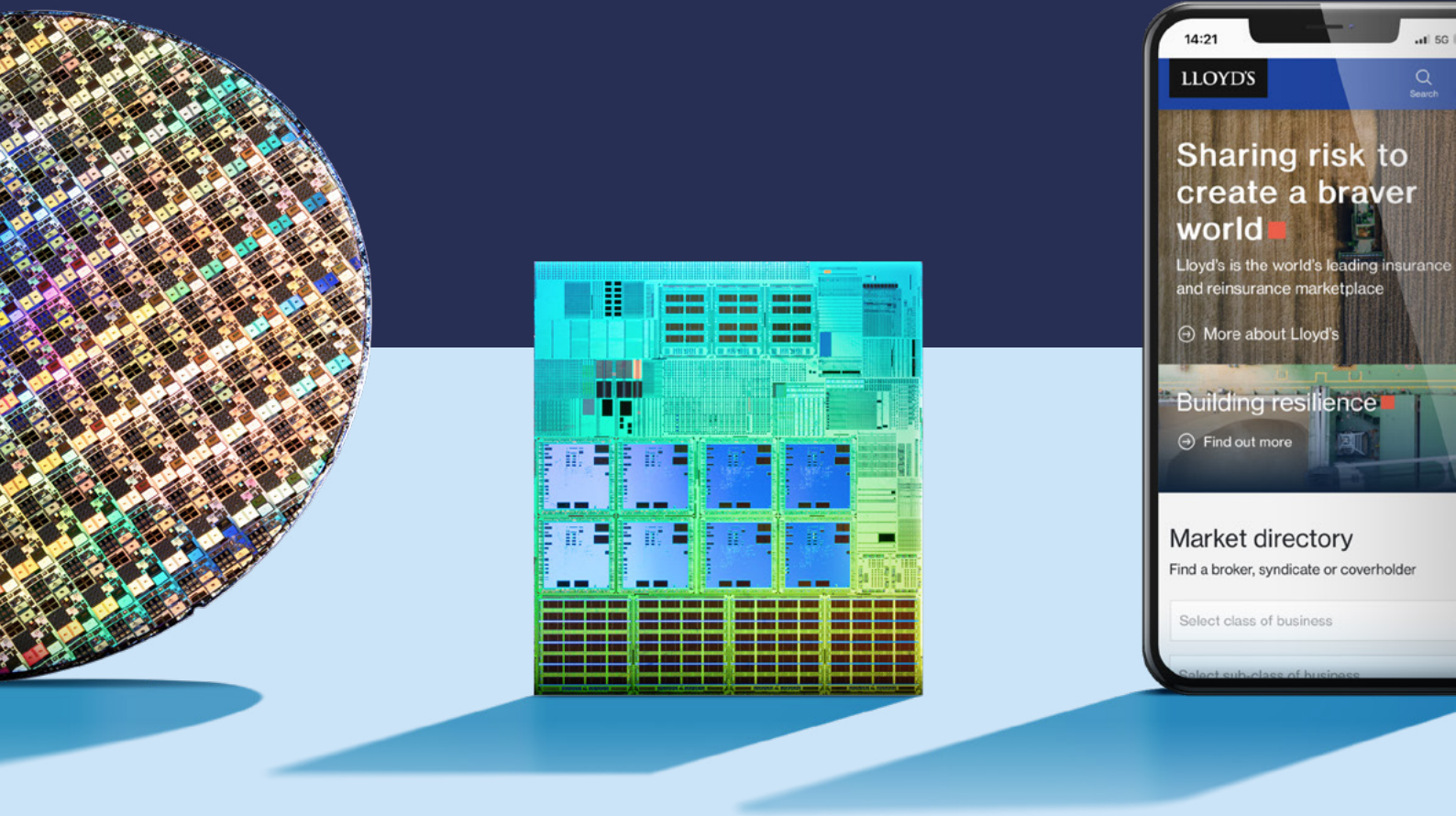
LLOYD'S | wtw

Loose connections:
Rethinking semiconductor supply chains

Part 3: Insurance innovation opportunities



Lloyd's Futureset

Introduction and key findings

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In November 2022, Lloyd's and WTW published a joint report "From farm to fork: Rethinking food and drink supply chains", the first in a series of three reports exploring supply chain risk. The report examined the food and drink sector's risk challenges and aimed to spark product innovation through outlining the opportunities to develop new supply chain solutions. Our second report in the series explores the semiconductor industry and its response to supply chain risks.

As highlighted in section two of this report, the research shows that the majority of businesses operating in the semiconductor sector are advanced in terms of their supply chain resiliency and have a willingness to do more. The third and final part of this report, 'Insurance innovation opportunities' aims to provide the insurance industry with a greater understanding of customer needs, protection gaps and potential insurance solutions for semiconductor supply chain risks. Over 140 semiconductor businesses have been surveyed and interviewed for their insights, and it is clear that the insurance industry has an opportunity to work in partnership with an industry proactively embracing its risks to enable global resilience.

Similar to the conclusions in 'From farm to fork', we find there is significant scope for product innovation through increased collaboration between the semiconductor industry and insurers. This is where Lloyd's, through initiatives such as Futureset, the Lloyd's Lab, and brokers who advise the industry as risk partners, can convene stakeholders, support conversations and enable new partnerships and solutions to be forged.

There are several areas highlighted by semiconductor businesses that represent the best opportunities for insurers to innovate and to push for growth in both premium and market share. This part of the report focuses on highlighting the innovation opportunities the semiconductor businesses shared with us.

Key findings include:

- **The semiconductor industry has been on a sustained journey of risk maturity**, in response to a multidimensional supply chain that enables the industry. There is good awareness of their risks, semiconductor businesses have heavily invested in risk management practices and are increasingly partnering with third parties to provide new data sources in the face of ongoing global change. There is also recognition they can always do more, and semiconductor businesses are interested in exploring where they can work with insurers.
- **There is room for expert, data driven dialogue between the semiconductor industry's technical stakeholders and the insurance market** to ensure more effective knowledge transfer that can support innovation and semiconductor companies' desires to purchase solutions that better meet their needs.
- **Enhancing supply chain data is the biggest opportunity for progress and risk and insurance related innovation**, with more information available than ever before to build a view of supply chains. This is where partnerships with technology providers responding to operational efficiencies and market tools and services, such as risk management and supply chain diagnostic tools, can support translation and transmission – therefore accelerating the opportunities for insurers to innovate.

Supply chain insurance awareness and product innovation opportunities in the semiconductor industry

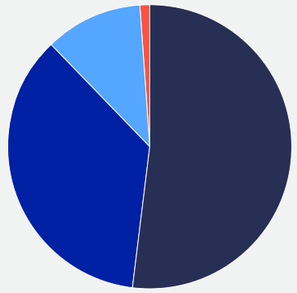
Supply chain insurance awareness and product innovation opportunities in the semiconductor industry

To move forwards in supporting the semiconductor industry in transferring their risks, it is important to understand the current state of supply chain insurance for the semiconductor industry and the barriers that have prevented progress (see **Box 1**).

Across our interviews with semiconductor companies there was a good degree of knowledge of the insurance covers available for industry supply chain specific risks. This is in contrast to the food and drink industry where we saw clear gaps around coverage such as trade disruption insurance. This was further evidenced through the global supply chain survey, where 88% of semiconductor companies said that insurance for supply chain risks was either mission critical or necessary, and 64% shared that supply chain risks were covered by specific insurance. In the medium term (the next 3-5 years), 81% said a lack of insurance solutions was among the greatest challenges to addressing their risks and represents a clear signal to the insurance industry as a willing industry looking to explore new solutions to meet future challenges with risk transfer.

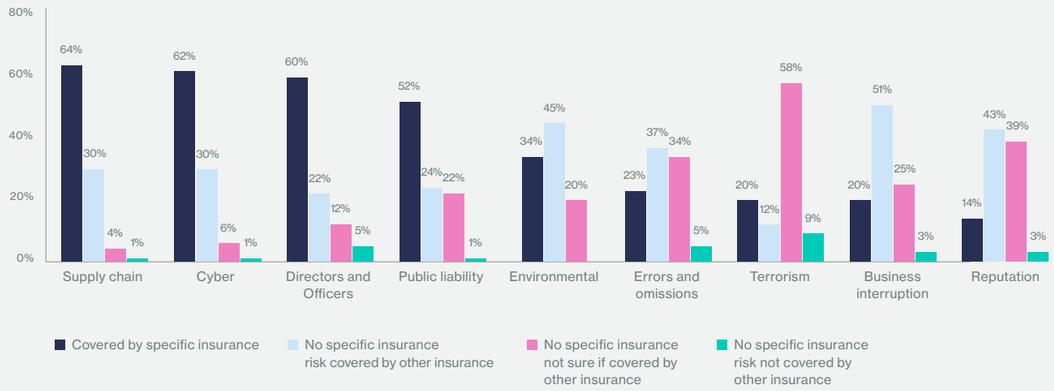
Figure 1: WTW Global Supply Chain Survey 2023

What level of priority does your organisation give to insurance for supply chain risks?

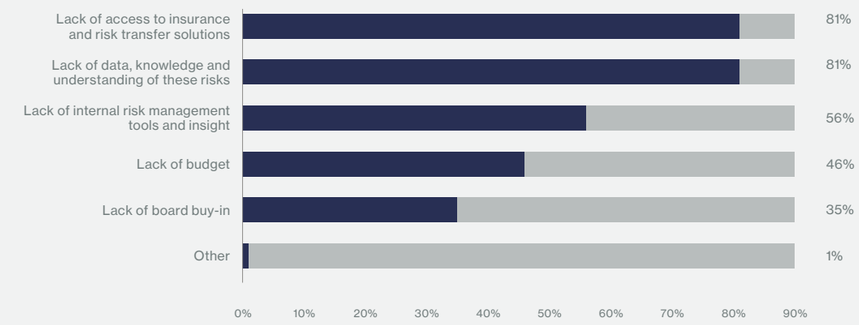


Mission critical; it's must-have cover	52%
Some cover is necessary	36%
Cover is good to have, but not essential	11%
Would not buy specific cover	1%

Figure 1: WTW Global Supply Chain Survey 2023



What are the three greatest challenges to addressing your risks over the next 3 to 5 years?



Source: WTW Global Supply Chain Survey 2023, semiconductor companies[1]

Most people we spoke with as part of this research agreed that awareness and visibility of the risks in the semiconductor supply chain is an issue that needs to be addressed in a more meaningful way, potentially through partnerships and more open discussion. While the semiconductor industry has been proactively managing its supply chain risks and gathering data, they recognise they can always do more and have been embracing new partnerships with companies who can support this journey. These partnerships benefit insurers as with greater access to more meaningful supply chain data, insurers have a better chance of understanding supply chain risk and may allow insurers to provide further capacity and limits. As with most sensitive sectors, some information related to key suppliers in the semiconductor value chain would be considered highly confidential. In these instances - national security issues due to geopolitical sensitivities – data cannot be shared up and down supply chains or with insurers, impacting the full risk picture.

Box 1: Current state of the supply chain insurance for the semiconductor industry

The semiconductor supply chain revolves around some large and key suppliers, so insurers are mindful of accumulations and their risk appetites when considering supply chain cover for these key suppliers. The semiconductor companies we spoke with recognise this as an issue, but also suggested that the insurance market could benefit from being more creative and work with their partners to develop solutions that address current gaps.

Several products exist in the global insurance market affording some cover for supply chain risks, including business interruption (BI), with suppliers' extensions typically included by endorsement to provide contingent business interruption (CBI) cover, and extending to other policies such as political violence, marine cargo, or product recall insurance can also be purchased to address specific supply chain risks. Unlike the food and drink industry where it was suggested supply chain risks could be covered under an end-to-end policy given greater sharing of information, the range of risks faced along the semiconductor supply chain is wider and in some cases has key dependencies that are considered systemic even within the sector. Having said that, depending on the quality of the supplier in question and the information they can provide, named supplier coverage is available and coverage provided under the above policies.

(Re)insurers tend to limit coverage by inserting sub limits or even excluding certain suppliers. While some semiconductor companies can secure policies that include cover for an unspecified supplier (un-named suppliers' extensions), limits tend to be low and are very much dependent on the size of the insured and the overall policy premium. Specified suppliers in Tier 1 can be covered for higher limits, subject to the provision of Construction Occupancy Protection Exposure (COPE) information. Perils are often limited, particularly when it comes to certain geographies or catastrophe type perils such as extreme weather in Taiwan, which can experience typhoons.

Tier 2 suppliers and below are not generally included in CBI cover, but can theoretically be added on a specified basis, subject to the same COPE information that is required for Tier 1. However, due to the challenges in assessing the risks for Tier 2 suppliers and below, appetite across the market to offer this cover is generally restricted, both in terms of the limits and perils underwriters are prepared to cover. As we saw in the food and drink industry, COPE information is typically difficult for semiconductor companies to collect from their many and often diverse suppliers (and increasingly so for Tier 2 or Tier 3 suppliers). Having said that, if the cover available in return were to provide a clear resilience dividend to them, many of the semiconductor decision makers spoken to as part of this research indicated that they could make the provision of this information part of the procurement onboarding and renewal process. Doing so would also provide such companies with useful information about the resilience of their suppliers, and in return support their own supply chain risk management processes.

In their response to the above points, many of the semiconductor clients spoken with use Alternative Risk Transfer solutions to find coverage that will protect their supply chains. One semiconductor business mentioned they currently buy a parametric solution for earthquakes in or around Taiwan that might impact their main supplier due to lack of a suitable indemnity product and a desire to seek protection – something they are frequently revisiting and would buy if available. The solution pays out if there is an earthquake within 'x' km of the suppliers fab and with a quake bigger than 'y' on the Richter scale. The policy pays regardless of whether there is physical damage to the semiconductor fabrication plant or not.

Another point raised was around the importance of equipment over inventory in the event of a loss. Cargo policies and wording are, for example, critical in this respect and the cargo industry's wide limits of liability caps can be a concern. Some companies mitigate this by trying to negotiate side agreements requiring shippers to take on a higher portion of this risk. This may be an area of opportunity for Alternative Risk Transfer (ART) solutions not only in the cargo space but also more broadly for natural catastrophe risks.

Current barriers to overcome

According to the semiconductor companies we spoke with, suitable insurance coverage for supply chain risks doesn't exist or is seen as too difficult to procure – although they also highlighted the value of other standard insurance coverage they purchase. At the same time, some semiconductor companies mentioned a lack of understanding of the extensive supply chain risk management practices undertaken by businesses in the sector and felt that insurers have been slow to the needs of the sector and its robust management. Part three of this report has been developed with the goal of increasing understanding of the sector, to promote information sharing between the semiconductor industry and insurers, to highlight new opportunities for risk transfer and to potentially open the sector to new underwriters or appetite.

This research identifies several key barriers which are preventing growth and insurance gaps in semiconductor supply chains:

- Currently, there is a limited number of end-to-end supply chain products and solutions available from the global insurance market. Insurers' appetite for end-to-end supply chain coverage varies, and many will tread cautiously by taking on few customers when approached. This can create a cycle whereby customer adoption is limited, feeding, in turn, the insurer perception that demand for insurer solutions is scarce
- The pandemic highlighted the gaps in insurance cover, with economic losses resulting from shortages and delays not covered by property and marine cargo policies. Managing these exposures is a major issue for companies, especially in a market that is likely to harden further in difficult economic conditions over 2023 and beyond
- Alternative risk transfer solutions are still relatively new to the market and depend on several data factors which can be difficult to articulate or quantify. In addition, where ART solutions are structured, the cost may be prohibitive
- The loss of a major supplier such as TSMC or ASML could have catastrophic financial consequences for the industry, such that capacity is simply not available unless an alternative approach is taken, such as mutuality of risk adoption or other forms of financing. The semiconductor companies engaged with as part of this research recognise the difficulties around covering major market shocks, given the magnitude of such an event in financial terms, and are not seeking to transfer those risks. Moreover, the wider perception is that key suppliers, such as TSMC (Taiwan Semiconductor Manufacturing Company) and ASML (Advanced Semiconductor Materials Lithography), offer a high degree of resilience and therefore the likelihood of any long-term impact on supply chain continuity is extremely low. Creating alternative supply chain protection through building resilience in tandem with utilising insurance risk transfer mechanisms is the most sustainable approach to minimising the impacts of major supply chain disruption
- There has been limited appetite by insurers for Tier 2 and below supplier coverage – an area of interest highlighted by semiconductor companies. The legacy of past complex supply chain losses – regardless of industry – outweighs any comfort gained if insurers were to receive the same level of information provided by a mature Tier 1 client. This is where partnerships between insurers and insureds to increase understanding will be essential, and where insurers can tap into working forums within the semiconductor industry
- The level of information required to write a risk can be so extensive that often insureds will not be willing to engage with and complete the process. In some cases, for reasons of national security or commercial sensitivity, some semiconductor companies simply will not share data or information that insurers could use to structure market acceptable solutions

Opportunities to strengthen loose supply chain insurance connections

Our interviews have shown a growing maturity in managing risk and resilience across the semiconductor industry and a willingness to explore data sharing. Such an approach has not been previously considered and initiatives could include a group-wide marketing of risks together or alternatives to existing insurance solutions, for example offering direct and indirect suppliers cover would be welcomed.

There is also interest in alternative risk transfer (ART) products, including parametric products, which offer the opportunity to design bespoke solutions for businesses' supply chain risks, subject to a relevant, reliable and impartial index. Information and data requirements are extensive and this, coupled with pricing levels, means that there are relatively few covers written for businesses in the sector. This route offers potential for further development and is already being employed in some territories. In Japan for example, parametric solutions are used to support traditional insurance where parametric triggers are defined using the Shindo seismic scale adopted in meteorology stations. One company has set up a 'Shindo station' in its factory in Japan. When seismic activity triggers a recording within a predefined scale range the insurer will pay amounts as agreed within the policy. Using this approach offered companies reassurance that supply chain disruption losses could be met head on.

Semiconductor companies are unlikely to seek ground up cover to deal with recurrent disruptions and are accustomed to high levels of self-insurance on policies such as property damage and business interruption. However, cover for major disruptions that cause serious financial loss and result in loss of investor confidence is seen as highly valuable and semiconductor companies would like to explore new products with insurers. Interest in the combination of traditional risk transfer and alternative risk financing was evident and semiconductor decision makers agreed that demand for such solutions is likely to rise if volatility continues to play a role in the world stage.

The following risks faced by the semiconductor industry are currently not fully addressed by the insurance industry, and could represent a development opportunity for the insurers.

Scale of innovation required for each risk

Least → Most

Wording improvements, further specified cover

- **Indemnity periods are an area of concern** as a rebuild of a semiconductor fabrication site - given current supply chain issues and the number of major new builds - is closer to 5 years. Current indemity periods are typically 2 years.
- One semiconductor business mentioned they currently buy a **parametric solution for earthquakes in or around Taiwan that might impact their main supplier** due to lack of a suitable indemnity product and a desire to seek protection – something they are frequently revisiting and would buy if available.
- **Power supply interruption (either by man-made or natural catastrophe).** There could be a need for a further difference in conditions/limits/coverage level depending or whether the utility company is a state owned or a listed private firm, which will impact on the societal priorities.
- Cyber in the supply chain. **Opportunity to introduce specific supply chain cyber wording relating to interdependencies and to introduce common ransomware definitions,** including menu of coverage options.
- **ESG considerations across existing policies.** E.g. Insurers may need to consider extending coverage to cover where supply chains could be disrupted from goods in transit prevented from coming from – or going through – sanctioned territories.
- **Intellectual property is a key risk for the sector** raised throughout our research and survey findings.

Supply chain cover aimed at Tier 2 and below

Cover for non-specified suppliers is almost impossible to obtain and alternatives to the limited existing insurance solutions that offer direct and indirect suppliers cover would be welcomed by semiconductor companies. To support innovation in this demand area and increase visibility of the semiconductor supply chain **we have identified a series of technology-based companies who are actively working with semiconductor companies through risk management and supply chain diagnostic tools.** These developments could support translation and transmission of data that can identify unique suppliers, provide clarity on supplier tiers, and fill gaps in data to build a view on supply chains. There is a clear innovation opportunity for insurers to work with the industry and enter into partnerships with these technology providers. **Lloyd's Lab and other market incubation centres could support exploratory partnerships.**

Disruption caused by key bottlenecks

Key suppliers/fabrication site contingent business interruption cover available very limited. **Current covers include: specialist trade disruption insurance (TDI), political risks, and alternative risk transfer.** Insurers may want to explore alternative structured solutions. For example, most non-fabless semiconductors in event of a major loss at supplier-owned fabrication manufacturer would seek to take a **monetary settlement and use this to contract out production to an alternative foundry** rather than wait for the supplier to rebuild/reinstate. **Future policy wordings and insurance products may want to explore this flexibility.**

Weather, power and water

The impact from adverse weather and access to constant power and water are key **supply chain risks that semiconductor companies are facing they would like to seek cover for.** Potential options include:

- **Alternative risk transfer or parametric solutions for semiconductor production.** E.g. if temperature goes below X value for Y days, or if actual rainfall falls below x% of forecasted causing a water shortage.
- **Extensions or wording options in property policies** with the understanding that a power outage cover may be limited if the supplier of power does not result in a physical loss. Look to develop a broader service interruption (no fault) wording.

Contingent business interruption innovation

Aggregation around certain key/sole suppliers/fabrication production facilities makes contingent business interruption cover very limited due to the huge values involved. **Semiconductor companies are aware that end-to-end supply chain coverage is not feasible and highlighted an interest in new products that might support earnings smoothing.** Being able to demonstrate insurance coverage has been highly valued in ensuring investor confidence when dealing with supply chain disruptions, and semiconductor companies would welcome the opportunity to explore solutions with insures and wider capital markets.

New market support

With no spare capacity for chip production in the system currently, the construction of new fabrication sites has been deemed essential by both corporates and governments – if a fabrication site experiences disruption and there is high demand there are no spare sites that can come online to buffer production. While there is currently a downturn in semiconductor demand with current macroeconomic conditions, the future projection of technologies and long construction times means major semiconductor players have undertaken and announced construction (see Box 4, report section 2). The U.S. is leading the way here but both Europe and Asia are following suit. **Providing effective insurance products, both for the construction and for the operational aspects** once new fabrication sites come online, represents **an opportunity for the insurance industry to support the expansion and supply chain diversification resulting from the new production capacity.** There is an opportunity for insurers to signal support for the industry, as it has done for the transition to a low carbon economy.

Partnering with semiconductor companies to enhance their supply chain mapping and modelling

The semiconductor industry is actively aware of and managing their risks., They already have a lot of data on their supply chain, but also recognise they can do more. Semiconductor businesses are increasingly sensitive to the need to strengthen resilience and risk management within their operations and examples of best practice have been outlined in part 2 of this report. Semiconductor companies are already undertaking steps with third parties, and the insurance industry can join those efforts to further incentivise changes and support the development of new risk sharing solutions.

Access to data on supply chains has been a barrier for both clients and insurers. But that is changing: 70% of semiconductor companies surveyed have either identified all the data they require and have robust processes in place to gather it or are establishing those processes now. 56% of those surveyed are developing detailed understanding of their supplier networks, and 48% are using supply chain mapping software to do that.

Figure 2: Measures with greatest impact on managing supply chain risks

Source: WTW Global Supply Chain Survey 2023, semiconductor companies

As digitisation advances, businesses have responded to supply chain events by investing in efforts such as resource planning software, business continuity planning (BCP), deeper conversations with their own suppliers, and accompanying data that insurers can use to consider product innovation – whether that is designing new products or tailoring existing offerings. As well as insurance industry acceleration opportunities, there are technology companies innovating with the sector in business resilience, and industry forums and operational initiatives that could serve as partnership opportunities to fill data gaps (see **Box 3**). Insurers should also look to track the various policy acts being put in place that have been outlined in section 2 of this report. Pillar 3 of the EU Chips Act aims to set up a monitoring and crisis response mechanism, increasing data sharing within the industry. Much like the development of the cyber insurance market, this is an area where the Lloyd's market can look to engage with policy makers and governments to find new ways to share data and support growth.

Box 2: Standards and industry initiatives surfacing supply chain data points and maturity proxies

As with any industry, data is always in demand, and while many organisations have a data supply chain, they do not have full visibility into what that supply chain entails in its entirety, including visibility among partners. The standards of the semiconductor industry are currently characterised by general business continuity management systems and constituent elements that make up the supply chain as a whole, such as sustainability procurement and environmental management systems. Two such examples include ISO 9001:2015 and ISO 14001:2015:

- ISO 9001:2015 has become the most popular quality standard in the semiconductor industry. Given the complex processes of fabricating, assembling, and testing semiconductor devices, quality management has always been a critical component of semiconductor manufacturing. Quality management systems are fundamental to the design and manufacture of intricate semiconductor products – and are central to ensuring customer satisfaction and continuous improvement in the industry. This standard Section 6.1 'Risk and Opportunities' can be used to bring focus to the supply chain between the vendors and the beginning of a business's own manufacturing
- ISO 14001:2015 specifies requirements for an environmental management system whose purpose is to provide value for the environment, the organisation, and interested parties. This standard is particularly applicable to the semiconductor industry due to the water and energy-intensive process by which semiconductors are manufactured and produced. It will be increasingly relevant as investors and electronics makers insist upon greener supply chains, driving manufacturers to embark upon low-carbon sustainability

Understanding the need to drive action, the semiconductor industry has several industry initiatives:

- Semiconductor Equipment and Materials International (SEMI) is the global trade association representing the industry's manufacturing, design and supply chain endeavors dedicated towards covering semiconductors, microprocessors, and general electronics. SEMI plays an active role in enacting industry standards and influencing public policy at the national and supranational level. SEMI's International Standards Program is a key service offered by the association for the benefit of the worldwide electronics design and manufacturing industries in North America, Europe, and Asia. Such standards are voluntary technical agreements between suppliers and customers whose purpose is to outline industry best practices, terminology, test methods, and specifications
- The Global Semiconductor Alliance (GSA) is a neutral platform for collaboration between the world's leading semiconductor and electronics manufacturing businesses. With a global footprint representing over 250 corporate members in over 25 countries in North America, Europe, and Asia, GSA membership encompasses 70% of the global semiconductor industry. The GSA's remit has grown commensurate with the increasingly global nature of the electronics industry to incorporate semiconductors, software, solutions, systems, and services via global executive and technical forums, working groups, and thought leadership workshops. The organisation's CEO Council is comprised of the industry's leading CEOs and helps drive the industry's overall direction

Building confidence with a transparent supply chain picture

Access to reliable, quality data underpins underwriters' ability to quote for a risk. For the calculation of business interruption exposures, there is a well-defined process and approach to calculating losses which the industry is comfortable with. Based on this, the possibility of developing a parallel Supplier Interruption Exposure could be explored. Another potential acceleration opportunity is the use of analytical tools and third-party data providers to surface more information between insurers and semiconductor companies.

Box 3: Digital twins

Digital twinning is a process in which a physical object, system or a being is recreated on a virtual interface. During this stage, a fully developed digital replica is constructed for use in future testing, development, and experimentation. Companies such as Siemens have created the Siemens Digital Enterprise Suite that can coordinate integrated software and automation solutions for industrial companies, while DHL Global logistics have created a digital twin warehouse used for handling Tetra Pak products. The warehouse is one of the biggest Tetra Pak warehouses worldwide and remains the first smart warehouse as a digital twin for DHL in the Asia-Pacific region.

This kind of technology opens a window on to a step change in data and forecasting capacity that could be harnessed to improve insurer understanding and pricing of risk. Semiconductor companies already use modelling and simulations and so the extra investment required may be relative. Moreover, existing providers of supply chain resilience and risk management intelligence and analytics could also be included as part of the solution.

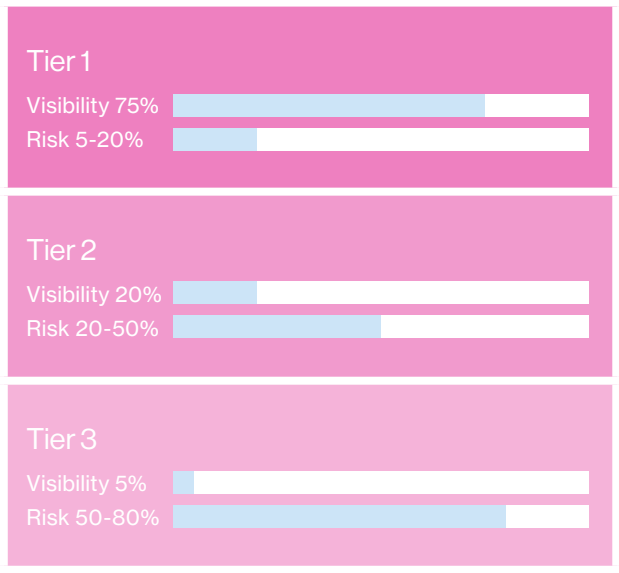
Supply chain modelling and mapping

Many semiconductor companies mitigate supply chain risk as far as reasonably practicable (and many do so to a far higher degree than companies in other industries), but there will be elements of risk they cannot totally control, e.g., will a supplier of a supplier suffer a property damage loss which takes them out of production for a period? Most businesses do their best to reduce this Tier 2 and deeper risk as far as possible by identifying and qualifying secondary suppliers. Contingencies could include measures such as placing suppliers on standby (either formally or by way of reciprocal agreement) or introducing additional buffer stocks.

From an insurer perspective, supporting or incentivising organisations to take such actions will ultimately result in greater mitigation of risk and exposure. Third party companies like Resilinc, e2open, Blue Yonder, and WTW are examples where insurers and brokers are using technology, risk engineering expertise and insurance to help clients identify, assess, mitigate, and transfer supply chain risks:

Resilinc

Resilinc aims to support semiconductor companies to effectively manage supply chain risks through multi-tier supply chain mapping, real-time supply chain intelligence and risk monitoring, as well as other service offerings that drive and collaboration between organisations and their supplier(s), allowing leadership teams to work towards mitigation, management, and transfer of risk. Bringing about this visibility and collaboration is essential as risk typically concentrates in lower supplier tiers:



Source: Resilinc

Resilinc's capabilities are centred around its supply chain risk management platform that uses data, artificial intelligence, and supply chain risk management to offer:

- Supply chain modelling: multi-tier mapping, risk scores for suppliers, sub-tier failure analysis, what-if simulations, geographic hotspots. This modelling builds on 12 years of validated supply chain mapping and historical disruption data. Resilinc's supplier network includes 800,000 validated global suppliers mapped down multiple tiers, encompassing over 1 million sites, and over 4 million parts, and raw materials. Using these insights, predictive analytics are used to identify how suppliers, sites, commodities, and raw materials may perform 30, 60, and 90 days out
- AI-based event monitoring: 104 million news and social feeds monitored 24/7 across 100 languages, with event watch alerts issued where supply chain disruption potential has been assessed. Further specific offerings include CommodityWatch, which combines AI and machine learning with proprietary data to predict commodity price fluctuations and supply constraints across dozens of commodities, 30, 60, and 90 days out
- Supplier engagement: supplier onboarding and training, alongside resiliency scoring and analytics to support the development of an accurate, validated supply chain map

e2open

e2open is supporting semiconductor companies through a technology platform that aims to unify end-to-end manufacturing, logistics, and distribution partners to building resilience into its customers' supply chains. e2open use this in conjunction with other capabilities such as Demand Sensing to create a virtual map of Tier 1, 2, and 3 suppliers of any given business. Capabilities include:

- Manufacturing Collaboration: provides complete visibility into end-to-end manufacturing processes and costs at all stages of production to improve operational efficiency, collaborate on product design, and reduce invoicing inaccuracies. For one client, e2open report their platform processes more than 150,000 transactions a day for the semiconductor manufacturer and supports more than 500 internal and external users[2]
- Supply inventory collaboration and forecasting: multi-tier visibility into materials and goods at supplier locations, allowing businesses to proactively manage shortages and excesses. All inventory management models are supported
- Real-time location visibility into every shipment across all modes, legs, and regions to support identification of potential disruptions and respond

Blue Yonder

Blue Yonder is supporting semiconductor companies through a predictive supply chain and execution solutions platform geared toward warehouse management, transportation, and integrated business planning[3]. Blue Yonder leverage artificial intelligence and machine learning capabilities to bring together solutions across planning, execution, and delivery to optimise a company's operations seamlessly to incorporate the moving parts of the supply chain. This includes:

- Network design and optimization: mapping and modelling the supply chain network, from raw materials through omni-channel fulfilment, which in turn allows scenarios to be run over multiple time horizons to test operational performance
- Integrated business planning: supporting greater supply chain resilience through what-if scenarios based on short-term and long-term business and financial strategies, which can be used to respond to market changes and disruptions
- Real-time visibility and collaboration: real-time visibility through Luminate® Control Tower across supply chain partners, including suppliers, contract manufacturers, transportation carrier and third-party logistics

Software as a Service

SAP

SAP have been building on their core function as a key enterprise resource planning (ERP) software company to provide wider services around analytics and decision making and has been working with semiconductor companies through its High-Technology Industry Solutions.

To cope with the recent semiconductor shortage and to gain greater visibility of the industry's supply chain, SAP began a collaboration in July 2022 with PDF Solutions, a global leader in semiconductor manufacturing data analytics. This collaboration is envisioned to help semiconductor companies improve cost-of-yield analysis and provide end-to-end lot and device traceability from wafer manufacturing to packaging chip, integrating PDF Solutions' Exensio® analytics platform with SAP's entire suite of ERP solutions[4].

Other examples of solutions include:

- Embedded AI, advanced analytics, and intelligence process automation to deliver real-time planning, run simulations of demand or supply changes, and use forecasting algorithms to determine capacity and material constraints
- SAP's Business Network is a platform that enables collaboration with trading partners in the entire value chain (suppliers, logistics, procurement, service providers, and asset managers)
- Integrated Business Planning (SAP IBP) for supply chain solutions to provide sales and operations and demand-driven replenishment

Oracle

As semiconductor fabrication production facilities rely on electronic design automation (EDA) to design and validate their manufacturing processes, **Oracle** have been a long-time partner of the semiconductor industry through their high-performance computing (HPC) capabilities. With the significant increase in demand for low-power, high-performance silicon-integrated circuits, bringing products to market quickly and efficiently as possible requires both specificity and sophistication in infrastructure and architecture.

More recently, Oracle have been expanding their offerings to semiconductor companies through a cloud computing platform to manage critical business processes for manufacturing, supply chain, quality management, and Capital Expenditure investments. This includes three core components: Oracle Cloud Supply Chain Management (SCM), Cloud Infrastructure (OCI), and Enterprise Resource Planning that aim to improve supply chain planning, inventory, manufacturing, order procurement, resiliency, and facilitate product lifecycle management.

Amazon Web Services (AWS)

AWS Supply Chain uses AWS cloud infrastructure to unify data, provide actionable insights, and demand planning. At the heart of this is a supply chain data lake designed to gather data from a variety of sources that creates a real-time map. The platform automatically generates insights based on proprietary machine learning models to forecast inventory levels and potential disruptions. AWS Supply Chain can be integrated into an existing enterprise resource planning (ERP) without the need for re-platforming or long-term contracts (e.g. SAP capabilities are readily integrated[5]).

More broadly, AWS are also exploring data sharing and tools to support sustainability reporting. Although some information is being shared across the industry, for example from foundries to design houses, the industry is lacking a concerted effort to define an industry standard for data sharing and preservation of anonymity[6], which they are currently exploring and is one to watch. On the sustainability reporting side, AWS are exploring how they can assist the semiconductor industry in using data from product and engineering teams, manufacturing value chain partners, foundry suppliers, and assembly/test divisions to meet their short- and long-term scope 1, 2 and 3 emission goals[7].

Transportation providers

DHL

DHL is involved in every stage of the semiconductor value chain, beginning with materials sourcing and ending with worldwide distribution. As well as providing transportation, DHL are working with semiconductor companies to provide inbound logistics, shipping and distribution, warehousing, automation, and final mile & reverse logistics. They specialize in providing transportation between semiconductor manufacturing, assembly & test, and distribution stages, with aggregated and anonymized data a potential source to increase supply chain tier visibility.

For critical and sensitive technologies such as semiconductors, DHL provides end-to-end temperature, ambient, humidity and shock controls as part of its larger SmartSolutions IoT products. To cover such sensitive loads as semiconductors, DHL also offers customers an “all-risks” insurance option, covering the freight value and transportation cost against physical loss or damage from any external cause. As one of the first to commit to more sustainable supply chains, DHL abides by its Green Logistics Solutions via its GoGreen Plus service to provide real emissions reductions through carbon insetting for both ocean and air freight on all trade lanes as well as green real estate solutions for storage and warehousing.

Nippon Express

Nippon Express is an industry leader in capital equipment handling, a key component of semiconductor manufacturing. The company provides end-to-end integrated supply chain management with cater-to-time, temperature, shock, and tilt sensitivity technology on its air and sea containers. Logistical management is provided for fab, assembly, and test products via real-time GPS tracking, specialized pallets, data loggers, and industry-specific shock absorbing equipment. The company’s geographic specialization in active production areas featuring large concentrations of high-tech industries has provided Nippon Express with a competitive edge. In October 2022, the company introduced a series of new containers to handle semiconductor manufacturing equipment and other precision technologies for intra-Asia trades. As semiconductors and their manufacturing equipment travel largely by air, Nippon Express is seeking to cause an industry shift from air freight to ocean freight as a result of roll-on roll-off cost advantages and greater lead times[8].

UPS

UPS have also specialized in High-tech Logistics transportation offerings that provide semiconductor companies with kitting and pre-assembly, custom packaging, multi-channel distribution, reverse logistics and foreign trade zone (FTZ) solutions. This includes multimodal freight shipping and cross border logistics, from consolidation to customs clearance, and final delivery. UPS Order Watch, a cloud-based purchase order (PO) and organizational change management (OCM) information platform, helps businesses manage international suppliers with more accountability, control, and traceability, with aggregated and anonymized data a potential source to increase supply chain tier visibility. Under UPS cargo insurance offering, shipments can be further covered by InsureShield® coverage via UPS Capital Insurance Agency, Inc. or trade credit protection services that includes trade credit insurance, collections services, credit intelligence, and credit throughput options[9].

Opportunities to accelerate this further include:

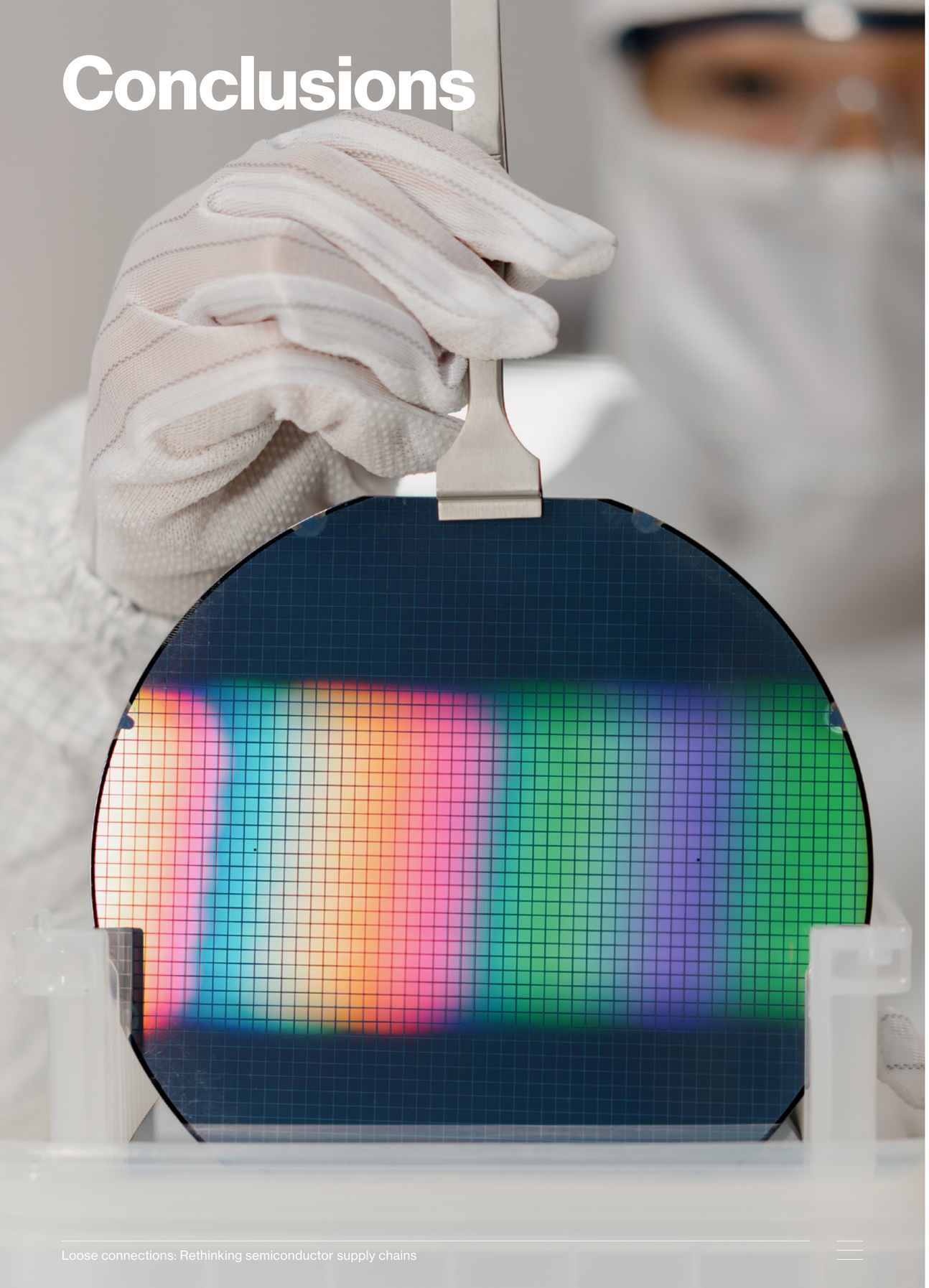
01 Establishing unique supplier identifiers for every company to generate a granular view of networks, supplier tiers, routings etc. Unique identifiers can also support insurers in understanding aggregations. Progress in this area is already underway with some technology companies offering dedicated data processing platforms – this could be complemented in the semiconductor industry by transportation and logistics providers whose data could augment the view of connections between nodes to map greater levels of supplier tiers.

02 The pandemic accelerated the use of remote working not only in office environments but also in the property loss control sector by using remote surveys, increased drone utilisation and remote image transfer among other innovations. Further development here could enable the creation of a physical hazard view simply from geocodes, extending property loss control services to Tier 2 suppliers and beyond.

03 Availability of ‘real time’ data on events affecting the supply chain is growing, but wider adoption of this capability would enable proactive and faster reactive responses and reduce impacts of loss. Insurers could play a role in incentivising greater uptake of this data.

04 Semiconductor data collation has been mentioned above, but this could be enhanced through the creation of industry supply chain risk standards and subsequent data sharing with insurers. This could be provided by the insured as a pre-requisite to conversations about cover availability and cost (i.e. to demonstrate whether they are a well-managed enough risk for insurers to want to engage with). In time, these developments could feed into ‘digital twins’ (see **Box 3**) mapping out supply chains and risk resilience plans to provide a greater view of risk and enable more sophisticated modelling.

To support these opportunities, brokers and risk advisory partners, in partnerships with technology solutions providers – some of which have been highlighted throughout this report – can explore how to fill data gaps and connect organisational resilience proactivity to risk transfer solutions. The semiconductor companies WTW spoke with would welcome such discussions with their insurance partners. Notably we see increasing demand for semiconductor specific, detailed risk surveys at key suppliers, and the semiconductor industry would welcome discussions around engineering expertise to offer more insight on their individual risks.



Conclusions

Conclusions

The supply chain disruption experienced during the COVID-19 pandemic, and more recently following the outbreak of conflict in Ukraine, have highlighted both the importance of the semiconductor industry and the fragility of global food security and supply chains. The improved visibility of supply chain related exposures through data is increasingly recognised as a key factor for ensuring that insurance continues to play a meaningful role for the sector. The semiconductor industry recognises that without providing insurers with better data, and without a more bespoke conversation with its insurance partners, their capacity and coverage needs may not be met.

Insurers have a unique opportunity to partner with an industry deeply exploring its supply chain risks, learn from their risk management actions and join their mapping and modelling efforts. This is a two-way partnership; insurers can encourage the semiconductor industry to continue building resilience into their supply chain, while the semiconductor companies can give insurers data and information to help insurers gain the comfort needed around aggregations and understanding downside exposure to provide innovative risk transfer solutions. Entering into dialogue with businesses operating across the semiconductor industry value chain can help both insurers and customers better understand the challenges around obtaining specialist insurance cover, and whether cover could be restructured, segmented or consolidated to make it more effective and sustainable.

Brokers and risk management service providers have a unique opportunity to support conversations between insurers and insureds. For an industry built on the principle of bringing teams together to discuss and share risk, the dialogue on supply chain needs to be reopened and new partnerships need to be formed to allow it to respond to a fast-moving landscape. Semiconductor companies are acting now, and brave and agile insurers can harness this opportunity.

Lloyd's will continue to support innovation around semiconductor supply chain protection gaps through Lloyd's Futureset, the Lloyd's Lab (including Futureminds) and our leadership of the Sustainable Markets Initiative (SMI) Insurance Taskforce.

Through this research, we hope to help businesses and private investors understand how specific risks across semiconductor supply chains can be managed, where existing support from the insurance industry is currently available, and where new specialist coverage could be introduced. We will continue to work closely with underwriters across the Lloyd's market, including members of Lloyd's Product Launchpad, to help them understand where protection gaps may lie and explore potential innovation opportunities.

The semiconductor industry is not the only sector to have experienced significant supply chain challenges in recent times. Our supply chain research series will finish with a view into transportation and logistics – an essential component of all supply chains as all goods must travel. This final report in the series will build on the transportation insights highlighted in the food and drink, and semiconductor industry reports to understand the role of the sector and how businesses are supporting every industry they touch in managing supply chain risk.

Transportation and logistics

A supply chain is only as strong as its weakest link, and transportation and logistics are already experiencing massive global dislocations. The result has created shortages of key manufacturing components, order backlogs, delivery delays and a spike in transportation costs and consumer prices, highlighting the potential for disruptions to cascade through global systems

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