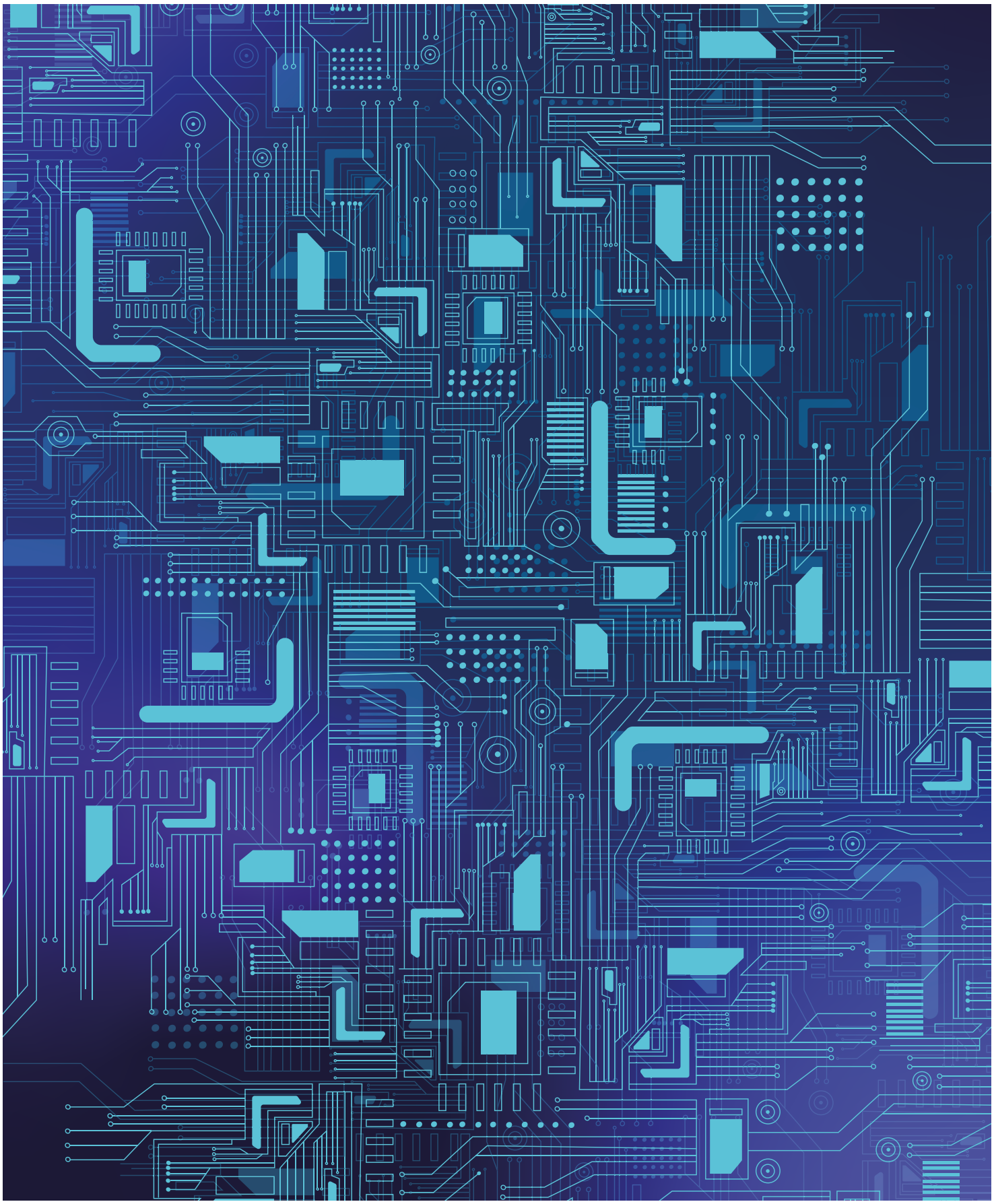
SPOTLIGHT

Savills Research

Building Blocks of Growth:

Semiconductors and the Logistics Sector

savills

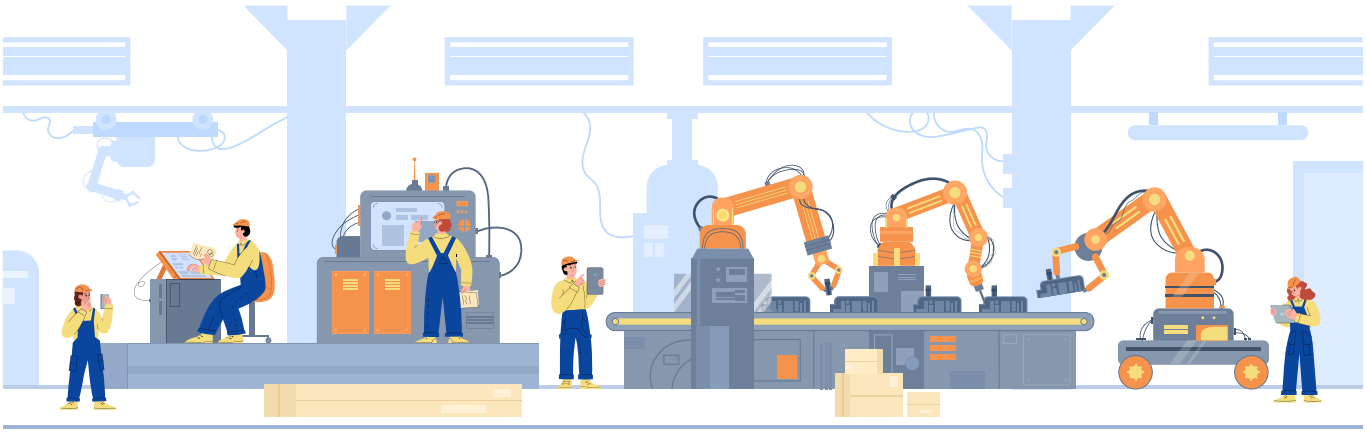


SECTOR OVERVIEW • REAL ESTATE IMPACTS • POLICY DEVELOPMENTS

The Semiconductor Shortage

ALSO KNOWN AS THE "CHIP SHORTAGE"

Experienced in 2021 and 2022 has been primarily attributed to a combination of factors that disrupted the global supply chain and increased demand for semiconductors.



The Covid-19 pandemic played a significant role in creating this disruption. With more people relying on electronic devices and technologies during lockdowns, the demand for laptops, smartphones, gaming consoles, and home appliances surged. This sudden increase in demand led to a higher need for semiconductors.

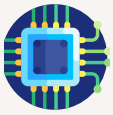
The automotive industry was particularly impacted by the pandemic. Many car manufacturers temporarily shut down production as the pandemic spread. However, when the demand for vehicles rebounded faster than anticipated, manufacturers struggled to keep up with the sudden surge in orders for automotive semiconductors. This increased demand from the automotive sector further exacerbated the supply-demand imbalance.

The pandemic also disrupted global supply chains, creating significant challenges for semiconductor production and delivery. Factory shutdowns, logistical issues, and reduced production capacity due to Covid-19 safety measures increased lead times for semiconductors.

The highly complex fabrication processes in semiconductor manufacturing require specialized equipment and facilities, and increasing production capacity takes time and substantial investment. The sudden surge in demand outpaced the available manufacturing capacity, resulting in supply shortages.

The concentration of semiconductor manufacturing in certain regions, particularly East Asia, contributed to vulnerabilities in the supply chain. Disruptions, such as factory closures and trade restrictions, in these regions, had a ripple effect on the global supply of semiconductors. On top of this, trade tensions and geopolitical issues between major economies, such as the U.S. and China, impacted the semiconductor supply chain.

The semiconductor industry relies on a complex network of suppliers, including raw materials, equipment, and packaging providers. Disruptions at any point in this network can significantly impact the production and supply of semiconductors globally.



Europe's share of semiconductor production will need to **more than double** to reach the EU Chips Acts targets

5.7 **additional jobs** will be created for every person employed in semiconductor production

We expect revenue from these firms to **increase by up to 349%** if this is achieved

10.8 million sq m of demand will be generated by the **successful expansion** of the semiconductor sector

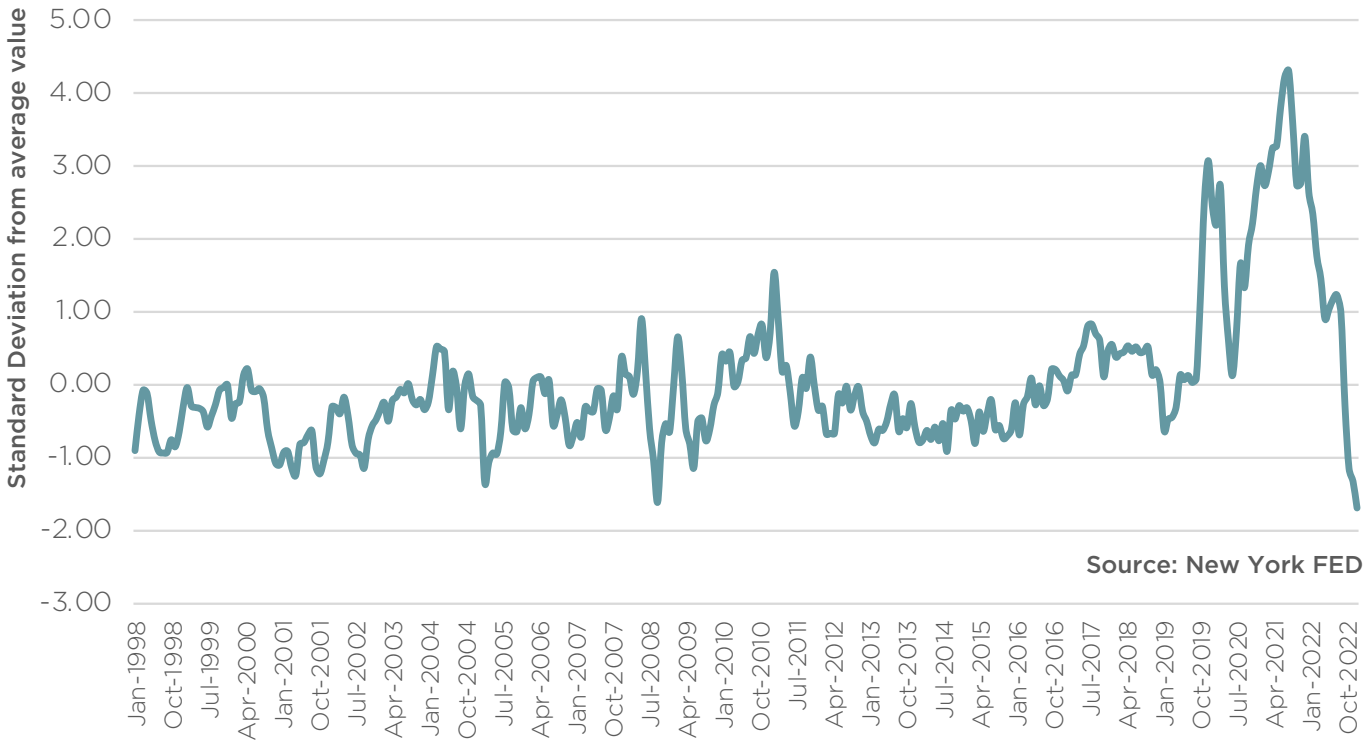
The start of 2023 has seen many of these trends reverse.

Central Banks have responded to high inflation rates by hiking interest rates, reducing business activity. At the same time, household consumption slowed in the face of a cost-of-living crisis, reducing demand for electrical goods and cars. One positive impact of the economic slowdown has been reduced demand for international freight, allowing the supply chains to recover from the pandemic-era turmoil.

These developments have reduced the strain on semiconductor supply, allowing it to catch up with demand. Simultaneously, semiconductor demand declined in the first half of 2023, but this is likely to be a short-lived trend. Megatrends that include AI, electric vehicles, cloud computing, automation in manufacturing and logistics, the Internet of Things (IoT) and other cutting-edge emerging technologies like AR/VR, quantum computing and 6G network connections will fuel a sharp rise in semiconductor demand.

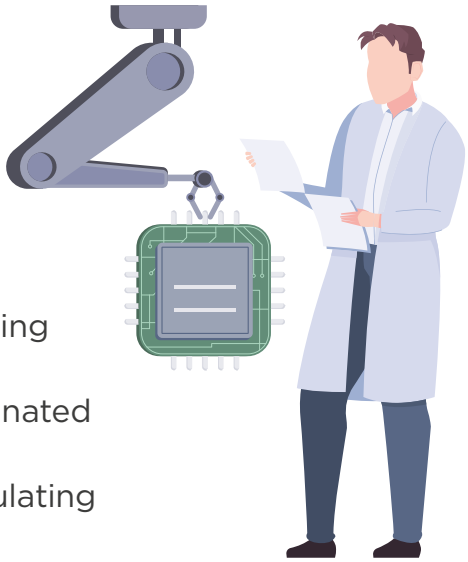
Economies which seek to develop and integrate these technologies and products will need access to a steady supply of semiconductors. Regardless of the business cycle and short-term cyclical declines in demand, the long-term trend is an increase in demand for these products. Semiconductors have become integral to the functioning and forward trajectory of modern economies. Shortages in supply will have an increasing impact on the production of goods and, consequentially, the security of their supply rising swiftly up policymakers' agendas.

Global supply chain disruption has declined sharply in the last year



Source: New York FED

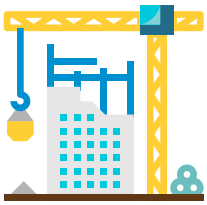
What's involved in
PRODUCING SEMICONDUCTORS



Semiconductor production has two key areas of focus: Research and Development (R&D) and Fabrication. Both processes have highly intensive capital and labour requirements, with the fabrication of semiconductors being an order of magnitude more intensive in terms of capital requirements. The fabrication process has become dominated by South-East Asian economies. Recent policy changes enacted by the USA, UK and EU primarily focus on stimulating growth in the fabrication of chips.

Attracting fabs, which can produce semiconductors at scale, is the biggest challenge facing the EU and other Western economies. Build costs have risen sharply across all real estate sectors in recent years, and semiconductor fabs have been no exception.

Intel estimates that the construction of a fab can take up to three years, **costing $10 billion to build and requiring 6,000 construction workers.**



The design of fabs is unique to individual producers and extremely capital-intensive. Furthermore, the energy requirements of the fabs are similarly intensive, with fabs in China reportedly requiring between 30-50MW at peak usage – equivalent to 30,000 to 50,000 residential homes. Given the power-related planning constraints across Europe in recent years, which Savills has noted in recent reports, this is another hurdle for policymakers and semiconductor producers to overcome.

In addition to large initial capital requirements, semiconductor fabrication is highly dependent on the availability of skilled labour. Despite technology and automation playing a significant part in manufacturing processes, a heavy reliance on educated employees to operate complicated equipment is currently unavoidable. To complicate matters further, the technology involved is evolving rapidly, and firms must compete to hire from a shallow labour pool qualified to operate it. One of the driving forces in the rise of Asia's semiconductor industries has been a competitive advantage in labour costs. While this disparity has eroded as incomes have risen in these markets, it has left Europe facing an uphill battle to regain lost market share. Indeed, with Western economies already struggling with tight labour markets, government policy will need to smooth this skill gap to make locating in their markets more viable.

Geographical Breakdown

Over the last 30 years, the geographic breakdown of semiconductor manufacturing and production has undergone significant changes. One of the most prominent of which has been the aforementioned rise of Asia, with Taiwan, South Korea and China becoming dominant players.

Taiwan has become the lynchpin of the semiconductor market and is home to well-established semiconductor companies, the most notable of which is the Taiwan Semiconductor Manufacturing Company (TSMC).

Taiwan produces over **60%** of the global semiconductor supply and over **90%** of the cutting-edge semiconductors. The majority of which is produced by TSMC.

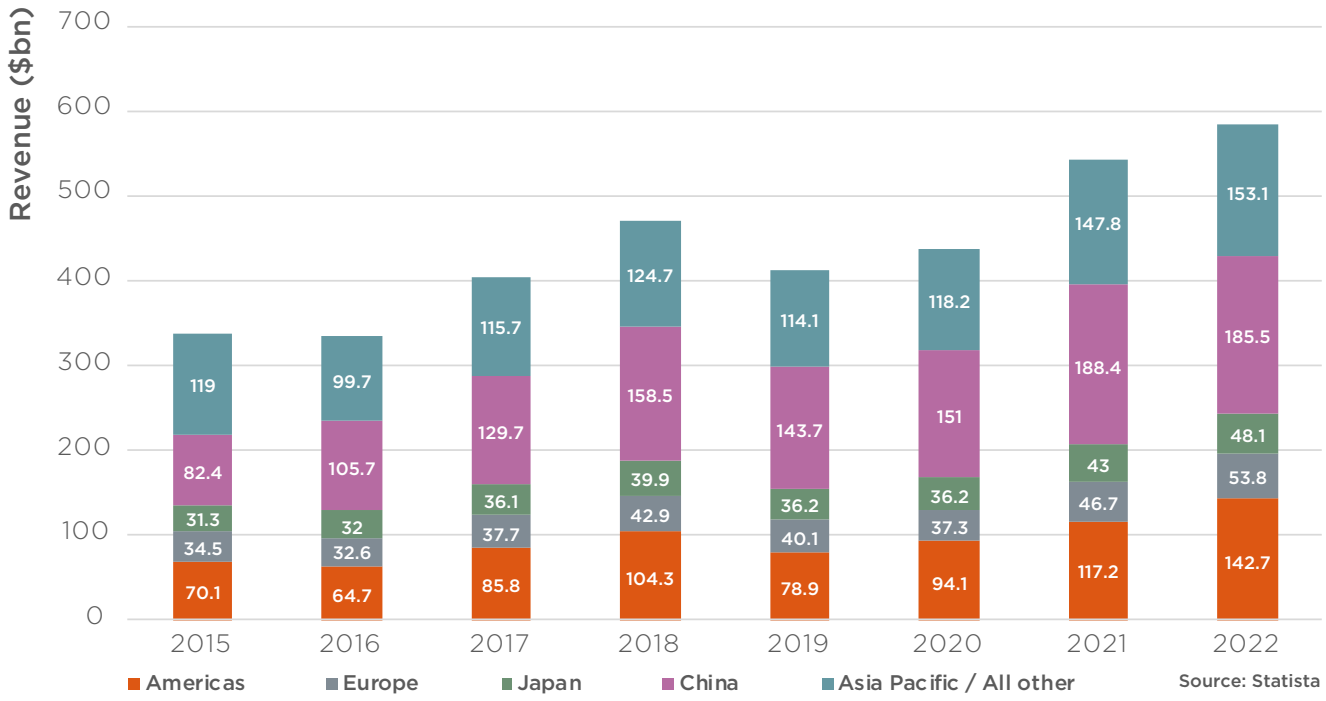
Taiwan's rise to dominance has led to deep dependence on the island, even as geo-political tensions in the region have led to analysts questioning the long-term reliability of supply.

South Korea has also established itself as a leader in memory chip production, with domestic producers such as Samsung and SK Hynix playing a significant role in global supply. China has intensified efforts to reduce its reliance on imported chips through its "Made in China 2025" policy, investing heavily in manufacturing facilities. China faces key technical challenges but has made significant strides in catching up with its competitors.

North America continues to play a significant part in the semiconductor production ecosystem, with major companies like Intel, Qualcomm and Nvidia, all well-regarded for design capabilities, located there. Europe has seen its share of manufacturing slip as Asia's has risen. Europe's R&D expertise has proven to be a bulwark for the industry, but it has struggled to compete with Asia on production costs. China has grown to be the largest market by revenue since 2015, with its share of global revenue growing from:

24% in 2015 → **32%** in 2022

Notably, this growth has come at the expense of other Asia Pacific producers whose shares have fallen from 35% to 26%. China's rise suggests a degree of success in their targeted policies over the last decade, which shows that well-thought-out government intervention can be highly effective in supporting domestic production.



Policy developments
IN THE SECTOR

The pandemic put the importance of a stable supply of semiconductors to modern economies in stark relief. Additionally, as geo-political tensions have risen and threatened global supply chains, most developed economies have introduced policies aiming to bolster their domestic semiconductor production.

The flagship policy in the EU is the EU Chips Act which will see the EU set aside an estimated €43bn in funding up to 2030.

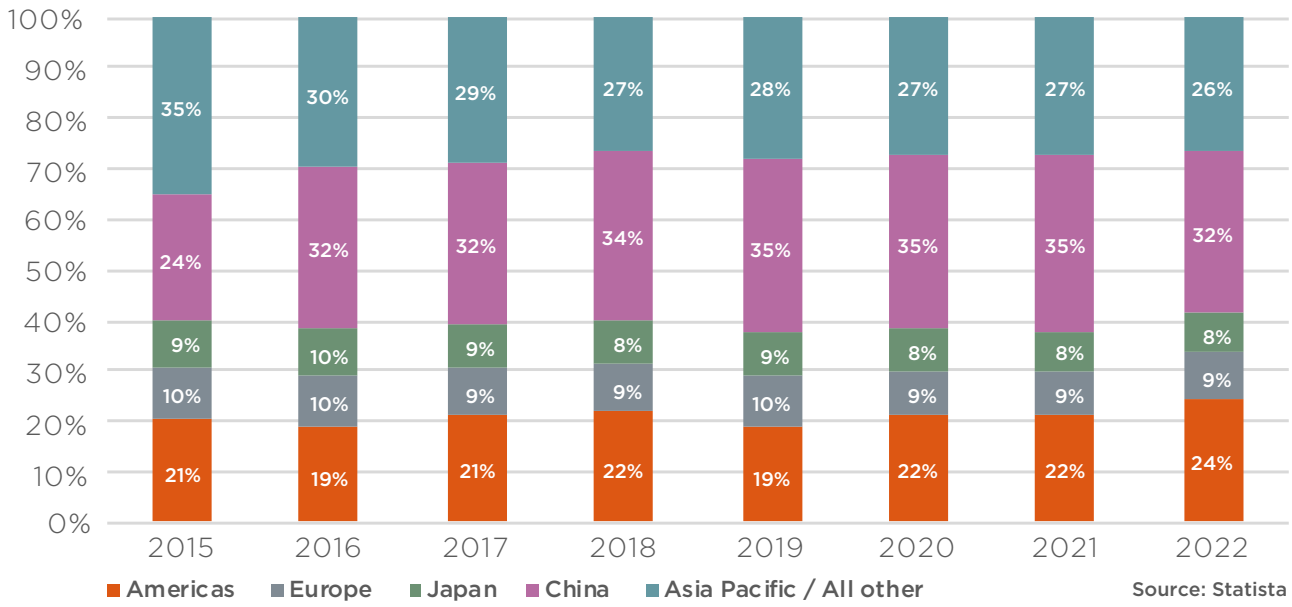
The act aims to improve the EU's existing strengths in R&D and reignite the industrial-scale production of chips in the EU, which has lagged behind that of Asian economies in recent decades. In the US, the CHIPS and Science Act provides roughly $52.7bn in new funding to boost domestic research and manufacturing of semiconductors. The US's share of global production has fallen from 37% in 1990 to 12% in 2021, and the act aims to reverse this trend. The recently released UK National Semiconductor Strategy has set aside £1bn in funding to focus on the UK's pre-existing strengths in design, research and advanced chip production. Policymakers hope that improved domestic R&D outcomes and incentivising international cooperation will foster growth amongst domestic chip firms.

In Asia, China is accelerating efforts to close its technological gap: investing around USD 150 billion over the past decade in line with a series of plans and initiatives like the "Made in China 2025" policy.

Japan has announced public funding of $8 billion for domestic semiconductor investment, with additional funding being made available. South Korea's "K-Semiconductor Belt" strategy will support the domestic industry through tax incentives of 20% on new fabs, complementing domestic companies' private investments in R&D and manufacturing. This will cost the government an estimated $450 billion between 2021 and 2030. Under Taiwan's "Invest in Taiwan" initiatives, semiconductor firms get significant tax credits on R&D and reductions on income tax. The policy's goal is to maintain Taiwan's dominance in production through technological breakthroughs.

The focus of this report is, of course, the European market. The EU is home to several world-leading equipment and raw materials suppliers, giving it a strong starting base for increasing domestic production. Europe excels at R&D, and firms producing in the EU are global leaders in automotive and industrial equipment - high-growth markets for semiconductor demand. The European Semiconductor Industry Association (ESIA), an organisation representing the semiconductor industry, believes that the European focus should be on developing a better understanding of global supply chains to monitor their functioning and understand future trends. Policymakers and business leaders would consequentially be better able to anticipate disruptions. The ESIA believes that building international partnerships based on mutual interest is a key strategy in preventing international supply chains from breaking down.

APAC nations account for the majority of global semiconductor revenues



Source: Statista

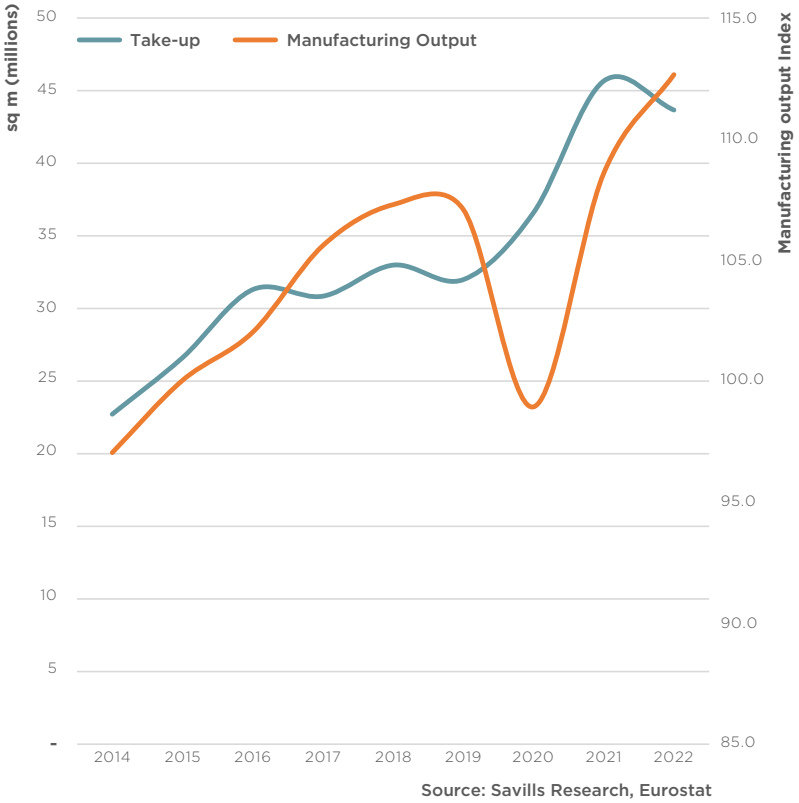
Real Estate Impacts

REAL ESTATE AND MANUFACTURING

The link between manufacturing activity and demand in the industrial and logistics market is well-explored and self-evident. As long-term demand for manufactured goods rises, manufacturing occupiers will expand their real estate footprints to increase capacity. Higher manufacturing output will increase the volume of goods moving through the economy, stimulating demand for logistics demand. Indeed, this effect is apparent in the relation between EU manufacturing output and European take-up, shown below.

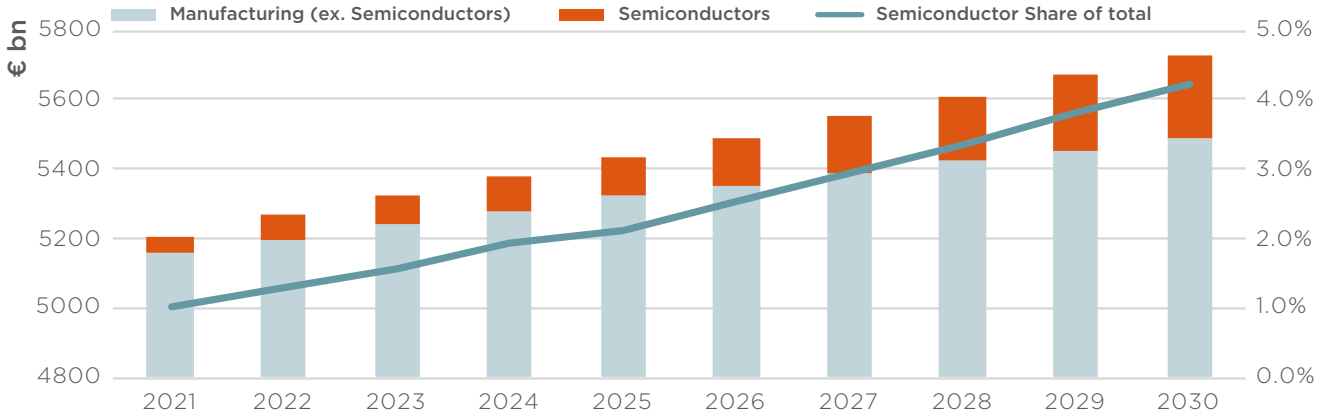
This aggregate data underplays the relationship between the two, and we would expect to see similar relationships in national markets. Markets in economies with higher weightings of industrial-based occupation, like Germany and Poland, have a stronger relationship and take-up in these markets will be more sensitive to increases in manufacturing investment. We would also note that most of the variation between the two series is due to Covid-era declines in productivity due to lockdowns.In 2021, total European manufacturing revenues reached €5,209 billion, while total semiconductor revenue reached €53.8 billion – equating to just over 1% of total European manufacturing revenues. Assuming that manufacturing grows at the compound annual growth rate experienced between 2011 and 2021 (1.07%) and European semiconductor revenues reach the €241.56bn figure needed to achieve the EU's targets, this share could grow to 4.2% by 2030. This growth represents an additional increase in manufacturing revenues of 2.9% over the period, driving take-up in the European logistics sector.

There is a clear relationship between manufacturing output growth and logistics take-up



Source: Savills Research, Eurostat

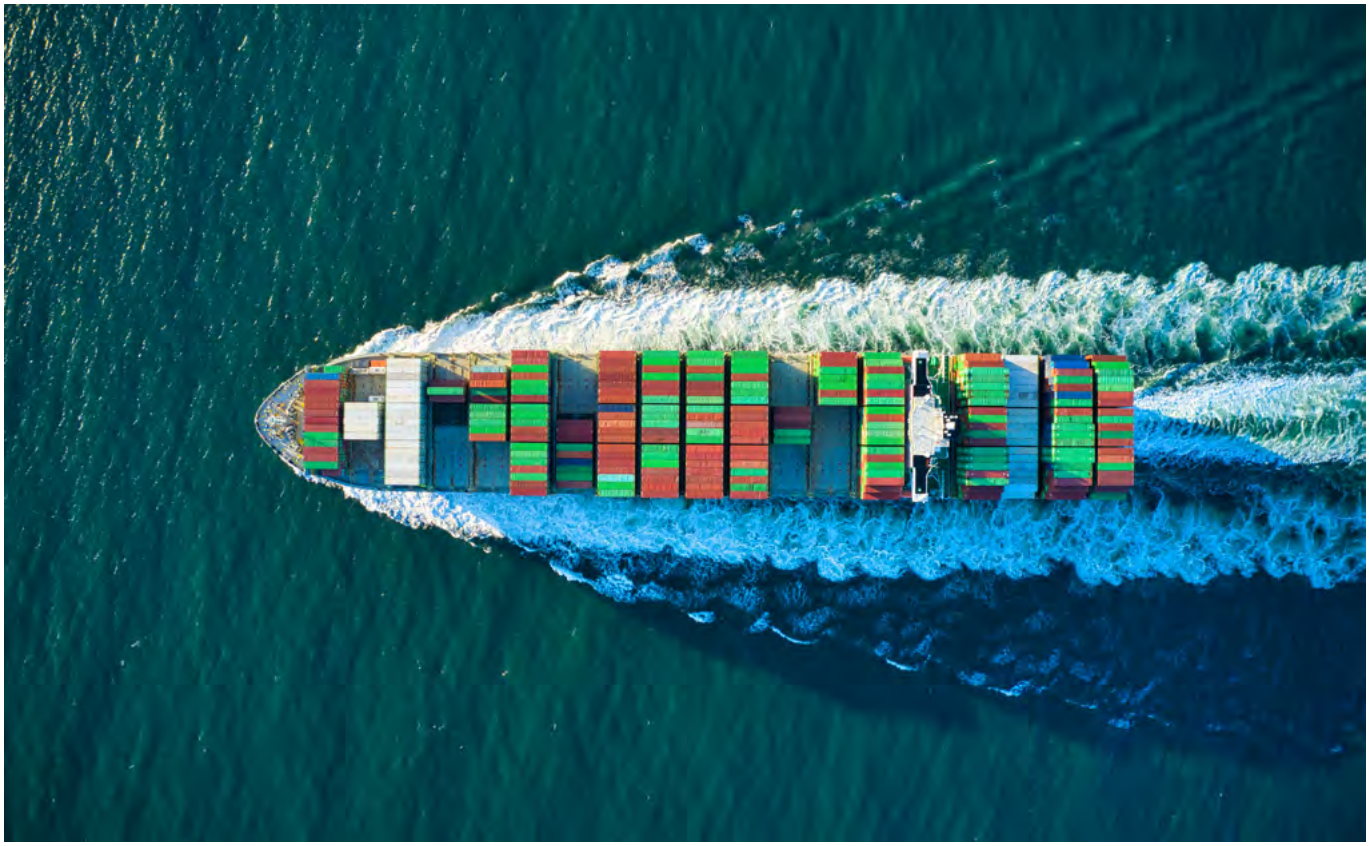
Revenue from semiconductor production is set to account for a growing share of EU manufacturing revenue

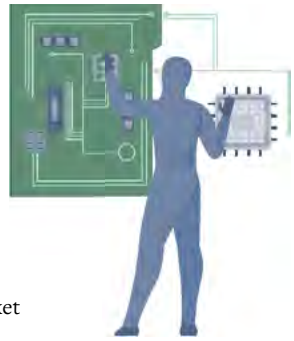


Source: Savills Research

In the US, research from the Semiconductor Industry Association (SIA) suggests that every $1bn in Gross Value Added to GDP (On a simplistic level, GVA is the total of all revenues from final sales and net subsidies) generates an additional $0.89bn of GVA in indirectly. We would note that much of this indirect GVA would come from complementary manufacturing and logistics industries. This would suggest that the increase in semiconductor revenues by 2030 could roughly generate an additional €167.2bn in revenue per annum in the manufacturing and logistics sectors.

On the ground, Savills is already seeing evidence of take-up driven by semiconductors and manufacturing, with at least one manufacturer of equipment needed for semiconductor production actively looking to expand their footprint in the EU. Across Europe, we have seen an uptick in enquiries from manufacturers. In the UK, Automotive, Manufacturing and Food Production accounted for 28% of total take-up in 2022, well ahead of the long-run average of 23%.





In addition to direct growth in demand from semiconductor producers, we expect to see more expansions amongst the previously mentioned semiconductor equipment manufacturers to facilitate increased production.

Requirements from specialist material suppliers of raw materials and chemicals for semiconductors would inevitably grow as production increased. Indeed as output increases, specialised packaging and testing companies that provide protective packaging, ensure proper electrical connection and enable the integration of chips into final products would also grow. All of these firms will either be operating within the logistics real estate market or require the services of 3PLs, stimulating demand for development land and logistics assets. This will inevitably lead to an uplift in demand in the medium to long term, forming part of the ongoing trend of onshoring we have started to observe in Europe.

CHINA

Further evidence of the relationship between manufacturing and the logistics sector has been shown using the "Made in China 2025" strategy as a natural experiment . The paper used a double difference methodology, looking at locations where investment increased through the "Made in China 2025" policy to show a causal relationship between the application of the policies and the high-quality development of the logistics sector. Further empirical research has shown that upgrading and transforming the secondary industrial industry (an industrial activity that converts raw materials into commodities and products) requires simultaneous expansion in the logistics sector.

What this means for logistics real estate is that success in enhancing the development of the European semiconductor industry will not just drive logistics occupier demand but may be reliant on adequate development of logistics itself. One factor in this is technological innovation within the logistics industry, but at a basic level increasing the volume of goods moving through the economy will inevitably require greater real estate footprints. In the context of acute shortages in the supply of suitable logistics buildings and land in recent years, it is clear that a secular increase in demand will put further pressure on supply. From a policymaker's perspective, it's imperative that the supply of logistics space can adequately service the manufacturing output that they aim to stimulate.

INTERNATIONAL EXAMPLES

A burgeoning semiconductor industry would drive logistics demand through channels beyond the movement of manufacturing output. Stimulating the industry would drive employment growth in the regions where fabs or research labs are built.

These jobs would, in turn, drive residential demand and, thus, consumer demand. The supply-chain-related chaos during the pandemic has made it increasingly clear that logistics space can be considered a form of infrastructure. Without adequate space, it becomes more challenging to supply goods to consumers in a timely or cost-effective manner. Thus, a sudden influx of new households in an area will need a corresponding increase in logistics space to service the resulting consumer demand.

On an international level, there are a plethora of examples of this effect. In Arizona, where Taiwan Semiconductor Manufacturing Company (TSMC) has announced the construction of a new $40bn plant in Northern Phoenix, property prices have surged amidst rising demand.

The site employs **9,000 construction workers,** and **600 'seed' engineers** were sent from Taiwan, with **600 additional engineers already in training.** These engineers crucially also bring their families with them, driving population growth. TSMC has said that the Arizona plant will **create 4,500 jobs** directly, and they expect the plant will indirectly create an **additional 10,000 supply-chain-related jobs.**

American firm Intel, also present in Arizona, has invested close to $32bn since 1979 and is investing a further $20bn to build two new fabs. Intel estimates they have created 58,600 jobs for the local economy and directly or indirectly support more than 700,000 full-time and part-time jobs in the US - counting for 0.5% of US GDP. In Ireland, Intel has invested more than €17bn to build a fab in Leixlip, bringing the company's total investment into Ireland to €30bn. The new fab will employ 1,600 new roles directly and has supported more than 5,000 construction jobs over the past three years, boosting economic demand. In mainland Europe, Intel plans to invest a further €17bn in Germany, creating 3,000 permanent high-tech jobs at Intel and 'tens of thousands of additional jobs across suppliers and partners and has further investment plans in France, Germany, Italy, Poland and Spain. The company plans to invest €80bn in the EU over the next decade along the entire value chain (R&D, Manufacturing, Advanced Packaging).

Potential Outcomes

It is challenging to give an accurate estimate of the occupational footprint of the industry in terms of logistics. The 'fabs' themselves are strictly custom-built, usually by their occupiers. As such, we have split this analysis into two parts. Firstly, we look at typical densities for employment in the manufacturing sector. We consider space taken by the fabs themselves and the direct employment generated by the industry, which is attributed to logistics demand.

The European semiconductor ecosystem was responsible for roughly **200,000 direct jobs in 2020**

An additional **1,000,000 jobs** created for systems, applications and services in Europe

Micro and nano electronics contribute about **10% of GDP** in Europe

Intel's fabs in Ireland, Arizona and Oregon are all at least **23,225 sq m (250,000 sq ft)** in size with significant labour and materials requirements.

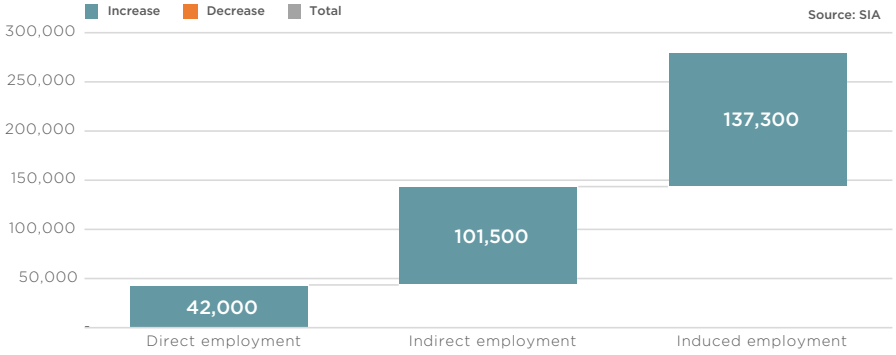
The second component of our demand estimation examines total job creation, both direct and indirect and attributes household demand to logistics. While many workers would have found employment elsewhere, demand induced by semiconductor employment is likely to occur in specific regions creating excess demand in certain areas like that experience in areas where TSMC or Intel have previously set up. In Arizona, for example, there has been a significant increase in household construction due to the boost in employment TSMC has brought to the area, and logistics demand will consequentially rise in response to population growth in a given area. Furthermore, competition for labour created by a growing semiconductor sector will drive significantly above-average wages. Employees in the industry will have higher disposable incomes and, consequentially, a higher propensity to consume.

The SIA suggests that a one-off $50bn federal incentive program could support the construction of an additional ten fabs in the US that would not have been built otherwise. The SIA suggests this would increase direct employment by 42,000 jobs from 277,000 to 319,000 in the US. Assuming a jobs multiplier from earlier research by the industry body, which found a 6.7 jobs multiplier, the semiconductor industry would support an additional 280,000 jobs in this scenario. Of these, 101,500 (36%) would be indirect employment in industry and services adjacent to the semiconductor industry and 137,300 jobs from induced employment.

WE MAKE A NUMBER OF ASSUMPTIONS IN THIS ANALYSIS:

- The EU successfully increases its share of semiconductor production as set out in the EU Chips Act.
- For Household demand, we assume an average household size of 2.3 persons, in line with the EU average.
- We assume 6.4 sq m of demand per household for logistics space generated by household consumption.
- We assume the 6.7 jobs multiplier for the semiconductor industry set out by the SIA.

US-based employment figures show high levels of indirect and induced employment from semiconductor employment growth



FORECASTED DEMAND

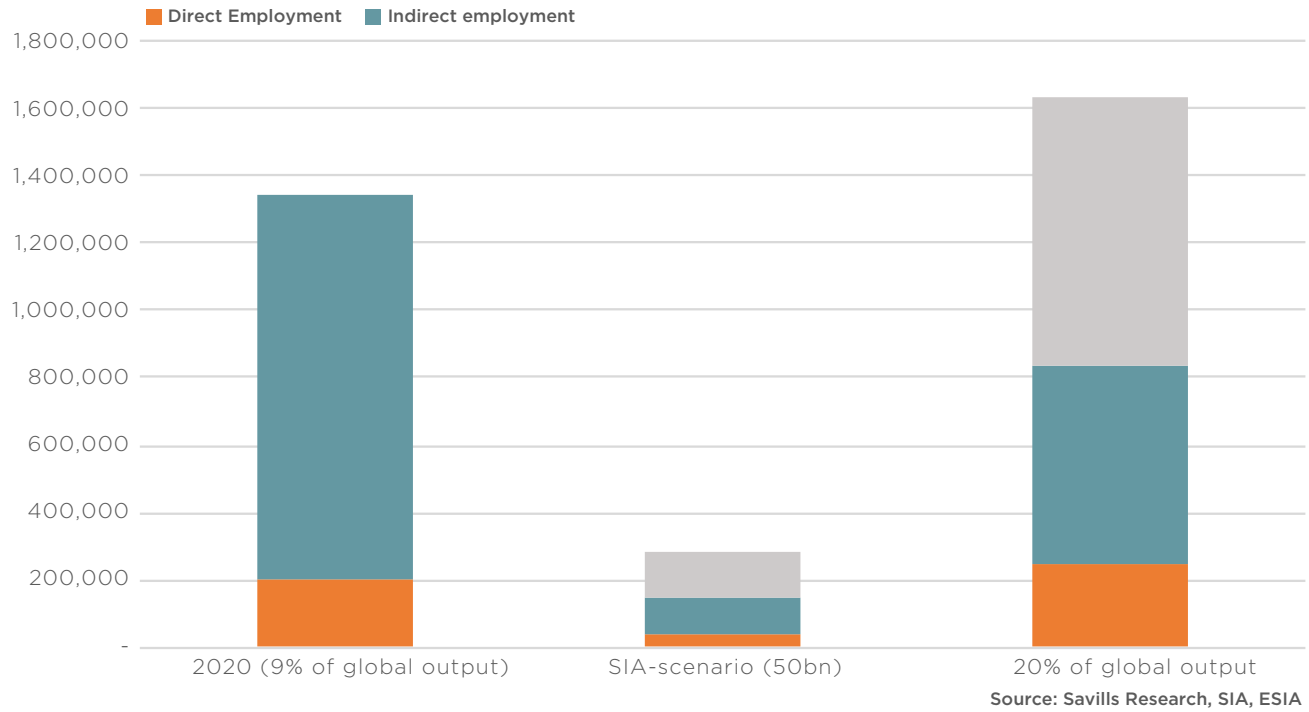
If we assume that the EU Chips Act has a similar outcome to the $50bn investment proposed by the SIA, and ten fabs are built across Europe, we expect to see an additional 38,000 roles in the sector. This equates to 232,000 sq m of demand. Notably, this represents the lower bound in terms of the size of these units, with many fabs typically being significantly larger. This volume of demand in isolation is not particularly significant in the context of the overall European market, which has seen an average of 29.2 million sq m of take-up each year since 2014. Savills believes the more substantial impact would come through additional indirect employment generated, which could drive up to 4.9 million sq m of take-up in response. While this is in and of itself not a massive increase in take-up, in tandem with other tailwinds in the logistics market, it could contribute to downward pressure on the vacancy rate.

Our upper bound calculation in this area will assume that the EU successfully doubles the size of the semiconductor industry. Production will have to more than double to achieve the 20% of global output outlined by the EU Chips Act, as other parts of the world also look to expand their output. Taking the 200,000 workers in the sector quoted by the ESI and assuming that this number will double over the period to reflect the substantial increase required, which translates to an additional 244,444 workers to reach a 20% share.

Extrapolating from the SIA's figures, this suggests that 58 fabs would need to be constructed by 2030. For context, in 2023, a record 33 fabs are under construction globally as semiconductor supply begins to ramp up. Seventeen new fabs are expected to complete between 2021 and 2023, a record for the region. In this context, while these ambitions, like the EU Chips Act itself, are lofty, it is not impossible for this quantum of space to be delivered.

This would require up to 1.35 million sq m of space for fabs alone. Crucially semiconductors would directly compete with other manufacturers and logistics operators for the development land required. In terms of the indirect employment driven by the sector, we would expect to see between 2.4 million sq m and 4.9 million sq m of logistics demand arising from this level of development.

The objectives set by the EU could generate an additional 1.6m jobs



Source: Savills Research, SIA, ESIA

HOUSEHOLD CONSUMPTION

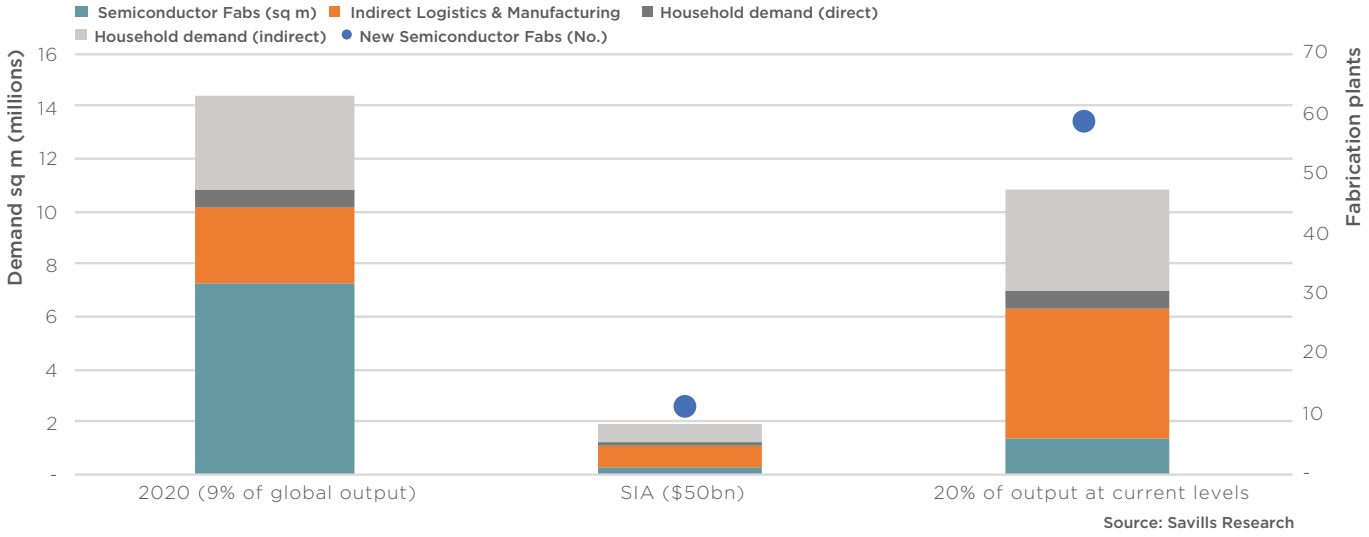
In addition to the demand driven by the fabs and the ancillary businesses that support them, the employment that the industry will generate will lead to further demand for consumer goods from the households formed by employees.

Analysis by Savills suggests that each additional household will create a requirement for 6.4 sq m of logistics space. In the context of the 280,000 additional jobs in line with the ESI's forecasts, this would generate some 847,000 sq m of demand in the EU. Expanding on this with our successful EU Chips Act scenario, we would expect to see up to 4.5 million sq m of logistics demand from the 1.6 million additional jobs created through direct, indirect and induced employment as a result of the strong growth required to reach this level of output. Notably, jobs in the semiconductor industry will command wages above local economies' average wages, giving these households higher disposable incomes and levels of consumption.

In combination with the direct demand from semiconductor firms and the indirect demand stemming from their output, this would boost demand by up to 10.8 million sq m. This would occur over the course of the next seven years and would provide a boost to overall logistics demand and leasing activity, driving down the vacancy rate and supporting rental growth in the long term.

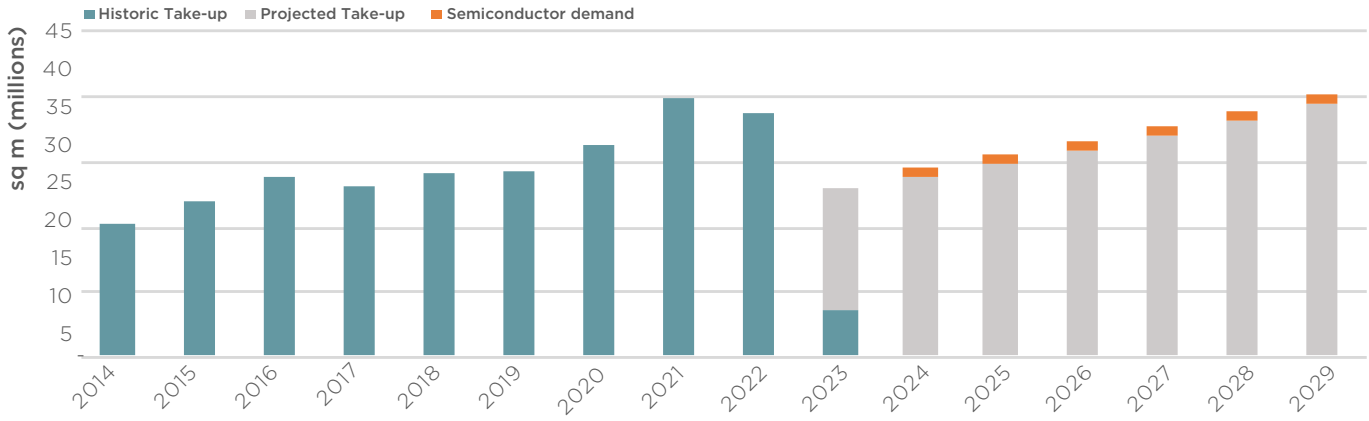
We assume that take-up reverts to its pre-pandemic long-run trend between 2024 to 2030. Taking the five-year average of 2014 to 2019 of 25.62 million sq m of take-up and apply the compound annual growth rate for the period (7.1%), we can forecast take-up, assuming that the eCommerce boom of 2020-2022 was an anomaly. This is likely to understate take-up as eCommerce's rise represents a structural change in the market, so we expect take-up to be higher than this. Distributing semiconductor-induced take-up evenly across the period, we would expect to see an additional 1.55 million sq m of demand per annum. This accounts for an average of 4.4% of overall European logistics demand.

Estimated direct and indirect demand from semiconductor output growth



Source: Savills Research

Take-up from semiconductor firms is set to account for 4.4% on average over the next seven years



Source: Savills Research

Key Take Aways

Semiconductor demand is set to continue to grow sharply over the next decade

Growth is expected to soar amid emerging megatrends. These include AI, electric vehicles, cloud computing, automation in manufacturing and logistics, the Internet of Things (IoT) and other cutting-edge emerging technologies like AR/VR, quantum computing and 6G network connections. Industry analysts expect the global semiconductor market to grow from $574.4bn in 2022 to $1,380.8bn in 2029, exhibiting a 12.2% CAGR.

Europe faces stiff competition with more established markets

Europe has fallen behind relative to other developed markets in terms of fabrication. The EU is home to several world-leading equipment and raw materials suppliers, giving it a strong starting base for increasing domestic production. Europe excels at R&D, and firms producing in the EU are global leaders in automotive and industrial equipment - high-growth markets for semiconductor demand. Unfortunately, offshoring trends in recent decades have seen much of the production of chips move to Asia. Even as the EU looks to stimulate growth through the Chips Act, other economies, including the current market leaders, have introduced similar policies, which may dampen the impact of the Act.

Sensible policy-making will be crucial to successful growth

The semiconductors industry is complicated, with significant land, energy, and labour requirements. If the EU is to be successful in its objectives, it will have to overcome hurdles around land, planning permission, energy, and labour supply to attract semiconductor firms. These requirements have all been significant hurdles to developers in the logistics space in recent years.

The clear links between manufacturing and logistics demand extends by corollary to the semiconductor sector

The link between strong industrial and manufacturing output and growing logistics demand is well-documented. It stands to reason that as more goods move through the economy, we expect to see increased demand for services that use them. The construction of these facilities will also require significant upticks in construction, with all of the associated logistics needs in terms of building materials. In addition to this, we would expect growth in the sector to stimulate household consumption through employment growth.

Part of a wider trend of rising logistics demand

If the EU successfully hits its target of 20% of global output, we expect to see up to 10.8m sq m of additional logistics demand by 2030. While this will only account for an average share of 4.4% of overall logistics take-up, this is not insubstantial and will combine with the wider trend of manufacturers onshoring their production processes into Europe. Bringing semiconductor production to Europe is an offshoot of this trend. In addition to competition from eCommerce firms returning to expansion as the economy recovers, we would expect a strong recovery in logistics demand in the coming years.

Savills Commercial Research

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