269b1a53-dd66-4446-8da8-f54d39403bfc.
[63] Lee Hsien Loong, 'The Endangered Asian Century: America, China, and the Perils of Confrontation', *Foreign Affairs* 99, no. 4 (4 June 2020): 52–58, https://www.foreignaffairs.com/articles/asia/2020-06-04/lee-hsien-loong-endangered-asian-century.
[64] Ng Wei Kai, 'New 'Non-Aligned Movement' Needed for Countries amid US-China Tensions: Vivian Balakrishnan', *The Straits Times*, 10 November 2022, https://www.straitstimes.com/singapore/politics/new-non-aligned-movement-needed-for-countries-to-keep-collaborating-amid-us-china-tensions-vivian-balakrishnan.
[65] Weilun Soon, 'India and Vietnam Could Benefit as Chipmakers Shift Away from China', *CNBC*, 12 December 2022, https://www.cnbc.com/2022/12/13/india-vietnam-may-benefit-as-chipmakers-shift-from-china-amid-us-curbs.html.

building Singapore's 5G network. Telecommunications operators said they had opted for Ericsson and Nokia themselves, while the responsible minister stressed that no vendor had been 'explicitly excluded'.[66] Retaliation from China did not follow.

Yet until the tech war also seriously affects Singapore, it raises the interesting prospect of the city-state playing the role of interface between the Western semiconductor chain and Chinese customers. Singapore offers a safe space for all players, both in terms of financial, legal and physical infrastructure, as well as in terms of political fallout.

Relevant political relations with the other countries in the region

The importance of Singapore and the United States for each other in the security realm has been touched upon already. This is mirrored on the economic side, with the important presence of US companies Micron, GlobalFoundries, KLA and Applied Materials.

Although Singapore's long-serving Prime Minister Lee Kuan Yew was initially a staunch anti-communist, he was also pragmatic about diversifying Singapore's reliance. In the 1970s, trade relations with China therefore took off in more serious form, thanks to trade missions by both the government and the Singapore–Chinese Chamber of Commerce and Industry. Famously, China's leader Deng Xiaoping visited Singapore and proposed that it serve as an example for China to learn a few things from. Since then, economic and political interactions have only increased. Singapore's sovereign wealth fund GIC and Temasek are active in the Chinese market, as are the major banks.

China's growing proficiency in the industry is reflected in the JCET presence in OSAT and the purchase of UTAC by a Beijing-based private equity fund. Beyond that, however, Chinese presence is limited, because an aim for self-reliance keeps most of China's industry at home, leaving just a few offices for research and commercial purposes in Singapore. Much more visible is the rise of the large Chinese tech companies' presence in Singapore, because of their need to find talent and engage with the world. Tencent, Alibaba, ByteDance and others all have substantial offices or even global headquarters in Singapore.

Singapore's ties with Taiwan also go back a long way, but have been handled with great care because of their sensitivity. There is a Taipei Representative Office in Singapore and a Singapore Trade Office in Taipei. Singaporean conscripted soldiers have been training in Taiwan every year since the 1970s under Operation Starlight. Until recently, leaders on both sides would engage in many 'private' visits

[66] Abhishek Vishnoi and Yoojung Lee, 'Huawei Loses Main Singapore 5G Networks to Ericsson, Nokia', *Bloomberg*, 24 June 2020, https://www.bloomberg.com/news/articles/2020-06-24/singapore-issues-final-5g-awards-to-singtel-starhub-m1-group.

and economic ties were strong during the boom years. Close ties are reflected by the presence of many Taiwanese tech companies, from ASE and VIS to UMC and TSMC–NXP joint venture, SSMC.

South Korea and Singapore established formal diplomatic relations in 1975. Together with Hong Kong and Taiwan, the two form part of the Four Asian Tigers. Samsung Semiconductors has an office at the Samsung Hub in Singapore. Both South Korea and Japan depend on the Strait of Malacca for sea freight to Europe.

Singapore's relations with Malaysia are complex. Today, many companies maintain a presence on both sides of the border. Singapore's connections and legal infrastructure provide a great home for the headquarters of companies that want to take advantage of Malaysia's cheaper and more plentiful resources for manufacturing. Dutch firm BESI is an example of this approach.

As the centre for the region, Singapore attracts a lot of South-East Asian talent. It also serves as a hub for multinational companies seeking a safe portal to the region. The overview of companies given above shows that several use it as their regional headquarters.

India's role in South Asia and its non-aligned stance, yet critical attitude towards China, make it an important consideration in Singapore's search for balancers. Singapore's GLCs are active in India, including in setting up industrial parks, as they have in China. In practical terms, together with Bangladesh, India serves as an important source of foreign workers in Singapore as well as foreign talents in the technology and finance industries.

In the Netherlands, the recent purchase of the Eindhoven High Tech Campus by Singapore's GIC caused some unrest, after a failed counter-offer by the municipality of Eindhoven and *Stichting* Brainport.[67] In the other direction, ASM International is the Dutch semiconductor company with the greatest reliance on Singapore. NXP has SSMC in its joint venture with TSMC. Other Dutch companies mainly seek a Singaporean presence for sales and service.

4. Implications for the Dutch sector

Singapore is deeply involved in the global semiconductor industry and has been from the start. All the big companies are present in the city-state. Micron, GlobalFoundries and SSMC are the most

[67] Pieter Couwenberg, Erik van Rein and Nelleke Trappenburg, 'Eindhoven probeerde verkoop van High Tech Campus te verijdelen', *Financieel Dagblad*, 11 February 2022, https://fd.nl/bedrijfsleven/1429470/eindhoven-probeerde-verkoop-van-high-tech-campus-aan-singaporezen-te-verijdelen-vfa3caswP62l.

important, but companies from the United States, Germany, the Netherlands, Japan and South Korea all sought a presence in Singapore at the start of their global success.

In every major operation, Singapore's EDB plays a role. Dutch firm ASMI's manufacturing move to Singapore is a case in point. Cooperation with government plans is essential to be able to compete for a spot within Singapore. The up-side is that this does not seem difficult, as Singapore's policy is one of welcoming foreign companies in order to help grow the city-state's share in manufacturing. This is in contrast to the more protectionist policies of countries that have domestic champions they seek to protect.

JTC Corporation is a useful partner in accessing working space for smaller companies yet to establish a Singapore presence. The 'Manufacturing 2030' plan's ambitions require more production to take place within Singapore. The five areas of focus in the EDB's vision for the future semiconductor industry focus on cutting-edge semiconductor production. Smaller Dutch companies seeking to grow in these areas can benefit and take inspiration from the ASMI story, as well as use the research facilities under development.

Singapore's foreign policy of neutrality allows it to play the role of meeting point between the West and China, also in the tech industry. If China remains closed off and Hong Kong's bridging role continues to diminish, amid the heating trade war between Beijing and Washington, Singapore's role as a meeting point will increase in importance. Dutch companies can take advantage of this.

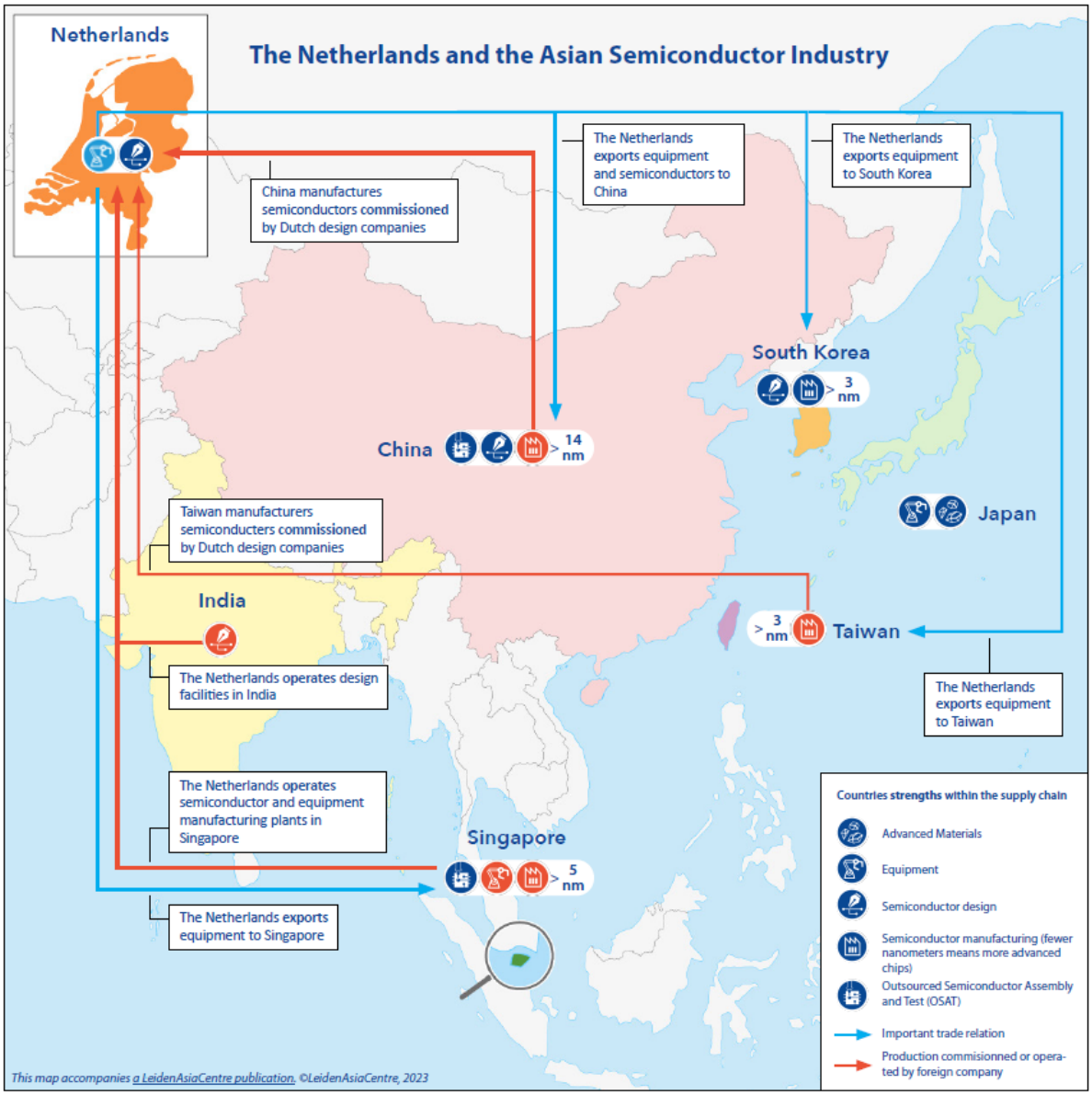
As its government policies prove, Singapore puts a lot of energy into maintaining and expanding its role in the global semiconductor supply chain. Large developments are underway that will ensure that capacity grows. However, Singapore cannot ignore the growing pressure that the United States brings to bear on other countries to fall in line and, as the overlap in shared interests between Washington and Beijing decreases, Singapore's room for manoeuvre shrinks.[68] Singapore has also shown itself in its security practice to be more closely aligned with the United States. At the same time, Prime Minister Lee Hsien Loong's warning against spheres of influence[69] and the strong support for a constructive American role in the region[70] reflect a subtly expressed fear of being locked into the region by China.

[68] Chong Ja Ian, 'Other Countries Are Small Countries, and That's Just a Fact: Singapore's Efforts to Navigate US–China Strategic Rivalry', in *China–US Competition: Impact on Small and Middle Powers' Strategic Choices*, ed. Simona A. Grano and David Wei Feng Huang (Cham: Palgrave MacMillan, 2023), p. 310, https://doi.org/10.1007/978-3-031-15389-1.
[69] Lee Hsien Loong, 'The Endangered Asian Century: America, China, and the Perils of Confrontation', *Foreign Affairs* 99, no. 4 (4 June 2020): 52–58, https://www.foreignaffairs.com/articles/asia/2020-06-04/lee-hsien-loong-endangered-asian-century.
[70] Lee Hsien Loong, 'PM Lee Hsien Loong's Opening Remarks at Joint Press Conference with US Vice President Kamala Harris', Prime Minister's Office, Singapore, 23 August 2021, https://www.pmo.gov.sg/Newsroom/PM-Lee-Opening-Remarks-at-Joint-Press-Conference-with-US-VP-Kamala-Harris.

Dutch companies need to be aware of the opportunities that Singapore offers as a portal to engage with both China and the South-East Asian region. The important role of Singapore government support means that good local connections matter. The overview of companies given in this chapter shows the omnipresence of the EDB in supporting investment. Companies that obtain grants, tax advantages and other help in Singapore have an advantage over competitors without a presence there. Given that it should not be difficult for private parties to engage the EDB, this is mainly a risk to other countries rather than companies per se.

One development to watch is the direction in which the tech war develops. For now, Singapore serves as a safe interface between an OECD-oriented semiconductor supply chain and regional as well as Chinese customers. This actually increases Singapore's attractiveness in the short term. In the long term, it is harder to predict whether this interface will be allowed to continue to exist. But even if it disappears, Singapore will remain an important node of production for the big global companies, as it has been from the start.

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