



# **Securing the UK's Semiconductor Supply Chain In an Era of Geopolitical Uncertainty**

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## Key point summary

This paper seeks to explore how the UK can work with like minded partners to strengthen the resilience of semiconductor supply chains globally.

- **Semiconductors are the building blocks of modern life:** From smartphones to energy networks and advanced weapons systems, having a resilient supply of semiconductors is vital to the UK's prosperity and security.
- **Taiwan plays an indispensable role in the semiconductor supply chain:** While no country has a complete end-to-end semiconductor supply chain, Taiwan plays an unparalleled role at the production phase – producing over 70% of the world's semiconductors and over 90% of the most advanced chips.
- **China's threats against Taiwan pose a catastrophic risk to the semiconductor supply chain:** Analysts predict that disruption to semiconductor foundries in Taiwan could cost US\$490 billion in revenue for electronic device manufacturers annually, with knock-on effects for supply chains in nearly all manufacturing sectors.
- **The UK is highly exposed to supply chain disruption:** This paper calls for the UK government to produce a semiconductor strategy that prioritises three key areas:
  - **Playing to its strengths:** the UK has world leading capabilities in semiconductor design, and advanced and compound material semiconductors. Significant investment in human capital, research and development and lowering barriers to attracting global talent are essential to ensuring the UK staying at the cutting edge of these developments.
  - **Cooperating with allies:** the UK will not create a resilient semiconductor supply chain alone. It should welcome and seek to play a role in the 'Chip 4 Alliance', which seeks to 'friendshore' semiconductor production between the US, Taiwan, Japan and South Korea.
  - **Safeguarding Taiwan's security:** Taiwan's indispensable role in semiconductor supply chains means that maintaining peace across the Taiwan strait must be a strategic priority for the UK. The UK should cooperate with its allies to deter Beijing's aggression against Taiwan through increased political, economic and defence cooperation in the region.

## What are semiconductors?

Semiconductors (commonly referred to as 'chips') are components that enable electronic devices to function. They are found in nearly all electronic goods, not only laptops and smartphones, but also cars, fridges and traffic lights. Demand for semiconductors is set to grow rapidly in the coming decades, with the components vital to development of technologies in smart devices, green energy and next generation communications infrastructure such as 5G networks. Semiconductors will also play a vital role in the future of the military industrial sector, with advanced weapons systems, artificial intelligence and space all dependent on the development of semiconductors. At present, the total global semiconductor market in 2022 is valued at 601 billion US dollars.<sup>1</sup>

## What are the risks posed by semiconductor supply chain disruption?

The foundational role played by semiconductors in nearly all industries means that disruption to international semiconductor supply chains has knock on effects across the global economy.

The need for a stable supply of semiconductors was put into sharp relief at the onset of the COVID-19 pandemic, as lockdown restrictions created bottlenecks and shortages in labour intensive stages of the semiconductor production process. It is estimated that these shortages impacted 169 industries globally,<sup>2</sup> with costs to the automotive industry alone estimated to total \$210 billion in fallen revenues and the lost production of 7.7 million vehicles in 2021.<sup>3</sup> In the UK, semiconductor shortages

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<sup>1</sup> Gartner (2023), 'Gartner Says Worldwide Semiconductor Revenue Grew 1.1% in 2022', 17 January 2023, <https://www.gartner.com/en/newsroom/press-releases/2023-01-17-gartner-says-worldwide-semiconductor-revenue-grew-one-percent-in-2022>

<sup>2</sup> Ihsaan Fanusie (2021), 'Supply chain issues causing 'unprecedented' non-recession inventory slump: JPM', Yahoo Finance, 10 August 2021, <https://uk.finance.yahoo.com/news/jp-morgan-supply-chain-bottlenecks-causing-unprecedented-non-recession-inventory-slump-165650327.html?guccounter=1>

<sup>3</sup> Jin, H. (2022), 'Automakers, chip firms differ on when semiconductor shortage will abate', Reuters, 4 February 2022, <https://www.reuters.com/business/autos-transportation/automakers-chip-firms-differ-when-semiconductor-shortage-will-abate-2022-02-04/>

played a major part in the closure of car maker Honda's Swindon factory and the collapse of flagship battery start-up Britishvolt.<sup>4</sup>

Given the vital role played by semiconductors in defence and dual use technologies, supply chain disruption also has important geostrategic ramifications. Countries that cannot guarantee a secure and resilient supply of semiconductors risk their prosperity, security and have a reduced room for manoeuvre when rising to meet new challenges.

## **What would the impact of military action against Taiwan have on global semiconductor supply chains?**

The prospect of Chinese military action against Taiwan is not a remote possibility. President Xi Jinping has repeatedly reiterated the Chinese Communist Party's desire to 'reunify' the island with the mainland and refuses to rule out the use of force to do so. China sent 1,727 military planes into Taiwan's air defence zone in 2022, nearly doubling on the year before.<sup>5</sup>

It is difficult to understate the detrimental impact that Chinese military action or economic blockade against Taiwan would have on global semiconductor supply chains. The Taiwan Semiconductor Manufacturing Co. (TSMC) alone is responsible for over 70% of the world's semiconductor production by revenue, and over 90% of production in the most advanced semiconductors (defined as those less than 10 nanometers in size).<sup>6</sup> Some of the world's largest tech firms, including Apple, Amazon and Google rely on Taiwan-based contract manufacturers for nearly 90 percent of their chips.<sup>7</sup>

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<sup>4</sup> Jolly, J. & Collingridge, J. (2023), 'Britishvolt 'collapsed owing £120m' as UK car industry reports dismal year', The Guardian, 26 Jan 2023, <https://www.theguardian.com/business/2023/jan/26/british-volt-collapsed-owing-120m-as-uk-car-industry-reports-dismal-year>

<sup>5</sup> Agence France-Presse (2023), 'China's warplane incursions into Taiwan air defence zone doubled in 2022', The Guardian, 2 Jan 2023, <https://www.theguardian.com/world/2023/jan/02/chinas-warplane-incursions-into-taiwan-air-defence-zone-doubled-in-2022>

<sup>6</sup> Varas A., Varadarajan, R., Goodrich, J. & Yinug, F. (2021) 'Strengthening Global Semiconductor Supply Chain In An Uncertain Era', *Semiconductor Industry Association/Boston Consulting Group*, [https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021\\_1.pdf](https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf)

<sup>7</sup> Arcuri, G. & Lu, S. (2022), 'Taiwan's Semiconductor Dominance: Implications for Cross-Strait Relations and the Prospect of Forceful Unification', CSIS, 22 March 2022, <https://www.csis.org/blogs/perspectives-innovation/taiwans-semiconductor-dominance-implications-cross-strait-relations>

According to expert estimates, a full-scale disruption of semiconductor foundries in Taiwan would have an annual spillover impact of a US\$490 billion in lost revenue decline for electronic device manufacturers across different markets.<sup>8</sup> Such disruption would be a major contributing factor to the US government's reported estimates of \$2.5 trillion in annual losses to the global economy should China blockade Taiwan.<sup>9</sup>

The impact would be more than short term disruption. Taiwan has achieved its position as the world's leading advanced semiconductor manufacturer through five decades of accumulating capital investment and technical expertise. Taiwan is unique in having comprehensive manufacturing capabilities across different stages of semiconductor production and has a large talent pool of engineers at differentiated levels of expertise. Analysts predict it would take at least three years and a \$350 billion investment for the rest of the world to build enough capacity to replace Taiwanese foundries.<sup>10</sup>

## How resilient is the UK's semiconductor supply chain?

The UK has a very limited semiconductor production capacity, accounting for only 0.5% of semiconductor sales globally. Most of the UK's 25 semiconductor production plants are designed to produce "legacy nodes", with chip sizes greater than 180 nanometers, and none are capable of producing the most advanced silicon semiconductors.<sup>11</sup> As such, the UK's manufacturing sector is dependent on semiconductor imports and is highly exposed to shocks in the international semiconductor supply chain.

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<sup>8</sup> Varas A., Varadarajan, R., Goodrich, J. & Yinug, F. (2021), 'Strengthening Global Semiconductor Supply Chain In An Uncertain Era', *Semiconductor Industry Association/Boston Consulting Group*, [https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021\\_1.pdf](https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf)

<sup>9</sup> Hille, K. & Sevastopulo, D. (2022), 'US warns Europe a conflict over Taiwan could cause global economic shock', *Financial Times*, 10 November 2022, <https://www.ft.com/content/c0b815f3-fd3e-4807-8de7-6b5f72ea8ae5>

<sup>10</sup> Varas A., Varadarajan, R., Goodrich, J. & Yinug, F. (2021), 'Strengthening Global Semiconductor Supply Chain In An Uncertain Era', *Semiconductor Industry Association/Boston Consulting Group*, [https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021\\_1.pdf](https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf)

<sup>11</sup> Business, Energy and Industrial Strategy Committee (2022) 'The semiconductor industry in the UK: Fifth Report of Session 2022–23', 22 November 2022, <https://committees.parliament.uk/publications/31752/documents/178214/default/>

Despite its limited production capacity, the UK does play an important role in semiconductor design and development. British firms such as ARM Holdings are the world leaders in semiconductor design, with 95% of smartphones globally using an ARM patent.<sup>12</sup> The UK is also a leader in manufacturing compound and advanced material semiconductors. While most chips are made with silicon, compound and advanced material semiconductors open new possibilities for chips, in particular, handling higher power loads and operating at higher temperatures.<sup>13</sup> Compound semiconductors will play a vital role in future communications, aerospace, and new energy application markets, and are a key component in electric cars.

## **How can the UK boost the resilience of its semiconductor supply chains?**

The semiconductor supply chain is complex and relies on drawing designs, materials and manufacturing inputs from across the world. Each stage of the production process is highly specialised and no one country has dominance across all stages of the design and production process. To replace the existing international supply chain with an end-to-end, domestic supply chain would require an incremental upfront investment of more than US\$1 trillion and would push semiconductor prices to climb sharply.<sup>14</sup> 'Onshoring' semiconductor production is therefore not a viable option for the UK.

As the UK government prepares to publish its long awaited semiconductor strategy, this paper argues that this should be built around three core tenets. First, the UK should develop a semiconductor strategy which plays to its strengths in chip design and advanced material semiconductors through increasing investment in research and development and human capital. Second, the UK needs to cooperate with its trusted allies to ensure a diverse and resilient semiconductor production capacity globally. Third, Taiwan's indispensable role in advanced semiconductor production

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<sup>12</sup> Department for Digital, Culture, Media and Sport (2022), 'The Semiconductor Industry in the UK', 5 July 2022, <https://committees.parliament.uk/writtenevidence/109609/pdf/>

<sup>13</sup> Fryer, T. (2018), 'Compound semiconductors point the way ahead for life after silicon', E&T, 13 September 2018, <https://eandt.theiet.org/content/articles/2018/09/compound-semiconductors-point-the-way-ahead-for-life-after-silicon/>

<sup>14</sup> Varas A., Varadarajan, R., Goodrich, J. & Yinug, F. (2021), 'Strengthening Global Semiconductor Supply Chain In An Uncertain Era', *Semiconductor Industry Association/Boston Consulting Group*, [https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021\\_1.pdf](https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf)

means that promoting Taiwan's security must also be at the front and centre of the UK's semiconductor strategy.

### **1. *Playing to its strengths***

Since the strength of the UK's role in the semiconductor supply chain lies in the design phase, rather than the manufacturing phase, for the UK to maintain its leading position it must nurture its human capital, invest in research and development and attract talent from around the globe.

The UK should look to mirror the ambitious investment in research and development set out by the US and EU 'Chip Acts'. The US Chip Act contains an \$11 billion fund for research and development and talent training and \$81 billion for the National Science Foundation (NSF) to invest in developing research and STEM talent.<sup>15</sup> Similarly, the EU's Chips for Europe Initiative dedicates around 3.3 billion euros to support technical capacity building, research and development and personnel training.<sup>16</sup>

In contrast, the UK's Engineering and Physical Sciences Research Council, Science and Technology Facilities Council and Innovate UK received a combined total of just over £3 billion for all projects in 2020 - 2021.<sup>17</sup> The UK's semiconductor strategy must set out dedicated funding for research and development for both universities and the private sector, as well as investing in regional 'clusters' of semiconductor innovation such as Cambridge, South Wales and the North East of England that have allowed for links between academia and businesses.

To attract global talent the government must also remove high fees and barriers to entry for those seeking to work and study in the UK. The government's flagship scheme to encourage top scientists to work in the UK only issued one visa in its first year.<sup>18</sup> The UK must seek to increase the number of skilled work visas given to the STEM sector while decreasing fees for both applicants and employers.

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<sup>15</sup> 117th Congress (2022), 'H.R.4346 - Chips and Science Act', 8 September 2022.

<sup>16</sup> European Commission (2022), 'Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework of measures for strengthening Europe's semiconductor ecosystem (Chips Act)', 8 February 2022.

<sup>17</sup> UK Research and Innovation (2022) 'Annual Report and Accounts 2021-22', 19 July 2022, <https://www.ukri.org/wp-content/uploads/2023/01/UKRI-180123-AnnualReportandAccounts-21to22.pdf>

<sup>18</sup> Murugesu, J.A. (2022), 'UK visa for top scientists was given to just one person in first year', *New Scientist*, 1 Jun 2022, <https://www.newscientist.com/article/2322750-uk-visa-for-top-scientists-was-given-to-just-one-person-in-first-year/>

Also key to protecting the UK's strategic advantage is blocking competitor's attempts to buy up UK firms and expertise. Of particular note is the Chinese government's 'Made in China 2025' strategy, which seeks to 'decouple' from the West in critical technologies, including through acquiring foreign expertise for Chinese firms.<sup>19</sup> The UK government was right to use 'call in' powers granted under the National Security and Investment Act to unwind the Chinese owned Nexperia's takeover of British semiconductor manufacturing firm Newport Wafer Fab, citing concerns that the firm could use the takeover to gain advances in compound semiconductors to the detriment of the UK's own capabilities. However, the lengthy delays to the decision, and eventual u-turn under significant parliamentary pressure, raise questions over the efficiency and credibility of the call in process. Ensuring the screening committee has sufficient capacity to analyse acquisitions is particularly important given the Chinese government's strategy of using third country's companies as the vehicle to make acquisitions of technology companies abroad.<sup>20</sup>

## **2. Cooperating with allies**

Given that the UK cannot produce an end to end semiconductor supply chain, cooperating with its allies to safeguard its security of supply is a strategic priority.

The UK should join 'friendshoring' initiatives, which seek to develop a comprehensive supply chain between like minded partners that share similar values and strategic interest. Notably, it is within the UK's strategic interest that US-led initiatives such as the 'Chip 4 Alliance' Japan, Taiwan and South Korea succeed. The Chip 4 Alliance aims to promote a supply chain between the four countries with US firms specialising in chip design, Japan leading the supply of key materials and equipment, and Taiwan and South Korea being the key manufacturing countries. The UK can play an important diplomatic role in encouraging this initiative, which has so far struggled to mobilise.<sup>21</sup> If the UK were to join as a 5th partner in this alliance, there would be

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<sup>19</sup> The State Council of the People's Republic of China (2022), 'Made in China 2025', <https://english.www.gov.cn/2016special/madeinchina2025/>

<sup>20</sup> Schweizer, D., Walker, T. & Zhang, A. (2019), 'Cross-border acquisitions by Chinese enterprises: The benefits and disadvantages of political connections', *Journal of Corporate Finance*, 57, pp.63-85, <https://doi.org/10.1016/j.jcorpfin.2017.12.023>; Shead, S. (2021), 'TECH The Chinese firm behind the acquisition of the UK's largest chip plant is state backed, analysis shows', CNBC, 7 July 2021, <https://www.cnbc.com/2021/07/07/nexperia-owner-wingtech-is-backed-by-chinese-government-analysis-says.html>

<sup>21</sup> Davies, C., Song, J.A, Inagaki, K. & Waters, R. (2022), 'US struggles to mobilise its East Asian 'Chip 4' alliance', *Financial Times*, 13 September 2022, <https://www.ft.com/content/98f22615-ee7e-4431-ab98-fb6e3f9de032>

opportunities for UK firms to play a leading role at the design stage of this supply chain. Similarly, the UK should aim to take part in the early warning and monitoring mechanism agreed between the US and the EU to monitor and prepare for semiconductor supply chain disruptions.<sup>22</sup>

Taiwan's booming semiconductor industry also presents a lucrative opportunity for UK firms. While UK firms are unlikely to match their advanced production capabilities, Taiwanese firms such as TSMC rely on satellite companies to provide components, designs and software development. UK firm Oxford Instrument has led the way in signing a cooperative research project with the Industrial Technology Research Institute in Taiwan for the development of next-generation compound semiconductors.<sup>23</sup> The UK government should strengthen diplomatic representation at the British Office Taipei to further facilitate dialogue between Taiwanese and UK technology firms to identify trade opportunities.

### **3. Safeguarding Taiwan's security**

Reports have suggested that the UK government will seek to end its reliance on Taiwanese chips as part of its new semiconductor strategy.<sup>24</sup> While the government is right to strengthen the diversity of its supply chains, cutting the UK's dependency on Taiwanese semiconductors is neither feasible nor desirable.

Taiwan plays an indispensable role in the semiconductor supply chains. Taiwan's dominance is particularly high in the most advanced chips, where it produces over 90% of the world's supply. Analysts estimate it would take the rest of the world several years and at least a US\$350 billion investment for the rest of the world to build enough capacity to replace Taiwanese foundries.<sup>25</sup>

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<sup>22</sup> Reinsch, W.A., Benson, E. & Arasasingham, A. (2022) 'Securing Semiconductor Supply Chains: An Affirmative Agenda for International Cooperation', CSIS, 2 August 2022, [https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802\\_Reinsch\\_Semiconductors.pdf?WMGKge29KFMObw9Bkvwzkomj4mUtsr](https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/220802_Reinsch_Semiconductors.pdf?WMGKge29KFMObw9Bkvwzkomj4mUtsr).

<sup>23</sup> Flaherty, N. (2021), 'Taiwan taps Oxford Instruments to expand compound semiconductor supply chain', eeNews Europe, 4 October 2021, <https://www.eenewseurope.com/en/taiwan-taps-oxford-instruments-to-expand-compound-semiconductor-supply-chain/>

<sup>24</sup> Wickham, A., Seal T. & Donaldson, K. (2023), 'Sunak Urged to Cut UK Use of Taiwan Chips Due to China Risk', Bloomberg, 20 January 2023, <https://www.bloomberg.com/news/articles/2023-01-20/sunak-urged-to-cut-uk-reliance-on-taiwan-chips-due-to-china-risk>

<sup>25</sup> Varas A., Varadarajan, R., Goodrich, J. & Yinug, F. (2021), 'Strengthening Global Semiconductor Supply Chain In An Uncertain Era', *Semiconductor Industry Association/Boston Consulting Group*, [https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021\\_1.pdf](https://www.semiconductors.org/wp-content/uploads/2021/05/BCG-x-SIA-Strengthening-the-Global-Semiconductor-Value-Chain-April-2021_1.pdf)

Guaranteeing Taiwan's security and maintaining peace across the Taiwan strait must therefore form a core part of the UK's semiconductor strategy. By deterring China from carrying out military action against Taiwan, the UK is not only supporting a key democratic ally in the region but is also acting to secure its critical supply chains and the prosperity of the UK economy.

The UK must urgently set out a Taiwan strategy to deter Chinese coercion against Taiwan through economic, political and defence cooperation with Taiwan and likeminded partners. The UK-Japan defence agreement is a welcome step towards strengthening the UK's capabilities in the region, while increased participation in freedom of navigation missions with allied partners would signal its commitment to the region's security. The UK should also make clear to the Chinese government the severity of economic sanctions and diplomatic isolation that any action against Taiwan would be at least on par with measures taken against Russia following the invasion of Ukraine.

China's attempts to isolate Taiwan from the international stage are a core part of its strategy to weaken international resistance to future coercion against Taiwan. By fostering greater political, economic and people to people ties with Taiwan, the UK can push back against these attempts. The UK should support Taiwan's increased role in multilateral institutions, such as the World Health Organisation and International Labour Organisation, as well as Taiwan's accession to the Comprehensive and Progressive Trans-Pacific Partnership (CPTPP) once the UK finalises its membership of the group. There are also underexploited avenues for encouraging greater trade, educational partnerships and cultural exchange between the UK and Taiwan.

## Policy recommendations

### *Recommendations to the UK government:*

- Increasing investment in semiconductor research and development for both universities and the private sector through increasing funding available to the Engineering and Physical Sciences Research Council, Science and Technology Facilities Council and Innovate UK, while also investing in regional clusters to promote partnerships between academia and the private sector.
- Developing the UK's human capital by removing barriers to entry for global talent, including expanding the number of skilled work visas given to the STEM sector while decreasing fees for both applicants and employers.
- Leading efforts to establish semiconductor supply chain 'friendshore' initiatives, by joining as a 5th partner in the proposed 'Chip 4 Alliance' with the US, Japan, Taiwan and South Korea.
- Facilitating forums with likeminded partners to monitor risks of supply chain disruption, beginning by aiming to join the monitoring mechanism agreed between the US and EU.
- Strengthening diplomatic representation in Japan, South Korea and Taiwan to further identify and facilitate trade opportunities for UK semiconductor firms.
- Deterring China from taking coercive actions against Taiwan, through increasing the UK's presence in the region and making clear that any aggression will result in economic sanctions and diplomatic isolation of the same severity of measures taken against Russia following the invasion of Ukraine.
- Securing Taiwan's role in the global economy and international community by supporting Taiwan's increased role in multilateral institutions and seeking to develop underexploited avenues for encouraging greater trade, educational partnerships and cultural exchange between the UK and Taiwan.

