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Economic Cooperation

Helping Businesses Build and Maintain Open, Secure and Resilient Supply Chains

APEC Policy Support Unit

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EXECUTIVE SUMMARY

Introduction

This report is submitted to the Committee on Trade and Investment (CTI) of the Asia-Pacific Economic Cooperation (APEC) by FTI Consulting and the APEC Policy Support Unit. The report provides an independent analysis of vulnerabilities in global supply chains, the impacts of recent disruption to firms and economies, and strategies that both firms and governments are thinking about to make supply chains more resilient. It concludes with a number of recommendations for APEC to promote resilient supply chains across the Asia-Pacific region.

We took a robust and comprehensive approach to identify the pain points of global supply chains and the types of strategies that businesses and governments are deploying to build resilience. This involved reviewing contemporary literature, conducting a survey of more than 700 firms across APEC in five traded goods sectors (consumer goods and retail, food and beverage, extractives and mineral processing, transportation, and resource transformation/manufacturing), performing case study interviews with C-suite executives and managers, and leveraging FTI's in-house supply chain expertise.

The COVID-19 pandemic has put an unprecedented spotlight on global supply chains. The fallout from lockdowns and restricted economic activity sent shockwaves across the global economy, the impact of which is still being felt in the form of price inflation and shortages of goods like semiconductors and minerals. With one in twenty companies suffering a supply chain disruption costing at least USD 100 million every year,¹ the importance of supply chain stability and resilience cannot be underestimated. Some of the recent disruption has incurred significant costs:

- In 2020, world gross domestic product (GDP) fell by 3.4 percent, totalling over USD 42 trillion of lost economic output.
- On all major shipping routes globally, container rates increased between April 2020 and December 2021, with the Drewry Hong Kong–Los Angeles container price index (USD per 40-foot box) up 472 percent and the Shanghai export Containerised Freight Index up 492 percent. The cost of shipping a 40-foot container from China to the US west coast peaked at USD 20,600 in September 2021, rising 1,400 percent over its cost in February 2020.² In 2021, the price of a 40-foot container shipped from Australia to London rose 52 percent – from USD 1,550 to USD 2,350. While rates have reduced to pre-pandemic levels, shipping costs continue to be a crucial contributor to global

¹ K. Alicke et al., "Is Your Supply Chain Risk Blind – or Risk Resilient?" McKinsey & Company, 14 May 2020, <https://www.mckinsey.com/capabilities/operations/our-insights/is-your-supply-chain-risk-blind-or-risk-resilient>

² "Global Shipping Costs Are Returning to Pre-Pandemic Levels," *The Economist*, 9 January 2023, <https://www.economist.com/graphic-detail/2023/01/09/global-shipping-costs-are-returning-to-pre-pandemic-levels>

inflation: IMF research suggests that a doubling of freight rates leads to a 0.7 percentage point increase in inflation.³

- Experts estimated that the global shortage of semiconductors, which is expected to last beyond 2024, cost the US economy USD 240 billion in 2021,⁴ and cost USD 210 billion in lost car sales globally in 2021.⁵
- Apple estimated quarterly sales losses of at least USD 4 billion in 2022 as a result of lockdowns and supply bottlenecks.⁶
- Estimates of global inflation suggest that consumer prices rose to between 8 to 9 percent in 2022 and this is expected to decline to around 6 percent in 2023, according to the International Monetary Fund (IMF).⁷ According to the Federal Reserve Bank of New York, supply shocks were responsible for 40 percent of the inflation that occurred from 2019 to 2021.⁸
- In 2022, USD 313 billion global economic loss was incurred from natural catastrophes – 4 percent above the twenty-first century average.⁹

Many stakeholders that we talked to indicated that their broad response to the disruption from COVID-19 involved three phases:

- An initial knee-jerk reaction to supply chain breakdown that involved building buffers into their supply chain in the form of inventory stockpiling, obtaining extensions from their customers and vendors, and negotiating flexibility into contracts. However, these reactionary initiatives did not resolve the issue or address vulnerabilities in the supply chain.
- The second phase involved looking at innovative solutions to shipping issues such as sourcing space on containers or other transport modes not subject to constrictions. With shipping costs up four to five times what they were pre-pandemic, firms were price takers with no countervailing buyer power. Firms also started to look at procuring more reliable suppliers. In this phase, firms began to understand the complexities of their supply chain and how a lack of visibility posed such a threat to it. Firms started to think

³ Y. Carrière-Swallow et al., “How Soaring Shipping Costs Raise Prices around the World,” IMF Blog, 28 March 2022, <https://www.imf.org/en/Blogs/Articles/2022/03/28/how-soaring-shipping-costs-raise-prices-around-the-world>

⁴ O. Villafranca, “Chip Shortage Cost U.S. Economy Billions in 2021,” *CBS News*, 28 January 2022, <https://www.cbsnews.com/news/chip-shortage-cost-us-economy-billions-in-2021/>

⁵ M. Wayland, “Chip Shortage Expected to Cost Auto Industry \$210 billion in Revenue in 2021,” *CNBC*, 23 September 2021, <https://www.cbc.com/2021/09/23/chip-shortage-expected-to-cost-auto-industry-210-billion-in-2021.html>.

⁶ G. Stahl, “Apple Sees \$4 Billion to \$8 Billion Impact From Supply Constraints,” *The Wall Street Journal*, 29 April 2022, <https://www.wsj.com/livecoverage/earnings-latest-news-amazon-apple/card/apple-sees-4-billion-to-8-billion-impact-from-supply-constraints-76OCRGJRufb6jooeJmtm>

⁷ International Monetary Fund (IMF), *World Economic Outlook: Countering the Cost-of-living Crisis* (Washington, DC: IMF, October 2022), <https://www.imf.org/en/Publications/WEO/Issues/2022/10/11/world-economic-outlook-october-2022>

⁸ The Economist, “Global Shipping Costs Are Returning to Pre-Pandemic Levels”.

⁹ Aon, “Aon: Global Insured Losses from Natural Disasters Exceeded \$130 Billion in 2022, Driven by Second-Costliest Event on Record,” 25 January 2023, <https://aon.mediaroom.com/2023-01-25-Aon-Global-Insured-Losses-from-Natural-Disasters-Exceeded-130-Billion-in-2022,-Driven-by-Second-Costliest-Event-on-Record>

about digitisation, scenario planning, the need for real-time data and how to achieve visibility.

- The third phase involved more medium- to long-term thinking about supply chains in terms of undertaking a thorough risk assessment of the supply chain, mitigation strategies, and considerations around nearshoring and onshoring. Other considerations included sustainability of the supply chain and compliance with evolving regulations.

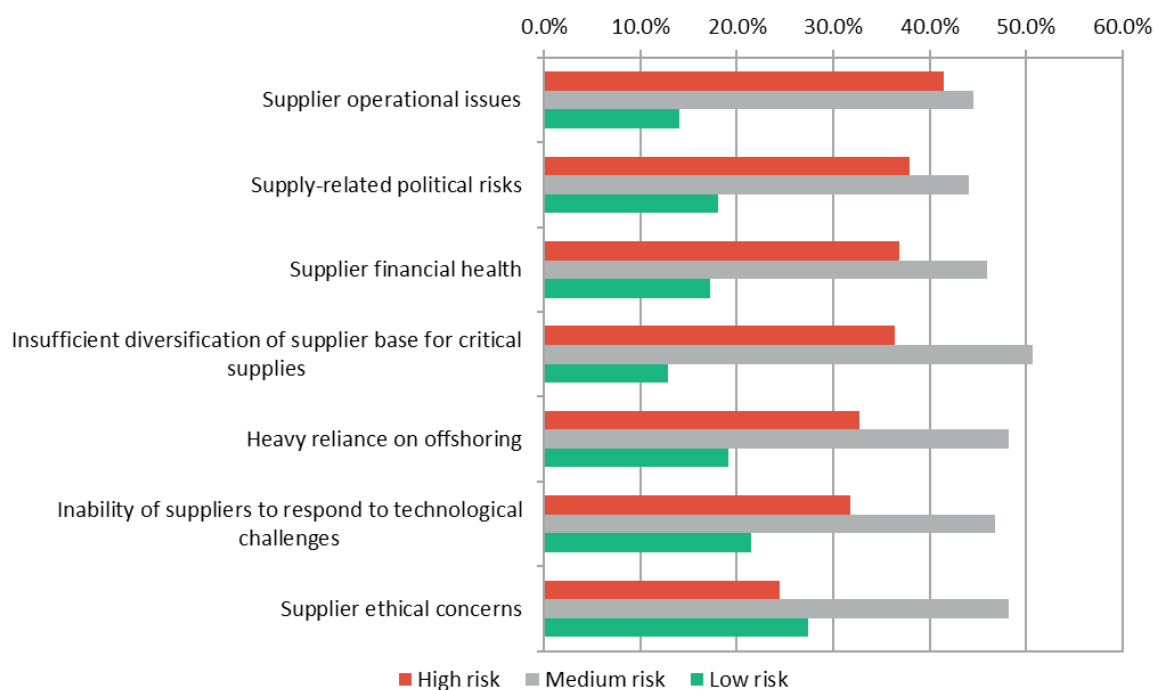
Supply chain disruption has not ended, and businesses recognise that resilience will be key to weathering the inevitable future disruption. Businesses have to consider the trade-off between resiliency and efficiency; the disruption has challenged the consensus on lean supply chains and just-in-time inventory, laying the ground for a debate on the merits of nearshoring and raising fears of a return to protectionist trade practices.

Beyond issues around supplier reliability, shipping and tariffs, businesses now have to align their supply chain with commitments to environmental sustainability and ensure compliance with international labour standards. This further emphasises the need to achieve greater visibility of the supply chain in order to fulfil due diligence obligations. It also underlines the potential need for considerable investment in technology and network localisation tactics.

Key supply chain risks and their impacts

Respondents to FTI’s global supply chain resilience survey identified the risks to their supply chain as encompassing global factors such as freight costs and shipping issues, economic slowdown, natural disasters and trade disputes, in addition to firm-level risks such as insufficient diversification of suppliers, heavy reliance on offshoring, and inability of suppliers to respond to technological changes.

Biggest risks to supply chain (% of respondents)



The impacts of supply chain disruption have been well documented. Most respondents to FTI's survey indicated that supply chain disruption cost them between 11 and 20 percent of their annual revenue.

Compared with other sectors, a larger share of respondents in manufacturing reported delays in production and delivery and increased costs of production, while a lower share of respondents from the transportation sector reported inventory shortages as an impact. A larger share of respondents in the consumer goods sector reported losses of sales and revenue, while the food and beverage sector reported a lower relative frequency of impacts in terms of downsizing.

Large-sized enterprises struggled the most with delays in production and delivery and increased production costs, while micro enterprises struggled the most with loss of sales and revenue. In addition to tangible impacts of supply chain disruptions, firms also faced damage to brand reputation and recognition, and customer loyalty.

In the case study interviews conducted for this research report, some of the broad themes around supply chain vulnerabilities included:

- Shipping and logistics issues – congestion at major ports, shortages of containers, cash-flow problems for freight forwarders, complex customs and quarantine regulations, lack of communication flow and rising warehousing costs.
- Inability of suppliers to respond to technological change – respondents to both FTI's survey and case study interviews stressed the lack of digitisation in supply chain modelling and management. 'Not enough systems talk to each other, and this impedes smooth information flow,' one stakeholder noted.
- Lack of supply chain visibility – information about order fulfilment, delays and even the location of goods became unreliable following the pandemic. With little transparency, visibility and understanding about and across the full supply chain, businesses struggled to manage the myriad risks around shipping and logistics, troubleshoot problems, and make decisions in real-time. These difficulties also meant that it was hard to give customers confidence in the reliability of delivery and posed potential cost inefficiencies and non-compliance with regulatory standards.
- Insufficient diversification of suppliers and a reliance on offshoring pre COVID-19 – supply chain professionals have recognised that where outsourcing previously generated efficiencies, it also poses excess risk if the various links in the supply chain freeze up. Stakeholders acknowledged both the advantages and disadvantages of nearshoring and onshoring, and indicated that it may be appropriate to re-shore supply chains for domestically critical goods such as microchips and semiconductors. One case study outlined the many advantages of 3D printing for producing component parts for the manufacturing sector, thereby reducing the reliance on importing high volumes of parts.

Supply chain resilience strategies

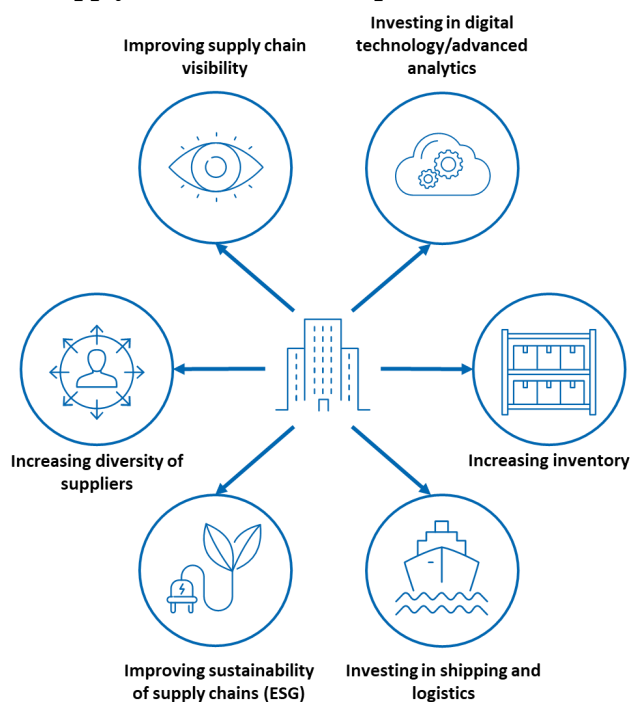
More than 85 percent of survey respondents indicated that they intended to revise their supply chain strategy to make it more resilient, and 51 percent estimated that it would cost up to 30 percent over current spending to achieve resilience.

In general, respondents to FTI’s survey viewed the following strategies as likely the most effective means of achieving resilience:

- Increasing inventory on hand
- Improving supply chain visibility
- Investing in shipping and logistics
- Improving sustainability of the supply chain – environmental, social and governance (ESG) components
- Investing in digital technology
- Increasing diversity of suppliers

Across the survey and interviews, most stakeholders agreed that there was a need to procure multiple sources of raw materials inputs, and to increase inventories on hand – from just-in-time to just-in-case inventory. There has also been a shift from planning and forecasting to scenario modelling, which produces a range of possible supply chain outcomes/impacts depending on the likelihood of certain risks materialising.

Supply chain initiatives to promote resilience



ESG=environmental, social and governance

We explored in more detail the strategies that firms are considering through case study interviews and this shone light on how firms are deploying some of the initiatives indicated in the survey. For example, many stakeholders mentioned the use of blockchain technology to assist in achieving greater supply chain visibility, particularly from the perspective of achieving compliance with laws concerning international labour standards and legislation around ethical sourcing of supply chain inputs.

We also asked firms how their supply chain priorities evolved since the pandemic in terms of factors such as minimising cost, timeliness and reliability. While minimising cost and enhancing efficiency remained the top two priorities both pre- and post-pandemic, reliability and timeliness of the supply chain were given higher weights post-pandemic, as was re-shoring or nearshoring. Case study interviews revealed that while nearshoring is a talking point among supply chain managers, it may be a longer-term objective, once a thorough understanding of the supply chain is achieved and some stakeholders noted that the decision to nearshore or onshore will intersect with considerations around trade agreements and the regulatory environment.

Digitisation, technology and use of advanced analytics were raised as a key ambition going forward, particularly in the transportation, extractives and minerals, and consumer goods sectors. It is hoped that increased digitisation will aid communication flow between tiers of the supply chain and allow for real-time information updates that can inform more timely decision making. Availability of rich data can also permit the use of advanced analytics, scenario planning and prediction. Stakeholders also noted the use of innovative platforms such as Flexport and Ofload to help them streamline shipping and customs processes.

In case study interviews, stakeholders suggested that assistance from APEC and member governments could be sought around regulatory certainty, taking advantage of trade agreements and cybersecurity and digitisation. For example, evolving regulations in terms of trade rules, tariffs, customs laws and labour requirements pose a threat to the smooth operation of supply chains. Achieving compliance with new labour regulations and the extent of due diligence involved will require a thorough understanding of all tiers and nodes in a company's supply chain, and companies are seeking government guidance in this area.

Some of the measures put in place by APEC member governments have included policies around onshoring production of goods considered critical to domestic security, including semiconductors. In August 2022, US President Joe Biden signed the CHIPS Act of 2022 into law, aiming to strengthen and revitalise the US position in semiconductor research, development and manufacturing. Initiatives in Japan have tended to offer subsidies to firms to promote domestic production of critical goods, while also encouraging firms to strengthen supply chains between Japan and some APEC member economies. Some governments have also invested in direct procurement and stockpiling of critical goods or those of strategic importance.

FTI's resilience toolkit

Future supply chains will have to be visible, agile and sustainable if they are to function in an increasingly uncertain global environment. Firms are the key actors in driving this change from the previous era of efficient and lean supply chains. Government also has a role to play in influencing the production decisions of businesses and taking the lead in areas of domestic significance, for example, stockpiling key resources when necessary.

In line with the objectives of the study, we sought to develop a framework that can guide APEC's thinking for building and maintaining open, secure and resilient supply chains at the firm and economy-wide level. These toolkits are outlined in Chapter 6.

At the firm level, the cornerstones of the toolkit relate to:

- Preparing for risk
- Raising supply chain flexibility
- Reviewing product design and production
- Enhancing digitalisation of the supply chain
- Raising social and environmental sustainability in supply chains

At the government and economy-wide level, the key themes in the toolkit include:

- Supporting continuity of supply and economic growth
- Maintaining price stability
- Preserving trade that supports supply chain resilience
- Enhancing digitalisation of supply chains
- Maintaining a conducive business environment
- Supporting investment and technological innovation
- Supporting greater social and environmental sustainability across supply chains

Key areas for APEC going forward

Respondents to FTI's survey asked the following of government to support supply chain resilience:

- Keeping trade policy transparent and accessible
- Promoting policies aimed at strengthening domestic supply chain capabilities
- Reducing tariffs and non-tariff barriers
- Reducing customs administration
- Promoting trade harmonisation and regulatory coherence

In order to increase resilience, APEC members should support change within their economies and across the Asia-Pacific region. This starts with raising awareness of the need for supply

chain resilience. APEC members should look beyond current vulnerabilities and challenges, and concentrate on those that will probably arise in the future. Key to resiliency will be encouraging regional collaboration and discouraging economies acting unilaterally.

Success will most likely involve a mix of measures, including the following, each of which aligns with the three pillars of APEC's agenda (trade and investment liberalisation; business facilitation; economic and technical cooperation) and the APEC Putrajaya Vision 2040:

- *Risk scanning and monitoring* – APEC should monitor and share information about risks, vulnerabilities and likely resiliency of APEC member economies and their critical supply chains. This could assist in identifying early warning indicators for economies and possibly for key industries/sectors.
- *Trade facilitation* – reducing trade friction and bureaucracy at the border. This would build on progress already made by APEC members to implement a Single Window system for the processing of trade documents, enhancing common digital infrastructure to improve the ability of private operators to exchange information with border agencies.
- *Shipping and logistics focus* – detailed review of vulnerabilities and emerging issues in shipping, transport infrastructure and logistics within APEC member economies, and promotion of measures to resolve issues therein.
- *Digitisation agenda* – continued efforts in promoting digitisation in trade and industry, with a much heavier focus on supply chains. This should involve detailed studies on sectors that have pioneered the digitisation of supply chains.
- *Sustainability of supply chains* – continued encouragement of green growth through heightened transparency and accountability for environmental performance throughout supply chains.

1 INTRODUCTION

This report is submitted to the Committee on Trade and Investment (CTI) of the Asia-Pacific Economic Cooperation (APEC) by FTI Consulting and the APEC Policy Support Unit. The report provides an independent analysis of supply chain vulnerabilities in the Asia-Pacific region and outlines a number of recommendations to promote open, secure and resilient supply chains across the region.

Over the past three decades, global supply chains have become more significant to trade and economic activity, as production and manufacturing have become more globalised. In pursuit of efficiency and competitiveness, firms sought to move production offshore, choosing to rely on just-in-time shipping. Over time, this led to the concentration of trade and manufacturing around key hubs, many of which are in the Asia-Pacific. When the COVID-19 pandemic struck in early 2020, economies went into lockdown and shipping channels froze. This led to a sharp drop in international trade and massive supply chain disruption. With manufacturing activity so widely dispersed around the globe, this would lead to shortages of key goods, ranging from necessities like personal protective equipment and medicines, to construction materials, electronics and automobiles. This would subsequently lead to volatility across a wide spectrum of markets for traded goods and impose substantial costs for business. The onset of disruption to supply chains would set the scene for disruption at the economy level, leading to declines in economic activity, unemployment, shortages, and the beginning of price inflation.

Both firms and policymakers are now more cognisant than ever of the risks that supply chain disruption poses to their supply chains and to the wider economy. Companies have had to take a hard look at how they source, produce and distribute products and services under conditions not previously experienced for decades. The disruption has also challenged the consensus on lean supply chains as a business model, leading to a fundamental rethink of the way that supply chains and international trade is organised.

FTI's global supply chain resilience survey showed that since the pandemic, 85 percent of responding firms indicated that they intended to revise their supply chain strategy to make it more resilient and this outcome was observed by sector and across size of responding organisation. Most supply chain managers have changed their priorities away from pursuing cost efficiency toward pursuing resilience and agility in their supply chain. The survey found that most supply chain managers aim to spend up to 30 percent over current supply chain costs to achieve a level of resiliency going forward.

In addition to rethinking the supply chain strategy, recent years have also seen sustainability and ethical sourcing of inputs become more vocal talking points among businesses and policymakers. Consumers demand that businesses make substantial efforts to tackle environmental issues and demonstrate that they have procured inputs from sustainable sources. This is coupled with the rise of legislation and regulations that implore firms to demonstrate

that their supply chain is in compliance with international labour standards.¹⁰ Add to this the rise of geopolitical conflicts and complex economic sanctions, and it is clear that businesses face a number of profound challenges in coming years to maintain a supply chain that is resilient, transparent and compliant.

In this report, we sought to understand the impact of the COVID-19 pandemic in terms of supply chain disruption and what risks made firms particularly vulnerable to the fallout, how firms are responding and what initiatives policymakers should consider to promote resiliency at the economy level.

1.1 OBJECTIVES FOR THE STUDY

The study had four key objectives:

- 1) review vulnerabilities in global supply chains in recent years and their impacts on trade and businesses in APEC economies
- 2) review applicable supply chain strategies that are taken by firms and governments
- 3) develop recommendations to help businesses promote dynamic and innovative supply chains that are also open, secure and resilient
- 4) learn best practices that are adopted by firms and governments and in industries to develop long-term supply chain strategies

1.2 OVERVIEW OF METHODOLOGICAL APPROACH

Table 1.1 outlines the considerations and actions undertaken to achieve the objectives of the study. In pursuing these objectives, we sought to examine the impact and consequences of the pandemic and other social factors (such as the shift toward a climate-resilient future global economy) on trade and supply chains within the APEC region. We also sought to determine relevant industry sectors that are most vulnerable to supply chain disruption and how they fared over the past three years. We further analysed the types of supply chain strategies being considered and implemented in these industry sectors through a combination of desktop research, primary research and case study interviews with relevant stakeholders. Together, this formed an evidence base for some recommendations that APEC could promote to foster more resilient and flexible supply chains across the region, as well as trade practices that will continue to facilitate economic cooperation between economies.

¹⁰ International labour standards are legal instruments that set out basic principles and rights at work as set forth by the International Labour Organization (ILO). International labour standards are intended to protect workers' rights, ensure decent work, and guarantee humane working conditions. For more elaborations on international labour standards please refer to 'Box 2.2. ILO and international labour standards' in "APEC Economic Policy Report 2017" (Singapore: APEC, 2017), <https://www.apec.org/publications/2017/11/2017-apec-economic-policy-report>.

Table 1.1. Roadmap of considerations and actions to achieve objectives of study

Objective	Analysis	Sources	Chapter of report
Review vulnerabilities in global supply chains in recent years and their impacts on trade and businesses in APEC economies	<ul style="list-style-type: none"> • Identify key risks and vulnerabilities in global supply chains • Identify key impacts on trade across the APEC region • Understand implications and causes of supply chain disruption, including from the pandemic and other factors • Identify and examine vulnerable and essential sectors affected by supply chain disruption 	<ul style="list-style-type: none"> • Literature review • FTI global supply chain resilience survey • Case studies • FTI supply chain experts • Global economic indicator databases 	2, 3
Review applicable supply chain strategies that are taken by firms and governments	<ul style="list-style-type: none"> • Identify key strategies that firms are adopting to achieve supply chain resilience • Discuss strategies with firms • Identify key strategies adopted by governments and international fora to promote supply chain resilience 	<ul style="list-style-type: none"> • Literature review • FTI global supply chain resilience survey • Case studies • FTI supply chain experts 	4, 5
Develop recommendations to help businesses promote dynamic and innovative supply chains that are also open, secure and resilient	<ul style="list-style-type: none"> • Synthesise the analysis and draft recommendations for promoting resilient supply chains across the APEC region 	<ul style="list-style-type: none"> • Case studies • FTI supply chain experts 	6, 7
Learn best practices that are adopted by firms and governments and in industries to develop long-term supply chain strategies.	<ul style="list-style-type: none"> • Develop a framework for the long term for building and maintaining open, secure and resilient supply chains among APEC economies 	<ul style="list-style-type: none"> • FTI supply chain experts 	6, 7

1.2.1 Desktop research/analysis

The team undertook a targeted literature review of contemporary supply chain issues to understand vulnerabilities and risks, impacts, costs and implications, and the types of strategies that firms are considering and implementing. This provided insights on the latest commercial thinking about supply chain resiliency and helped to inform the survey and subsequent case study interviews.

Given the comprehensive scope of this study, it was necessary to leverage a wide range of data sources. The sources utilised include, but are not limited to, the following:

- Australian Bureau of Statistics
- Bloomberg
- Department of Statistics Singapore
- Federal Reserve Economic Data
- Forbes
- FTI Consulting
- General Statistics Office of Viet Nam
- International Monetary Fund (IMF)
- Organisation for Economic Co-operation and Development (OECD)
- Reuters
- StatsAPEC
- Statistics Bureau of Japan
- World Bank

1.2.2 Survey methodology

Sample industry sectors

Supply chain disruption has affected various sectors of the economy depending on the length of a sector's supply chain and the extent of reliance on overseas inputs and the degree of interconnectedness. In collaboration with the APEC Policy Support Unit, we considered what industrial sectors would be relevant to the study.

We undertook cross economy desktop research on supply chain issues by sector for each of the APEC economies (see Appendix A). For example, surveys by the Australian Bureau of Statistics in relation to reports of supply chain difficulties by industry sector showed that sectors least affected included arts and recreation and finance, while sectors such as

wholesaling, construction and logistics reported greater impact.¹¹ A 2021 survey by the US Census Bureau of US companies on the extent of supply disruptions indicated that the most affected sectors were manufacturing, construction, retailing, wholesaling, accommodation and food services and administrative and support services.¹² Overall, the meta-analysis suggested that the disrupted sectors common to most of the APEC economies include retail trade, manufacturing, wholesaling, construction and mining.

From this research, as well as interviewing industry stakeholders and supply chain experts, and collaborating with experts in the APEC Policy Support Unit, we finalised the key sectors for the survey as follows:

- Consumer Goods/Retail
- Food & Beverage
- Extractives & Mineral Processing
- Transportation
- Resource Transformation/Manufacturing

The list of subsectors based on the General Industry Classification Standard underlying these sectors is given in Table 7.2 in Appendix A.

Survey outcomes

FTI Consulting conducted extensive new primary research in the area of supply chain disruption and strategies, surveying 748 decision makers (mostly senior management, board member or C-suite) across the Asia-Pacific and across the five key industry sectors, as outlined in Table 1.2.¹³ The results of this survey were supplemented with qualitative insights from industry and subject matter experts.

¹¹ Reserve Bank of Australia, “Box B: Supply Chains during the COVID-19 Pandemic,” May 2021,

<https://www.rba.gov.au/publications/smp/2021/may/box-b-supply-chains-during-the-covid-19-pandemic.html>

¹² S. Helper and E. Soltas, “Why the Pandemic Has Disrupted Supply Chains,” The White House, 17 June 2021,

<https://www.whitehouse.gov/cea/written-materials/2021/06/17/why-the-pandemic-has-disrupted-supply-chains/>

¹³ The detailed subsectors and economy breakdown are outlined in Appendix A.

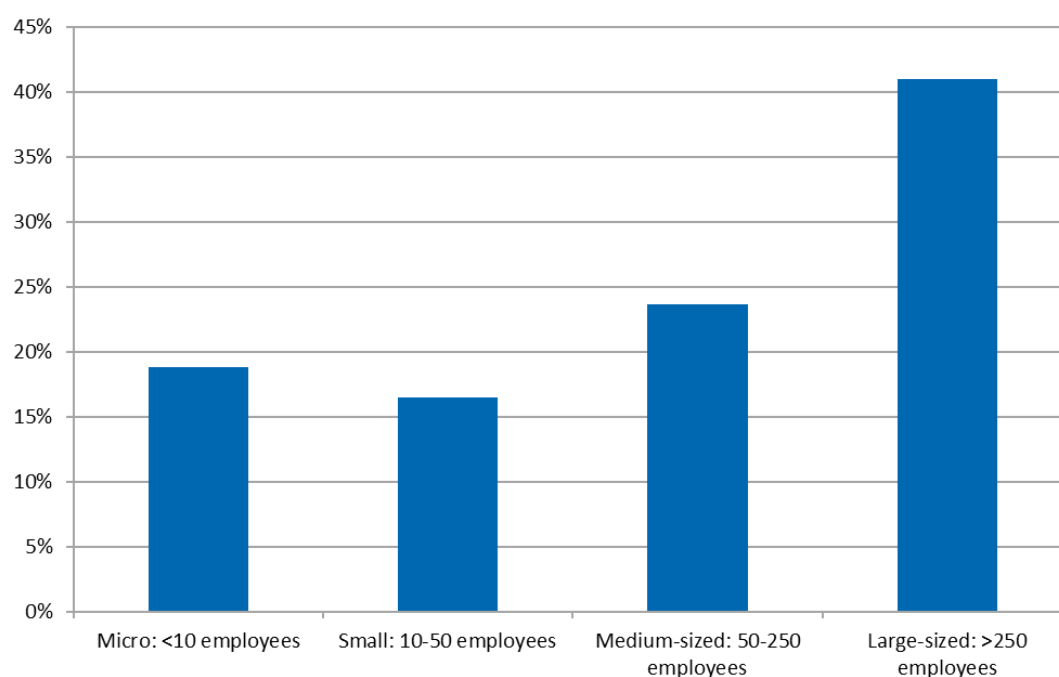
Table 1.2. FTI’s global supply chain resilience survey

Industry sector	Region A	Region B	Region C	Region D	Region E	Other	TOTAL
Consumer Goods/Retail	24	44	27	13	28	1	137
Food & Beverage	41	30	23	31	16	0	141
Extractives & Mineral Processing	26	10	43	22	8	1	110
Transportation	27	16	20	38	20	0	121
Resource Transformation/Manufacturing	36	38	18	15	49	0	156
Other	19	6	1	0	4	53	83
TOTAL	173	144	132	119	125	55	748

Note: Region A: Australia; New Zealand; Papua New Guinea. Region B: Brunei Darussalam; Indonesia; Malaysia; the Philippines; Singapore; Thailand; Viet Nam. Region C: Canada; Mexico; United States. Region D: Chile; Peru. Region E: China; Hong Kong, China; Japan; Korea; Russia; Chinese Taipei.

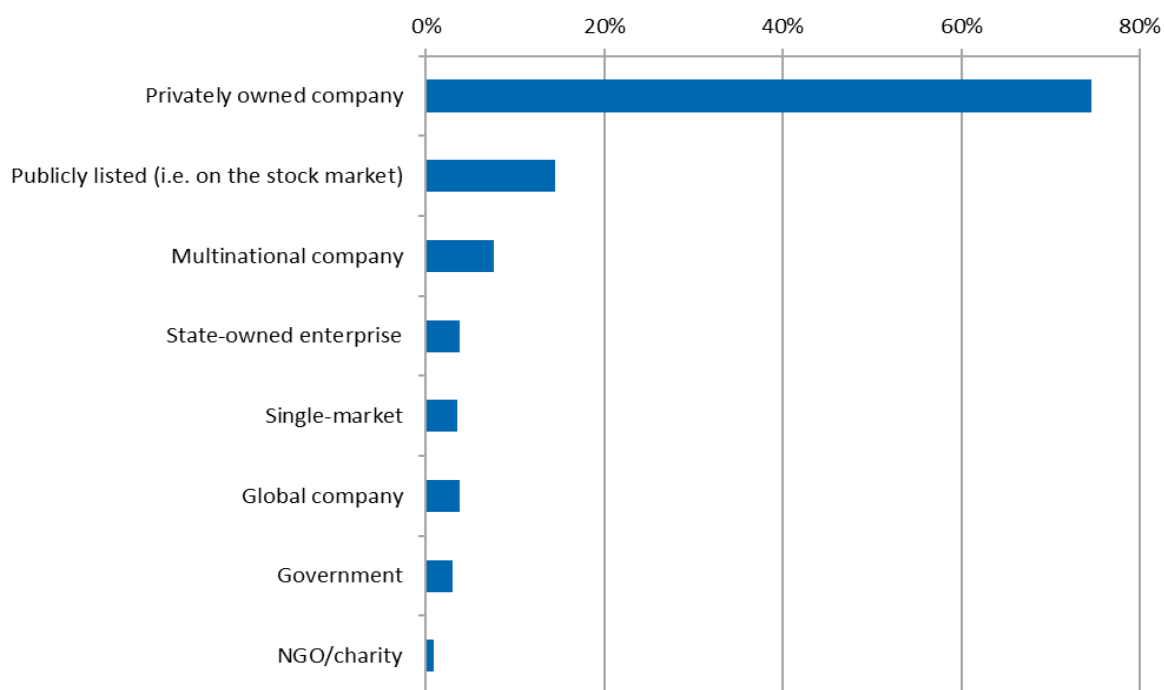
A major share of responding organisations was large-sized (defined as those with over 250 employees) as illustrated in Figure 1.1; while 87 percent of global respondents were either C-suite, senior management or managers.

Figure 1.1. Size of responding organisations



The breakdown of responding organisations is given in Figure 1.2, with more than 70 percent classified as privately owned.

Figure 1.2. Breakdown of responding organisations



1.2.3 Case studies

We undertook targeted case study interviews across the five industrial sectors for the analysis. The aim of case study interviews was to obtain more industry (and company) specific insights, and to understand industry experts' views on how their respective sector is responding to the need for supply chain resilience, what strategies they considered most effective, as well as what initiatives policymakers could promote. Participants in case studies were chosen based on the size of their organisation, extent of operations across the APEC region and the length of their supply chain.

1.3 REPORT STRUCTURE

The remainder of this report is structured as follows:

- **Chapter 2** provides an overview of key risks and vulnerabilities in global supply chains, as indicated by FTI's survey and stakeholder engagement.
- **Chapter 3** summarises the impact of vulnerabilities in global supply chains in terms of costs to business and wider macroeconomic effects.
- **Chapter 4** outlines supply chain strategies adopted by businesses in pursuit of resilience.

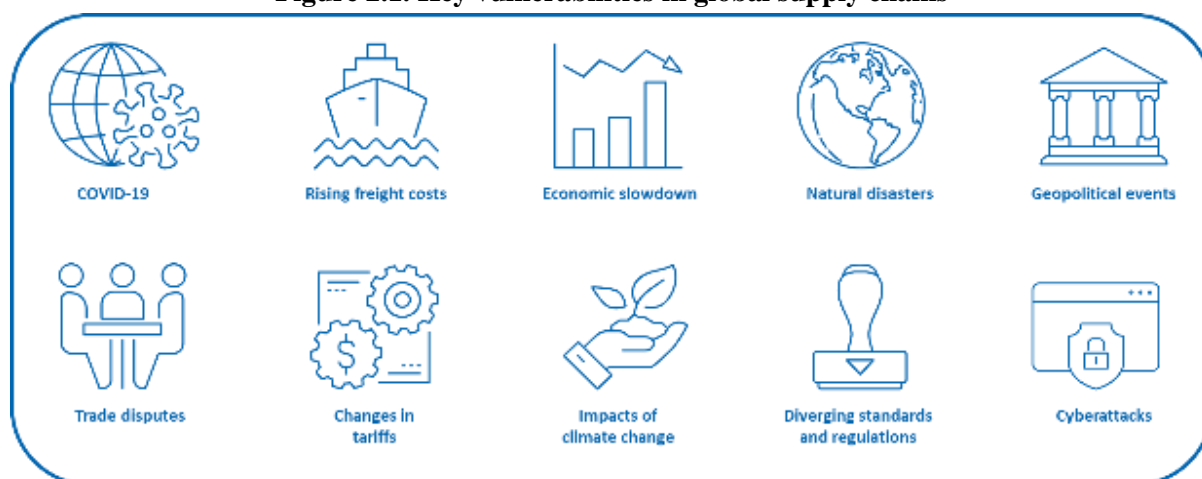
- **Chapter 5** outlines some of the supply chain policies promoted by various governments.
- **Chapter 6** outlines a toolkit for building and maintaining open, secure and resilient supply chains.
- **Chapter 7** ties together the detailed analyses and assessment completed in the preceding chapters to present a number of recommendations for APEC.

2 KEY RISKS AND VULNERABILITIES IN GLOBAL SUPPLY CHAINS

Prior to the pandemic, efficient global supply chains were structured around fundamental factors such as comparative advantage, resource endowments, costs, market size, geography, and institutional quality. Over time, this led to concentration of trade around certain key hubs as companies strategically located certain operations to boost competitiveness. Despite the economic efficiency, this increased the level of risk exposure, leaving global supply chains vulnerable to disruption. Over the last three years, businesses have had to take a hard look at how they source, produce and distribute products and services under conditions they had not previously conceived of.

This section identifies some of the key risks and vulnerabilities in global supply chains as observed in recent years (Figure 2.1). Some of these include volatility in freight costs, geopolitical and geoeconomic events, trade disputes, climate change, economic slowdown and cyber threats.

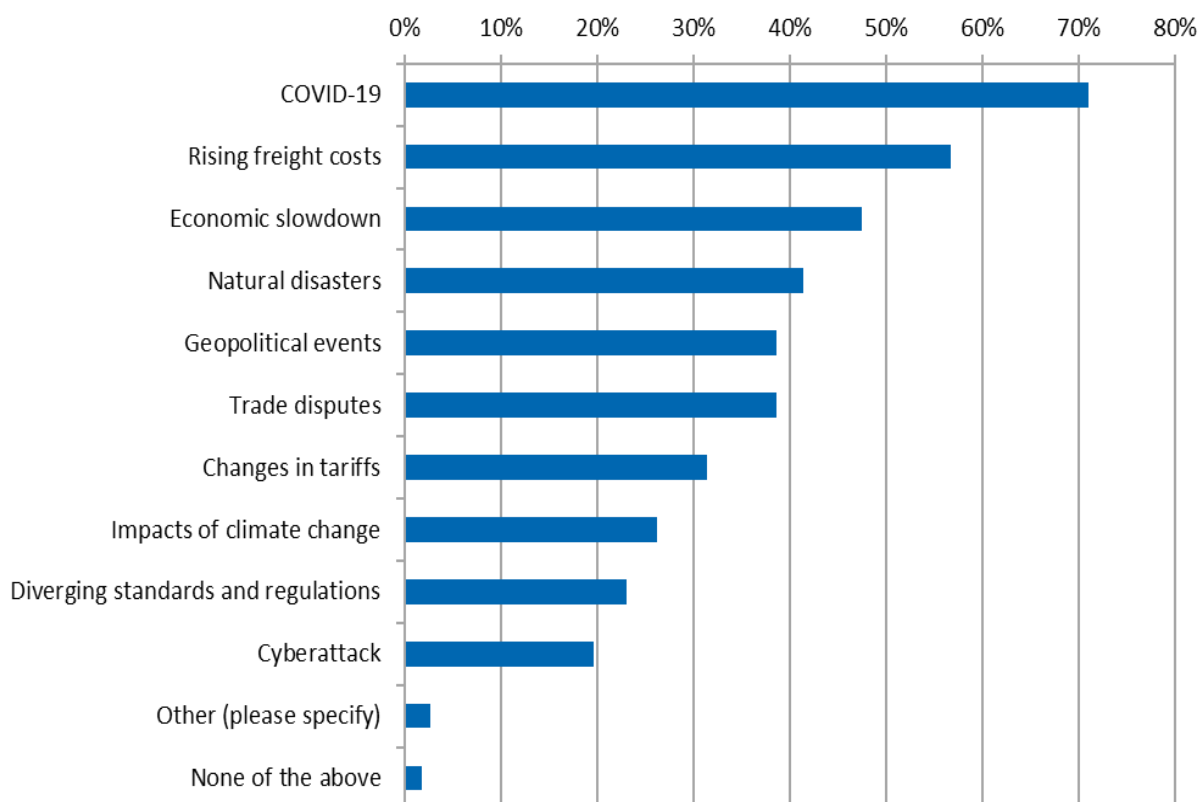
Figure 2.1. Key vulnerabilities in global supply chains



2.1 INSIGHTS FROM FTI’S GLOBAL SUPPLY CHAIN RESILIENCE SURVEY

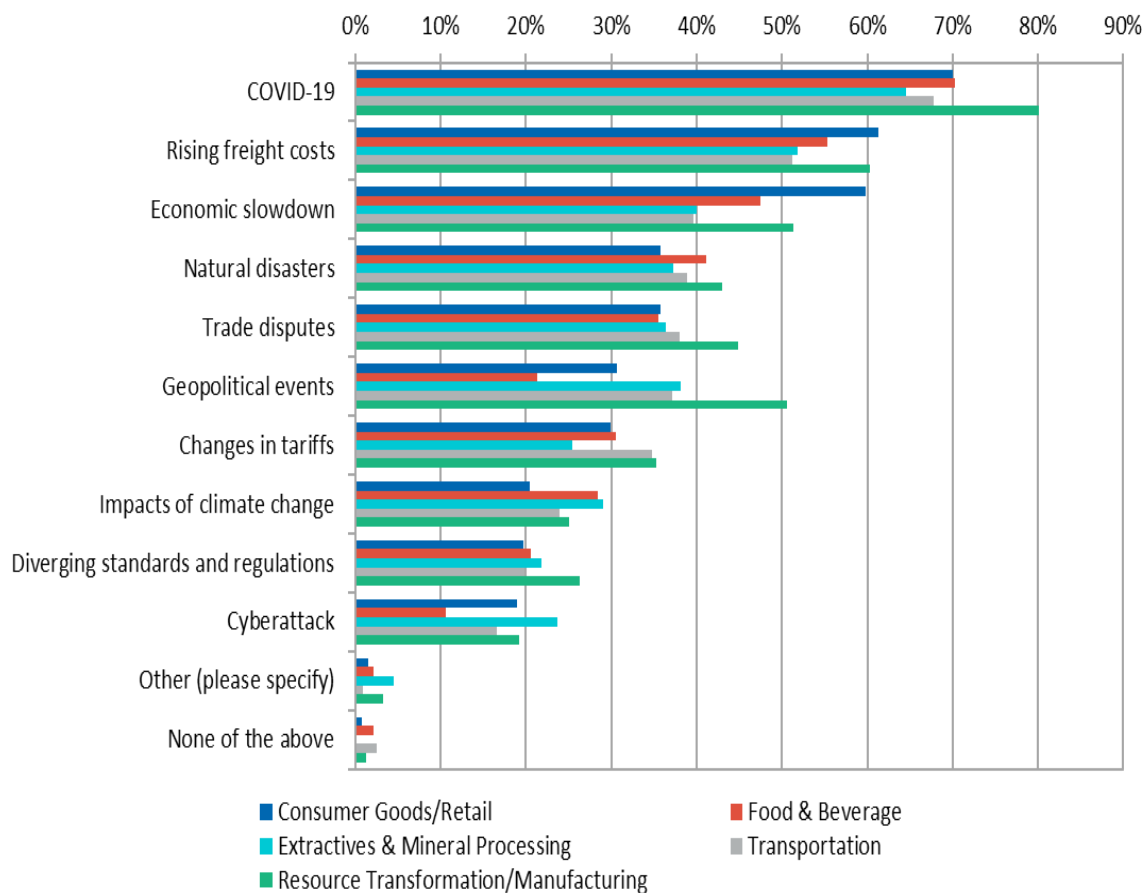
One of the key questions put to participants in FTI’s global supply chain resilience survey was to identify the factors that have disrupted supply chain operations in recent years. The main factors, based on percentage of respondents, are illustrated in Figure 2.2. COVID-19 was ranked as the highest disruptor, given its all-encompassing economic effects over the past three years. Freight costs, economic slowdown and natural disaster were the next highest ranked disruptors. Cyberattack was ranked as the least disruptive factor despite the rising incidence of cyberattacks recently.

Figure 2.2. Key factors that have disrupted supply chains in recent years (% of respondents)



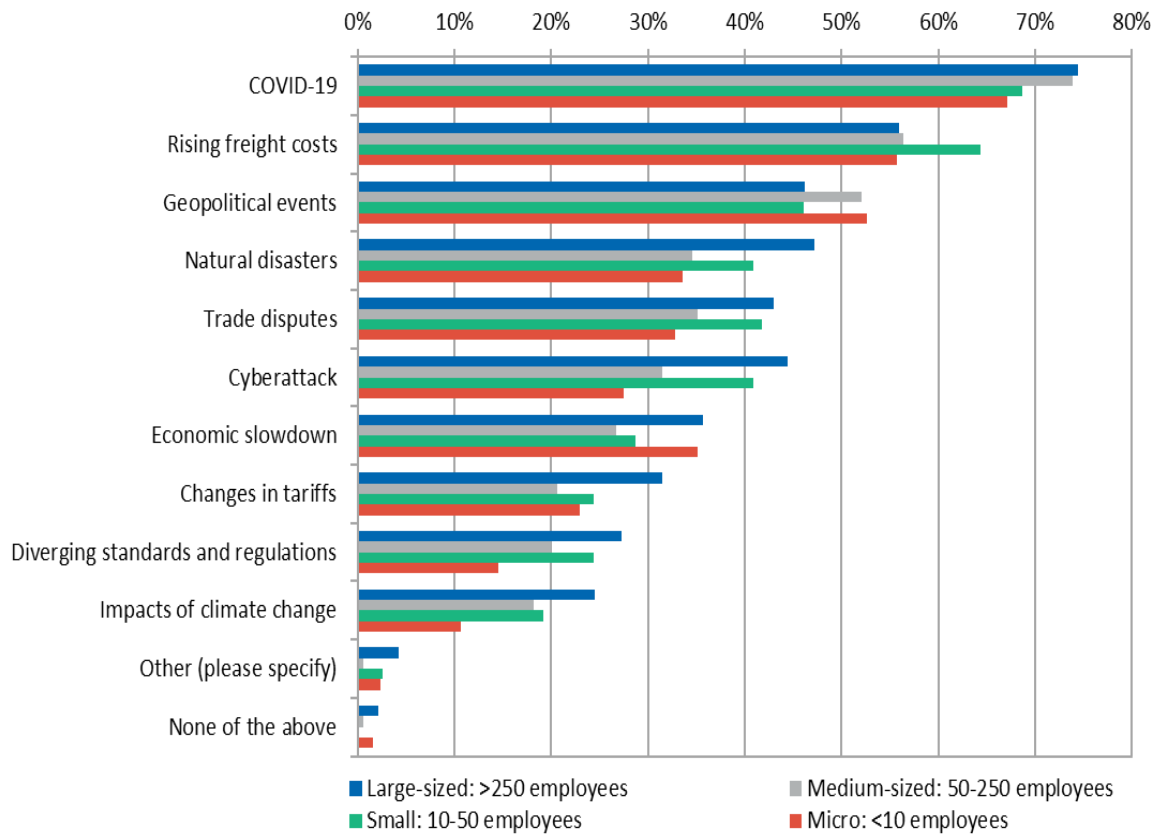
In terms of variation by industry sector, Figure 2.3 shows that the sectoral breakdown largely mirrored the findings across the pooled sample of respondents. However, higher shares of respondents in the consumer goods/retail sector (compared to other sectors) highlighted rising freight costs (61 percent) and economic slowdown (60 percent) as key disruptors to their supply chain. Respondents in the resource transformation/manufacturing sector listed COVID-19, rising freight costs and economic slowdown as the top key factors. In addition, a higher share of respondents in manufacturing reported impact from diverging standards and regulations compared to other sectors. The latter is consistent with case study interviews that we undertook. Although not the top concern, impacts of climate change were indicated as disrupting supply chains by 29 percent of respondents in the extractives and mineral processing sector, followed by the food and beverage sector (28 percent).

Figure 2.3. Key factors that have disrupted supply chains in recent years (% of respondents) – sectoral distribution



The breakdown of disruptive factors by size of organisation (Figure 2.4) shows that COVID-19 remains the overwhelmingly biggest disruptor across all groups of firms, although the pandemic seems to have hit large- and medium-sized organisations disproportionately harder. Rising freight costs – the second biggest disruptor to all groups of firms – reportedly affected small firms more than other groups, with 64 percent of respondents from small firms quoting rising freight costs as a disrupting factor. Responses from the survey also suggested that large firms seem to be less disrupted by rising freight costs compared with small firms. Cyberattack, which was ranked lowest in the sample overall, was given more weight by large- and medium-sized firms, compared to small and micro companies.

Figure 2.4. Key factors that have disrupted supply chains in recent years (% of respondents) – breakdown by size of organisation



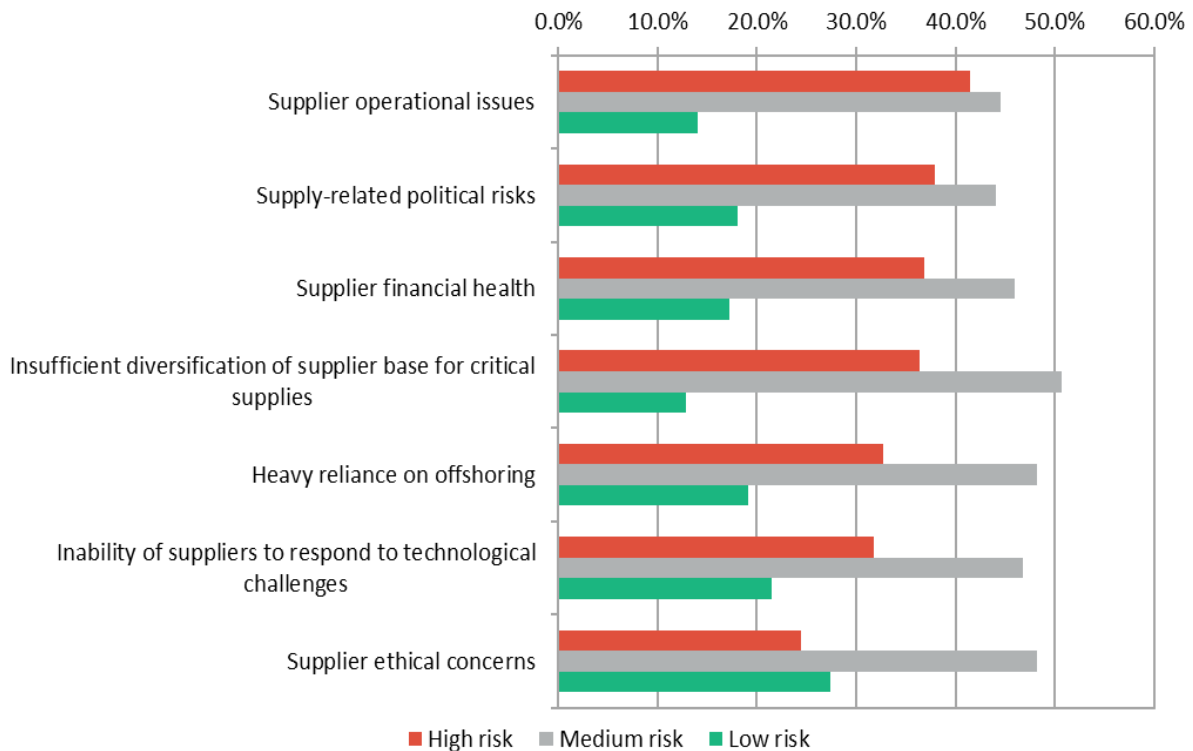
In the comments section to this question, some of the open-ended responses included factors such as:

- Currency movements
- Labour and accommodation shortages
- Sovereign risk
- Availability of containers and ships
- Credit availability
- Industrial disputes
- Sanctions and risk of secondary sanctions for counterparties
- Shipping, ports and railroad congestion
- Raw materials shortages

When asked what they perceived as the biggest risk to their supply chain (Figure 2.5), respondents ranked the following as the high-risk factors:

- Supplier operational issues
- Supply-related political risks
- Supplier financial health
- Insufficient diversification of supplier base for critical supplies
- Heavy reliance on offshoring
- Inability of suppliers to respond to technological challenges
- Supplier ethical concerns

Figure 2.5. Biggest risks to supply chain (% of respondents)



Applying a weighted average¹⁴ to the three risk categories – high, medium and low – puts supplier operational issues and insufficient diversification of supplier base on top. However,

¹⁴ Each level of risk was assigned an integer value (1, 2 and 3 for low, medium and high risk respectively). A percentage weighting for each level of risk was calculated by dividing by the total number of respondents. The weighting for each level of risk was calculated by multiplying the percentage weighting by the assigned integer values. The final number for the weighted average was the sum of the resulting weightings.

the closeness of the results in terms of weighting suggests that there is not one single risk to supply chain functioning but a combination of many risks.

Figure 2.6. Biggest risks to supply chain – weighted average



Figure 2.7. Biggest risk to supply chain (% of respondents) – breakdown by size of company

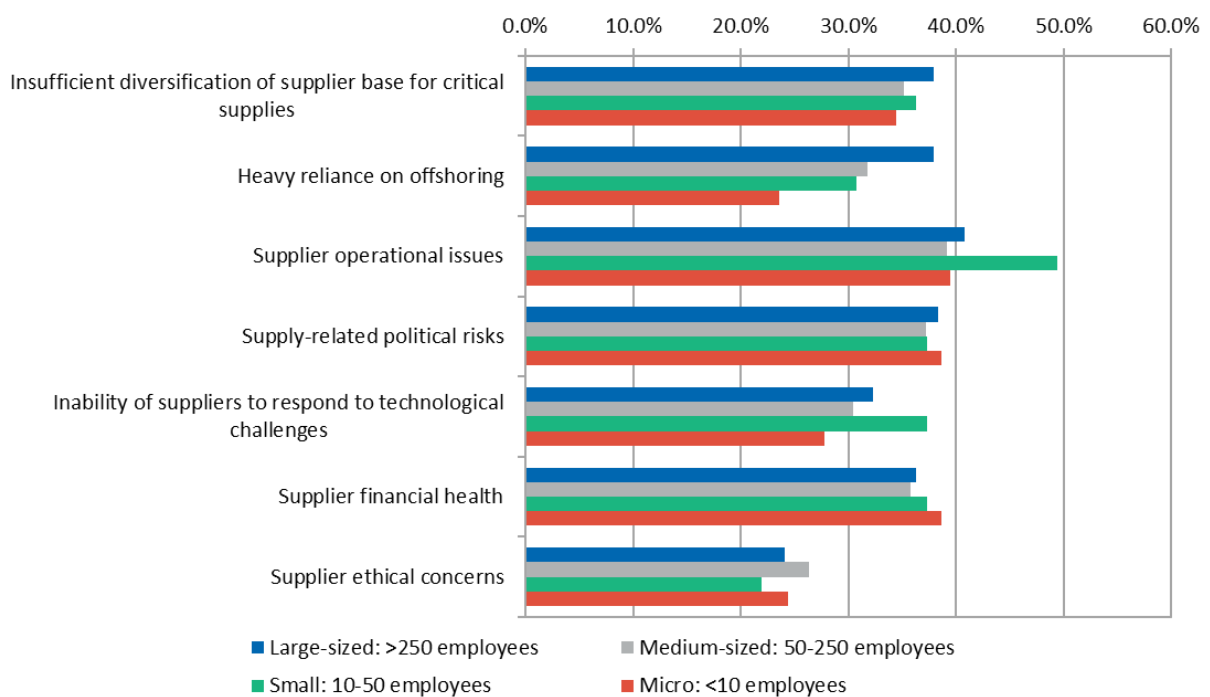


Figure 2.7 shows that small-sized firms indicated supplier operational issues as their top risk. Compared with other groups of firms, supplier financial health was a relatively more significant issue for micro-sized firms. A larger share of respondents from large-sized firms (relative to other smaller firms) identified heavy reliance on offshoring and insufficient diversification of supplier base as key risks, and this is consistent with large firms that have long and interconnected global supply chains.

Overall, inferring from the results portrayed in Figure 2.2 to Figure 2.7, respondents to FTI's global supply chain resilience survey suggest that the key disruptors and risks to their supply chain are the following:

- COVID-19 pandemic
- Rising freight costs
- Economic slowdown
- Natural disasters
- Trade disputes
- Supplier operational issues
- Supply-related political risks
- Supplier financial health
- Insufficient diversification of supplier base for critical supplies
- Heavy reliance on offshoring
- Inability of suppliers to respond to technological challenges

Some of these risks are worth exploring in more detail in the next section.

2.2 DISCUSSION OF RISKS AND VULNERABILITIES IN GLOBAL SUPPLY CHAINS

In addition to the survey findings on the key risk factors and vulnerabilities in global supply chains, discussions with stakeholders and supply chain experts provided useful insights into how these risks arise and play out that are worth exploring.

2.2.1 Shipping issues and elevated freight costs

Issues with shipping and logistics was a recurrent theme in FTI's survey and in interviews with stakeholders. Most of the issues centred around:

- Congestion at major ports and delays in unloading cargo – for example, in 2022, ships awaiting berth at the Port of Shanghai peaked at 344, while shipping something from a warehouse in China to one in the US was taking 74 days longer than usual.¹⁵
- Delays in unloading cargo – aggregate time of turnaround for the three largest European container ports, Rotterdam, Antwerp and Hamburg, were 8 percent, 30 percent and 21 percent respectively above their five-year normal levels during 2022.¹⁶
- Shortages of containers – the shortages drove up the price of use and therefore driving up the price of shipping goods internationally.¹⁷
- Manufacturing of containers limited to certain key hubs.
- Cumbersome compliance checks/documentation and regulatory uncertainty.
- Elevated freight costs (see Figure 3.10 in Chapter 3) and marine fuel prices.
- Long delays in clearance at the border.
- Bottlenecks and communication issues around quarantine requirements and customs procedures.
- Lack of coordination among border agencies, especially relating to clearance of regulated goods ‘at the border’. Some stakeholders noted that there is potential for quarantine and clearance to take place before goods depart their economy of origin.
- Lack of regional cross-border customs-transit arrangements.
- Lack of transparency in port charging structure.
- Impeded information flow between all parties along the port supply chain.
- Regulations on shipping lines, preventing ships from docking in a timely manner.
- Heightened awareness of the environmental impact of shipping and environmental, social and governance (ESG) commitments.
- Variations in cross-border standards and regulations for movements of goods, services and business travellers.
- Cash-flow problems for freight forwarders.
- Rising insurance costs for shippers.
- Suspension of major shipping lines.

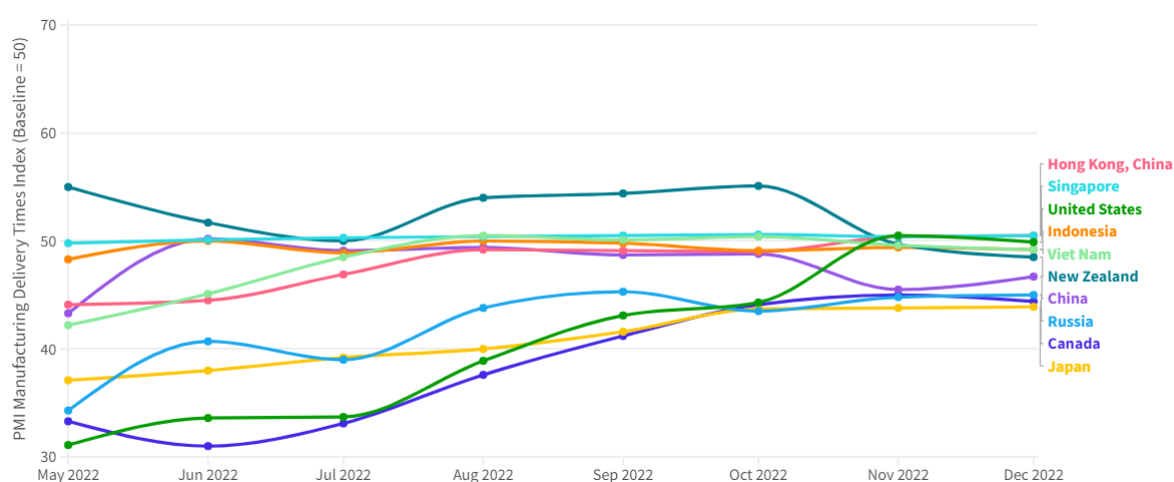
¹⁵ M. Jones, “Snarled-up Ports Point to Worsening Global Supply Chain Woes – Report,” *Reuters*, 4 May 2022, <https://www.reuters.com/business/snarled-up-ports-point-worsening-global-supply-chain-woes-report-2022-05-03/>

¹⁶ Jones, “Snarled-up Ports.”

¹⁷ Atlas Logistics Network, “Shipping Container Shortage May Last Well into 2022,” 2021, <https://atlas-network.com/shipping-container-shortage-may-last-well-into-2022/>

These issues seem to confirm the general perception of delayed delivery times among manufacturers in the region. The Standard & Poor's PMI manufacturing delivery time index demonstrates that there was a general slowing down in the APEC region during 2022. The indices for some APEC economies were below the benchmark score of fifty for most of 2022, indicating that for each month manufacturing firms perceived delivery times to be longer than before (Figure 2.8). Delivery times in 2022 seemed to improve only in New Zealand although by the end of the year it started to follow the general deteriorating trend as observed by other economies in the region.

Figure 2.8. PMI manufacturing delivery times index in the APEC region, 2022



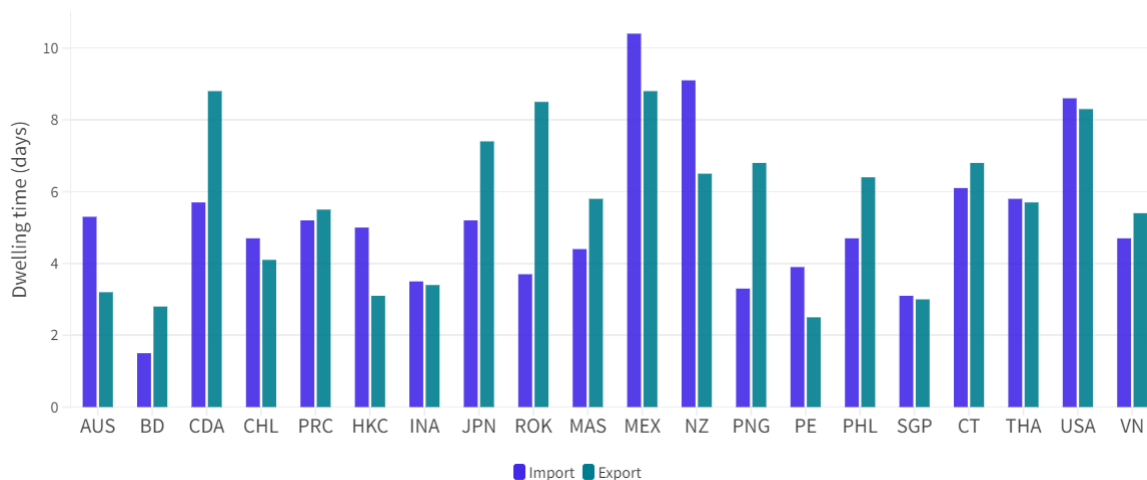
Source: Standard and Poor's Global Market Intelligence database, accessed 18 October 2023

This deteriorating pattern can partly be attributed to lengthy dwell times which can stretch to more than five days in some economies (Figure 2.9). Particularly important is the dwell time for importing activities as timely delivery of inputs is key in ensuring the resiliency of supply chains. In the APEC region, it took about 135 hours (5.6 days) on average for imported goods to sit at ports of destination before being transported to buyers. This is significantly longer than the 72 hours often used as benchmark by major seaports.¹⁸ For comparison, in the five years before the pandemic (2014–2018), the global average dwelling time was about six days.¹⁹ This suggests that while logistics performance has returned to its pre-pandemic level, no significant improvement on this aspect was recorded.

¹⁸ G. Rankine, *Benchmarking Container Terminal Performance*, Container Port Conference, Rotterdam, The Netherlands, 2003; G. Kahyarara and D. Simon, *Maritime Transport in Africa: Challenges, Opportunities, and an Agenda for Future Research*, UNCTAD Ad Hoc Expert Meeting, Mombasa, Kenya, 2018.

¹⁹ UNCTAD, "Review of Maritime Transport 2019" (New York: United Nations Publications, 2019).

Figure 2.9. Dwelling time in the APEC region by activities, 2022



AUS= Australia; BD=Brunei Darussalam; CDA=Canada; CHL=Chile; PRC=China; HKC=Hong Kong, China; INA=Indonesia; JPN=Japan; ROK=Korea; MAS=Malaysia; MEX=Mexico; NZ=New Zealand; PNG=Papua New Guinea; PE=Peru; PHL=the Philippines; SGP=Singapore; CT=Chinese Taipei; THA=Thailand; USA=United States; VN=Viet Nam

Source: World Bank, accessed 18 October 2023, <https://lpi.worldbank.org/export-delays>

The case study on MYC International Logistics gives first-hand insights on the experience of a freight forwarding business in navigating supply chain disruption over the past three years.

Case study: MYC International Logistics

MYC International Logistics is an Australian freight forwarding company with partnerships across the Asia-Pacific region, offering services in sea, road and air freight, as well as other areas such as customs clearance, wharf transport and warehousing.

FTI Consulting spoke to Raffaele Sellaro, Managing Director at MYC to get an executive’s insight to the industry and what the impacts of the recent supply chain disruptions have been.²⁰

Supply chain issues facing the logistics industry

Logistics companies, in particular, bore the brunt of international (and some intranational) borders being shut down from COVID-19, preventing people and products from entering or exiting economies. Logistics companies faced challenges around shipping delays, compliance and customs clearance and cash-flow constraints.

- When borders were shut down and everyone was forced to stay home to work, a lot of consumer demand shifted from services to goods. There were delays in ships docking and unloading on the coast of Australia by between two to three weeks, compared to pre-Covid when docking and unloading could take up to seven days at most. Taking three weeks to get a ship into the port and unloaded has financial impacts as well as knock-on delays along the relevant supply chains. In some cases, ships would wait offshore to dock or alternatively go to another port, leading to a loss of business for the freight forwarder. There was also

²⁰ MYC International Logistics, Website, accessed 31 March 2023, <https://www.myclogistics.com/>

uncertainty as to the exact time of docking and unloading, meaning that ship tracker systems were inaccurate, which frustrates clients of freight forwarders. MYC saw transshipments through Singapore being delayed by as long as three weeks, reporting that Singapore is overloaded as a transshipment hub.

- Quarantine and clearance requirements also took longer to complete since COVID-19 as border agencies were short staffed, and in some cases, shippers did not have the appropriate documentation completed.
- Cash-flow constraints are an aspect of the business still in recovery. With compliance and security checks taking longer, fewer ships are able to dock, and since invoices are only issued to end users once a ship is docked, there are delays in invoice distribution and billing. As shippers seek payment before a ship has docked, and end users will not make payment to the freight forwarder until goods are delivered, this means that freight forwarders face cash-flow problems. Since the pandemic, shippers also have a tendency to change contract terms ad hoc, seeking faster payment, and freight forwarders often have limited ability to switch shipping lines, particularly under tight deadlines. There has also been an increase in infrastructure charges and booking and security fees at local port terminals, with as many as seven individual charges now being levied compared to just two pre-pandemic. Given the nature of ports in an economy, freight forwarders are typically not in a position to negotiate with port operators on fees and charges.
- Despite the increase in volumes of merchandise trade since the pandemic, the protracted settlement time for invoices means that freight forwarders have needed more working capital.
- These struggles have seen slow processing at the terminal and information not being efficiently transferred, as well as a decrease in shipping lines and an estimated 20 percent cost increase (in the case of MYC). Many of the same issues at ports in Australia have been experienced with shipments destined for the South Pacific; Fiji; New Zealand; and the US.

Response to supply chain issues

One strategy employed by MYC was to start with their client's initial shipment forecast, assess any delays on shipping routes, then advise their clients to adjust their delivery forecasting and orders accordingly. Knowing that a shipment is going to be delayed might mean the client increases the size of their orders, places more frequent orders and keeps greater inventory on hand. If clients typically ordered one shipment per month, they doubled this to two shipments per month, particularly if shipping time is uncertain and potentially up to twice as long as pre-pandemic. This, however, increases holding costs for clients (e.g., warehouse space and security) but for great certainty around inventory, clients were happy to absorb these costs. MYC noted that their clients also sought greater visibility and understanding of shipping lines, leveraging platforms such as CargoWise to understand shipping bottlenecks.²¹ Speaking to clients, MYC said that they all increased prices down to their clients/consumers to factor in the delays and demands. Other companies, such as IKEA, simply

²¹ CargoWise, Website, accessed 31 March 2023, <https://www.cargowise.com/>

chartered their own vessels entirely, allowing for more freedom in shipping, as well as cargo security.²²

Suggestions for policy support

As a result of ongoing delays and process changes since the pandemic, companies have been forced to increase prices to clients/consumers. MYC considers that slow terminal processing and compliance testing is a major cause of delays, particularly toward the busy end-of-year period, and must be the first issue tackled. This can be done with refinement of security processes by government and customs agents, for example, through a trade certificate system, or through clearer documentation processes for greater throughput. Consumer price increases could also be avoided by giving more bargaining power to importers, rather than the shipping companies. Other jurisdictions have used similar systems and seen good results.

MYC noted that the market for shipping lines has become more concentrated, and that the Australian industry has a reduced number of shipping lines to negotiate with, compared to ten years ago. Where rerouting in the past was an option for freight forwarders in response to price changes, this is less of an option today. MYC considers that the shipping industry is likely to undergo continued consolidation in the future, with ports, shippers, freight forwarders, etc. all merging into one entity to achieve synergies and efficiencies.

MYC suggested that smoother quarantine and customs processes would assist in reducing shipping delays and bottlenecks, including more appropriate staffing of quarantine agents and planning for seasonal variations in shipping demand. A more streamlined process for customs clearance could be implemented at the borders, with more accurate planning of timelines; for example, if it is anticipated that document processing will take longer than usual, the industry should be informed in real time. Regular consultation and liaison between government agencies and shipping/freight forwarding industry bodies would also allow for more frequent exchange of critical information.

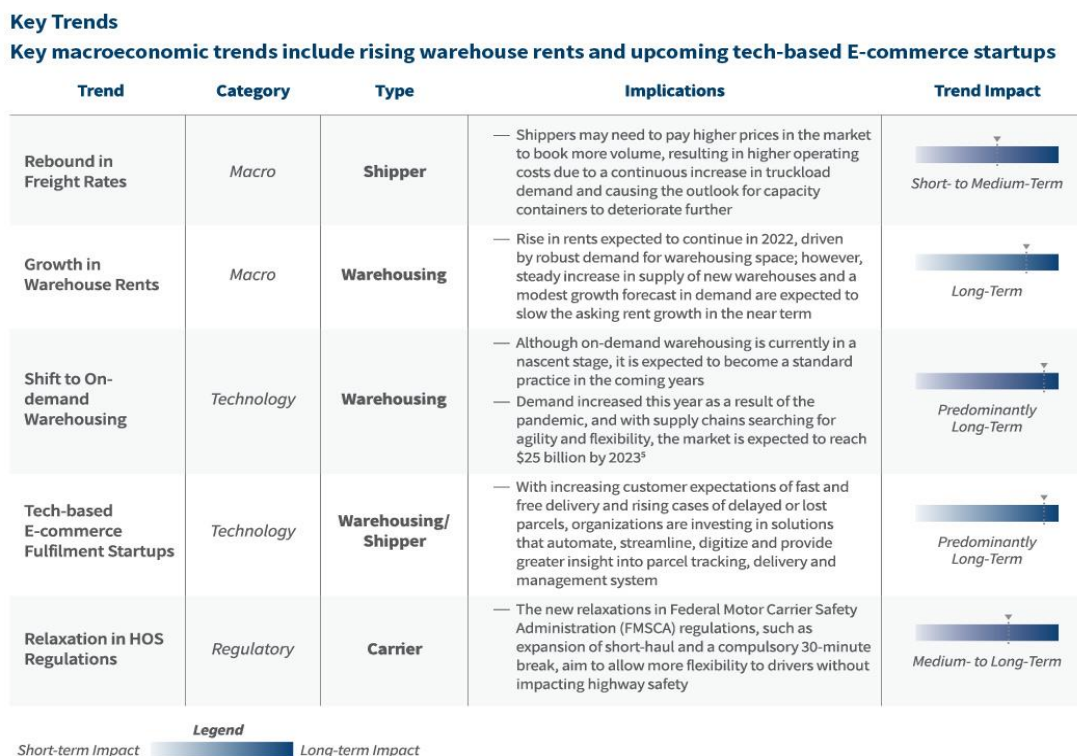
MYC also suggested fast-track importing facilities, for example, where there are preapproved shippers and agents that have shipments approved ahead of time based on their track record. In Australia, such an arrangement exists – the Trusted Trader Program – which seeks to expedite customs clearance.²³

Finally, MYC suggested a level of customs harmonisation and standardisation of regulations, as the written text, for example in packaging regulations, changes very frequently, incurring costs for freight forwarders.

²² The Maritime Executive, “Ikea Is Buying Containers and Chartering Vessels,” 2 September 2021, <https://maritime-executive.com/article/ikea-is-buying-containers-and-chartering-vessels>

²³ Australian Border Force, “Australian Trusted Trader,” updated 1 July 2021, <https://www.abf.gov.au/about-us/what-we-do/trustedtrader>

Figure 2.10. Key challenges in shipping and logistics



Source: FTI Consulting, “Transport and Logistics Industry – Year End Recap,” 8 April 2022, <https://www.fticonsulting.com/insights/articles/transportation-logistics-industry-year-end-recap>

FTI supply chain experts have mapped out some of the key challenges facing shipping and logistics going forward, as illustrated in Figure 2.10. These include, for example, growth in warehouse rents; with increased stockpiling and businesses starting to hold more inventory on hand, comes costs in storing inventory, driving up demand for warehouse space.

Many of the issues with shipping have spawned a debate on the merits of nearshoring and onshoring, i.e., bringing production closer to home. This is explored further in Chapter 4.

2.2.2 Insufficient diversification of supplier base

Respondents to the survey and stakeholder interviews noted a general lack of diversification in the supplier base. This involved a disproportionate reliance on key suppliers, both domestic and international. Once these suppliers were impacted by COVID-19 conditions and supply channels were disrupted, firms were left without delivery of key inputs and this straddled most sectors that we focused on. In some cases, declining financial health sent some key suppliers into insolvency, leaving firms upstream struggling to procure alternative suppliers.

For example, in the construction sector in Australia, scarcity of building materials caused substantial delays in planned construction projects. This was particularly evident from early 2021 until the second quarter of 2022. This was further compounded by strong demand in the residential and non-residential sectors of the construction market. These shortages have

resulted in some substantial price jumps. During 2022, structural timber and steel products experienced cost increases of over 40 percent, while other materials such as electrical conduits and plastic pipes increased by as much as 25 percent. Some contractors are now asking for ‘rise and fall’ provisions to be included in contracts and seeking extensions for completing jobs because of materials shortages.²⁴

Companies in the Australian construction sector that we spoke to have sought to revamp their supply chain to include multiple sources of supply for key raw materials, including scenario modelling to try to estimate the impacts of switching between suppliers in response to a supply chain disruption.

2.2.3 Inability of suppliers to respond to technological changes

Respondents to FTI’s global supply chain resilience survey pointed to the inability of suppliers to respond to technological changes. When probed in case study interviews with stakeholders, this related to shortfalls in digitisation. Previous research suggests that supply chains have a 43 percent level of digitisation, indicating that most businesses are missing out on the advantages of a digital supply chain.²⁵ Digitisation makes networks more transparent and autonomous, which can allow the supply chain to work as an ecosystem of connected nodes. One reason for the lack of digitisation to enhance supply chain performance is the technology growth gap. This gap occurs where supply chain processes are not married up with advances in technology such that processes are streamlined to their full potential.

Combining data, analytics, hardware and software, process improvement and skilled users, a digitalised supply chain can assist with:²⁶

- Linking and combining of cross functional data
- Uncovering the origins of performance problems by delving into ERP (enterprise-resource planning), warehouse management and advance planning
- More informed decision making and risk mitigation in real time
- Forecasting demand and performance with advanced analytics

2.3 SUMMARY OF KEY FINDINGS

This section has identified some of the key risks and vulnerabilities in supply chains, as indicated in FTI’s global supply chain resilience survey. Some of the highlights are as follows:

- The factor which disrupted supply chains the most was COVID-19 with 71 percent of respondents selecting it as a response. Other factors that respondents rated as a key

²⁴ FTI Consulting, “Supply Chain Disruption – The Risk to Global Economic Recovery” (FTI Consulting, 2022), <https://www.fticonsulting.com/-/media/files/apac-files/insights/articles/2022/aug/supply-chain-disruption-risk-global-economic-recovery.pdf?hash=682E300CF6AF6C3122&rev=290eda9a2ebb4195a48b2c43eb8a60cb>

²⁵ E. Gezgin et al., “Digital Transformation: Raising Supply-chain Performance to New Levels,” McKinsey & Company, 17 November 2017, <https://www.mckinsey.com/capabilities/operations/our-insights/digital-transformation-raising-supply-chain-performance-to-new-levels>

²⁶ Gezgin et al., “Digital Transformation.”

disruptor to their supply chains were rising freight rates (56.7 percent), economic slowdown (47.5 percent) and natural disasters (41.4 percent).

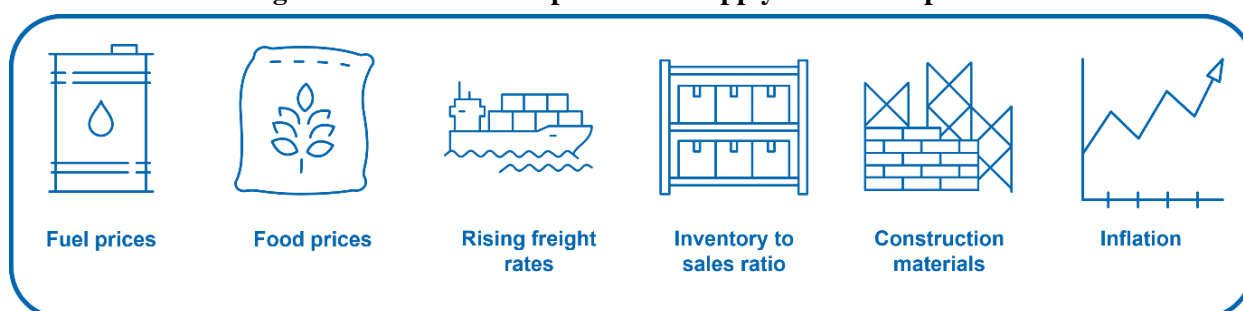
- Higher shares of respondents in the consumer goods/retail sector (compared to other sectors) highlighted rising freight costs (61 percent) and economic slowdown (60 percent) as key disruptors to their supply chain. Respondents in the resource transformation/manufacturing sector listed COVID-19, rising freight costs, and economic slowdown as the top three factors. In addition, a higher share of respondents in manufacturing reported impact from diverging standards and regulations compared to other sectors.
- COVID-19 remains the overwhelmingly biggest disruptor across all groups of firms, although the pandemic seems to have hit large- and medium-sized organisations disproportionately harder. Rising freight costs – the second biggest disruptor for all groups of firms – reportedly affected small firms more than other groups, with 64 percent of respondents from small firms quoting rising freight costs as a disrupting factor. Responses from the survey also suggested that large firms seem to be less disrupted by rising freight costs compared with small firms.
- Most risks were flagged as a medium risk for the majority of respondents. Supplier operational issues, supply-related political risks, supplier financial health, and insufficient diversification of supplier base for critical supplies were ranked as the highest risks by the respondents. A weighted average of the ‘risks to supply chain’ data shows supplier operational issues ranked as the biggest risk to supply chains.

3 COSTS AND IMPACTS OF SUPPLY CHAIN VULNERABILITIES

Vulnerabilities in global supply chains can have resounding impacts on both the firms involved and the wider economy. The past three years have seen firms face significant losses in revenue and increased costs of production. This can be seen in the feedback obtained by various surveys, including FTI's, carried out among businesses. One survey indicated that the average revenue loss due to supply chain disruption was USD 182 million (or 1.74 percent of their annual revenue) per organisation.²⁷ Another survey suggests that supply chain disruptions cost the average organisation about 45 percent of one year's profits over a decade.²⁸ Most respondents to FTI's global supply chain resilience survey indicated that supply chain disruption cost them up to 20 percent of their annual revenue.

At the wider economy level, we have seen shortages of key goods, price inflation, factory closures and surging freight rates. This section explores some of the impacts of recent supply chain disruption in terms of firm-level costs and wider macroeconomic effects, as illustrated in Figure 3.1.

Figure 3.1. Identified impacts from supply chain disruption



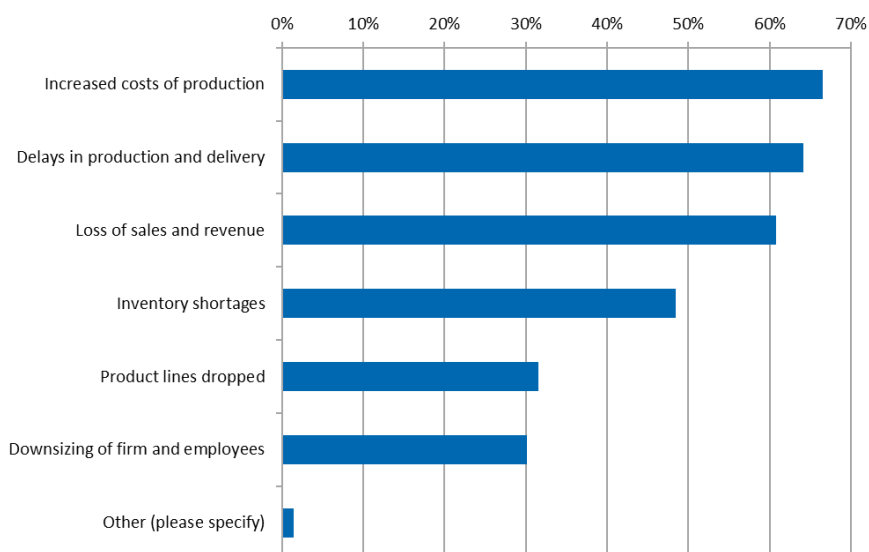
3.1 INSIGHTS FROM FTI'S GLOBAL SUPPLY CHAIN RESILIENCE SURVEY

Respondents to FTI's global supply chain resilience survey indicated that the key impacts of the supply chain disruption (Figure 3.2) were increased costs of production, delays in production and delivery, loss of sales and revenue, and inventory shortages.

²⁷ Interos, "Resilience 2022: The Interos Annual Global Supply Chain Report" (Interos, 2022), https://www.interos.ai/wp-content/uploads/2022/05/Resilience-2022_Interos_Annual-Global-Supply-Chain-Report_5_11_2022.pdf

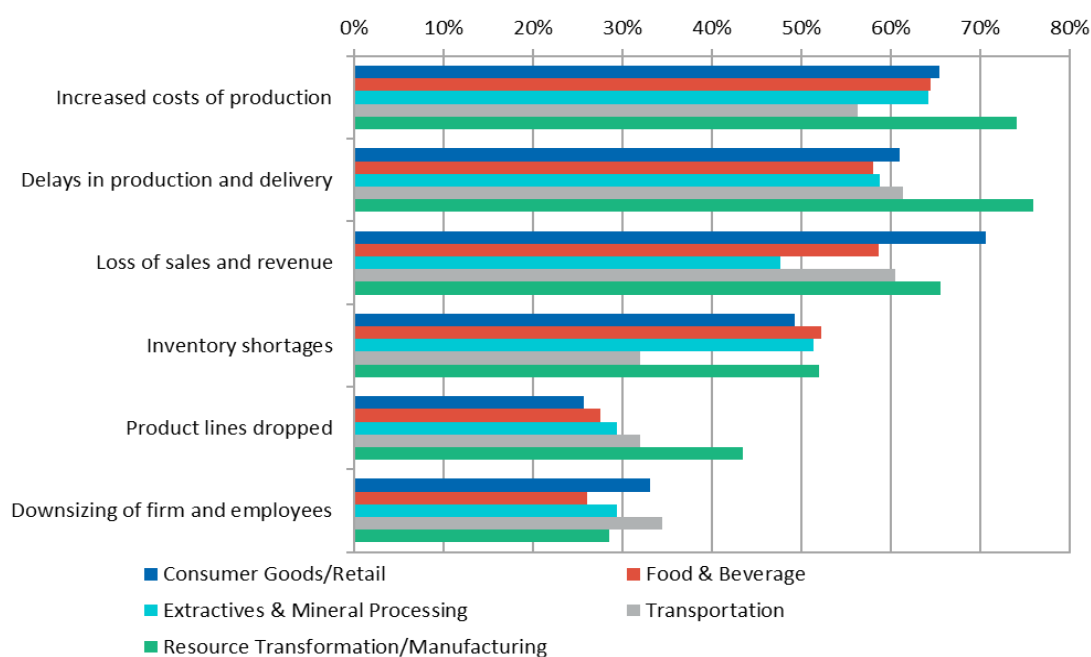
²⁸ K. Aliche and D. Luchtenberg, "Supply-chain Resilience: Is There a Holy Grail?" McKinsey & Company, 8 December 2021, <https://www.mckinsey.com/business-functions/operations/our-insights/supply-chain-resilience-is-there-a-holy-grail>

Figure 3.2. Impacts of supply chain disruption (% of respondents)



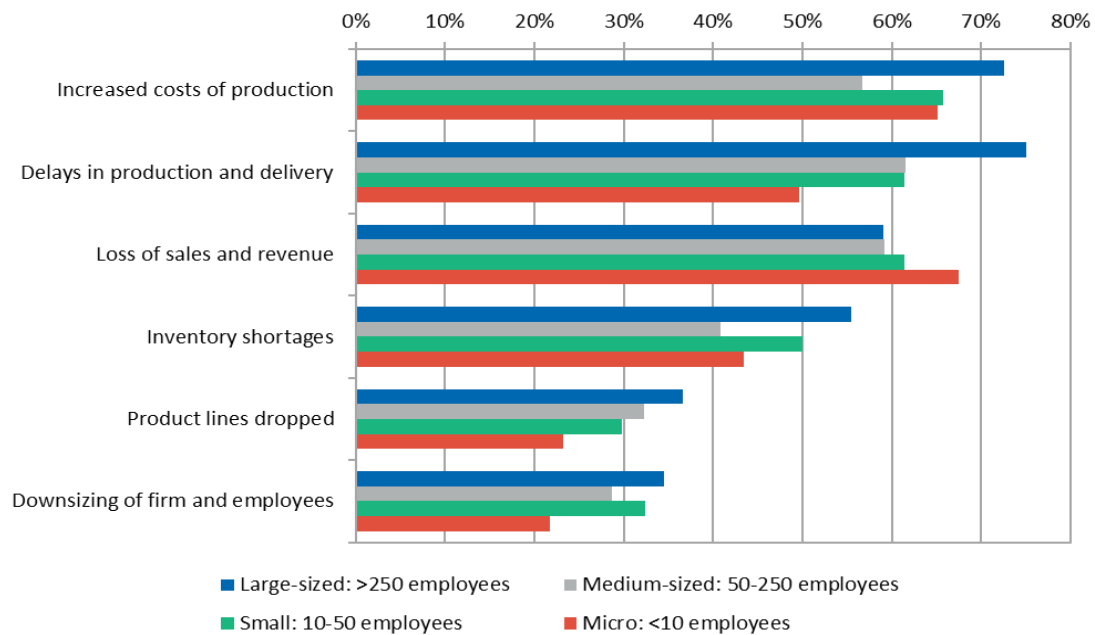
The sectoral distribution of impacts is plotted in Figure 3.3. Higher shares of respondents in resource transformation (manufacturing) identified delays in production and delivery (76 percent) and increased costs of production (74 percent) as the two key impacts, while a lower share of respondents from the transportation sector (32 percent) reported inventory shortages as an impact. The consumer goods sector reported losses of sales and revenue more than any other sector (71 percent), while downsizing was witnessed relatively more in transportation and consumer goods/retail than in other sectors. Scale-down of product lines was mentioned by 44 percent of respondents in manufacturing, significantly higher than other sectors.

Figure 3.3. Impacts of supply chain disruption – sectoral distribution



The breakdown by size of responding firms is given in Figure 3.4. Large-sized enterprises struggled the most with delays in production and delivery (reported by 75 percent respondents from large firms) and increased costs of production (73 percent), while micro-sized enterprises struggled the most with loss of sales and revenue (67 percent). Relative to other smaller firms, large firms suffered the most from inventory shortages. Figure 3.4 also suggests that the impact of product lines scale-down is proportional to the size of responding firms, with bigger firms seeing more product lines dropped.

Figure 3.4. Impacts of supply chain disruption – breakdown by size of organisation

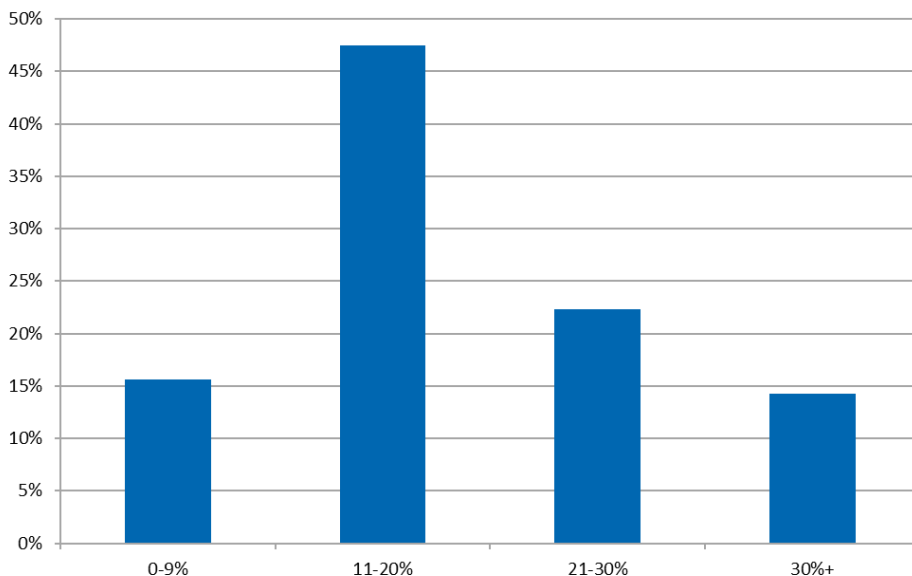


Other impacts identified in the commentary to this question included:

- Inability to quote far into the future on projects due to delays and rising/uncertain costs
- Reduction in research and development (R&D)
- Increase in merger and acquisitions (M&A) activity
- Rise in litigation and regulatory action

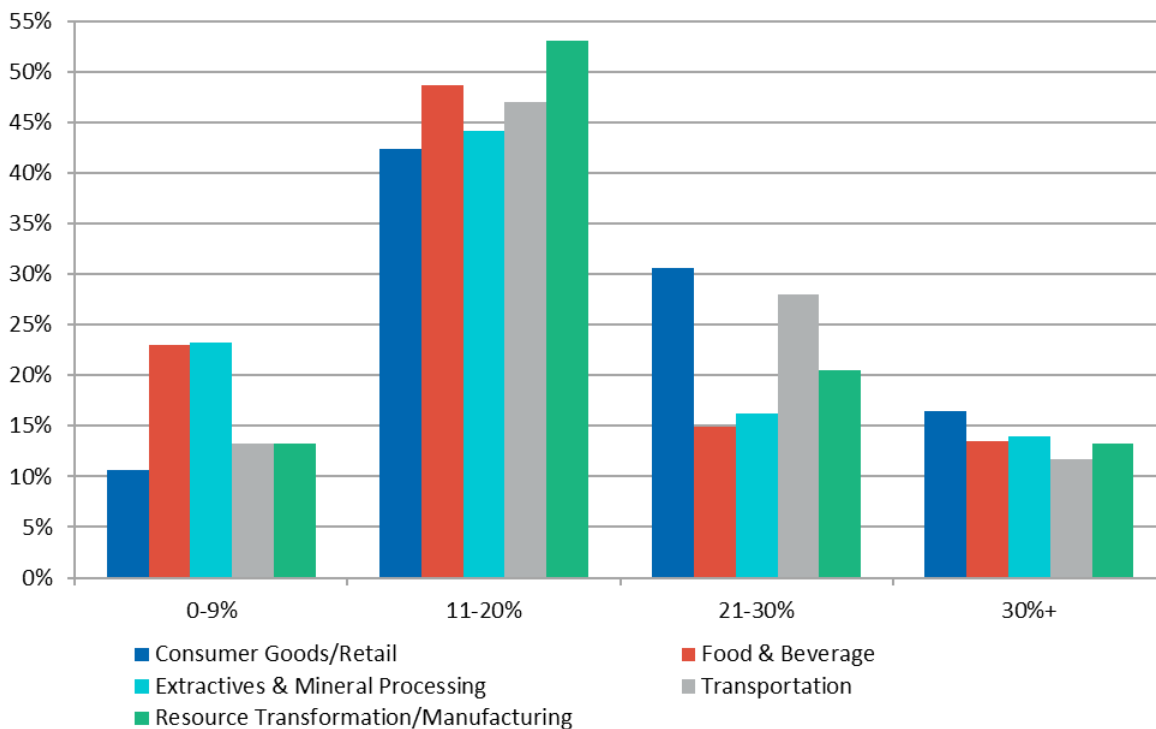
For those respondents that indicated a loss of sales and revenue (more than half of the sample), most reported losses of between 11 and 20 percent (Figure 3.5).

Figure 3.5. Percentage loss of sales and revenue due to supply chain disruption



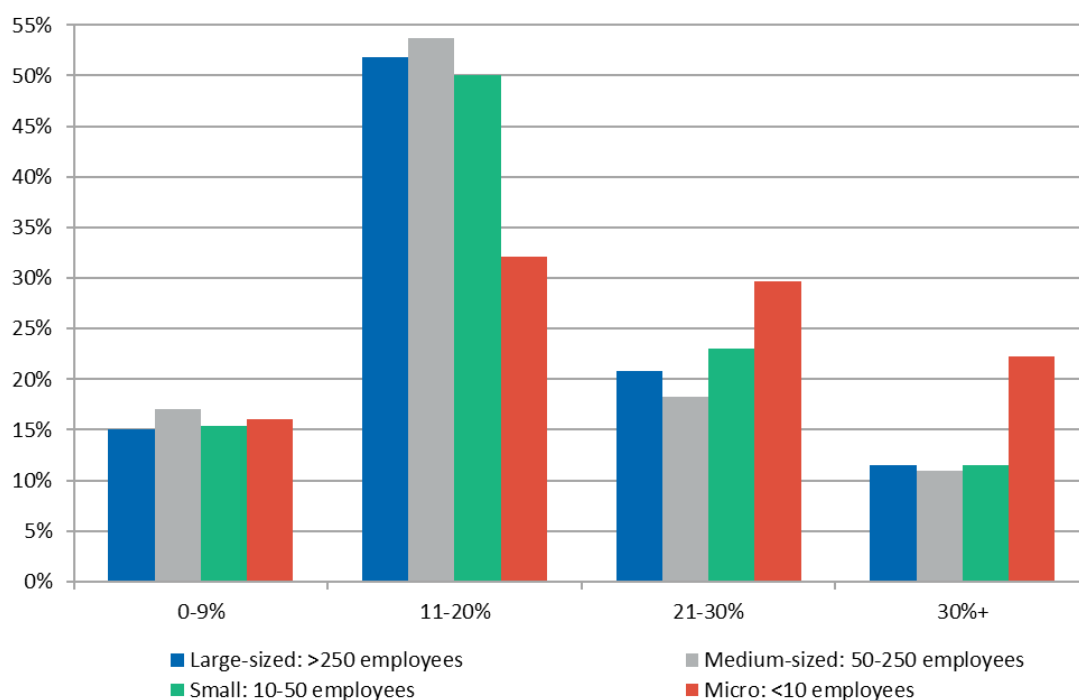
The sectoral breakdown of percentage loss of sales and revenue due to supply chain disruption is plotted in Figure 3.6. While the majority of firms across all surveyed sectors suffered losses of between 11 and 20 percent, 31 percent of firms in the consumer goods/retail sector and 28 percent of those in transportation (including airlines) experienced losses of 21 to 30 percent, which is a substantial decline.

Figure 3.6. Percentage loss of sales and revenue – sectoral breakdown



When we looked at losses by size of firms (Figure 3.7), while the findings mirror the overall results for the pooled sample, a larger share of micro-sized firms indicated losses of 21 percent and above (in contrast to large, medium and small firms). Recent supply chain disruption over the course of the COVID-19 pandemic saw many firms, particularly non-franchise businesses, cease operations and this trend is captured in the survey in terms of micro firms suffering the biggest losses.

Figure 3.7. Percentage loss of sales and revenue – breakdown by size of firm



Overall, respondents to FTI's global supply chain resilience survey suggested that some of the impacts from the fallout in global supply chains in recent years included:

- Increased costs of production
- Delays in production and delivery
- Loss of sales and revenue – approximately 11–20 percent across the sample
- Inventory shortages

Stakeholder comments on costs and impacts of supply chain vulnerabilities

In interviews with stakeholders and supply chain experts, several highlighted the impact of supply chain disruption on a company's brand and reputation. This can have more long-term impacts in competitive markets if the company loses recognition with its customer base. A similar survey in 2021 reported that firms were as likely to report damage to brand reputation as a consequence of supply chain disruption as they were to report increased costs of operations; larger firms (those with revenues in excess of USD 1 billion) were more likely to

report this outcome, with healthcare and pharmaceutical firms suffering the most damage to image and experiencing high customer complaints.²⁹

Respondents to the survey also highlighted geopolitical events as a disruptor to supply chains (see Figure 2.2) and in discussions with supply chain professionals, many referenced the impact of economic sanctions stemming from geopolitical conflicts on their supply chain. Some stakeholders stated that geopolitical conflicts and sanctions were their biggest concern over the next five years along with the uncertainty that this poses for building and maintaining a supply chain.

Economic sanctions take various forms, such as import and export bans and restrictions, increased import tariffs, blocking of the payments, bans on the use of foreign seaports, restrictions for freight and road transport as well as insurance and legal services, asset freeze, travel bans, etc. Trade restrictions on exports and imports cover goods (including components and equipment), services (including logistics and payments), capital and technologies.

Stakeholders were of the view that ongoing geopolitical conflicts were the second major shock to their supply chain since 2020 and this was a further awakening to structural deficiencies in their chain.

Finally, stakeholders mentioned the rise in litigation from supply chain disruption. Many firms have faced disputes over late deliveries and the spillover effect of delays on other companies. For example, if there is an issue with a specific part that is used in an engine component, the problem could reverberate through multiple tiers of the supply chain, eventually even reaching the original equipment manufacturer (OEM). As delays and cost implications work their way through the supply chain, the question of how to allocate losses between suppliers can arise, laying the ground for a dispute.

3.2 MACROECONOMIC IMPACTS OF SUPPLY CHAIN DISRUPTION

3.2.1 Impact on global trade volumes

When COVID-19 struck, the combination of supply and demand shocks was anticipated to cause a substantial decline in international trade. However, lockdowns would see a rise in demand for traded goods and a significant drop in demand for services (including international travel). Comparing the final quarter of 2019 to the second quarter of 2020, the volume of global commerce in goods declined by 12.2 percent and trade in services fell even more drastically, by 21.4 percent.³⁰ In early 2022, trade in services remained weak, primarily due to the declines in travel from the lockdowns.

²⁹ The Economist Intelligence Unit (EIU), “*The Business Costs of Supply Chain Disruption*” (GEP and EIU, 2021), https://impact.economist.com/perspectives/sites/default/files/the_business_costs_of_supply_chain_disruption_gep_1.pdf

³⁰ International Monetary Fund (IMF), “Global Trade and Value Chains during the Pandemic,” in *World Economic Outlook: War Sets Back the Global Recovery* (Washington, DC: IMF, April 2022), Ch. 4, <https://www.imf.org/-/media/Files/Publications/WEO/2022/April/English/ch4.ashx>

The intensity of the pandemic and the degree of governmental reactions to it are crucial to understanding the disparities between expected and actual import growth over the past three years. In the 2022 World Economic Outlook, the International Monetary Fund (IMF) reported that economies whose pandemic experience was more severe (more COVID-19 cases, more stringent containment measures, or less mobility) exhibited excess import demand for goods; that is, the fall in goods imports caused by the pandemic was less than predicted by the model.³¹

Figure 3.8. Imports and exports of merchandise goods in the APEC economies



Source: World Trade Organization, Time Series on International Trade, accessed 31 March 2023, <https://timeseries.wto.org/>

Figure 3.8 depicts the change in merchandise exports of APEC economies from 2000. It shows the sharp rise in merchandise exports coming into 2010 and 2021. Both follow the same pattern of the economy rebounding in terms of exports after the significant initial economic shocks of the global financial crisis in 2009 and the COVID-19 pandemic.

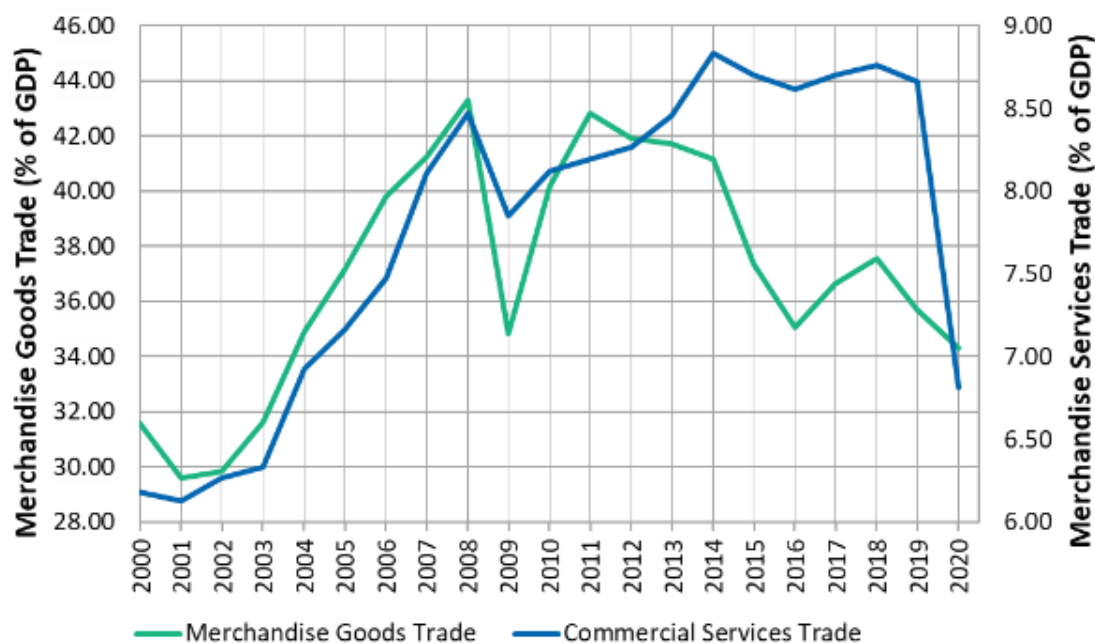
Figure 3.9 presents the trade in merchandise goods and commercial services in the APEC region. It is evident from the data that trade in APEC declined significantly following the COVID-19 pandemic, in particular services trade. This mirrors the decline in global trade, which dropped 8.9 percent in 2020 – the steepest drop since the global financial crisis in 2009.³² Nonetheless, it dropped less than the global financial crisis as although services represent most of the economic activity in the advanced economies, services only account for a quarter of

³¹ IMF, “Global Trade and Value Chains during the Pandemic.”

³² R. Dickinson and G. Zemaityte, “How Has the COVID-19 Pandemic Affected Global Trade?” World Economic Forum, 8 August 2021, <https://www.weforum.org/agenda/2021/08/covid19-pandemic-trade-services-goods/>

global trade.³³ Despite Asia’s trade recovering in the second half of 2020, primarily due to the recovery of China’s trade, other economies including low-income economies were heavily affected. The Asian economies that were hit particularly hard by the supply chain disruptions were those exporting oil and gas, as prices decreased and demand for hydrocarbons took a dive.³⁴

Figure 3.9. Merchandise goods and commercial services trade in the APEC economies



Source: World Trade Organization, Time Series on International Trade, accessed 31 March 2023, <https://timeseries.wto.org/>

3.2.2 Impact on shipping prices

Figure 3.10 plots freight indices worldwide. A sharp increase in containerised freight rates was observed from June 2020 to December 2020, after which the rates generally increased until the end of 2021. The increase in rates was observed in all major shipping routes, with the Drewry Hong Kong–Los Angeles container price index (USD per 40-foot box) up 472 percent from April 2020 to December 2021, and the Shanghai export Containerised Freight Index up 492 percent over the same period. The cost of shipping a 40-foot container from China to the US west coast peaked at USD 20,600 in September 2021, rising 1,400 percent over its cost in February 2020.³⁵ From 17 August 2021, Hapag-Lloyd announced a major rise in fees on containers shipped from Australia to Europe. The price of a 40-foot container shipped from Australia to London rose a staggering 52 percent in mid-August 2021 – USD 2,350 up from

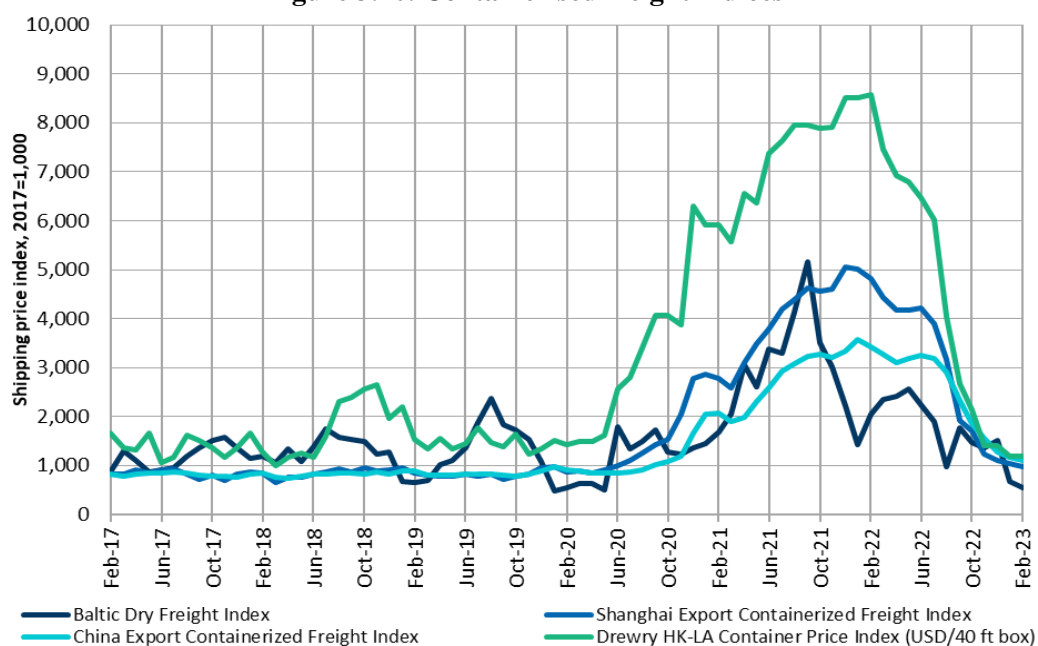
³³ Bank of England, “How Has Covid Affected Global Trade?” 23 July 2021, <https://www.bankofengland.co.uk/bank-overground/2021/how-has-covid-affected-global-trade>

³⁴ Asian Development Bank (ADB), “ADB Data Show the Extent of COVID-19 Trade Disruption in Developing Asia,” 13 August 2021, <https://www.adb.org/news/features/adb-data-show-extent-covid-19-trade-disruption-developing-asia>

³⁵ The Economist, “Global Shipping Costs Are Returning to Pre-Pandemic Levels.”

US\$1,550.³⁶ In order to maintain service levels, the Mediterranean Shipping Company (MSC) raised rates by USD 1,000 for every refrigerated 20-foot equivalent unit (TEU) entering Australia from the US in September 2021. Maersk also reportedly implemented peak season surcharges, ranging from USD 750 to USD 1,500, on all cargo from Asia to Australia.³⁷ The rates began to stagnate heading into the third quarter of 2022, yet many of the indices, particularly the Drewry container price index and the Shanghai Containerised Freight Index, remained at an all-time high. Spot rates have since declined to levels similar to those seen before the COVID-19 pandemic. In the week beginning 13 February 2023, the Drewry World Container Index declined to the lowest point since July 2020 while the Shanghai Containerised Freight Index declined to the lowest point since June 2020.³⁸

Figure 3.10. Containerised freight indices



Note: Data was extracted on 17 February 2023.
 Source: Bloomberg, 2023.

³⁶ J. Wiggins, “‘Unprecedented Times’ for Ocean Freight as Fees Soar,” 2021, *Australian Financial Review*, 9 August 2021, <https://www.afr.com/companies/transport/unprecedented-times-for-ocean-freight-as-fees-soar-20210806-p58glf>

³⁷ Wiggins, “‘Unprecedented Times’ for Ocean Freight.”

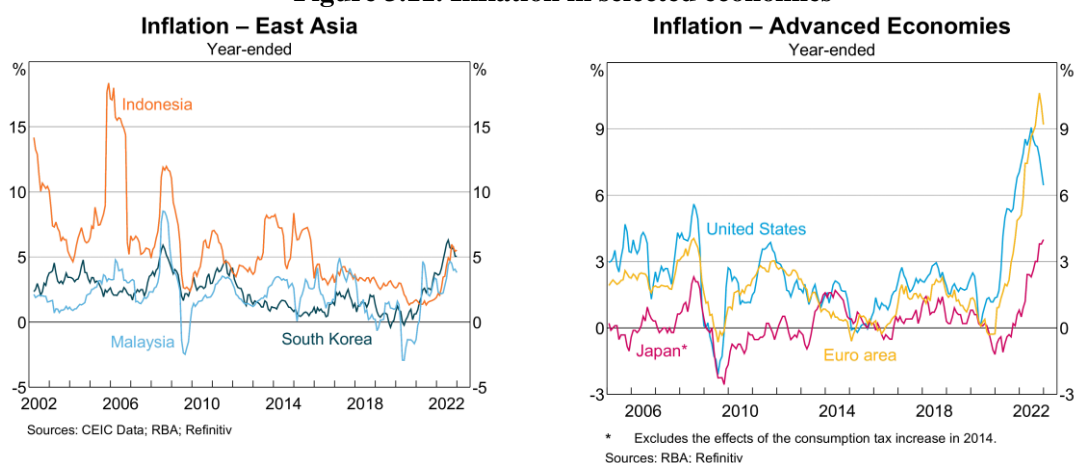
³⁸ L. Jensen, LinkedIn post, February 2023, https://www.linkedin.com/posts/larsjensenvespuccimaritime_spot-rates-continue-to-decline-yesterday-activity-7029773551016538114-w-Ig/?utm_source=share&utm_medium=member_desktop

3.2.3 Impact on prices

Global consumer price inflation lifted in 2021 and then surged in 2022. The surge pushed inflation to multi-decade highs in developed economies. While still substantial, the upturn in inflation has been less dramatic in East Asia.

High inflation in 2021 and 2022 surprised many macroeconomic forecasters, including the IMF.³⁹ The IMF views that the uplift in 2021 was probably due to the combination of excess demand, stemming from fiscal policy stimulus measures in many advanced economies, coinciding with strained supply chains and tight labour markets. The steep surge in inflation in 2022 hints at an increased role for supply shocks, related to clogged supply chains and geopolitical tensions.

Figure 3.11. Inflation in selected economies



Source: Reserve Bank of Australia, “Chart Park: World Economy,” accessed 31 March 2023, <https://www.rba.gov.au/chart-pack/world-economy.html>

There are some indications that inflation has now come down from peaks reached in late 2022, especially in some of the largest economies in Asia: China; India; Indonesia; Korea; and Chinese Taipei.⁴⁰ Despite the recent declines, inflation persists at elevated levels in many economies. Further supply disruptions and price shocks remain a possibility.⁴¹ Continued management of the risks from supply-side shocks remains a vital concern for businesses and policymakers.

³⁹ IMF, *World Economic Outlook: Countering the Cost-of-living Crisis* (Washington, DC: IMF, October 2022), <https://www.imf.org/en/Publications/WEO/Issues/2022/10/11/world-economic-outlook-october-2022>

⁴⁰ ADB, “*Asian Development Outlook (ADO) 2022 Supplement: Global Gloom Dims Asian Prospects*” (Manila: ADB, December 2022), <https://www.adb.org/publications/ado-supplement-december-2022>

⁴¹ ADB, “ADO 2022 Supplement.”

3.2.4 Supply chains and global economic growth

Disrupted supply chains put a drag on global trade and industrial production.⁴² Given the important role played by trade and industrial production, these impacts have reduced growth in global GDP. The IMF estimates that shipping and other supply chain problems shaved off 0.5–1.0 percentage points from potential GDP growth in 2021.⁴³

To prevent the recent upsurge in inflation from becoming entrenched, central banks have rapidly lifted policy rates. Countering the widespread cost-of-living crisis is expected to suppress demand and growth this year.⁴⁴ In its update of the World Economic Outlook in January 2023 the IMF projects that global growth will fall from 3.4 percent in 2022 to 2.9 percent in 2023. This could be viewed as the cost of curbing inflation pressures, some of which can be attributed to the impact of supply chain disruptions. Notably, the IMF identifies that sustained disruption and the unpredictable outcome of conflict are key risks in the current world economic outlook.⁴⁵ Raising resiliency in global supply chains is viewed as a one of the key tasks of economic managers to return the global economy to growth with price stability.

3.3 SUMMARY OF KEY FINDINGS

This section has identified costs and impacts of supply chain vulnerabilities, as indicated in FTI's global supply chain resilience survey and background research. Some of the key highlights are as follows:

- The biggest impacts of supply chain disruptions according to the survey respondents were increased costs of production (66.5 percent), delays in production and delivery (64.2 percent) and loss of sales and revenue (60.8 percent).
- Higher shares of respondents in resource transformation (manufacturing) identified delays in production and delivery (76 percent) and increased costs of production (74 percent) as the two key impacts, while lower shares of respondents from the transportation sector (32 percent) reported inventory shortages as an impact. The consumer goods sector reported losses of sales and revenue more than any other sector (71 percent), while downsizing was witnessed relatively more in transportation and consumer goods/retail than in other sectors. Scale-down of product lines was mentioned by 44 percent of respondents in manufacturing, significantly much higher than other sectors.
- Large-sized enterprises struggled the most with delays in production and delivery (reported by 75 percent respondents from large firms) and increased costs of production (73 percent), while micro-sized enterprises struggled the most with loss of sales and

⁴² M.G. Attinas et al., "Supply Chain Disruptions and the Effects on the Global Economy", *ECB Economic Bulletin* no. 8 (2021), https://www.ecb.europa.eu/pub/economic-bulletin/focus/2022/html/ecb.ebbox202108_01~e8ceebe51f.en.html

⁴³ IMF "World Economic Outlook Update: Rising Caseloads, a Disrupted Recovery, and Higher Inflation" (Washington, DC: IMF, January 2022).

⁴⁴ IMF, "World Economic Outlook: Countering the Cost-of-Living Crisis."

⁴⁵ IMF, "World Economic Outlook Update: Inflation Peaking amid Low Growth" (Washington, DC: IMF, January 2023).

revenue (67 percent). Relative to other smaller firms, large firms suffered the most from inventory shortages. The impact of product lines scale-down is proportional to the size of responding firms, with bigger firms seeing more product lines dropped.

- Of those that indicated a loss of sales and revenue, 47.5 percent of respondents reported an 11 to 20 percent loss of sales and revenue due to supply chain disruption. A larger share of micro-sized firms indicated losses of 21 percent and above in contrast to large, medium and small firms.
- Disruption in global supply chains contributed to swings in global trade volumes and prices which have fed a surge in global consumer price inflation, forcing many central banks to tighten monetary policy, reducing growth in global GDP.

4 SUPPLY CHAIN STRATEGIES ADOPTED BY BUSINESSES IN PURSUIT OF RESILIENCE

Most businesses that we spoke to indicated that their broad response to the disruption from COVID-19 involved three phases:

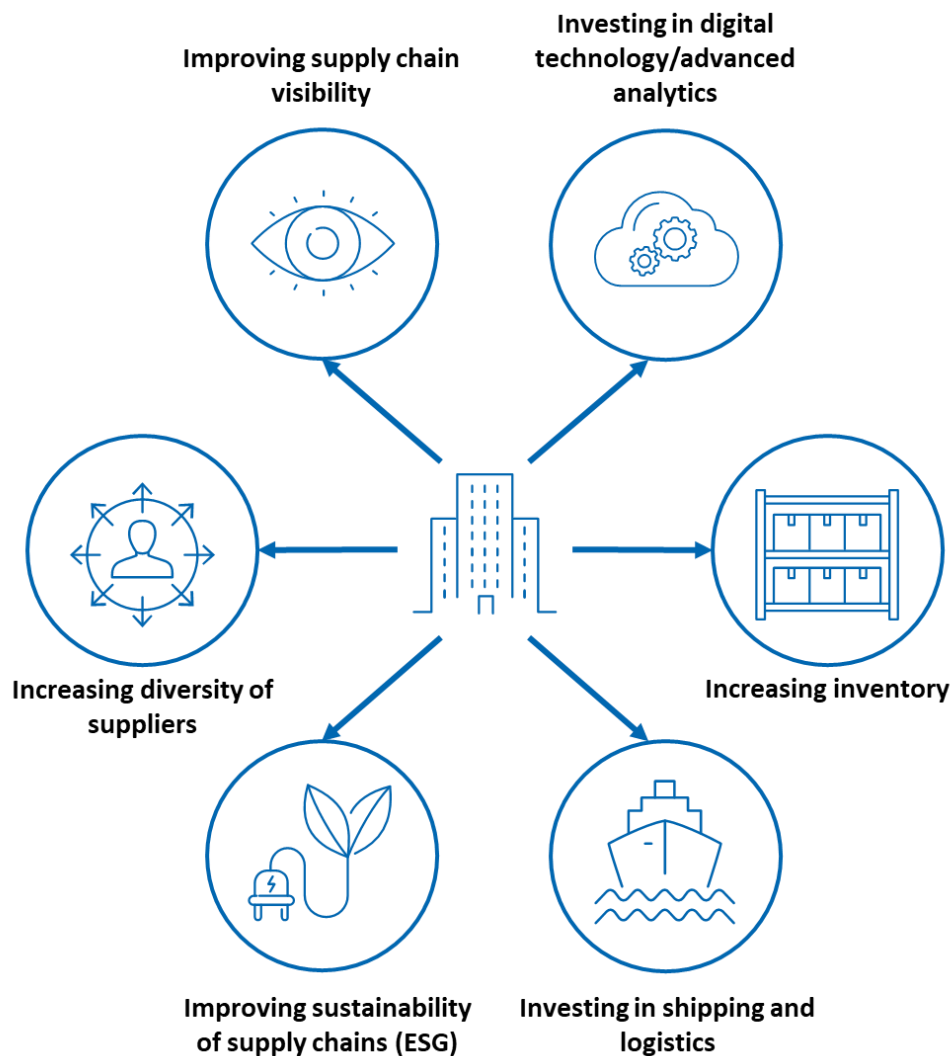
- An initial knee-jerk reaction to supply chain breakdown that involved building buffers into their supply chain in the form of inventory stockpiling, obtaining extensions from customers and other stakeholders, and negotiating flexibility into contracts. However, these reactionary initiatives did not resolve the issue or address vulnerabilities in the supply chain.
- The second phase involved looking at innovative solutions to shipping issues such as sourcing space on containers or other transport modes not subject to constrictions. With shipping costs up four to five times what they were pre-pandemic, firms were price takers with no countervailing buyer power. Firms also started to look at procuring more reliable suppliers. In this phase, firms began to understand the complexities of their supply chain and how a lack of visibility posed such a threat to it. Firms started to think about digitisation, scenario planning, the need for real-time data and how to achieve visibility.
- The third phase involved more medium- to long-term thinking about supply chains in terms of more thorough risk assessment of the supply chain, mitigation strategies and considerations around nearshoring and onshoring. Other considerations included sustainability of supply chains and compliance with evolving regulations.

It is almost universal that most businesses intend to reconsider their supply chain strategy in light of events since 2020, whether it be a wholesale redesign or some small tweaks to reduce risk. While this may involve considerable upfront investment in the short term, over the medium to long term, a more resilient supply chain should be able to withstand external shocks that cause costly disruption. Recent research suggests that companies can now expect supply chain disruptions lasting a month or longer to occur every 3.7 years.⁴⁶

This section outlines some of the long-term strategies intended to be adopted by firms in pursuit of supply chain resilience, as highlighted in Figure 4.1. We draw on survey insights from FTI's global supply chain resilience survey as well as interviews with supply chain professionals. This section also incorporates findings from relevant studies.

⁴⁶ S. Lund et al., "Risk, Resilience, and Rebalancing in Global Value Chains," McKinsey & Company, 6 August 2020, <https://www.mckinsey.com/business-functions/operations/our-insights/risk-resilience-and-rebalancing-in-global-value-chains>

Figure 4.1. Supply chain strategies in pursuit of resilience



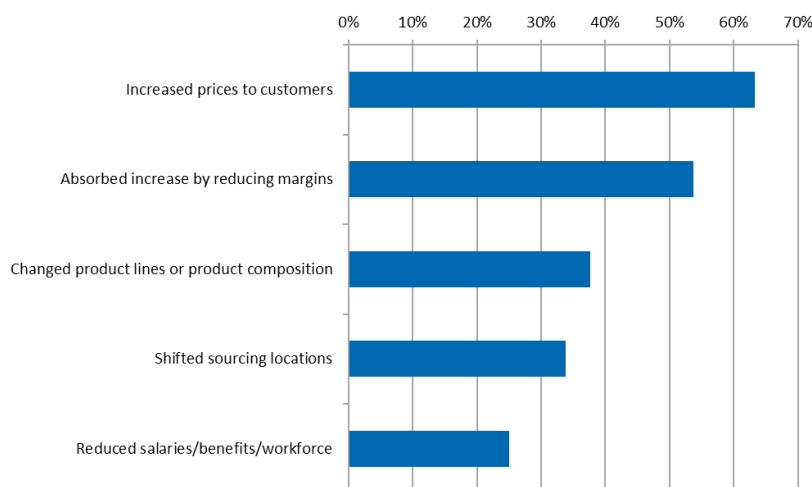
ESG=environmental, social and governance

4.1 INSIGHTS FROM FTI’S GLOBAL SUPPLY CHAIN RESILIENCE SURVEY

4.1.1 Initial response to supply chain disruption

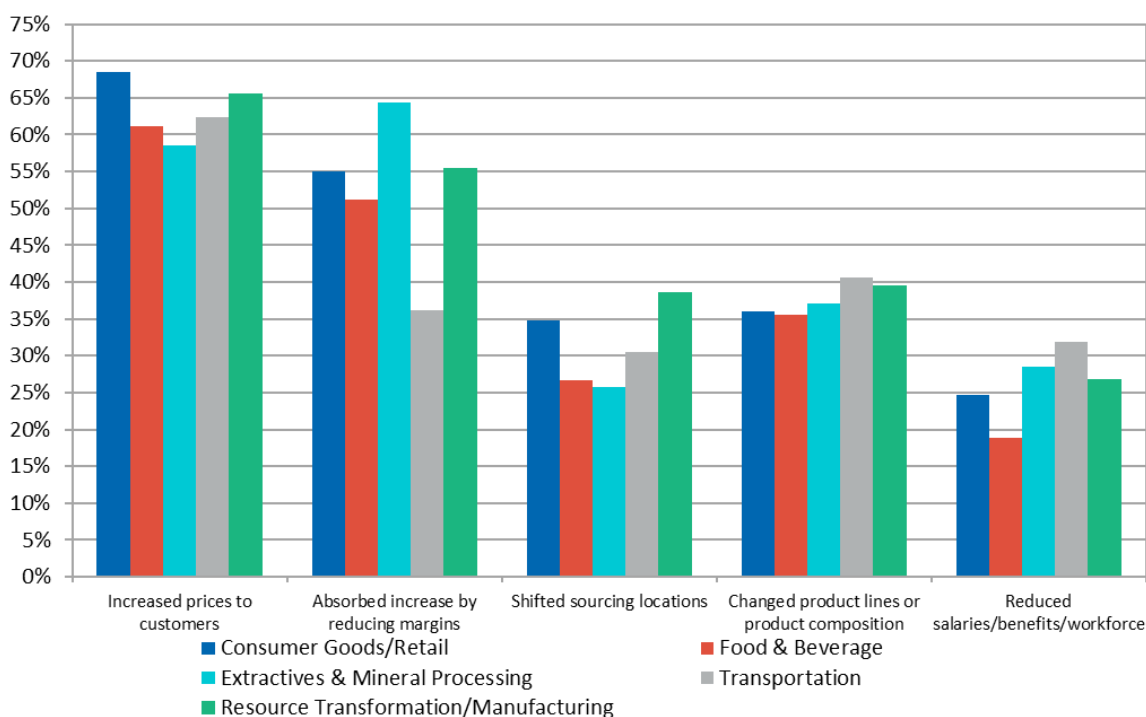
Figure 4.2 illustrates respondents’ main responses to increased costs of production. Increasing prices to consumers was identified by 63.3 percent of respondents. More than half of the surveyed businesses (53.8 percent) shared that they absorbed the increased costs by reducing margins. Lower numbers of firms indicated that their response was to shift sourcing locations, which might suggest that there were challenges in finding alternative sources of supply. Only one fourth of respondents mentioned that they reduced salaries and the size of their workforce, and this is consistent with what we observed during the pandemic, where there were some layoffs initially, but this was confined to certain sectors such as hospitality and travel.

Figure 4.2. Response to increased costs of production



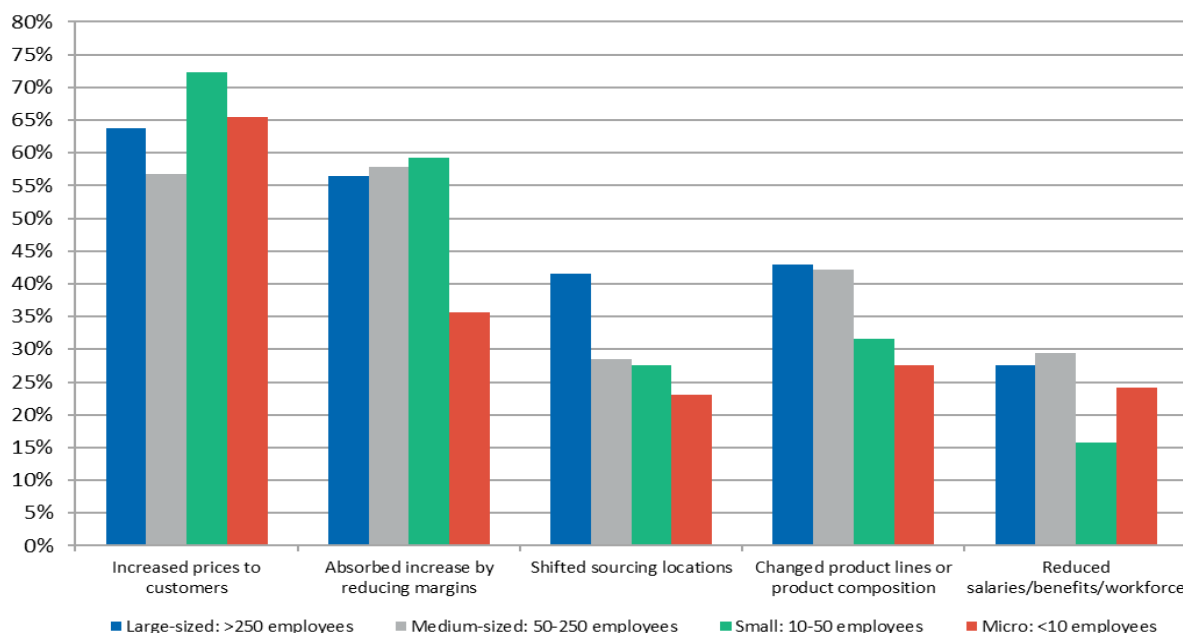
At the sectoral level (Figure 4.3), passing on higher costs to consumers through increased prices is the most chosen response across all sectors, except extractives and mineral processing. Sixty-four percent of surveyed firms in extractives and mineral processing coped with increased production costs by reducing their margins, whereas the transportation sector recorded just 36 percent of firms absorbing the elevated costs by cutting down on profits – the lowest across all sectors. Although a less common response, shifting sourcing locations is relatively more widely implemented by firms in manufacturing (39 percent) and consumer goods/retail (35 percent) than other sectors. Reducing workforce, salaries and/or benefits is the least implemented action in most sectors, particularly in food and beverage where less than one fifth of firms scaled down their human resources.

Figure 4.3. Response to increased costs of production – sectoral breakdown



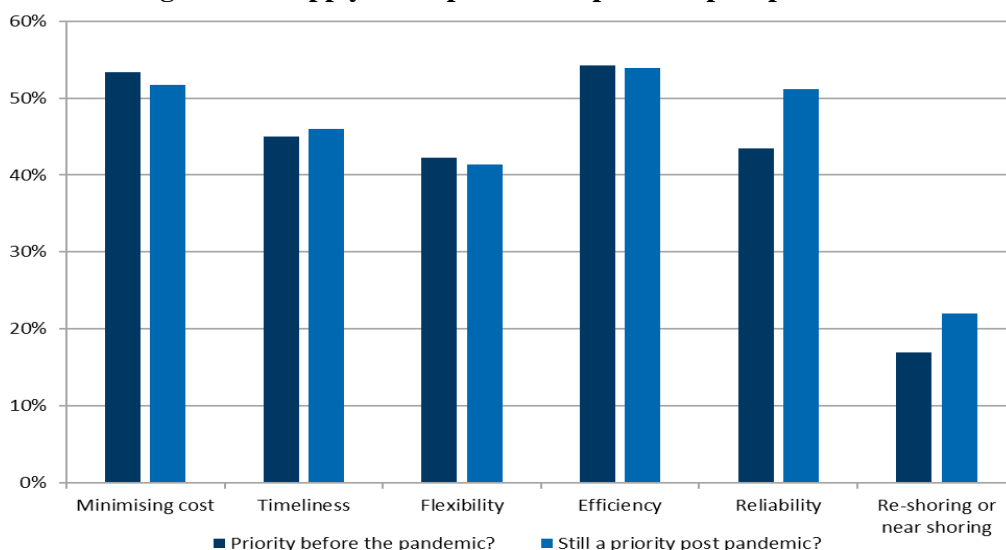
When we looked at survey responses to increased costs of production by size of the firm (Figure 4.4), small- and micro-sized firms tended to pass costs on to consumers more than other groups. While nearly 60 percent of most groups of surveyed businesses absorbed increased production costs by reducing margins, only one third of micro-sized firms did so. Shifting sourcing locations and changing product composition were implemented more by larger businesses, with more than 40 percent of large firms changing sourcing locations and/or product lines.

Figure 4.4. Response to increased costs of production – breakdown by size of firm



We asked firms how their supply chain priorities evolved (Figure 4.5) since the pandemic in terms of factors such as minimising cost, timeliness and reliability. While minimising cost and enhancing efficiency remained the top two priorities both pre- and post-pandemic, reliability of the supply chain was given significantly higher weightage post-pandemic, as was re-shoring or nearshoring.

Figure 4.5. Supply chain priorities – pre- and post-pandemic



The responses by sector provide interesting insights (Table 4.1). While efficiency remained the key priority in most sectors, some sectors gave efficiency a slightly decreased priority score post-pandemic. Food and beverage, extractives and minerals, and resource transformation (manufacturing) reported minimising cost as having a lower priority post-pandemic. Reliability was uniformly given higher priority post-pandemic by survey respondents. In addition, most sectors reported re-shoring/near shoring as having higher priority post-pandemic.

Table 4.1. Priorities pre- and post-pandemic – sectoral breakdown

	Consumer Goods/Retail		Food & Beverage		Extractives & Mineral Processing		Transportation		Resource Transformation/ Manufacturing	
	Pre-pandemic	Post-pandemic	Pre-pandemic	Post-pandemic	Pre-pandemic	Post-pandemic	Pre-pandemic	Post-pandemic	Pre-pandemic	Post-pandemic
Minimising cost	55%	61%	54%	46%	50%	45%	42%	49%	56%	53%
Timeliness	36%	46%	37%	43%	45%	45%	45%	40%	54%	51%
Flexibility	42%	46%	40%	32%	48%	40%	35%	36%	45%	46%
Efficiency	56%	49%	51%	51%	45%	53%	49%	47%	64%	63%
Reliability	47%	50%	44%	50%	35%	48%	38%	50%	47%	49%
Re-shoring or nearshoring	16%	19%	9%	15%	19%	23%	16%	15%	23%	29%

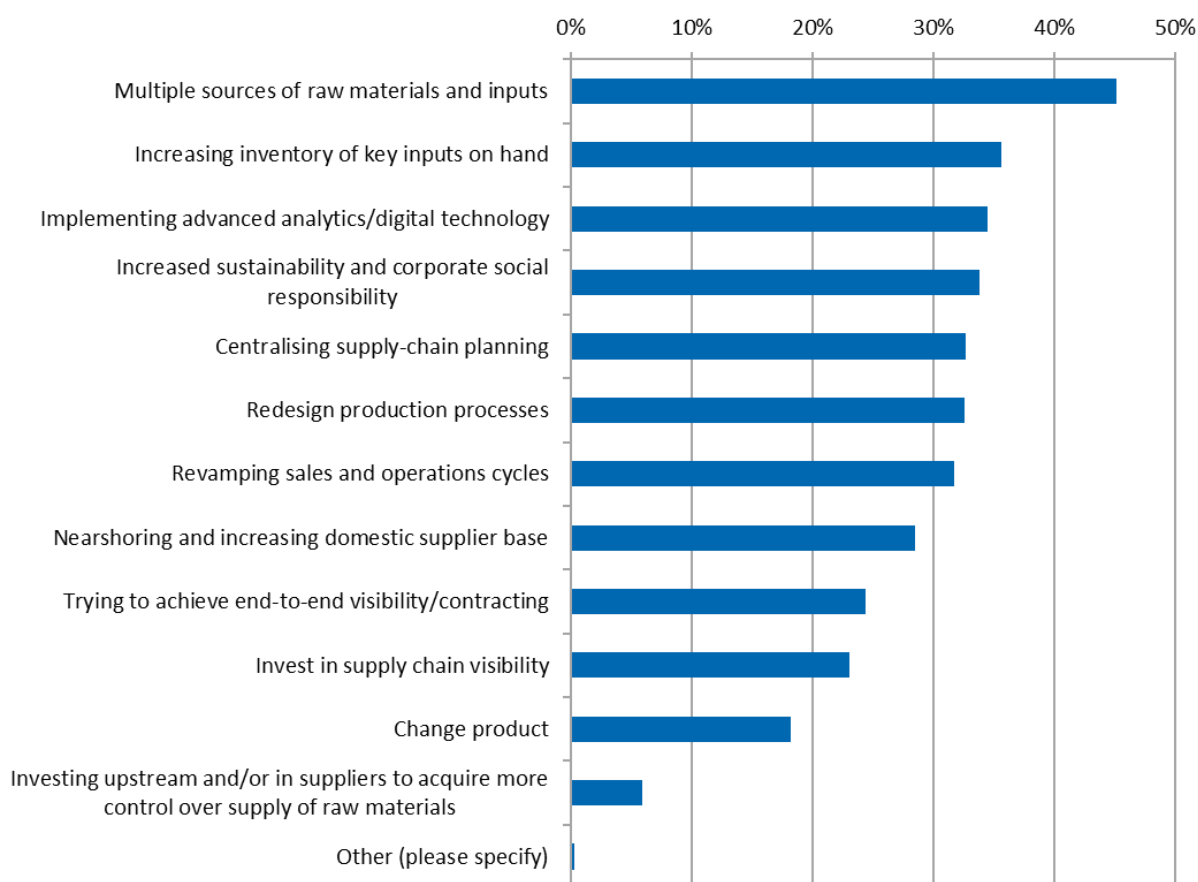
These findings suggest that efficiency is still priority and that businesses want both efficiency and resiliency/reliability, such that there is not a trade-off between the two priorities.

4.1.2 Medium- to long-term response to supply chain disruption

When asked about plans to revise their supply chain, 85 percent of responding firms indicated that they intended to revise their supply chain strategy to make it more resilient and this outcome was observed by all sectors and across size of responding organisations.

As illustrated in Figure 4.6, 45.2 percent of respondents indicated that they intended to look for multiple sources of raw materials and inputs to improve supply chain resiliency, and this was the most common response. This action was followed by increasing inventory or key inputs on hand (35.7 percent) and implementing advanced analytics/digital technology (34.5 percent). The action with fewest responses was investing upstream and/or in suppliers to acquire more control over supply of raw materials (5.9 percent) followed by changing the product (18.2 percent).

Figure 4.6. Actions to make supply chain more resilient



The sectoral breakdown (Table 4.2) gives interesting insights on the priority strategies by sector.

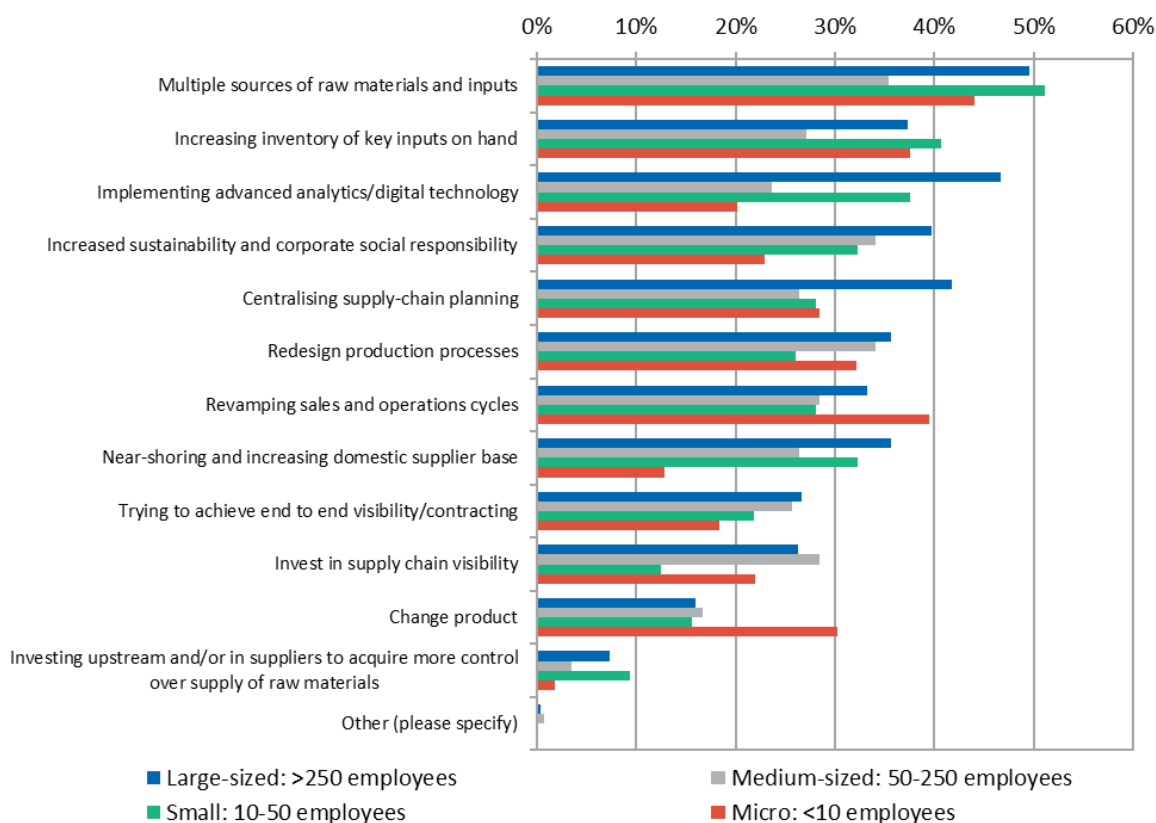
Table 4.2. Actions to make supply chain more resilient – priority by sector

Consumer Goods/Retail	Food & Beverage	Extractives & Mineral Processing	Transportation	Resource Transformation/Manufacturing
<ul style="list-style-type: none"> Procure multiple sources of raw materials Increasing inventory Revamping sales and operations cycles Advanced analytics 	<ul style="list-style-type: none"> Procure multiple sources of raw materials Revamping sales and operations cycles Increasing inventory 	<ul style="list-style-type: none"> Procure multiple sources of raw materials Advanced analytics Increased sustainability and corporate social responsibility 	<ul style="list-style-type: none"> Advanced analytics Redesign production processes Increased sustainability and corporate social responsibility (CSR) 	<ul style="list-style-type: none"> Procure multiple sources of raw materials Centralising supply chain planning Redesign production processes

Across each of the analysed sectors, not more than one third of the respondents indicated an intention to nearshore, and 10 percent or less of the respondents are interested in investing

upstream or in suppliers. Nonetheless, manufacturing firms showed a relatively higher interest in nearshoring and upstream investment, with 33 percent planning to nearshore and 10 percent to invest upstream. The transportation sector indicated use of advanced analytics as a top priority, and this aligns with what stakeholders told us in terms of addressing information asymmetries and communications issues in the shipping sector. See for example the case study on Flexport (section 4.2.2).

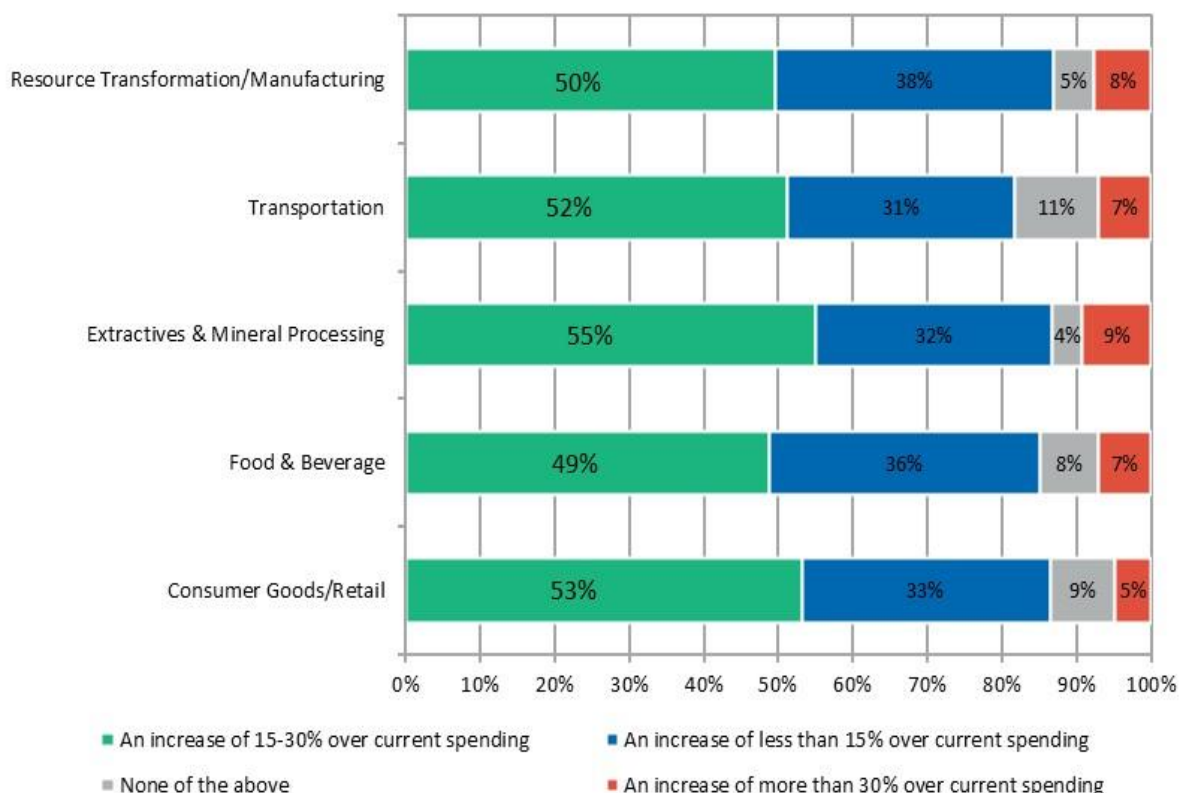
Figure 4.7. Actions to make supply chain more resilient – breakdown by size of firm



Firms of all sizes focused most on diversifying sources of raw material and inputs (Figure 4.7). Relative to other larger firms, micro-sized firms put more focus on revamping sales and operations cycles and changing their product. On the other hand, large firms focused significantly more on implementing advanced analytics/digital technologies, centralising supply chain planning, and taking action around sustainability and corporate social responsibility (CSR) relative to other smaller firms.

Figure 4.8 shows a sectoral breakdown, with between 49 and 55 percent of respondents committed to increasing current spending on supply chains by 15 to 30 percent to improve resiliency. Between 31 and 38 percent of respondents across different sectors committed to an increase of less than 15 percent, and less than 10 percent committed to increasing spending by over 30 percent. The extractives and mineral processing sector planned to increase spending the most, relative to other sectors.

Figure 4.8. Spend on making supply chain more resilient – sectoral breakdown



When asked about the effectiveness of supply chain measures (Figure 4.9), increasing diversity of suppliers was rated the most effective, with 31 percent of respondents rating this measure as ‘very effective’. The response for reskilling the workforce and investing in shipping/logistics was similar with 30 and 29 percent of respondents rating these measures ‘very effective’, respectively. Improving supply chain visibility was also ranked effective. Greater outsourcing and offshoring was rated as the most ‘ineffective’ measure (9 percent of respondents), and interestingly this was followed by nearshoring production (6 percent). It is important to note that support for different strategies will depend on the specific circumstances of any given business.

Figure 4.10 plots the sectoral breakdown of supply chain measures rated as ‘very effective’. Investing in upstream suppliers was considered very effective for the extractives and mineral processing sector, while food and beverage rated reskilling workforce as very effective.

Figure 4.9. Views on effectiveness of supply chain resilience measures

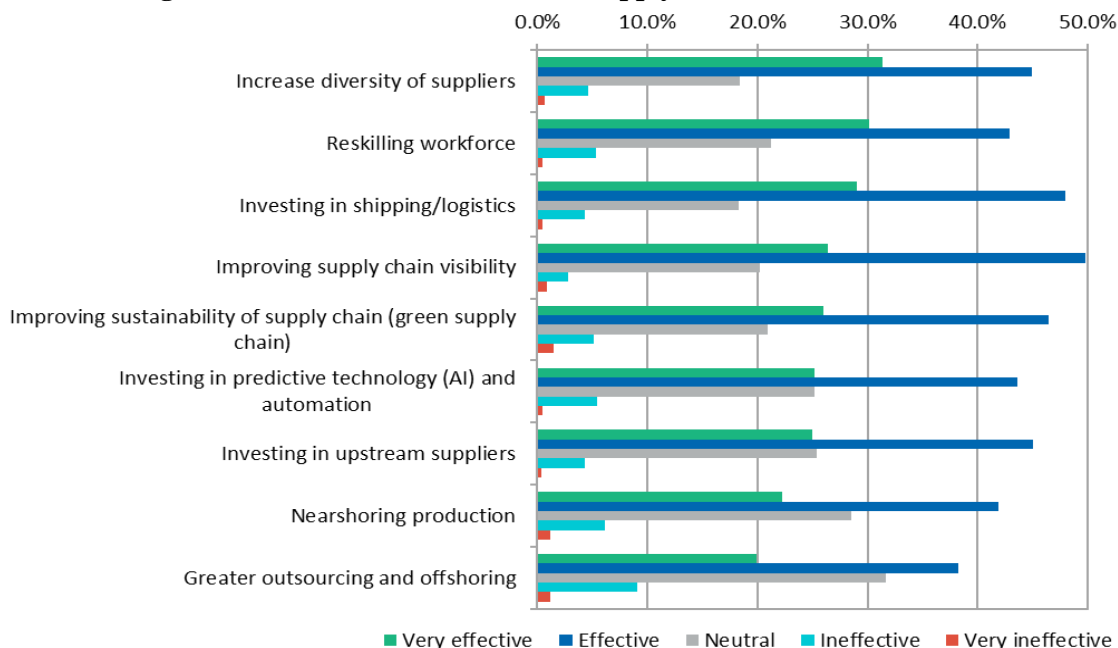


Figure 4.10. Supply chain resilience measures – very effective – sectoral breakdown

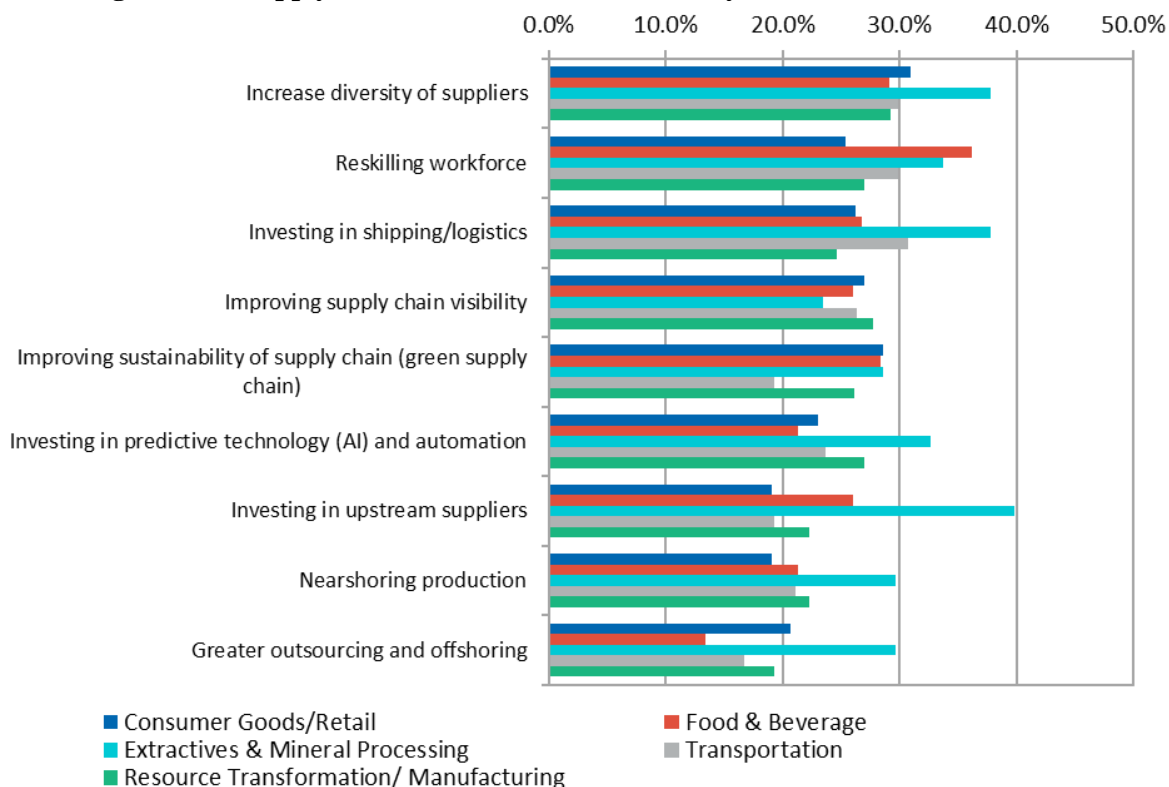
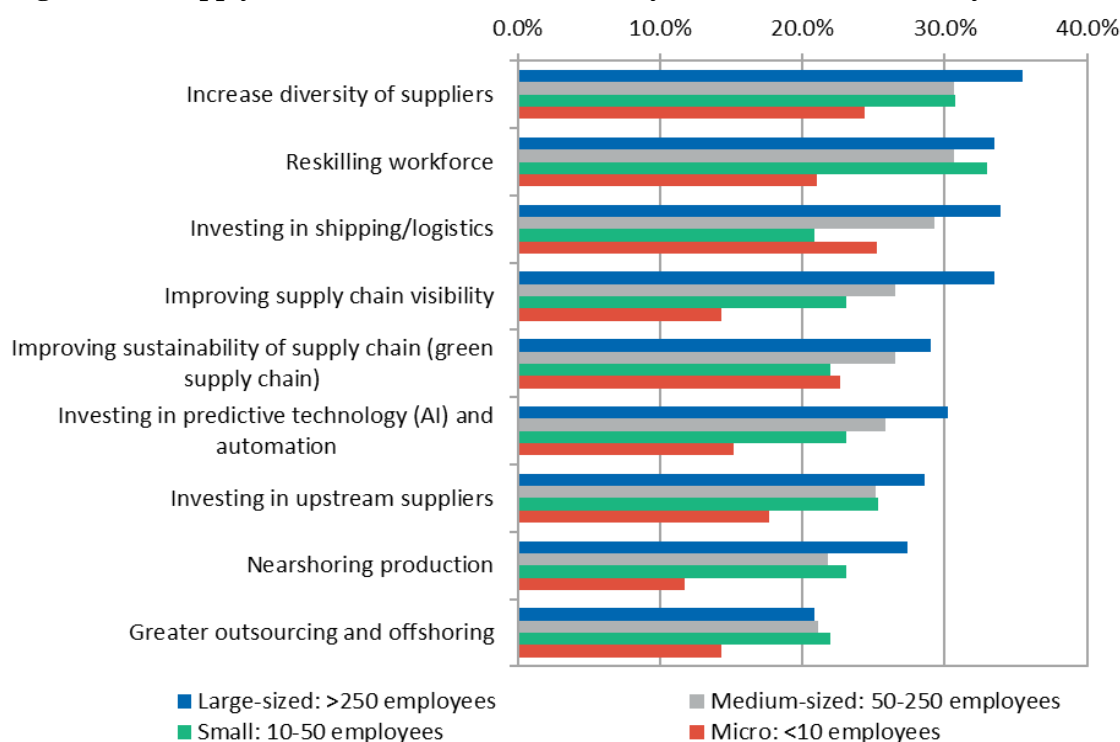


Table 4.3. Supply chain resilience measures – very effective – sectoral breakdown

Consumer Goods/Retail	Food & Beverage	Extractives & Mineral Processing	Transportation	Resource Transformation/Manufacturing
<ul style="list-style-type: none"> • Increase diversity of suppliers • Improve sustainability of supply chain • Improve supply chain visibility • Invest in shipping and logistics 	<ul style="list-style-type: none"> • Reskill workforce • Increase diversity of suppliers • Improve sustainability of supply chain • Invest in shipping and logistics 	<ul style="list-style-type: none"> • Invest in upstream suppliers • Invest in shipping and logistics • Increase diversity of suppliers • Reskill workforce 	<ul style="list-style-type: none"> • Invest in shipping and logistics • Increase diversity of suppliers • Reskill workforce • Improve supply chain visibility 	<ul style="list-style-type: none"> • Increase diversity of suppliers • Improving supply chain visibility • Reskill workforce • Invest in AI and automation

When analysing the responses where measures were ranked as ‘very effective’ by size of firm, the trend was similar to the total pool of results (Figure 4.9).

Figure 4.11. Supply chain resilience measures – very effective – breakdown by size of company



Investing in AI and automation is considered a very effective measure to improve supply chain resilience by larger firms rather than those of smaller scale. Notably, most firms indicated reskilling their workforce as a priority (‘very effective’), although a significantly lower share of micro-sized businesses found this measure useful. This accords both with what stakeholders

told us in discussions and also current research on the need for improved talent in supply chain management.⁴⁷

Overall, from the preceding analysis, the survey suggests that key medium to long term actions that businesses are taking to make their supply chain more resilient include:

- Procuring multiple sources of raw materials and inputs
- Increasing inventory on hand
- Implementing advanced analytics (including digitalisation)
- Increased sustainability and corporate social responsibility
- Improving supply chain visibility

When we asked firms to rank the effectiveness of additional measures in terms of effectiveness, the measures deemed most effective included:

1. Increasing diversity of suppliers
2. Investing in shipping and logistics
3. Improving supply chain visibility
4. Improving sustainability of supply chain
5. Investing in technology (AI) and automation.
6. Reskilling the workforce

Below we consider some of these actions in more detail.

4.2 DISCUSSION OF KEY RESILIENCE STRATEGIES

Having identified the key resilience strategies for businesses both from the survey and from reviewing contemporary literature, we sought to gather deeper insights from stakeholders engaged in global supply chains as to the viability and practicability of these strategies, and what strategies they were implementing.

4.2.1 Increasing diversity of suppliers

The rise of trade protectionism against the backdrop of geopolitical tensions, COVID-19 and related social distancing and lockdown measures affecting production resulted in supply chain disruptions for several industries across goods such as nickel, aluminium, copper, steel, platinum metal groups, ammonia, fertilisers, semiconductors and silicon chips.⁴⁸ This global

⁴⁷ E. Gezgin et al., “Digital Transformation: Raising Supply-chain Performance to New Levels,” McKinsey & Company, 17 November 2017, <https://www.mckinsey.com/capabilities/operations/our-insights/digital-transformation-raising-supply-chain-performance-to-new-levels>

⁴⁸ J.P. Morgan, “What’s Behind The Global Supply Chain Crisis?” 25 May 2022, <https://www.jpmorgan.com/insights/research/global-supply-chain-issues#:~:text=Supplypercent20chainpercent20problemspercent20emergedpercent20during,laborpercent20shortagespercent20andpercent20structuralpercent20factors>

shortage of components parts particularly for the automotive industry exemplifies the importance of having multiple sources of supply. Implementing a supplier diversification strategy can be an effective way of strengthening supply chain connections. This could involve developing a network comprising suppliers which range in size, are widely spread geographically and have varying capabilities.

There have been notable instances where companies have been reducing their reliance on their traditional suppliers. Prior to the pandemic, some companies explored alternative supply chain options in different regions. This shift was driven by various factors, including rising labour costs, concerns about trade disruptions, and evolving policies.⁴⁹

A similar trend can be observed with certain technology companies. For instance, there have been strategic decisions by major companies to relocate their production operations to other economies. These decisions were influenced by various factors, including the need to reduce risk by diversifying production and address vulnerabilities in the supply chain. Additionally, companies are keen on tapping into growing customer demand in specific markets.⁵⁰

Strategic partnerships

Stakeholders that we interviewed also mentioned the importance of strategic partnerships with suppliers of raw materials. Partnering with suppliers of key raw materials can increase visibility, giving greater control of the supply chain. Collaboration can involve forecasting of supply and demand, supply chain planning and managing inventory and capacity, thereby enhancing risk mitigation and strengthening the entire supply chain.

In one survey, it was shown that companies that regularly collaborated with suppliers experienced higher growth, exhibited lower operating costs and were more profitable.⁵¹ Nonetheless, although companies were able to pinpoint specific examples where collaboration with suppliers had been successful, the company executives expressed their difficulties in integrating this approach more broadly across procurement and their firm-wide supply chain strategies.

⁴⁹ I. Kalish, "Economic Brief: Supply Chains Diversify amid Disruptions," CFO Journal by Deloitte, 5 May 2021, <https://deloitte.wsj.com/articles/economic-brief-supply-chains-diversify-amid-disruption-01620241328>

⁵⁰ M. Binder, "India Is Now the Second Largest Smartphone Market in the World, Surpassing the U.S.," *Mashable SE Asia*, 2020, <https://sea.mashable.com/tech/8831/india-is-now-the-second-largest-smartphone-market-in-the-world-surpassing-the-us>

⁵¹ A. Gutierrez et al., "Taking Supplier Collaboration to the Next Level," McKinsey & Company, 7 July 2020, <https://www.mckinsey.com/capabilities/operations/our-insights/taking-supplier-collaboration-to-the-next-level>

Case study: Ford's strategic partnerships

Ford has partnered with SK Innovation, a large petroleum business heavily engaged in the energy and battery industry. SK Innovation's battery business provides cell, module, pack and battery management systems; they are growing and plan to lead the global market by 2030.⁵²

Ford is also collaborating with Redwood Materials, a company involved in battery materials, in order to provide affordable and sustainable electric vehicles to American consumers.⁵³ This strategic partnership will allow Ford to work toward a highly sustainable supply chain as working directly with Redwood Materials will increase the recycling of batteries, scrap and end-of-life vehicles. These two partners complement each other and will allow Ford to better manage operations, reduce risk and improve visibility.

As part of accelerating the electrification of the automobile industry, Ford also seeks to develop facilities in Europe, having recently signed a non-binding memorandum of understanding with SK On Co., Ltd. (a company operating battery manufacturing businesses in Korea; part of SK Innovation Co.⁵⁴) and Koç Holding for a joint venture business in Turkey. Specifically, it could result in one of the largest commercial vehicle battery facilities in Europe.⁵⁵ Based on the multi-billion-dollar investments Ford announced in 2021 and 2022, it is clear that they see value in forming partnerships with relevant parties to accelerate the decarbonisation of the automobile industry. Not only does this benefit Ford from the perspective of business control, but also with regard to environmental, social and governance (ESG) standards and sets an example for other companies to look into similar forward-looking strategic investments involving partnerships.

The need for diversity of supply (be it product or geographic diversity) and procuring multiple individual suppliers is particularly relevant for companies that rely on semiconductor chips. The case study below looks at the ongoing shortage of semiconductor chips and how some businesses have navigated this challenge.

Case study: Shortage of semiconductors

Since 2020, there has been a global shortage of semiconductor computer chips, restricting production of numerous electronic products, as well as cars and solar panels. This was caused by the COVID-19 lockdowns, beginning in 2020, during which many people were required to work from home, leading to an increase in home technology product sales. The supply of semiconductors quickly ran out, and with factories unable to reopen due to COVID-19, there was no way of replenishing supply.

Further downstream, back-end operations such as chip packaging and testing, which take place mostly in South and Southeast Asia, particularly Malaysia, were also restricted. These processes are very labour intensive, making them more sensitive to public health measures.⁵⁶

Further constraints have arisen due to water shortages. The severe drought in Chinese Taipei, the worst in more than 50 years, has compelled chip manufacturers to contend with scarcity of water. The production of semiconductors consumes vast quantities of water; the world's largest semiconductor producer, TSMC Co., Ltd, which is based in Chinese Taipei, uses more than 150 million litres of water per day.⁵⁷

At the end of 2021, Apple experienced a loss of approximately USD 6 billion due to supply constraints that affected most of their products.⁵⁸ In the first quarter of 2022, Apple experienced a 26 percent quarter-over-quarter decrease in sales.⁵⁹

Strategic response

Numerous semiconductor manufacturers have announced large investments into new production facilities, including TSMC, Samsung Electronics and Intel.⁶⁰ However, these are not short-term solutions, as early forecasts predict full operation to commence in Q3 2024 at the earliest.

Some companies have also invested in R&D to alter their production processes. Historically, many machines on the assembly line have been designed to receive materials of one particular type (or a few types), packaged in one particular way. Now that those supply chains have been disrupted, firms are altering their production lines to adapt to inputs from other sources.

Other actions that have been taken include rewriting semiconductor software so that they serve more functions; ‘perhaps code can be rewritten in such a way that a single chip can do more work than it formerly did,’ noted one expert.⁶¹

The action that some automotive manufacturers have taken (to the dissatisfaction of customers) is to deliver ‘unfinished’ products. Some cars have been sent to customers with a previous version of computer software installed, to be upgraded to the current model at a later date, once the semiconductors become available.

A fast-moving consumer goods (FMCG) company that we spoke to mentioned that one of the biggest difficulties it faced during the pandemic was a lack of maturity in contracts. Prices in contracts are often locked in for 12 months, meaning that wholesale and shipping prices are locked in for the duration of the contract. While wholesale suppliers have the agility to change prices on inbound products and services (for example, in response to global disruptive events),

⁵² C. Wang, , “Newcomer EV Battery Manufacturer SK on Plans to Lead Global Market,” *Forbes*, 8 September 2022, <https://www.forbes.com/sites/catherinewang/2022/09/08/newcomer-ev-battery-manufacturer-sk-on-plans-to-lead-global-market/?sh=1052b39b1f8b>

⁵³ Ford, “Ford to Lead America’s Shift to Electric Vehicles with New Mega Campus in Tennessee and Twin Battery Plants in Kentucky; \$11.4B Investment to Create 11,000 Jobs and Power New Lineup of Advanced EVs,” Ford Media Center, 27 September 2021, <https://media.ford.com/content/fordmedia/fna/us/en/news/2021/09/27/ford-to-lead-americas-shift-to-electric-vehicles.html>

⁵⁴ As an intermediate holding company of SK Group, SK Innovation Co., Ltd., engages in the development and production of petroleum products. It operates through the Petroleum Development and Battery Businesses. “Profile: SK Innovation,” *Forbes*, accessed 31 March 2023, <https://www.forbes.com/companies/sk-innovation/?sh=4f720d2d7e90>

⁵⁵ Ford, “Ford, SK and Koç Set to Create a Joint Venture to Accelerate Ford’s Electrification Revolution in Europe,” Ford Media Center, 14 March 2022, <https://media.ford.com/content/fordmedia/feu/en/news/2022/03/14/battery.html>

⁵⁶ J.P. Morgan, “Supply Chain Issues and Autos: When Will the Chip Shortage End?” accessed 31 March 2023, <https://www.jpmorgan.com/insights/research/supply-chain-chip-shortage>

⁵⁷ Cheung, E., “The chipmaking factory of the world is battling Covid and the climate crisis,” *CNN*, 10 June 2021, <https://edition.cnn.com/2021/06/10/tech/taiwan-chip-shortage-covid-climate-crisis-intl-hnk/index.html>

⁵⁸ D. Kline, “Apple Has a \$6 Billion Supply Chain Problem,” *TheStreet*, 2022, <https://www.thestreet.com/investing/apple-has-a-6-billion-supply-chain-problem-that-may-get-worse>

⁵⁹ J.P. Morgan, “What’s Behind the Global Supply Chain Crisis?”

⁶⁰ Center for Strategic & International Studies (CSIS), “*Innovation Lightbulb: Global Investments in Chip Manufacturing*,” 22 May 2023, <https://www.csis.org/analysis/innovation-lightbulb-global-investments-chip-manufacturing>

⁶¹ D. Walsh, “How Auto Companies Are Adapting to the Global Chip Shortage,” MIT Management Sloan School, 21 June 2022, <https://mitsloan.mit.edu/ideas-made-to-matter/how-auto-companies-are-adapting-to-global-chip-shortage>

vendors have limited scope to change prices at the retail level, often leading to margin squeeze. Despite the surge in demand volumes, this did not compensate for the tightening of margins due to the lack of flexibility in contract terms. This makes it difficult to compete across the Asia-Pacific region. The company highlighted the need for skills in negotiating contracts with suppliers, including understanding what terms to look for and the need to seek flexibility in pricing.

4.2.2 Investing in shipping and logistics

Respondents to FTI's survey and stakeholder interviews stressed the impact of shipping and logistics issues on their supply chain, particularly with respect to information asymmetries and uncertainties around shipping times, customs clearance times, container unloading and freight processing.

Shippers and freight forwarders that we spoke to were of the view that future trends could see shippers buy out port companies, freight forwarders, shipping lines and containers. Every interface in the supply chain can cause delay – for example, hoarding, trucking, container tracking – and such delays have financial implications. All of these costs are passed on to the consumer which can hurt competitiveness. Buying links in the chain allows for better control and seamless traction along the chain. This includes port companies buying storage, warehousing, thereby moving from the core business to other related businesses (for example, DP World,⁶² Abu Dhabi ports) for better control and an improved service offering.

In relation to traceability issues and information asymmetries, one technology platform that stakeholders mentioned several times was Flexport.

Case study: Flexport

Flexport is a supply chain and logistics management platform that integrates and connects supply chain data allowing for streamlining of cargo and freight processing.⁶³ It is also engaged in loading and unloading cargo. In 2022, it was valued at USD 8 billion.⁶⁴

Companies of all sizes use Flexport, from emerging brands to Fortune 500s, and it moves close to USD 19 billion of merchandise globally in 2021. Flexport assists with logistics management, transportation and trade management.

The full suite of services includes:

- Visibility enhancement
- Order management
- Customs assistance
- Climate awareness
- Ocean/air freight
- Container filling – 'less than container'
- Trucking
- Capital/cash flow assistance
- Trade advisory

⁶² DP World, Website, accessed 31 March 2023, <https://www.dpworld.com/>

⁶³ Flexport, Website, accessed 31 March 2023, <https://www.flexport.com/>

⁶⁴ R. de León, "Freight Forwarding Firm Flexport Raises Nearly \$1Billion in Funding, Adds Shopify, Michael Dell as Investors," *CNBC*, 7 February 2022, <https://www.cnbc.com/2022/02/07/flexport-raises-nearly-1-billion-as-shopify-michael-dell-invest.html>

- Duty drawback
- Cargo insurance
- Product classification
- Compliance certification

How does it solve supply chain problems?

Container filling

One of the most innovative services that Flexport offers is called less than container load (LCL), to resolve the issue of containers being less than full but still incurring full costs to the shipper.⁶⁵ Flexport's analysis showed that on average, only 65 percent of full container load (FCL) containers on the Transpacific Eastbound route were fully utilised.⁶⁶ This contributes to global supply chain inefficiency and the impact of wastage affects the economy and the environment, for example, through higher shipping costs, port congestion and pollution.

If a shipper has insufficient cargo for FCL, it might make sense to ship LCL, which can prove more reliable if ocean space is tight. Businesses only pay for the space required on a container and can ship straight away instead of waiting for a full container. This is provided on the Flexport platform through OceanMatch, an ocean freight offering that matches unused space in containers with other Flexport cargo, optimising freight pricing for a specific cargo size without compromising on speed.⁶⁷

With over 300 lanes and origin-to-destination coverage managed on the Flexport platform, businesses can find a reliable LCL option that will meet budget, schedule and expectations. Flexport report that their consolidated shipments are rarely subject to demurrage, detention, additional chassis days or empty return delays, and are less sensitive to chassis shortages.

Flexport's standard service gives flexibility, while the expedited service offers faster speeds, and can streamline processes further. Flexport notes that OceanMatch saves up to 35 percent of the cost per container with minimal risk of damages, customs delays and other handling.

By matching shipments' specific weight and volume, lane, and cargo ready date using Flexport's global supply chain data, it can consolidate cargo and fully utilise one container – eliminating the need for multiple semi-empty FCL containers. An LCL with OceanMatch only takes an average of 1–2 extra shipping days than a FCL container. The reduction in port volume aids in reducing port congestion, as well as reducing freight related carbon emissions.⁶⁸

Customs assistance

Flexport offers customs brokerage services to assist with customs clearance. By buying this service, users can access Flexport's platform for data analytics at the purchase order (PO) and stock keeping unit (SKU) level. Standard reporting includes landed costs when the platform can capture all of the costs of acquiring a product internationally. Flexport brokers find patterns to improve import strategy, increase duty avoidance, while the Flexport platform tracks inventory in motion, leading to resolutions before they result in clearance delays or additional scrutiny by customs.⁶⁹ Flexport

⁶⁵ Flexport, "Products: LCL," accessed 31 March 2023, <https://www.flexport.com/products/less-than-container/>

⁶⁶ R. Radhakrishnan, "Filling Up Underutilized Ocean Containers with OceanMatch," Flexport, 28 March 2019, <https://www.flexport.com/blog/filling-up-half-empty-ocean-containers-with-oceanmatch/>

⁶⁷ Radhakrishnan, "Filling Up Underutilized Ocean Containers."

⁶⁸ Radhakrishnan, "Filling Up Underutilized Ocean Containers."

⁶⁹ Flexport, "Products: Customs," accessed 31 March 2023, <https://www.flexport.com/products/customs/>

brokers also help with product classification, reducing the risk of delays and penalties from misclassification.

Trade advisory

The Flexport platform structures data from key documents so that trade advisors can retrieve insights and make changes to the supply chain. An automated commercial environment (ACE) analysis tool helps reveal savings opportunities and compliance risks by analysing users' historical trade data. Flexport trade advisors provide an in-depth compliance assessment, using ACE analysis to drive detailed consultations.

Cash-flow management

One of the key issues facing businesses is that they are required to pay shippers in advance of receiving payment from final consumers and this can cause cash-flow issues. This is particularly the case for freight forwarders who have to pay shipping costs upfront but do not receive payment from customers until delivery. Often, ships waiting to be unloaded at ports can exacerbate cash-flow issues for freight forwarders.

Flexport offers flexibility with regard to supplier payments and logistics costs to better line up with revenues.⁷⁰ Inventory Finance allows users to have Flexport pay suppliers on their behalf, while Logistics Finance allows users to push out the due dates on Flexport freight and duty invoices. Credit limits range from USD 250,000 to USD 20 million, with monthly fees in the range of 0.75 percent to 1.5 percent of invoice value per month.

Visibility

The Flexport platform structures product-level data and becomes a one-stop shop for the supply chain, providing visibility and control from end to end. Data from inventory, commercial invoices and other documents combine to reveal landed costs, historical price comparisons, and other key business metrics.⁷¹

Usage and impact

Flexport's services are used in a wide variety of industries.

Intermax - Intermax is an outerwear manufacturer based in Viet Nam, having been established in Korea in 1995. Key inputs are imported from many economies. Flexport offers freight forwarding to Intermax's customers, allowing for real-time information transfer on the platform, including, for example, shipping times, bookings, document management.⁷² Intermax also benefits from cash-flow services of Flexport.

American Metalcraft - American Metalcraft is a leading wholesale producer of kitchen and restaurant-ware.⁷³ It sought a digital upgrade to the freight forwarding component of its supply chain. American Metalcraft's buying team has benefitted from greater transparency into their in-transit

⁷⁰ Flexport, "Products: Capital," accessed 31 March 2023, <https://www.flexport.com/products/capital/>

⁷¹ Flexport, "Products: Customs."

⁷² Flexport, "Customer Success: How Intermax Experiences Speed, Efficiency, and Visibility with Flexport," accessed 31 March 2023, <https://www.flexport.com/customers/Intermax/>

⁷³ Flexport, "Customer Success: How American Metalcraft Ships 5.2M Products and Reduces Stockouts with Flexport," accessed 31 March 2023, <https://www.flexport.com/customers/american-metalcraft/>

inventory, enabling them to make faster and more informed decisions. The added visibility and real-time notifications have also helped the finance team, who can access timely financial data to assess the financial health of the company's supply chain. American Metalcraft has experienced 10 percent fewer annual inventory stockouts since working with Flexport.

An FMCG company that we spoke to noted that during the pandemic, it was a price taker, taking whatever ships were available in order to keep up with consumer demand. Where it previously had a network of 15 freight companies, post COVID-19, the company has changed to a more simplified model, dealing exclusively with Ofload as the service provider.⁷⁴ This was considered a smart strategic decision as the performance of Ofload is above any other of the providers in the marketplace and this has driven significant efficiencies. Consolidating systems to using Ofload did not come at a cost as the rates were reduced across the board and Ofload used some of the same freight companies that the FMCG company had previously used.

4.2.3 Improving supply chain visibility

A robust risk identification methodology should review the entire end-to-end supply chain, including workflow and processes; regulatory compliance; export controls, sanctions, and trade issues; cybersecurity; ESG issues; track-and-trace or material identification; procurement and sourcing strategies; due diligence on third-party vendors; fraud and counterfeiting; factory and labour conditions; and strategic communications.⁷⁵

Global supply chains involve a complex web of parties; for example, the Apple 2020 supplier list comprises 204 companies spread over 43 economies and 6 continents.⁷⁶ One survey of supply chain professionals indicated that less than 2 percent of companies have a level of visibility in their supply chain that goes beyond the second tier (a business's supplier's supplier).⁷⁷ In a 2021 FTI survey among supply chain executives and managers, less than half of responding organisations had a strategic end-to-end supply risk management function or had developed risk mitigation plans and strategies.⁷⁸

By accurately mapping a supply chain in more depth, firms can more clearly identify the most high-risk points along the chain, allowing them to target and mitigate these risks, making their supply chain more reliable and less susceptible to shocks and underperformance. Technology can also be used to map a firm's supply chain more accurately. It provides the capability to map a supply chain to the first tier (a business's direct supplier), second tier (the business's

⁷⁴ Ofload, Website, accessed 31 March 2023, <https://www.ofload.com.au/>

⁷⁵ FTI Consulting, "Mitigating Supply Chain Risks Takes Board Knowledge to a New Frontier," 14 February 2022, <https://www.fticonsulting.com/insights/articles/mitigating-supply-chain-risks-board-knowledge-new-frontier>

⁷⁶ M. Szczepanski, "Resilience of Global Supply Chains: Challenges and Solutions," European Parliamentary Research Service, November 2021, [https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI\(2021\)698815](https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2021)698815)

⁷⁷ K. Alicke et al., "How COVID-19 Is Reshaping Supply Chains," McKinsey & Company, 23 November 2021, <https://www.mckinsey.com/business-functions/operations/our-insights/how-covid-19-is-reshaping-supply-chains>

⁷⁸ FTI Consulting, "A Wake Up Call for Supply Chain Resiliency," 22 June 2021, <https://www.fticonsulting.com/insights/articles/supply-chain-survey-results-summary>

supplier’s supplier) and beyond this level. The case study below gives an overview of FTI’s supply chain ‘x-ray’ for identifying risks and developing a roadmap for mitigating these risks.

Case study: FTI Supply Chain X-ray

FTI’s Supply Chain X-Ray can be conducted rapidly (3–5 weeks in most cases) to enable companies to identify and prioritise critical supply issues and cost risks and develop a set of opportunities to improve profitability and increase supply chain resilience.⁷⁹

	Identify key risks and opportunities	Develop and prioritise initiatives	Execute transformation programme
ACTIVITIES	<ul style="list-style-type: none"> - Develop material cost, working capital and operating metrics baseline - Assess current end-to-end supply chain operations, core demand/supply and operations planning processes and technologies, e.g., sales and operations planning (S&OP), scheduling, commodity strategy, etc. - Review supply contracts and pricing - Conduct maturity model and benchmarking analysis - Identify gaps and improvement opportunities 	<ul style="list-style-type: none"> - Prioritise and phase opportunities for execution based on size of opportunity, complexity of execution, resources required, etc. - Develop implementation programme and business case for priority initiatives - Identify and phase key risks, and develop mitigation strategies and resilience action plan - Develop scorecard/executive dashboard and process to measure savings and implementation progress 	<ul style="list-style-type: none"> - End-to-end visibility of key cost and supply risks - Understanding of leading practices and strategies adopted by industry players - Prioritised, execution-ready initiatives - Accrual of benefits within 30–60 days from launch of transformation program - Rigorous benefits tracking and progress review process and dashboards defined - Supply chain resilience action plan
OUTPUTS	<ul style="list-style-type: none"> - Materials and supply chain cost baseline - Supply chain benchmarking and maturity model 	<ul style="list-style-type: none"> - Prioritise list of initiatives, and create phased, execution-ready implementation plan - Develop high-level business case/return on investment (ROI) - Create resilience action plan 	

4.2.4 Improving sustainability of the supply chain

In recent years, businesses have faced growing pressure from stakeholders to consider environmental and sustainability issues in business practices and ESG initiatives have hence become a core element of most organisations’ corporate strategies. Many ESG risks stem from

⁷⁹ FTI Consulting, “Supply Chain X-Ray Brochure: Supply Risk Mitigation and Profit Improvement,” 14 July 2021, <https://www.fticonsulting.com/insights/brochures/supply-chain-x-ray-brochure>

a business's supply chain and its contracts with suppliers.⁸⁰ Lack of compliance with ESG commitments, such as on ethical sourcing of raw inputs, compliance with international labour standards, and environmental sustainability of operations, presents significant brand risk to companies and the supply chain. Some of the steps businesses can take to improve sustainability of their supply chain include:⁸¹

- Putting in place supplier codes of conduct to ensure that vendors comply with ESG requirements
- Making supply chain data transparent
- Undertaking supply chain due diligence
- Develop a compliance framework

In the shipping and logistics sector, Danish shipping company, Maersk, has developed a framework comprising 14 categories that cover all of Maersk's sustainability responsibilities, risks and opportunities. Their three defined priorities are to decarbonise logistics, sustainability in their end-to-end offerings and responsible business practices. As part of Maersk's strategy to decarbonise shipping they have engaged eight strategic partners to supply green fuel for the 19 methanol-enabled container vessels Maersk has on order.⁸²

Shipping companies we spoke to also mentioned new IMO 2023 regulations coming into play, which aim to reduce carbon emissions from ocean freight. Some of the energy-efficient measures proposed includes reducing the speed of ships, which could mean reducing throughput or using multiple ships and this is likely to impose costs.

The case study below explores the use of blockchain technology in helping to ensure that the supply chain is compliant with international labour standards and legislation around ethical sourcing of inputs.

⁸⁰ J. Mottau et al., "Sustainable Procurement: Five Tips to Manage ESG Risk in Your Supply Chain Contracts," Allens Linklaters, 30 May 2022, <https://www.allens.com.au/insights-news/insights/2022/05/Sustainable-procurement-five-tips-to-manage-ESG-risk-in-your-supply-chain-contracts/>

⁸¹ Mottau et al., "Sustainable Procurement."

⁸² Maersk, "A.P. Moller – Maersk and SunGas Renewables Sign Strategic Green Methanol Partnership," 15 December 2022, <https://www.maersk.com/news/articles/2022/12/15/maersk-and-sungas-renewables-sign-strategic-green-methanol-partnership>

Case study: Can blockchain help with ensuring an ethical supply chain?⁸³

In addition to supply chain disruptions from vulnerabilities such as logistics bottlenecks, shortages of materials and components, demand volatility, lack of transparency into all tiers of a supply chain, some government actions can also create unexpected hurdles in the ‘last mile’ such as unforeseen cargo detentions and compliance requirements.

Australia,⁸⁴ Germany;⁸⁵ and the US⁸⁶ have recently proposed or enacted regulations or legislation aimed at ensuring companies take affirmative steps to prevent and eliminate exploitative labour practices in both their direct and indirect supply chains.

As supply chains have grown more complex with additional tiers, the risk of exposure to potential human rights issues has grown as well. Importers subject to withhold release orders (WROs) often lack complete visibility into their full supply chain, and regulators might not specify where their suspicions on exploitative labour practices may lie.

In the US, if Customs and Border Protection (CBP) receives information that ‘reasonably indicates’ merchandise intended for importation contains any components that are the result of exploitative labour practices, the agency may detain the suspected merchandise at the port of entry under the authority of a WRO.

To combat allegations of the use of exploitative labour practices with regards to US imported merchandise, the burden of proof is on the importer. Importers must provide proof of admissibility, including a certificate of origin conforming to the template set out in section 19 CFR §12.43(a) of the US customs rules, within three months of the importation.

US Customs cargo detentions FY 2019–2021	
12	cargo detentions in 2019
324	cargo detentions in 2020
967	cargo detentions in 2021(as of 6 August 2021)
USD 422m	total value of cargo detentions 2020–2021 (as of September 2021)

Source: Customs and Border Protection (CBP), Trade Statistics, <https://www.cbp.gov/newsroom/stats/trade>; as published in M. Bell et al., “*Trade and Labor Compliance: Increased Enforcement Activity Spurs Need for Technology-based Solutions*” (FTI Consulting, 2021).

FTI Consulting’s experience in advising clients suggests that merely complying with the basic requirements for a certificate of origin and attestation as described in Part 12.43 will likely be an inadequate defence against the agency’s assertions.

Potential solution

Blockchain technology can help companies document production updates to a single shared ledger, which provides complete data visibility and a single source of accurate data, in turn helping businesses to manage increased supply chain scrutiny.

Developing or improving trade and labour compliance procedures often requires a multifaceted and customised approach, especially when faced with an ever-changing enforcement landscape. In addition to traditional trade compliance measures such as documentation, due diligence and reasonable care, a robust labour compliance process will also benefit from a more modern, technology-based approach.

For example, blockchain and digital token technology can provide immutable certification throughout the supply chain, which can be independently verified by regulators or a credible third party to trace and validate the origin of materials and labour, as well as provide real-time logistics tracing.

Blockchain solutions have been successfully implemented in similar contexts for supply chain and origin audits and inspections, supply chain tracing, and global, digital product tracking to improve regulatory compliance as well as achieve time and cost efficiencies. A combined technology- and regulatory-driven approach can be tailored to improve the traceability of all aspects of the supply chain and designed to create an irrefutable, digital record of compliance. In addition to the regulatory compliance benefits of a traceable supply chain, blockchain demonstrates a company's commitment to transparency and accountability to its business partners, customers and other stakeholders.

Applications of blockchain technology can be used to demonstrate a compliant supply chain, including validation of workforce compliance, and can be presented as verified evidence rebutting the underlying allegations of a WRO or in support of the admissibility of merchandise.

How is blockchain being used and what is the impact?

Spending on blockchain is expected to grow to more than USD 3 billion by 2026.⁸⁷ Companies in a wide range of industries are embedding blockchain solutions in their supply chains.

For example, a global food and beverage company adopted blockchain technology to track coffee from bean to cup⁸⁸ while another company, using blockchain, can now trace a product's travels throughout their supply chain within 2.2 seconds, a process that previously took seven days.⁸⁹

A blockchain smart contract has been used by a Canadian oil transport company to reduce insurance costs. Using sensors placed on rail cars, a shipment of crude oil from Western Canada to the Gulf of Mexico is monitored through blockchain in real time. Insurance premium payments would be cancelled if a set of criteria is met, including whether the oil had been completely offloaded and each car empty for the return trip.⁹⁰

⁸³ M. Bell et al., "Trade and Labor Compliance: Increased Enforcement Activity Spurs Need for Technology-based Solutions" (FTI Consulting, 2021), <https://www.fticonsulting.com/-/media/files/us-files/insights/capabilities/2021/oct/trade-labor-compliance-service-sheet.pdf?rev=792ef4def43d456c900e8b77f2f15166&hash=2FC05685E7FCF7B51C294593AC21E730>

⁸⁴ A. Hudson, "New legislation sets agenda for Customs & Trade, and Transport industries in 2023" (Rigby Cooke Lawyers, 2023), <https://www.rigbycooke.com.au/legislation-for-custom-trade-transport-industry/>

⁸⁵ "German Bundestag Passes New Law on Supply Chain Ethics," *Deutsche Welle (DW)*, 6 November 2021, <https://www.dw.com/en/german-bundestag-passes-new-law-on-supply-chain-ethics/a-57855174>

⁸⁶ Global Affairs Canada (n.d.). "Canada-United States-Mexico Agreement (CUSMA) – Chapter 23 – Labor". Retrieved July 10, 2023, from <https://www.international.gc.ca/trade-commerce/trade-agreements-accords-commerciaux/agr-acc/cusma-aceum/text-texte/23.aspx?lang=eng>

⁸⁷ FTI Consulting, "Is Blockchain the Key to a More ESG-Compliant Supply Chain?" 26 January 2022, <https://www.fticonsulting.com/insights/fti-journal/blockchain-esg-compliant-supply-chain>

⁸⁸ Bloomberg, "Starbucks Customers, Farmers Can Now Trace Their Coffee with Blockchain," SupplyChainBrain, 26 August 2020, <https://www.supplychainbrain.com/articles/31800-starbucks-customers-farmers-can-now-trace-their-coffee-with-blockchain>

⁸⁹ Hyperledger Foundation, "Case Study: How Walmart Brought Unprecedented Transparency to the Food Supply Chain with Hyperledger Fabric," accessed 31 March 2023, <https://www.hyperledger.org/learn/publications/walmart-case-study>

⁹⁰ Hyperledger Foundation, "Case Study: How Walmart Brought Unprecedented Transparency."

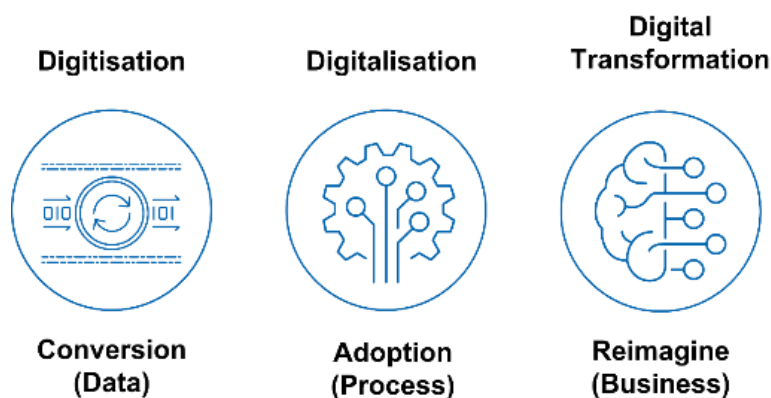
Blockchain solutions are also being used to enhance visibility of supply chains in relation to human trafficking prevention, detection and reporting. Blockchain has also helped companies focus on ESG on reducing carbon footprints, ESG disclosures, and sustainability tracking because of improved visibility into all tiers of the supply chain.

4.2.5 Implementing digital technologies

The different technologies available in the current market give companies the capability to communicate supply chain information and data in more advanced and efficient ways. This includes using artificial intelligence (AI) to provide greater visibility along the supply chain or sharing crucial information such as warehouse inventory and trucking capacity.⁹¹ Research suggests that companies that aggressively digitalise their supply chains can expect to boost annual growth of earnings before interest and taxes by 3.2 percent – the largest increase from digitising any business area – and increase annual revenue growth by 2.3 percent.⁹²

There are a number of different approaches to digital technologies as illustrated in Figure 4.12. Digitisation is the process of converting analog processes into digital processes, this is typically achieved with the use of software.⁹³ Digitalisation is slightly different to digitisation and does not have a unique clear definition. There are many interpretations of digitalisation and for the purpose of this report it will be defined as designing an existing end-to-end process to be a digital process.

Figure 4.12. The different approaches to digital technologies



⁹¹ M.J. Saénz et al., “Digital Transformation Is Changing Supply Chain Relationships,” *Harvard Business Review*, 7 July 2022, <https://hbr.org/2022/07/digital-transformation-is-changing-supply-chain-relationships>

⁹² Gezgin et al., “Digital Transformation.”

⁹³ DDC, “What is Supply Chain Digitization, and Why Does It Matter?” accessed 31 March 2023, [https://www.ddcfo.com/freight-process-insights/what-is-supply-chain-digitization-and-why-does-it-matter#:~:text=Supply%20chain%20digitization%20\(or%20supply,external%20sources%20\(e.g.%20internal%20historical](https://www.ddcfo.com/freight-process-insights/what-is-supply-chain-digitization-and-why-does-it-matter#:~:text=Supply%20chain%20digitization%20(or%20supply,external%20sources%20(e.g.%20internal%20historical)

Digital transformation is completely distinct from the other two approaches: it is not an incremental digital improvement but a full reimagination. This can be described as a total redesign of a solution to leverage digital techniques and opportunities to achieve a different yet vastly better approach to solving a problem. Digital transformation looks beyond a single process and focuses on a holistic all-of-service/organisation view. It is not making a process digital but redefining a whole process.

At the height of the pandemic, office furniture company Haworth Inc. was in a hurry to set up an e-commerce platform to meet the surging demand for the USD 2 billion company's products.⁹⁴ At this stage of the pandemic, global and domestic logistics were in disarray, especially, of particular importance to Haworth, trucking. Haworth's dealers required real-time information regarding their deliveries, and Haworth began using software from FourKites Inc.⁹⁵ to pinpoint truck movements in order to assist their customers plan around the disruptions. The level of granularity Haworth required during the pandemic was not temporary, and it is now a permanent feature to their operations. The investment in logistics technology companies has been increasing rapidly, with venture capitalists and other private-equity investment providing funding at a rate of USD 9 billion per quarter since late 2020.⁹⁶

Case study: Artificial intelligence

AI solutions are being developed specifically to address supply chain issues. These include advanced analytics-based forecasting, digital-twin supply-chain simulation and supply-chain optimisation tools.⁹⁷ Firms can use AI to identify risks and potential shocks or underperformance in the supply chain before they become a severe threat. Access to sales information and predictions could allow suppliers to more accurately determine the amount of inventory that is required at a specific point in time. This explicitly links to managing and predicting the need for inventory buffers.

AI technologies also allow firms to address complex issues and build supply-chain resilience. Value-chain resilience refers to the ability to quickly recover from challenges. The way AI can help strike a balance between efficiency and resiliency is by using simulations that incorporate different scenarios. This allows firms to evaluate countless scenarios and develop highly advanced risk identification processes.⁹⁸

Another useful application of AI is its ability to identify optimal plans for different time horizons. AI technology can recommend operational decisions that balance cost and revenue

⁹⁴ B. Murray (Bloomberg), "Supply Chains Undergoing Digital Transformation 'Golden Age'," gCaptain, 4 January 2023, <https://gcaptain.com/supply-chains-undergoing-digital-transformation-golden-age/>

⁹⁵ FourKites is a supply chain intelligence platform, delivering real-time visibility and execution for 1200+ companies and third-party logistics firms across 200 economies. Using a patented artificial intelligence to calculate shipment arrival times, FourKites enables customers to lower operating costs, improve on-time performance and strengthen end-customer relationships. FourKites Website, accessed 31 March 2023, <https://www.fourkites.com/>

⁹⁶ FourKites website.

⁹⁷ V. Dilda et al., "Building Value-chain Resilience with AI," McKinsey & Company, 26 November 2021, <https://www.mckinsey.com/industries/metals-and-mining/our-insights/building-value-chain-resilience-with-ai>

⁹⁸ Dilda et al., "Building Value-chain Resilience with AI."

in order to provide real-time end-to-end visibility, allowing firms to more effectively and efficiently anticipate and react to disruptions in their supply chains.⁹⁹ An example of this is implementing machine learning algorithms which learn demand patterns and use these to predict which categories of product, or at a more granular level, which specific products consumers will need at a specific point in time. By meeting and predicting demand more precisely, companies can manage their inventory more accurately and boost customer satisfaction and loyalty.¹⁰⁰

4.2.6 Increasing inventory on hand

Respondents to FTI's survey as well as supply chain professionals that we spoke to indicated that they doubled inventory orders almost immediately once the pandemic hit, and that they continue to hold high levels of additional inventory on hand. Despite the additional costs that this incurs in terms of warehouse space and security, stakeholders consider this a prudent move as a guard against future shortages or delays in shipping and logistics. Recent experience has shown that there are significantly costs to businesses if there is a delay in obtaining critical inventory and raw inputs. For example, the global shortage of semiconductor chips created a severe backlog of automobile production, leading to a reduction of USD 210 billion in global car sales.¹⁰¹ Another estimate suggests that the global shortage cost the US economy USD 240 billion in 2021.

Maintaining an inventory buffer or cushion can be an effective way to keep stockout costs low and reduce shipping and order fulfilment delays. The amount of additional inventory required by firms is dependent on a number of factors. These include the type of product being distributed, the average lead times of production, the inventory history of the firm and the predictability of order trends. An inventory management system is imperative in order to keep an adequate cushion stock. The system must have capabilities to track stock and demand so that reorder dates can be programmed into the system.¹⁰²

Regardless of the method chosen to calculate the required cushion inventory, it is invaluable to store and organise historical order and inventory data so that it is at a firm's disposal. In some instances, it could be wise to collaborate with a third-party logistics partner as such partners can provide benefits such as optimising the supply chain and providing expertise, technology

⁹⁹ Dilda et al., "Building Value-chain Resilience with AI."

¹⁰⁰ J. Lagunas and J. Matchette, "Supply Chain Analytics and AI in Driving Relevance, Resilience and Responsibility," Accenture, 22 September 2021, <https://www.accenture.com/bg-en/insights/artificial-intelligence/supply-chain-analytics-ai>

¹⁰¹ Alix Partners, "Shortages related to Semiconductors to Cost the Auto Industry \$210 Billion in Revenues This Year, Says New AlixPartners Forecast," 23 September 2021, <https://www.alixpartners.com/media-center/press-releases/press-release-shortages-related-to-semiconductors-to-cost-the-auto-industry-210-billion-in-revenues-this-year-says-new-alixpartners-forecast/>

¹⁰² C. McLeod, "Cushion Inventory and Why It's So Important," Shipfusion, 15 June 2021, <https://www.shipfusion.com/blog/cushion-inventory-and-why-its-so-important/>

and additional resources, including alleviating pressures from dealing with and managing logistics issues.¹⁰³

The following case study illustrates the benefits to Toyota of its stockpiling strategy.

Case study: Toyota

A combined earthquake and tsunami in Japan in 2011 wiped out many of Toyota's suppliers and caused a 75 percent decrease in profit.¹⁰⁴ Unprepared, this has the potential to cause a company to bleed funds and potentially go bankrupt.

Prior to 2011, Toyota, like many companies, used a just-in-time inventory system, with each step of the production process only producing what is required for the next step.

After the 2011 earthquake and tsunami in Japan disrupted Toyota's supply chains, a team within the company started building a dataset of suppliers, suppliers' suppliers, and suppliers' suppliers' suppliers (three steps out). This led to an inventory build-up of essential components, so that the company had enough stock to continue production through any future supply chain disruptions (at least for a few months).¹⁰⁵

In their database creation, they made sure to highlight the roughly 1,400 components in their cars (out of 30,000) that have the longest lead times.¹⁰⁶ Where standardisation of the parts was an option, they did so, allowing them to utilise multiple suppliers so that if one shuts down, Toyota can continue producing. When standardisation was not an option, Toyota increased the inventory of these 1,400 parts to ensure they could continue production until their supplier was back up and running.

Toyota also split their supply chain into three different sources,¹⁰⁷ meaning if one is cut off, the other two may still be available to provide missing supplies.

Finally, Toyota created a database called the RESCUE system, which keeps Toyota in constant communication with their suppliers. RESCUE is a system in which suppliers can update their progress in real time, and Toyota can track consistently.¹⁰⁸

Toyota, unlike many other automakers, kept workers employed during the COVID-19 pandemic. When workers could not be in the factories, they were at home figuring out how to improve productivity when they returned to work.

¹⁰³ McLeod, "Cushion Inventory and Why It's So Important."

¹⁰⁴ Associated Press, "Toyota Profit Slides on Japan Earthquake Disruption," *The Guardian*, 2011, <https://www.theguardian.com/business/2011/may/11/toyota-profit-hit-by-japan-earthquake>

¹⁰⁵ C. McDaniel, "Making Supply Chains Resilient," *Discourse* (magazine), 7 March 2022, <https://www.discoursemagazine.com/economics/2022/03/07/making-supply-chains-resilient/>

¹⁰⁶ C. McDaniel, "Streamlining Toyota's Supply Chain," *Discourse* (magazine), 22 February 2022, <https://www.discoursemagazine.com/economics/2022/02/22/streamlining-toyotas-supply-chain/>

¹⁰⁷ D. Foulis, "How Toyota Supply Chain Management Led the Way for Modern Supply Chains," Ideagen, 6 December 2021, <https://www.ideagen.com/thought-leadership/blog/how-toyota-supply-chain-management-led-the-way-for-modern-supply-chains>

¹⁰⁸ Toyota, "Five Years On: Toyota's Efforts to Build a Disaster Resilient Future," 11 March 2016, <https://global.toyota/en/detail/11373994>

What was the impact?

As a result of the contingency plan, Toyota had enough components to continue production at the same pace for four months when COVID-19 struck, where other automotive companies were forced to slow or even halt production. The company survived the first two waves of lockdowns without slowing production, and only cut production by 40 percent once the third and fourth waves hit. Unfortunately, due to the sheer number of COVID-19 cases and strict actions taken by global governments to lock down borders, Toyota inevitably had to shut down production entirely. In recovery, Toyota is on track to return to pre-pandemic production levels sooner than competitors,¹⁰⁹ due to their stockpiling of inventory. Toyota had a supply of computer chips built up before the pandemic hit, that they can now utilise to recover their production levels.

Case study: Puma

During the COVID-19 pandemic, various lockdowns across Asia caused Puma stores and supply chain contributors to shut down. Notably, in 2021, a factory in Viet Nam that is responsible for sneaker production for numerous brands, including Puma, was shut down as a result of COVID-19 lockdowns.¹¹⁰ With their second-largest producer (behind China) being entirely shut down for months, there were very few Puma exports making it to shelves internationally.

Strategic response

Puma ensures they have a backup of inventory, so that in the event that their next line of apparel is not available, they can continue to stock the previous season's clothing or a new product, and the line that was supposed to be released would simply be delayed until it could be stocked.¹¹¹

Puma also implemented the TradeLens system. This is a digital tracking system for their inventory, so that they can better forecast exactly when new products will arrive and can adjust their marketing strategy accordingly.

Another key aspect of risk mitigation is the Puma Vendor Financing Programme. Implemented in 2016 (with increased utilisation in 2020), this programme allows suppliers to be paid earlier, based on Puma's credit rating, meaning they can reliably ship products sooner.¹¹²

Throughout the entire pandemic, Puma offices kept in close contact with both suppliers and their local retail stores, to ensure coordination between all aspects of their supply chain.

¹⁰⁹ Fitch Ratings, "Toyota's Recovery to Outpace Peers' Despite Chip Shortage, Lingering Covid-19 Risks," 13 May 2021, <https://www.fitchratings.com/research/corporate-finance/toyota-recovery-to-outpace-peers-despite-chip-shortage-lingering-covid-19-risks-13-05-2021>

¹¹⁰ M.D. Berg, "Vietnam Factory Shutdown: How It Could Impact Holiday Inventories for Adidas, Nike, Puma, Wolverine and Other Companies," Yahoo! Life, 24 July 2021, <https://www.yahoo.com/lifestyle/vietnam-factory-shutdown-could-impact-170544682.html>

¹¹¹ P. Ramjug, "When the Supply Chain Buckled, This Co-Op at Puma Laced Up Her Sneakers and Jumped In," Northeastern Global News, 8 November 2021, <https://news.northeastern.edu/2021/11/08/puma-supply-chain-issues/>

¹¹² Puma, "Puma Annual Report 2020: Sourcing," 2021, <https://annual-report.puma.com/2020/en/combined-management-report/sourcing.html>

What was the impact?

As a result of the measures taken by Puma, their sales decreased by only 1.4 percent (currency adjusted) during the 2020 financial year. They had sufficient inventory for stores to remain open for a few weeks into the pandemic but shut down entirely during lockdowns.

Due to the increased communication and the financing programme, Puma has managed to recover and restore their supply chains very quickly, seeing 2021 financial year sales increasing by 32 percent from the previous financial year.

Most sources attribute Puma's speedy recovery in large part to the TradeLens system, which allows Puma access to data (and notifications) for 95 percent of its shipments.

4.2.7 Nearshoring production

While nearshoring production as a resilience strategy was given lower weight in the FTI survey, it was a recurring theme when we spoke to stakeholders. Firms have started to think about the viability of sourcing materials locally to reduce the reliance on international trade and supply chains.

Nearshoring brings business processes geographically closer to home, often to a neighbouring economy, while onshoring relocates operations to the home economy of a company itself. This could be relying on suppliers that are geographically closer to production facilities in order to reduce transportation costs and time, improve product quality and reduce risks. Nearshoring can be the preferable or more realistic alternative to onshoring as some products may use materials that are unable to be locally sourced.¹¹³

Motivations for nearshoring can include advancing into new markets, purchasing strategic assets or seeking lower production costs.¹¹⁴ In a 2021 FTI survey among supply chain executives and managers, approximately 70 percent of companies that said that they were reassessing their global supply chain strategy were planning to conduct a shift toward actively nearshoring or onshoring their supply chain.¹¹⁵

Examples of nearshoring and onshoring

Several multinational retail brands have nearshored over the past few years. In 2021, PVH, an American clothing company, announced the closure of its offshore operations in a major manufacturing plant in Ethiopia.¹¹⁶ Italian-based fashion brand Benetton began to nearshore production in late 2021, moving away from low-cost manufacturing hubs in Asia and

¹¹³ FTI Consulting, "Is It Time to Consider Bringing Your Supply Chain 'Home'?" 1 August 2022, <https://www.fticonsulting.com/insights/fti-journal/time-consider-bringing-supply-chain-home>

¹¹⁴ V. Chin et al., "As Supply Chains Localise, Industrial Policy Springs Back," BCG, 22 November 2021, <https://www.bcg.com/publications/2021/the-importance-of-global-value-chains-as-industrial-policy-springs-back>

¹¹⁵ FTI Consulting, "A Wake Up Call for Supply Chain Resiliency," 22 June 2021, <https://www.fticonsulting.com/insights/articles/supply-chain-survey-results-summary>

¹¹⁶ C. Lieber, "PVH Corp. Will Close Its Manufacturing Facility in Ethiopia," The Business of Fashion, 17 November 2021, <https://www.businessoffashion.com/news/global-markets/pvh-corp-will-close-its-manufacturing-facility-in-ethiopia/>

expanding manufacturing in economies such as Serbia, Croatia, Turkey, Tunisia and Egypt. Its Chief Executive, Massimo Renon, expressed Benetton's aim to halve production in Asia by the end of 2022.¹¹⁷ Renon described it as 'a strategic decision to have more control on the production process and also on transport costs, today a shipping container that used to cost USD 1,200–1,500 can cost USD 10,000–15,000, with no certainty of a delivery date'.¹¹⁸

There also appears to be a growing concern among consumers of quality products which last longer and are made of ethically sourced materials, and nearshoring to improve visibility and control of the end-to-end supply chain is a step many retail companies are taking.¹¹⁹ This aligns with the discussion in section 4.2.4 on ESG. Other companies such as Lululemon, Nordstrom and Steve Madden have also begun to nearshore production for these reasons.

In late 2021, Ford Motor Company announced a USD 11.4 billion investment, in conjunction with their partner SK Innovation, to onshore production of electric vehicles and batteries.¹²⁰ This investment will consist of two major complexes: a USD 5.6 billion campus in Tennessee and a USD 5.8 billion battery manufacturing complex in Kentucky. These facilities are expected to create 11,000 jobs altogether as well as set the trend in the US automotive industry for a carbon-neutral and zero-waste facility. One of the key purposes of this investment is to make electric vehicles more affordable and sustainable for domestic customers by localising the supply chain network.

The Danish toy company Lego, after halting production 15 years ago, has reignited production in the US with a USD 1 billion manufacturing plant in Virginia. This is a strategic move to nearshore production for the US market, one of Lego's largest markets, thereby minimising the impacts of global supply chain disruptions. Global chief operations officer (COO) of Lego, Carsten Rasmussen, explained that 'this will allow us to rapidly respond to changing consumer demand'. This is another example of a global company which has re-evaluated their priorities and considered nearshoring as a primary supply chain strategy to combat the ongoing global supply chain disruptions.

Some economies are also taking the option to bring production onshore. One example is semiconductor chips, a good the US federal government deems a 'strategic resource' for the economy's economic prosperity and domestic defence. According to the US Department of Commerce, only 12 percent of global semiconductor production takes place in the US – down from 37 percent in 1990 – compared to more than 70 percent in Asia.¹²¹ In July 2022, the US Congress passed the CHIPS Act to strengthen domestic semiconductor manufacturing, design

¹¹⁷ E. Anzolin, "How Global Supply Chains Are Falling Out of Fashion," *Reuters*, 30 September 2021, <https://www.reuters.com/business/retail-consumer/how-global-supply-chains-are-falling-out-fashion-2021-09-30/>

¹¹⁸ Anzolin, "How Global Supply Chains Are Falling Out of Fashion."

¹¹⁹ A. Schaverien, "Consumers Do Care About Retailers' Ethics And Brand Purpose, Accenture Research Finds," *Forbes*, 12 December 2018, <https://www.forbes.com/sites/annaschaverien/2018/12/12/consumers-do-care-about-retailers-ethics-and-brand-purpose-accenture-research-finds/?sh=4a32709716f2>

¹²⁰ Ford, "Ford to Lead America's Shift to Electric Vehicles with New Mega Campus."

¹²¹ FTI Consulting, "Is It Time to Consider Bringing Your Supply Chain 'Home'?"

and research and to reinforce America's chip supply chains.¹²² The US government has proposed subsidising onshore chip manufacturing to level the playing field against global competitors that receive government funding, such as China; Korea; and Chinese Taipei. The hope is to increase domestic production of chips and avoid future shortages.

Meanwhile, nearshoring and onshoring practices may be accompanied by import substitution programmes, and protectionist and anticompetitive practices, leading to subsidy wars and growth of trade protectionism.¹²³

Advantages and disadvantages of nearshoring and onshoring

The advantages common to nearshoring and onshoring options are many. Proximity to customers, which typically improves speed to market, stands out. This is increasingly critical as more consumers demand quick and personalised service from vendors.

Relocating near or onshore also enables companies focused on ethical or sustainable sourcing to monitor more closely third- and fourth-party vendors and potentially meet their ESG goals. Another advantage of nearshoring is an increase in competition, which compels companies to move closer to their operations or customers. There are also subsidies and incentives to onshoring as increased political support at different levels of governments can take the form of a lower tax burden. Employees are becoming more vocal about environmental issues. This is clear from a recent report produced by intranet company Unily that found that 83 percent of workers believed their employers were inadequately addressing sustainability and climate change. The report also identified that 65 percent would be more willing to work for a company with robust environmental policies.¹²⁴

As highlighted by the COO of Lego, companies want to have the ability to respond quickly to consumer demand, particularly in light of the recent transportation and logistical challenges (see section 2.2.1).

There are various trade-offs in nearshoring that companies should consider, as summarised in Figure 4.13. In terms of disadvantages, domestic shipping rates can be higher than those abroad, and regulations have the potential to be more burdensome than elsewhere. This could lead to higher taxes and greater overall cost. Additionally, key factors such as labour, material and infrastructure could be significantly more expensive when nearshoring. The investment involved in nearshoring, as exemplified by the billion-dollar investments made by Ford and Lego, often means that it is not a decision that can be reversed without incurring significant costs and time. Finding reliable manufacturing or logistics partners can also be challenging.

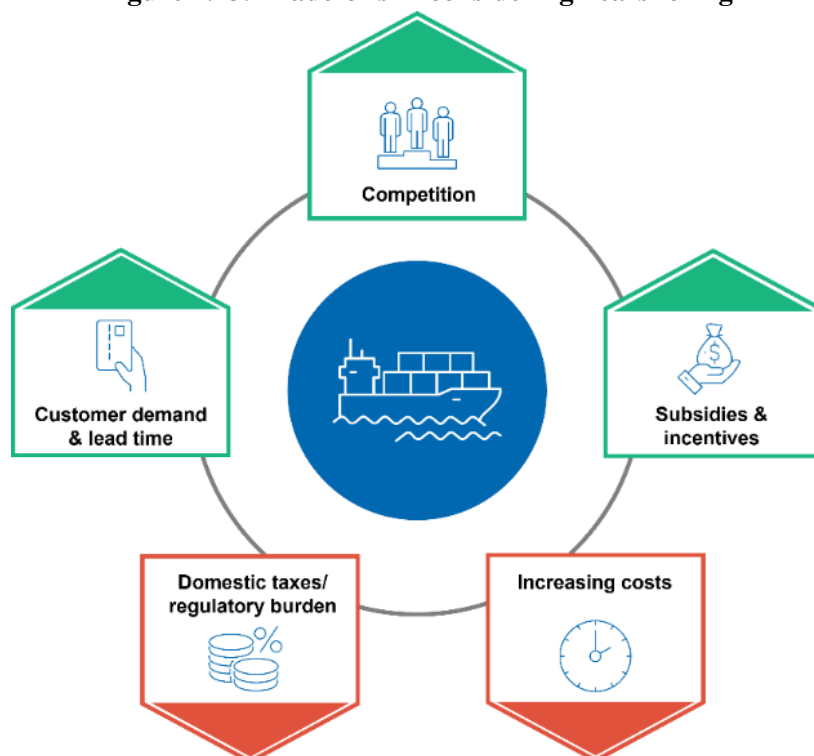
¹²² For the CHIPS and Science Act of 2022, see "About CHIPS for America," NIST, accessed 31 March 2023, <https://www.nist.gov/chips>

¹²³ "In Search of Resilience," *The Economist*, 6 October 2021, <https://www.economist.com/special-report/2021/10/06/in-search-of-resilience>

¹²⁴ A. Gaskell, "Employees Demand that We Become More Sustainable," *Forbes*, 21 October 2021, <https://www.forbes.com/sites/adigaskell/2021/10/31/employees-demand-that-we-become-more-sustainable/?sh=bb4a6193f807>

Nevertheless, in the wake of the COVID-19 outbreak, the frequency of references to re-shoring, onshoring and nearshoring in companies' earnings presentations has surged 10 times.¹²⁵

Figure 4.13. Trade-offs in considering nearshoring



Source: FTI Consulting, “Is It Time to Consider Bringing Your Supply Chain ‘Home’?,” 1 August 2022, <https://www.fticonsulting.com/insights/fti-journal/time-consider-bringing-supply-chain-home>

The International Monetary Fund (IMF) noted that while production location decisions may genuinely be driven by the motive of efficiency and resiliency, the potential risk lies in the implementation of policy interventions that are more driven by government policies that may inadvertently lead to unintended outcomes, or worse yet, intentionally result in economic benefits for some at the expense of others. This could set off a perilous chain reaction toward geoeconomic or global trade fragmentation,¹²⁶ which could cost the global economy dearly (Figure 4.14).

There is an intricate landscape between supply chain dynamics and the broader considerations of global trade and economic resilience. In the semiconductor supply chain, for example, diversification or finding an alternative supplier is exceptionally challenging, especially within

¹²⁵ K. Georgieva, “Confronting Fragmentation Where It Matters Most: Trade, Debt, and Climate Action,” IMF Blog, 16 January 2023, <https://www.imf.org/en/Blogs/Articles/2023/01/16/Confronting-fragmentation-where-it-matters-most-trade-debt-and-climate-action>

¹²⁶ The IMF paper notes that while the definition of geoeconomic fragmentation (GEF) excludes fragmentation that results from prudential policies implemented in a globally coordinated manner, there is often a blurry line between prudential and protectionist measures. See S. Aiyar et al., “Geoeconomic Fragmentation and the Future of Multilateralism”, IMF Staff Discussion Note No. SDN/2023/01, January 2023.

a short timeframe. If access to major chip suppliers is restricted, rapidly expanding manufacturing capacity in other locations to offset their supply is nearly impossible due to the substantial requirements for research and development and capital expenditure.¹²⁷ A new facility capable of producing 50,000 wafers per month costs around USD 15 billion and needs to be run non-stop once completed as facilities typically become obsolete in five years or less.¹²⁸ Furthermore, costs differ between places. Intel estimates that the operational expenses for a semiconductor fabrication plant, commonly referred to as a "fab," in Europe could be 40% to 50% higher compared to other regions. The majority of semiconductor companies also refrain from dual-sourcing at fab level due to the prohibitive costs associated with design.¹²⁹ It is also suggested that 'friend-shoring' strategy that involve excluding potential low-cost suppliers and trade partners, could further restrict the benefits of global trade and is unlikely to contribute to resilience.¹³⁰ While, in some cases, friend-shoring might enhance the security of supply of essential inputs, it could come with a substantial economic cost, resulting in real GDP losses as high as 4.7% in certain economies.¹³¹

In pursuing strategies to develop resilience, governments and businesses also need to prioritise supply chain efficiency. Without efficient supply chain operations where firms are able to select the most efficient suppliers, attempts to build resilience in a targeted industry have a high risk of failure. For instance, in the semiconductor industry, economies of scale play an important role to remain competitive and innovative in the global market.¹³² As such, reducing supply chain risk through building domestic industry that imposes higher financial costs than the existing offshore facilities may lead to chronic under-performance from unproductive companies.¹³³ In addition, healthy competition allows productive firms to grow and to drive research and development. Yoon (2023) argues that the de-globalization trend of the semiconductor industry and "technology protectionism" have accelerated the dissolution of the global supply chain system based on efficiency.¹³⁴ A recent article by The Economist also argues that precautionary measures at times could be more costly than the risks they aim to mitigate.¹³⁵

¹²⁷ K. Ji, et al., "Mapping Global Supply Chains – The Case of Semiconductors," (Rabobank: 2023), <https://www.rabobank.com/knowledge/d011371771-mapping-global-supply-chains-the-case-of-semiconductors>.

¹²⁸ "The Chip Shortage Keeps Getting Worse. Why Can't We Just Make More?," *Bloomberg*, 6 May 2021, <https://www.bloomberg.com/graphics/2021-chip-production-why-hard-to-make-semiconductors/#xj4y7vzkg>.

¹²⁹ Lloyd's, "Loose Connections: Rethinking Semiconductor Supply Chains," (Lloyd's, 2023), <https://www.lloyds.com/news-and-insights/futureset/futureset-insights/rethinking-semiconductor-supply-chains>.

¹³⁰ International Monetary Fund (IMF), "Growing Threats to Global Trade" (Washington, DC: IMF, June 2023), <https://www.imf.org/en/Publications/fandd/issues/2023/06/growing-threats-to-global-trade-goldberg-reed>

¹³¹ B. S. Javorcik, et al., "Economic Costs of Friend-Shoring," CID Faculty Working Paper Series 2022.422, Harvard University, Cambridge, MA, September 2022.

¹³² Pictet, "Friend shoring and the semiconductor industry", 15 November 2023, <https://www.pictet.com/sg/en/insights/chris-miller-friend-shoring-and-the-semiconductor-industry>

¹³³ Project Syndicate, "American CHIPS Off the Chinese Block", 18 August 2022, <https://www.project-syndicate.org/commentary/chips-act-subsidies-will-undermine-semiconductor-competition-and-innovation-by-anne-krueger-2022-08>.

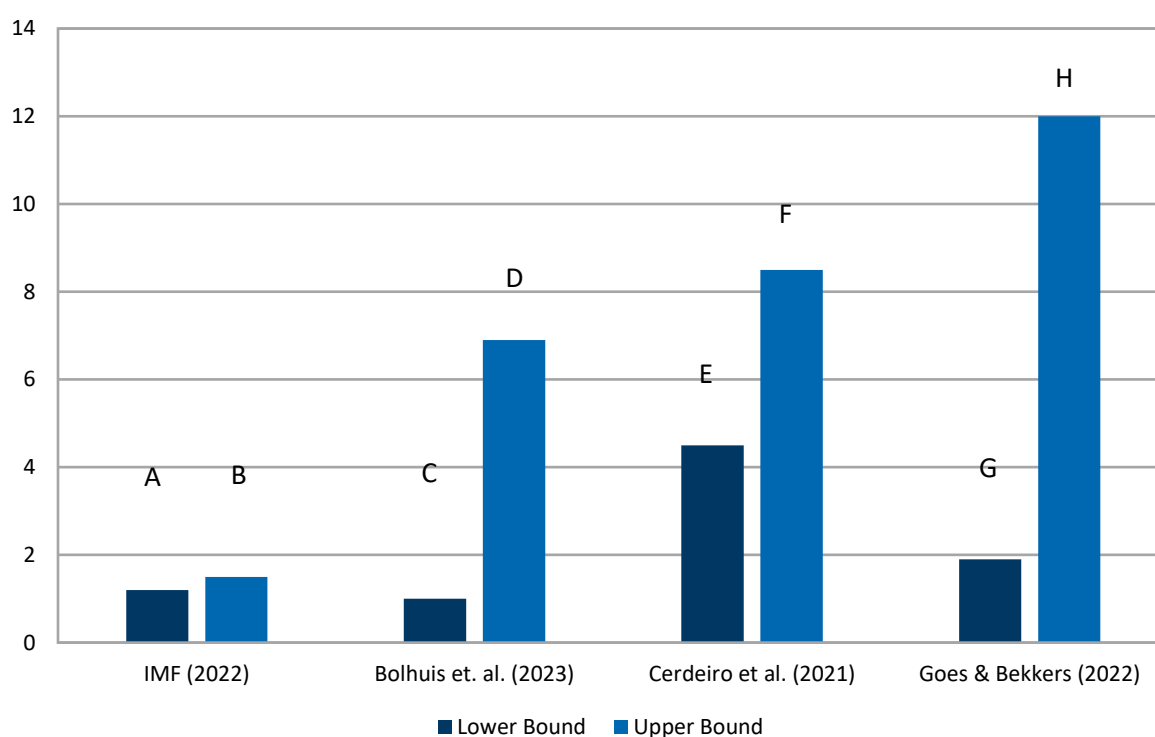
¹³⁴ Yoon J. "Supply Chain Security in the Age of Techno-Geopolitics: Case in the Semiconductor Industry." *The Korean Journal of International Studies* 21, no. 1 (2023): 27-60. <https://doi.org/10.14731/kjis.2023.04.21.1.27>.

¹³⁵ "Attempts to make supply chains "resilient" are likely to fail," *The Economist*, 2 October 2023, <https://www.economist.com/special-report/2023/10/02/attempts-to-make-supply-chains-resilient-are-likely-to-fail>.

A T20 policy brief¹³⁶ highlighted the following key recommendations for G20 governments in improving economic resilience and robustness as well as flexibility of supply chains: (i) evaluate current regulatory frameworks to ensure that firms can conduct their supply chain operations in the most flexible and efficient manner and (ii) minimize the number of products deemed to be strategic or of domestic security interest to reduce special incentives or screening policies.

The highest costs to the global economy would be incurred where there is a full technological decoupling and these costs could reach to 8–12 percent of world GDP. According to the Global Trade Alert database, there has been an increase in the number of trade restrictions or protectionist measures implemented by economies, particularly in high-tech industries that are probably associated with domestic security or strategic competition.¹³⁷

Figure 4.14. Maximum losses (% of GDP) from geoeconomic or global trade fragmentation



Note: Source of fragmentation: (A) trade fragmentation + sectoral misallocation; (B) trade fragmentation + sectoral misallocation + non-tariff barriers (NTBs) in other sectors; (C) strategic decoupling; (D) trade fragmentation; (E) trade fragmentation + NTBs in other sectors; (F) trade fragmentation + sectoral misallocation + lower knowledge diffusion; (G) decoupling only in electronic sector; (H) full technological decoupling.

Source: Adapted from S. Aiyar et al., “Geoeconomic Fragmentation and the Future of Multilateralism”, IMF Staff Discussion Note No. SDN/2023/01, January 2023, Figure 1.1. Please also refer to the cited individual papers in the references.

¹³⁶ M. Mikic, B. Nag, and S. Stephenson, “Supply Chain Resilience, Friend-shoring, and the Pursuit of Non-Economic Objectives”, T20 Policy Brief, June 2023

¹³⁷ International Monetary Fund (IMF), *Regional Economic Outlook for Asia and Pacific: Sailing into Headwinds* (Washington, DC: IMF, October 2022), <https://www.imf.org/en/Publications/REO/APAC/Issues/2022/10/13/regional-economic-outlook-for-asia-and-pacific-october-2022>

The following case study gives insights on the views of an additive manufacturing firm on how 3D printing has the potential to resolve reliance on importing key component parts.

Case study: 3D printing, the key to resiliency of the manufacturing supply chain?

Aurora Labs 3D is an Australian additive manufacturing company. It specialises in the design and use of high-power multi-laser printing for manufacturing applications supporting a number of industries including mining, energy, infrastructure, utilities and defence.¹³⁸ The company is listed on the ASX under the code A3D with a market capitalisation of AUD 5.52 million.¹³⁹

FTI Consulting spoke to Matthew Lester, the Commercialisation and Corporate Development Manager at Aurora Labs 3D to get insights on supply chain disruption from an expert in this industry.

Supply chain issues and strategic response

The manufacturing and mining industries, in particular – those that need very specific and unique component parts – have faced supply chain constraints over the past few years, and this has also been observed in the auto sector, particularly in relation to semiconductors.

In response, some companies have sought to nearshore production of these component parts, and this can often be done using additive manufacturing, more commonly known as 3D printing. 3D printing encompasses a myriad of materials and technologies, and Aurora Labs focuses on a metal 3D printing process called Laser Powder Bed Fusion (L-PBF), which uses various metal powders and lasers to create products. This is particularly useful for items that involve complex shapes that are costly to manufacture conventionally, and/or have a high number of variations with a low volume of demand.

Once a 3D design has been created, it can be sent to a printer and printed immediately rather than requiring significant tooling or molds to produce high volumes of parts. This also means that design changes are easier to implement, enabling rapid innovation and design improvements, because rather than having to alter the entire production line, they can simply load a new design onto the computer. Additive manufacturing essentially relies on four key inputs: the machine and material feedstock, which typically account for 60–80 percent of the cost of producing the initial near-net shape, with consumables, skilled labour and overheads accounting for the remainder. Outside of the 3D printing process itself, significant attention is given to the design of the product as well as post-process finishing (such as machining) to the final product shape. A 2021 analysis of printability of 30,000 component parts found that close to 85 percent of parts could be successfully produced via 3D printing.

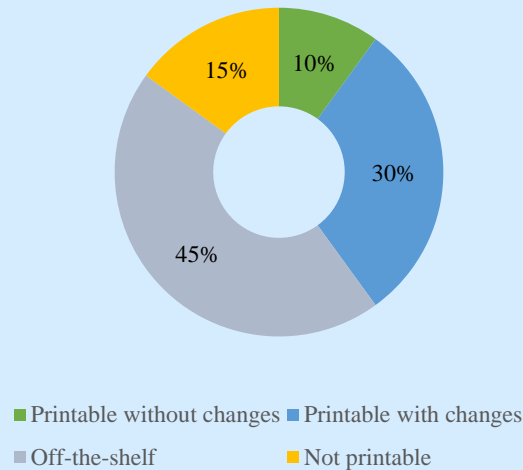
As an example, Chevron, an energy company, has turned to 3D printing technology to produce components parts, reducing supply chain risk exposure: ‘Our planned maintenance schedule was in jeopardy due to current supply chain issues. We realised this supply crunch could impact operations and our bottom line. We worked with Lincoln Electric to explore how parts could be created faster

¹³⁸ Aurora Labs, Website, accessed 31 March 2023, <https://www.auroralabs3d.com/>

¹³⁹ ASX, “Aurora Labs Limited,” accessed 31 March 2023, <https://www2.asx.com.au/markets/company/a3d>

so we could resume operations as planned'.¹⁴⁰ There are also opportunities in the medical, defence, space/aerospace and transport industries (especially with the move to electric vehicles).

Figure 4.15. Printability of parts



Source: Castor, "Analysis of 30,000 Component Parts," in "2021 Additive Manufacturing Trends Report" (Castor, 2021), <https://www.3dcastor.com/2021-industry-report>

What issues do additive manufacturing companies face?

While additive manufacturing can be a tool to mitigate business supply chain risks, additive manufacturing companies also face their own issues. They experienced logistics issues due to the lockdowns and restrictions as a result of COVID-19. For example, Aurora stockpiled some key resource inputs such as feedstock in response to shipping delays.

Aurora also noted the relative slow growth of additive manufacturing in Australia compared to more mature markets in the US and Europe. A key reason for this is the size and maturity of their respective manufacturing sectors, especially in industries such as defence, automotive and aerospace, industries that historically have led adoption of additive manufacturing. Another important difference is the disparity in policy initiatives from government to facilitate an environment necessary for additive manufacturing to thrive.

For example, in Singapore, there has been a concerted and consistent effort to grow an advanced manufacturing industry, including additive manufacturing. These initiatives link additive manufacturing to strategic applications, foster partnerships between universities and industry, and take a long view approach to develop an ecosystem. Last year in the US, the Biden administration announced the AM Forward programme, which aims to encourage large companies to source additively manufactured parts from smaller US-based suppliers.

¹⁴⁰ P. Madeleine, "Chevron Is Solving Supply Chain Issues with 3D Printing," 3Dnatives, 3 May 2022, <https://www.3dnatives.com/en/chevron-is-solving-supply-chain-issues-with-3d-printing-030520225/>

What can policy do to help?

Aurora emphasised the need to promote an ecosystem of advanced manufacturing in Australia and more widely around the Asia-Pacific. Given the observed issues in sourcing components parts through long, interconnected global supply chains, additive manufacturing provides a great opportunity to produce these parts locally if the technology is adopted more widely. Additive manufacturing is usually only a part of the value chain, with part design, testing and post-processing also required. This means that there is significant demand for skilled employment.

Policy encouraging businesses to utilise additive manufacturing could help manufacturing companies increase supply chain resilience and achieve a smaller carbon footprint due to reduced international shipping. Government support can include funding for more training and education facilities, policy or tariffs restricting imports for particular parts, or subsidies for companies utilising processes that reduce their climate impact.

Another key avenue for increasing demand for additive manufacturing is the defence sector. Many other economies, particularly the US, utilise additive manufacturing for printing various parts, including runways, tools and even buildings.¹⁴¹

4.3 SUMMARY OF KEY FINDINGS

- FTI Consulting’s global supply chain resilience survey revealed that in response to the increased costs of production, most respondents passed these costs onto the consumer by increasing prices (63.3 percent). This was followed by absorbing the increase by reducing margins (53.8 percent).
- Most supply chain priorities before the COVID-19 pandemic remained priorities after the COVID-19 pandemic. Efficiency was nominated as a priority before and after the pandemic by around 54 percent of the businesses surveyed. The largest change in priorities was in reliability. Businesses are not seeking to trade off efficiency for reliability. They now seek both. When broken down to a sectoral level there were not any significant differences.
- 45.2 percent of respondents indicated that they intend to look for multiple sources of raw materials and inputs to improve supply chain resiliency, while just 5.9 percent intend to invest upstream and/or in suppliers to acquire more control over supply of raw materials.
- Between 49 and 55 percent of respondents intend to increase current spending on supply chains by 15 to 30 percent to improve resiliency.
- Increasing diversity of suppliers was rated the most effective measure to improve supply chain resiliency, with 31.3 percent of respondents rating this measure as ‘very

¹⁴¹ M. Clemens, “The Use of Additive Manufacturing in the Defense Sector,” 3Dnatives, 30 June 2022, <https://www.3dnatives.com/en/the-use-additive-manufacturing-defense-sector300620224/>

effective'. The response for reskilling the workforce and investing in shipping/logistics was similar with 30.1 and 29.0 percent of respondents rating these measures 'very effective', respectively. Businesses have pursued a number of pathways to raising resiliency.

- The survey results indicate that businesses have a wide-ranging approach to what they expect from their supply chains and they have applied a variety of measures to raise resilience to address risks and vulnerabilities that are specific to their business.
- Discussions with key businesses revealed that their response changed as the circumstances changed. Sometimes this reflected wild swings in market conditions in supply, demand and prices, and sometimes it reflected the limitations of initial approaches. Businesses have adapted. Resiliency for many successful businesses following the pandemic and other disruptive events has involved raising flexibility to deal with risk, while also meeting the commercial imperatives of controlling costs and pursuing efficiency.

5 GOVERNMENT MEASURES TO PROMOTE SUPPLY CHAIN RESILIENCE

Fragilities evident in global supply chains prompted policymakers to take urgent action and many policy measures were quickly deployed. This section samples and reviews some of the policy measures applied in APEC economies as well as regional and global initiatives. It also reports on the views of business operating in APEC member economies about government initiatives gathered through the survey and through consultation with key businesses complemented with information and analysis from pertinent sources.

5.1 INSIGHTS FROM FTI'S GLOBAL SUPPLY CHAIN RESILIENCE SURVEY

In FTI's global supply chain resilience survey, respondents were asked their view on initiatives that government can implement to promote supply chain resiliency. Figure 5.1 plots the views of respondents in this regard. Close to 60 percent of respondents considered keeping trade policy transparent and accessible as a key measure that can aid supply chain resiliency. Interviews with stakeholders also emphasised the complexity and evolving nature of trade agreements and concern over how to keep abreast of developments as they relate to their supply chain. Survey respondents also rated policies aimed at strengthening domestic supply chain capabilities highly (50 percent) and reducing tariffs and non-tariff barriers (45.6 percent). Some of the open-ended responses to this question made suggestions for initiatives such as:

- Encouraging local manufacturing to reverse the offshoring trend
- Promoting trade and business in nearshore economies
- Introducing ceiling price/cost to logistics players, i.e., hauliers, shipping lines, forwarding agents
- Removing all forms of trade protectionism, illegal sanctions and anti-competitive practices
- Improving efficiencies with regard to port and rail systems
- Providing fuel subsidies for companies that meet a threshold designated by the government so that transport companies that are reliable and supply/transport the most goods receive a certain percentage of discount to bring down their costs

Figure 5.1. Views on government initiatives to promote supply chain resiliency (% of respondents)

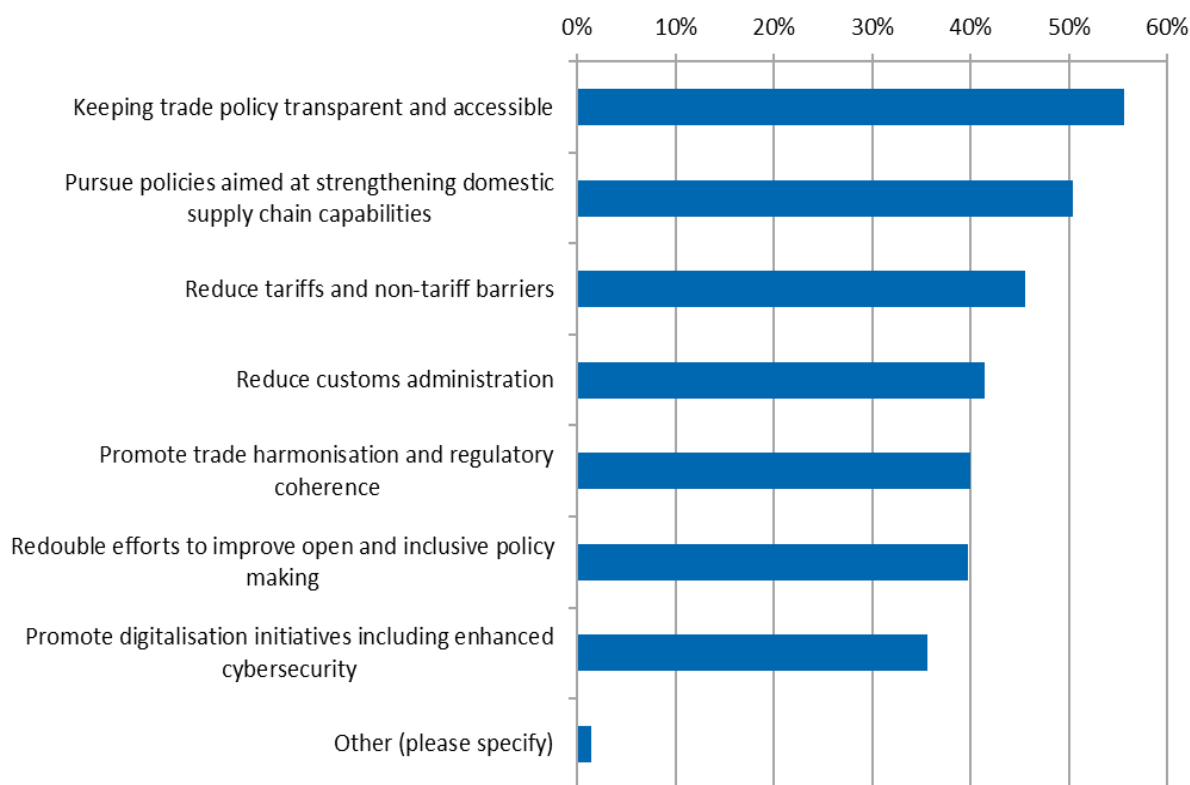
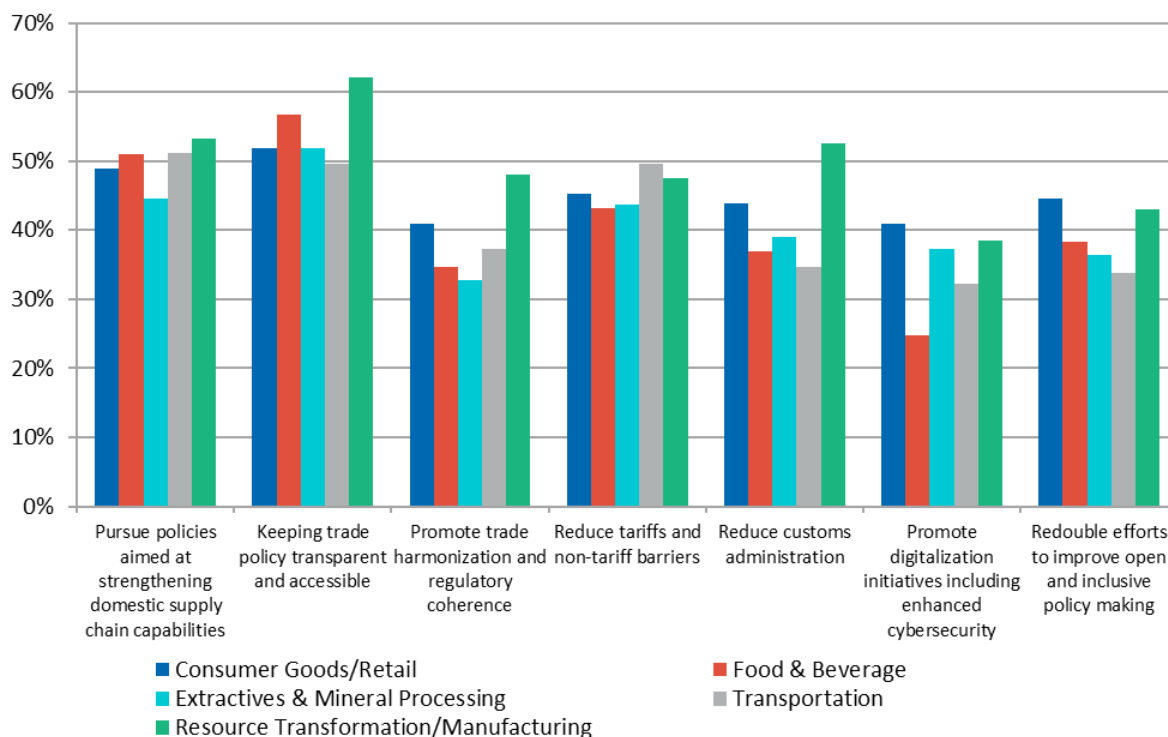


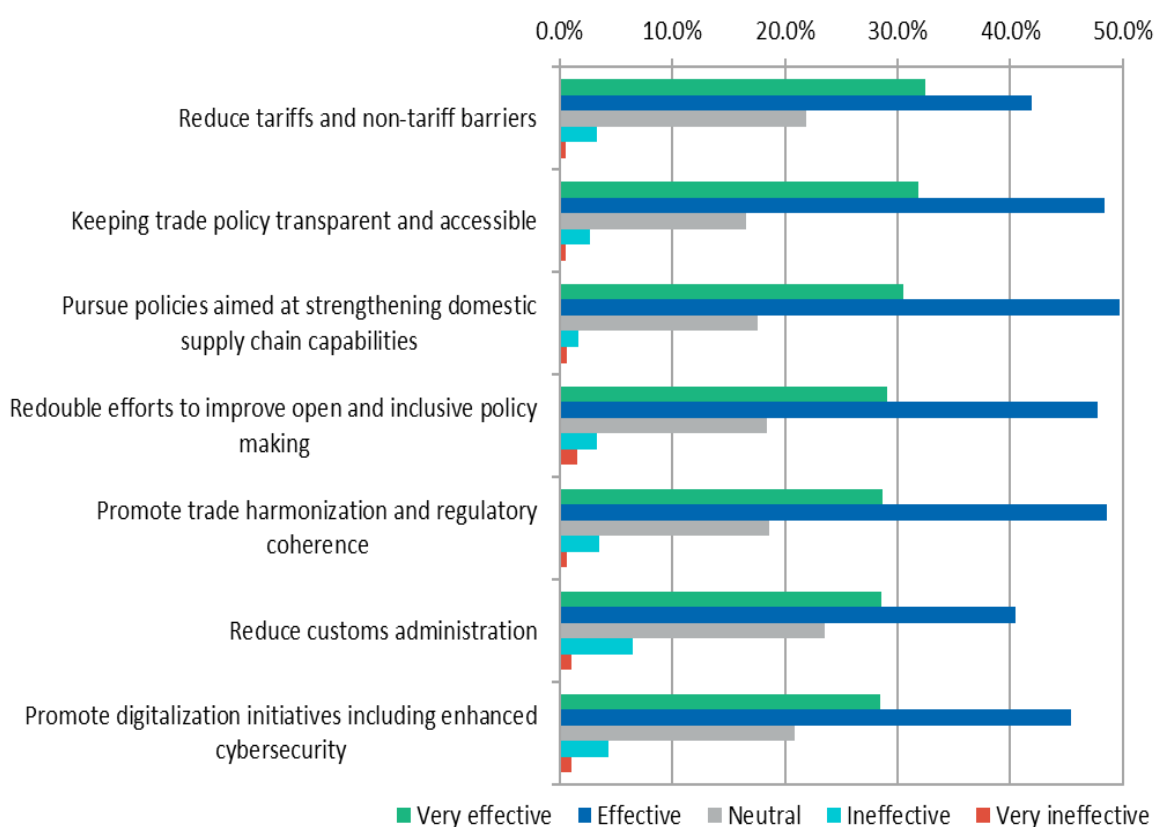
Figure 5.2. Views on government initiatives to promote supply chain resiliency – sectoral breakdown



At a sectoral level (Figure 5.2), keeping trade policy transparent and accessible and policies aimed at strengthening domestic supply chain capabilities were given high weighting, particularly for food and beverage and resource transformation/manufacturing. The resource transformation/manufacturing sector also emphasised reducing customs administration (53 percent), promoting trade harmonisation and regulatory coherence (48 percent) as well as reducing tariffs and non-tariffs barriers (47 percent). Across most sectors, digitisation and cybersecurity initiatives were given relatively rather low weighting and this aligns with some of the earlier findings.

Respondents were also asked their views on how effective these policies could be (Figure 5.3). In general, reducing tariffs and non-tariff barriers and trade policy transparency were seen as the most effective means of promoting supply chain resiliency (rated as ‘very effective’ by 32.4 percent and 31.8 percent of respondents, respectively). Respondents also showed strong preference for policies aimed at strengthening domestic supply chain capability as well as trade harmonisation.

Figure 5.3. Views on effectiveness of government initiatives to promote supply chain resiliency



5.2 STAKEHOLDER COMMENTS ON GOVERNMENT MEASURES

When we talked to stakeholders about government measures to raise resilience, some of the key themes that arose related to:

- Evolving regulatory environment
- Compliance barriers – cost and complexity
- Regulatory red tape – inefficient documentation procedures
- Complexity of trade agreements and difficulty of being able to take advantage of them
- Assistance with cybersecurity and digitalisation

Evolving regulatory environment

Stakeholders noted frustrations with a constantly evolving regulatory environment in terms of trade rules, tariffs, customs laws and labour requirements that pose a threat to the smooth operation of supply chains. Any given change to the rules around importing and exporting can cause costly delays and uncertainty for either sourcing raw materials or delivering final goods to retailers.

One example noted was new global due diligence laws that will take effect in Germany; the US; Norway and other economies in 2023. Most due diligence legislation seeks to implement the standards set by the United Nations (UN) Guiding Principles on Business and Human Rights. An example is the German Supply Chain Act, formally the Act on Corporate Due Diligence in Supply Chains.¹⁴² This act aims to address issues around exploitative labour practices and environmental footprint. It will apply to companies with more than 3,000 employees in Germany, extending to companies with more than 1,000 employees in 2024. It also applies to foreign-registered companies that have operations in Germany. Companies will be required to provide annual reporting of due diligence activities and implement risk management systems, among other requirements. Non-compliance with the legislation will be met with hefty fines.

Such evolving legislative obligations on companies will enforce greater accountability and likely pose a cost and risk to the functioning of a supply chain. However, stakeholders noted that achieving compliance with these new regulations and the extent of due diligence involved will require a very thorough understanding of all tiers and nodes in a company's supply chain, which is useful in achieving greater resilience of the supply chain.

Difficulties taking advantage of trade agreements

Stakeholders noted the complexity of trade agreements and the lack of information made available from government agencies to assist firms in taking advantage of such agreements. Despite there being several attractive advantages of leveraging trade agreements in global

¹⁴² Norton Rose Fulbright (February 2023). "The German Supply Chain Act". Retrieved 31 March 2023, from <https://www.nortonrosefulbright.com/en/knowledge/publications/ff7c1d04/the-german-supply-chain-act#section1>.

supply chain networks, many firms remain cautious in taking advantage of the various agreements. This is due to two significant barriers to using a free trade agreement (FTA): the complex rules and requirements and strenuous compliance. For example, the US currently has 14 trade agreements with 20 economies, all of which come with their own rules and requirements. Given that the rules of eligibility or duty rates are always being updated, it can be difficult for firms to interpret and comply with the rules.¹⁴³ Moreover, the complexity associated with rules of origin, which are used to identify which products are eligible for duty-free or reduced duties, means that it can be difficult even to identify which FTA should be used in a given scenario.¹⁴⁴

Some stakeholders pointed to the EU single market as a potential aspiration for APEC economies, putting particular weight on the ease with which labour can move around economies. For example, shortages of both skilled and unskilled labour have caused supply chain bottlenecks in Australia and one stakeholder stressed the need to be able to bring in foreign workers at a reasonable cost and relatively quickly. Stakeholders also suggested that trade agreements should seek to align with broader goals of inclusivity, environmental targets and ethical trade.

Assistance with cybersecurity and digitisation

Cybersecurity was given lower weight in the survey compared to some of the stakeholder interviews. It remains a key risk to the operation of a company's supply chain given the fallout from a cyber-attack, particularly in an era of increased digitisation of international trade. The stakeholders that we spoke to indicated that they intended to increase investment in cybersecurity and that this was partly a response to governmental regulations obligating them to make such investments.

Stakeholders noted that in order to continue to encourage vigilance around cybersecurity, APEC has a role to play in facilitating cooperation across borders, developing harmonised standards and best practices, publishing guidelines for tackling cyber risks (incident response, threat intelligence, cybercrime investigations), facilitating public-private partnerships, and facilitating training and capacity building for member economies. This was similarly seen in APEC's Global Supply Chains Resiliency Survey among small- and medium-sized enterprises (SMEs), where key 'digital readiness' policy considerations included cybersecurity, virtual work capacity, digital application to customs procedures, and the use of digital services for optimising distribution networks.¹⁴⁵

¹⁴³ Thomson Reuters, "How to Leverage Free Trade Agreements (FTAs) in Your Supply Chain," 19 July 2022, <https://tax.thomsonreuters.com/blog/how-to-leverage-free-trade-agreements-ftas-in-your-supply-chain/>

¹⁴⁴ International Trade Administration, USA Department of Commerce, "Identify and Apply Rules of Origin," accessed 31 March 2023, <https://www.trade.gov/identify-and-apply-rules-of-origin>

¹⁴⁵ APEC, "Key Trends Report: APEC Global Supply Chains Resiliency Survey – Industry and Government" (Singapore: APEC, 2021), <https://www.apec.org/publications/2021/05/apec-global-supply-chains-resiliency-survey---industry-and-government-survey>

Respondents to FTI's global supply chain resilience survey emphasised the need for more efforts in supply chain technology (including digitisation efforts) to improve visibility and more data-driven decision making. This theme recurred in the case study interviews.

Stakeholders pointed to APEC's work in encouraging the uptake of digitalisation through some of its work in bridging the digital divide, including enhancing the public–private partnership environment to increase investment in digital infrastructure and technologies. Member economies can also facilitate the wide adoption of innovative supply chain practices to improve broad-based productivity, and this can be achieved through industry engagement. Tackling the digital divide and adoption issues may also feed into broader environmental, social and governance (ESG) themes such as promoting more inclusive and sustainable supply chains.

5.3 SAMPLE OF GOVERNMENT AND MULTILATERAL SUPPLY CHAIN INITIATIVES SINCE THE PANDEMIC

Policy initiatives to patch and repair what were widely perceived to be broken supply chains proliferated following the outbreak of COVID-19. Reflecting the urgency of the situation, many initial measures concentrated on rapidly securing critical inputs to combat the pandemic and providing access to critical inputs. Many of these initiatives placed weight on redeveloping domestic sources of supply, or sometimes accessing trusted suppliers from neighbours.

As the challenges to supply chains changed, the policy response also changed. A surge in demand for goods exceeded the capacity of domestic and international suppliers while severe weather events added considerable disruption. The continuing impacts of the pandemic and rising concern about security flowed into surging inflation, particularly in food and energy prices. Emergency measures applied in response to these threats sought to apply temporary controls and restraints over imports and exports.

There is a renewed focus on building resiliency in recent initiatives taken by governments and policy frameworks proposed by multilateral bodies. Many of these sorts of initiatives have referred to evidence-based analysis of the risks and vulnerabilities. They then focus policy attention on the industries and links in the supply chains that are of critical importance. These initiatives also look to preserve or restore openness to the policy mix. This leads naturally to building trust in trading commitments with trading partners as well as in facilitating an open business environment that promotes growth and innovation while advancing clear and transparent policy measures and goals.

At the individual economy level, governments can promote the competitiveness of domestic industries and leverage the skills and knowledge that individual firms have acquired through their interaction with global supply chains.

Government also has a role to play in ensuring regional cooperation by maintaining open trade policies (for example, the recently signed Regional Comprehensive Economic Partnership

Agreement (RCEP)¹⁴⁶ and mutually beneficial initiatives (such as the Supply Chain Resilience Initiative (SCRI)¹⁴⁷), building trust in trading commitments and avoiding policy interventions that disrupt the smooth working of supply chains. For example, in APEC's Global Supply Chains Resiliency Survey among SMEs, it was noted that 'For SMEs operating in global supply chains, their main demand is to create a business environment that, on one hand, enables them to operate and grow, while on the other hand, reduces considerably regulatory requirements, logistics, compliance and financial risks'.¹⁴⁸ At the government level, APEC's survey among industry and government noted that the top three policy areas of consideration to support businesses as a result of the COVID-19 pandemic include providing training and learning, ensuring higher participation in global supply chains, preventing supply chain disruption, and increasing business competitiveness and innovation.¹⁴⁹

In the face of limited resources, a compelling study¹⁵⁰ suggests that while SMEs encounter challenges in prevention and planning, they possess the ability to endure and recover from external threats and stressful events by harnessing the concept of both ambidexterity capabilities and strategic positioning or consistency. Ambidexterity¹⁵¹ refers to the balancing act between exploiting existing knowledge (exploiting the present) and venturing into new territories with innovative ideas (exploring the future). Conversely, strategic positioning¹⁵² refers to the ability of SMEs to adhere to a core business strategy despite ever-changing circumstances. This enables them to maintain a clear sense of direction and focus on unique competitive position, ultimately providing a sense of perseverance.

To illustrate, when examining different stockpiling strategies, there are unique challenges and considerations these small firms face. While sharing warehouses with competitors may be less common due to business rivalry¹⁵³ and lack of trust¹⁵⁴, alternative avenues for collaboration can be pursued to develop their supply chain resilience and optimize efficiency. For instance, micro-companies can forge collaborative partnerships that revolve around sharing resources related to transportation, packaging, or distribution channels.¹⁵⁵ By engaging in non-

¹⁴⁶ Department of Foreign Affairs and Trade (DFAT), "Regional Comprehensive Economic Partnership Agreement," accessed 31 March 2023, <https://www.dfat.gov.au/trade/agreements/in-force/rcep>

¹⁴⁷ "Joint Statement on the Supply Chain Resilience Initiative by Australian, Indian and Japanese Trade Ministers," DFAT, 27 April 2021, <https://www.dfat.gov.au/news/media-release/joint-statement-supply-chain-resilience-initiative-australian-indian-and-japanese-trade-ministers>

¹⁴⁸ APEC, "Key Trends Report: APEC Global Supply Chains Resiliency Survey – Small to Medium Enterprises," (Singapore: APEC, 2021), <https://www.apec.org/publications/2021/05/apec-global-supply-chains-resiliency-survey---small-to-medium-enterprises>.

¹⁴⁹ APEC, "Key Trends Report: APEC Global Supply Chains Resiliency Survey – Industry and Government."

¹⁵⁰ Iborra, M., Safón, V., and Dolz, C. "What explains the resilience of SMEs? Ambidexterity capability and strategic consistency." *Long Range Planning* 53, no. 6 (2020): 101947. <https://doi.org/10.1016/j.lrp.2019.101947>.

¹⁵¹ O'Reilly, C. A., & Tushman, M. L. (2004). The ambidextrous organization. *Harvard Business Review*, April, 74-83.

¹⁵² Porter, M. E. "What Is Strategy?" *Harvard Business Review* 74, no. 6 (1996): 61-78.

¹⁵³ Spivack, M. S., "Warehouse Space Is the Latest Thing Being Hoarded," 1 February 2022, *The New York Times*. Retrieved from <https://www.nytimes.com/2022/02/01/business/warehouses-supply-chain.html>.

¹⁵⁴ McKinsey & Company. (n.d.). Overcoming barriers to multitier supplier collaboration. Retrieved from <https://www.mckinsey.com/capabilities/operations/our-insights/overcoming-barriers-to-multitier-supplier-collaboration#/>.

¹⁵⁵ Allen, A. (2021, February 23). Firms collaborating with competitors on logistics. Supply Management. Retrieved from <https://www.cips.org/supply-management/news/2021/february/firms-collaborating-with-competitors-on-logistics/>.

competitive collaborations, these small businesses can elevate their supply chain resilience while capitalizing on the advantages of resource sharing. In doing so, they retain their competitive edge in their core business operations while still safeguarding against potential disruptions.

Next, we look at a sample of policy initiatives by APEC economies that are geared toward promoting supply chain resiliency. These are provided as examples of the nature of measures that have been applied and the commentary also sets out when they were applied and what the aims of the measures were. (A full inventory of all of the measures applied by all APEC members is beyond the scope of this research.)

5.3.1 Australia

- The Australian Productivity Commission was tasked to develop a framework to identify supply chains that are vulnerable to disruption. The commission has also identified strategies to manage supply chain risks and the circumstances under which government might intervene. This helped the government concentrate subsequent policy interventions upon activities where the effort was proportionate to the risks and expected returns.¹⁵⁶
- The Office of Supply Chain Resilience (Department of Industry, Science and Resources) was established to identify and monitor critical supply chain vulnerabilities that could impact Australia's domestic interest. The office also advises the Australian government about potential actions to improve resilience.¹⁵⁷
- The Supply Chain Resilience Initiative Phases 1 and 2 (2020–2021) provides up to AUD 2 million to establish or enlarge a manufacturing capability or a related activity to address supply chain vulnerabilities for a critical product or input identified in the Sovereign Manufacturing Capability Plan.¹⁵⁸
- The Supply Chain Resilience Initiative (Department of Foreign Affairs) is an international collaboration between Australia; India; and Japan to promote best practice domestic supply chain policy and principles. The initiative also seeks to strengthen supply chains of the participating economies through fostering closer interconnectedness of their businesses.¹⁵⁹

¹⁵⁶ Australian Government Productivity Commission, "Vulnerable Supply Chains: Interim Report," 2021, <https://www.pc.gov.au/inquiries/completed/supply-chains/interim>.

¹⁵⁷ Department of Industry, Science and Resources, "Office of Supply Chain Resilience," accessed 31 March 2023, <https://www.industry.gov.au/trade/office-supply-chain-resilience>.

¹⁵⁸ Australian Government Business, "Funding for Business to Invest in Capabilities to Address Supply Chain Vulnerabilities," 7 March 2023, <https://business.gov.au/grants-and-programs/supply-chain-resilience-initiative>

¹⁵⁹ DFAT, "Boosting Supply Chain Resilience," accessed 31 March 2023, <https://www.dfat.gov.au/trade/for-australian-business/boosting-supply-chain-resilience>.

Case study: Australian Productivity Commission

A 2021 study by the Australian Productivity Commission¹⁶⁰ developed a framework to identify supply chains for goods and services that are vulnerable to disruptions and whose absence would impact the economy, domestic security and wellbeing in Australia.

The framework starts by identifying those products that are vulnerable to supply chain disruptions using a data scan. It then identifies which of these vulnerable products are used in essential industries. The last step uses expert assessment to stress-test the data-driven analysis and to determine, from among the vulnerable products used in essential industries, those that are critical (goods and services that are difficult to replace or for which the production process cannot be quickly altered to avoid their use).

It was determined that Australia's supply chain issues for vital items are insufficiently severe or would not be ameliorated by massive government-directed stockpiling or directly subsidising domestic manufacturing. Instead, the government should concentrate its efforts on bolstering the resilience of critical supply chains by assisting sectors and businesses with the flexibility to switch to production during a crisis.

The report suggested that resilience must extend beyond initiatives such as diversifying suppliers or nearshoring, which typically dominate public discourse, and encompass the transformation of supply networks through new technology and ways of working, and the recruitment of more supply chain management talent.

5.3.2 Japan

- Program for Promoting Investment in Japan to Strengthen Supply Chains (2020) – select firms received government funding to aid supply chain resiliency through domestic production of critical products and materials.¹⁶¹
- Program for Strengthening Overseas Supply Chains (2020) offers financial support to Japanese companies to strengthen supply chains between Japan and 10 ASEAN economies, including moving production to those economies and away from others.¹⁶²

5.3.3 Korea

- The Republic of Korea announced a critical metals strategy in late 2021. This included a plan to nearly double the economy's stockpile of strategic inputs like lithium, cobalt, nickel and rare earths. Under the strategy, Korea plans to raise stockpiles to be sufficient to accommodate needs for at least 100 days of current usage. This would raise stockpiles from the current average of 56.8 days for each of the 35 critical minerals

¹⁶⁰ Australian Government Productivity Commission, "Vulnerable Supply Chains: Study Report," 2021, <https://www.pc.gov.au/inquiries/completed/supply-chains/report>.

¹⁶¹ S. Watanabe, "Japan's Initiatives to Secure Supply Chains and Its Key Challenges," Italian Institute for International Political Studies (ISPI), 17 March 2022, <https://www.ispionline.it/en/publication/japans-initiatives-secure-supply-chains-and-its-key-challenges-34186#:~:text=Strengthening%20Supply%20Chains,-,The%20Program%20for%20Promoting%20Investment%20in%20Japan%20to%20Strengthen%20Supply,products%20and%20materials%20in%20Japan>

¹⁶² Watanabe, "Japan's Initiatives to Secure Supply Chains."

identified. This is intended to improve resiliency to supply chain shocks. The critical minerals strategy is also connected to the government's vision of Korea as one of the globe's leading sources of electric-vehicle batteries within the next decade.¹⁶³

5.3.4 Singapore

- Singapore is an open, highly connected economy that is vulnerable to supply chain shocks and has experience with scarcity. The government of Singapore, in partnership with the private sector, stockpiles food and other essential items. This includes stockpiles of drugs and medical supplies, fuel and key construction materials. Stockpiles have been expanded as the risks of disruption have been seen to increase.¹⁶⁴
- Singapore has acted to preserve its reputation as a reliable and trusted partner among businesses and the international community. It was one of the few governments that did not impose export controls, even at the height of the pandemic when masks, respirators and vaccines were scarce.
- Singapore also works together with a wide range of trusted partners to ensure supplies flow even under difficult circumstances. At the height of the pandemic, Singapore was active in establishing new joint initiatives to reaffirm its commitment to maintaining open and secure supply chains.

5.3.5 The US

- The Coronavirus Aid, Relief, and Economic Security Act (a USD 2.2 trillion economic stimulus package signed into law in March 2020) provided for the assessment of gaps and strengthening of supply chains for drugs and medical devices.
- The Defence Production Act in May 2020 authorised the International Development Finance Corporation to allocate funds for expanded domestic production of strategic resources.
- In February 2021, the Biden administration commissioned a government-wide review of critical supply chains in four key areas: pharmaceuticals, semiconductors, batteries and minerals.¹⁶⁵ The 100-day review report provided a range of recommendations to build resilient supply chains, that is, to promote the capacity of supply chains to recover quickly from an unexpected event. These included: (1) rebuilding production and innovation capabilities; (2) supporting the development of markets with high-road production models, labour standards and product quality; (3) leveraging the government's role as a market actor; (4) strengthening international trade rules,

¹⁶³ M. Hui, "South Korea Is Developing a Critical Metals Strategy to Back a Lofty Battery Goal," *Yahoo! Finance*, 9 August 2021, <https://finance.yahoo.com/news/south-korea-developing-critical-metals-115054334.html>.

¹⁶⁴ Singapore Public Sector Outcomes Review, "Strengthening Our Supply Chain Resilience," updated 6 December 2022, <https://www.mof.gov.sg/singapore-public-sector-outcomes-review/citizens/our-shared-future-and-place-in-the-world/strengthening-our-supply-chain-resilience>.

¹⁶⁵ The White House, "Executive Order on America's Supply Chains," 24 February 2021, <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/02/24/executive-order-on-americas-supply-chains/>.

including trade enforcement mechanisms; (5) working with allies and partners to decrease vulnerabilities in global supply chains; and (6) partnering with industry to take immediate action to address existing shortages.¹⁶⁶

- In August 2021, the Federal Maritime Commission launched an inquiry into the timing and appropriateness of ocean carrier surcharges.¹⁶⁷ The inquiry followed complaints received from multiple parties reporting that ocean carriers were levying new additional fees, such as congestion surcharges, with little notice or explanation. Eight ocean carriers were asked to justify the legality of various congestion or related surcharges implemented or announced by them.
- In October 2021, the Federal Maritime Commission established a National Shipper Advisory Committee comprising individuals who represent companies importing and exporting cargo to and from the US.¹⁶⁸ The purpose of the committee is to advise the Federal Maritime Commission on policies relating to the competitiveness, reliability, integrity and fairness of the international ocean freight delivery system. The committee also exists as a resource for the Federal Maritime Commission to consult. The committee is expected to initially focus on three broad areas of interest: information sharing and transparency; cargo fees and surcharges; and current conditions in the supply chain.¹⁶⁹
- In March 2022, the Freight Logistics Optimisation Works (FLOW) initiative was introduced, which is an information-sharing initiative to pilot key freight information exchange between parts of the goods movement supply chain. Participants include private businesses, warehousing, logistics companies and ports.¹⁷⁰
- In May 2022, the Additive Manufacturing Forward program was launched which aims to encourage larger manufacturers to assist smaller US suppliers to increase the use of 3D printing.¹⁷¹
- In July 2022, the US Congress passed the CHIPS Act to strengthen domestic semiconductor manufacturing, design and research and to reinforce America's chip supply chains.¹⁷²

¹⁶⁶ The White House, "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Board-Based Growth" (The White House, June 2021), <https://www.whitehouse.gov/wp-content/uploads/2021/06/100-day-supply-chain-review-report.pdf>.

¹⁶⁷ Federal Maritime Commission, "Commission Questions Shipping Lines about Surcharges," 4 August 2021, <https://www.fmc.gov/commission-questions-shipping-lines-about-surcharges/>.

¹⁶⁸ Federal Maritime Commission, "FMC Holds First Meeting of the National Shipper Advisory Committee," 28 October 2021, <https://www.fmc.gov/fmc-holds-first-meeting-of-the-national-shipper-advisory-committee>.

¹⁶⁹ Federal Maritime Commission, "FY2023 Budget Justification" (Federal Maritime Commission, March 2022), <https://www.fmc.gov/wp-content/uploads/2022/03/Federal-Maritime-Commission-CONG23-Budget-Submission.pdf>.

¹⁷⁰ Congressional Research Service, "Summary of Selected Biden Administration Actions on Supply Chains," 13 May 2022, <https://crsreports.congress.gov/product/pdf/IN/IN11927/2>.

¹⁷¹ Congressional Research Service, "Summary of Selected Biden Administration Actions on Supply Chains."

¹⁷² Semiconductor Industry Association, "Congress Passes Investments in Domestic Semiconductor Manufacturing, Research & Design," accessed 31 March 2023, <https://www.semiconductors.org/chips/>.

- The US has also engaged in stockpiling of key strategic resources including petroleum, medical equipment and other materials that can be drawn on amid supply chain disruptions.¹⁷³ The Strategic National Stockpile contains antibiotics, antivirals, vaccines, ventilators and beds, stored in secret locations across the US to supplement state and local resources, while the Strategic Petroleum Reserve includes vast storage of oil.¹⁷⁴

5.3.6 Regional and subregional joint initiatives

- In March 2020, several economies including Australia; Brunei Darussalam; Canada; Chile; Myanmar; New Zealand; and Singapore committed to maintaining open and connected supply chains.¹⁷⁵
- In May 2020, Australia; Canada; Korea; New Zealand; and Singapore signed a joint statement reaffirming their commitment to cross-border flows and concrete actions to alleviate the impact of COVID-19. Signatories agreed to:¹⁷⁶
 - Expedite customs procedures and refrain from introducing export restrictions on essential items such as food and medical supplies. There was also agreement to ensure the continued operation of logistics networks via air, sea and land freight.
 - Facilitate the resumption of essential cross-border travel, while balancing public health considerations in line with efforts to combat the pandemic.
 - Minimise the impact of COVID-19 on trade and investment and facilitate an inclusive and sustainable economic recovery from the pandemic.
- The Minerals Security Partnership (MSP) was created in response to the increasing demand for critical minerals, and problems and issues rendering their supply chains vulnerable to disruption. Australia; Canada; Finland; France; Germany; Japan; Korea; Sweden; the United Kingdom; the US; and the European Union were partners when the MSP was announced in June 2022.¹⁷⁷ The initiative is intended to bolster critical mineral supply chains essential for the clean energy transition. It focuses on critical minerals that are inputs for electric vehicles and advanced batteries. The partnership seeks to ensure that critical minerals are produced, processed and recycled in a manner

¹⁷³ A. Siripurapu and N. Berman, “The State of U.S. Strategic Stockpiles,” Council of Foreign Relations, updated 2 March 2023, <https://www.cfr.org/background/state-us-strategic-stockpiles>.

¹⁷⁴ Siripurapu and Berman, “The State of U.S. Strategic Stockpiles.”

¹⁷⁵ New Zealand Government, “Canada, Australia, Chile, Brunei and Myanmar Join NZ and Singapore in Committing to Keeping Supply and Trade Links Open,” 25 March 2020, <https://www.beehive.govt.nz/release/canada-australia-chile-brunei-and-myanmar-join-nz-and-singapore-committing-keeping-supply>.

¹⁷⁶ Singapore Public Sector Outcomes Review, “Strengthening Our Supply Chain Resilience.”

¹⁷⁷ International Energy Agency, “Minerals Security Partnership,” updated 27 October 2022, <https://www.iea.org/policies/16066-minerals-security-partnership>.

that supports partners' realisation of the full economic development potential of their mineral resources. Activities are understood to include:¹⁷⁸

- Strengthening information sharing between partner economies
- Increasing investment in secure critical minerals supply chains
- Development of recycling technologies
- The MSP partners intend to pursue investments in ways that maintain high ESG standards.
- In a multilateral meeting in late 2021, the major global trading partners suggested that four key pillars were fundamental to supply chain resiliency:¹⁷⁹
 - *Transparency of supply chains*: Greater transparency of supply chains can promote greater awareness of risks and bottlenecks, and assist organisations in figuring out whether alternative sources for inputs are required. This level of openness can lead to a swifter response to disruptions and should be cross-border in nature.
 - *Diversity of supply*: Cross-border collaboration to ensure multiple sources of supply for inputs reduces the risk of reliance on certain key suppliers. This means avoiding unnecessary trade restrictions and allowing more free flow of goods and services. Supply chains should also be competitive and dynamic, free of monopolisation.
 - *Security*: Security should be recognised as a high priority, particularly in technology supply chains. It can prevent damage or disruptions that interfere with critical systems or infrastructure or contribute to unnecessary costs, inefficient delivery schedules, loss of intellectual property and goods, or delivery of unauthorised or compromised products.
 - *Sustainability*: Trying to achieve global sustainability goals including responding to climate change and labour conditions can lead to a more innovative, productive industry and greater shared prosperity. Investing in environmental sustainability can attempt to mitigate risks to supply chains from climate change.
- The United States–Mexico–Canada Agreement (USMCA) entered into force on 1 July 2020. The agreement modernised the previous North America Free Trade Agreement (NAFTA) especially in relation to intellectual property and digital trade. Key changes included increased environmental and working regulations, greater incentives for

¹⁷⁸ International Energy Agency, “Minerals Security Partnership.”

¹⁷⁹ The White House, “Chair’s Statement on Principles for Supply Chain Resilience,” 31 October 2021, <https://www.whitehouse.gov/briefing-room/statements-releases/2021/10/31/chairs-statement-on-principles-for-supply-chain-resilience/>

automobile production in the US, more access to Canada’s dairy market and an increased duty-free limit for Canadians who buy US goods online.¹⁸⁰ Analysts are of the view that the agreement will encourage business to reduce reliance on a single location for critical inputs in their respective supply chains. This is particularly the case for firms focused on sectors such as automotives, electronics and textiles as the agreement facilitates cost savings from lower tariffs and provides the opportunity for these businesses to expand export markets.¹⁸¹

- The COVID-19 pandemic, bilateral trade disputes and widespread disruption in supply chains formed a dramatic backdrop to the decision to sign and then ratify the Regional Comprehensive Economic Partnership Agreement (RCEP).¹⁸² This is a free trade agreement among the Asia-Pacific economies of Australia; Brunei Darussalam; Cambodia; China; Indonesia; Japan; Korea; Laos; Malaysia; Myanmar; New Zealand; the Philippines; Singapore; Thailand; and Viet Nam. The members account for about 30 percent of global GDP. This is some two times larger than the share of global GDP held by Europe (about 15 percent). The RCEP is expected to eliminate about 90 percent of the tariffs on imports between its signatories¹⁸³ within 20 years of coming into force on 1 January 2022. The agreement covers trade in goods and services, investment, economic and technical cooperation, and creates new rules for electronic commerce, intellectual property, government procurement, competition, and small- and medium-sized enterprises.¹⁸⁴ The agreement signals the intent of the parties to look beyond immediate challenges and to reach for the opportunities presented by more open trade and investment policies in the fast-growing and dynamic Asia-Pacific region. Analysts indicate that agreements on this scale will influence business decisions on the location of plants, distribution functions, sales and sourcing of inputs.¹⁸⁵

5.3.7 International agency initiatives

The case study below looks at a framework for risk management that the Organisation for Economic Co-operation and Development (OECD) has developed.

Case study: OECD supply chain risk matrix

The OECD has published a supply chain risk assessment matrix based on the likelihood of the risk and the impact of the risk factors. The matrix is based around four capabilities of government: anticipating risks, using domestic policy tools, utilising public–private tools and

¹⁸⁰ LibreTexts, 2022, *North American Trade*, https://socialsci.libretexts.org/Courses/Mizzou_Academy/World_History_A_B/21%3A_The_Long_Decade/21.03%3A_21.3_North_American_Trade?

¹⁸¹ Thomson Reuters, “How to Leverage Free Trade Agreements (FTAs) in Your Supply Chain.”

¹⁸² Department of Foreign Affairs and Trade (DFAT), “Regional Comprehensive Economic Partnership Agreement.”

¹⁸³ F+L Daily, “RCEP Free Trade Agreement Enters into Force,” 3 January 2022, <https://www.fuelsandlubes.com/rcep-free-trade-agreement-enters-into-force/>

¹⁸⁴ M. Ptashkina, “Revisiting the Effects of Preferential Trade Agreements,” October 2022, https://mashapta.github.io/ptashkina_jmp.pdf

¹⁸⁵ Thomson Reuters, “How to Leverage Free Trade Agreements (FTAs) in Your Supply Chain.”

using international tools (Table 5.1). Key to understanding the nature of supply chain vulnerability and disruption is understanding and anticipating risks, which will allow policymakers to identify the appropriate policy responses and provide insights on how to prepare for future shocks.

At the domestic level, investing in infrastructure, enabling digital trade, sound procurement management and regulatory flexibility can promote supply chain resiliency while also contributing to productivity and competitiveness. Some of the policy responses include creating a domestic strategy for risk management particularly for vital supply chains where vulnerability indicators that cover a wide range of potential risk factors are agreed upon and accounted for. These could encompass the potential risks and impacts and highlight the top priorities for government action. In addition, there should be cooperation across various government agencies for the risk management strategies to be effective.

Cooperation with the private sector is also typically seen as key to coordination and coherence in responding to economic challenges. Such cooperation can include firm-level risk management strategies, public-private action plans, the stress testing of supply chains, and strategic governance at the domestic level. Governments and businesses can collaborate to increase risk preparedness by identifying the variety of potential risks to essential activities, mapping the domestic and foreign parties involved in some essential logistic chains, gathering, and exchanging data on potential concentration and bottlenecks upstream, or creating stress tests for essential supply chains.

Given the interconnected nature of supply chains in terms of global dependencies, governments can cooperate at the international level, from multilateral, plurilateral and bilateral agreements, to softer forms of policy coordination and peer review. Transparency is also critical in helping government manage fast-evolving crises, for example, sharing lessons learned, building confidence in supply and trust in global markets, and helping avoid harmful policy choices. Governments can also work together to lower barriers to trade and investment for essential goods and their underlying inputs.

Governments can also implement trade facilitation measure. For example, in times of crisis, this could include fast clearance through customs or expedited certification. The OECD notes that trade facilitation measures have generally proven to be more efficient when they are coordinated across economies, and even more so when they are included in a series of initiatives taken to promote cooperation, regulatory convergence, and the harmonisation of rules.

Table 5.1. OECD risk management matrix

Risk management tools: Anticipate risks	Domestic policy tools: Minimise exposure to shocks	Public-private tools	International tools: Keep markets open
Identify potential risks	Infrastructure	Firm-level risk management strategies	Predictability and transparency
Determine government role	Digital trade	Public-private action plans	International agreements
Strategies and guidelines	Procurement	Stress tests	Trade facilitation
Shock diagnosis	Regulatory flexibility	Strategic governance	International regulatory cooperation

Specific measures at international level could include:

- Address gaps in rules-based trading system that have given rise to trade issues
- Invest in standardising and collecting comparable information at the domestic and international levels – this could facilitate market monitoring
- Streamline border process, e.g., fast tracking/pre-approval customs clearance and more flexible application of product certification in emergencies
- Enhanced cooperation between agencies at borders (ports, shipping, freight forwarders, customs)
- Communication and information-sharing to assist sectors in adjusting to changing requirements
- Recognising conformity assessment procedures – encourage testing by partner economies to expedite administrative procedures at port of entry

Source: Summarised from OECD, “Keys to Resilient Supply Chains,” accessed 31 March 2023, <https://www.oecd.org/trade/resilient-supply-chains/>

5.3.8 Global trade initiatives

The WTO deals with the global rules of trade. Its primary function is to serve as a forum for Members to monitor compliance with WTO agreements, to negotiate trade rules, and to resolve disputes. A number of provisions and various agreements relate to how trade is conducted within supply chains.

- The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) sets out minimum standards for the protection of intellectual property, including patents, trademarks and copyrights. This can impact the way that companies manage their supply chains, where they consider intellectual property issues when sourcing materials or products.
- The Agreement on Technical Barriers to Trade (TBT) aims to reduce technical barriers to trade, such as standards and regulations that can create unnecessary obstacles to the flow of goods between economies. This can help to make global supply chains more efficient by reducing the need to meet different standards in different economies.
- The Agreement on Rules of Origin sets out rules for determining the economy of origin of goods. This can be important in the context of supply chains, as it can determine whether goods are eligible for certain trade preferences or subject to certain tariffs.
- The relatively recent Trade Facilitation Agreement (TFA) contains provisions for expediting the movement, release and clearance of goods, including goods in transit. The TFA intends to simplify, modernise and harmonise export and import processes.

This should be of considerable value in reducing the regulatory burden faced by traders moving goods across borders through global supply chains.

WTO Members have been active in seeking to strengthen supply-chain resilience and global trade flows in the wake of the COVID-19 pandemic and other major disruptions. Members are discussing information about trade and trade-related measures notified by Members as well as information reported by the Secretariat. Key points from the WTO Trade Monitoring Report published in December 2022¹⁸⁶ are summarised below.

- The WTO secretariat notes that a consistent feature of the trade and trade-related measures taken in response to the COVID-19 crisis has been the frequent changes, adjustments and then a gradual roll-back of such measures to reflect the evolving situation.
- Since the outbreak of the pandemic, 443 COVID-19-related trade and trade-related measures in the area of goods have been introduced. Most were trade-facilitating (246, or 56 percent), while the rest were trade-restrictive (197, or 44 percent).
- As of mid-October 2022, 79.2 percent of the COVID-19-related trade restrictions have been repealed, leaving 27 export restrictions and 14 import restrictions in place. Although the number of the pandemic-related trade restrictions still in place has decreased, their trade coverage remains important at USD 134.6 billion.
- During the review period for the most recent report, from mid-October 2021 to mid-October 2022, WTO members introduced more trade-facilitating (376) than trade-restrictive (214) measures on goods. Most of the facilitation happened on the import side while most of the restrictions were on the export side. For the first time since the beginning of monitoring by the WTO, the number of export restrictions outpaced that of import restrictions.

5.4 SUMMARY OF KEY FINDINGS

- The initial focus of the policy response to the risks posed by the pandemic was to increase domestic manufacturing and supply – essentially, onshoring to address acute shortages in critical goods. Many initiatives concentrated on a common short list of key goods, notably medical goods, pharmaceuticals and critical minerals.
- The focus on enhancing resilience involves a greater emphasis placed on maintaining open markets, promoting diversification, fostering innovation and engaging in international collaboration to tackle common challenges.

¹⁸⁶ World Trade Organization, “Report shows increase in trade restrictions amidst economic uncertainty, multiple crises,” 2022, https://www.wto.org/english/news_e/news22_e/tmwto_06dec22_e.htm

- The survey of businesses indicates that close to 60 percent of respondents considered keeping trade policy transparent and accessible as a key measure that can aid supply chain resiliency.
- Business stakeholders noted frustrations with the regulatory landscape in terms of trade rules, tariffs, customs laws and labour requirements that pose a threat to the ability of supply chains to respond and adapt to change and disruption.
- The WTO noted that governments quickly applied a large number of trade and trade-related measures in response to the COVID-19 crisis and other disruptive events. Most measures were trade-facilitating, while the rest were trade-restrictive. Governments have been gradually phasing out these measures, particularly the restrictive ones, but the stock of measures that remains, and the volume of trade affected, is still significant in scale.

6 BUILDING AND MAINTAINING OPEN, SECURE AND RESILIENT SUPPLY CHAINS: TOOLKITS FOR FIRMS AND POLICYMAKERS

This section provides toolkits for building and maintaining open, secure and resilient supply chains at the firm and economy-wide level. It draws on earlier findings about approaches applied by business as well as insights from relevant studies. It also presents best practices, common elements and long-term strategies applied by governments to raise resilience in supply chains across APEC economies.

Before discussing the toolkits, several concepts are discussed to refresh our understanding regarding resiliency in supply chains.

6.1 RESILIENCY AND STABILITY IN SUPPLY CHAINS

Levy (1995) put forward the stability-based approach on examining resilience in supply chains. The stability-based view assesses the preparedness and ability of supply chains to return to their initial, stable state in the event of disruptions. In this perspective, there is a notion of a stable condition in which supply chains efficiently operate within a certain range of anticipated fluctuations. In addition, a supply chain can also be characterized as “stable” if “components and goods move smoothly from suppliers to assembly to customers”.¹⁸⁷

An example of such stability indices is the KPMG Supply Chain Stability index. The index gauges US supply chain stability by assessing three contributing factors of capacity, freight and labour, and supply.¹⁸⁸ This allows users to see how each factor affects the overall stability of supply chain. The stability index highlights three primary factors that contribute to supply chain variability: global sourcing, labour requirements and inventory levels.¹⁸⁹ For instance, observation of the index shows that during COVID-19 lockdowns and Suez Canal blockage about 80-90% of supply chain instability can be attributed to freight and labour issues. On the other hand, the instability that followed the Deepwater Horizon oil spill in 2010 mostly came from capacity-related issues. Such readings provide organisations with better understanding of the drivers of supply chain instability so that they can better navigate the uncertainties if similar disruptive events happen in the future.

Supply chain stressors such as material shortages, labour shortages, limited visibility, global tensions, high operating costs pose significant challenges to supply chain stability and

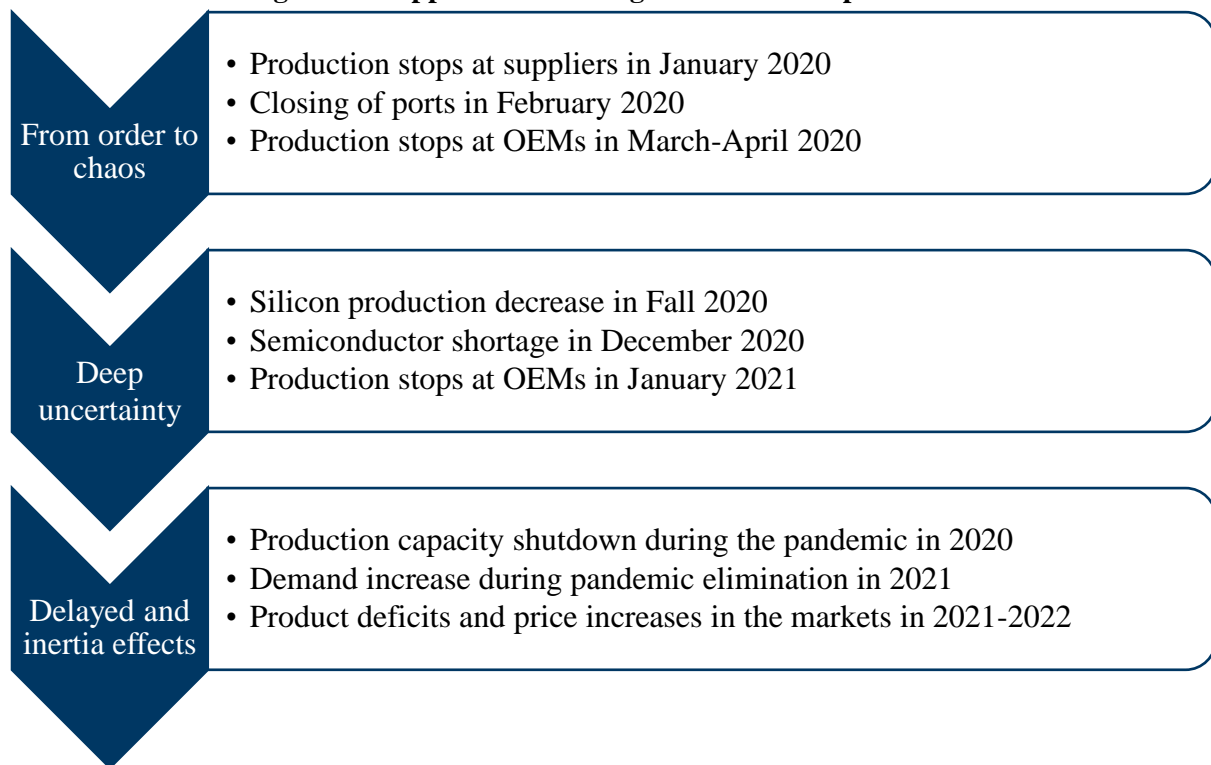
¹⁸⁷ Levy, David L. “International Sourcing and Supply Chain Stability.” *Journal of International Business Studies* 26, no. 2 (1995): 343–60. <http://www.jstor.org/stable/155544>.

¹⁸⁸ KPMG, “Supply Chain Stability Index,” accessed 20 November 2023, <https://kpmg.com/us/en/articles/2023/supply-chain-stability-index.html>

¹⁸⁹ KPMG, “Supply Chain Stability Index: Q1-2023 Quarterly Index Report,” accessed 20 November 2023, <https://kpmg.com/kpmg-us/content/dam/kpmg/pdf/2023/q1-2023-supply-chain-stability-index-report.pdf>

resiliency.¹⁹⁰ The pandemic has introduced a specific stressor for supply chains known as the ripple effect, where disruptions propagate through the network. These ripple effects (Figure 6.1), observed more frequently at various pandemic stages, significantly grew, negatively impacting nearly all industries globally, including semiconductor supply chains.¹⁹¹ Stable supply chains in high-performance semiconductors are crucial to the development of high-tech fields such as aerospace, artificial intelligence and autonomous driving components.¹⁹²

Figure 6.1 Ripple effects during the COVID-19 pandemic



Source: Adapted from Figure 3 in Ivanov and Dolgui (2022).

A report by accountancy firm BDO, based on a survey of 100 CFOs in the US manufacturing sector, found supply chain stability was the most important factor (cited by 20%) in overcoming the pandemic impact, followed by keeping low input costs and productivity (both 17%).¹⁹³ The other two factors highlighted by the survey are market demand and trade policy stability.¹⁹⁴

¹⁹⁰ Newton, E., "Supply Chain Stressors: How to Relieve the Tension," Supply Chain Connect, 24 March 2023, <https://www.supplychainconnect.com/leaders/supply-chain-technology/article/21262650/supply-chain-stressors-how-to-relieve-the-tension>

¹⁹¹ Ivanov, D. and Dolgui, A. Stress testing supply chains and creating viable ecosystems. *Oper Manag Res* 15 (2022): 475–486. <https://doi.org/10.1007/s12063-021-00194-z>.

¹⁹² Maihold, G. and F. Mühlhöfer. "Supply Chain Instability Threatens Security of Supplies: Options for Industry and Policymakers," SWP Comment No. 60, December 2021, https://www.swp-berlin.org/publications/products/comments/2021C60_SupplyChainInstability.pdf

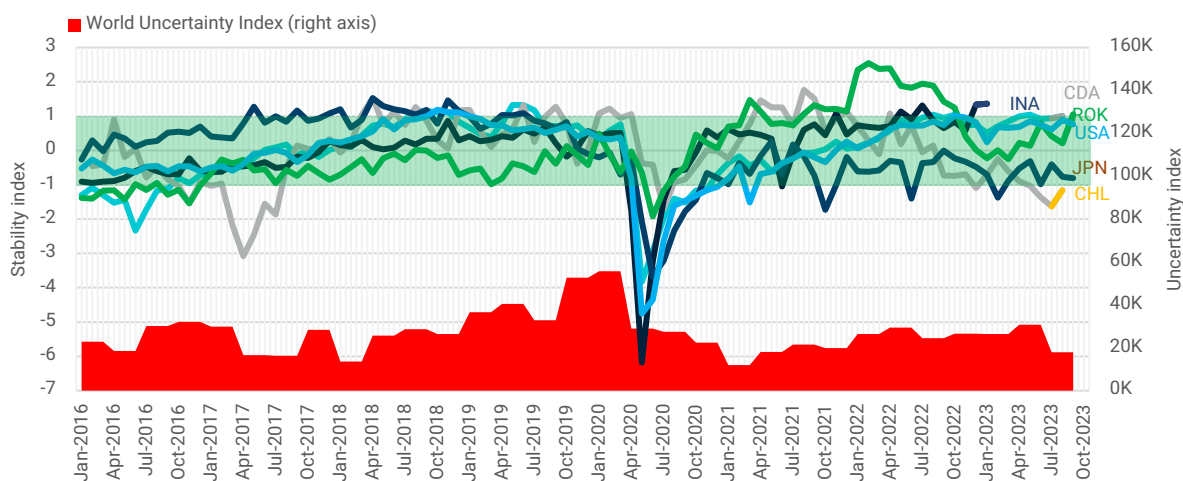
¹⁹³ Patchett, L., "Supply chain stability critical for recovery, say manufacturers," Supply Management, 20 January 2021, <https://www.cips.org/supply-management/news/2021/january/supply-chain-stability-critical-for-recovery-say-manufacturers/>

¹⁹⁴ BDO, "2021 Manufacturing CFO Outlook Survey," <https://www.bdo.com/insights/industries/manufacturing/2021-manufacturing-cfo-outlook-survey>

Resiliency assessment under the stability-based concept can be performed by comparing how production activities behaves under stable condition when there are notable changes or fluctuations in the market. Table 7.4 in Appendix B presents a non-exhaustive list of some of these production and market indicators and its sources. Some of this data is available at economy-level but with various frequencies. Daily, or monthly data are preferable because events affecting production sometimes happen rather quickly and effects would be better captured in narrower periods of time.

Figure 6.2 presents an example of such resiliency assessment in selected APEC economies using a stability index constructed from the OECD Industrial Production Index.¹⁹⁵ The monthly seasonally adjusted industrial production index from OECD’s Main Economic Indicators publication is used as proxy for supply chain situations.¹⁹⁶ Focusing on supply chain stability, the indices are normalized to production capacity in each economy which is assumed to be its historical average. An economy’s supply chain is said to be relatively stable if the stability index moves within one standard deviation as shown by the green-shaded area in the figure. As mentioned earlier, to assess resiliency, this stability index ideally should be compared to any data summarizing evolving market events. Global situation is described by the red-shaded area which represents the World Uncertainty Index from the IMF. From the figure, it can be seen that some economies have relatively less-resilient supply chains as shown by deeper slumps and slower recovery during periods of major disturbances. This indicates that firms would benefit from certain government supports to improve supply chain resiliency.

Figure 6.2. Supply chain stability in selected APEC economies



CDA=Canada; CHL=Chile; INA=Indonesia; JPN=Japan; ROK=Korea; USA=United States

Source: APEC Policy Support Unit (PSU) staff calculations; IMF, accessed 28 November 2023,

<https://www.imf.org/en/Publications/fandd/issues/2020/03/imf-launches-world-uncertainty-index-wui-furceri>.

¹⁹⁵ While there are many facets of supply chain resiliency, for simplicity, the index here only considers production in its supply chain assessment of APEC economies. More comprehensive assessment should consider all other factors that contribute to supply chain stability and resilience.

¹⁹⁶ OECD, “Industrial Production,” accessed 20 November 2023, <https://data.oecd.org/industry/industrial-production.htm>

A resilient supply chain also involves the concept of security and efficiency. Supply chain security refers to the ability to prevent and mitigate risks and threats posed on supply chains operation. Global disturbances, administrative failures, criminal acts, and fraudulent acts are some of the threats that could cause delays or failure to deliver to consumers. Accounting for these factors is key to assessing supply chain security because they could lead to potential disruptions of supply chain networks. Such disruptions could be costly to the economy as businesses have to bear extra costs dealing with the losses which would be passed down to consumers in the form of more expensive prices. Moreover, there is a reputational issue attached to supply chains security as it signals how conducive an economy is for doing business.

Supply chain security may be affected by supply-related risks. Seamless sourcing of inputs for production process ensures that procedures are able to meet market demands. Predictability and consistency of the production process could be compromised by higher supply-related risks. This reduces cost efficiency as firms load more inventories to avoid shortages of inputs. Some of the factors that may affect firms' ability to source inputs include, among others, supplier reliability, source diversification, quality of inputs, input costs, and logistics issues. Logistics issues are especially important to supply chain security as goods move all the way from suppliers, producers, to consumers through logistics networks. Indicators that might be useful to evaluate whether these issues are problematic include delivery and lead times (Figure 2.8 and Figure 2.9), output defect rates, import concentration indices, origin of supplies, and shipping costs. A non-exhaustive list of possible sources for these indicators is presented in Table 6.1.

Supply chain visibility is also an essential element of supply chain security. It relates to the ability of actors to have access to timely and accurate supply and demand information considered to be useful for their operations.¹⁹⁷ Increased visibility improves supply chain security by allowing businesses to anticipate the risks of disruptive impacts upon its performance. Aspects of supply chain visibility typically include order, inventory, shipment, and production visibilities. The shipment visibility aspect, for instance, may be illustrated by the track and tracing score from the World Bank's Logistic Performance Index (LPI) dashboard.

Some of the supply-related risk metrics can also be used as indicators to measure efficiency. An efficient supply chain makes the best use of available resources to deliver products in a timely manner with the lowest possible cost. Time and cost-related supply chain indicators could help in providing a general idea about how efficient an economy's supply chains are relative to those of other economies. As an illustration, manufacturers could diversify supply risks by comparing the PMI suppliers' delivery time index (Figure 2.8) between the possible economies from which it can source its materials from.

¹⁹⁷ Kalaiarasan, R., et. al. "Supply chain visibility for improving inbound logistics: a design science approach." *International Journal of Production Research* 61, no. 15 (2023): 5228–5243. <https://doi.org/10.1080/00207543.2022.2099321>.

Institutional issues also influence supply chain security. A strong legal and administrative framework provides a predictable environment for businesses to operate. For instance, a strong judicial system builds sufficient trust between partners to enter into business arrangements because they could expect any potential dispute to be efficiently resolved in the courts. The state of institutional quality itself can be assessed by some indicators related to law enforcement and public sector performance.

Table 6.1. Possible indicators to assess supply chain efficiency

No.	Indicator	Data source for APEC economies
1	Maritime transport cost	OECD
2	Freightos Baltic Index (FBX)	Freightos
3	Baltic Dry Index (BDI)	Baltic Exchange
4	PMI suppliers' delivery time index	S&P
5	Mean dwell time of containers	World Bank
6	International shipment score	World Bank
7	Timeliness score	World Bank
8	Unit labour cost	OECD
9	LPI – Custom score	World Bank

After the global pandemic, building a strategic supply chain policy is indispensable. Supply chain instability, highlighted by the pandemic, poses a significant threat to resiliency where businesses and policymakers must collaboratively work together to mitigate vulnerability and meet the rising complexities.¹⁹⁸

6.2 TOOLKIT AT THE FIRM LEVEL

Firms and businesses in general should be viewed as the principal actors in the drive to increase supply chain resilience. They are equipped and able to adopt strategies that take the situation of both the individual company and the overall market into account. Governments can also play a role by facilitating or constraining the sourcing and supply chain decisions made by firms.

Good practice interventions generally fall into one of three categories, according to their focus on restrictions, encouragement and different degrees of cooperation and coordination.¹⁹⁹

Key measures and strategies that can be assembled, drawing on experience and insights recorded in earlier sections of this report are summarised in Table 6.2.

¹⁹⁸ Maihold, G. and F. Mühlhöfer. "Supply Chain Instability Threatens Security of Supplies: Options for Industry and Policymakers"

¹⁹⁹ M. Schneider-Petsinger, "US and European Strategies for Resilient Supply Chains Balancing Globalization and Sovereignty," (Chatham House, September 2021).

Table 6.2. Building open, secure and resilient supply chains for firms

Strategic element	Actions for firms	Good practice government support
Prepare for risk		
<i>Identify and assess future supply chain risks</i>	<ul style="list-style-type: none"> • Risk screening • Stress testing 	<ul style="list-style-type: none"> • Identify critical supply chains and risks • Base domestic risk management strategies on results of systematic analysis and stress tests
<i>Anticipate impact of disruption</i>	<ul style="list-style-type: none"> • Assess implications of: <ul style="list-style-type: none"> ○ variability in demand ○ variability in supply ○ variability in performance (including timeliness, consistency and price) 	<ul style="list-style-type: none"> • Stress tests for domestic stockpiles • Private-public dialogue to strengthen capacity to respond to pervasive disruptive events
Raise supply chain flexibility		
<i>Build buffers</i>	<ul style="list-style-type: none"> • Review: <ul style="list-style-type: none"> ○ inventories ○ lead times 	<ul style="list-style-type: none"> • Domestic stockpiles (or stockpiles held jointly with like-minded economies) for products with strategic significance
<i>Review supplier networks</i>	<ul style="list-style-type: none"> • Hedge suppliers, raising diversity contract terms • Reduce supplier numbers, raising reliability 	<ul style="list-style-type: none"> • Raise transparency about supply chain requirements in public procurement • Public procurement contracts to provide model or good practice provisions to accommodate pervasive disruptive events
<i>Review geographic mix</i>	<ul style="list-style-type: none"> • Alter geographic diversity • Reduce exposure to key risks 	<ul style="list-style-type: none"> • Reduce and remove constraints on raising geographic diversity and foreign production (taxes, tariffs, or local content requirements or incentives, tax concessions or subsidies for re-shoring, onshoring, near-shoring or otherwise limiting diversification of supply chains) • Free-trade agreements (FTAs), which could shift production or otherwise diversify supply chain • Measures to work with like-minded economies and trusted partners to secure supply
<i>Raise control over supply chains</i>	<ul style="list-style-type: none"> • Contracting for greater certainty • Partnering with key suppliers • Vertical integration with main or critical suppliers 	<ul style="list-style-type: none"> • Waive regulatory provisions that impede restructuring solutions while preserving competition and safety
Review product design and production		
<i>Restructure for resiliency</i>	<ul style="list-style-type: none"> • Simplify products and reduce complexity • Expand capacity in pinch points 	<ul style="list-style-type: none"> • Review, revise and remove regulations that are no longer fit for purpose or reduce flexibility and resiliency • Provide discussion forums to smooth introduction of innovative approaches in critical pinch points in supply chains (such as ports)
<i>Raise flexibility in production</i>	<ul style="list-style-type: none"> • Pursue more flexible production and distribution capacity including novel techniques, such as 3D printing 	<ul style="list-style-type: none"> • Relax regulatory provisions that constrain supply chain flexibilities
Enhance digitalisation of supply chains		

Strategic element	Actions for firms	Good practice government support
<i>Raise visibility</i>	<ul style="list-style-type: none"> Invest in digital performance-management systems – improving capability to analyse data and key elements of supply-chain performance, sooner Enter into supply chain partner data exchange arrangements. 	<ul style="list-style-type: none"> Invest in digital infrastructure to support more efficient transportation, logistics and customs clearances
<i>Improve planning</i>	<ul style="list-style-type: none"> Improve specific tools – such as logistics management, inventory planning, or network-modelling – or enhance broader end-to-end planning systems 	<ul style="list-style-type: none"> Cooperate and coordinate public–private parties to streamline processes at the border for critical goods in times of emergency
<i>Apply or join digital supply chain platforms</i>	<ul style="list-style-type: none"> Invest in coordination of all aspects of the supply chain such as integration, operations, purchasing, and distribution, streamlining activities and improving customer experience. 	<ul style="list-style-type: none"> Review and revise regulations that are obstacles to flexibility and agility
<i>Raise security and trust</i>	<ul style="list-style-type: none"> Create trusted and tamper-proof records of a goods’ provenance and journey through supply chains (including via blockchain technologies) Strengthen cybersecurity throughout supply chains 	<ul style="list-style-type: none"> Developing and supporting domestic and regional strategies for protection against the theft or damage of products and data Streamline formalities for preapproved/trusted consignees and consignments
Raise social and environmental sustainability in supply chains		
<i>Address climate change</i>	<ul style="list-style-type: none"> Account for and commit to reduce emissions throughout supply chain 	<ul style="list-style-type: none"> Raising accountability for emissions across domestic and global supply chains Some governments apply charges on emissions including on imported goods
<i>Integrate with the circular economy</i>	<ul style="list-style-type: none"> Manage and minimise waste across supply chains 	
<i>Apply social protections</i>	<ul style="list-style-type: none"> Assess and account for performance of social and ethical protections throughout supply chain 	<ul style="list-style-type: none"> Policies introducing a mandatory duty to carry out robust due diligence practices in relation to social, environmental, and ethical aspects, throughout supply chains

Source: M. Schneider-Petsinger, “US and European Strategies for Resilient Supply Chains Balancing Globalization and Sovereignty” (Chatham House, September 2021); FTI Consulting.

6.3 ISSUES IN APPLICATION OF THE TOOLKIT

The toolkit reflects the insights gathered from firms in APEC member economies about measures they have taken in response to recent disruptions in supply chains.

6.3.1 Prepare for risk

The majority of firms in the APEC member economies surveyed applied at least one and sometimes many of the risk management strategies included in the toolkit. Most firms placed a higher priority on taking action immediately in response to threats as they evolved (see Chapter 4), and they placed less emphasis on analysis. That was understandable given the sense of emergency that prevailed at the time of the initial COVID-19 outbreak, the pressures to respond quickly and the lack of data regarding the extent and duration of disruptions which changed rapidly.

A more thorough and considered risk assessment is proposed as the first element of the toolkit. There is now more time and more data about the nature and impact of disruption. It is likely

that the insights obtained from this first element will enhance the effectiveness of the strategies and actions pursued in the remainder of the toolkit.

Government support for firms involves raising capacity to anticipate, discover and deal with supply-chain disruptions and manage risks. The more that is known and shared about emerging threats to supply chains, the easier it will be for firms to identify potential problems, to improve the speed and quality of information for early warning systems, and to respond to supply-chain problems.²⁰⁰ There are good examples of comprehensive, evidence-based analysis and mapping of key risks and vulnerabilities in global supply chains undertaken by governments,²⁰¹ businesses and international organisations. Some governments have also established specific agencies to continue to assess risk and share information with the private sector.

International organisations such as IMF have attempted to assess, for example, using highly disaggregated international trade data, the spillover effects of supply shocks from the import of specific goods. The Federal Reserve Bank of New York has developed the Global Supply Chain Pressure Index which combines various metrics to offer a comprehensive overview of possible supply chain disruptions.²⁰²

Similar measures have also been developed by major analytics and consulting companies. The Supply Chain Vulnerability Index from GlobalData leverages trade data to map economies vulnerability in the global supply chain. FM Global with its economy-level Supply Chain Resilience Index measures the extent to which the supply chain of enterprises is resilient to any disruptive events. Some of these measures are presented in Appendix B for illustrative purposes.

At the firm level, efforts are emerging to develop resiliency index to pinpoint vulnerabilities before they manifest, employing a quantitative assessment of operational and macro impact risks.²⁰³

6.3.2 Raise supply chain flexibility

Building buffers

Creating greater buffers was a common approach adopted by firms to strengthen resilience (see Figure 4.6 and section 4.2.6). This included expanded inventories (i.e., stockpiling) or building in additional lead times. This approach has drawbacks. Holding larger inventories involves greater costs and is not always feasible, given the nature of the products (which may have limited shelf life). It is generally difficult to increase stockpiles at the time when they are most needed, that is, when shortages are looming. Increasing stockpiles can lead to hoarding which

²⁰⁰ Schneider-Petsinger, "US and European Strategies for Resilient Supply Chains."

²⁰¹ Please refer to the case study on Australia Productivity Commission that is included in this report.

²⁰² The Global Supply Chain Pressure Index incorporates metrics such as the Baltic Dry Index (BDI), the Harpex index, airfreight cost indices from the U.S. Bureau of Labor Statistics, and relevant components from Purchasing Managers' Index (PMI) surveys. See: Federal Reserve Bank of New York. (n.d.). Global Supply Chain Pressure Index (GSCPI). Retrieved from <https://www.newyorkfed.org/research/policy/gscpi#/overview>.

²⁰³ For example, see: Bain & Company. (n.d.). Supply Chain Resiliency Index. Retrieved from <https://www.bain.com/consulting-services/operations/supply-chain/supply-chain-resiliency-index/>.

makes supply chain blockages more difficult to manage for everyone. Extending lead times may preserve many just-in-time benefits, but when applied on a widespread basis, this slows supply, production and the economy at large. At best, these are partial or temporary solutions. Firms should apply other elements of the toolkit which help to raise underlying flexibility.

Review supplier networks and geographic mix

Firms can review their supplier networks. They may hedge some supplier risk by diversifying the mix, reducing their exposure to key suppliers at the cost of raising transaction costs with a larger number of suppliers with smaller scale orders.

Governments may encourage or oblige companies to revert to domestic production or “onshore” or “re-shore” a proportion of their productive capacity. While such policies may support the desired outcome of securing supply in an emergency situation, they may alter the risk profile of supply. While increasing domestic production may reduce exposure to international risks, this comes at the cost of raising exposure to local shocks involving events such as natural disasters or disease outbreaks.²⁰⁴ One key additional risk is the possibility that these measures lead to retaliatory action from other economies, thereby starting a wave of protectionism and led to negative spillovers for trading partners.

Mandatory or compulsory measures will probably increase production costs (reflected in higher domestic prices) and thus reduce productivity; additionally having multiple suppliers may result in the loss of certain degree of economies of scale.²⁰⁵ The main result of policy mandated change is likely to be reduced economic growth in the medium to long term. It would be prudent to limit the use of mandatory policy controls over supply chains to the period of an emergency.

Raise control over supply chains

Issues with shipping and logistics was a recurrent theme in FTI’s global supply chain resilience survey and in interviews with stakeholders.²⁰⁶ Most of the issues centred around:

- Bottlenecks in moving goods efficiently from port to port – uncertainty around timelines
- Cumbersome compliance checks and regulatory uncertainty
- Long delays in clearance at the border
- Container issues including shortages and inadequate resources to offload containers
- Manufacturing of containers limited to certain key hubs
- Regulations on shipping lines, preventing ships from docking in a timely manner
- Lack of transparency into port charging structure

²⁰⁴ See discussion on nearshoring in section 4.2.7.

²⁰⁵ Schneider-Petsinger, “US and European Strategies for Resilient Supply Chains.”

²⁰⁶ See discussion on issues in shipping and logistics (section 2.2.1).

- Impeded information flow between all parties along the port supply chain

Consolidation in transport and logistical supply chains is one means of managing risks and raising control. Several shippers indicated in the survey and in stakeholder consultation meetings that they were concerned that the future will see the larger global shipping companies buy out port companies, freight forwarders, shipping lines and key assets, including the stock of containers.

As noted in Chapter 4, every interface in the supply chain can cause delay and this costs money, for example hoarding, trucking, container tracking. All of these costs are passed on to the consumer which can hurt competitiveness and has worrying implications for adding to inflationary pressures. Stakeholders noted that buying links in the chain allows for better control and seamless traction along the chain. This includes port companies buying storage, warehousing, moving from the core business to other related businesses (e.g., DP World,²⁰⁷ Abu Dhabi ports) for better control and an improved service offering. Some companies are also forming alliances with customers, offering a one stop shop for all these customers' needs.

Supply chain consolidation can lead to a lack of competition for shipping and likely higher prices for importers and exporters. Equally, operating within cumbersome and inflexible market structure adds costs and risks.

Some firms consulted in this research suggested that regulation of the sector needs to be overhauled, including modernising some regulations that originated more than a century ago. The challenge is to preserve competition where it is most needed while also providing flexibility to permit business to find workable structures. This may involve relaxation of regulatory impediments.

Some key initiatives that APEC could consider might include establishing a port sector supply chain forum, publishing information on port sector supply chain performance, and undertaking some detailed studies in this area.

Given bottlenecks experienced around shipping and logistics during the COVID-19 pandemic, some of the initiatives around shipping could include:

- *Logistics sector regulation*: Improving logistics sector regulation will assist in the promotion of effective competition and prevent the negative effects of the industry's propensity to vertically integrate.
- *Port governance*: Advancing port governance and management changes in conjunction with trade facilitation initiatives would help to streamline port and customs clearance operations.²⁰⁸

²⁰⁷ DP World, Website, accessed 31 March 2023, <https://www.dpworld.com/>

²⁰⁸ World Bank, "Reshaping Global Value Chains in Light of COVID-19: Implications for Trade and Poverty Reduction in Developing Countries" (World Bank, 2020), <https://openknowledge.worldbank.org/entities/publication/dd74bd89-c813-573b-b9de-dfc98beab039>

- *Improving policies:* Improving rules would not only lower trade costs and enhance punctuality, but it would also permit the development of effective continuity plans for maintaining ports and customs operations during a crisis, such as working with a restricted workforce under social distancing.²⁰⁹
- *Improved infrastructure:* The pandemic has demonstrated the importance of infrastructure improvements, in particular, mitigating trade disruption related to supply interruptions. For instance, updating and modernising port infrastructure on critical global shipping routes could assist in reducing global bottlenecks.

6.3.3 Review product design and production

In the long run (when all factor inputs and costs are variable) firms are able to restructure their production processes and raise flexibility. Production lines can now be changed with lower costs from interruption, meaning that it is possible to remove or alter some inputs.

Technological change now also permits the opportunity to skip key high-risk links in traditional supply chains. 3D printing capabilities could allow supply of critical components and spare parts essentially on demand without long term inventory holding costs and without reliance on distant and tenuous transport links.

Firms should review these emerging capabilities and determine if they can be applied to meet their needs while raising flexibility and resilience. These opportunities would require an investment in time and resources to understand how they can be applied in practice and how they change underlying risk and vulnerabilities.

6.3.4 Digitalisation

Greater digitalisation of supply chains will allow firms to better balance the trade-off between efficiency and resilience. Technologies based on the cloud artificial intelligence (AI) and blockchain, for example, allows firms to monitor their suppliers more quickly, often in real time, and in more detail.²¹⁰ Investment in digital infrastructure is already underway and is vital to pre-empt and manage disruptive events. Enhancing these capacities involves significant investment and costs which will ultimately be passed on to customers. The research findings provided earlier in this report suggest that while seeing the importance of digitisation, many firms have prioritised other actions.²¹¹ This strategic action point is a critical element in the toolkit as it enables and supports capacity for flexibility and agility that underpin resilience.

6.3.5 Raise security and trust

Cybersecurity was given lower weight in the survey compared to some of the stakeholder interviews and related literature. It remains a key risk, however, to the operation of supply

²⁰⁹ World Bank, “Reshaping Global Value Chains in Light of COVID-19.”

²¹⁰ The Economist Intelligence Unit (EIU), “*The Business Costs of Supply Chain Disruption*” (GEP and EIU, 2021), https://impact.economist.com/perspectives/sites/default/files/the_business_costs_of_supply_chain_disruption_gep_1.pdf .

²¹¹ See Table 4.2.

chains given the impacts and fallout from a successful cyber-attack, particularly in an era of increased digitisation of international trade.

The stakeholders that we spoke to indicated that they intended to increase investment in cybersecurity. This was partly a response to governmental regulations obligating them to make such investments.

APEC recently undertook a stocktake of APEC economies’ cybersecurity approaches.²¹² In order to continue to encourage firms to be vigilant to the needs and risks around cybersecurity, APEC has continued to play a role in facilitating cooperation across borders, developing harmonised standards and best practice, publishing guidelines for tackling cyber risks (incident response, threat intelligence, cybercrime investigations), facilitating public-private partnership, and facilitating training and capacity building for member economies.

6.3.6 ESG and supply chains

While it appears as the last element of the toolkit, raising social and environmental sustainability should be viewed as a non-negotiable bottom line. If firms fail to progress in managing these risks, they may well find themselves excluded from accessing major markets and facing a querulous reception from investors and business partners, and hostility from policymakers and regulators.

6.4 RESILIENT SUPPLY CHAINS AT THE ECONOMY-WIDE LEVEL

Government is generally the primary actor when considering good practice at the economy-wide level. Table 6.3 sets out a framework summarising strategic measures and actions that would be effective in maintaining open and resilient supply chains across APEC economies.

Table 6.3. Building open, secure and resilient supply chains at the economy-wide level

Economy-wide aims	Good practice government support
Support continuity of supply and economic growth	
<i>Enhance preparedness</i>	<ul style="list-style-type: none"> • Support the ability of industry to anticipate, discover and deal with widespread supply-chain disruptions • Improve transparency, visibility and traceability of supply-chain layers, and share this information along the supply chain • Private–public dialogue to strengthen capacity to respond to pervasive disruptive events
<i>Anticipate and mitigate impacts of disruption</i>	<ul style="list-style-type: none"> • Stress testing for banks and insurance companies to include supply chain disruptions and preparation of risk mitigation plans
<i>Maintain security of supply of goods and services with strategic importance</i>	<ul style="list-style-type: none"> • Stress testing the need for domestic stockpiles (or stockpiles held jointly with allies) for products with strategic significance

²¹² APEC, “Standards and Process-based Approach to Enhancing Cybersecurity” (Singapore: APEC, 2020), https://www.apec.org/docs/default-source/publications/2020/7/standards-and-process-based-approach-to-enhancing-cybersecurity/220_scsc_standards-and-process-based-approach-to-enhancing-cybersecurity.pdf?sfvrsn=54c7b190_1.

Economy-wide aims	Good practice government support
<i>Target public procurement solutions as a last resort</i>	<ul style="list-style-type: none"> • Many governments procured vaccines, personal protective equipment (PPE) and other supplies to combat the pandemic
Maintain price stability	
<i>Contain or cap price increases for key goods</i>	<ul style="list-style-type: none"> • Temporary price caps on goods of strategic significance only
<i>Manage price pressures in supply chains</i>	<ul style="list-style-type: none"> • Lifting export restrictions applied as a temporary measure, initially in the context of the pandemic and more recently in the context of the various unilateral restrictive measures and the food security crisis, is essential to reduce price spikes and volatility • Public procurement contracts provide model or good practice provisions to accommodate price rises through disruptive events
Preserve trade that supports supply chain resilience	
<i>Reinforcing an open and rules-based global trade system</i>	<ul style="list-style-type: none"> • Exercising restraint in the use of export restrictions; supporting World Trade Organization (WTO) reform; negotiating free trade agreements (FTAs)
<i>Review geographic mix in trade and supply chains</i>	<ul style="list-style-type: none"> • Reduce and remove constraints on raising geographic diversity and foreign production (taxes, tariffs, or local content requirements or incentives, tax concessions or subsidies for re-shoring, onshoring, nearshoring or otherwise limiting diversification of supply chains) • FTAs, which could shift production or otherwise diversify supply chains • Measures to work with allies and trusted partners to secure supply
Enhance digitalisation of supply chains	
<i>Advance governance frameworks for new technologies</i>	<ul style="list-style-type: none"> • Facilitate transparency and visibility along the supply chain (supporting blockchain, for example) or help firms adjust production swiftly (such as 3D printing). Review and revise regulations and governance provisions that are obstacles to flexibility and agility
<i>Invest in digital infrastructure</i>	<ul style="list-style-type: none"> • Enhance capacity in public administration and regulation of key nodes in supply chain networks to support more efficient transportation, logistics and customs clearances
<i>Coordinate</i>	<ul style="list-style-type: none"> • Public-private dialogue to streamline processes at the border for critical goods in times of emergency
<i>Raise security and trust</i>	<ul style="list-style-type: none"> • Developing and supporting domestic and regional strategies for protection against the theft or damage of products and data • Streamline formalities for preapproved/trusted consignees and consignments
Conducive business environment	
<i>Fit-for-purpose regulation</i>	<ul style="list-style-type: none"> • Review, revise and remove regulations that are no longer fit for purpose or reduce flexibility and resiliency
<i>Enhance flexibility</i>	<ul style="list-style-type: none"> • The process of granting authorisation or licences for essential products or services can be expedited or made faster

Economy-wide aims	Good practice government support
<i>Support investment and technological innovation</i>	<ul style="list-style-type: none"> • Governments should lead by example, investing in digitalisation of their own systems (especially customs) and promote confidence and trust in digital supply chain infrastructure

Sources: FTI Consulting; M. Schneider-Petsinger, “US and European Strategies for Resilient Supply Chains Balancing Globalization and Sovereignty” (Chatham House, September 2021); OECD, “Keys to Resilient Supply Chains: Regulatory Flexibility,” accessed 31 March 2023, <https://www.oecd.org/trade/resilient-supply-chains/regulatory-flexibility/>

6.5 COMMENTS ABOUT APPROACHES ADOPTED BY GOVERNMENTS

6.5.1 Supporting continuity of supply

Many governments procured vaccines, PPE equipment and other supplies to combat the pandemic. Constraints in fiscal resources limits this approach to a small range of goods that are vital in meeting critical needs. It cannot be relied upon to cure widespread and enduring shortages.

Governments in APEC member economies also stockpile some critical goods. In the United States, for example, the Strategic National Stockpile covers selected pharmaceutical and medical supplies. The US Department of Energy’s Strategic Petroleum Reserve is the world’s largest emergency reserve of crude oil. Stress tests could be used to determine if a government’s domestic stockpiling strategy is adequate to prevent shortages. Reviews are necessary to assess which products should be viewed as critical and added to the stockpile or strategic reserves.

Identifying critical products and stockpiling them is challenging and comes at a substantial cost. Governments have to apply risk management strategies to balance coverage and protections provided against the costs. A number of APEC members have agreed to share stockpiles in case of emergencies which is one way of achieving a better balance between the risks and costs.

6.5.2 Maintaining price stability

The first line of defence to the risk of spiralling inflation from supply bottlenecks should be to tackle the bottlenecks directly. This can be achieved, for instance, by fast-tracking the removal of inflexible rules and regulations that impede expansion of transport and logistics services. Other measures could include temporary relaxation of limitations on port operating times, simplification of customs inspections, loosening of immigration regulations to address workforce scarcities, and similar measures.

Export restrictions can reduce domestic price pressures in some circumstances. However, as more economies implement restrictions there is an increased likelihood of price volatility, panic

buying, shortages and hoarding.²¹³ Export restrictions often result in reduced supply in the longer term and generally prove to be inimical to price stability and economic growth.

The application of price caps to manage risks of inflation from disruption of supply chains also entails risk of unintended consequences. If the caps are set too high, they are ineffective. If they are set too low, they will lead to undersupply and serve to entrench rather than resolve shortages. Governments rarely have sufficient information to set the caps so that they are efficient.

If export restrictions and price caps are applied, the measures should be applied on a temporary basis and withdrawn when the crisis subsides.

6.5.3 Preserving trade that supports supply chain resilience

While global supply chains can become the source of vulnerabilities and transmit shocks, it is also true that they can contribute to absorb shocks during a crisis thus facilitating a faster recovery. Rather than mandatory re-shoring or onshoring of supply via domestic sources, preserving trade can help by shifting production across different locales avoiding risk hotspots, or by diversifying inputs and sources of supply.

Finding the right balance between onshoring and preserving trade will vary depending on the specific economic sectors and the type of emergency being faced. Often, this is a choice best left to firms, as they have a strong incentive to get the balance right. Policy makers should weigh up each case carefully on its merits.

6.5.4 Public sector enhancement of digitalisation in supply chains

Government can enhance the transition towards digitisation throughout supply chains thereby raising resilience. Policymakers' most immediate opportunity should be to invest in digitalisation of the business of government itself, raising efficiencies and also raising confidence and trust in digital processes along the supply chain, including among businesses and final consumers.

Streamlining formalities for preapproved/trusted consignees and consignments would also provide additional incentives for business to switch to approaching processes digitally.

6.5.5 Conducive business environment

Business environment among APEC economies will continue to be key to facilitating supply chain resilience. Member economies can factor in business priorities when negotiating trade agreements to encourage inward investment that can be critical to supply chain resilience. This includes investment rules that meet high standards and that offer a stable, predictable and transparent investment environment. Investment liberalisation extends beyond individual member economies to the broader theme of advancing regional economic integration, as

²¹³ Australian Trade and Investment Commission, "Insight – High Food Prices Drive Rise in Export Restrictions," 25 May 2022, https://www.austrade.gov.au/news/insights/insight-high-food-prices-drive-rise-in-export-restrictions?utm_source=miragenews&utm_medium=miragenews&utm_campaign=news

captured under the Free Trade Area of the Asia-Pacific (FTAAP). APEC can continue to facilitate this through bilateral collaboration, including relevant fora and information sharing.

6.5.6 Enhanced flexibility

Governments have sought to improve regulatory systems to make them more agile and flexible when coping with emergencies. This has been essential to allow economies to access and utilise all supply sources with minimal constraints. It's important to note that this doesn't involve compromising safety or quality requirements, but rather involves the temporary suspension of certain requirements or the speeding up of the authorisation or licensing procedures for essential products or services.²¹⁴

To facilitate the movement of goods in times of crisis, governments can also take steps to expedite customs administration and the timely release of critical goods by simplifying procedures without undermining health and safety. There was some criticism from business respondents to the survey reported in earlier parts of this research report that, sometimes in practice, customs and biosecurity controls contributed to delays. Even trusted trader schemes seemed to make little difference to the delays that were experienced in clearing goods across borders. The intent of these arrangements is sound and making them work as expected offers significant potential to raise flexibility and resilience in supply chains.

6.6 SUMMARY OF KEY FINDINGS

In line with the objectives of the study, we sought to develop a framework that can guide APEC's thinking for building and maintaining open, secure, and resilient supply chains at the firm and economy-wide level. At the firm level, the cornerstones of the toolkit relate to:

- Preparing for risk
- Raising supply chain flexibility
- Reviewing product design and production
- Enhancing digitalisation of the supply chain
- Raising social and environmental sustainability in supply chains

At the government and economy-wide level, the key themes in the toolkit include:

- Supporting continuity of supply and economic growth
- Maintaining price stability
- Preserving trade that supports supply chain resilience
- Enhancing digitisation of supply chains

²¹⁴ OECD, "Keys to Resilient Supply Chains: Regulatory Flexibility," accessed 31 March 2023, <https://www.oecd.org/trade/resilient-supply-chains/regulatory-flexibility/>

- Supporting a conducive business environment
- Supporting investment and technological innovation
- Supporting greater social and environmental sustainability across supply chains

Raising resilience of supply chains to address emerging needs of business and government is unlikely to be realised through a one-size-fits-all approach. Instead, a toolkit approach has been deployed that sets out a range of techniques that can be selected to fit the specific needs of an industry or economy.

7 KEY FINDINGS: OPEN, SECURE AND RESILIENT SUPPLY CHAINS IN THE POST-PANDEMIC ERA

The confluence of the COVID-19 pandemic, the rise of trade protectionism, including in the form of unilateral restrictive measures, trade disputes, the drift toward inward-looking policies in some quarters, as well as ongoing structural change in the underlying economy, the transition to greater environmental sustainability and more active management of social and ethical problems throughout supply chains, presents multiple risks. Building and maintaining open, secure and resilient supply chains will require multifaceted solutions. This chapter draws out key findings from the research results reported in earlier chapters. It also points to a range of long-term actions and strategies for building and maintaining open, secure and resilient supply chains in the APEC economies.

7.1 KEY RISKS AND VULNERABILITIES

Businesses consulted through this study have indicated that their supply chains are vulnerable to a raft of vulnerabilities. The COVID-19 pandemic highlighted the vulnerability of supply chains; the key risk faced by firms that use and provide supply chain services is that the era of ever decreasing costs with constantly improving supply chain performance is over. Looking back, there was a period of remarkable stability for two to three decades. COVID-19, and now many other global shocks, has shattered any prospect of a return to the old business-as-normal in the near future. While shipping prices – including the cost of a shipping container - have fallen from their recent peak, they remain well above levels sustained over recent decades.

Supply chain resilience was once defined as the ability to return to normal operations in an acceptable period of time after being disrupted.²¹⁵ Now that it is clear that the numbers and types of threats that can undermine a supply chain are greater than ever, and this situation is likely to endure for some time, resilience now transcends normal operations and extends into consideration of the durability of firms, up and down the full supply chain into the foreseeable future.

The many recent disruptions to global supply chains applied a significant penalty to many businesses. This was heaviest for those that adapted slowly or had less capacity to manage risks. Supply chain resilience is no longer limited to the ability of a business to manage risk. Businesses are not merely looking to avoid costs and inconvenience. Resiliency now means that in addition to managing risk, business organisations need to be better positioned to deal with –and benefit from – disruption and transformative changes already underway in global markets.

²¹⁵ A. Bayhaqi and L. Ge Lai, “A Decade of Supply Chain Initiatives: Opportunities and Challenges in Post-COVID-19 Recovery,” APEC Policy Brief no. 42, January 2022.

Failure in this may have profound implications for business continuity and the success of a business. Building and maintaining resilient supply chains should be viewed as a critical element of business planning for the next few years at least.

7.2 RECOMMENDATIONS TO BUILD RESILIENCE FOR FIRMS AND BUSINESS

Firms across APEC member economies are not inclined to withdraw from global supply chains but are looking to modify and improve them. They are aiming to raise flexibility while retaining the efficiencies of scale derived from global and regional trade and distribution of production. This is necessary to retain their competitive strengths in what remains a highly competitive and more volatile market environment.

The multifaceted risks, vulnerabilities and opportunities presented to firms and industries that are increasingly reliant on long and complex supply chains require a multifaceted response. Firms need more information and insight about the full range of actions that they can pursue and how and when they can be applied to address identified risks. That is, they need a toolkit.

The key elements of the toolkit proposed for use by firms includes the following.

- Raising preparedness – expand scanning of major risks and include supply chain stress testing in business planning and risk management strategies.
- Restructure and redesign supply chains – build in buffers, raising inventories and adding lead times; manage the mix of suppliers; and manage geographic diversity to produce greater flexibility and resilience in supply chains.
- Change product design – simplify products and production processes, bypassing or skipping higher-risk links in supply chains.
- Investment in digitalisation – access more data, enhance decision-making tools, join or create supply chain platforms to provide end-to-end visibility and capacity to make decisions in real time and raise flexibility across the supply chain. It will also be important to invest in building confidence and trust in digital business activities throughout supply chains to combat rising cybersecurity threats.
- Enhanced environmental, social and governance (ESG) commitments – raise capacity to account for the environmental, social and ethical dimensions of each firm’s performance and its full supply chain. This will raise capacity to comply with emerging policy expectations and regulation. It will also be increasingly important to have complete transparency in order to meet the rising expectations of investors, suppliers and customers.

7.3 APPROACHES FOR MANAGERS AND GOVERNMENTS

Governments are well-placed to assist business to address systemic, economy-wide risks to global value chains, particularly those resulting from unexpected events like the COVID-19 pandemic and natural disasters and changes in policy settings. Governments can play a direct role, intervening to raise continuity of supply in some cases where the dangers of a loss of supply are considered to be critical or acute. Managers in an economy more often play a less

direct role providing information, encouragement or cooperation with firms, and where unavoidable, act to regulate, restrict and shape the decisions made mostly by businesses and industry to raise resiliency in their supply chains.

Specific measures were identified and assessed which would:

- Support continuity of supply and economic growth and maintain price stability
- Preserve openness to trade that supports supply chain resilience, which would encompass maintaining an open, non-discriminatory, rules-based, predictable and stable multilateral trading system and resisting the growth of trade protectionism, including in the form of unilateral trade restrictions²¹⁶
- Enhance digitalisation of supply chains, focusing on measures while simultaneously developing existing physical infrastructure; and increase the level of supply chain automation (increase productivity and reduce operating costs)
- Reduce trade, logistics and administrative costs for economic operators, including through facilitation of cross-border procedures, significant automation and digitalisation of customs operations; full implementation of the WTO Trade Facilitation Agreement; investment facilitation; facilitation of domestic regulation in services; logistics services development and reduction of respective costs; and reduction of administrative burdens on trade²¹⁷
- Assist businesses in adapting to modern environmental, social, and labour standards used by the global market leaders²¹⁸
- Encourage initiatives from the private sector that raise transparency and trust that could support supply chain effective formation and functioning
- Conducive business environment

There are risks and challenges associated with many of the measures identified. The measures are offered as options or mechanisms that could be selected when they fit specific circumstances or needs.

7.4 MULTILATERAL COOPERATION AND REGIONAL INITIATIVES

7.4.1 Supply chain resilience and APEC

Helping businesses promote dynamic and innovative supply chains that are also open, secure and resilient is implicit in many of APEC's fundamental goals and objectives. APEC

²¹⁶ APEC, "APEC Workshop on Effective Domestic Policymaking for Stimulating Economic Upgrading through Global Value Chains: Summary Report" (Singapore: APEC, 2022),

http://mddb.apec.org/Documents/2022/CTI/WKSP3/22_cti_wksp3_summary.pdf

²¹⁷ APEC, "APEC Workshop on Effective Domestic Policymaking for Stimulating Economic Upgrading through Global Value Chains."

²¹⁸ APEC, "APEC Workshop on Effective Domestic Policymaking for Stimulating Economic Upgrading through Global Value Chains."

champions free and open trade and investment, promotes regional economic integration, encourages economic and technical cooperation, seeks to enhance human security, and facilitates a favourable and sustainable business environment.

The APEC Supply-Chain Connectivity Framework Action Plan (SCFAP), implemented before the COVID-19 pandemic, highlighted the importance of improving transparency and efficiency at the border, building trust and improving supply chain visibility. A review of progress identified that high logistical costs, as well as underdeveloped policy and regulatory infrastructure for digital commerce and slow adoption of automation and harmonisation of regulations, were impeding achievement of the region's full potential.

Given the strength in the evidence that economies in the APEC region are interdependent, particularly in terms of trade and global value chains, building resilience together as a region is particularly important.²¹⁹

Resilient supply chains have to be built and maintained domestically and in partnership with dependable neighbours. Reducing the harms that accompany greater engagement in the region and in the global economy and promoting greater self-reliance when confronting disruptive events and crisis situations, do not have to mean abandonment of open regionalism that has been a keystone for APEC members for many decades. Open, secure and resilient supply chains in and among APEC economies will be advanced by continuing to apply the three pillars of APEC's agenda focus²²⁰ (trade and investment liberalisation; business facilitation; economic and technical cooperation) and to pursue the three economic drivers of Putrajaya Vision (trade and investment; innovation and digitalisation; strong, balanced, secure, sustainable and inclusive growth).²²¹

7.4.2 Potential focus areas for APEC

In order to increase resilience, APEC members have to support change within their economies and across the Asia-Pacific region. APEC members should look beyond current vulnerabilities and challenges, and concentrate on those that will probably arise in the future.

Success will most likely involve a mix of measures including the following:

- Risk scanning and monitoring – APEC should monitor and share information about risks, vulnerabilities and likely resiliency of APEC member economies and their critical supply chains. This could assist in identifying early warning indicators for economies and possibly for key industries/sectors.
- Trade facilitation – reducing trade friction and bureaucracy at the border. This would build on progress already made by APEC members to implement a Single Window

²¹⁹ B. Sangaraju and A. Bayhaqi, "Managing Risks in Global Value Chains: Strengthening Resilience in the APEC Region," APEC Policy Brief no. 37, December 2020.

²²⁰ APEC, "Scope of Work," updated September 2021, <https://www.apec.org/about-us/how-apec-operates/scope-of-work>

²²¹ APEC, "APEC Putrajaya Vision 2040," 2020, https://www.apec.org/meeting-papers/leaders-declarations/2020/2020_aelm/annex-a

system for the processing of trade documents to enhance common digital infrastructure easing private operators' abilities to exchange information with border agencies.

- Shipping and logistics focus – detailed review of vulnerabilities and emerging issues in shipping, transport infrastructure and logistics within APEC members, and promotion of measures to resolve issues therein (see section 2.2.1).
- Digitisation agenda – continued efforts in promoting digitisation in trade and industry, with a much heavier focus on supply chains. This should involve detailed studies on sectors that have pioneered the digitisation of supply chains.
- Sustainability of supply chains – continued encouragement of green growth through raised transparency and accountability for environmental performance throughout supply chains.
- APEC should continue to promote supply chain resilience through green growth initiatives, education and training outreach, bilateral committees and fora, and encouraging the harmonisation of supply chain related environmental standards across the region, as well as facilitating knowledge sharing in terms of best practice. The latter can include the more appropriate and efficient means for firms to achieve compliance of their supply chain with respect to ethical sourcing of inputs.

APPENDIX A. SURVEY SECTORS AND REGIONS

Table 7.1. Sectoral supply chain disruption by economy based on desktop research

Economy	Accommodation and food services	Admin & support	Agriculture, forestry, fishing and hunting	Arts, entertainment and recreation	Construction	Healthcare	Manufacturing	Mining	Real estate	Retail trade	Services (professional, scientific and technical)	Transport & warehousing	Wholesale trade
Australia ⁱ		X			X		X	X		X			X
Brunei Darussalam ⁱⁱ					X					X			X
Canada ⁱⁱⁱ			X	X					X	X	X		X
Chile ^{iv}								X					X
People's Republic of China ^v							X			X			
Hong Kong, China ^{vi}										X			
Indonesia ^{vii}						X				X			
Japan ^{viii}							X			X			
Republic of Korea ^{ix}							X						
Malaysia ^x							X			X			
Mexico ^{xi}							X			X			
New Zealand ^{xii}							X			X		X	X
Papua New Guinea ^{xiii}					X		X	X		X			
Peru ^{xiv}										X			X
The Philippines ^{xv}							X			X			X
The Russian Federation ^{xvi}	X		X		X		X	X		X		X	
Singapore ^{xvii}							X			X			
Chinese Taipei ^{xviii}							X						
Thailand ^{xix}							X						
United States ^{xx}	X				X		X			X			X
Viet Nam ^{xxi}							X						

Table 7.2. Sectors for survey and analysis

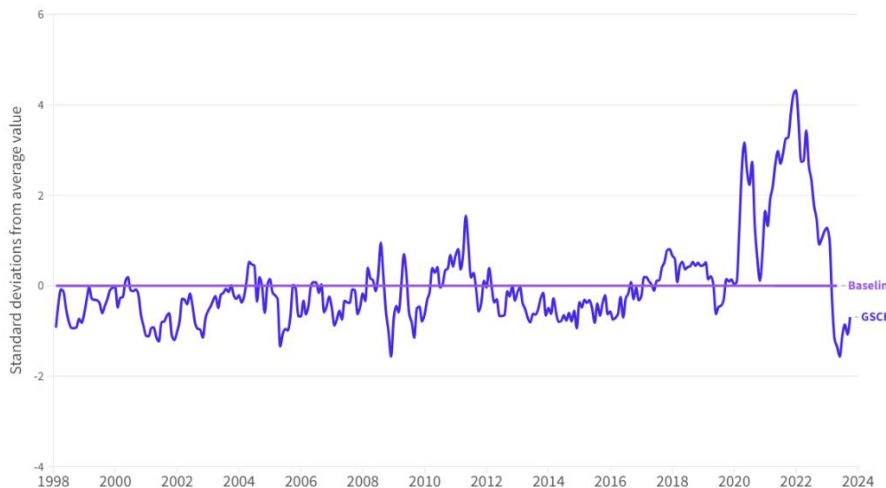
Sector for APEC study		GICS sector code	GICS sector	GICS industry group code	GICS Industry group
Consumer Goods/Retail	E-commerce	25	Consumer Discretionary (Consumer Cyclical)	2550	Retailing
	Apparel	25		2520	Consumer Durables & Apparel
	Accessories & Footwear	25		2520	Consumer Durables & Apparel
	Appliance Manufacturing	25		2520	Consumer Durables & Apparel
	Building Products & Furnishings	25		2520	Consumer Durables & Apparel
Food & Beverage (incl. Wholesaling)	Agricultural Products	30	Consumer Staples (Consumer Defensive)	3020	Food, Beverage & Tobacco
	Meat	30		3020	Food, Beverage & Tobacco
	Poultry & Dairy	30		3020	Food, Beverage & Tobacco
	Processed Foods	30		3020	Food, Beverage & Tobacco
Extractives & Minerals Processing	Construction Materials	15	Materials	1510	Materials
	Iron & Steel Producers	15		1510	Materials
	Metals & Mining	15		1510	Materials
Transportation	Air Freight & Logistics	20	Industrials	2030	Transportation
	Marine Transportation	20		2030	Transportation
Resource Transformation/ Manufacturing	Aerospace	20	Industrials	2010	Capital Goods
	Automobiles	25	Consumer Discretionary (Consumer Cyclical)	2510	Automobiles & Components
	Auto Parts	25		2510	Automobiles & Components
	Containers & Packaging	15	Materials	1510	Materials
	Electrical & Electronic Equipment	45	Information Technology	4520	Technology Hardware & Equipment
	Industrial Machinery & Goods	20	Industrials	2010	Capital Goods
	Chemicals	15	Materials	1510	Materials

Table 7.3. Economy and regional coverage in FTI's global supply chain resilience survey

Region	Economy
Region A	Australia
	New Zealand
	Papua New Guinea
Region B	Brunei Darussalam
	Indonesia
	Malaysia
	The Philippines
	Singapore
	Thailand
	Viet Nam
Region C	Canada
	Mexico
	United States
Region D	Chile
	Peru
Region E	China
	Hong Kong, China
	Japan
	Republic of Korea
	Russia
	Chinese Taipei

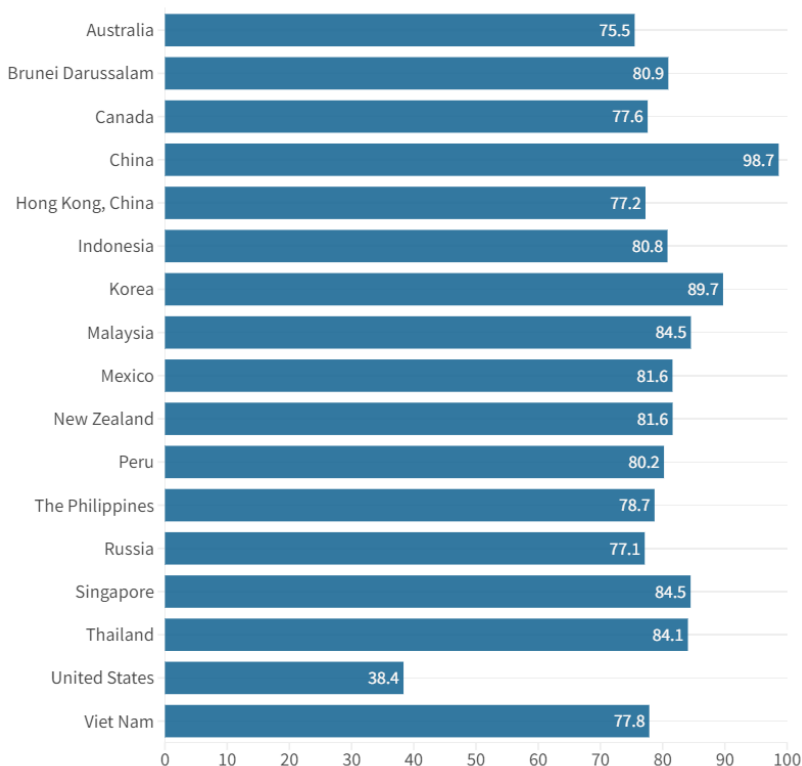
APPENDIX B. INDICATORS OF SUPPLY CHAIN RESILIENCE

Figure 7.1. Global Supply Chain Pressure Index (GSCPI)



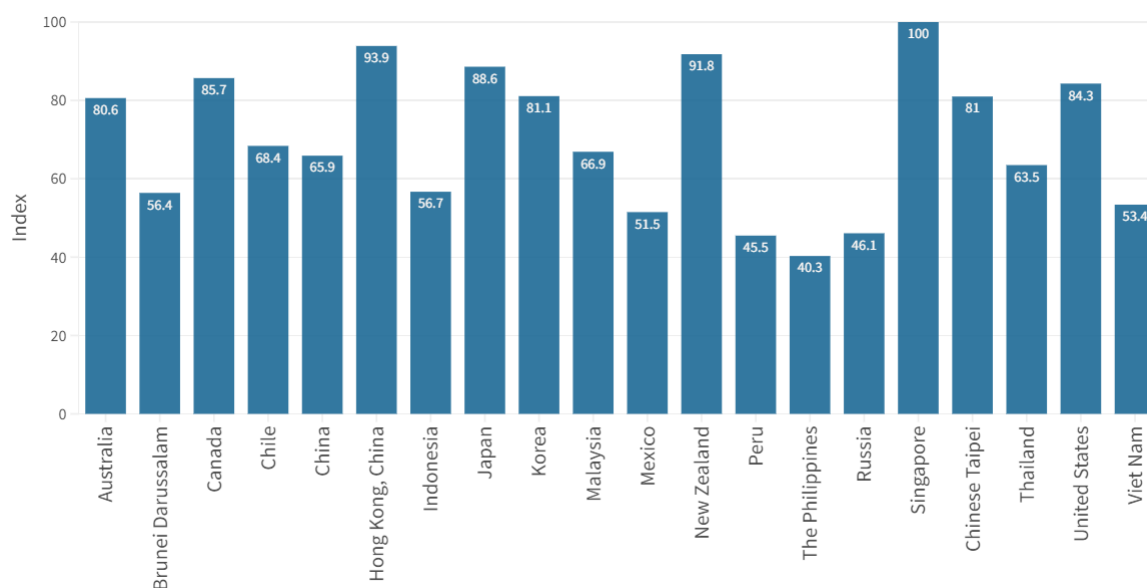
Note: Data was extracted on 19 October 2023. The average value used as baseline here is the index’s historical average.
 Source: Federal Reserve Bank of New York, 2023.

Figure 7.2. Supply Chain Vulnerability Index 2020



Note: Data was extracted on 19 October 2023. Higher index indicates lower vulnerability in the global supply chain. Indices for Chile; Japan; Papua New Guinea; and Chinese Taipei are not available.
 Source: GlobalData, 2023, accessed 18 October 2023, <https://www.investmentmonitor.ai/features/supply-chain-vulnerability-index-2022/?cf-view>

Figure 7.3. Global Resilience Index 2023



Note: Data was extracted on 19 October 2023. Higher index indicates higher resiliency in economic, risk quality and supply chain factors. Data for Papua New Guinea is not available.

Source: FM Global, 2023, accessed 18 October 2023, <https://www.fmglobal.com/research-and-resources/tools-and-resources/resilienceindex>

Table 7.4. Possible indicators to assess supply chain resiliency (stability perspective)

No.	Indicator	Description	Data source options for APEC economies
Block 1: Production-related information			
1	PMI indices	Measures changes in business conditions in manufacturing sector	<ul style="list-style-type: none"> S&P
2	Industrial Production Index	Measures industrial output of economies relative to 2015	<ul style="list-style-type: none"> OECD MEI
3	Production capacity utilization	Measures production capabilities that are being utilised at any given time	<ul style="list-style-type: none"> various depending on economies
4	Production Prices Index	Measures prices of outputs	<ul style="list-style-type: none"> various
Block 2: Information on market fluctuations or disruptions			
5	Standard Chartered's Disruption Index	Tracks seven leading indicators which shape global economy	<ul style="list-style-type: none"> Standard Chartered
6	Producer Price Indices	Tracks monthly development in prices of producers output	<ul style="list-style-type: none"> OECD MEI
7	Global Supply Chain Pressure Index (GSCPI)	Provides a summary of global supply chain condition	<ul style="list-style-type: none"> The Federal Reserve Bank of New York
8	Oil prices	Tracks prices of oil as a key input in production processes	<ul style="list-style-type: none"> various
Ready-to-use indices			

No.	Indicator	Description	Data source options for APEC economies
9	KPMG ASCM Supply Chain Stability Index	Measures how much pressured exerted on firms supply chain performance in the face of volatilities	<ul style="list-style-type: none"> KPMG (US only)
10	GEP Global Supply Chain Volatility Index	Measures how stretched supply chain capacity is	<ul style="list-style-type: none"> S&P
11	Global Trade Resilience Index	Measures economies' ability to resist trade shocks by reviewing their policies and capabilities	<ul style="list-style-type: none"> Whiteshield

Source: Compiled by APEC PSU staff.

ⁱ Reserve Bank of Australia, "Box B: Supply Chains during the COVID-19 Pandemic," May 2021, <https://www.rba.gov.au/publications/smp/2021/may/box-b-supply-chains-during-the-covid-19-pandemic.html>; J. Ball, "Trade and Supply Chains: Pressure Points in Perspective Part Two," Committee for Economic Development of Australia (CEDA), 13 May 2020, [https://www.ceda.com.au/NewsAndResources/Opinion/International-affairs/Trade-and-supply-chains-pressure-points-in-per-\(1\)](https://www.ceda.com.au/NewsAndResources/Opinion/International-affairs/Trade-and-supply-chains-pressure-points-in-per-(1))

ⁱⁱ A. Wong, "COVID-19 Business Updates: Fourth Round of De-escalation Starts July 27," *Biz Brunei*, 22 July 2020, <https://www.bizbrunei.com/2020/07/covid-19-brunei-business-updates/>; Borneo Bulletin, "Consumers, Businesses in Brunei Feel Price Pinch on Food, Imports due to Disruptions to Global Supply Chain," *The Star*, 5 June 2022, www.thestar.com.my/aseanplus/aseanplus-news/2022/06/05/consumers-businesses-in-brunei-feel-price-pinch-on-food-imports-due-to-disruptions-to-global-supply-chain/; S.F.P. Dato Musa and K.H. Basir, "Livestock Shortage amidst COVID-19: A Case of Brunei Darussalam," *IOP Conference Series: Earth and Environmental Science* 756, (2021): 012013, <https://iopscience.iop.org/article/10.1088/1755-1315/756/1/012013>; R. Hj. Abu Bakar, "Construction Sector Faces Supply Chain Disruptions amid COVID-19," *The Scoop*, 12 September 2020, <https://thescoop.co/2020/09/12/construction-sector-faces-supply-chain-disruptions-amid-covid-19/>

ⁱⁱⁱ S. Tam, S. Sood and C. Johnston, "Analysis on Supply Chains in Canada, Second Quarter of 2022," (Statistics Canada, 2 June 2022), <https://www150.statcan.gc.ca/n1/en/pub/11-621-m/11-621-m2022008-eng.pdf?st=e6adAK2p>

^{iv} C. Selman et al., "Supply Chains Disruptions in Latin America," S&P Global, 8 February 2022, <https://ihsmarkit.com/research-analysis/supply-chains-disruptions-in-latin-america.html>; C. Molinari, "ProChile Highlights Measures to Ensure Logistics Continuity during COVID-19 Crisis," *SeafoodSource*, 14 April 2020, <https://www.seafoodsource.com/news/supply-trade/prochile-highlights-measures-taken-for-logistics-continuity-in-times-of-covid-19>

^v G. Interesse, "Managing Your China Manufacturing & Supply Chains During COVID Outbreaks," *China Briefing*, 21 December 2022, <https://www.china-briefing.com/news/managing-china-manufacturing-supply-chains-during-covid-outbreaks/>

^{vi} US Department of Agriculture, "Hong Kong: Food Consumers Feel the Pinch of Supply Chain Disruptions," 19 November 2021, <https://www.fas.usda.gov/data/hong-kong-food-consumers-feel-pinch-supply-chain-disruptions>

^{vii} N. Hafiz et al., "COVID-19 and Its Implications to the Assessment of Sustainable Palm Oil Supply Chain Management: An Indonesian Perspective," *Frontiers in Sustainability*, 4 January 2022, <https://www.frontiersin.org/articles/10.3389/frsus.2021.738985/full>; A. Sohal et al., "Indonesia May Partner with Australia to Develop Digital Healthcare Supply Chains in Response to COVID-19 Pandemic," *The Conversation*, 19 July 2021, <https://theconversation.com/indonesia-may-partner-with-australia-to-develop-digital-healthcare-supply-chains-in-response-to-covid-19-pandemic-158408>; P. Sembada et al., "Impacts of the Covid-19 Pandemic on the Supply Chain of Broiler Chicken in Indonesia," *E3S Web Conference* 306 (2021); 02005, https://www.e3s-conferences.org/articles/e3sconf/abs/2021/82/e3sconf_icadai21_02005/e3sconf_icadai21_02005.html

^{viii} U. Bhatti, "Rising COVID-19 Cases and Supply Chain Disruptions Overshadow Japan's Olympic Games Boost," S&P Global, 2021, <https://ihsmarkit.com/research-analysis/rising-covid19-cases-and-supply-chain-disruptions-overshadow-olympic-games-boost-sep21.html>; S. Seiya, "Covid-19 Pandemic: Supply chain Disruptions in Southeast Asia Affecting Japan and the World," *ThinkChina*, 27 September 2021, <https://www.thinkchina.sg/covid-19-pandemic-supply-chain-disruptions-southeast-asia-affecting-japan-and-world/>; T. Ito, "Identifying the Impact of Supply Chain Disruption Caused by COVID-19 on Manufacturing Production in Japan," *Economic Research Institute for ASEAN and East Asia (ERIA) Discussion Paper* 405, September 2021, <https://www.eria.org/publications/identifying-the-impact-of-supply-chain-disruption-caused-by-covid-19-on-manufacturing-production-in-japan/>; AFP, "Now, Supply Chain Disruption Hits McDonald's in Japan; French Fries Take a Hit," *WION*, 23 September 2021, <https://www.wionews.com/world/now-supply-chain-disruption-hits-mcdonalds-in-japan-french-fries-take-a-hit-439149>

- ^{ix} E. Na, “South Korean Firms Fret over China Supply-chain Disruptions – with ‘Chaos’ to Continue,” *South China Morning Post*, 9 July 2022, <https://www.scmp.com/economy/global-economy/article/3184665/south-korean-firms-concerned-china-supply-chain-disruptions>; K. Kang et al., “Global Supply Crisis Endangers S. Korea’s Manufacturers,” *The Korea Economic Daily*, 9 November 2021, <https://www.kedglobal.com/supply-chain/newsView/ked202111090002>
- ^x J.A. Xavier, “Govt’s Expansionary Policies Slowed Impact of Supply Chain Disruptions,” *New Straits Times*, 25 March 2022, <https://www.nst.com.my/opinion/columnists/2022/03/782928/govts-expansionary-policies-slowed-impact-supply-chain-disruptions>; S. Sarif et al., “COVID-19 and Operational and Supply Chain Disruptions: Navigating the Legal Risk,” Azmilaw, 2020, <https://www.azmilaw.com/insights/covid-19-and-operational-and-supply-chain-disruptions-navigating-the-legal-risk/>; C. Chin, “The Impact of Food Supply Chain Disruptions amidst COVID-19 in Malaysia,” *Journal of Agriculture, Food Systems and Community Development* 9, no. 4 (2020): 161–3, <https://www.foodsystemsjournal.org/index.php/fsj/article/view/858>
- ^{xi} N. Torres, “Corporate Mexico Feels Heat from Global Supply Chain Crunch,” *Reuters*, 10 November 2021, <https://www.reuters.com/world/americas/corporate-mexico-feels-heat-global-supply-chain-crunch-2021-11-09/>
- ^{xii} R. Sen and S. Srivastava, “The Pandemic Exposes NZ’s Supply Chain Vulnerability – Be Ready for More Inflation in the Year Ahead,” *The Conversation*, 18 February 2022, <https://theconversation.com/the-pandemic-exposes-nzs-supply-chain-vulnerability-be-ready-for-more-inflation-in-the-year-ahead-176232>; The NZ Treasury, “The Economic Impacts of Global Supply Chain Disruption,” 24 November 2021, <https://www.treasury.govt.nz/publications/research-and-commentary/rangitaki-blog/weu-special-topic-economic-impacts-global-supply-chain-disruption>
- ^{xiii} “Supply Chain Causing Major Stress for Papua New Guinea’s Businesses,” *Business Advantage PNG*, 13 July 2022, <https://www.businessadvantagepng.com/supply-chain-causing-major-stress-for-papua-new-guineas-businesses/>; M. Bourke and M. Kanua, “Potential Response to COVID-19 in PNG: Support for Food Production,” *Devpolicy Blog*, 2020, <https://devpolicy.org/potential-response-to-covid-19-in-png-support-for-food-production-20200421-1/>
- ^{xiv} Achilles, “Mining in Peru, Supply Chain Prospects,” 2021, <https://www.achilles.com/industry-insights/mining-in-peru-supply-chain-prospects/>; J. Grillo-Núñez et al., “Impacts of COVID-19 on the Value Chain of the Hake Small Scale Fishery in Northern Peru,” *Marine Policy* 134 (2021), <https://www.sciencedirect.com/science/article/pii/S0308597X2100419X>; Putri Aisyah, “High Demand amid Supply Chain Disruptions Lead to Asparagus Price Increases,” *Tridge*, 6 July 2022, <https://www.tridge.com/data-insights/market-price-asparagus-peru-lsoyupua07>
- ^{xv} Philippine Daily Inquirer, “Filipinos Feel Pinch of Inflation as Logistics Crisis Bites,” *The Nation*, 14 June 2022, <https://www.nationthailand.com/international/40016633>; Food and Agriculture Organization of the United Nations (FAO), “Rapid Assessment of the Impact of COVID-19 on Food Supply Chains in the Philippines” (Manila: FAO, 2021), <https://reliefweb.int/report/philippines/rapid-assessment-impact-covid-19-food-supply-chains-philippines>
- ^{xvi} World Bank, “Russia’s Economy Loses Momentum amidst Covid-19 Resurgence; Awaits Relief from Vaccine” (Washington, DC: World Bank, 2020), <https://openknowledge.worldbank.org/server/api/core/bitstreams/750ebe46-3562-5b84-819d-39d5ff5f2b93/content>
- ^{xvii} C. Tortajada and N. Lim, “Food Security and COVID-19: Impacts and Resilience in Singapore,” *Frontiers in Sustainable Food Systems* (2021), https://www.researchgate.net/publication/356743700_Food_Security_and_COVID-19_Impacts_and_Resilience_in_Singapore; N. Suratman, “Singapore Manufacturing Slows in Aug, Faces Supply Chain Disruptions,” *Independent Commodity Intelligence Services*, 3 September 2021, <https://www.icis.com/explore/resources/news/2021/09/03/10681296/singapore-manufacturing-slows-in-aug-faces-supply-chain-disruptions/>
- ^{xviii} Reuters. (2021, September 2). “Asian factory activity loses momentum”. *Taipei Times*. Retrieved from <https://www.taipetimes.com/News/biz/archives/2021/09/02/2003763630> and Cheung, “The chipmaking factory of the world is battling Covid and the climate crisis.”
- ^{xix} S. Mazumdar, “COVID Surge in Southeast Asia Disrupts Global Supply Chains,” *Deutsche Welle (DW)*, 2021, <https://www.dw.com/en/covid-surge-in-southeast-asia-disrupts-global-supply-chains/a-59062324>
- ^{xx} S. Helper and E. Soltas, “Why the Pandemic Has Disrupted Supply Chains,” *The White House*, 17 June 2021, <https://www.whitehouse.gov/cea/written-materials/2021/06/17/why-the-pandemic-has-disrupted-supply-chains/>
- ^{xxi} Lien Hoang, “Vietnam’s Supply Chains Struggle to Shake Off Covid Impact,” *Financial Times*, 1 December 2021, <https://www.ft.com/content/2eb1bdaa-fa8e-4d1e-9b47-85006df9e897>; Minh Son, “Vietnam Suffers Unprecedented Supply Chain Disruptions,” *VnExpress*, 6 September 2021, <https://e.vnexpress.net/news/business/economy/vietnam-suffers-unprecedented-supply-chain-disruptions-4352450.html>; Lien Hoang, “Vietnam’s Factory Operations Hit as Supply Chain Snags Multiply,” *Nikkei Asia*, 11 April 2022, <https://asia.nikkei.com/Spotlight/Supply-Chain/Vietnam-s-factory-operations-hit-as-supply-chain-snags-multiply>