OECD Supply Chain Resilience Review

Navigating Risks

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Please cite this publication as:
OECD (2025), *OECD Supply Chain Resilience Review: Navigating Risks*, OECD Publishing, Paris, https://doi.org/10.1787/94e3a8ea-en.

ISBN 978-92-64-92970-8 (print)
ISBN 978-92-64-61386-7 (PDF)
ISBN 978-92-64-38595-5 (HTML)

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Preface

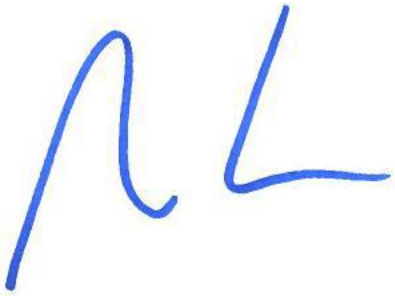
International trade has been a powerful driver of increased incomes and living standards around the world. However, our global trading system has been under growing pressure in recent years. Barriers to trade are on the rise. Shocks such as the COVID-19 Pandemic and Russia's war of aggression against Ukraine have demonstrated the far-reaching impact of supply chain disruptions. New risks and uncertainty have emerged in the wake of geopolitical tensions, growing supply concentration, and instances of economic coercion.

Policy makers have a range of tools available to identify and manage supply chain risks. These tools will need to be balanced to ensure they do not unduly compromise the benefits of global trade for competition, innovation, productivity, efficiency and ultimately growth. Indeed, well-functioning, competitive and diversified global markets can be a key contributor to economic resilience.

The 2023 OECD Ministerial Council Statement welcomed the approval of an OECD strategy to promote open markets and a rules-based international trading system in good working order. Building resilient supply chains is a key pillar of that strategy. In 2024, Ministers at the OECD Ministerial Council Meeting affirmed their commitment to enhancing cooperation on economic resilience and economic security by reducing vulnerabilities, welcomed OECD work that contributes to building fact-based awareness on supply chain resilience, and agreed to continue monitoring trade interdependencies to maintain competitive markets for critical supply chains through work led by the OECD Trade Committee.

Guided by these priorities, the OECD's Trade Committee has shaped and overseen a programme of work on resilient supply chains. The OECD has developed unique evidence-based research and analysis, complemented by a series of expert discussions and multi-stakeholder dialogues, including with the participation and support of *Business at the OECD (BIAC)* and the *OECD Trade Union Advisory Committee (TUAC).* This work has drawn from country experience, and identified new approaches to anticipating and monitoring shocks, analysing and mitigating impacts, and cooperating across the public and private sectors.

This *OECD Supply Chain Resilience Review* brings together the OECD's work in this area. It highlights the importance of a balanced approach to mitigating supply chain risks without undermining the upside benefits that come with expanding international trade. Going forward, the OECD will continue to foster dialogue and provide objective, evidence-based analysis in support of open markets and a rules-based international trading system in good working order.



Mathias Cormann
Secretary-General

Acknowledgements

The *Supply Chain Resilience Review* was co-ordinated by John Drummond and Irene Oliván García, under the supervision and guidance of Marion Jansen. The main authors of the report are Christine Arriola, Orlando Bates, Mattia Cai, Ricardo Chiapin Pechansky, Janos Ferencz, Matteo Fiorini, Alexander Jaax, Przemyslaw Kowalski, Javier Lopez Gonzalez, Sébastien Miroudot, Silvia Sorescu, Enxhi Tresa, Elisabeth Van Lieshout and Carmen Zürcher. Ana Maria Muresan designed and prepared the country-by-country statistical annex.

The following Directorates in the OECD Secretariat provided valuable comments on drafts of the report: Trade and Agriculture Directorate (Julia Nielson, Lisa Marie Breyer, Henrique Caporali, Francesco Felici, Jasmin Joksimovic, Chiara del Giovane); Economics Department (Lukasz Rawdanowicz); Directorate for Science, Technology and Innovation (Norihiko Yamano); Directorate for Financial and Enterprise Affairs (Tihana Bule, Barbara Bijelic, Allan Jorgensen).

The following individuals from outside the OECD Secretariat provided useful comments during the initial drafting stage of the report: Joseph Francois (WTI), Roberta Piermartini (WTO), Ralph Ossa (WTO), Victor Stolzenburg (WTO).

This publication was supported by a voluntary contribution from Costa Rica, Chair of the 2025 OECD Ministerial Council Meeting.

Caitlin Boros managed the text production of the report and Ana Maria Muresan led the data visualisation strategy. Fiona Hinchcliffe edited the report, and Marc Regnier prepared the figures for publication. The authors would like to thank Andrew Esson for the support in designing and assembling the country-by-country annex, and Laëtitia Christophe, Michèle Patterson and Erianne Trepanier for their overall support.

The content of this publication draws on outputs prepared under the aegis of the OECD Trade Committee, and benefits from the efforts of delegates in verifying and commenting on the databases and publications that form the evidence base for this work.

Abbreviations

BACI	French acronym of “Base pour l’Analyse du Commerce International”: Database for International Trade Analysis
CGE	Computable general equilibrium
CRM	Critical raw materials
EG	Environmental good
FDI	Foreign direct investment
GVC	Global value chain
HHI	Herfindahl-Hirschman Index
HS6	World Customs Organization’s Harmonized System
ICIO	OECD inter-country input-output tables
ICT	Information and communications technology
IMF	International Monetary Fund
INDIGO	OECD Index of Digital Trade Integration and Openness
IoT	Internet of Things
ILO	International Labour Organization
LPI	Logistics performance index
MNE	Multinational enterprise
MOEs	Major other economies
OECD	Organisation for Economic Co-operation and Development
SME	Small and medium-sized enterprises
STRI	OECD Services Trade Restrictiveness Index
TFA	Trade Facilitation Agreement
TFI	OECD Trade facilitation indicators
TiVA	OECD Trade in value added indicators
WTO	World Trade Organization

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Executive summary

Navigating risk, not isolation, builds supply chain resilience. Policy plays a key role in creating the enabling environment for agile, adaptable and aligned supply chains that are an essential antidote to a fragile, frozen and fractured international trading system.

This OECD *Supply Chain Resilience Review* draws on recent data, indicators and monitoring of supply chains to set out a sensible and balanced approach to navigating supply chain risks without undermining the upside benefits that come with global trade.

Most global trade remains diversified, but import concentration is on the rise

Based on a broad assessment of supply chain structures and vulnerabilities, this report finds that most trade flows remain relatively diversified. Approximately 30% of exported products are subject to high levels of concentration in few trading partners. That said, import concentration is on the rise, as countries are increasingly sourcing products from fewer suppliers than is globally possible. The number of cases of suboptimal diversification is 50% higher in the 2020s than it was in the late 1990s.

Some sectors and countries may be more exposed to shocks than others

Economies with strong vertical links to major foreign economies tend to be more exposed to international supply chain shocks. However, impacts of shocks occurring in domestic sectors tend to be larger than impacts of shocks occurring in foreign sectors. Industries also vary in their exposure to foreign markets. For example, the strategic manufacturing sector (including industries such as petroleum and electronics) has one of the highest levels of upstream and downstream foreign product exposure. In the OECD, 26% of inputs for strategic manufacturing industries are sourced from abroad, and 27% of their output depends on foreign final demand. These supply chains are highly complex, often requiring more production steps and border crossings.

Relocalising supply chains can come at a high economic cost

Modelling presented in the report demonstrates that re-localisation could decrease global trade by more than 18% and global real GDP by more than 5%, with no consistent improvements in resilience. GDP stability would decrease in more than half of the economies analysed.

Global supply chains are affected by the digital transformation and by policies pursuing environmental objectives

The digital transformation policies pursuing environmental objectives are driving change across most economies. They offer opportunities for improving supply chain efficiencies, resilience and sustainability (both environmental and social), but also raise potential risks. Emerging sustainability requirements and the accelerated pace of digitalisation are adding to pressures on supply chains, which are already facing substantial challenges from factors such as geopolitical uncertainty, economic fluctuations, and the concentration of critical raw materials (CRMs) in certain regions. However, these pressures also open the door to transformative change.

Supply chains can be resilient without undermining the benefits of open trade

There are risks everywhere – in the domestic economy as much as in foreign economies from which key inputs are sourced. Firms seek resilience strategies for all types of risks and cannot focus only on risks related to foreign supply. Evidence suggests that agility and adaptability are instrumental for the flexibility needed to build resilience. Aligning interests among partners in the production network (including suppliers, governments and non-governmental organisations) facilitates co-ordinated and co-operative responses and contributes to the achievement of environmental and social goals.

To ensure agility, adaptability and alignment in global supply chains, governments play an important role as facilitators, integrators, and providers of infrastructure and emergency resources, in co-operation with the private sector. While these resilience strategies can be implemented at the country level, they are more efficient if co-ordinated internationally. Policy can:

- **Promote trade facilitation policies:** Reduce frictions to trade and create a stable, transparent and predictable regulatory framework for businesses.
- **Strengthen key supply chain service sectors**: Remove market access barriers for critical services sectors, and work towards greater regulatory interoperability across countries.
- **Facilitate the digitalisation of supply chain operations**: Enable firms to digitise processes and be more agile in responding to supply chain shocks by lowering tariffs on ICT goods, streamlining regulations and co-operating on international regulations for digital trade.
- **Support international co-operation, and co-ordination with the private sector**: Use multi-government trade agreements and supply chain partnerships to set rules, co-ordinate and reduce regulatory heterogeneity for the above measures, and work with the private sector to prepare for emergencies.
- **Design policies that balance sustainability, efficiency and resilience**: Focus on the performance of global supply chains as an ecosystem, and not target a single objective (such as assurance of supply) without assessing possible trade-offs with economic outcomes, sustainability and implementation costs.

1 Overview

The key to supply chain resilience is not found in the elimination of risk, but in the effective navigation of risk. This is best accomplished by working together, through public, private and international cooperation with trusted partners. Policy environments that enable agility, adaptability and alignment are an essential antidote to a fragile, frozen and fractured international trading system.

The *OECD Supply Chain Resilience Review* encourages the strategic use of policy tools related to trade facilitation, digitalisation, trade in services and emerging data and analytical capacities to ensure stronger, safer and more prosperous trade. This report synthesises recent work of the OECD Trade Committee. It draws on the OECD's unique data, indicators and monitoring of supply chains to set out a sensible and balanced approach to navigating supply chain risks without undermining the upside benefits that come with expanding global trade. In so doing, it explores and assesses the resilience of global supply chains and presents findings that address the following questions:

- Are global supply chains overly vulnerable to external shocks?
- Can we identify critical trade dependencies?
- What are the opportunities and risks arising from digital transformation and from paths towards achieving environmental objectives?
- How can we keep supply chains resilient without disrupting the benefits of openness?
- What policies can support supply chain resilience?

The report is divided into two parts. Part I assesses the degree to which countries may be overly dependent on others and discusses the likely costs to economies if international trade began to fragment. It then focuses on the interlinkages between policies pursuing environmental objectives and the digital transformation on the one hand and the functioning of international supply chains on the other hand, highlighting mutual opportunities and vulnerabilities.

Part II makes the case that agile, adaptable, and aligned supply chains are the key to resilience. It explores the main areas where governments can play a role and sets out policy recommendations with these objectives in mind.

The country-by-country statistical annex for each OECD Member country uses an "at-a-glance" format to monitor their degree of interdependency with trading partners and the preparedness of their policy landscape for facilitating agile, adaptable and aligned supply chains.

1.1. Supply chains enable competitive production

Supply chains are integral to how firms produce and trade, and indispensable to a competitive production economy. Today, 60% of global trade consists of intermediate products – goods and services that businesses use as inputs to be able to produce the final products sold to consumers.

International trade boosts productivity. It allows firms to gain access to a larger and more sophisticated pool of capabilities and resources, while consumers benefit from lower prices and more diversified products. International supply chains also play an important role in increasing income in emerging and developing economies, significantly contributing to a reduction in global poverty (Figure 1.1).

Figure 1.1. In less developed countries, greater participation in international trade is associated with higher GDP growth over the long run

Annual average rate of change in trade and GDP per capita, for 55 low and lower-middle income countries, 1995-2022

Note: This chart considers the 55 countries that the World Bank classifies as low-income or lower-middle income, and for which data are available on both variables (represented by the dots on the chart). The variables are presented as average annual rates of change between 1995 and 2022. Dashed red line is a simple linear regression line.
Source: Authors' calculations based on World Bank (2025[1]), World Development Indicators (database), https://databank.worldbank.org/source/world-development-indicators, accessed 16 January 2025.

1.2. Current trade flows are relatively well diversified, but there are some trends towards over-concentration

Recent events have sharpened awareness of the potential risks associated with reliance on international supply, and possible vulnerabilities to localised shocks. Potential disruptions are widespread and varied, ranging from climate shocks or interruptions affecting logistics and transport, to policy induced shocks such as economic coercion by a strategic trading partner. One way of understanding a country or sector's vulnerability to such disruptions is to monitor import and export concentration across trading partners. This report uses granular trade data to assess trade dependencies and their evolution over time for the world and for OECD Members. It finds that while global exports and imports of products have become more concentrated towards specific countries since the mid-1990s, current average levels of concentration are not alarming. Around 70% of exported products are relatively well diversified and only approximately 30% of products record high levels of concentration. Global concentration of exports across supplying countries is higher than global concentration of imports across destination countries. This can be explained by the tendency of countries to specialise in the production of different products (or inputs and components), while consuming relatively similar baskets of products.

Still, on average, countries are increasingly sourcing products from fewer sources than is in principle globally possible. Comparing data from the early 2020s with the late 1990s, the report finds there are 50% more cases where countries import products from fewer than half of the suppliers than are globally possible, in markets where supply is already concentrated, a condition the report labels as 'significant' concentration. While such significant concentration may reflect economic and geographic factors, as well as countries' preferences and policies (including those that lead to trade distortions), it is also a potential source of vulnerability to shocks. This trend is however almost entirely driven by non-OECD countries as OECD countries' level of such significant import concentration has remained stable over the observed period. In this regard, China's contribution to countries' significant import concentration has increased from 5% to 30% over the past 25 years while the combined contribution of the United States, Germany and Japan decreased from 30% to 15%.

To summarise, OECD data show that while some trade flows appear significantly concentrated, large, if not dominant, portions of global and national trade are relatively well diversified. Several countries—most notably within the OECD group—have used international markets to diversify and reduce dependency. That said, there is still untapped potential in diversifying further.

1.3. Some sectors and countries may be more exposed to shocks than others

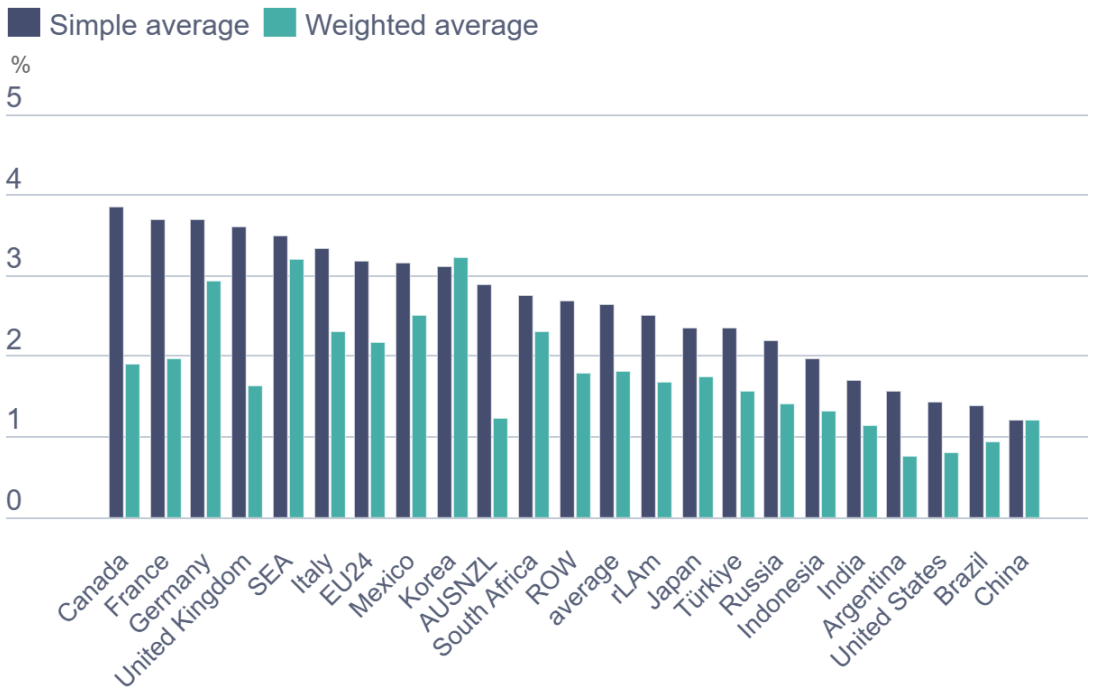
The model in this report shows that economies with strong vertical links to major foreign economies tend to be more exposed to international supply chain shocks, with Canada, France, Germany, and the United Kingdom being the most exposed across all economies considered in the model. The United States, Brazil, and China are less exposed due to their greater reliance on domestic product and factor markets in most sectors, which allow for effective allocation of factors of production (Figure 1.2). China is the second-most important source of shocks for most economies (after their own domestic economies).

The impact of shocks occurring in domestic sectors tend to be larger compared to those occurring in foreign sectors. This is because, in most sectors, the reliance on foreign inputs and foreign markets for final products is smaller than the reliance on domestic inputs, product and factor markets. In addition, international markets offer broader adjustment and diversification options than domestic ones.

Sectors vary in their exposure to foreign markets. The strategic manufacturing sector (of critical importance for national and economic security, such as petroleum or electronics) has one of the highest levels of upstream and downstream foreign product exposure. In the OECD, 26% of inputs for strategic manufacturing industries are sourced from abroad, and 27% of their output depends on foreign final demand. These supply chains are highly complex, often requiring more production steps and border crossings.

Figure 1.2. Countries vary in their exposure to shocks impacting supply chains

"Maximum exposure" * to 1% sector and country-specific production shocks



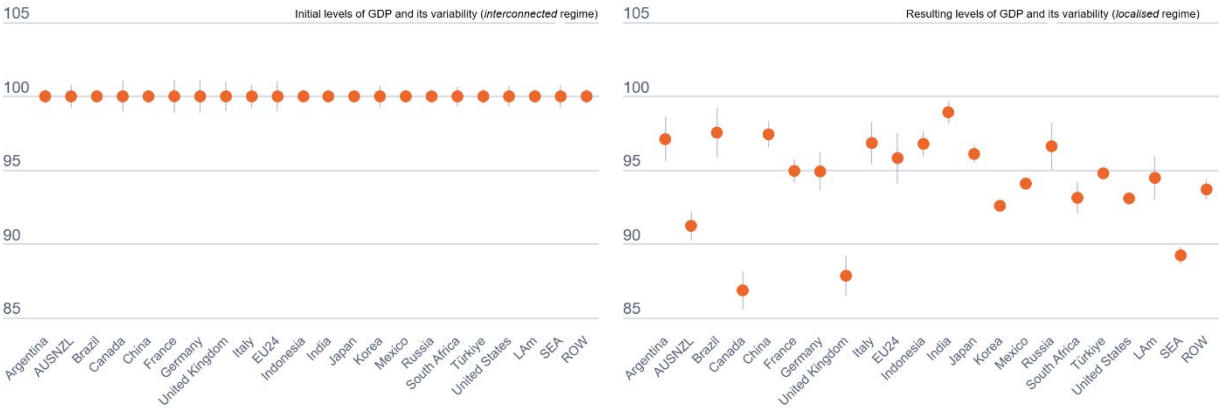
Note: *These figures show "maximum exposure" for a given country which experiences consequences of 1% production shocks occurring randomly in other parts of the global economy. Maximum exposure is first calculated at the country-sector level as the sum of all the simulated negative output changes to the affected sector that can result from the whole range of positive and negative 1% production shocks in other countries and sectors. For presentation in this figure, it is then averaged across all sectors for each country. A 3% impact would mean, for example, that production could be reduced by 3% if all shocks capable of reducing a country's sectoral output occurred simultaneously. Values of output at the starting point of the simulation are used as weights to produce weighted averages.
rLAm=other Latin American countries not included individually; ROW=rest of world.
Source: Arriola, Kowalski and van Tongeren (2024[2]) using OECD METRO model simulations.

1.4. Relocalising supply chains may result in GDP declines and more variable output for most countries

OECD modelling shows that some policies aiming to make value chains more domestic (relocalised) could be costly and may not necessarily offer more stability in the face of shocks (Figure 1.3). Compared to an interconnected regime, relocalisation (for details, see Chapter 3), could decrease global trade by more than 18% and global real GDP by more than 5%, with individual countries losing between 1.1 and 12.2% of GDP depending on the extent and nature of their GVC integration. In addition, the relocalised regime was no more resilient to shocks – in terms of the stability of GDP, production and consumption (i.e. deviations of these variables from the baseline levels in reaction to shocks)– than the interconnected regime. In fact, for more than half of the economies, the stability of GDP decreased in the localised regime. This illustrates that openness and the geographical diversification of input sources and output destinations in GVCs can offer important options for adjusting to disruptions and mitigating exposure to shocks from a greater number of sources.

Figure 1.3. Most countries could see GDP declines and more variable output under a "localised" supply chain scenario

Simulated impact on GDP for selected OECD and major other economies of a supply chain localisation scenario



Note: All changes in variables are relative to the level of the interconnected regime base scenario, which is set to equal 100. Orange dots show the base in the given regime relative to the interconnected base and whiskers show average deviations for negative and positive trade cost shocks. LAm=Latin American countries; SEA=South East Asia; ROW=rest of world.
Source: Arriola et al. (2020[3]), "Efficiency and risks in global value chains in the context of COVID-19", https://doi.org/10.1787/3e4b7ecf-en.

1.5. Global supply chains are affected by the digital transformation and by policies pursuing environmental objectives

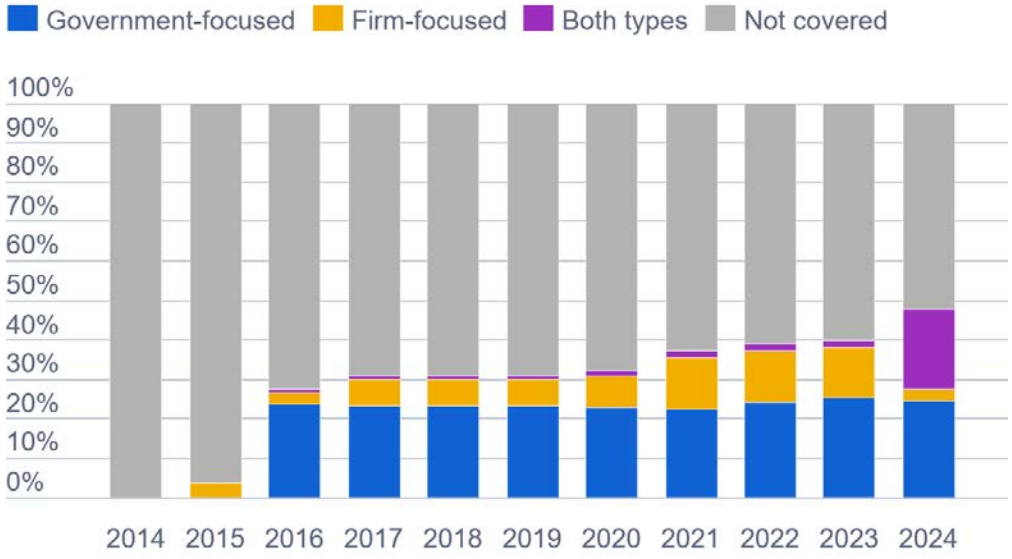
Supply chains evolve in a changing environment, and both digitalisation and the objective of transitioning to more environmentally sustainable supply chains, are important catalysts of this change. Various environmental requirements and the accelerated pace of digitalisation are adding to the pressures on supply chains, which are already facing substantial challenges from factors such as geopolitical uncertainty, economic fluctuations, and the concentration of critical raw materials (CRMs) in certain regions. However, these pressures also open the door to transformative change. By harnessing digitalisation, prioritising environmental sustainability, and by meaningfully addressing social risks, supply chains can become more resilient and play an active role in achieving policy objectives.

Exports of environmental products grew by 30% between 2012 and 2022 globally, with low-income countries more than doubling their exports of environmental goods[1]. However, supply chains for environmental goods are also exposed to supply chain vulnerabilities, particularly because the production of critical raw materials necessary for the shift to low carbon energy products is currently concentrated in a handful of extracting and processing locations. The five-fold increase of the use of export restrictions on industrial raw materials witnessed over the past 15 years illustrates the risks such levels of concentration can generate. The intertwined nature of global production in the form of GVCs has brought the sustainability of supply chains to the fore in recent years. Ensuring that production along the supply chain undertaken in a sustainable manner has been an increasing priority for many governments and publics within and outside the OECD. In this context, sustainability is broadly understood to include protection of the environment, adequate working conditions, and respect of human rights. In sectors like plastics, wood, textiles, motor vehicles and machinery, for instance, the majority of greenhouse gas (GHG) emissions occur upstream in the supply chain. In sectors like textiles and electronics, more than half of the value added is generated in countries characterised by very weak labour rights (measured by freedom of association).

A variety of government policies and multistakeholder, government-run, or industry-led initiatives have emerged over the past several decades to help address these concerns (e.g. supply chain sustainability laws, voluntary sustainability standards, environmental labelling and other information schemes). This has led to a complex and fast changing regulatory and policy landscape. Moreover, the benefits, costs and outcomes of different tools aimed at enhancing sustainability require further analysis, including how effects are distributed across the supply chain, particularly for developing countries and small and medium enterprises (SMEs).

Figure 1.4. Labour-related supply chain laws may cover close to half of global production

Approximate share of global output covered by supply chain sustainability laws



Note: This graph displays a rough approximation of the share of global output that is directly or indirectly linked to countries that have enacted supply chain sustainability laws. Grey elements indicate that output is produced in a setting where neither the country hosting the economic activity, nor the country where the corresponding company is headquartered, has enacted a supply chain law. Orange elements refer to output that is either generated in countries with a firm-focused due diligence law or by subsidiaries of companies whose headquarters are located in countries with such a law. Similarly, blue elements refer to output directly or indirectly associated with countries that have introduced government-focused supply chain laws. Purple elements refer to output linked to both types of laws. Drawing on the OECD Analytical AMNE database, the underlying approach disregards delays between the enactment of a law and its entry into force as well as any thresholds defining applicability to specific firms

Source: Jaax and van Lieshout (2025[4]).

The reach of such initiatives has been growing in recent years, with supply chain sustainability laws linked to labour issues estimated to cover close to half of global production in 2024 (Figure 1.4). A challenge may lie in designing frameworks that align sustainability and efficiency with resilience.

The digital transition can make supply chains more efficient and transparent, playing a critical role in enhancing supply chain resilience. It can do so by enabling end-to-end supply chain visibility – helping businesses to better and more proactively manage emerging risks – and by enabling supply chain managers to monitor real-time information about markets, to more efficiently anticipate and react to shocks. However, while digital technologies bring numerous benefits, they also introduce new sources of pressures and vulnerability. These include greater vulnerability to cyberattacks, together with vulnerabilities that arise from the limited number of global suppliers of digital services. Balanced approaches to data governance can deliver important gains, especially for developed countries.

1.6. Supply chains can be resilient without undermining the benefits of open markets

Commonly proposed strategies for addressing the risk of foreign supply, such as dual sourcing, diversification of supply or reshoring, can increase the complexity of supply chains, affect growth and may not always improve resilience. There are risks everywhere – in the domestic economy as much as in foreign economies from which key inputs are sourced. Firms adopt resilience strategies for all types of risks and cannot focus only on risks related to foreign supply. Moreover, uncertainty is not just a vulnerability – it is also an opportunity. It is precisely the competitive advantage of global firms to benefit from market arbitrage, shifting production and exploiting opportunities in local markets they operate in.

To build resilient supply chains, firms generally rely on three basic building blocks: redundancy (maintaining safety stocks and back-up suppliers), flexibility (developing dynamic capabilities to quickly adapt and change the organisation of supply chains when a disruption occurs) and a culture of responsiveness (adequate training of staff and managers as well as decentralised decision-making to quickly solve issues as they arise). Efficient risk management strategies combine these three blocks. Resilience strategies are also tailored to the type of risks: for routine risks the cost of redundancy strategies is acceptable, while for major crises inventories and back-up capacity will never be enough and firms need to be flexible to absorb disruptions.

Top-performing firms tend to have supply chains possessing three qualities, described as “triple-A” (Lee, 2004[5]) because they are:

- agile – they can react quickly to any change in demand or supply
- adaptable – they can adjust over time to structural changes and evolving strategies
- aligned with the interests of all suppliers in the production network, as well as with a variety of stakeholders, including governments and non-government organisations (NGOs).

Agility and adaptability are part of the flexibility needed to build resilience. The alignment of interests facilitates co-ordinated and co-operative responses and is also important for environmental and social issues.

1.7. Policy approaches for agile, adaptable and aligned supply chains

While not every disruption or delay is a market failure requiring government intervention, governments do play a crucial role – as facilitators, integrators, and providers of infrastructure and emergency resources in co-operation with the private sector. Government intervention is also required for major risks or disruptions that exceed firms’ capabilities of routine risk management.

The following actions can have a high impact on the agility and adaptability of supply chains, as well in aligning interests among stakeholders.

- **Promote trade facilitation policies.** These aim to make trade and customs laws, regulations, documents, and procedures simpler and more efficient. They play a key role in streamlining and simplifying the technical and legal procedures at the border for products to be traded internationally. Such policies:
  - enhance agility in the face of more frequent, high-impact supply chain shocks and disruptions – they proved essential during the COVID-19 pandemic.
  - help firms adapt to sustainability regulatory requirements and prove compliance at the border
  - support alignment across stakeholders through enhanced consultations with traders and co-operation among border agencies

- **Strengthen key supply chain service sectors.** Services play a crucial role in supporting agile, adaptable and aligned global supply chains by enhancing efficiency, reducing costs, and ensuring seamless connectivity from manufacturers to consumers. Air, sea, road and rail transport help carry goods across countries, while logistics services help manage the complex flow of goods, optimising inventory management and allocation of capacity and resources. However, evidence from the OECD's Services Trade Restrictiveness Index (STRI) shows substantial barriers to trade across these sectors. Key actions include:
  - Remove market access barriers for critical services sectors, notably transport, financial and telecommunications services.
  - Work towards greater regulatory interoperability across countries by strengthening common regulatory standards and expanding tools such as mutual recognition of qualifications and permits.
  - Foster international co-operation to create a more predictable, transparent, and efficient regulatory environment, thereby enhancing global trade in services, driving innovation, and promoting economic growth.
- **Facilitate the digitalisation of supply chain operations.** The role of digitalisation in managing supply chains is extensive and transformative. Digital transformation hinges on access to hardware, but tariffs and non-tariff measures on information and communication technology (ICT) goods can hinder the adoption of digital technologies, and the increasingly tight regulatory environment can undermine the ability of firms to adapt to unforeseen shocks. Concerns about privacy protection, cybersecurity, national security, regulatory reach, competition and industrial policy have all led to growing data regulation.
  - Lower tariffs on ICT goods to enable firms to digitise processes and be more agile in their response to supply chain shocks.
  - Streamline regulations governing digital trade and enable data flows and transfers. Cross-border data flows are the lifeblood of today's international trade and supply chain transactions.
  - Enhance international regulatory co-operation over digital trade.
- **Support international co-operation, and co-ordination with the private sector and other stakeholders.** International co-operation is fundamental for addressing the systemic nature of supply chain vulnerabilities and the cross-border nature of regulatory challenges. At the same time, as firms operate supply chains and have direct control over sourcing strategies, inventory management and distribution networks, co-ordination between governments and the private sector is key for building resilient supply chains.
  - Develop and use multi-government trade agreements and supply chain partnerships to collectively set rules, co-ordinate and harmonise regulations for trade facilitation measures, pro-competitive rules for services supporting supply chains and the digital trade integration described above.
  - Use public-private partnerships as a structured mechanism to align the efforts of firms and governments.
  - Create "industrial commons" and preparedness conferences involving stakeholders from the government and private sector to establish integrated forms of emergency preparedness.
- **Design policies that balance sustainability, efficiency and resilience.** To promote agile, adaptable and aligned supply chains, policy design can account for the interplay between resilience and other objectives, including sustainability and efficiency. Aligning these goals in ways that promote long-term economic stability and sustainable development —while maintaining the capacity to withstand disruptions — may present challenges. Achieving synergies across these dimensions is possible, though not without inherent trade-offs. Key actions may include:

- Capture synergies between resilience, efficiency and sustainability. For example, investing in renewable energy infrastructure enhances energy security while reducing carbon footprints; adopting energy-efficient technologies—such as smart grids or decentralised renewable energy systems—enhances the reliability of energy supplies and environmental outcomes.
- Address trade-offs when balancing objectives. Firms designing resilient supply chains must weigh the costs of redundancy against efficiency and environmental considerations, such as waste. Flexibility in production processes, improved supply chain visibility through digital tools, and co-operative relationships with suppliers allow firms to adapt quickly to disruptions without over-reliance on resource-intensive measures. Using renewable energy in operations and transport can offset the environmental impacts of redundancy, aligning sustainability with resilience.
- Aim for the least possible distortionary policy design and implementation of laws aimed at promoting sustainability and encourage stakeholder participation in their development and implementation. Enact facilitation measures to minimise the costs of implementing sustainable practices, especially for SMEs, and consider support to trading partners. Minimise certification costs for compliance with sustainability standards, including through clear guidance on how compliance is verified.

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Note

[1] Environmental goods analysis is based on the Combined List of Environmental Goods as updated in Moïsé and Tresa (2025[6]).

Part I Monitoring supply chain interdependencies

2 The state of international supply chains

Supply chains are integral to production and trade, and today's economies are more interlinked than ever. This chapter presents the state of play of global value chains, drawing on OECD data and indicators to map trends in trade patterns for countries and sectors, variations in trade interlinkages and potential exposure to shocks.

The 21st century global economy is characterised by an unprecedented degree of international integration. Following the emergence of global value chains (GVCs) over the past few decades, it is now extremely common for the different stages of a production process (e.g. design, production, marketing, manufacturing, assembly, distribution) to be carried out in different countries (Gereffi and Fernandez-Stark, 2016[1]). The emergence of GVCs has been transformative in many ways. They have created new business opportunities, boosted productivity and reduced poverty (OECD, 2013[2]; Elms and Low, 2013[3]; World Bank, 2020[4]).

Economic globalisation is not new. In the mid-19th century, for example, a significant increase in international trade and cross-border flows of capital and labour was already occurring. However, during this wave of globalisation (Williamson, 1996[5]) trade consisted largely of products fully manufactured in one country and exported to consumers in other countries. There were already trade flows of raw materials and commodities, but manufacturing was occurring in a single location.

The economic globalisation that has taken place in the past three decades is different, as production itself is now "unbundled" across countries (Jones and Kierzkowski, 2001[6]); (Baldwin, 2016[7]). This "unbundled production" has been facilitated by technological progress, falling costs of maritime transport (containerisation), long-distance communications, and trade and investment liberalisation. Such international fragmentation of production is reflected, for example, in the high volume of cross-border trade accounted for by products that are not destined for final use by consumers, but that serve instead as intermediate inputs or capital into further production processes. According to the OECD Trade in Value-Added (TiVA) database, intermediate products accounted for as much as 60% of global trade (goods and services) in 2020. Moreover, imports and exports of capital products whose purpose is investment (e.g. machinery, equipment, intellectual property) were responsible for an additional 12% of global trade.

This chapter explores the rise of GVCs, their benefits and risks, and recent trends in their reorganisation. It also investigates concomitant implications for trade policy and international trade integration.

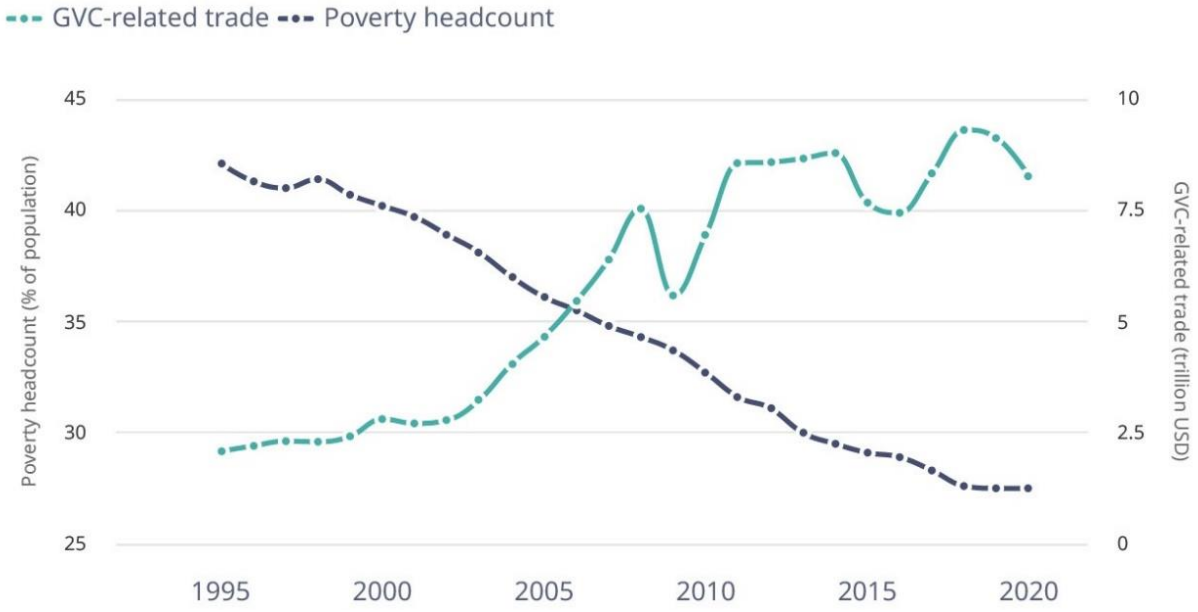
2.1. International supply chains have boosted efficiency, created new opportunities and reduced poverty

The emergence of international supply chains has enabled real time co-ordination between highly specialised businesses located in different parts of the world. This has created new business opportunities and boosted productivity through the ability to achieve finer specialisation in a specific task or input (OECD, 2013[2]). Firms have also gained access to a larger and more diversified pool of capabilities and resources, helping them to innovate and produce more sophisticated products (Lema, Pietrobelli and Rabellotti, 2019[8]). Empirical evidence from industries and firms highlights the positive links between GVC participation and productivity (Criscuolo and Timmis, 2017[9]; Del Prete, Giovannetti and Marvasi, 2017[10]; Constantinescu, Mattoo and Ruta, 2019[11]).

While various factors explain the significant drop in global poverty since the 1990s, the emergence of GVCs has played an important role in increasing income in emerging and developing economies (Elms and Low, 2013[3]; World Bank, 2020[4]; WTO, 2024[12]). The rise in GVC trade[1] is associated with a decrease in the percentage of the world population living in poverty, according to the World Bank's societal poverty lines (Figure 2.1). In low-income and lower-middle income countries there is a clear correlation between increased GDP per capita and the share of trade in GDP (Figure 2.2).

Figure 2.1. The emergence of GVCs is accompanied by a very significant drop in global poverty

Poverty headcount and GVC-related trade at the world level, 1995-2020



Note: The poverty headcount ratio represents the percentage of the population living in poverty according to the World Bank's societal poverty lines. The societal poverty line is based on the extreme poverty line (USD 2.15 per day), but varies across countries and over time to reflect different stages of economic development (i.e. the poverty line gradually moves upwards as a country's median income grows). GVC-related trade refers to goods and services that are exported as part of an international production network. More specifically, GVC-related trade is comprised of all traded items that pass through at least two international borders before they end up embodied in a final product. In other words, these are products that are re-exported at least once before they are absorbed in final demand. GVC-related trade is calculated using input-output techniques (Borin and Mancini, 2019[13]).

Source: Based on data from the World Bank. The poverty headcount ratio at societal poverty line was retrieved from (World Bank, 2025[14]), *World Development Indicators* (database), https://databank.worldbank.org/source/world-development-indicators; GVC-related trade was obtained from the World Integrated Trade Solutions (WITS) dataset (WITS, 2025[15]) and is based on the OECD's Inter-Country Input-Output tables (ICIO) (OECD, 2024[16]).

Figure 2.2. In less developed countries, greater participation in international trade is associated with higher GDP growth over the long run

Annual average rate of change in trade and GDP per capita, low and lower-middle income countries, 1995-2022

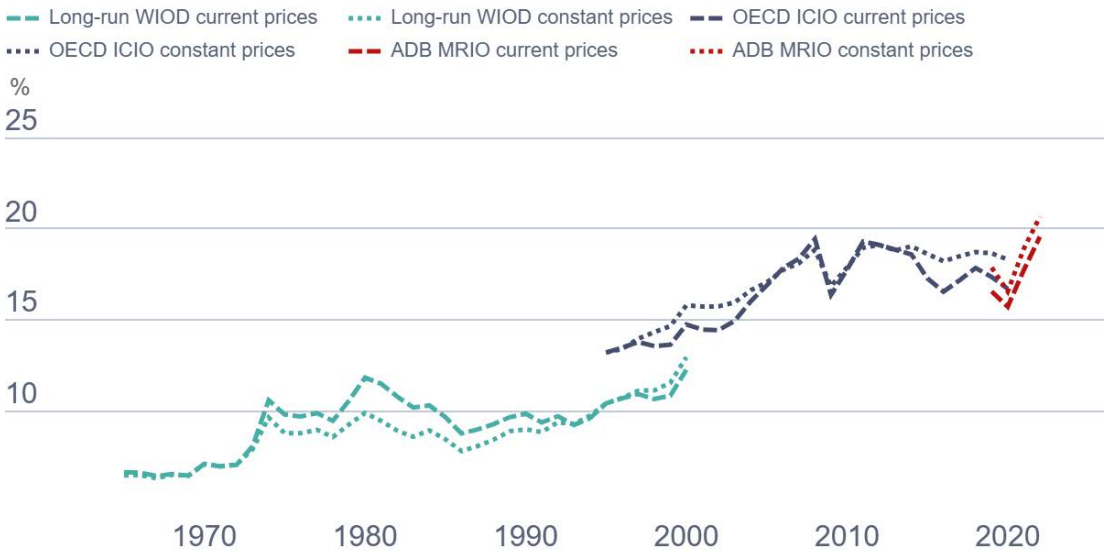
Note: This chart considers the 55 countries that the World Bank classifies as low-income or lower-middle income, and for which data are available on both variables (represented by the dots on the chart). The variables are presented as average annual rates of change between 1995 and 2022. The dashed red line is a simple linear regression line.
Source: Authors' calculations based on World Bank (2025[14]), *World Development Indicators* (database), https://databank.worldbank.org/source/world-development-indicators.

2.2. Production and trade are more globalised than ever

The 21st century started with historically high levels of globalisation. Those levels continue, notwithstanding episodes of disruption in global markets. Figure 2.3 shows that the degree to which world production depends on trade in inputs continues to rise. The "import intensity of global production" is the sum of all gross imports of intermediate inputs along the value chain expressed as a percentage of gross output. For each dollar of output in the world, this indicator tells us how many cents correspond to trade in intermediate inputs in GVCs.[2]

Figure 2.3. The cross-border dispersal of production has significantly increased since 1965

Import intensity of production at the world level, 1965-2023



Note: In general, the results in constant prices are obtained by chain-linking the indicator. In the case of the ADB-MRIO, however, they are computed from underlying input-output data expressed in constant prices. In each case, the base year is 2010. The OECD ICIO, the ADB-MRIO, and long-run WIOD are all global input-output databases constructed by linking and harmonising information from a variety of statistical sources (e.g. national supply and use tables, international trade statistics, national accounts, and so forth). The databases differ in time and country coverage, in industry classification, as well as in a variety of methodological aspects.
Source: Based on OECD Inter-Country Input-Output tables (ICIO) (OECD, 2024[16]) and long-run World Input–Output Database (WIOD) tables (University of Groningen, 2023[17]) in current and previous year's prices; and Asian Development Bank Multiregional Input-Output Tables (ADB-MRIO) in current and constant prices (ADB, 2024[18]).

Although an initial rise in the import intensity of production can be observed as early as the 1970s – following the end of the Bretton Woods system and the shift to floating exchange rates – it was only in the mid-1980s that it began to increase sharply (Figure 2.3). Around this time, advances in information and communications technologies lowered the costs of co-ordinating geographically dispersed activities, enabling multinational enterprises (MNEs) to engage in vertical specialisation.

The integration of production along GVCs accelerated during the 1990s with the collapse of the Soviet Union, the conclusion of the Uruguay Round and the creation of the World Trade Organization (WTO), a new wave of deep regional trade agreements, and market-oriented reforms in the People's Republic of China (hereafter "China") (and its subsequent accession to the WTO in 2001). At the onset of the financial crises in 2008, the cumulative value of trade in intermediate inputs at the world level had increased to 17 cents per dollar of output, up from 6 cents per dollar of output in 1965. The subsequent drop in the indicator reflects the collapse in trade that was part of the global financial crisis. By 2010 the import intensity of production had largely recovered to its pre-crisis level (Figure 2.3). In 2023, the global import intensity of production stood at a historically high level.

2.3. Trends vary across countries and industries: Slowbalisation?

In the 2010s, the fast pace of globalisation began to slow. After 2011 the import intensity of production decreased – as measured in current prices (dashed blue line in Figure 2.3 above). This has sometimes been interpreted as a sign that value chains are getting shorter (i.e. a process of diminished

interdependence between countries in which production becomes more local) (Haugh et al., 2016[19]; James, 2018[20]; Livesey, 2018[21]; Antràs, 2020[22]).

However, the apparent decline in production dispersal has an alternative explanation. When computed from data in current prices, the indicator fails to account for important price movements that took place over that period. In the 2010s, prices of raw materials declined significantly (Figure 2.4). Everything else being equal, a drop in input prices naturally reduces the value of imported intermediates, so that the import intensity of production shrinks even if the volume traded stays unchanged.

Figure 2.4. The price of raw materials declined over 2010-2020

All commodity price index, 2000-2023

Note: 2016=100.
Source: International Monetary Fund (2024[23]), *IMF Primary Commodity Price System* (database), https://data.imf.org/commodityprices.

Computing the import intensity of production from data in constant rather than current prices (Figure 2.3, dotted blue line) demonstrates that the dispersal of production did stop growing after the 2008 global financial crisis but remained stable afterwards until 2019. The decline in 2020-2021 related to the COVID-19 pandemic was followed by a strong rebound in trade leading to higher shares of trade in intermediate inputs in gross output. More recent data, when available, will shed further light on potential scenarios for the future (Altman, Bastian and Fattedad, 2024[24]).

2.3.1 Use of imported inputs varies across economies

When the import intensity of production in constant prices is examined at the country level, important differences emerge between major economies (Figure 2.5). In the case of China, use of imported inputs increased sharply between 1995 and 2005. This period was marked by rapid growth in manufacturing and large-scale shifts of production activities by MNEs to China. This fast industrialisation increased China's imports of foreign-made inputs. Over time, domestic input suppliers became more competitive, and government support encouraged the development of more domestic value chains for selected high-end products. China upgraded its position in GVCs, shifting from processing trade and final assembly to the exports of branded products incorporating domestic inputs. Eventually, around the time of the global financial crisis (2008-2010), the import intensity of China's production began to decline. Notwithstanding

this clear trend towards greater domestic sourcing, China's use of imported inputs remains high compared to OECD Member countries.

In OECD Member countries, on the other hand, the average import intensity of production increased relatively more slowly during the 1990s and 2000s, but it still trended upwards after the global financial crisis (Figure 2.5). The indicator did start to decline in the second half of the 2010s – reflecting diverging trends across the main OECD economies. The United States and Japan experienced a slight decline, while there was no slowdown for the European Union (analysed as a single economy). Imports of intermediate inputs (from non-EU economies) continued to account for a growing share of production after 2011, with a decline only observed during the COVID-19 crisis in 2020.

Figure 2.5. Trends in the import intensity of production vary for the major economies

Import intensity of production for the major economies, 1995-2020

Note: EU27 aggregate is computed treating intra-EU trade as a single economy. Import intensity of global production is computed by adding together all gross imports of intermediate inputs along the value chain before expressing the result as a percentage of gross output.
Source: Based on OECD's Inter-Country Input-Output (ICIO) tables in previous year's prices (OECD, 2024[16]).

2.3.1. Some industries rely more on international supply chains than others

Looking at the import intensity of production for specific industries, there are differences both in changes over time and absolute levels (Figure 2.6). The import intensity of production is much higher in some industries, such as coke and petroleum, water transport and motor vehicles. In the coke and petroleum value chain, imported intermediate inputs accounted for about half of the value of output in 2019, which is more than two times the corresponding proportion for food products. These differences are explained by structural characteristics (e.g. perishable products that cannot be transported over long distances multiple times, proximity to raw materials, etc.); firms' organisational choices (e.g. outsourcing vs. in-house production); and policy measures (e.g. high tariffs on inputs preventing the offshoring of their production).

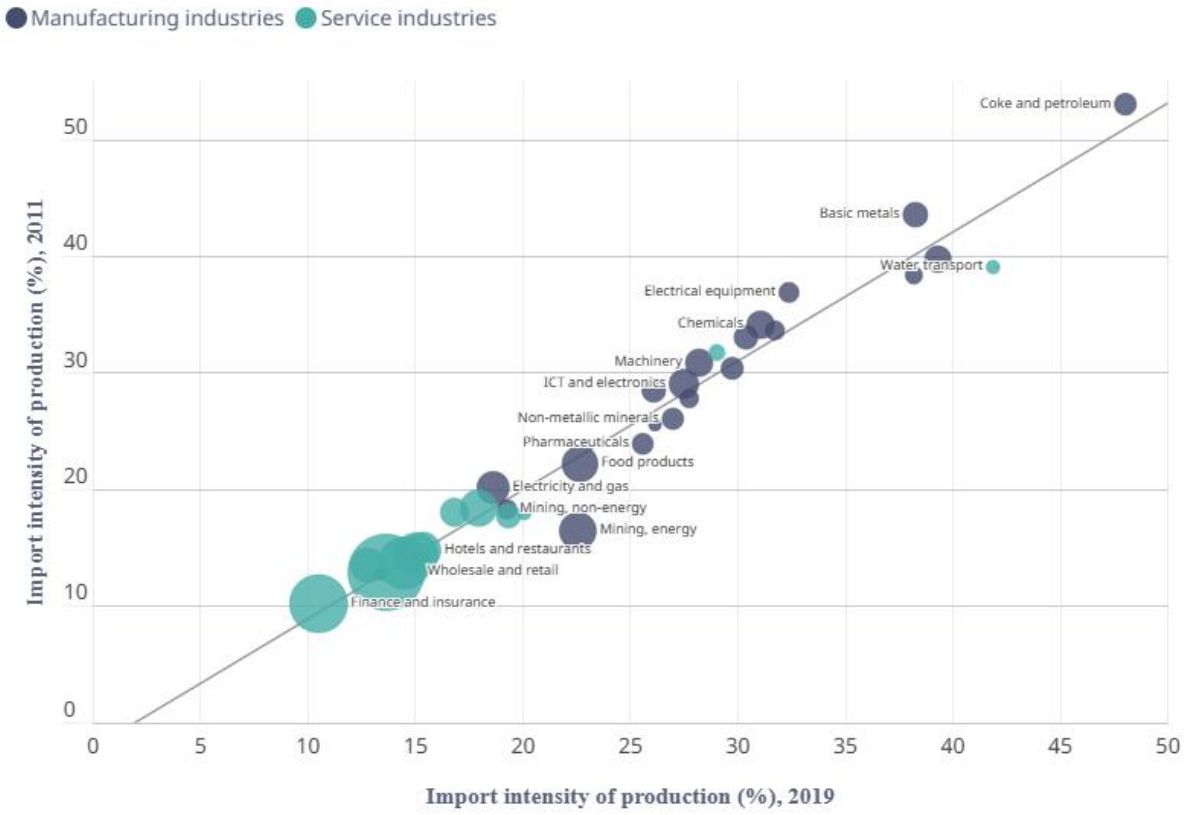
There are also differences over time when comparing the import intensity of production in 2011 and in 2019. The value chain with the highest level of international sourcing in 2019 – coke and petroleum – shows a clear shift towards more domestic supply chains, indicated by its data point lying in the bottom right triangle of Figure 2.6, meaning that the value was larger in 2011 than in 2019. This represents a decrease in international sourcing and marks a shift towards more domestic supply. This is also the case for basic metals. On the other hand, the supply chains for other industries, such as water transport, mining

(non-energy) and pharmaceuticals, have become more international. Overall, manufacturing industries tend to be more on a trend towards lower import intensities, while services are tending towards higher import intensities (notwithstanding some heterogeneous trends within services and manufacturing industries).

While Figure 2.6 highlights the varying degrees to which different sectors rely on imported inputs, it does not shed light on the geographical distribution of these supply chains. Geography is important as firms strategically select suppliers from specific economies, guided by historical ties, supplier availability, expectations about growth paths and cost differences across markets, and geopolitical considerations. Box 2.1 offers insights into the geography of intermediate sourcing and foreign direct investments in the pharmaceutical supply chain.

Figure 2.6. Patterns of international sourcing differ across industries

Import intensity of production, selected industries, world, 2019 versus 2011



Note: The size of the bubble represents the value added of the corresponding industry at the world level in 2019.
Source: Based on OECD ICIO tables in previous year's prices (OECD, 2024[16]).

Box 2.1. What guides sourcing decisions in pharmaceutical supply chains?

The COVID-19 pandemic highlighted the role of resilient pharmaceutical supply chains in safeguarding public health. Yet, medicine shortages are a recurring challenge beyond pandemic periods, motivating governmental efforts to bolster security of supply (OECD, 2024[25]).

This box explores the recent evolution of sourcing patterns in this sector, adopting a broad lens that includes both patented brand-name drugs and generic versions of medicines whose patent has expired.[1] Analysing data on pharmaceutical trade and investment flows provides two complementary perspectives on changes to the geography of pharmaceutical supply chains. Trade flows in pharmaceutical intermediate goods offer a glimpse into global sourcing patterns at given points in time, allowing changes in trading patterns to be monitored. A snapshot of intermediate trade flows encapsulates companies' prior decisions on where to produce and source goods (reflecting past decisions on investing in subsidiaries, in relationships with suppliers, etc.). Implications of those past choices, together with the limited availability of suppliers, shape companies' sourcing patterns. By contrast, foreign direct investment trends indicate corporate strategies for the future. Investments allow corporate leaders to reshape the geography of their company's activities by establishing new subsidiaries or expanding existing ones.

Pharmaceutical trade trends

The Herfindahl-Hirschmann Index (HHI), a frequently used measure of market concentration, can help provide insight into the potential for diversification of supply chains. The HHI is calculated using detailed product-level data to assess the concentration of imports.[2] Ranging from 0 (fully diversified) to 1 (fully concentrated), it indicates whether sourcing of intermediate inputs relies on a small number of supplying countries. Recent OECD work uses a HHI value of 0.2 to indicate relatively high concentration. As shown in the left-hand graph of Figure 2.7, the level of concentration has fallen slightly since 2011, when it was 0.39. However, there has been no strong trend in recent years, with it staying relatively high at 0.31 in 2022 — within a range that part of the literature identifies as signalling critical concentration.[3]

The right-hand graph in Figure 2.7 links sourcing of inputs to two dimensions of distance. Geographical distance informs interpretation of a potential shift towards suppliers closer to the company's home country (where the headquarters are located). Conversely, geopolitical distance relates to a potential reorientation of supply chains towards greater reliance on inputs from geopolitically aligned economies. As is customary in the related literature (Gopinath et al., 2025[26]), Figure 2.7 draws on a proxy for geopolitical distance based on a comparison of countries' voting patterns at the United Nations General Assembly. This metric helps to gauge changes in supply chain linkages between politically misaligned countries (Gopinath et al., 2025[26]).[4]

In the right-hand graph in Figure 2.7, both measures of distance are normalised so that the level observed in 2004 corresponds to 100. A reduction in geographical distance compared to 2004, i.e. values lower than 100, would suggest a shift towards reorganising supply chains closer to home. For geopolitical distance, values below 100 could point to efforts to reduce ties with geopolitically misaligned countries.

Signs of a reduction in both types of distance appeared in the early 2010s, which were shaped by the aftermath of the global financial crisis and the introduction of new rules governing the international financial system (Brei and von Peter, 2018[27]). Trade patterns in the years since 2015 are ambiguous regarding geographical and geopolitical distance, with recent flows mirroring mid-2000s levels. While

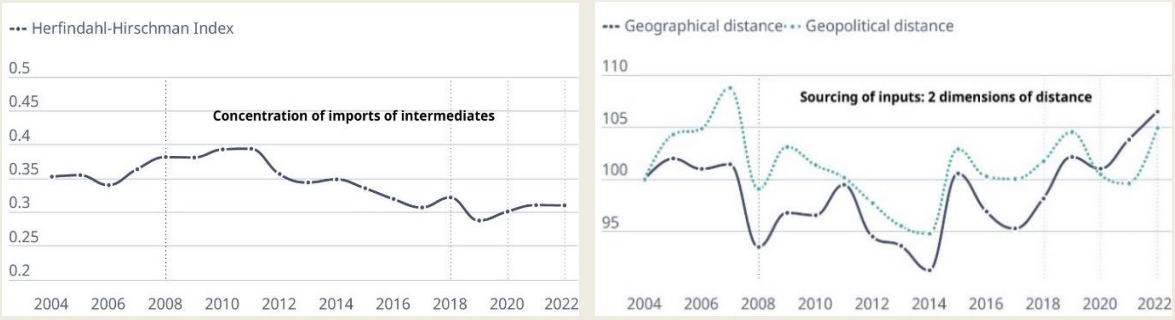
no clear shift is apparent, the most recent data points (since 2020) hint at increasing trade between distant economies.

This resonates with contributions highlighting the role international trade played in the global response to the pandemic (World Bank and WTO, 2022[28]). Trade in medical goods expanded during the pandemic. Faced with a surge in demand, supply chain managers likely needed to source products from farther afield.

Overall, the relatively stable pattern emerging from Figure 2.7 may point to underlying factors that limit supply chain managers' capacity to alter the geography of sourcing in the short run. Constraints such as past investments in manufacturing sites and supplier relationships, lengthy regulatory approval processes, complexities related to intellectual property rights, and a scarcity of alternative suppliers likely restrict the room for rapid reconfigurations of supply chains.

Figure 2.7. Concentration of pharmaceutical imports remains high despite a modest reduction since 2011

Evolution of geography of trade in pharmaceutical intermediates



Note: The two graphs above draw on information on imports of intermediate goods for the pharmaceutical sector. The left graph displays the evolution of the Herfindahl-Hirschmann Index (HHI) for imports of pharmaceutical intermediates. Weighted by trade volumes and the country's share of global pharmaceutical output, it indicates to what extent imports of intermediates rely on a small number of supplying countries. Higher values indicate a higher degree of concentration. The right graph shows the evolution of geographical and geopolitical distance for pharmaceutical intermediate trade flows. Both measures of distance are normalised so that 100 represents the average level of distance observed for trade flows in 2004. The vertical dotted lines indicate the timing of the global financial crisis (2008), the rise in trade tensions between China and the United States (2018), the outbreak of the COVID-19 pandemic (2020), and the Russian war of aggression against Ukraine (2022).
Source: Authors' analysis based on the (BACI) database (Gaulier and Zignago, 2010[29]) in combination with information on geographical distance from the Centre for Prospective Studies and International Information (CEPII) database (Conte, Cotterlaz and Mayer, 2022[30]) and a measure of geopolitical distance proposed by Bailey, Strezhnev and Voeten (2017[31]).

Pharmaceutical investment trends

Contrasting with the picture emerging from trade data, information on foreign direct investment (FDI) suggests companies are changing their supply chain strategies. Based on all the investments of pharmaceutical companies worldwide, the top-left graph in Figure 2.8 illustrates a marked shift towards investment destinations that are geographically and geopolitically closer, especially since 2016. During the period shown here (2004-2024), average geopolitical distance was greatest in the mid-2000s, while geographical distance peaked in the mid-2010s. A shift towards greater proximity on both measures is visible after 2016. The tendency is even more pronounced for investments made since 2022.

When focusing on subsets of investments by business function (HQ functions, R&D and production projects), two observations stand out: (1) projects linked to headquarter functions (upper-right graph) – encompassing strategic activities, training, and IT infrastructure – as well as projects focused on research and development (lower left graph), display a trend towards a reduction of both dimensions of

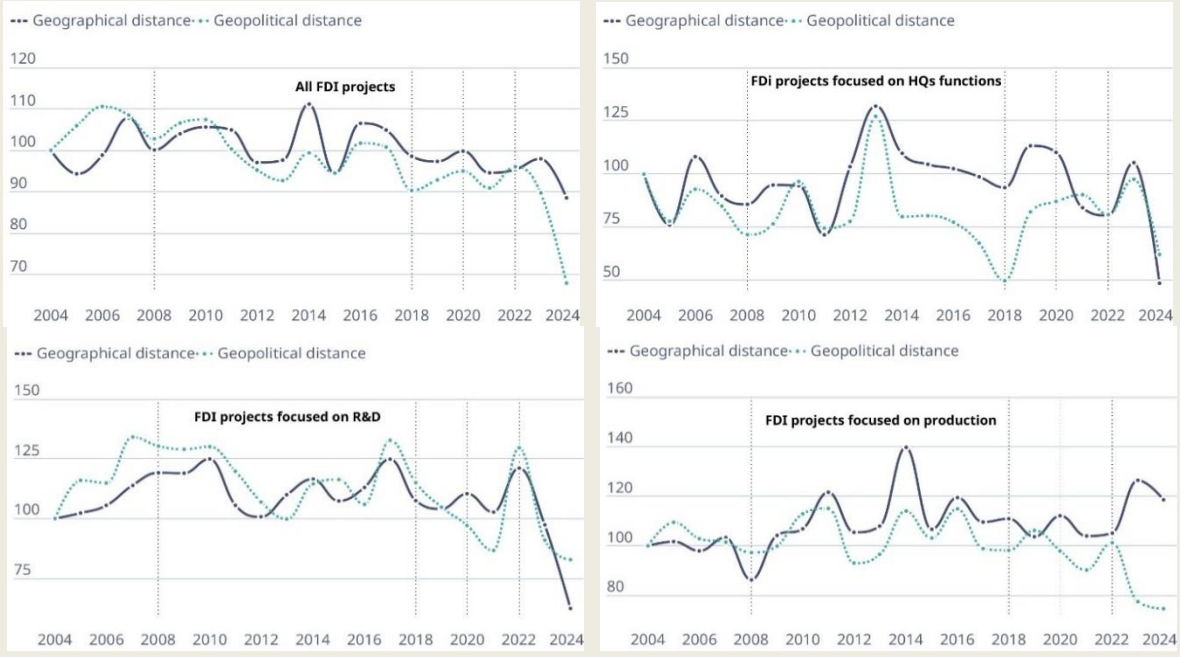
distance, mirroring the overall pattern (upper-left graph); (2) the picture is remarkably different for production-focused investments (lower-right graph). While geopolitical distance is also trending downwards, geographical distance has remained relatively stable since 2017 and even saw an increase in 2023.

This pattern aligns with a scenario where pharmaceutical companies try to minimise exposure to risks by curtailing investments in geopolitically distant countries. Importantly, the absence of a clear drop in geographical distance for production-focused investments suggests that rather than nearshoring, companies might seek to maintain a varied global production network while strategically decreasing stakes in geopolitically tense economies.

In summary, synthesising the insights emerging from trade and investment data yields two principal observations: (1) the geography of sourcing evolves only slowly, reflecting multi-faceted constraints; and (2) companies appear likely to weigh the benefits of geopolitical risk mitigation against the costs of abandoning an established, historically shaped supply chain structure.

Figure 2.8. Recent investment trends suggest companies seek to lower geopolitical risk exposure

Evolution of two dimensions of distance for pharmaceutical foreign direct investment (FDI) projects



Note: The four graphs above show the evolution of geographical and geopolitical distance for foreign direct investment (FDI) projects in the pharmaceutical sector recorded in the fDi Markets database between 2003 and April 2024. Both measures of distance are normalised so that 100 represents the average level of distance observed for investment projects in the year 2004. The top left-hand graph draws on information on all investment projects in the pharmaceutical sector covered by the fDi markets database for this period. Conversely, the other three graphs only refer to subsets, based on the primary function of the investment project as recorded in the fDi markets database. The upper right-hand graph refers to investments dedicated to functions of headquarters, the lower left-hand graph draws on information on investments focused on research and development, and the lower right-hand graph covers projects focused on production activities. The vertical dotted lines indicate the timing of the global financial crisis (2008), the rise of trade tensions between China and the United States (2018), the outbreak of the COVID-19 pandemic (2020), and the Russian war of aggression against Ukraine (2022).
Source: Authors' analysis based on fDi Markets database of the Financial Times[1].

Notes to Box 2.1
1. Trade data rely on the *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[29]) and encompass 71 6-digit intermediate products assigned to the pharmaceutical sector based on a correspondence table created for the OECD BTIGE database (https://www.oecd.org/en/data/datasets/bilateral-trade-in-goods-by-industry-and-end-use-category.html). Information on FDI is sourced from the fDi Markets database of the Financial Times (fDi Markets, a service from The Financial Times Limited 2024. All Rights Reserved). This comprehensive resource tracks greenfield investments worldwide. For each investment project, the database provides a description of the corresponding business function. The analysis presented in this section is based on counts of all investment projects assigned to the pharmaceutical sector in this database.
2. The Herfindahl-Hirschmann Index (HHI) was calculated through a three-step process: First, a granular HHI was computed by summing the squared market shares for each pharmaceutical product, importer, and year. Second, these preliminary HHI values were adjusted by the proportion of each product in the importer's total pharmaceutical intermediate imports to derive an importer-specific HHI. Finally, the importer-specific HHIs were weighted by the importer's contribution to global pharmaceutical production, using OECD data, to compute the global HHI for a given year.
3. While Figure 2.7 presents a weighted average HHI across all importing countries and pharmaceutical intermediates, this aggregate view may mask higher concentration levels and differing trends at the individual country level. Similarly, calculating concentration at the level of individual firms or incorporating indicators of a product's substitutability would yield a different perspective. Moreover, there is no universally accepted threshold defining critical concentration. Regarding concentration of imports, Baur & Flach (Baur and Flach, 2022[32]) use 0.33, whereas Arriola et al. (2024[33]) and the European Commission (European Commission, 2021[34]) employ a threshold of 0.4. For more details on HHI and related analysis, please see section 3.3.
4. Data on geographical distance come from the CEPII gravity database (Conte, Cotterlaz and Mayer, 2022[30]). The geopolitical distance metric is derived from Bailey, Strezhnev, & Voeten (2017[31]) based on UN General Assembly votes. The original variable was first converted into a five-year moving average, beginning two years before the year in question. For example, for the analysis referring to 2020, the average from 2014-2018 was used. For limitations of this data source, see Voeten (2023[35]).

2.3.2. Exposure to upstream and downstream production shocks varies across industries

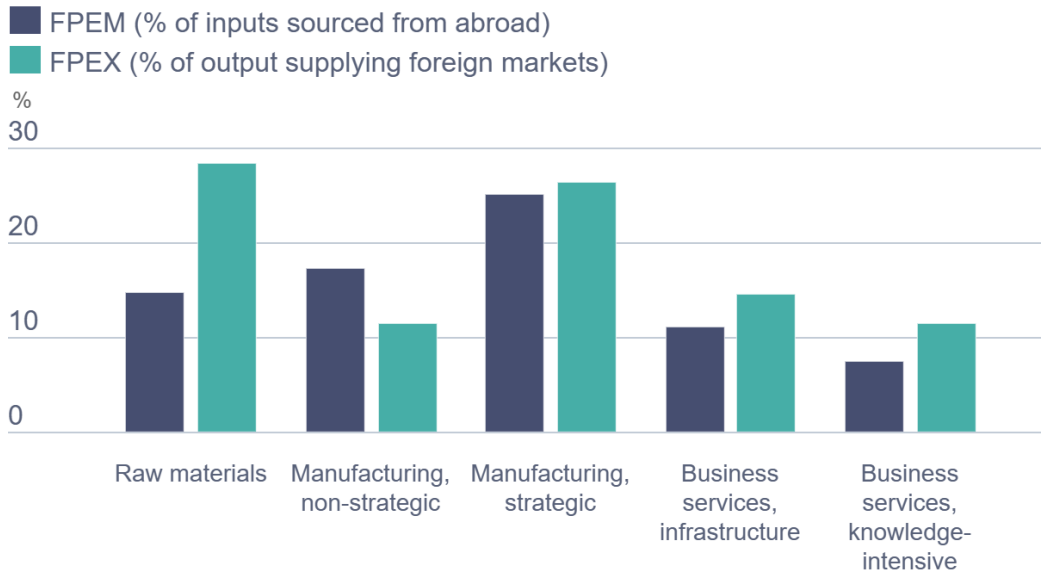
The import intensity of production, with its emphasis on an industry's reliance on inputs sourced from abroad, can be construed as an indicator of exposure to shocks from foreign input suppliers. Firms, however, are also exposed to shocks that might affect their foreign customers. Figure 2.9 presents two indicators of exposure to foreign production, foreign product exposure for imports (FPEM) and foreign product exposure for exports (FPEX) (Baldwin, Freeman and Theodorakopoulos, 2022[36]). FPEM indicates the percentage of an OECD sector's inputs that are supplied from abroad. Similarly, FPEX captures the sector's reliance on sales to foreign markets.

The figure shows that exposure to foreign markets tends to be high for upstream sectors such as raw materials. This is also the case for sectors supplying services to foreign markets, in particular infrastructure services which are essential for cross-border trade, such as transport and distribution. Non-strategic manufacturing, which focuses on consumer goods, is the only sector in the OECD with higher upstream dependencies (on foreign inputs, FPEM) than for foreign sales (FPEX). On average, the most exposed sector both upstream and downstream is strategic manufacturing (that includes industries such as petroleum and electronics) and reflects the complexity of the industry's supply chains which require more production steps and border crossings.

The section is linked to the country-by-country statistical annex on international supply chain interdependencies and trends. It shows the percentage of a country's sector that could be exposed to foreign disruptions, both upstream (FPEM) and downstream (FPEX) for each OECD Member country (Annex B).

Figure 2.9. Foreign exposure varies across OECD industries

Percent of inputs sourced from abroad (FPEM) and outputs supplying foreign markets (FPEX), OECD averages, 2020



Note: FPEM and FPEX are indicators of foreign supply chain exposure on the import and export sides, respectively (Baldwin, Freeman and Theodorakopoulos, 2022[36]). Both indicators are on gross trade terms and account for direct linkages (i.e. the supplier of an input) and indirect linkages (i.e., the supplier's supplier). The OECD is presented as a weighted average, where weights are sectorial final demand. Raw materials correspond to agriculture and mining. The manufacturing sector is split into strategic and non-strategic industries, following the definition in IMF (2023[37]), in its report's Annex to Chapter 4. Strategic manufacturing refers to industries that are identified to be of critical importance for national and economic security, such as petroleum and electronics. The services sector is split into infrastructure services, such as transport and retail, and knowledge-intensive services, such as corporate, scientific or IT services.
Source: Based on OECD Inter-Country Input-Output (ICIO) tables (OECD, 2024[16]).

2.3.3. Multinational enterprises account for a large share of trade in GVCs

MNEs' investment decisions have profound effects on the structure of supply chains. For a firm aiming to reach its foreign customers, exporting its products across country borders may not be the only available option. In many sectors, firms choose to serve their foreign markets by setting up local branches operated through subsidiary companies, known as affiliates.[3] From the point of view of their host countries, affiliates are domestic firms. Nevertheless, they operate under the control of their foreign parent company.

In fact, the growing number of companies that have set up foreign branches over the years has been driven by a variety of motives beyond serving local markets. Often, MNEs are drawn to a country by a combination of factors, including its location, natural resources, labour costs, specialised knowledge and the regulatory environment.

MNE groups abroad are nowadays among the most important actors in the global economy. At the world level, the foreign affiliates of MNEs accounted for 11% of global gross output in 2020 (Figure 2.10). Following a period of rapid expansion in the 2000s, this share has been stable since 2011. These figures do not account for the activities of MNEs in their home country, i.e. the activities of headquarters and other home country establishments. According to OECD estimates, the domestic activities of MNEs account for an additional 20% of global gross output. As a result, the activities of MNEs represent around one-third of global gross output.

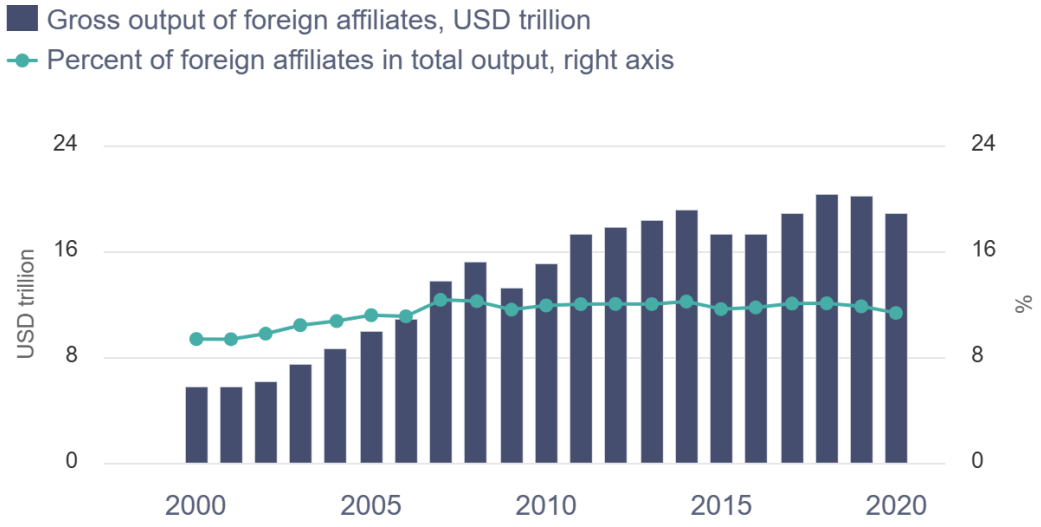
The activities of MNEs tend to both originate and be concentrated in OECD Member countries. Of all the gross output produced by foreign affiliates globally, 71% is produced by affiliates (regardless of location)

of MNEs that are headquartered in OECD Member countries and 57% is produced by foreign affiliates located in OECD Member countries.

The share of foreign affiliates' sales in world gross output has remained roughly constant since the 2008 global financial crisis. While FDI flows have shown some sign of decline since 2016 (IMF, 2023[37]), there is no similar trend when it comes to the activities of foreign affiliates.[4] Multinational production has instead become more dynamic in the past decade with the rise in MNEs from emerging economies and the developing world (Buckley et al., 2023[38]).

Figure 2.10. MNEs' foreign affiliates accounted for 11% of global production in 2020

Global gross output for foreign affiliates, 2000-2020



Note: Gross output reflects the total production of an economic activity. In general, it can be interpreted as a measure of sales or revenue. However, in the case of activities that predominantly rely on buying goods for subsequent resale (e.g. wholesale and retail trade), gross output is measured as sales less cost of goods sold.
Source: Based on OECD (2024[39]), OECD Analytical Activities of MNEs (AMNE) database, https://www.oecd.org/en/data/datasets/multinational-enterprises-and-global-value-chains.html.

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Notes

[1] GVC trade refers to trade flows associated with the vertical specialisation of economies that import inputs in order to export. For a more detailed definition, see note under Figure 2.1.

[2] Relying on gross trade flows, this indicator double counts the value added in inputs that cross borders several times, thus accounting for the level of segmentation in world production and not just the foreign value added included in gross output.

[3] For statistical purposes, a firm is designated as a foreign affiliate if more than half of the voting power is controlled directly or indirectly by a foreign entity.

[4] FDI flows or stocks are often regarded as a biased measure of foreign affiliates' activity as they are affected by mergers and acquisitions, profit shifting and financial restructuring (Beugelsdijk et al., 2010[40]; Blanchard and Acalin, 2016[41]).

3 Understanding trade dependency and the impacts of disruptions

Recent shocks and disruptions have sharpened awareness of the potential risks associated with reliance on international supply. This chapter explores these concerns and uses modelling to understand where vulnerabilities may lie and the possible effects of shocks. It also assesses the likely economic impacts of attempts to “re-localise” production.

The preceding chapter described the evolution of supply chains in international commerce and how this trend has contributed to interdependence across national economies. In this context, it is worth exploring whether greater trade interdependency contributed to the negative economic consequences of recent shocks, or whether it was in fact an attenuating factor (OECD, 2022[1]; Arriola, Kowalski and van Tongeren, 2021[2]). However, current geopolitical and trade tensions, expanding interventions by national governments, intensified international competition for scarce natural resources and greater policy uncertainty have increased awareness of the potential negative implications of trade interdependencies, and the risk that over-reliance on some trading partners could result in significant economic and societal damage in the event of unexpected disruptions, or could become a tool for economic coercion, undermining national or strategic security.

Perceptions of the negative sides of trade dependencies have resulted in calls for deglobalisation, friend-shoring, near-shoring, creating trading blocs or re-localising supply chains (e.g. Arriola (2020[3]); Crowe and Rawdanowicz (2023[4]). On the other hand, there are concerns that some of these policy responses, aimed at minimising trade risks and improving supply chain resilience, may not be well designed and could unintentionally undermine the benefits of international trade and reduce resilience (discussed further in Chapter 5). There is also the risk that such measures could trigger a process of fragmentation of the international trading system.

This chapter explores potentially vulnerable trade links, referred to here as “trade dependencies” or “critical trade dependencies” (i.e. dependencies considered to be particularly important economically, or otherwise).[1] One approach to minimising trade risks and improving supply chain resilience is to scan for such trade dependencies and devise policies to increase diversification. The chapter discusses approaches used to quantify such dependencies across major trading economies and a wide range of trade products, to then analyse the geographical concentration of merchandise imports and exports for specific trade partners. Additionally, the chapter describes economic modelling approaches that try to capture some of the dependencies across a wider range of sectors, including services. It concludes with a discussion of estimates of the economic costs that could be expected if policy-induced attempts to reduce trade dependencies lowered trade integration. The chapter is linked to the country by country statistical annex on international supply chain interdependencies and trends. Annex B presents a snapshot of import and export concentration for OECD countries over time.

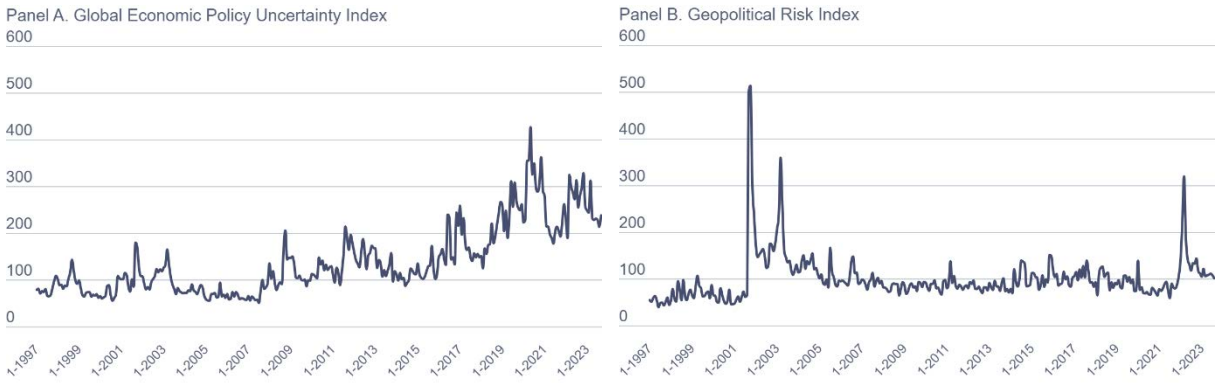
3.1. Perceptions of increasing external shocks undermine trust in trade

Perceptions of geopolitical, policy and economic uncertainty have highlighted awareness of the possible negative aspects of interconnectedness, and the propagation of shocks in international supply chains. Measuring these phenomena is a complex undertaking, and results are not always straightforward to interpret. However, the past five years were marked by several large shocks (COVID-19 and subsequent transport and supply chain disruptions, Russia’s war of aggression against Ukraine, and interruptions of traffic in Suez and Panama Canals) and several recent studies and measurement initiatives have demonstrated signs of greater perceived uncertainty.

The economic policy uncertainty index, for example, which draws on analysis of words used in major newspapers, official policy sources and surveys of professional forecasters (Baker, Bloom and Davis, 2016[5]), shows that global economic policy uncertainty has increased progressively during recent episodes of economic and geopolitical shocks. This uncertainty index suggests that global policy uncertainty increased markedly in the aftermath of the 9/11 terrorist attacks in 2001, during and in the aftermath of the 2008-10 global financial crisis, during the COVID-19 pandemic and after Russia’s war of aggression against Ukraine in 2022. In the period 2020-2023, policy uncertainty was on average significantly higher than in any of the previous decades covered by this methodology (Figure 3.1, Panel A).

Figure 3.1. Perceptions of uncertainty and geopolitical risks fluctuate over time

Indices of policy uncertainty and geopolitical risk



Note: Values of the indices are presented as in the original sources and therefore scales in the two panels and not directly comparable. In Panel A the series is normalised to mean 100 in the period 1985-2009 while in Panel B the series is normalised to mean 100 in the period 1900-2019.
Source: For Panel A, the Economic Policy Uncertainty Index, https://www.policyuncertainty.com/ and Baker, Bloom and Davis (2016[5]). For Panel B, the Geopolitical Risk Index, https://www.matteoiacoviello.com/gpr.htm and Caldara and Iacoviello (2022[6]). Originally compiled in Arriola, Kowalski and van Tongeren (2024[7]), based on OECD Business and Consumer Confidence Indices data.

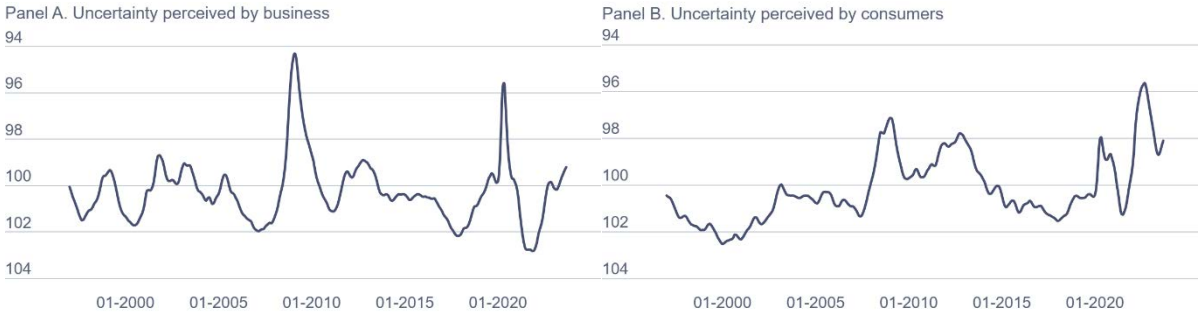
Similarly, the newspaper-based index of geopolitical risk (Caldara and Iacoviello, 2022[6]) shows an increase in the perception of geopolitical risk following the 9/11 terrorist attacks in 2001, and another significant increase in the aftermath of Russia's invasion of Ukraine in February 2022 (Figure 3.1, Panel B). Considered over a longer historical perspective, the same index shows that although the perceptions of geopolitical risk attained in the early 2020s were higher than those seen in the late 1990s, they were still markedly lower than during some previous episodes of geopolitical tensions, for example the Gulf War, Korean War and, particularly, World War I and World War II (Caldara and Iacoviello, 2022[6]).

The OECD Business and Consumer Confidence Indices, which are based on surveys of attitudes towards future developments, show increases in both business and consumer uncertainty for the OECD area in the aftermath of 9/11 and the global financial crisis, at the beginning of the COVID-19 pandemic and, particularly for consumers, following Russia's war of aggression against Ukraine (Figure 3.2).

While assessing the resilience of global supply chains, it is important to keep in mind that the period 2020-2022 posed challenges of a previously unseen magnitude. This is apparent in Figure 3.3. It displays the Federal Reserve Bank of New York's Global Supply Chain Pressure Index (GSCPI), a summary measure of supply chain disruption. The values of the GSCPI observed at the height of the COVID-19 pandemic crisis dwarfed anything seen in the previous two decades, a period which itself had witnessed some significant supply chain shocks (e.g. the earthquake in Japan and the floods in Thailand in 2011). Despite continuing geopolitical tensions, the GSCPI has been below its long-term average since early 2023.

Figure 3.2. Business and consumer perceptions of uncertainty increase following major events

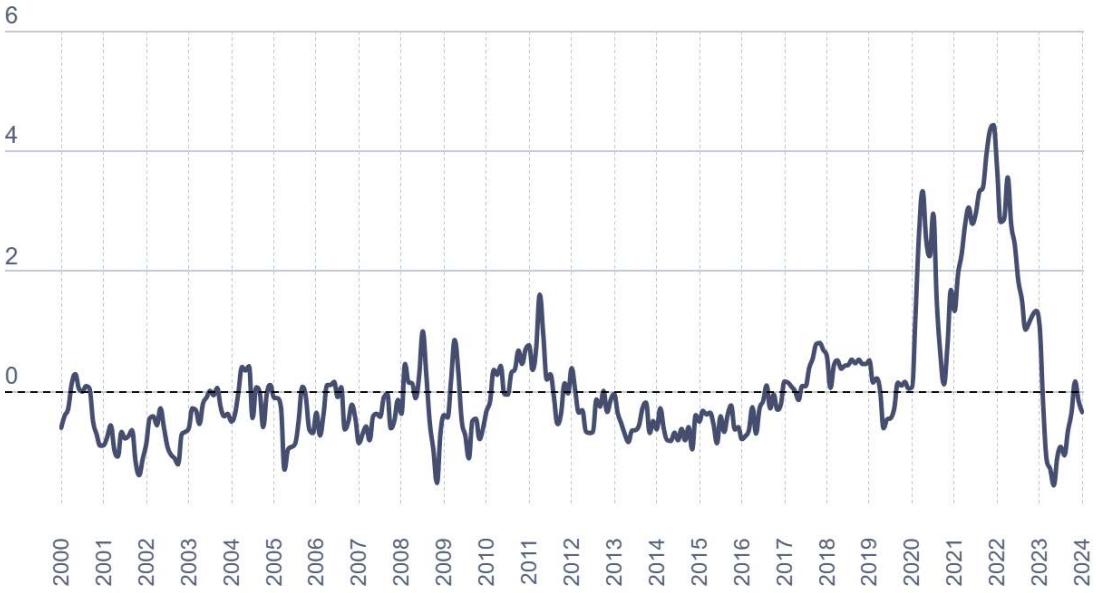
Values of OECD Business and Consumers Confidence indices for the OECD area



Note: Values of indices are shown on reverse scales to show "uncertainty" as the inverse of confidence, as measured in the OECD Business and Consumers Confidence survey. Numbers above 100 suggest an increased confidence in near future business performance or consumer confidence, and numbers below 100 indicate pessimism about future performance. These confidence indicators provide information on future developments. For business confidence, they are based upon opinion surveys on developments in production, orders and stocks of finished goods in the industry sector. For consumer confidence, they provide an indication of future developments of households' consumption and savings, based on answers about their expected financial situation, their sentiment about the general economic situation, unemployment, and their savings capability.
Source: Arriola, Kowalski and van Tongeren (2024[7]), "Shocks in a highly interlinked global economy", https://doi.org/10.1787/4a2f0127-en, based on OECD Business and Consumer Confidence Indices data.

Figure 3.3. The COVID-19 pandemic put supply chains under unprecedented pressure

Global Supply Chain Pressure Index (GSCPI), January 2000-June 2024



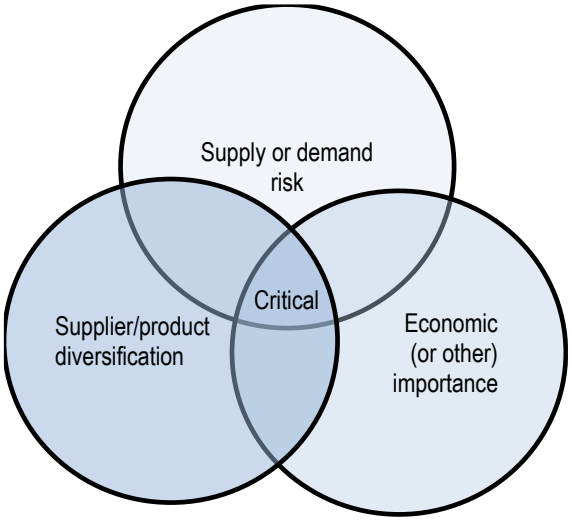
Note: The index is constructed by aggregating data on various types of international transportation costs, as well as country-level manufacturing data, and is expressed in terms of standard deviations around an average value of zero.
Source: Federal Reserve Bank of New York Global Supply Chain Pressure Index, https://www.newyorkfed.org/research/policy/gscpi#/overview.

3.2. Anticipating risks associated with trade dependency

Identifying potential trade dependencies, and associated economic and other risks, has been high on the policy agenda since the COVID-19 pandemic. It is nonetheless difficult to identify objective analytical criteria and measurements that would allow a clear separation of those trade links that may be a source of concern from those that are advantageous. This is in part related to the fact that relevant considerations are often non-economic and reflect country-specific perceptions of national security priorities. Thus, the potential contribution of economic analysis is limited but can nevertheless help draw a more comprehensive picture of some of the economic characteristics of global and national trade linkages which have been put forward as examples of trade dependencies. It can also help assess the economic costs and benefits associated with different policy options.

The emerging literature on this topic, as summarised in Arriola et al. (2024[8]), suggests that critical trade dependencies can be defined as trade flows that combine three characteristics: high economic (or other) importance; high risk of supply disruption; and few options for supplier or product diversification or substitution (Figure 3.4). The three characteristics and their measurement are discussed below.

Figure 3.4. Three criteria help to identify critical trade dependency



Source: Arriola et al. (2024[8]). "Towards demystifying trade dependencies: At what point do trade linkages become a concern?", https://doi.org/10.1787/2a1a2bb9-en.

Identifying economically or other key imported products often first involves examining how a specific import (e.g. a mineral or a service) is used in the production processes of domestic industries. The next step is to determine whether those industries themselves are important national industries, or whether the import is essential from other perspectives (e.g. essential food products or medicines). In some cases, an additional criterion is added which considers whether the absence of the product would cause detrimental harm to the economy, society or a country's strategic interests. Assessing whether this is the case requires consultation with industry experts. For economically important national industries, a disruption in their supply could have economy-wide repercussions. However, less economically sizeable industries can also be considered important, for example if they are concentrated geographically or are important for a country's industrial, technological or social performance. To identify critical dependencies in exports, the analysis typically considers an exported product's contribution to total exports. However, it can also include other strategic considerations, such as the essential nature of, or technologies embodied in, the exported product.

As supply or demand disruptions can have different sources, any analysis of supply or demand risk needs to explore political, geographical or natural risks which may concern specific products or wider ranges of products. The higher the probability of disruptions and the higher the supply risk, the higher the degree of criticality. Identifying the main trading partners in the trade linkages is one of the key issues in the risk assessment in the context of the trade dependency debate. This is because geographic, economic and geopolitical risks are often related to the country's affiliation or the location of trading partners. However, the growing incidence of climate change-related disruptions has also triggered interest in risks which may be concentrated in specific geographical areas (e.g. coastal or flood areas, areas exposed to extreme temperatures or specific transport routes).

The consequences of supply or demand disruptions can be alleviated if alternative trading partners are available (or alternative types of products). In applied trade policy analysis, this possibility of substitution is typically captured by concentration of imports and exports across partner countries and products, as well as by elasticities of substitution.[2]

The trade dependency criteria in Figure 3.4 provide a useful conceptual distinction of the different characteristics that may underpin critical dependency, even if most of the measures that are used to quantify them in applied work may be either imperfect indicators of these characteristics, or may capture more than one of them. In recent analysis, the OECD has investigated different sources of data and key modelling frameworks which can be used to identify trade flows falling under this definition and to examine their characteristics and evolution (Arriola et al., 2024[8]). One of the conclusions was that, given the lack of a commonly accepted definition and approach to measuring trade dependencies, as well as the fact that various data and modelling approaches have different advantages and constraints, it is best to combine alternative methods to shed light on trade dependency.

One approach is to analyse traditional inter-country input-output (ICIO) data which were discussed in Chapter 1 in the context of mapping supply chain interlinkages. This can help to better capture indirect linkages and supply and demand dependencies while accounting for the whole supply chain, which may span across different economic sectors (e.g. Ayadi et al. (2021[9]), Baldwin and Freeman (2022[10]), Schwellnus et al. (2023[11]), Inomata and Hanaka (2021[12]), Arriola (2024[8])). Another approach is to use fully fledged economic models—typically computable general equilibrium (CGE) models—that not only incorporate information on trade concentrations and inter-sectoral linkages, but also allow modelling of behavioural responses across specific economic sectors as well as the whole economy (Grassia et al., 2022[13]); (Arriola et al., 2020[3]); (Arriola et al., 2023[14]); (Chepeliev, Hertel and van der Mensbrugghe, 2022[15]); (Rose, Chen and Wei, 2022[16]). However, such models are typically based on data aggregated by sector and can therefore mask some of the vulnerabilities associated with producing and trading specific products. They are also based on additional modelling assumptions and parameters (Section 3.7).

The third popular approach – and the one which is used in the section below – is to assess trade dependency using granular merchandise trade data. Despite some limitations – the most significant being that they only cover direct merchandise trade linkages[3] – the approach enables a granular picture to be painted of linkages across a diverse list of merchandise (some 5 000 products) and a comprehensive coverage of trading partners (some 230 countries) over the last 20 years. Studies which follow this approach build on the concept of trade concentration, i.e. reliance on only a few suppliers for imports, or only a few markets for exports, of specific products (e.g. Bonneau and Naka (2020[17]), McKinsey Global Institute (2023[18]), Productivity Commission (2021[19]), European Commission (2022[20]), (Vicard and Wibaux (2023[21]), Barthou, Haraboure and Samek (2024[22]). While the various studies using the granular merchandise trade data approach may use somewhat different measures of concentration and criteria to determine dependency, the shared hypothesis is that if a country imports a given product from, or exports it to, only a few partners, this country may find it hard to find alternatives in case of foreign supply or demand disruptions.

3.3. National imports and exports have become more concentrated

The granular trade data approach described above has been used in recent OECD work to study the main features of trade dependencies and their evolution over time for the world and the OECD area (Arriola et al., 2024[8]; Kowalski and Bates, 2025 forthcoming[23]). In this work, trade dependency has been determined by analysing jointly several measures of dependency such as the overall global concentrations of exports and imports of products across all exporting and importing countries, concentrations of countries' imports of specific products, and the main trading partners' shares in these imports and exports.

To measure the overall concentration of imports and exports of products across trading partners, this work follows several recent studies which make use of the Herfindahl-Hirschman Index of concentration (HHI). Calculated as the sum of squared market shares, the HHI lies between 1/*n* (where all of the *n* suppliers have equal shares), and one (where there is only one monopolistic supplier of imports or one monopsonistic destination for exports). While there are no objective thresholds of HHI values that clearly indicate low and high concentration, some indicative thresholds have been used in applied work.[4] Abovementioned OECD work uses an HHI value of 0.2 to indicate relatively high concentration.[5]

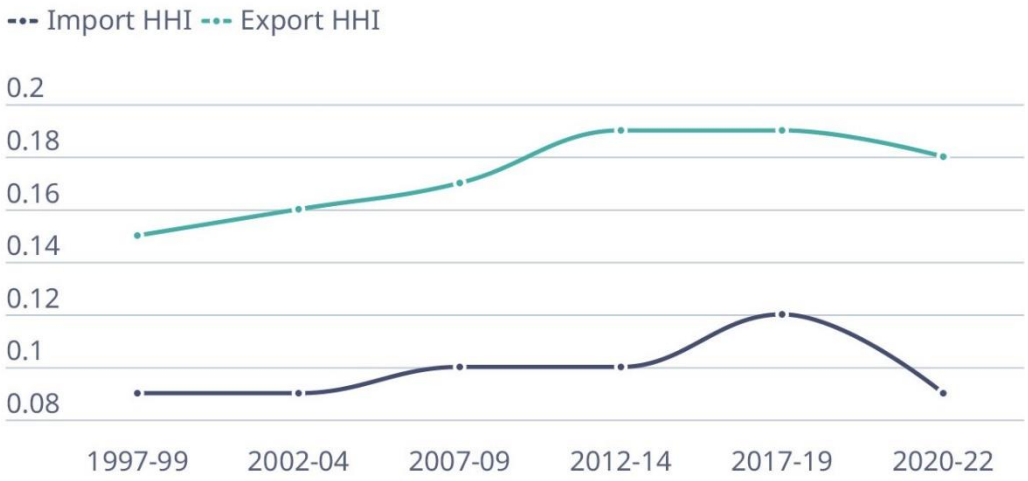
To paint a comprehensive and balanced picture of trade concentration and trade dependency, this approach calculates the HHI values for different types and levels of international trade in merchandise products:

- When calculated across all countries which export (or import) a given product, the index captures *global concentration* of supply (or demand) for that product.
- When calculated for a product and an individual importing (or exporting) country across all the corresponding export (or import) partners, the index captures *national concentration* of imports (or exports) of that product.
- Combining global and national concentration can determine cases of *"significant" national concentration* where the national import (or export) concentrations are much higher than the corresponding global export (or import) concentrations, suggesting that imports are being sourced from (or exports are destined for) significantly fewer countries than is in principle possible.
- Some bilateral product-level trade linkages can be further classified as *bilateral trade dependencies* where more than 10% of a country's imports (or exports) come from (or are exported to) one partner, and the country has a high *national concentration* of imports (or exports) for this product.

One of the key findings of this analysis is that the global concentration of both exports and imports of products[6] increased from the mid-1990s, before declining somewhat during the COVID-19 pandemic (Figure 3.5). In part, the growing global concentration of trade likely reflects finer levels of specialisation in international supply chains which proliferated during this period. In international supply chains, specialisation tends to occur at the level of specific specialised inputs and tasks rather than finished complex products. As a result, many more, and often smaller, actors are involved in the production of complex products, making relatively small contributions in the form of parts and components or semi-processed products, possibly leading to a higher incidence of more specialised and more concentrated trade flows. This trend is consistent with the perception of an increase in vulnerabilities to unexpected shocks transmitted through international trade and supply chains, and especially with concerns about the growing concentration of supply. However, it is also clear that, while global export and import concentrations have both grown, their average levels remain low, with their HHI values not exceeding 0.2.

Figure 3.5. Global concentration of exports and imports has generally increased

Product level Herfindahl-Hirschman Index (HHI) of concentration of global imports and exports, average across all HS6 products



Note: The shares considered in the calculation of the HHIs in this figure are national shares of worldwide exports (or imports) of a specific product.
The export and import concentration indices presented in this and subsequent figures are calculated first for each specific HS6 product and then averaged for the purposes of presentation across product categories (i.e. global "averages" for all trade in this case). The averages therefore measure typical export or import concentrations across all active bilateral trade flows observed in the dataset. The analysis covers the period for which harmonised trade data at the product level are available (1997-2022). Since trade values can vary significantly from one year to another, especially for more disaggregated HS product categories, three-year (or two-year) averages are calculated to track evolution of dependencies over time.
Source: OECD calculations using the *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

Figure 3.5 also shows that global concentration of exports across supplying countries is higher than global concentration of imports across destination countries. This can be explained by the tendency of countries to specialise in the production of different products (or inputs and components), while consuming relatively similar baskets of products.

Overall, the data demonstrate that large, if not dominant, portions of trade are relatively well diversified. For example, even for global exports, which tend to be more concentrated that global imports (Figure 3.5) only about 30% of products record relatively high levels of concentration, while exports of all other products are relatively well diversified[7] (Arriola et al., 2024[8]). This suggests that large portions of international markets are characterised by a reasonable amount of competition, and therefore that specific exporters and importers have limited control over supply or price formation.

In addition, the most concentrated export products do not tend to be those typically identified as being "strategic".[8] Instead they tend to include light manufacturing products, most notably textiles and footwear (Figure 3.6). Some animal and vegetable products are also among the highly concentrated exports, as are some inorganic chemicals and base metals. At the same time, global exports of several advanced manufacturing products (e.g. in the advanced machinery and motor vehicles industry) tend to be relatively highly diversified across exporting countries. This reflects multiple factors which are likely to drive production and trade concentration, including some which drive international specialisation and exchange, such as natural endowments, comparative advantage, low costs of production and processing, and economies of scale.

While global exports of products do not appear to be overly concentrated (Figure 3.5), countries tend to source their imports from fewer partners than are theoretically available globally, as illustrated by the higher

values of the HHI index when calculated for national imports and exports (Figure 3.7). Countries are also exporting to fewer markets than are theoretically available globally,[9] although the average concentration of national exports is lower than for imports and has declined slightly over the investigated period. The higher concentration of imports is consistent with the recent public debate in many countries on import dependencies, but for some countries export dependencies may also be significant.[10]

Figure 3.6. Global export concentrations are higher for some selected sectors

Top 30 most and least globally-export concentrated HS sectors, 2017-19

30 most export-concentrated	HHI value	30 least export-concentrated	HHI value
66 - Umbrella, sun umbrellas, walking-sticks, (...)	0.51	17 - Sugars and sugar confectionery (...)	0.15
67 - Prepared feathers and down and articles (...)	0.45	34 - Soap, organic surface-active agents, wa (...)	0.15
53 - Other vegetable textile fibres; paper yarr (...)	0.41	88 - Aircraft, spacecraft, and parts thereof (...)	0.15
14 - Vegetable plaiting materials; vegetable p (...)	0.40	48 - Paper and paperboard; articles of paper (...)	0.15
80 - Tin and articles thereof (...)	0.38	59 - Impregnated, coated, covered or laminat (...)	0.15
46 - Manufactures of straw, of esparto or of ((...)	0.38	27 - Mineral fuels, mineral oils and products c (...)	0.15
92 - Musical instruments; parts and accessori (...)	0.33	38 - Miscellaneous chemical products (...)	0.15
37 - Photographic or cinematographic goods (...)	0.29	20 - Preparations of vegetables, fruit, nuts or (...)	0.15
95 - Toys, games and sports requisites; parts (...)	0.29	40 - Rubber and articles thereof (...)	0.15
45 - Cork and articles of cork (...)	0.29	56 - Wadding, felt and nonwovens; special ya (...)	0.14
6 - Live trees and other plants; bulbs, roots a (...)	0.28	87 - Vehicles other than railway or tramway r (...)	0.14
65 - Headgear and parts thereof (...)	0.28	1 - Live animals; animal products (...)	0.14
13 - Lac; gums, resins and other vegetable sa (...)	0.27	49 - Printed books, newspapers, pictures and (...)	0.14
64 - Footwear, gaiters and the like; parts of s (...)	0.27	68 - Articles of stone, plaster, cement, asbes (...)	0.14
43 - Furskins and artificial fur; manufactures t (...)	0.25	16 - Preparations of meat, of fish or of crusta (...)	0.14
58 - Special woven fabrics; tufted textile fabri (...)	0.25	73 - Articles of iron or steel (...)	0.14
63 - Other made up textile articles; sets; worn (...)	0.25	84 - Nuclear reactors, boilers, machinery and (...)	0.14
50 - Silk (...)	0.24	30 - Pharmaceutical products (...)	0.14
91 - Clocks and watches and parts thereof (...)	0.24	75 - Nickel and articles thereof (...)	0.13
81 - Other base metals; cermets; articles ther (...)	0.24	31 - Fertilisers (...)	0.12
55 - Man-made staple fibres (...)	0.24	39 - Plastics and articles thereof (...)	0.12
94 - Furniture; bedding, mattresses, mattress (...)	0.23	72 - Iron and steel (...)	0.12
96 - Miscellaneous manufactured articles (...)	0.23	35 - Albuminoidal substances; modified starch (...)	0.12
23 - Residues and waste from the food indust (...)	0.23	79 - Zinc and articles thereof (...)	0.12
78 - Lead and articles thereof (...)	0.23	89 - Ships, boats and floating structures (...)	0.11
9 - Coffee, tea, matT and spices (...)	0.23	4 - Dairy produce; birds' eggs; natural honey; (...)	0.11
28 - Inorganic chemicals; organic or inorganic (...)	0.22	76 - Aluminum and articles thereof (...)	0.11
33 - Essential oils and resinoids; perfumery, c (...)	0.22	19 - Preparations of cereals, flour, starch or r (...)	0.10
5 - Products of animal origin, not elsewhere s (...)	0.22	24 - Tobacco and manufactured tobacco subs (...)	0.08
60 - Knitted or crocheted fabrics (...)	0.22	21 - Miscellaneous edible preparations (...)	0.07

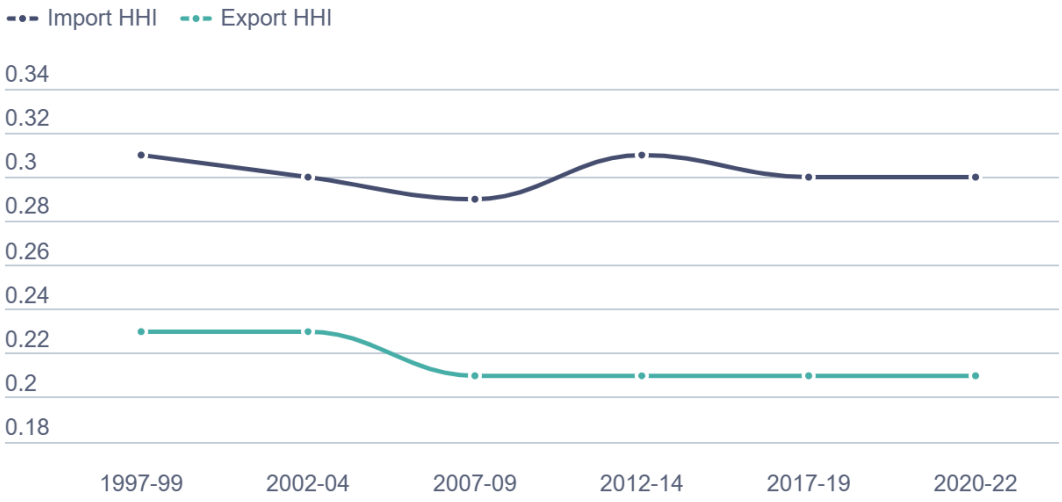
Note: The values show simple averages of HHI values across all HS6 products belonging to a given HS2 category (i.e. HS chapter, which is a more aggregated category of HS products). The higher the HHI value, the more concentrated the product's exports. Note that for some specific HS6 product categories, HHI values can be much higher than the sector average.
Source: Arriola (2024[8]), "Towards demystifying 'trade dependencies': At what point do trade linkages become a concern?", https://doi.org/10.1787/2a1a2bb9-en.

That country-level concentrations of trade tend to be higher than their corresponding global concentrations likely reflects a combination of natural factors – such as the role of geography – and trade costs, particularly in international supply chains, which remain concentrated regionally (i.e. relatively high shares of inputs sourced from abroad are sourced from countries in the same geographical region, such as within Europe, North America or Asia). They also reflect countries' preferences and policies. These are exemplified by the expansion of regional and preferential trade agreements since the 1990s, which by design tend to lower trade costs and give other advantages to selected trade partners, contributing thereby in principle to trade concentration. Strategic economic policies of importers and exporters can also play a role. As discussed by Arriola (Arriola et al., 2024[8]) and further below in this chapter, the relatively high level of

national import concentrations across trading partners has coincided, for example, with China's export-led trade strategies and its rising role as a source of trade dependencies for many importers (Section 3.6).

Figure 3.7. National concentrations of exports and imports are higher than the corresponding global concentrations

Product level Herfindahl-Hirschman Index of concentration of national imports and exports, average across all HS6 products



Note: *This measure is obtained as follows: (1) by calculating for each HS6 product and for each exporting (or importing) country an index of concentration (HHI) considering the shares of each trade partner in a country's exports (imports) of that product; and then (2) by calculating a weighted average across all relevant product lists, with weights equal to the value of exports (or imports) in that product across all partners. The date ranges (1997-99, 2002-04, etc.) denote the averages for three-year periods.
Source: OECD calculations using *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

3.4. OECD Member countries have relatively low trade concentration, but have scope to diversify further

Data sometimes shows large differences between the global and national trade concentrations of certain products. To understand this, it is necessary to distinguish between two scenarios: one in which the number of suppliers is inherently constrained because only a few countries export the product; and another, where even though many suppliers or customers exist globally, countries choose to rely on significantly fewer suppliers than what is potentially available. The latter occurs due to "economy-specific choices" (McKinsey Global Institute, 2023[18]), where factors specific to a given economy such as geography, trade agreements or consumer preferences, lead countries to trade with fewer partners than theoretically possible and result in national concentrations being higher than global concentrations.

Building on this observation, Arriola (2024[8]) and Kowalski and Bates (2025 forthcoming[23]) devised an approach that combines calculations of global and national concentrations to evaluate the incidence of such significantly concentrated trade. In this regard, "significantly concentrated" national imports (or exports) are defined as imports (or exports) of those products that are imported (or exported) by a given country from (to) at least twice as concentrated a range of suppliers (or markets) than is globally possible. Importantly, the determination of "significant concentration" of imports (or exports) was calculated for only products which are already highly concentrated at the global level, i.e. when the HHI value for global exports (or imports) of the given product is equal to or higher than 0.2.

Presented as the number of HS6 products for which national imports or exports are significantly concentrated (Figure 3.8, Panels A and B), this measure is comparable across countries and has the appealing feature of taking into account what is in principle possible in terms of diversification in international markets.[11] This measure is therefore used in this chapter to illustrate the relative levels and trends of trade dependency across all countries. It is also used in Annex B to illustrate the evolution of the number of products with significant import and export concentration for each OECD Member.

Overall, the incidence of significant concentration of national imports and exports has increased on average, but considerably more for imports than exports. Figure 3.8 shows the average number of products with such significant import concentration for all countries in the sample, as well as OECD Member countries, the major other economies (MOEs) grouping[12] and all other countries (i.e. countries which are not members of either the OECD or MOE groupings). Across all countries, on average, there were 50% more significantly import-concentrated products in the early 2020s than there were in the late 1990s (Figure 3.8, Panel A), whereas the level of significant concentration of exports has changed little since the beginning of the investigated period (Figure 3.8, Panel B). At the beginning of the 2020s there were six times as many significantly import-concentrated products per country as there were significantly export-concentrated products. However, while the incidence of significant import concentration has increased across all countries on average since the mid-1990s, the average for OECD Member countries has remained relatively stable—and periodically even fallen.

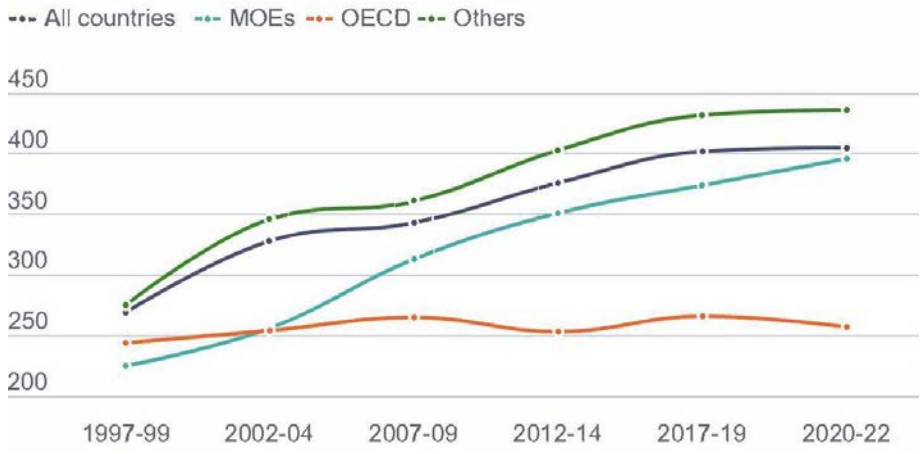
The lowest income countries tend to have the highest incidence of significant import concentrations globally. Many of the lower income countries belong to the category “Others” in Figure 3.8. Countries in this grouping tend to have on average a considerably higher number of significantly concentrated imports than OECD or MOEs; many of them have much lower per capita incomes than the OECD and MOEs. Several of them belong to the least developed country (LDC) grouping, are landlocked and have recently suffered, or are currently suffering, from a military conflict (Arriola et al., 2024[8]).

While on average across OECD Member countries the incidence of significant import dependency has been relatively stable, there is more variation for individual OECD Members. This is also shown in more detail in Figure 3.9, Panel A, for the G7 countries. Throughout the investigated period, Japan and Canada– and to a lesser extent the United States– tended to have higher levels of significant import concentrations than the European G7 members. Interestingly, all G7 countries have recorded gradual reductions in significant import concentrations since 2007-09.

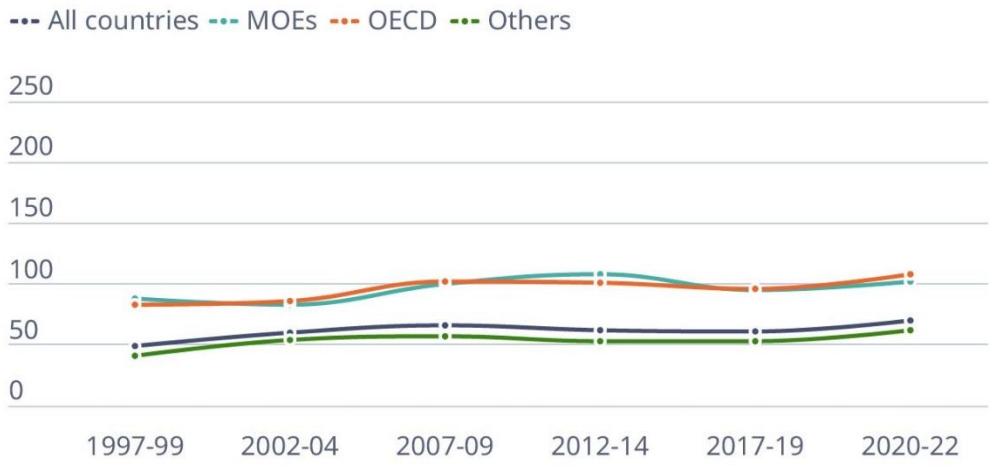
In contrast, there has been a remarkable increase in the incidence of significant import concentration in the MOE grouping (Figure 3.9, Panel B). This is accounted for mainly by India, Brazil and Indonesia, whose significant import concentration scores approximately doubled between the mid-1990s and the early 2020s. In South Africa, Russia and China the incidence of significant import concentration increased by less than 50%, and China in particular has seen the smallest increase of the group. Similar to the G7 countries, China has been gradually reducing its rate of significant import dependency since 2007-09.

Figure 3.8. "Significant" concentration is more prevalent for imports and in non-OECD Member countries

Panel A. Average number of HS6 products with significant import concentration per country



Panel B. Average number of HS6 products with significant export concentration per country

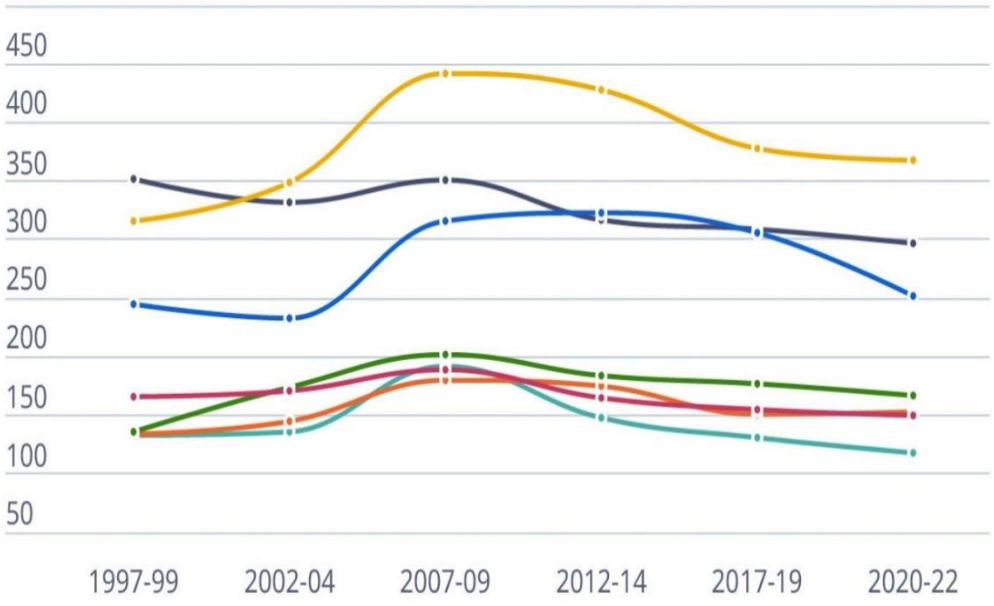


Note: MOEs = major other economies (Brazil, China, India, Indonesia, Russia and South Africa). Significant import (or export) concentration is designated for cases of bilateral trade links at the product level where the value of the country-level HHI for imports (or exports) is more than double the value of the corresponding HHI for global exports (or imports). To further constrain the spectrum of cases of significant concentration, an additional minimum cut-off value of the HHI calculated for global product-level exports (or imports) was set at 0.2. This means that only products with a global export HHI (or import HHI) of at least 0.2 and products with country-level imports HHI (country-level exports HHI) of at least 0.4 were considered. The concentration indices are calculated across all trading partners, including intra-EU trade for EU members.
Source: OECD calculations using Base pour l'Analyse *du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

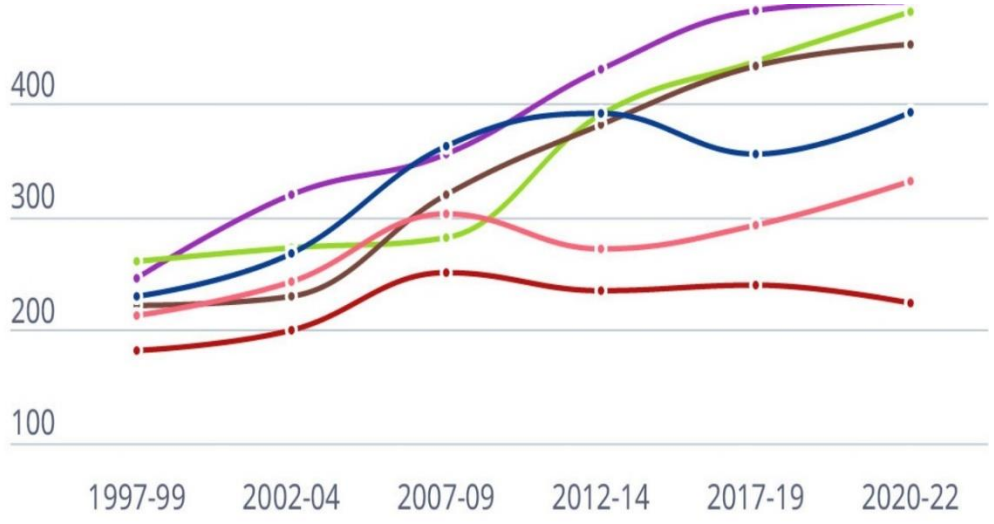
Figure 3.9. Import concentration is declining in the G7, but increasing in most MOEs

Number of HS6 products with significant import concentration in each country

Panel A. The G7 grouping



Panel B. The MOE grouping

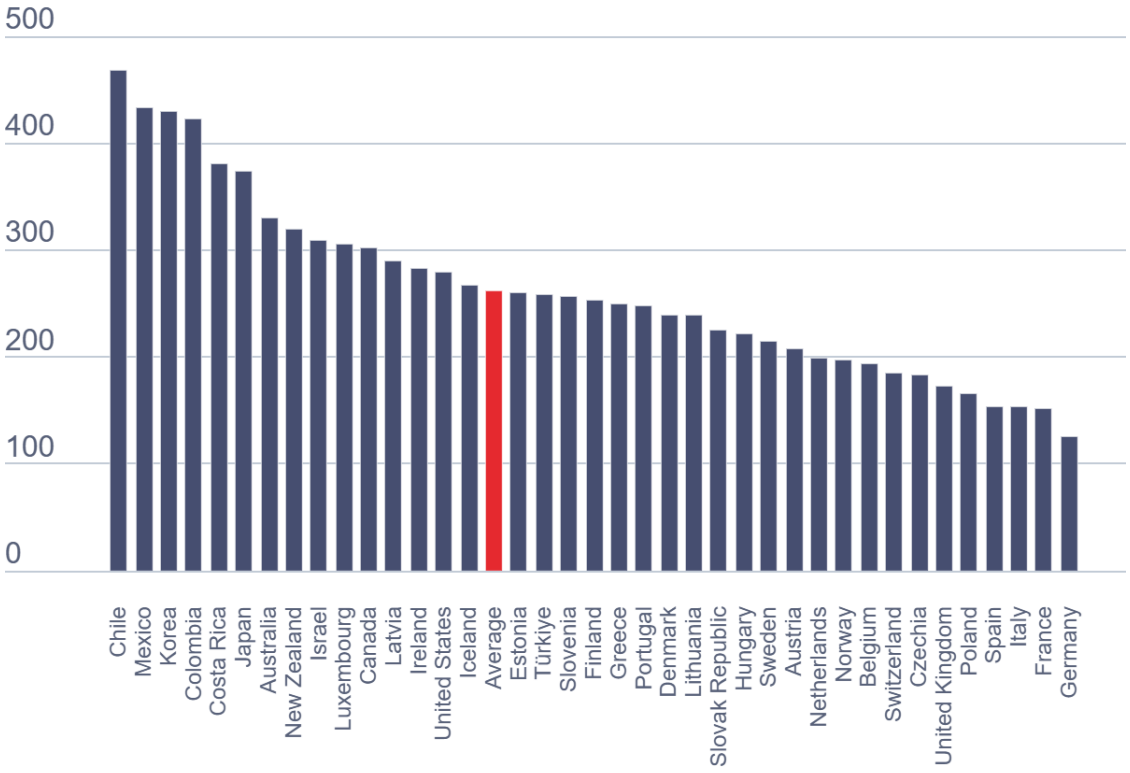


Note: MOEs = major other economies (Brazil, China, India, Indonesia, Russia and South Africa). Significant import (or export) concentration is designated for cases of bilateral trade links at the product level where the value of the country-level HHI for imports (or exports) is more than double the value of the corresponding HHI for global exports (or imports). To further constrain the spectrum of cases of significant concentration, an additional minimum cut-off value of the HHI calculated for global product-level exports (or imports) was set at 0.2. This means that only products with a global export HHI (or import HHI) of at least 0.2 and products with country-level imports HHI (country-level exports HHI) of at least 0.4 were considered. The concentration indices are calculated across all trading partners, including intra-EU trade for EU Members.
Source: OECD calculations using *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

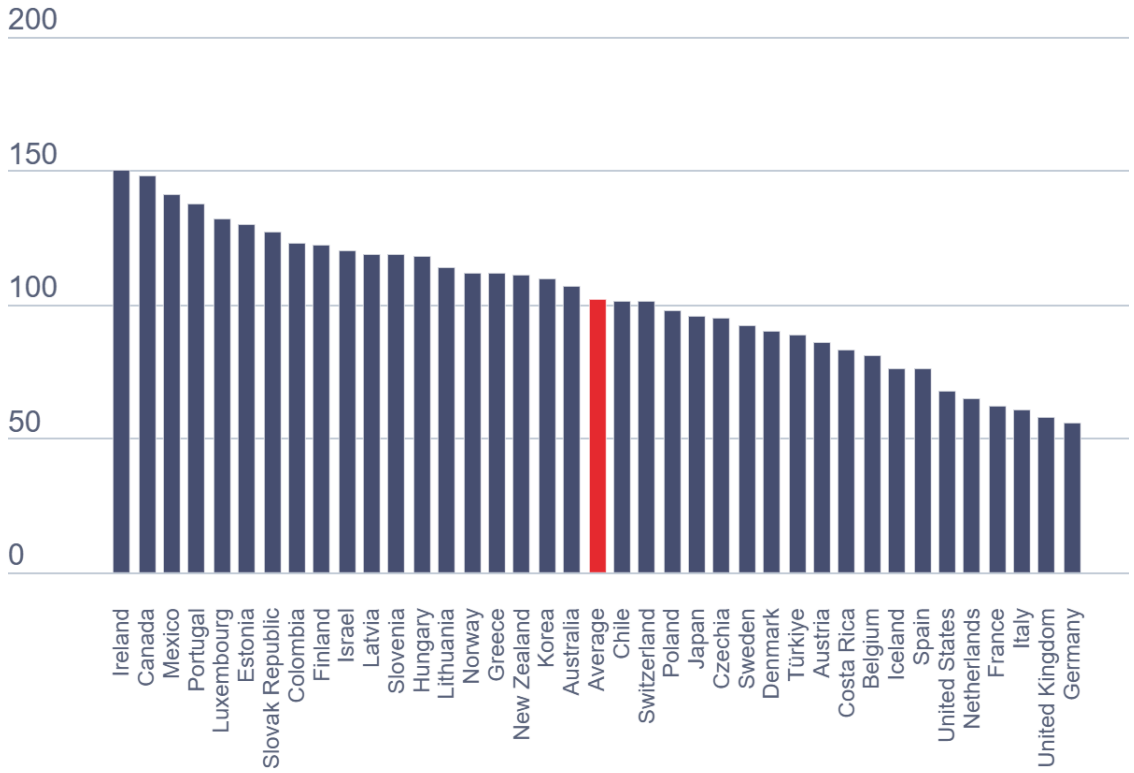
Within the entire OECD Membership, some countries have more concentrated imports and exports than others (Figure 3.10). They also differ in how this measure of trade dependency has evolved over time, as illustrated for each individual OECD Member in the accompanying country by country data annex. Germany, the United Kingdom, France and Italy tend to record the lowest scores for significant import and export dependency across the OECD Membership, while there is no clear pattern when it comes to countries with the highest dependency scores. It can nevertheless be observed that smaller economies tend to have relatively high significant export dependency scores – see also Kowalski and Bates (2025 forthcoming[23]).

Figure 3.10. Some OECD Member countries have more concentrated imports and exports than others

Panel A. Number of imported HS6 products with significant import concentration
(average of the periods 2017-19 and 2020-22)



Panel B. Number of exported HS6 products with significant export concentration (average of the periods 2017-19 and 2020-22)



Note: Significant import (or export) concentration is designated for cases of bilateral trade links at the product level where the value of the country-level HHI for imports (or exports) is more than double the value of the corresponding HHI for global exports (or imports). To further constrain the spectrum of cases of significant concentration, an additional minimum cut-off value of the HHI calculated for global product-level exports (or imports) was set at 0.2. This means that only products with a global export HHI (or import HHI) of at least 0.2 and products with country-level imports HHI (country-level exports HHI) of at least 0.4 were considered. The concentration indices are calculated across all trading partners, including intra-EU trade for EU Members.
Source: OECD calculations using Base pour *l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

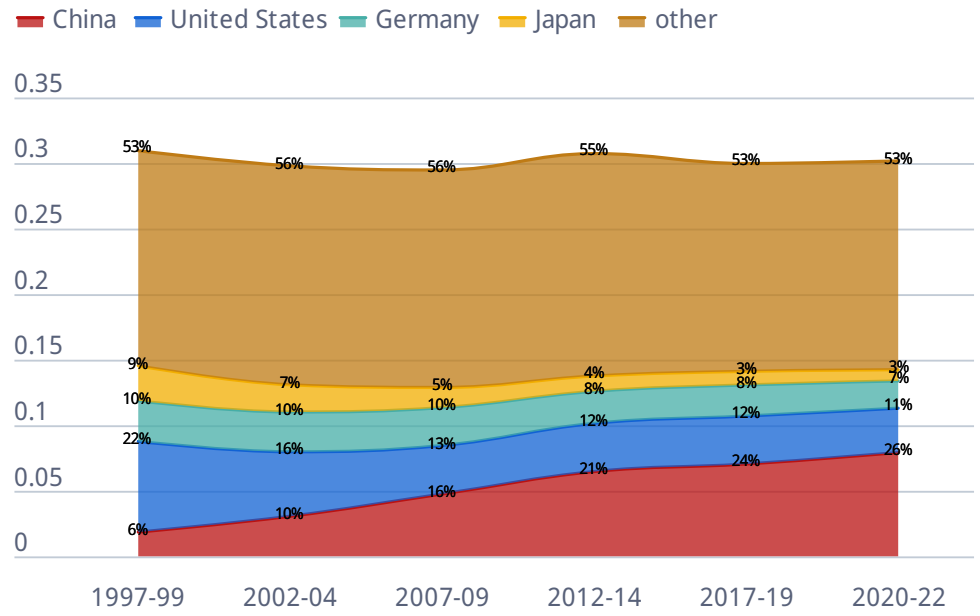
3.5. Global and OECD trade dependency on China has increased significantly, but China also depends on OECD countries

Geographic, economic and geopolitical risks are often related to the geopolitical affiliation or geographical location of countries' main trading partners. Identifying which trading partners countries rely on most from among their highly concentrated trade linkages can be key to understanding the risks associated with trade dependency.

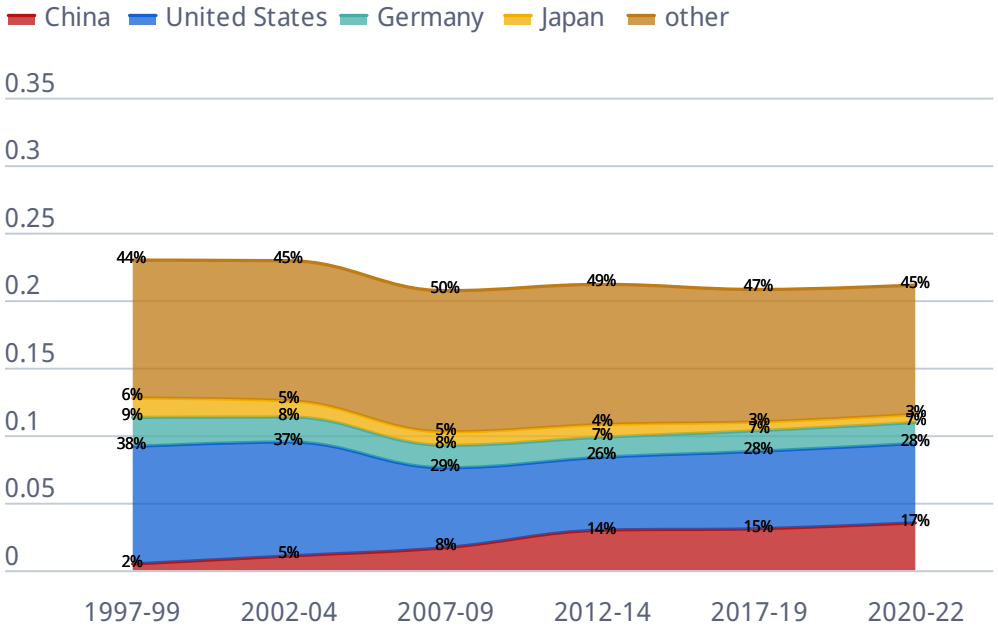
Several measures of trade concentration described in Section 3.4 indicate that, in the investigated period, one of the most prominent developments has been the rise of China as an ever more prevalent counterpart in highly concentrated trade linkages across the globe. This can be illustrated through China's growing contribution to measures of global average national import and export concentration, accompanied by falling shares of the other major trading partners such as the United States, Germany, and Japan(Figure 3.11). In numbers, China's contribution to countries' significant import concentration has increased from 5% to 30% over the past 25 years while the combined contribution of the US, Germany and Japan decreased from 30% to 15% (20% to 11% for the US, 7% to 3% for Germany and 3% to 1% for Japan) (Figure 3.11 Panel A).

Figure 3.11. China's contribution to countries' import and export concentrations is growing

Panel A. Average country-level import concentration (HHI indices, y-axis) and percentage contribution of major exporters (marked on graph)



Panel B. Average country-level export concentration (HHI indices, y-axis) and percentage contribution of major importers (marked on graph)

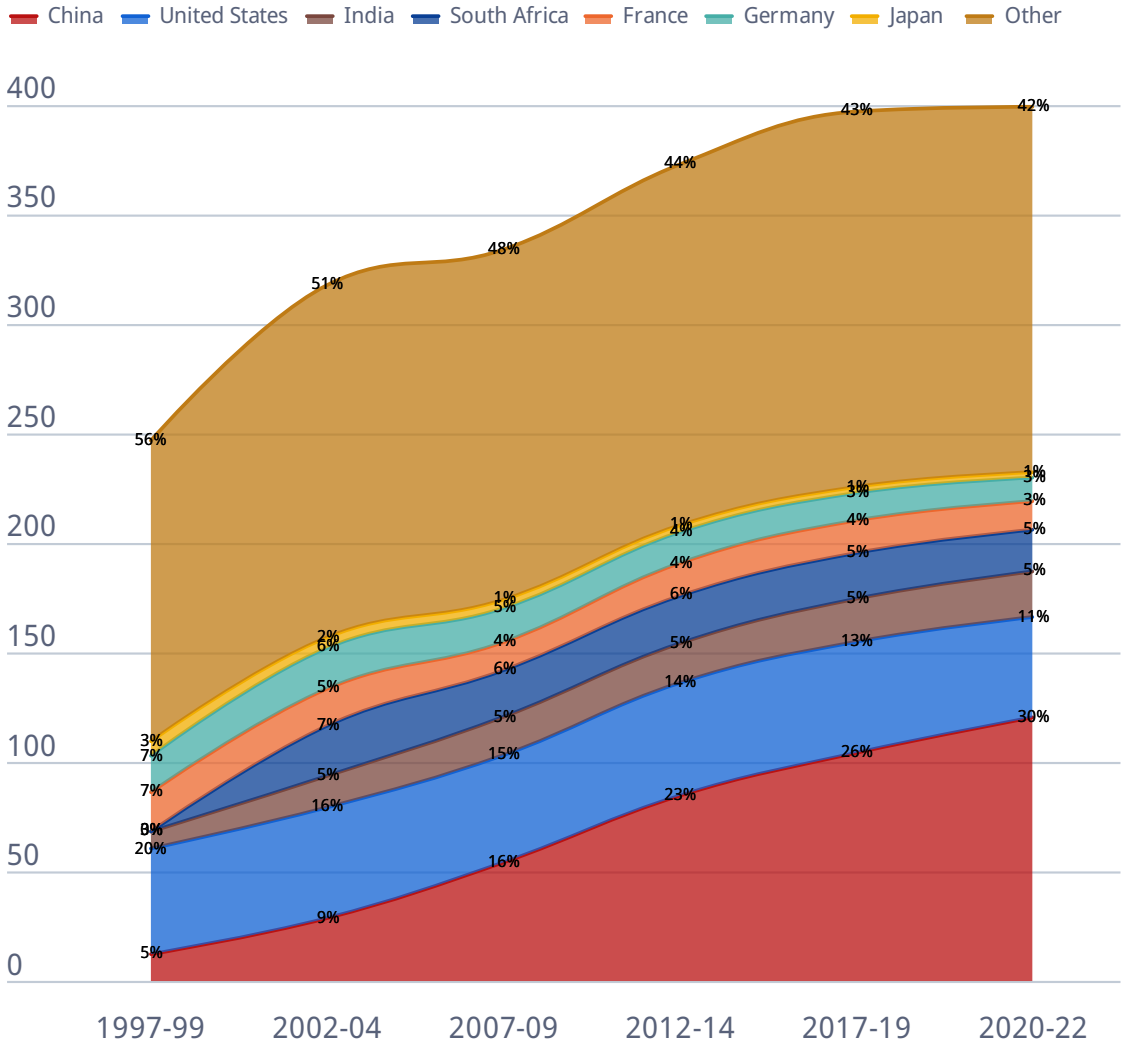


Note: these figures show the decomposition for selected exporters (Panel A) and importers (Panel B) of the values of the HII indices for global imports and global exports, respectively, presented in Figure 3.7 above.
Source: OECD calculations using Base pour l'Analyse *du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

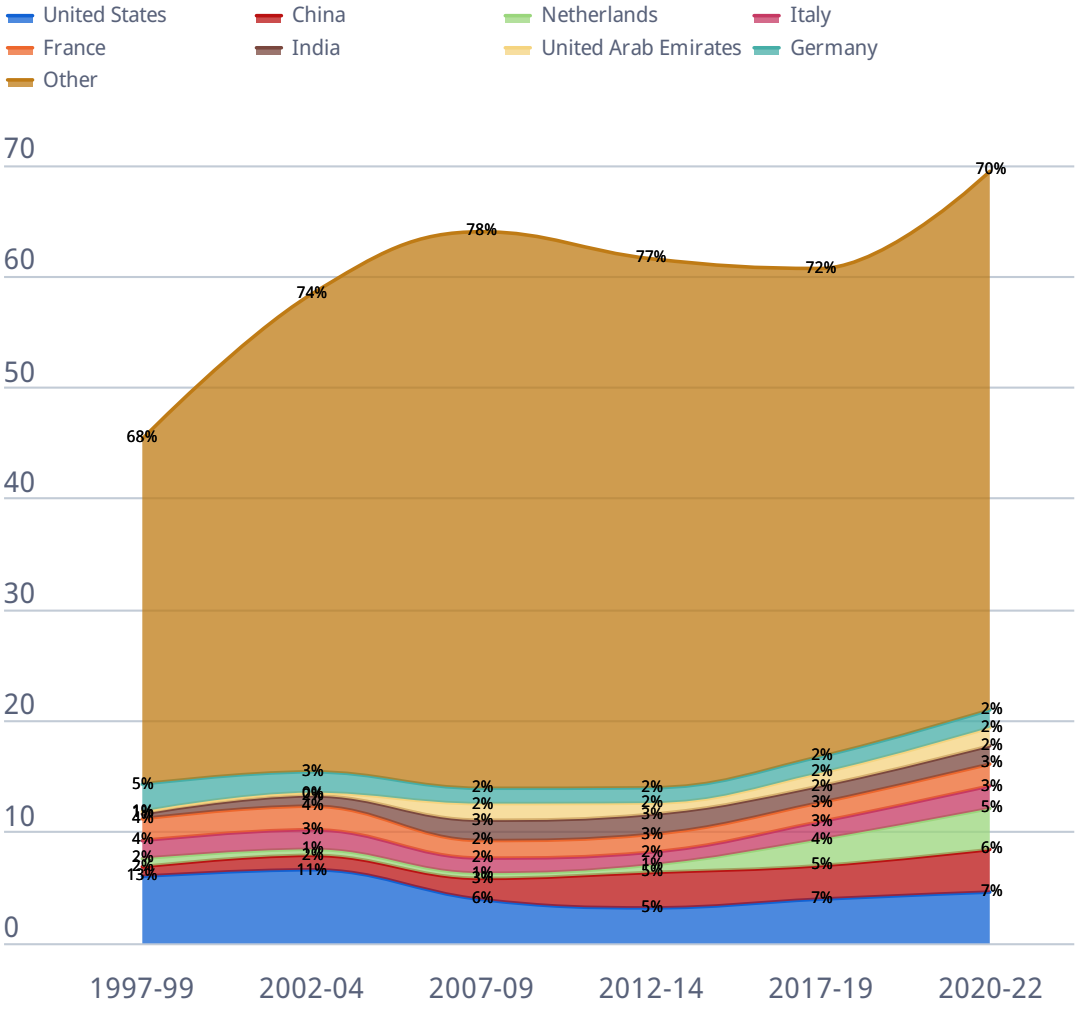
The extent of trade dependency on China can be further illustrated by breaking down the measures of significant import and export concentration of products by the largest trading partner. Figure 3.12 shows the average number of times a trading partner holds the highest share of imports (Panel A) or exports (Panel B) of significantly concentrated imports and exports for all countries. In the early 2020s, China was the main trading partner in 30% of cases of significantly concentrated imports (up from 5% in the late 1990s, Figure 3.12, Panel A) and for 6% of significantly concentrated exports (up from 2%, Figure 3.12, Panel B), although the average number of products for which exports were significantly concentrated was much lower than for imports.[13]

Figure 3.12. China's share in the significant concentration of both imports and exports is growing

Panel A. Average number of products for which imports are significantly concentrated (y-axis) and % of times in which the featured countries are the main trading partner (marked on graph)



Panel B. Average number of products for which exports are significantly concentrated (y-axis) and % of times in which the featured countries are the main destination market (marked on graph)



Note: these figures show the number of significantly concentrated imports and exports, as presented in Figure 3.8, broken down by the average number of times a trading partner holds the highest share of imports or exports respectively. This was calculated by counting the number of times an exporter (or importer) accounted for the highest share of a country's imports (or exports) of any given product whose imports (or exports) are significantly concentrated. This count is then averaged for each trading partner across all countries.
Source: OECD calculations using *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

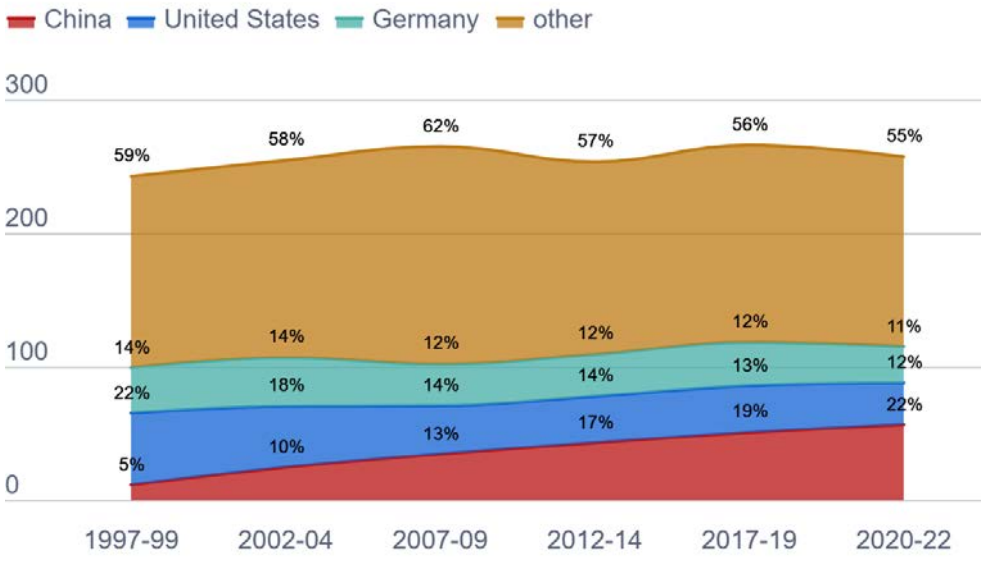
Reliance on China is more pronounced for the MOE grouping than for OECD Member countries (Figure 3.13 and Figure 3.14). In the early 2020s, China was the main trading partner in 60% of the MOEs' excessively concentrated imports (up from 9% in the late 1990s; Panel B, Figure 3.13), compared with 22% of cases for OECD economies (up from 5% in the late 1990s; Panel A, Figure 3.13). In contrast, for exports China has only become a slightly more important counterpart in significant export concentration for both country groupings (Figure 3.14).[14]

The extent and increase in reliance on China portrayed in Figure 3.12, particularly for imports, is backed up by another recent study (Arriola et al., 2024[8]) which used an alternative approach to measuring the contribution to trade dependencies of specific bilateral trading partners.[15] It found that bilateral trade dependency on China has increased considerably for several OECD Member countries and regions since the mid-1990s, and that it is now the single most important country featuring in trade dependencies for the OECD as a whole, and for several individual OECD Member countries.

Figure 3.13. MOEs have seen their import dependency on China increase more than OECD Member countries

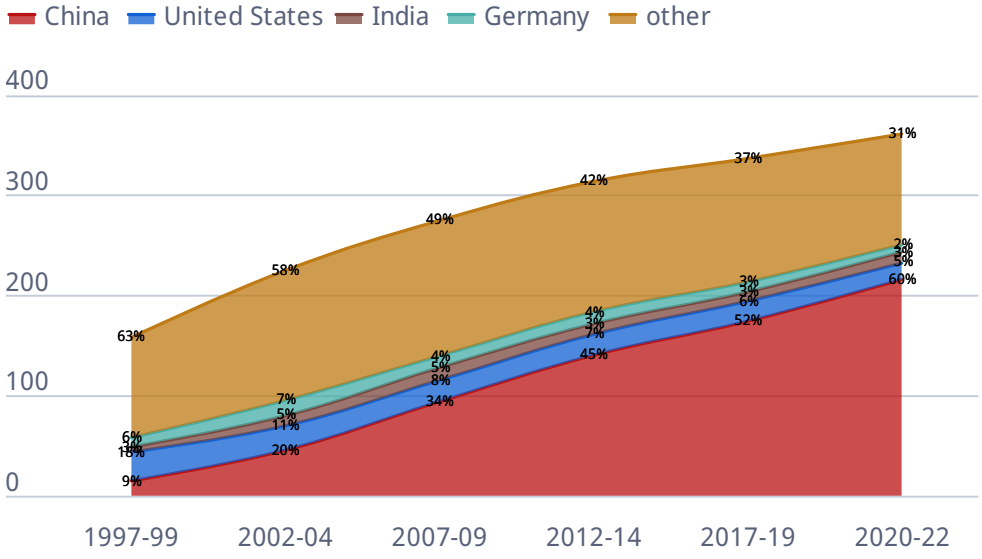
Panel A. OECD country dependency on main trading partner

Average number of products for which imports are significantly concentrated across the OECD (y-axis) and % of times in which the featured countries are the main trading partner (marked on graph)



Panel B. MOE import dependency on main trading partner

Average number of products for which imports are significantly concentrated across the MOE grouping (y-axis) and % of times in which the featured countries are the main trading partner (marked on graph)

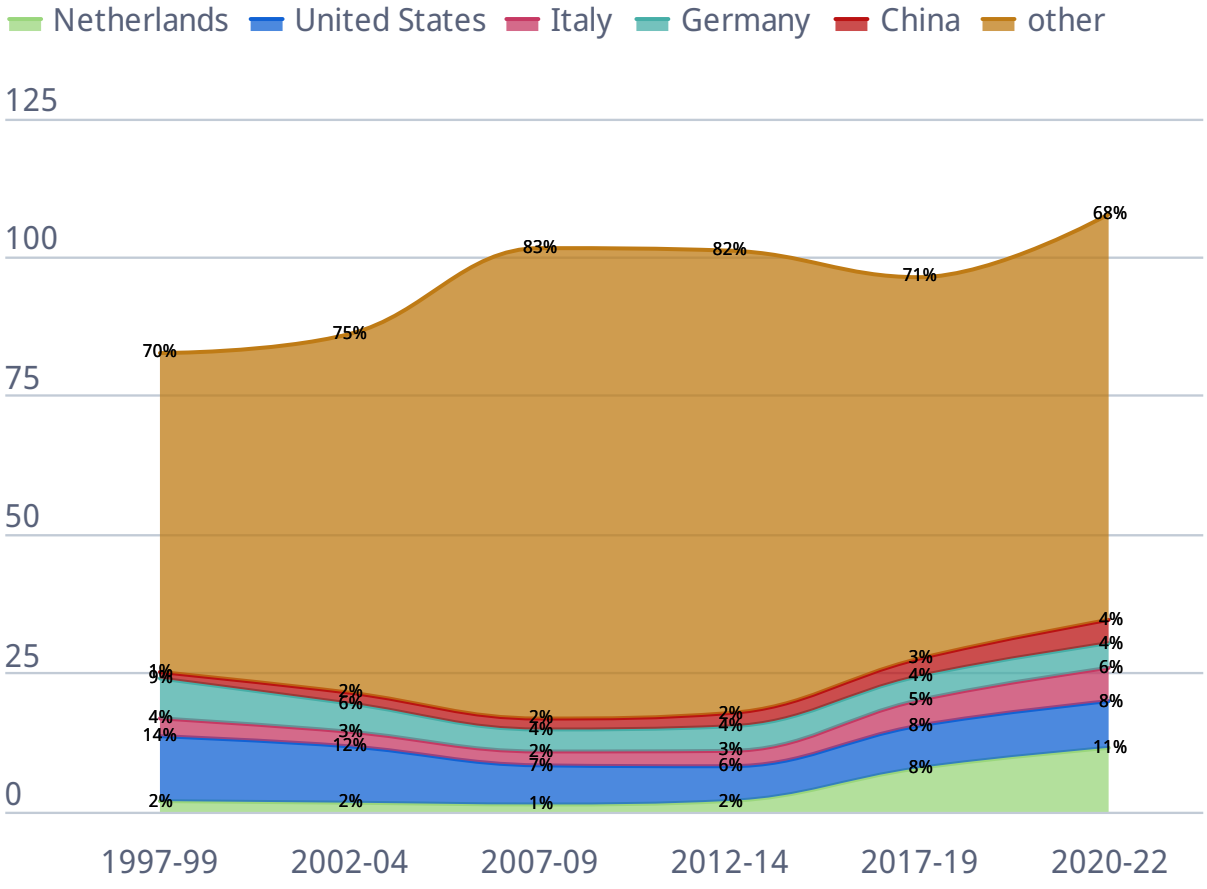


Note: These figures show the number of significantly concentrated imports and exports, as presented in Figure 3.8, broken down by the average number of times a trading partner holds the highest share of imports or exports accordingly. This was calculated by counting the number of times an exporter (or importer) held the highest share of a country's imports (or exports) of any given product for which imports (or exports) are significantly concentrated. This count is then averaged for each trading partner across all countries.
Source: OECD calculations using *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

Figure 3.14. China's role in export concentration in both OECD and MOE groups is less pronounced

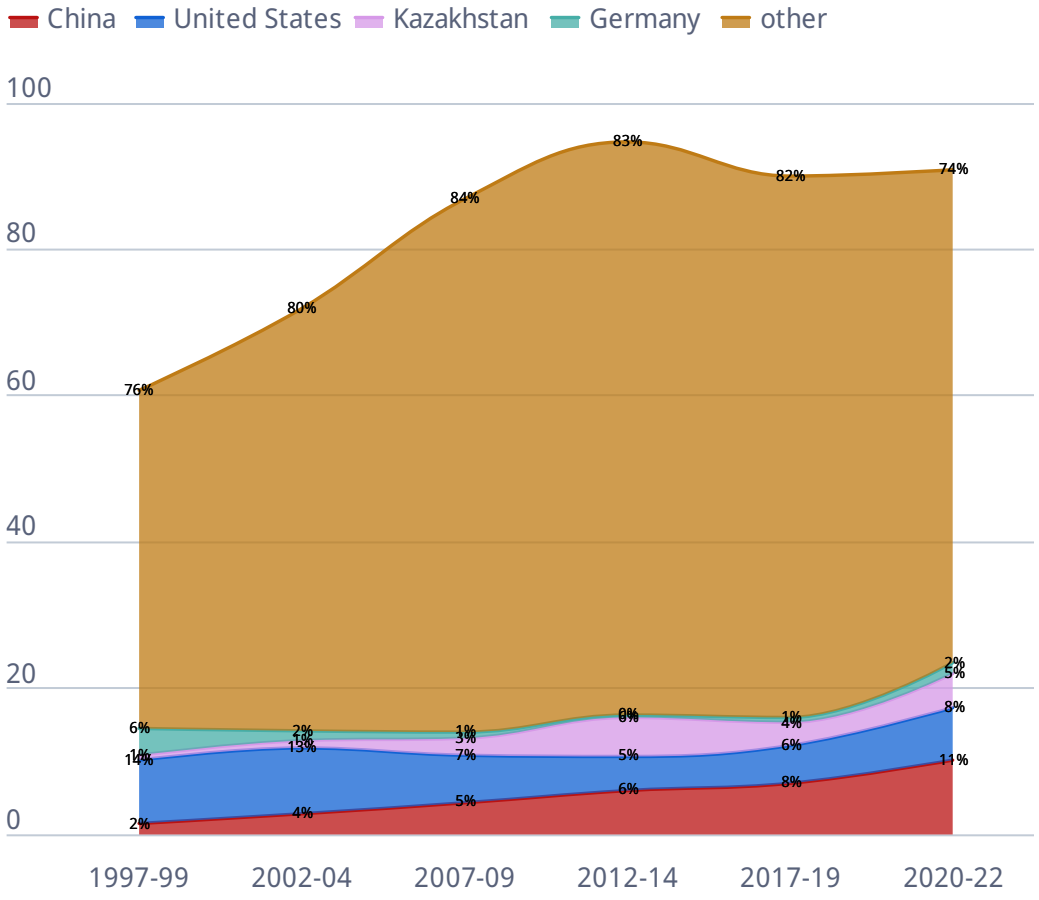
Panel A. OECD country export dependency on main trading partner

Average number of products for which exports are significantly concentrated across the OECD (y-axis) and % of times in which the featured countries are the main trading partner (marked on graph)



Panel B. MOE export dependency on main trading partner

Average number of products for which exports are significantly concentrated across the MOEs (excluding China) (y-axis) and % of times in which the featured countries are the main trading partner (marked on graph)



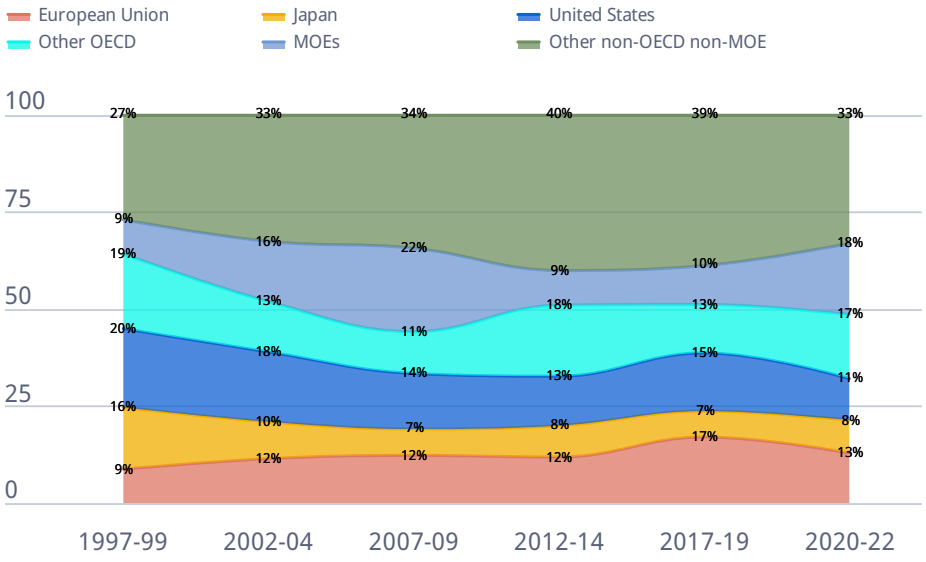
Note: These figures show the number of significantly concentrated imports and exports, as presented in Figure 3.8, broken down by the average number of times a trading partner holds the highest share of imports or exports accordingly. This was calculated by counting the number of times an exporter (or importer) held the highest share of a country's imports (or exports) of any given product for which imports (or exports) are significantly concentrated. This count is then averaged for each trading partner across all countries.
Source: OECD calculations using *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[24]).

At the same time, OECD economies' trade dependencies on China can also be viewed in the context of China's dependencies on OECD countries. The OECD as a group – and especially several individual OECD Member countries – are much more relevant counterparts in significantly concentrated import and export products for China than China is for the OECD (Figure 3.15). Throughout the investigated period, OECD Member countries were the main trading partners involved in China's significantly concentrated imports. Japan and the United States are the two countries that account for the highest shares of China's significantly concentrated imports throughout the period, although the shares of these two countries in China's dependencies have been gradually declining (Figure 3.15). The European Union as a group has also become progressively more important for China. Just before the COVID-19 pandemic the European Union was the main partner in 24% of cases of China's significantly concentrated imports, up from 10% in the late 1990s. China's sectoral dependencies involving OECD Member countries include industries in which several OECD Member countries also depend on China, particularly advanced manufacturing (e.g. manufacture of motor vehicles, manufacture of pharmaceuticals, manufacture of bearings, gears, gearing and driving elements, manufacture of lifting and handling equipment).

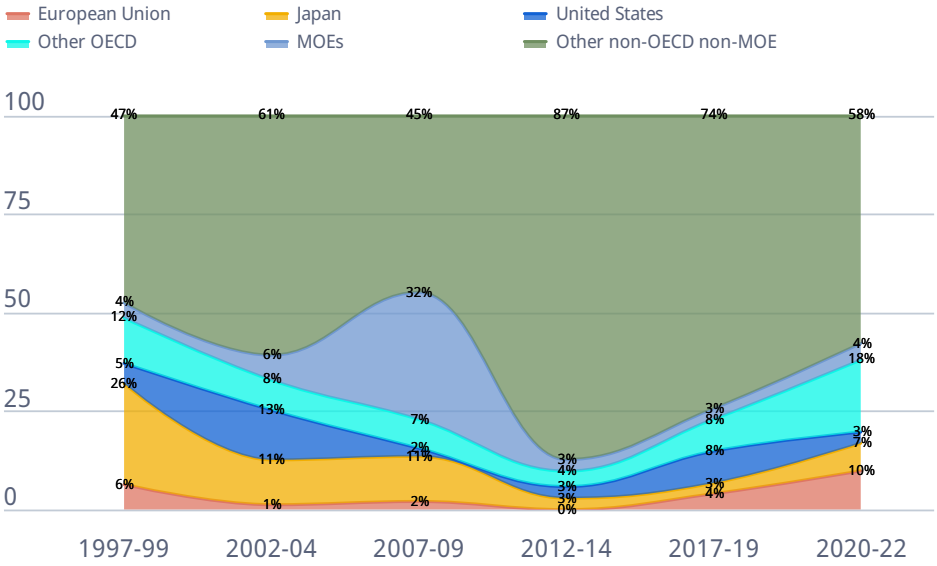
The high shares of the OECD in China's import dependencies, and vice versa, underscore the mutual character of some of these trade dependencies. For the MOE grouping, the growth in import dependency appears more one-sided, as China's import dependencies on other members of this country grouping have increased only slightly, while these countries have become considerably more dependent on China.

Figure 3.15. China has a large share of significantly concentrated trade with the OECD and EU

Panel A. Number of products for which Chinese imports are significantly concentrated and for which one of these trade partners is the main supplier



Panel B. Number of products for which Chinese exports are significantly concentrated and for which one of these trade partners is the main destination market



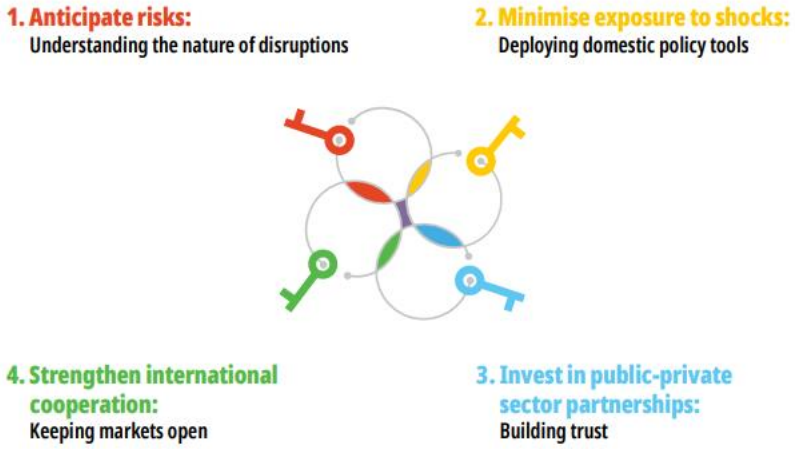
Note: these figures show the count of significantly concentrated imports and exports, as presented in Figure 3.8, broken down by the average number of times a trading partner holds the highest share of imports or exports accordingly. This was calculated by counting the number of times an exporter (or importer) held the highest share of a country's imports (or exports) of any given product for which imports (or exports) are significantly concentrated. This count is then averaged for each trading partner across all countries.
"Other OECD" are all the OECD Member countries except the United States, Japan, and OECD Member countries of the European Union.

3.6. Supply chain shocks need to be understood and anticipated

Given the diverse nature of shocks that have the potential to disrupt supply chains, policymakers need to understand how different events are likely to impact domestic and international stakeholders. Anticipating risk by understanding the nature of disruptions is one of the OECD's keys to resilient supply chains (Figure 3.16). While the analysis of trade dependency based on gross trade flows concerning individual products, as presented above, helps to unravel the main relevant trends over recent decades, it does not give the full picture. This is because the exposure of national economies to potential shocks, as well as their ability to adjust to these shocks, depends on these economies' specialisation and integration into international supply chains. These characteristics are not easy to gauge without a fully-fledged model of the global economy which accounts for intra and inter-industry linkages, while also adequately capturing economy-wide adjustments. This section describes OECD analysis which employed data and modelling tools to track possible effects across a full supply chain to better inform government and business efforts to enhance supply chain resilience.

Figure 3.16. Anticipating risks is one of the OECD's four keys to resilient supply chains

OECD policy toolkit to increase supply chain resilience



Source: OECD (2024[25]), *Keys to Resilient Supply Chains. OECD Policy Toolkit: Increasing supply chain resilience*, Resilient-Supply-Chains_Brochure-2024.pdf.

How shocks are transmitted along the whole supply chain, and the main market adjustments, were studied using the OECD's global trade computable general equilibrium (CGE) model METRO (Arriola, Kowalski and van Tongeren, 2024[7]).[16] Incorporating ICIO relationships, the model can capture the exposure to shocks of concentrated trade linkages that are due to direct import-export relationships, as well as those that may result from indirect trade links (e.g. when a product exported from one country to another embeds a component produced in a third country). Importantly, the approach also allows for the analysis of direct and indirect dependencies in the services sectors, unlike the analysis of merchandise trade data described in Sections 3.4 and 3.5 above. The model also accounts for conventional adjustment mechanisms such as price adjustments, substitution between different inputs, the re-balancing of intermediate and final product markets, as well markets for different kinds of labour and capital, and therefore gives a relatively comprehensive picture of possible economic impacts.

Focusing on national economic sectors' output responses to production shocks occurring in other domestic and foreign sectors connected vertically through supply chains and horizontally through competition in

product markets, the analysis considered which countries and broad sectors may be particularly vulnerable to shocks or could be a more significant source of risk for others. While the analysis relies on several assumptions which require care when drawing out policy implications (as for any other exercises using this type of methodology), a few broad findings and policy consequences are of interest and are summarised below.

The analysis shows that the current structure of domestic and international linkages, and economic adjustment mechanisms that operate through them, tend to dampen the impacts of shocks rather than amplify them. This was revealed by the finding that, in most cases, production disruptions somewhere in the global economy cause relatively small output responses elsewhere. That said, there were also some large outliers, indicating that shocks in some segments of the global economy may have more consequential effects than others.

The impacts of shocks occurring in other domestic sectors tend to be larger than impacts of shocks occurring in foreign sectors. This is because in most sectors the reliance on foreign inputs and foreign markets for final products is still less than reliance on domestic inputs and product and factor markets[17]. In addition, international markets offer broader adjustment and diversification options than domestic ones.

Production disruptions originating in foreign vertically-linked sectors – the kind of shocks that are at the centre of the debate on risks in international supply chains – do not appear to be the main source of disruptions. While the results confirm that disruptions in upstream sectors of the value chain can constrain access to intermediate inputs, and output declines downstream can lower demand for inputs, most such vertical impacts are two orders of magnitude smaller than the original shocks. The dispersion of impacts is also smaller than for domestic shocks. Again, this reflects the current levels of diversification and beneficial opportunities for adjustment in international supply chains.

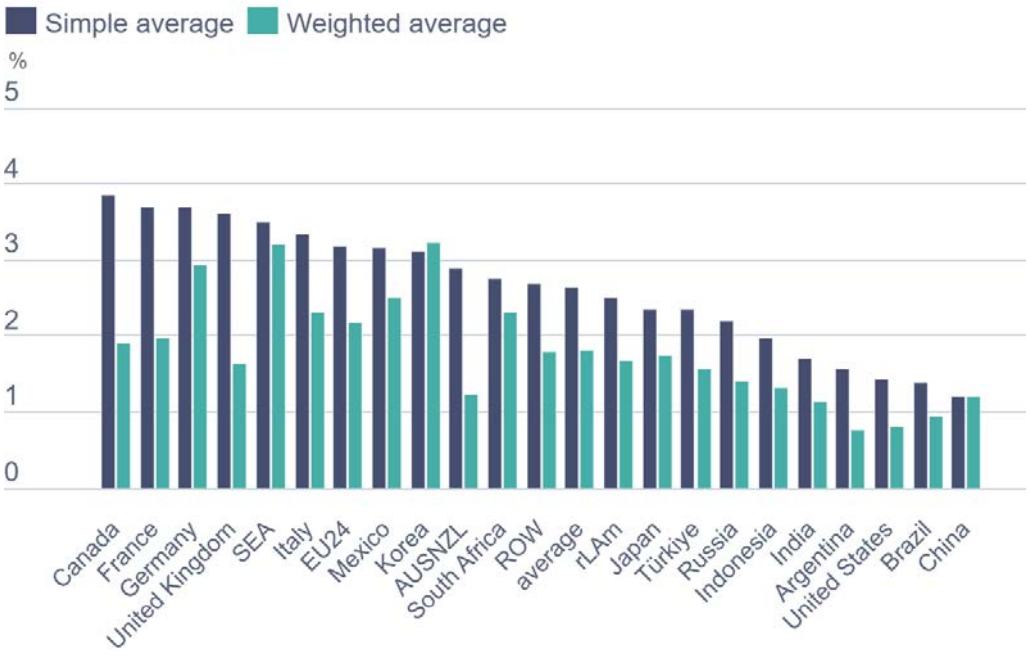
The results also suggest that a wide variety of domestic and international economic adjustment mechanisms play an important role in shaping responses to shocks. These include price signals leading to substitution towards other suppliers or other market outlets, and responses by labour and capital markets. Such mechanisms should therefore be included in assessments of trade dependency and resilience to shocks.

Impacts of shocks across national economies tend to be smaller when factors of production cannot move across sectors (i.e. in the short term) than when they can move freely (medium to long term). This underscores, among other things, that short-lived disruptions may matter less than disruptions that last longer and which allow more time for factor markets to react and pass on the impacts to other sectors. It also suggests that policies protecting employment from temporary shocks or restricting short-term capital movements may help to attenuate the impact of such shocks.[18]

While most of the impacts of shocks propagated through supply chains are much smaller than the initial shocks, in a small portion of cases responses can be more than three times larger than the original shocks. In addition, an accumulation of multiple adverse shocks can have more significant implications. Statistics summarising responses to such highly adverse constellations of shocks presented in this work suggest that some sectors and countries may be exposed more than others. For example, economies with strong vertical links to major foreign economies tend to be more exposed to international supply chain shocks, with Canada, France, Germany, and the United Kingdom being the most exposed across all economies considered in this modelling study. The United States, Brazil, and China are less exposed due to their greater reliance on domestic product and factor markets in most sectors (Figure 3.17).[19]

Figure 3.17. Countries vary in their exposure to international supply chain shocks

A maximum % combined impact on production of all possible 1% sector and country-specific production shocks



Note: These figures show "maximum exposure" for a given country which experiences consequences of shocks occurring randomly in other parts of the global economy. Maximum exposure is first calculated at the country-sector level as the sum of all the simulated negative output changes to the affected sector that can result from the whole range of positive and negative production shocks. For presentation in this figure, it is then averaged across all sectors for each country. A 3% impact would mean, for example, that production could be reduced by 3%. Values of output at the starting point of the simulation are used as weights to produce weighted averages.
SEA=South East Asia; rLAm=other Latin American countries not included individually; ROW=rest of world.
Source: Arriola, Kowalski and van Tongeren (2024[7]) using OECD METRO model simulations.

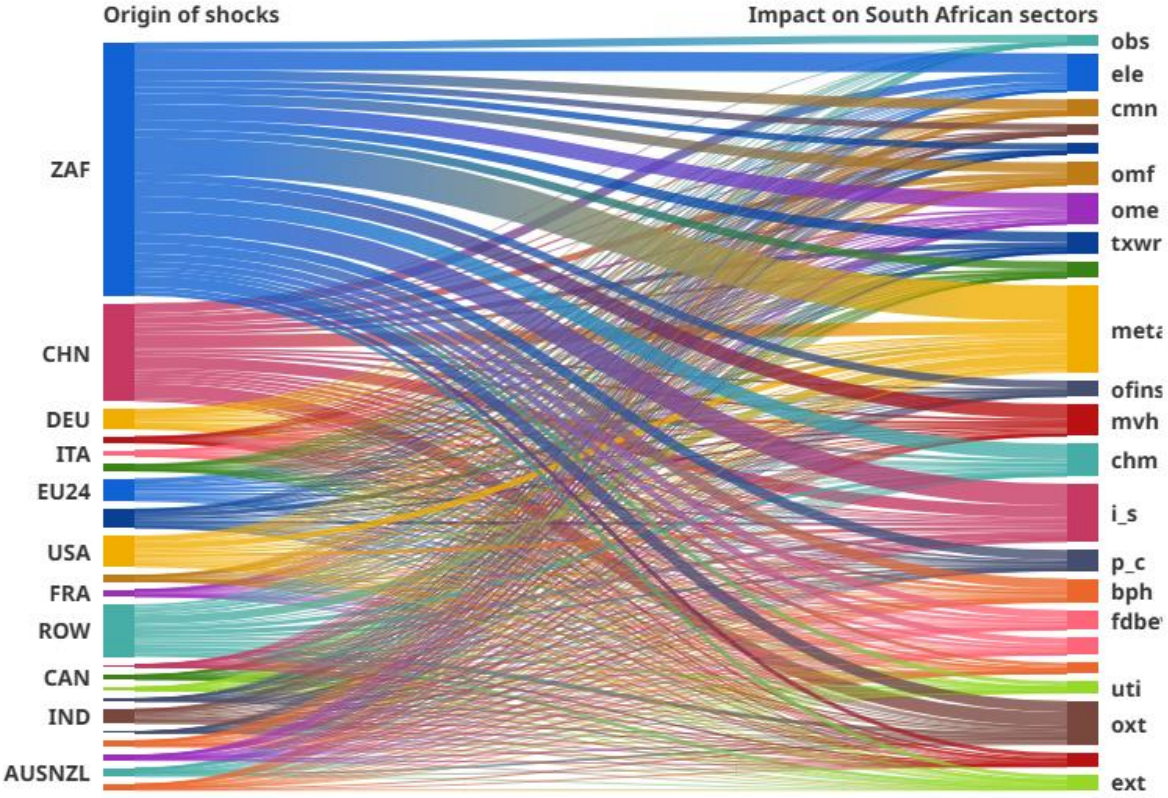
There are also important differences across countries and sectors in terms of which shocks contribute the most to exposure. For example, Germany's motor vehicles sector, which is found in this analysis to be only moderately exposed to international supply chain shocks compared to other sectors, tends to be more exposed than the motor vehicles sector of the United States, and a greater share of this exposure can be attributed to shocks originating in China (Arriola, Kowalski and van Tongeren, 2024[7]).

However, shocks that occur in other sectors of the national economy (i.e. domestic shocks) tend to dominate the exposure metrics, suggesting the most important sources of risks are within domestic economies. This is illustrated using the example of South Africa in Figure 3.18, which shows that most of the country's sectors (right scale) are exposed to shocks originating in other sectors of the domestic economy (left scale). However, China tends to be the country accounting for the greatest share of exposure that can be attributed to shocks originating abroad.

The two examples – of motor vehicles in Germany and South Africa's entire economy – both reinforce the findings from the analysis of granular data in preceding sections: China is the second-most important source of shocks for most economies (after their own domestic economies).

Figure 3.18. Modelling confirms the importance of China as a source of possibly consequential shocks, using the example of South Africa

Example: Breakdown of maximum impact on South Africa's production by sector (right) by country origin of shocks (left)



Note: These figures show "maximum exposure" for a given sector (right) which experiences consequences of shocks occurring randomly in other parts of the global economy, broken down by origin countries or regions of the shocks (left).
SEA=South East Asia; rLAm=other Latin American countries not included individually; ROW=rest of world. agr=agriculture, ext=coal, oil, gas extraction; oxt=mining; fdbev=food and beverage; txwr=textile and wearing appare; omf=other manufacturing; p_c=petroleum and coal; chm=chemicals; bph=basic pharmaceuticals; nmm=mineral products nec; i_s=ferrous metals; metals=metals and metals product; ele=electronic equipment; ome=machinery and equipment; mvh=motor vehicles and parts; uti=utilities; trd=trade; hosprec=hospitality and recreation; otp=transport nec; cmn=communication; ofins=financial services and insurance; obs=business services; oserv=other services.
Source: Arriola, Kowalski and van Tongeren (2024[7]), using OECD METRO model simulations.

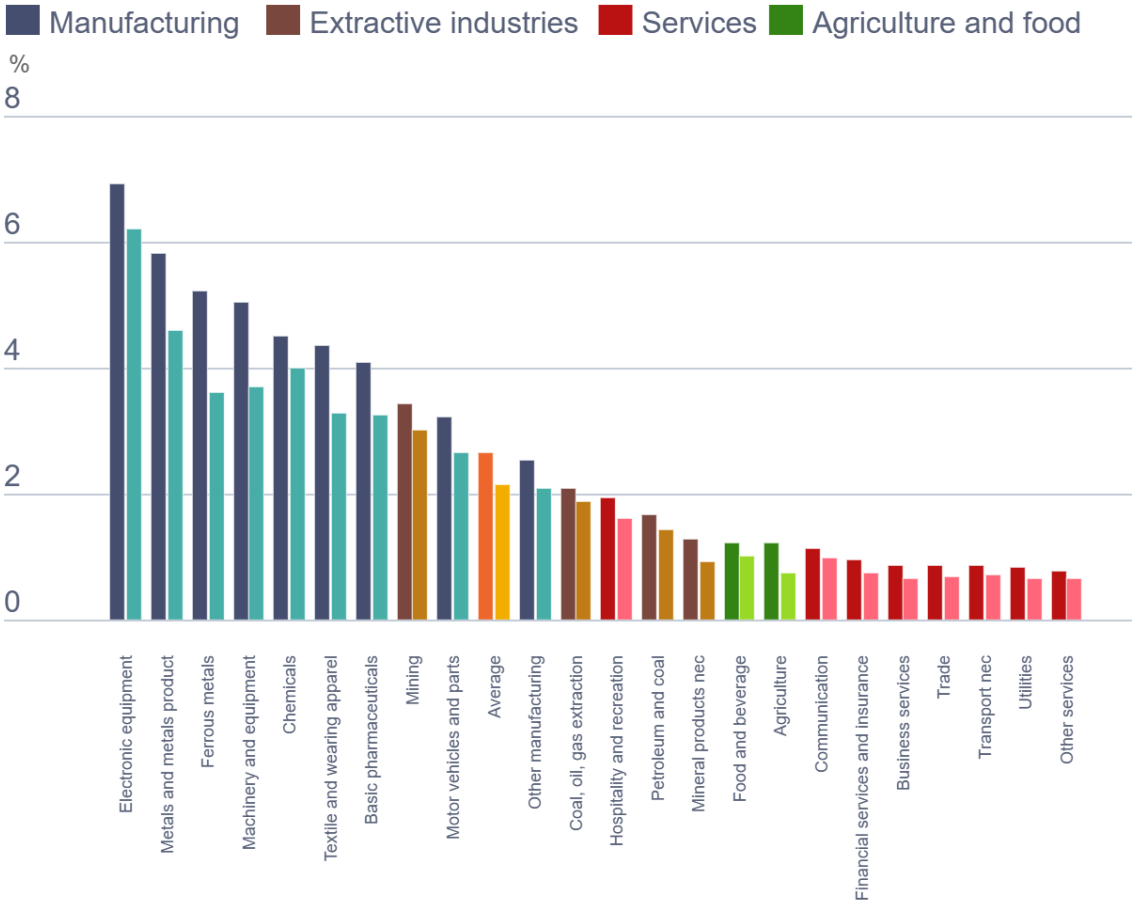
Modelling results also show that there is more variation in the measures of exposure across sectors than there is across countries, suggesting potential for sectoral initiatives to address exposure to shocks. In this context, it is important to note that manufacturing sectors are found to be on average much more exposed to foreign output shocks than services sectors or agriculture and food. This is because manufacturing sectors are more internationalised in terms of output destinations, as well as in sourcing of intermediate inputs. For this reason, manufacturing of electronics, metals, iron and steel, machinery and equipment, and chemicals appear to be the most exposed (Figure 3.19).[20]

Shocks originating in services sectors, which in some countries account for a large share of employment (e.g. hospitality and recreation, retail trade, construction, and warehousing and support activities), can have relatively big impacts across the global economy. However, the simulations reveal that the impacts of shocks originating in large services sectors tend to not be transmitted through constrained access to, or demand for, intermediate inputs (i.e. via vertical links in international supply chains), but rather through

domestic economy-wide impacts involving factor markets. In the medium to long run, an output reduction in those sectors tends to be associated with a release of labour and capital that finds employment in other parts of the economy, which impacts other sectors. For example, shocks to business services – a sector which has strong upstream and downstream linkages to manufacturing sectors – are characterised by a more classical transmission of vertical foreign shocks through international supply chains (i.e. between vertically linked upstream and downstream sectors located in different countries).

Figure 3.19. Globally-linked manufacturing sectors are most exposed to international supply chain shocks

Maximum exposure 1% sector and country-specific production shocks, dark bars are simple average and light bars are weighted average



Note: These figures show "maximum exposure" for a given sector which experiences consequences of 1% production shocks occurring randomly in other parts of the global economy. Maximum exposure is first calculated at the country-sector level as the sum of all the simulated negative output changes to the affected sector that can result from the whole range of positive and negative 1% production shocks. For presentation in this figure, it is then averaged across all countries for each affected sector. A 3% impact would mean, for example, that production could be reduced by 3% if all shocks capable of reducing a country's sectoral output occurred simultaneously. Values of output at the starting point of the simulation are used as weights to produce weighted averages.
Source: OECD METRO model simulations.

Aggregations may mask some impacts on critical products. The modelling that underlies this analysis does a satisfactory job of mapping broad shock exposure and transmission channels across the global economy. However, it is constrained by modelling assumptions, which are often linked to the availability of the data, and which are associated with important caveats for this analysis. One of the issues is the aggregation of sectors used in the analysis,[21] which may mask impacts linked to some more specific strategic categories of products which are at the centre of debates on the propagation of shocks and supply chain resilience (e.g. semiconductors, minerals used in environmentally sustainable technologies, or specific food and medical product categories). This may be particularly problematic if, in reality, there is a lot of heterogeneity within the broader sectors. For example, various raw materials which may be critical inputs into production in a variety of industrial sectors are aggregated together, which may result in an overly optimistic assessment of substitution possibilities.[22] Nevertheless, if signs of exposure to shocks are detected in the analysis conducted at the broad sector level, it suggests that at least some of the more specific activities or products that are covered by this broad category are also likely to be exposed. The analysis, and its implications, should therefore not be seen as exhaustive, but as a first filter for identifying those broad economic sectors which could be studied further in detail using methodologies that would allow for more product detail.

Over-simplification of complex relationships is another area to be aware of. In general, this type of modelling, which was historically used to quantify important aspects of agricultural, extractive and manufacturing sectors, makes simplifying assumptions about incredibly complex and potentially consequential linkages that underlie today's global economy. One example is the financial and payment system. In the analysis presented above, financial services are either not accounted for at all (this is the case in the analysis of the granular merchandise trade data) or only accounted for to the extent that their use by consumers is an input into production in other sectors (in the ICIO and CGE approaches) that do not include the money and currency markets or the payment system. The associated dependencies (e.g. on specific currencies or payment system links) that may be equally—or more—important than conventional product trade dependencies are therefore not taken into account. Yet the emerging literature suggests, for example, that reliance on a concentrated provision of financial services may be an important source of dependencies for some countries (Maggiori, Clayton and Schreger, 2024[26]).

3.7. Does re-localising or reducing trade minimise exposure to shocks and lower trade dependency?

The analysis presented in this chapter has indicated that some trade linkages appear highly concentrated and that this may increase the probability of economic or other damage by shocks, including policy induced shocks. This confirms the merit of monitoring measures of trade concentration in order to anticipate impacts of possible shocks and disruptions. Businesses will likely have an interest in incorporating such measures into their risk management practices. Strategic business decisions may not only be determined by dependencies but also by the likelihood of shocks, including policy shocks. However, if policymakers consider the private sector mitigation measures to be sub-optimal, they may intervene (e.g. Felbermayr and Janeba (2024[27]). Some governments could intervene by proposing the "near-shoring" or "friend-shoring" of supply chain partners. It is possible that some beneficial trade interdependencies might be lost from such an approach.

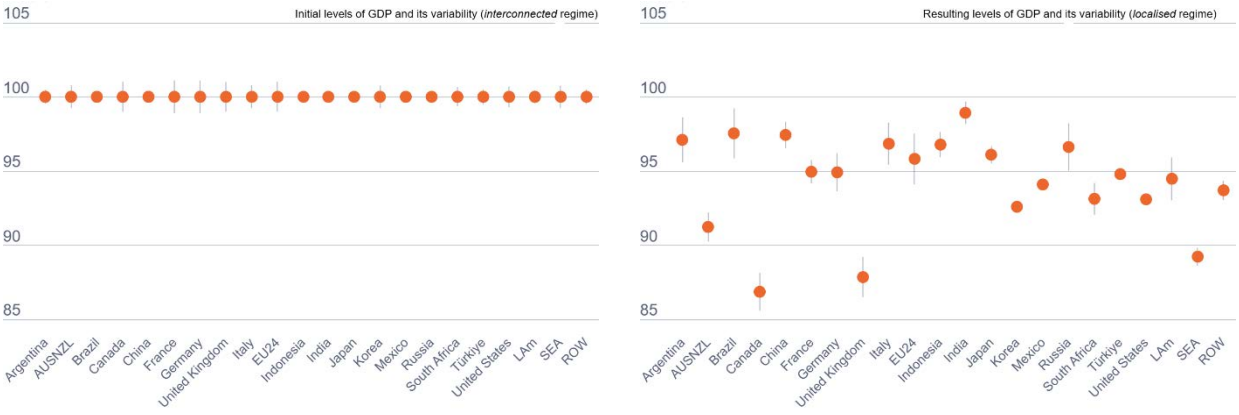
Some geopolitical tensions and policy uncertainties are already being factored into business decisions (Evenett, 2023[28]). A business survey of a large number of operations (Accenture, 2023[29]) and another survey of German companies (EconPol, 2024[30]) showed that, among other types of resilience-improving strategies, an increasing number of companies plan to make significant investments in re-shoring, re-locating and broadening their supplier base. These trends can also be seen at the economy-wide level, such as in the reorientation of bilateral trade between China, and the United States and the European Union, as well as in the growing importance of third economies (OECD, 2024[31]).

Recent analysis of economy-wide impacts shows that reversal of global economic integration could be costly. An IMF summary of model-based analyses of the costs of trade fragmentation undertaken by different authors and institutions in the aftermath of the COVID-19 pandemic and Russia's war of aggression against Ukraine (IMF, 2023[32]) concluded that the cost of impeding the trade and technology diffusion channel[23] could reach as much as 12% of national GDP for some economies.[24]

The OECD has also explored these impacts. A model-based OECD comparison of two scenarios – a fully "interconnected" trading regime and a "localised" regime—showed that some policies aiming to make value chains more domestic could be costly in terms of efficiency and would not necessarily offer more stability in the face of shocks (Figure 3.20). Compared to the interconnected regime, re-localisation involving higher import tariffs, subsidies to domestic production and additional constraints on international sourcing in all countries[25], could decrease global trade by more than 18% and global real GDP by more than 5%, with individual countries losing between 1.1 and 12.2% of GDP depending on the extent and nature of their GVC integration. In addition, when the effects of a stylised set of supply chain shocks were modelled[26] in the localised regime, there was little difference in the stability of GDP, production and consumption compared to the interconnected regime. In fact, for more than half of the economies, the stability of GDP decreased in the localised regime. This runs counter to some of the claims in the general debate on the risks of GVCs, and illustrates the reality that openness and geographical diversification of input sources and output destinations in GVCs can offer important options for adjusting to disruptions, as well as exposure to shocks from a greater number of sources.

Figure 3.20. Most countries could see GDP declines and more variable output under a "localised" supply chain scenario

Simulated impact on GDP for selected OECD and major other economies of a supply chain localisation scenario



Note: All changes in variables are relative to the level of the interconnected regime base scenario, which is set to equal 100. Orange dots show the base in the given regime relative to the interconnected base and whiskers show average deviations for negative and positive trade cost shocks. SEA=South East Asia; rLAm=other Latin American countries not included individually; ROW=rest of world.
Source: Arriola et al. (2020[3]), "Efficiency and risks in global value chains in the context of COVID-19", https://doi.org/10.1787/3e4b7ecf-en.

Other studies aim to illustrate the risks of a more significant disintegration of world trade for global trade and development. A WTO study draws on the WTO global trade model and the methodology developed in Goes and Bekkers (2022[33]) in the context of the possible implications of Russia's invasion of Ukraine (WTO, 2022[34]). The study models a range of scenarios in a hypothetical situation where increasing geopolitical tensions result in a division of the global economy into Eastern and Western blocks, with countries assigned to the blocks based on how they voted at the United Nations General Assembly on motions condemning Russia's invasion of Ukraine. It explores impacts on technology diffusion between advanced and developing economies. The study indicates a wide range of possible economic effects,

which range from below 1% of GDP for some countries to 12% for others, depending on their level of development and dependence on the technology diffusion channel.[27]

A related study by the IMF focused on Asia-Pacific and considered the effect of a hypothetical elimination of trade in high-tech manufacturing and energy across similarly defined geopolitical rival blocs (IMF, 2022[35]). The study found global output losses of up to 1.5% of global GDP, but suggested that trade-intensive countries in the Asia-Pacific region would be affected disproportionately, with losses estimated at about 3.3% of GDP. A subsequent assessment by IMF staff considered different fragmentation scenarios ranging from partial to complete trade restrictions between different blocs. Depending on the scenario and trade elasticities which determine the costs of adjustment to trade shocks in the model, output losses ranged from below 1% to 7% of GDP globally in the most disruptive scenarios (Bolhuis, Chen and Kett, 2023[36]).

Another recent OECD modelling study further illustrates some of the economic costs that may be associated with scenarios of global trade fragmentation (Arriola et al., 2024[8]). Looking more closely at possible implications of global trade fragmentation for OECD Member countries, the study modelled the possible economy-wide impacts of a reduction of trade between OECD and MOEs.28 A moderate and highly stylised scenario assumed that all goods and services trade flows between each of the OECD Member countries and each of the MOEs were reduced by 10% in real terms (referred to as a “trade reduction shock” or “trade shock”).29 This scenario was analysed using both the OECD’s Inter-Country Input-Output (ICIO) data and techniques and the OECD’s CGE trade model METRO.30

The analysis shows that most individual OECD and MOEs lose from this trade reduction scenario, although there is a significant amount of inter-country variation. Depending on the modelling framework used and the country considered, GDP declines range from nil to about 1.7%. OECD Member countries and sectors with stronger trade linkages with MOEs rather than with the OECD fare worse, while stronger linkages within the OECD help mitigate the impacts of the trade shock. OECD Member countries in Asia-Pacific, in particular Korea and Australia, are affected the most, while the OECD Member countries of North America remain largely unaffected. Across all OECD regions, the main driver of these GDP reductions is the decrease in trade with China, even though some OECD Member countries also have noticeable exposure to other MOEs. This is hardly surprising given that China accounts for almost two-thirds of the MOEs’ overall trade with the OECD.

The modelled trade shock is found to hurt the GDP of some MOEs more than those of OECD Member countries. This is because the export and import links which are being disrupted in this scenario represent a larger share of the economy in MOEs. Negative impacts on mining and quarrying reflect important OECD-MOEs mineral resource flows.

Not all sectors of the economies are exposed to the modelled trade shock to the same degree.[31] The list of the most impacted industries varies from one country to another, but it is fairly common to find the highest levels of exposure in the primary sector and, more specifically, in industries belonging to the mining and quarrying cluster. This is because the trade shock constrains several important flows of mineral resources between the OECD and MOEs.

Overall, the results of these various modelling studies considering different scenarios of fragmentation in international trade suggest that the debate on trade dependency and de-risking needs to consider carefully the possible costs and benefits of different policy choices. The different methodologies used to produce evidence all demonstrate a relatively high degree of trade interdependency between the OECD and other major economies (and especially between OECD Member countries and China), as well as potentially high economic costs of significant trade disruptions between these trading partners.

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Notes

[1] This is in line with much of the recent literature, as summarised in Arriola et al. (Arriola et al., 2024[8]).

[2] These depend on the technologies used in production and on consumer preferences, and are typically estimated econometrically and included in model-based assessments as model parameters.

[3] Relying solely on granular trade data does not typically allow one to capture the direct trade-production (or "input-output") linkages, which may lead to underestimating dependencies and the exposure of national industries. Furthermore, gross trade does not capture vulnerabilities from indirect linkages embedded in global supply chains. For example, computer monitors produced in Korea may indirectly depend on copper produced in Chile that is used to produce the wiring of the LEDs from China used in the Korean computer monitors. Due to limitations of a single methodology, studies often use a mix of methodologies or find innovative ways to address these limitations. For example, Arriola (2024[8]) used a mix of granular trade data analysis and input-output and computable general equilibrium (CGE) modelling to get a more comprehensive picture of the global evolution of trade dependency.

[4] The US Department of Justice and US Federal Reserve, for example, consider markets with a HHI of between 0.15 and 0.25 to be moderately concentrated, and markets with a HHI equal to or greater than 0.25 to be highly concentrated. See: https://www.justice.gov/atr/herfindahl-hirschman-index.

[5]This would be obtained if there were only five suppliers and each of them supplied an equal share of 20%, while a value of 0.1 would be obtained if there were ten suppliers with equal shares of 10%. These are only illustrative examples as, in reality, many different constellations of unequal market shares can yield a given HHI value.

[6]In the analysis, products are defined at the 6-digit level of the United Nation's Harmonised System (HS) of trade classification. See https://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx.

[7] It should be noted that there is considerable variation around the mean values of the concentration indices across all HS6 products. For example, in the period 2017-19, fifty-two out of 4 839 HS6 products with active trade links, which were equivalent to approximately 1% of all active links, were exported by only one country (i.e. they had HHI=1). More than ninety exported products had HHI readings equal or higher than 0.75 (2% of all active links). In contrast, 3 502 products — or 72% of exported products — had global export HHIs lower than or equal to 0.2 (Arriola et al., 2024[8])

[8] For example, a list of strategic products adopted in Arriola et al. (2024[8]) followed a study of fragmentation of FDI (IMF, 2023[32]) which had built on a list of advanced natural resources and manufacturing sectors designated as strategic in a study by the Atlantic Council (Tran, 2023[37]).

[9] Note that this does not take into account market access barriers or preferential trade agreements.

[10] As argued in Kowalski and Bates (2025 forthcoming[23]) export dependency tends to be important in small open economies, such as Lithuania.

[11] The measure is also highly correlated with other measures of national trade concentration that can be calculated using the same data and the HHI-trade shares methodology to monitor and assess the extent of trade dependency across countries and over time.

[12] The MOE grouping is composed of Brazil, China, India, Indonesia, Russia, and South Africa.

[13] Note also that the relatively high share of the Netherlands as a destination of significantly concentrated exports is explained by the important role played by the Netherlands' port of Rotterdam as the main entry point of merchandise imports to the European Union. This also illustrates some of the above foreshadowed limitations of using gross trade data to determine trade dependency.

[14] Here, too, the relatively high share of the Netherlands as a destination of significantly concentrated exports is explained by the important role played by the Netherlands' port of Rotterdam as the main point of entry of merchandise imports to the European Union.

[15] The study measured bilateral trade dependency as follows (also introduced in Section 3.4 above): a country's trade in a product with a specific partner is considered dependent in a given period if: (1) at least 10% of the country's imports (or exports) of that product come from (are exported to) that specific partner; and at the same time (2) the country cannot easily replace these specific bilateral imports (or exports) with alternative sources (or markets) because the country imports from (or exports to) relatively few suppliers (or markets) or, in other words, the overall concentration of their national imports (exports) of these products is high. This is considered to be the case when the HHI of import concentration across supplying countries (or export concentration across destination countries) is equal to or higher than 0.2.

[16] The OECD's trade model, METRO, is a multi-sector, multi-region computable general equilibrium (CGE) model of the world economy that uses data to explore the economic impact of changes in policy, technology, and other factors. METRO tracks the myriad ways economies are connected, how production and trade are linked through global value chains, and how resources are best allocated across all economic activities. For details see www.oecd.org/en/topics/metro-trade-model.html.

[17] Refers to the markets of factors of production (raw materials, labour, capital, and land) that businesses have to purchase, rent or hire in order to produce goods and services.

[18] One example here are the employment-protecting policies adopted during the COVID-19 pandemic in several EU countries. That said, the degree of impact under different factor mobility assumptions varies across sectors and countries, and depends on whether the impacted sector has a significant weight in domestic labour and capital markets. For more, see Arriola, Kowalski and van Tongeren (2024[7]).

[19] Note that due to data and computational limitations the coverage of individual countries in this analysis is more restricted than the detailed trade data analysis presented in earlier parts of this chapter.

[20] However, when production factors are assumed to not be able to move across sectors, extractive industries as well as manufacturing sectors linked to them (metals, iron and steel, chemicals) move towards the top of the shock exposure rankings. For a discussion of this effect, see Arriola, Kowalski and van Tongeren (2024[7]).

[21]The analysis distinguishes between 23 sectors (including 15 manufacturing and 8 services sectors), i.e. those displayed in Figure 3.19.

[22] Note that related OECD analysis looked at an alternative methodology which combined granular trade data and ICIO analysis to further unpack some of this important detail (Berthou, Haramboure and Samek, 2024[22]).

[23] Other channels include migration, and cross-border capital flows and financial integration, but these are less explored.

[24] The study also revealed that the estimated costs depend very much on strong and often uncertain assumptions about not only how to represent the complex economic interlinkages characterising the world trading system, but also what types of de-risking or fragmentation should be considered. These could range from small increases in trade policy barriers, through discriminatory regional integration, to the formation of more or less autarchic geopolitical trading blocs.

[25] The localised economies regime simulated a suite of hypothetical and stylised re-localisation policy responses, in which all countries decided to reduce their supply chain connectedness through an imposition of a 25% import tariff on all imported goods a combination of higher import tariffs, subsidies to domestic production (through imposition of value added subsidies equivalent to 1% of GDP directed to labour and capital in domestic non-services sectors) and additional constraints on international sourcing (achieved through halving export transformation elasticities and import substitution elasticities between domestic and foreign varieties of products and elasticities of substitution between different varieties of foreign products).

[26] The spectrum of shocks included equally probable and spatially uncorrelated increases and decreases in the cost of bilateral trade (for both imports and exports) between each country or region included in the model and all their trading partners.

[27] In this study, developing and emerging economies would lose the most from trade and technological decoupling because their economic performance depends the most on the technology diffusion channel, which is affected negatively by decoupling of trade between the blocks.

[28] Brazil, China, India, Indonesia, Russia, and South Africa.

[29] All the other trade flows were assumed to remain unaffected directly, but could be affected indirectly, for example through interruption of indirect links involving OECD-MOE trade if such links exist, or through redirection of trade and other economic adjustments.

[30] As described earlier, both these approaches enable an assessment of economy-wide implications of trade dependencies, though with different levels of country and industry detail and different emphases on various economic adjustment mechanisms. They also take a broader supply chain perspective, and capture not only those trade dependencies that stem from direct import-export relationships, but also those that may result from indirect trade links (e.g. when a product exported from one country to another embeds a component produced in a third country).

[31] In several cases, the sectors identified as the most heavily dependent on OECD-MOE trade represent only small shares of their country's economy. On the other hand, the list of highly impacted industries also includes those of great significance from both a domestic and a global point of view.

4 The digital transformation, environmental objectives and international supply chains

In many economies, the digital transformation and efforts to achieve environmental objectives are profound drivers of change. This chapter explores opportunities to improve supply chain efficiencies and sustainability (both environmental and social), as well as the potential associated risks.

Supply chain managers seek to adapt to constantly evolving challenges, uncertainties, emergencies, and other disruptions. Supply chains can also shape the global context in which they operate – including through the provision of products needed to implement digital and sustainability policies, and by contributing to environmentally and socially sound practices in economies and businesses along the chain. On the other hand, these twin transitions raise new risks for the resilience of supply chains, including geopolitical fragility, and the unintended divergences in the regulatory environment for sustainability. This chapter explores these dynamics in detail.

4.1. The digital transformation and the pursuit of environmental sustainability objectives introduce both opportunities and vulnerabilities

Supply chains evolve in a changing environment and both digitalisation and efforts to transition to more environmentally sustainable supply chains are important catalysts of this change. While this twin transition leads to new opportunities to increase the resilience and agility of supply chains, particularly through digitalising supply chains, it can also be a source of vulnerability when not properly managed.

Various environmental requirements and the accelerated pace of digitalisation are adding to the pressures on supply chains, which are already facing substantial challenges from factors such as geopolitical uncertainty, economic fluctuations and the concentration of critical raw materials (CRMs) in certain regions. However, these pressures also open the door to transformative change. By harnessing digitalisation, prioritising environmental sustainability, and meaningfully addressing social risks, supply chains can become more resilient and play an active role in advancing the digital transformation and the shift to low-carbon energy and products.

4.1.1. The digital transition is critical for resilient supply chains, but new risks need to be managed

The role of digitalisation in managing supply chains is extensive and transformative:

- Digital technologies, such as robotics, are increasingly being used to automate international production processes, including sorting, packaging, warehousing and quality control.
- Sensor technology, including Internet of Things (IoT) devices, Radio Frequency Identification (RFID) tags, global positioning systems (GPS), and smart labelling further enable real-time tracking of production along supply chains.
- Digital twin technologies enable virtual modelling of supply chain processes, enhancing optimisation and efficiency.
- Cloud-based communications platforms facilitate seamless communication and collaboration among suppliers, manufacturers, and retailers.
- Blockchain technologies, i.e. decentralised ledgers and smart contracts, ensure secure and transparent transactions along supply chains, including across borders.
- Predictive analytics, which are increasingly powered by artificial intelligence (AI), help manufacturers anticipate and respond to disruptions in upstream markets.

The digital transformation not only makes supply chains more efficient and transparent, it also plays a critical role in enhancing supply chain resilience. This happens by enabling end-to-end supply chain visibility – helping businesses better and more proactively manage emerging risks – or by enabling supply chain managers to monitor real-time information about markets to more efficiently anticipate and react to shocks.

However, while digital technologies bring numerous benefits, they also introduce new sources of pressures and vulnerability. For example, growing reliance on digitally interconnected systems can lead to greater

vulnerability to cyberattacks, whose effects could cascade throughout supply chains. Vulnerabilities can also arise from the limited number of global suppliers of digital services. For example, disruptions to cloud-computing suppliers can lead to global outages, as happened with Amazon Web Services in 2020 and Microsoft in 2024, affecting firms' ability to manage operations (Palmer, 2021[1]; Greenall, 2024[2]). Reliance on a few providers reduces resilience and can be a source of risk in itself.

In terms of environmental impacts, increased digitalisation can lead to growing demand for data centres, with important implications for energy consumption and carbon emissions.

4.1.2. Managing the digital transition can be complex

The digitalisation of supply chain activities, and consequently their ability to use digital tools to increase resilience, rests on a range of factors. Many are internal to the firms operating along the supply chain and include issues around the adoption and efficient use of digital technologies and their ability to analyse data. In this context, lead firms play a critical role in ensuring that the digital thread that ties activities along the supply chain remains unbroken and can be used to rapidly identify and react to disruptions.

However, some factors remain outside the remit of firms. These relate to the regulatory environment in which firms operate and whether or not it is favourable to the wider adoption, deployment and interoperability of digital technologies across international borders.

Governments can take measures to enable greater adoption of digital technologies along supply chains. They can ensure that domestic regulation is transparent, non-discriminatory and does not restrict trade more than is necessary to meet legitimate public policy objectives. For example, when enacting privacy and data protection policies, governments can seek policy solutions that enable open transfers of data while maintaining appropriate safeguards (Section 6.3). Such balanced approaches to data governance can deliver important gains, especially for developed countries. Recent evidence suggests that balanced approaches can lead to increases in GDP of 1.7% and increases in exports of over 3.5%. On the other hand, fragmented approaches to data governance can lead to reductions in GDP of around 4.5% and in exports of 8.5% (OECD/WTO, 2025[3]).

Governments can also engage in wider international co-operation on issues that matter for digital trade. This includes inserting digital trade provisions into trade agreements; including commitments that facilitate digital trade through the adoption of e-contracts, e-signatures and e-transferable records; as well as commitments supporting the non-imposition of customs duties on electronic transmissions. Governments can also support and pursue wider engagement on these issues in plurilateral and multilateral discussions at the WTO. One especially important aspect that can enhance the agility of supply chains is the digitalisation of border processes (further developed in Section 6.1).

While digital technologies offer transformative potential for building more sustainable and resilient supply chains, they are not without risks. Firms seek to adopt balanced approaches that leverage digital technologies while also addressing the new vulnerabilities these technologies introduce. Among other things, this requires investing in digital infrastructure and cybersecurity, diversifying technology providers, and managing broader social and environmental implications of digital transformation in supply chains.

4.1.3. Supply chains and the achievement of environmental sustainability objectives

Supply chain resilience can contribute to the achievement of environmental sustainability objectives. Trade through supply chains: (1) serves as a vehicle for trade in environmental goods; (2) strengthens environmental performance, for instance by ensuring resilience to negative environmental impacts, such as those caused by extreme weather events; (3) disseminates technologies that support environmentally sustainable production processes; and (4) allows economies of scale for the adoption of practices that promote a more circular economy. Environmental sustainability therefore requires that supply chains remain resilient to enable trade in environmentally sustainable goods and services, the development of the

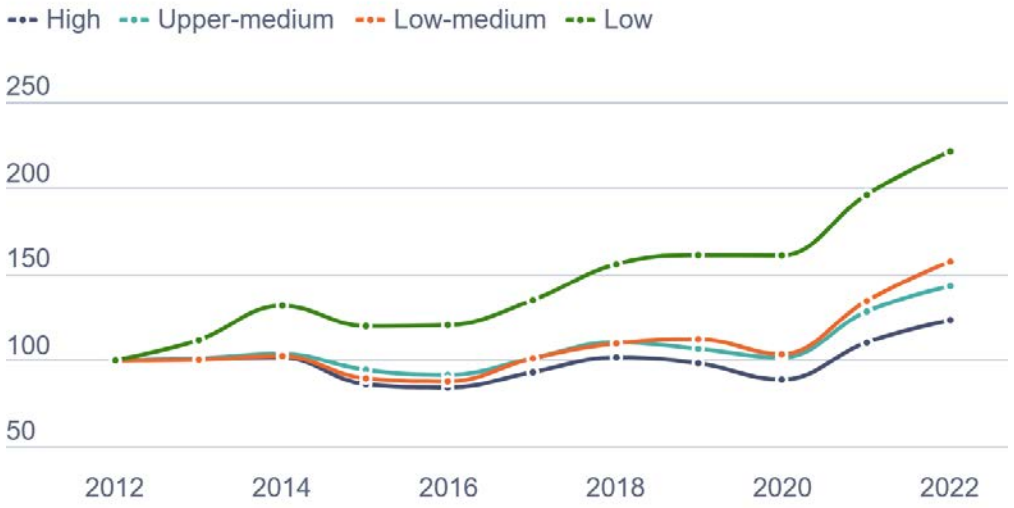
renewable energy sector and other instruments that increase environmental performance, as well as the integration of circular economy practices.

In an interconnected world with production spread across multiple countries, the pursuit of sustainability objectives can be enhanced by the adoption of more environmentally sustainable inputs. Environmental goods help to achieve this goal as they encompass technologies and products that reduce environmental risks and minimise pollution and resource use,[1] ranging from electric accumulators used for energy storage to air pollution control devices, such as catalytic converters for purifying or filtering gases, or clean energy plant inputs such as optical devices used in solar systems.

Evidence based on analysis using the Combined List of Environmental Goods (CLEG) shows that within the production chain, most goods considered as having an environmental purpose are intermediate inputs (47%) and capital goods (49%); final consumption products only represent around 4% of traded environmental goods (EGs) (Moïsé and Tresa, 2025[4]). This fact highlights the important role that trade in EGs may play in moving towards environmentally sustainable supply chains. However, while exports of environmental goods are higher in volume for high and middle-income countries, in the past two decades exports of EGs for low-income countries have more than doubled (Figure 4.1). EG exports across all countries have grown by 30% between 2012 and 2022. Even though tariffs affecting EGs are low due to several trade liberalisation rounds and the growing number of trade agreements over the years, they still remain high for low-income countries, reaching 13% for some products (Moïsé and Tresa, 2025[4]).

Figure 4.1. Exports of environmental goods are an opportunity for all economies

Evolution of EGs exports per income group as compared to base year 2012=100



Note: This graph shows the evolution of EGs exports based on the Combined List of Environmental Goods (CLEG). 2012=100. Countries' level of income comes from the World Bank classification.
Source: Moïsé and Tresa (2025[4]).

Another challenge to accessing environmentally sustainable inputs along supply chains stems from the presence of non-tariff measures (NTMs). Technical barriers to trade (TBTs) are the most common NTMs regulating EGs trade ranging from safety requirements to regulations for mandatory fuel economy labelling schemes for all vehicles under a specific weight or requirements for vehicle manufacturers to perform greenhouse gas emission tests. NTMs can become non-tariff barriers (NTBs) if measures such as technical regulation or conformity assessment procedures are applied unevenly or in a non-transparent manner y, increasing the trade costs of EGs. Trade facilitation measures can significantly reduce costs

arising from the diversity of domestic regulations or lack of clarity around them, by streamlining processes that products must undergo to enter a market (Section 6.1).

Many final environmental products, such as solar panels, electric vehicles and wind turbines, require critical raw materials (CRMs) in their production. Such materials feature at different stages of the production of EGs: the upstream stage, which consists of resource extraction; the midstream stage, covering raw material processing and the production of certain components; and the downstream stage, which covers the manufacturing of more complex components, assembly, sales, and end-of-life recycling. Given the concentrated nature of CRMs, not only geographically, but also in terms of ownership and control (Section 4.1.4), trade allows for these important inputs to be deployed to produce many EGs. For example, the production of batteries for electric vehicles (EVs) requires several components, such as lithium, cobalt, and nickel, which are available in only a few countries.

Equally important, supply chains serve as a key channel for making services accessible globally and for spreading the knowledge and technology necessary for environmental sustainability. Services can support both the invention and adoption of environmentally sustainable production methods, contributing to end-of-pipe pollution control, pollution prevention, and cleaner production. While traditional core environmental services (e.g. sewage, refuse disposal, sanitation) are recognised for their direct environmental benefits, a range of other services – such as engineering, financial, and maintenance – are essential to improve the environmental performance of a wide range of economic activities. Preliminary analysis shows that increased access to environmentally related services would result in improved environmental outcomes. Notably, sectors such as telecommunications, maintenance, financial services and other business services play a crucial role in driving these positive environmental outcomes (Beverelli et al., 2025[5])

Supply chains are also important for fostering innovation and diffusing technology that contributes to the achievement of environmental sustainability objectives. Resilience in supply chains is vital for the dissemination of environmental technologies embedded in goods and services, particularly for countries that lack domestic production capabilities. For example, Garsous and Worack (2021[6]) show that trade in wind turbines provides access to more efficient technologies than what would be possible to replicate domestically in the absence of trade.

Finally, as supply chains allow for products to travel, circular solutions become more challenging as polluting products and thus emissions are embedded in global chains. For instance, many harmful plastics products (Box 4.2), are embedded in goods that cross several borders along the supply chain and can harm the environment in various ways throughout their lifecycle, from the carbon footprint of their production, the chemical pollution associated with their manufacture, to leakage into the environment at their end of life (Moïsé and Tresa, 2023[7]). However, through circular economy solutions at different stages of production, and by increasing the economic viability of recycling markets (Box 4.2), supply chains can help to reduce this harm by facilitating processes such as product reuse, repair, refurbishment and remanufacturing, and recycling. These processes help use material resources more efficiently to sustain the global economy and alleviate environmental pressures associated with an increase in material production and consumption. Similarly, scaling up cross-border reverse supply chains (e.g. to recover and reuse critical raw materials embedded in used batteries) can help to deal with pressures coming from a concentration of resources in value chains, as well as the need to achieve environmental sustainability (Yamaguchi, 2022[8]).

Box 4.1. Supply chains are both a challenge and means of addressing plastic pollution

Reducing plastic pollution is an important environmental policy objective. Overall, annual global use of plastics more than tripled between 1991 and 2021 (OECD, 2022[9]). While international trade organised in supply chains has contributed to the increase in plastics, it also offers opportunities to tackle plastics pollution by implementing circular economy solutions.

Plastics production involves several stages, dispersed across many countries. The stages involved include the supply of raw materials, the manufacturing of primary and final plastics, and the end-of-life management and treatment of plastic waste. Findings from input-output analysis using the TiVA database show that on average 40% of the value added used to produce output from the plastics and rubber sector in a country is foreign, highlighting the significance of international supply chains in the plastics industry. The most common use of plastics (by volume) is for packaging. A key difficulty related to the value chains involved in plastics is identifying the flows associated with product packaging or any plastic embedded in products along supply chains, making circular economy approaches more challenging.

While international trade has contributed to the production and dispersal of plastics in different countries, mainly through packaging activities, it also presents an opportunity to tackle plastics pollution. Trade allows for the diffusion of technology and the spread of innovation at different phases of the plastics life cycle in countries where such technologies for recycling are lacking. Furthermore, supply chains may increase the economic viability of recycling markets, including through the diffusion of goods, services and technologies for plastics collection, waste management, recycling, and clean-up; the viability of repair and remanufacturing operations for products that contain plastics; and the viability of markets for environmentally sound and effective substitutes for plastics.

Source: Moïsé and Tresa (2023[7]), *Trade policies to promote the circular economy: A case study of the plastics value chain*, https://doi.org/10.1787/e36f2d91-en.

4.1.4. Critical raw materials required for the shift to low-carbon energy and products generate supply chain pressures

Extraction and processing of raw materials has traditionally been highly concentrated, not only geographically, but also in terms of ownership and control. This is mainly because the economic viability of the raw material industry requires extraction and processing to take place where these materials are the most naturally abundant, or where the geological and climatic conditions, infrastructure, technology and resources make the extraction and processing most economically viable. However, these natural characteristics of the raw materials industry also provide incentives for market participants and governments to exploit market power dynamics to pursue individual economic and non-economic objectives. For example, export restrictions on unprocessed forms of cobalt, lithium and nickel have been used by some of the main producers of these products to promote the development of domestic processing industries at the expense of their trading partners (Andrenelli et al., 2024[10]). Other forms of state intervention, such as special regulations, state ownership, investment restrictions and subsidies, are also pervasive in the sector.

The production and international trade of CRMs is increasingly concentrated in a handful of extracting and processing locations which account for the bulk of global supply (Kowalski and Legendre, 2023[11]). For example, the three top producing countries in 2022 accounted for 60% or more of the global production of cobalt (78%), lithium (92%), nickel (65%), and rare earth elements (90%) (Figure 4.2) which are used for producing batteries and equipment used in a number of renewable energy technologies such as solar and

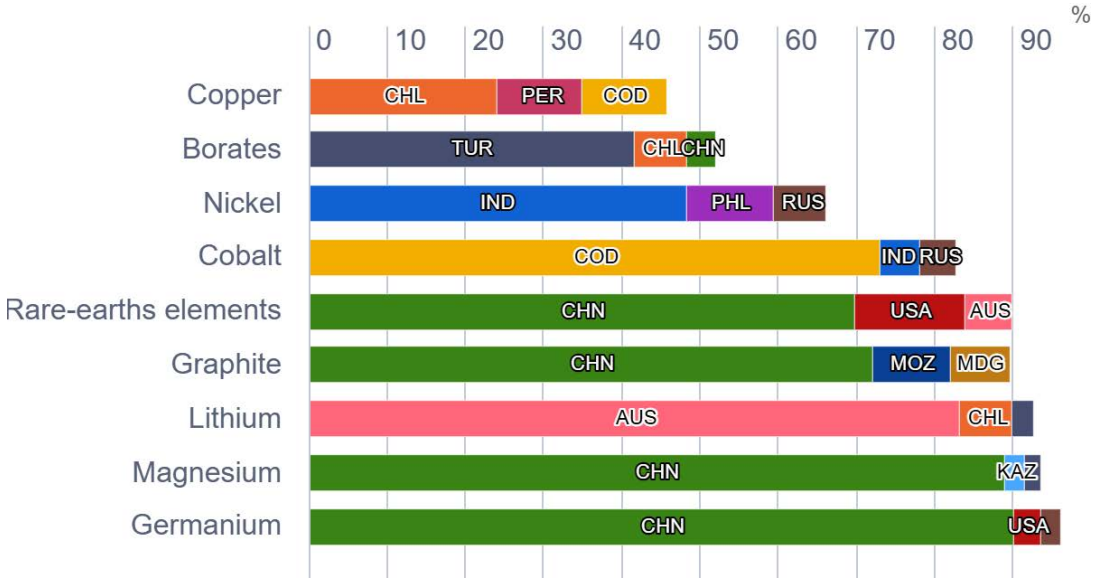
wind. Concentration of exports is particularly significant for unprocessed forms of cobalt, manganese, borates, chromium, magnesium and lithium (Figure 4.3).

Restrictions on exports of raw materials to favour domestic users to the detriment of foreign users are some of the most contentious forms of state intervention. As they undermine the economic viability and decrease the output of domestic extractive industries, this hampers the global supply of the materials concerned. In addition, if the exporter holds a large share of the market, export restrictions can increase world market prices, creating incentives for other exporters to impose them, resulting in spiralling negative effects on international markets.

The *OECD Inventory on Export Restrictions on Industrial Raw Materials*, which covers the period 2009-2022 (OECD, 2024[12]), shows that export restrictions on industrial raw materials saw a more than five-fold increase over this period (Figure 4.4). Due to their critical role in the digital transformation and the shift to low-carbon energy and products, and the high degree of trade dependency of most users, the imposition of export restrictions on raw materials risks negative spillover effects cascading down global supply chains.

Figure 4.2. Critical raw materials are produced by only a few countries

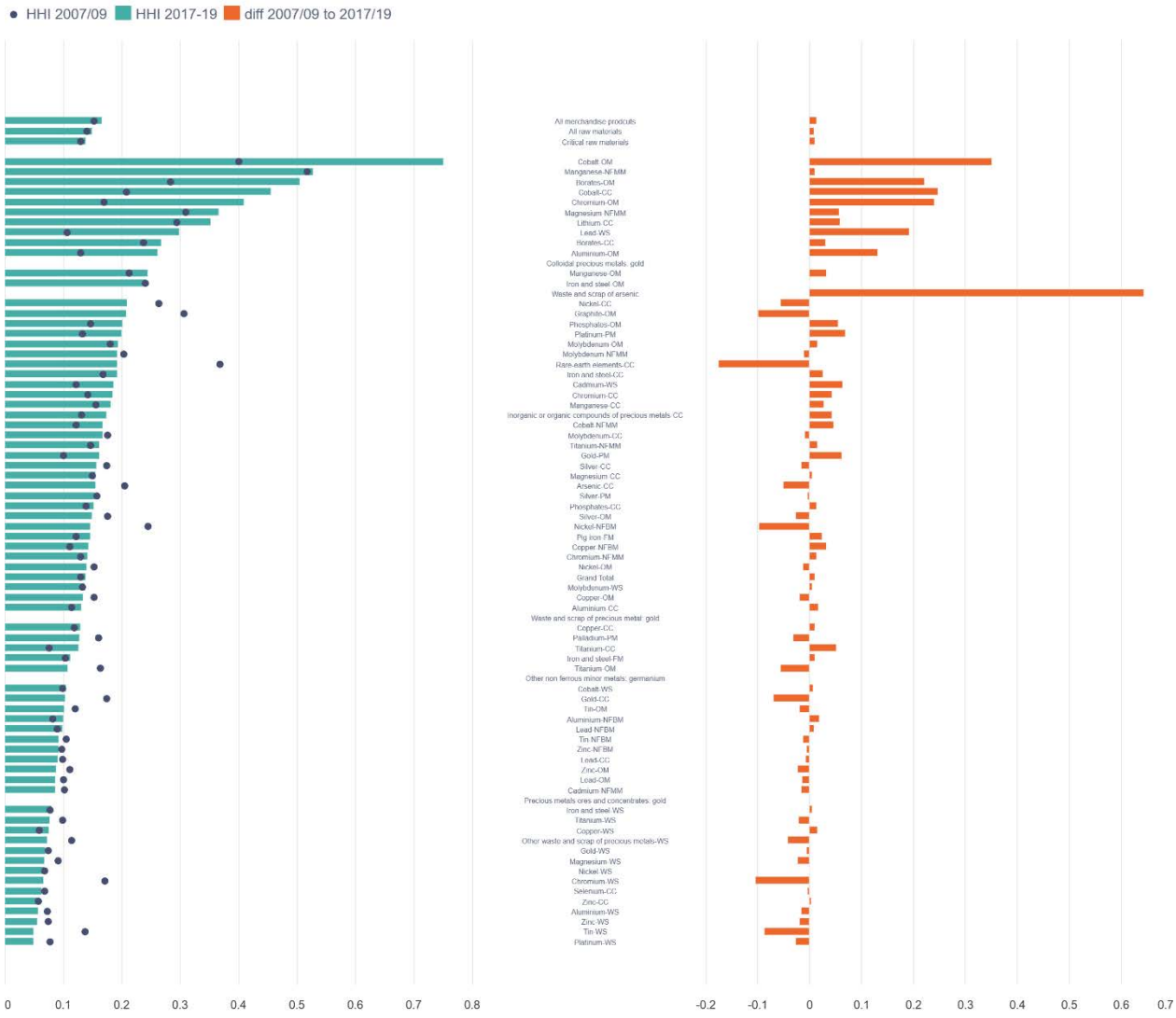
Share of top three producing countries in global production, 2022



Note: AUS – Australia; BRA – Brazil; CHN - China; CHL – Chile; COD – Democratic Republic of Congo; IDN – Indonesia, IND – India, KAZ – Kazakhstan, MDG – Madagascar; MOZ – Mozambique; PER – Peru; PHL – Philippines, TUR – Türkiye; RUS – Russian Federation; USA – United States.
Source: OECD, based on US Geological Survey.

Figure 4.3. The cross-border supply of certain raw materials is particularly concentrated among a few exporting countries

Global HHI index of export concentration across exporting countries and critical raw material products and sectors, 2007-09 and 2017-19

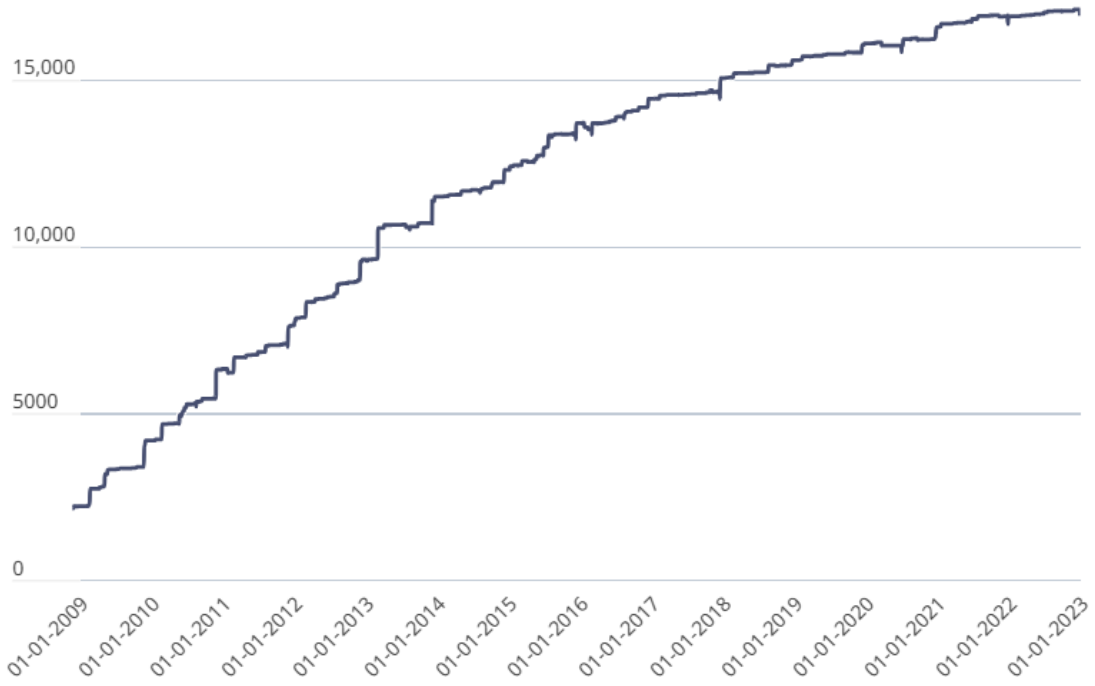


Note: the different 'sectors' to which the specific critical raw materials products may belong are labelled with the following acronyms: PM – precious metals and stones; OM – ores and minerals; CC – chemicals and compounds; NFMM – non-ferrous minor metals; NFBM – non-ferrous base metals; WS – waste and scrap; FM- ferrous metals. The Herfindahl-Hirschmann Index (HHI) was calculated using detailed product-level data to assess the concentration of exports. Ranging from 0 (fully diversified) to 1 (fully concentrated), it indicates whether sourcing of intermediate inputs relies on a small number of supplying countries.

Source: OECD calculations using the *Base pour l'Analyse du Commerce International* (BACI) database (Gaulier and Zignago, 2010[13]).

Figure 4.4. A growing number of exported raw material products are subject to at least one export restriction measure

Number of exported raw material products subject to at least one export restriction measure up to 1st January 2023



Note: The count of all types of measures in place across all covered raw materials and all implementing countries takes into account the stock of measures in place at the beginning of the period, as well as new additions and eliminations.
Source: OECD Inventory on Export Restrictions on Industrial Raw Materials, https://www.oecd.org/en/topics/export-restrictions-on-critical-raw-materials.html.

4.2. Promoting social and environmental sustainability along supply chains

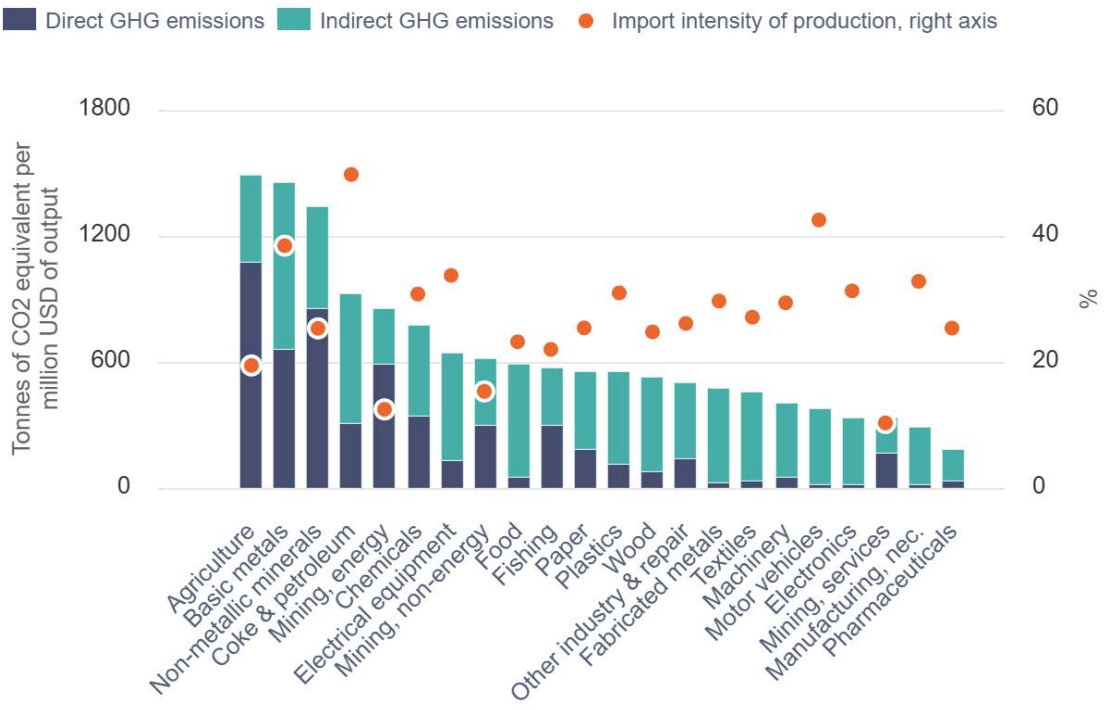
The intertwined nature of global production in the form of GVCs has drawn attention to the sustainability of supply chains to the fore of discussions in recent years. In this specific context, sustainability is broadly understood to include protection of the environment, adequate working conditions, and respect of human rights.

Consumers are increasingly concerned about the sustainability of final goods, as well as whether each of the inputs (and the inputs into the inputs and so forth) were produced in a sustainable manner. Public and private sector actors are also alert to considerations resulting from differentiated regulatory standards across jurisdictions.

Figure 4.5 shows, for production taking place in the OECD in selected supply chains, the amount of greenhouse gas (GHG) emissions embodied within the entire supply chain. This includes upstream indirect emissions, or emissions which take place in the supply chain prior to final production. For many sectors, such as food and electrical equipment, much or even most of the GHG emissions occur in earlier stages of production, both in the home economy and abroad.

Figure 4.5. For many sectors, most GHG emissions occur in economies upstream in the supply chain

GHG emissions factors (left axis) and import intensity of production (right axis) for selected supply chains

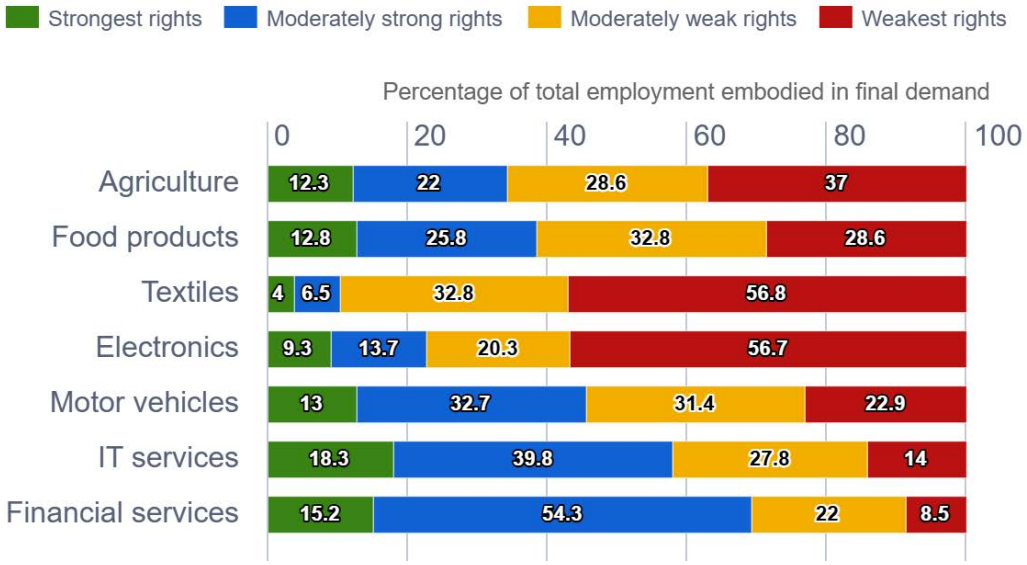


Note: For selected OECD supply chains, the chart reports GHG emissions per unit of final product (left axis), as well the import intensity of production (right axis). A distinction is made between "direct" emissions generated in the production of the final product itself and "indirect" emissions that arise upstream in the supply chain. The import intensity of production is a measure of the international unbundling of production. It captures the cumulated use of imported intermediate inputs throughout the supply chain, expressed as a percentage of the value of final output. The emission factors in this chart are conceptually close to the corporate carbon accounting practices set out in the GHG Protocol Corporate Accounting and Reporting Standard but there are important differences. Direct emissions correspond to Scope 1, that is, to emissions from sources controlled by the reporting organisation. Indirect emissions consist of Scope 2 (emissions associated with purchased energy) and upstream Scope 3 emissions (from sources that are not controlled by the reporting organisation). Scope 3, however, encompasses also a variety of downstream activities that are not captured in the chart (e.g. emissions associated with product use and end-of-life treatment).
Source: Balaban et al. (2025[14]).

Equally, although GVC integration can generally support improved job quality (Park, Lundquist and Stolzenburg, 2023[15]), the international fragmentation of production implies that a given final product may incorporate labour from countries with varying levels of worker rights protection. Figure 4.6 shows for selected industries the share of embodied employment used throughout the supply chain that took place in countries categorised into four levels of freedom of association rights. In some sectors, a significant portion of the employment used directly and indirectly to produce the final product is taking place in countries where the protection of unions and the right to organise are relatively weaker.

Figure 4.6. Labour rights along certain supply chains

Freedom of association rights along supply chains



Note: This graph shows the decomposition of total employment embodied in OECD countries' total final demand in seven International Standard Industrial Classification of All Economic Activities (ISIC) sectors (01-02, 10-12, 13-15, 26, 29, 62-63, 64-66) by quartiles of the distribution of the freedom of association rights in practice indicator provided by Kucera and Sari (2019[16]). The underlying trade and employment data refer to 2019, and the reference year of the labour rights indicator is 2020. Higher shares in the quartiles at the right-hand side of the figure suggest that a larger proportion of embodied labour was contributed by workers in markets with relatively weaker freedom of association rights.
Source: Jaax and van Lieshout (2025[17]), "Mapping efforts to protect worker rights in supply chains", https://doi.org/10.1787/f4eacea7-en.

4.2.1. Implementation of supply chain sustainability laws

Governments that seek to improve the sustainability of the supply chains of firms operating in their market face a challenge: production practices that are harmful to the environment or to workers can be happening abroad, where they do not have direct jurisdiction. In response, a variety of supply chain sustainability laws have been developed in recent years. Each of these laws operates in somewhat different ways, but two main mechanisms can broadly be distinguished.[2]

The first, most common approach is to impose due diligence requirements on firms that are producing or selling goods within a market, where the due diligence obligations extend to the firm's activities abroad. Examples of such firm-focused regulations include the United Kingdom's Modern Slavery Act and the European Union's Corporate Sustainability Due Diligence Directive. These laws generally require companies to provide documentation on the activities they undertake to ensure the sustainability of their supply chains. In more comprehensive forms, specific due diligence processes and practices can also be required; in a few cases, firms can even be held liable for any failures to prevent damage done to the environment or workers by their suppliers.

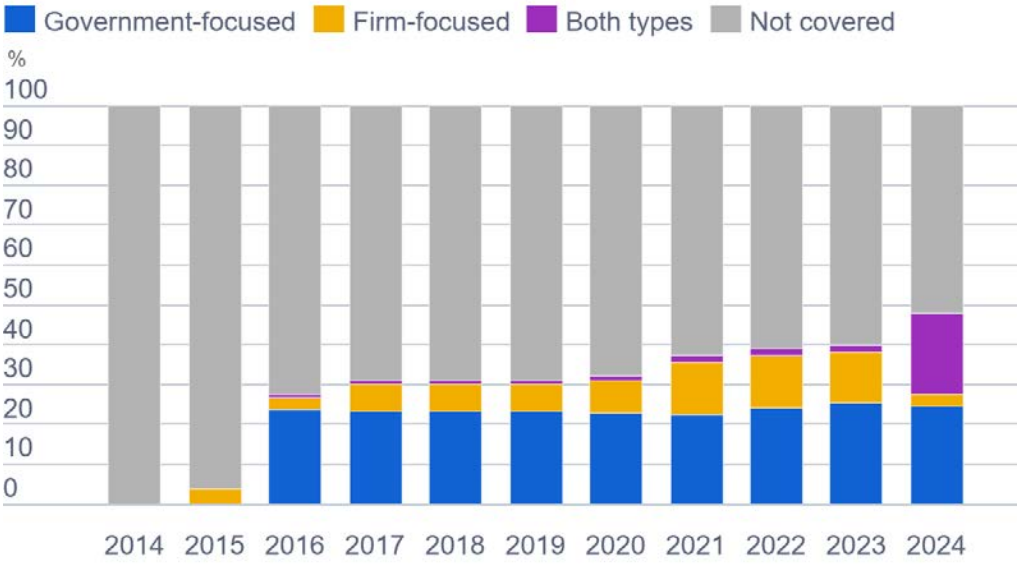
In a second set of laws, governments instead ban goods from entering or being sold in their market for which adherence to relevant social and environmental standards in their supply chain cannot be adequately guaranteed. In some cases – such as the European Union's Deforestation Regulation[3] – this requires firms to proactively submit paperwork at the border that documents the sustainability of their supply chain. In other cases, goods are only taken off the market when sufficient concern about their production methods arises, and firms are then required to provide evidence to the contrary to undo the

decision. This government-focused approach is commonly used in laws on forced labour, such as the United States' Trade Facilitation and Trade Enforcement Act or the EU Forced Labour Regulation.[4]

Over the past decade, supply chain sustainability laws have been adopted in an increasing number of countries. While estimating the extent of economic activities covered by these laws is fraught with difficulties, a set of simplifying assumptions used in recent OECD research focused on worker rights in supply chains allows for a tentative assessment of the potential coverage of these laws. Figure 4.7 provides an approximate indication of the evolution of the share of global output that is associated with countries which have a supply chain sustainability law related to worker rights in place.[5] Examining the economic activities in countries with such supply chain laws addressing labour issues, along with the foreign affiliates of firms headquartered in those countries, suggests that nearly half of global output is directly or indirectly connected to these laws.

Figure 4.7. Labour-related supply chain laws may cover close to half of global production

Approximate share of global output linked to supply chain sustainability laws addressing worker rights



Note: This graph displays a rough approximation of the share of global output that is directly or indirectly linked to countries that have enacted supply chain sustainability laws. Grey elements indicate that output is produced in a setting where neither the country hosting the economic activity, nor the country where the corresponding company is headquartered, has enacted a supply chain law. Orange elements refer to output that is either generated in countries with a firm-focused law with due diligence requirements or by subsidiaries of companies whose headquarters are located in countries with such a law. Similarly, blue elements refer to output directly or indirectly associated with countries that have introduced government-focused supply chain laws, such as a market or import ban. Purple elements refer to output linked to both types of laws. Drawing on the OECD Analytical AMNE database, the underlying approach disregards delays between the enactment of a law and its entry into force as well as any thresholds defining applicability to specific firms.
Source: Jaax and van Lieshout (2025[17]), "Mapping efforts to protect worker rights in supply chains", https://doi.org/10.1787/f4eacea7-en.

While sustainable supply chains are an important goal, the resulting regulatory efforts also create pressures. In regulating, governments affect the functioning of supply chains, which are generally complex webs of economic relationships between many inter-connected firms. Potential downsides of such regulation need to be carefully considered in the design and implementation of legislation. Moreover, ongoing uncertainty about the future regulatory environment makes adapting supply chains particularly challenging for firms.

The costs imposed by new regulations might alter patterns of trade flows and supply chains in ways that may not be in line with comparative advantage. There are costs involved in using more sustainable

production practices, but additionally the process of verifying and documenting the activities at all stages of a supply chain also involves significant transaction costs. A recent study estimates, for example, that firms will face annual costs ranging from EUR 40 000 to EUR 320 000to comply with the European Corporate Sustainability Reporting Directive as well as one-off costs between 36 000 and 287 000 upon implementation of the legislation, depending on the size and complexity of a firm (CEPS, 2022[18]).[6] This may also impact the possibility for developing countries with less developed institutions to benefit from global trade. While trade facilitation tools (Section 6.1) may help smooth the way in reducing frictions at the border, some transaction costs will nevertheless remain.[7]

As a result of these transaction costs, doing business with foreign suppliers – particularly those located in markets where there is no presumption of adequate enforcement of sustainability laws by relevant authorities – might become more burdensome. In response, firms could choose to reorganise their supply chains to avoid any business partners that might lead to additional paperwork or other regulatory hurdles. These choices are not driven by the quality or price provided by suppliers, but rather by avoidance of the transaction costs or potential uncertainty. Thus, production might be pushed to more inefficient locations and firms, negating the benefits of trade in ensuring that economic activity is allocated on the basis of productivity, as well as potentially reducing the inclusivity of the global economy.

A second challenge is that the costs imposed by supply chain regulations appear unlikely to be distributed equally. In particular, firms in developing countries and small and medium enterprises (SMEs) are likely to find these rules more burdensome to comply with. Although smaller firms are often exempted from supply chain sustainability laws directly, they may nevertheless be impacted as their downstream business partners may be required to report on the activities of their small suppliers. Acquiring familiarity with the relevant reporting schemes, as well as collecting the required information, is largely a fixed cost, which poses a far greater relative burden for those with smaller operating revenues and slimmer profit margins. For some smaller firms and specific firms in developing countries, the financial burden of meeting such requirements could even be too high to sustain participation in supply chains.

Increasing attention has been paid in recent years to the importance of ensuring that trade benefits everyone (OECD, 2017[19]); (WTO, 2024[20]). A major component of these efforts has been enabling SMEs and developing countries to export and to integrate into GVCs, as participation in international markets can be an important driver of economic development. Efforts to promote sustainability should be mindful of potential risks that could undermine the progress achieved towards these goals. Depending on the design of the law, businesses in trade partner countries might benefit from support such as guidance and information, technical expertise, or other forms of assistance to meet environmental and social performance expectations set by regulations.

Third, the current fragmentation and rapid changes of the current policy landscape for supply chain sustainability can create their own pressures. Countries have frequently approached their legislation in ways that may differ subtly or substantially. Regulation in this domain is also changing rapidly, and often considerable uncertainty exists about the implementation and timeline of new requirements. For example, Deconink et al. (2023[21]) demonstrate that variation in and lack of certainty about methodologies and reporting requirements for the environmental impact of food systems are causing a fragmented landscape of environmental initiatives. Similarly, due diligence reporting required by different countries' laws on social sustainability may differ in its content and format.

When the implementation of laws remains unclear or changes over time, firms are asked to prepare for a wider range of scenarios. This further exacerbates the challenges highlighted above, creating inefficiencies and potentially incentives to pull out of business with certain partners. Similarly, when regulations are not harmonised across jurisdictions, firms may incur administrative costs multiple times. Coordination among countries can be useful in order to avoid regulatory fragmentation, ensure policy coherence, and limit the regulatory burden on firms. Even if national laws differ in scope, terminology and requirements, they are in

many cases broadly aimed at addressing similar goals and are often rooted in the same international standards. This offers opportunities to identify synergies and improve policy cooperation.

Lastly, when supply chain laws create significant costs and when they are applied strictly and immediately, they might create incentives for firms to adopt "cut and run" approaches, i.e. cease doing business in markets where risks of sustainability violations exist. Yet, disengagement from a business relationship is meant to be a measure of last resort, either after failed attempts at mitigation, or where the enterprise deems mitigation not feasible, or because of the severity of the adverse impact. For example, market actors reported that due diligence requirements in the minerals sector have resulted in some firms avoiding artisanal and small-scale miners in conflict-affected and high-risk areas (OECD, 2021[22]).

While the creation of supply chain sustainability regulations is motivated by real and pressing concerns, their emergence may also pose an additional stressor to global value chains. Their potential costs and negative impacts need to be carefully weighed against the good they can do, and their design and implementation must take these trade-offs into account. This includes careful consideration of the market failures and other forces that lead to unsustainable supply chain practices in the first place (Park, Lundquist and Stolzenburg, 2023[15]).

As most supply chain sustainability laws have only been adopted relatively recently, their practical impact on the structure of supply chains and the sustainability of production across the world remains largely unexplored. Little is known about the way firms alter their strategies in response to these new legal frameworks. Research aimed at unpacking potential effects is needed in order to ensure sustainability policies benefit the environment and workers while addressing any unintended adverse effects on the efficiency and inclusiveness of supply chains.

4.2.2. Multistakeholder sustainability initiatives can complement regulation, but also add complexity

Supply chain sustainability laws are part of a broader ecosystem for sustainability governance. This ecosystem encompasses various elements, *inter alia*:

- International legal instruments, such as the ILO International Labour Standards, the Convention on International Trade in Endangered Species and the OECD Guidelines for Multinational Enterprises on Responsible Business Conduct
- National legislation (e.g. environmental protection laws, legislation for sustainability criteria in public procurement, technical regulations specifying sustainability requirements for products' characteristics or their related processes and production methods, tax concessions or subsidies pursuing sustainability objectives)
- Trade and investment policy instruments, such as trade agreements that increasingly integrate and pursue trade-related sustainability objectives, generalised system of preferences (GSP), and trade and investment promotion tools.
- Sustainability initiatives, which form another critical part of this ecosystem (Box 4.2).

Box 4.2. The wealth of sustainability initiatives influencing global trade

Businesses, governments and non-government organisations (NGOs) engage in sustainability governance through a variety of multi-stakeholder, government-run or industry-led initiatives, including environmental and social certification, environmental labelling and information schemes, voluntary sustainability standards, or other systems to facilitate, evaluate or demonstrate the sustainability performance of economic activities and outputs along supply chains. Most of these initiatives are designed to recognise and incentivise good practice against specific standards, often developed by the initiatives themselves. Many initiatives also support businesses with sustainable and responsible business conduct through promoting collaborative efforts, or providing policies, guidance and tools for assessing and managing sustainability risks or impacts. Examples of well-known sustainability initiatives include Fairtrade International, the Forest Stewardship Council (FSC), and OEKO-TEX for the textile and leather industry.

Unlike mandatory requirements such as due diligence legislations, many sustainability initiatives are voluntary in nature. However, expectations of consumers, investors and firms acting as powerful buyers of inputs may create a situation where choosing not to comply with the requirements of a sustainability initiative would result in exclusion from supply chains or investment (Fiorini et al., 2019[23]).

Most sustainability initiatives have been created within or with strong engagement by the private sector. Their development is partly driven by the actual or perceived failure of public governance alone in achieving sustainability objectives. For instance, the Forest Stewardship Council (FSC) was formed in 1993 after dissatisfaction grew due to the failure to approve a binding international instrument for forest preservation at the 1992 Earth Summit in Rio. A multi-stakeholder sustainability initiative, FSC involves NGOs, the private sector, environmental organisations, and representatives of local communities affected by deforestation in the design of standards for sustainable forestry and of global-reach systems to verify and communicate compliance with these standards (Cashore, Auld and Newsom, 2004[24]). NGOs like the World Wide Fund for Nature (WWF) have applied FSC's certification model to other commodity sectors, including the palm oil and soy industries (Auld et al., 2007[25]).

Today, sustainability initiatives are nearly as diverse as the combination of sustainability themes, products, and services they focus on, and the stakeholders involved. They are often defined, understood, and valued differently by different actors. They also differ significantly in their quality, design, core activities, scope, governance systems, and levels of transparency. While this diversity reflects the broad range of purposes, users, and uses of sustainability initiatives, it can also lead to confusion and inefficiencies when navigating and differentiating between initiatives.

Against this backdrop, the United Nations' International Trade Centre (ITC) and the OECD have proposed a flexible and value-neutral typology framework to foster a shared understanding of the complex landscape of sustainability initiatives (OECD/ITC, 2024[26]). Recognising their diverse and multifaceted nature, the ITC-OECD framework provides a structured set of parameters and a common language to help policymakers, private sector actors, NGOs, and other stakeholders differentiate between sustainability initiatives and, ultimately, use them to facilitate and verify the sustainability performance of economic activities along supply chains.

Well-designed and well-governed sustainability initiatives can be a useful tool to support companies' sustainability performance along global supply chains. Sustainability initiatives are engaged directly with the firms that make up global value chains. This allows them to leverage sector-specific expertise and, in some cases, conduct on-the-ground verification of the compliance of firms with sustainability standards, enabling transparency at a highly specific level. Even where the regulatory framework for sustainability is

weak, high-quality and high-integrity initiatives can provide motivation and reward for specific producers to achieve sustainability objectives.

However, the credibility and effectiveness of sustainability initiatives vary widely (Marx et al., 2024[27]). For example, among those initiatives for which data can be analysed, only a select few demonstrate ambitious public commitments to transparency and stakeholder engagement, which are important drivers of an initiative's credibility (Balaban et al., 2025[14]). Moreover, available data show that the prevalence of sustainability initiatives is uneven along supply chains, varying across sectors, tiers of supply and geographies. Overall, their voluntary nature, the fragmentation and complexity of their landscape, and the potentially high costs associated with voluntary implementation of their sustainability requirements or certification, are important factors that seem to prevent their overall sustainability impact from being transformative.

Despite these challenges, the potential contribution of such initiatives to make supply chains more sustainable has led policy makers to integrate them in a few public policy instruments. In the policy area of public procurement, for example, several jurisdictions have included legal mechanisms to recognise sustainability initiatives as one form of proof of compliance with specific sustainability requirements mandated by the law. Examples of this approach include the 2005 Act on Promotion of Purchase of Green Products of the Republic of Korea, and the European Union's (EU) Public Procurement Directive (2014/24).

Similarly, some supply chain sustainability laws, mostly in the EU or European countries, also reference sustainability initiatives. These include, among others, the EU Renewable Energy Directive (2009), the EU Conflict Minerals Regulation (2017), the EU Batteries Regulation (2023), the EU Critical Raw Materials Act (2024), and the EU Corporate Sustainability Due Diligence Directive. Sustainability initiatives are also expected to be an important topic in the context of the EU Deforestation Regulation.[8] Approaches to integrate sustainability initiatives in supply chain sustainability laws vary significantly, ranging from government-led "recognition of equivalence" models to more nuanced and flexible approaches that allow companies to use those initiatives most relevant to them, but ask them to evaluate the individual scope, alignment and credibility of the initiatives they use. In both contexts, governments have an important role to play in supporting companies and in promoting more credible public information on the scope and credibility of individual sustainability initiatives.

References to sustainability initiatives in these laws can be accompanied by a mechanism to assess the fitness and credibility of specific sustainability initiatives that wish to be recognised under a given legislation. These approaches can prove challenging for governments, particularly within normative frameworks with broad scope and where governments may lack resources. They also risk promoting over-reliance by enterprises and governments on recognised initiatives as an indicator of compliance (Balaban et al., 2025[14]).

Furthermore, there is an emerging trend of incorporating references to sustainability initiatives within trade agreements, in most cases reflecting a recognition of their potential role in advancing environmental sustainability governance. These new provisions are often non-binding or lack strong enforcement mechanisms. A few trade agreements go further and provide guidelines and recommendations setting specific characteristics that sustainability initiatives could follow to maximise their environmental impact while reducing the risk of creating unnecessary barriers to trade. This approach is taken for example in the environment chapter of the Comprehensive and Progressive Agreements for Transpacific Partnership (CPTPP), as well as in the free trade agreements between Brazil and Chile, Chile and Uruguay, Chile and Ecuador, and the United States-Mexico-Canada Agreement (USMCA). More recently, the new Agreement on Climate Change, Trade and Sustainability (ACCTS) signed by Costa Rica, Iceland, New Zealand and Switzerland in 2024 dedicates an entire chapter to introducing new guidelines for voluntary ecolabelling programmes.

Finally, sustainability initiatives can be used in the implementation of conditional trade preferences introduced by trade agreements. This is the case in the Swiss national ordonnance that regulates the

implementation of bilateral preferential tariffs granted by Switzerland to Indonesia on products in the vegetable oils sector and listed in the EFTA-Indonesia Comprehensive Economic Partnership Agreement. The agreement makes these preferences conditional on sustainable management of the vegetable oils sector and associated trade (Article 8.10). After benchmarking available initiatives covering palm oil, Switzerland's State Secretariat for Economic Affairs (SECO) identifies three initiatives to be aligned with the sustainability conditions of the EFTA-Indonesia agreement and accepts their certifications as a sufficient condition for palm oil imports from Indonesia to benefit from the preferential tariff.

Approaches to the design of policy frameworks that align sustainability and efficiency with resilience, in ways that foster long-term economic stability and sustainable development while ensuring the capacity to withstand disruptions are discussed in Chapter 7.

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Notes

[1] The definition of environmental goods (EGs) has been the subject of many discussions that will not be covered further in this report (see Moïse and Tresa (2025[4]). Past OECD analysis has defined EGs as goods used "to measure, prevent, limit, minimise or correct environmental damage to water, air and soil, as well as problems related to waste, noise and eco-systems" (OECD and Eurostat, 1999[28]).

[2] For a more in-depth discussion on the design and evolution of supply chain sustainability laws, specifically regarding labour rights protections, see Jaax and van Lieshout (2025[17]).

[3] Not in force at the time of writing this report – it will come into force on the 30 December 2025.

[4] The United States' Uyghur Forced Labour Prevention Act takes a more far-reaching approach along the same lines, whereby goods made wholly or in part in Xinjiang are presumed to have been made with forced labour unless evidence to the contrary can be provided.

[5] The paper from which this figure is drawn (Jaax and van Lieshout, 2025[17]) is focused on supply chain laws regarding social sustainability.

[6] Recent proposals to adjust the application of the EU Corporate Sustainability Reporting Directive may impact the accuracy of these estimates.

[7] See OECD (2025 forthcoming[29]).

[8] The regulation's article on risk assessment mentions certification or other third-party verified schemes, including voluntary schemes as potential sources of complementary information on compliance with the Regulation (Article 10(n) of the EU Deforestation Regulation).

Part II Beyond resilience: Agile, adaptable and aligned supply chains

5 Risk management at the firm-level

Supply chains are created and managed by firms, which are well positioned to provide insights on effective approaches to build resilience to shocks and disruptions. This chapter analyses the types of risks faced by firms and identifies successful practices. It highlights the role of “triple-A” supply chains – agile, adaptable and aligned – as a reliable source of resilience.

Policy actions in the wake of COVID-19 often focused on how to limit the risks of international sourcing, including diversifying supply or producing more closely to the domestic market. Such approaches are, to some extent, disconnected from the reality of international supply chains for three reasons. First, there are constraints on the location of production. Rubber trees or pineapples can only grow in certain places. This is not limited to primary commodities, as specific skills and knowledge also tend to be required from people or firms that are not necessarily available in the country of production. Consumers are also geographically dispersed and firms seeking to serve different markets may choose to establish in many different locations. There are also constraints in the geographical structure of supply chains and the choice of suppliers that do not allow for solutions such as repatriating all production.

Second, risks are everywhere, including in the domestic economy, and can affect multiple suppliers at the same time (as witnessed during the COVID-19 pandemic). Firms and governments seek responses to all types of risks and not just to risks identified for a specific type of input coming from a specific country. The next crisis may be very different from the scenario they have planned for.

Third, while there are risks when sourcing or producing internationally, there are also gains; a cost-benefit analysis generally suggests that some risks are acceptable. One can never eliminate all risks, so firms engage in what is called "real options", deploying their activities across countries to balance the benefits and risks (Klibi, Trepte and Rice Jr., 2024[1]).

Supply chain operations are exposed to many types of risks (Box 5.1). As explained by Sheffi (2015[2]), there are "known knowns", "known unknowns" and "unknown unknowns". The "known knowns" are routine risks that firms face every day, such as small variations in demand and prices. They also include long-term trends that firms can anticipate, such as urbanisation or population ageing. The "known unknowns" are events that are random but for which probability can be estimated from historical evidence. They include natural disasters such as floods or tornadoes. Because the probability can be calculated, firms can insure against such risks. The "unknown unknowns" are events for which the likelihood cannot be calculated, or that have not been imagined. The COVID-19 pandemic belongs to this category because global pandemics are too infrequent for firms to specifically prepare for. This is where firms turn to the development of general resilience, i.e. abilities and processes that allow them to face any type of risk.

Box 5.1. Resilience, vulnerability, and risk management in supply chains

Resilience can be defined as the ability to adapt and transform in response to adverse events. A supply chain is regarded as resilient if it can quickly return to stable operations following a disruption. Resilience is measured through the speed and effectiveness of recovery and not through the absence of disruption. For example, the resilience of an automotive supply chain is evaluated based on the time it takes to rebuild or stabilise inventory.

Vulnerability, on the other hand, is the susceptibility to the negative consequences of a disruption, influenced by the likelihood of disruption and the preparedness for it. Firms categorise and identify potential risks using a matrix where risks are ranked based on their likelihood (i.e. their probability of occurring) and their severity (i.e. their potential economic impact). For example, port congestion is a high-likelihood risk but with little impact on supply chains except for some extra delivery time. A pandemic, on the other hand, is a low-likelihood risk (often described as a rare "black swan" event), but with an extremely severe economic impact.

The supply chain management literature identifies five distinct categories of risk (Wagner and Bode, 2009[3]):

- Demand-side risk can arise from volatile customer demand and self-inflicted variability through forecast inaccuracy or hoarding. There is a "bullwhip effect" in supply chains as changes in

orders placed downstream by customers are amplified upstream due to the time lag in information and material flows.

- Supply-side risk includes supplier default, capacity constraints, quality or technological issues that limit the production capacity of firms and their ability to meet demand.
- Regulatory, legal and bureaucratic risk relate to measures taken by governments such as tariffs, trade sanctions or tax regimes, which can affect the organisation of supply chains and their costs.
- Infrastructure risk can create bottlenecks in logistics such as, for example, a port closure.
- Catastrophic risks, like a natural disaster, a war, or a global pandemic.

The first four types of risk result from relatively predictable[1] uncertainty and require routine risk management practices. The fifth type, catastrophic risk, emerges from unpredictable uncertainties and requires disaster management strategies to achieve resilience.

1. The literature refers to the concept of "ergodic" risks. An ergodic process is one whose properties can be deduced from a single (sufficiently long) random sample of the process. Non-ergodic processes change erratically at an inconsistent speed.

5.1. Firms use various strategies to build resilient supply chains

Firms adopt various strategies to manage risks. They generally consist of three basic building blocks – introducing redundancy, building flexibility, and changing the corporate culture (Sheffi, 2020[4]; Sheffi and Rice Jr., 2005[5]).

- Redundancy involves maintaining safety stocks, back-up suppliers and excess capacity in order to absorb any increase in demand and continue to serve customers during the disruption. There is a cost associated with such a strategy as firms need to invest in redundant assets that are not used when there is no disruption.
- Flexibility relates to developing the dynamic capabilities, such as organisational learning and responsiveness, that allow firms to quickly adapt and change the organisation of their supply chains when a disruption occurs. Flexibility needs to be established in procurement, production, distribution and customer-facing processes, as well as in control systems.
- The culture of responsiveness plays a more important role than control systems or processes, since it shapes the sensitivity to early warning signals and effective execution of crisis response plans. It involves the adequate training of staff and managers, as well as decentralised decision making.

Efficient risk management strategies are built on a combination of these three blocks. For example, inserting redundancy without establishing a culture of responsiveness may not achieve resilience. Flexibility is generally considered superior to redundancy because it supports continuous improvement, problem-solving at all organisational levels and general competitiveness. The high costs of redundancy strategies create a trade-off between resilience and efficiency, while investments in flexibility can support both resilience and economic performance. This is why agile, adaptable and aligned supply chains, discussed below (Section 5.3) are the best way to achieve sustainable competitive advantage.

Resilience strategies are also tailored to the types of risks. For routine risks involving small fluctuations in supply or demand, the cost of redundancy strategies is acceptable, and firms can rely on their inventories to adjust supply to demand. Flexibility is the preferred strategy for more severe risks where inventories and backup capacity are not enough to absorb disruptions. The literature highlights that applying routine risk management tools to extreme "black swan" events (the "unknown unknowns", as discussed above) can lead to waste, environmental burden and underperformance (Sodhi and Tang, 2021[6]).

5.2. Firms adopt a systemic approach to risks

While there is a push for policy measures aimed at compulsory stockpiling, geographic diversification, re-shoring or near-shoring, it is important to understand the complex nature of firms' decisions when they have to reassess their sourcing and location strategies (Thakur-Weigold and Miroudot, 2024[7]).

First, the literature on risk management highlights that there are risks everywhere – in the domestic economy as much as in foreign economies from which key inputs are sourced (Christopher and Peck, 2004[8]). The nature of risks can be different, but there is no safe place to produce, and global disasters such as climate change or pandemics affect all economies (Sodhi and Tang, 2021[6]). Resilience strategies are needed for all types of risks and cannot focus only on risks related to foreign supply. The experience of the pharmaceutical industry highlights that many shortages of medicines are related to quality issues, such as contaminations in factories that lead to removing from the market large quantities of drugs that are no longer available for patients. The risk of contamination is the same in foreign countries and in the domestic economy in this regulated industry, where all suppliers (domestic or foreign) are subject to the same quality standards (Cuddy, Lu and Ridley, 2023[9]). Box 2.1 in Chapter 2 offers a deep dive into what's guiding some of the sourcing decisions in the pharmaceutical industry.

In addition, strategies such as dual sourcing, diversification of supply, or re-shoring can increase the complexity of supply chains and may not always improve resilience (Mizgier, Wagner and Jüttner, 2015[10]). For example, geographic de-risking, such as re-shoring, friend-shoring or near-shoring, aims to reduce dependency on high-risk regions but often falls short of expectations. The reason is that only one segment of the supply chain (such as the final assembly) is generally re-shored or moved to another location, just pushing the risk associated with foreign supply upstream (Choudhary et al., 2022[11]). It is generally not possible to re-shore the whole supply chain (because there are many companies and industries involved, located in different countries, each with its own challenges when it comes to reshoring). Moreover, concentrating all production stages in the same location would create even higher levels of risks.

There are similar considerations regarding dual sourcing or diversification of supply at the firm level. On the one hand, it is useful to have several suppliers to ensure the security of supply for essential inputs. On the other hand, dual sourcing is not always feasible and for high-tech processes where very specialised inputs are needed, working with two suppliers is often more a source of risk than a solution (because the two suppliers will not deliver the exact same inputs and small differences can have a high impact on quality). In this case, firms prefer to build long-term relationships with suppliers they trust and who can solve problems when they arise (Jain, Girotra and Netessine, 2022[12]). Moreover, dual sourcing and diversification of supply also come with higher fixed costs and firms may prefer alternative less costly risk management strategies.

Second, firms try to balance the costs of holding inventory against the need for responsiveness. Firms that are best at managing risks and disruptions maintain balanced "Goldilocks"[1] quantities of inventory (Sheffi, 2020[4]), which are neither too much nor too little to respond to daily volatility at a reasonable cost (Tang, 2006[13]). Despite debates on "just-in-time" versus "just-in-case" inventory management (Pisch, 2020[14]) lean management is still regarded as the most effective strategy to mitigate disruptions (Netland, 2021[15]; Choi et al., 2023[16]). The essence of lean management is not to eliminate inventories, but to rely on decentralised problem-solving to continuously optimise the production system. Toyota, the company that invented lean management, was the last car manufacturer to be affected by shortages of semiconductors in 2021-2022 (Shih, 2022[17]).

Third, the fact that participating in global supply chains entails several risks is not seen by firms as a reason to no longer source from abroad or to stop serving foreign markets. There remain gains from trade and many benefits from international production (Section 2.1) that firms are not ready to relinquish and that outweigh the costs associated with risks (Contractor, 2021[18]). Moreover, uncertainty is not just a vulnerability but also an opportunity. It is precisely the competitive advantage of global firms to benefit from

market arbitrage, shifting production and exploiting opportunities in local markets. During COVID-19, GVC firms were more resilient due to this capacity to shift production (Giglioli et al., 2021[19]; Bonadio et al., 2021[20]). Global firms with the best risk management strategies generally benefit from crises because they respond faster than their competition to disruptions (Sheffi, 2015[2]; Sheffi, 2020[4]).

5.3. Triple-A supply chains can deal with uncertainty and change, while preserving the benefits of open trade

Top-performing firms tend to have supply chains that possess three different qualities. Described as "triple-A" supply chains (Lee, 2004[21]), they are (1) *agile*, meaning that they can react quickly to any change in demand or supply; (2) they are *adaptable*, as they can adjust over time to structural changes and evolving strategies; and (3) they *align* the interests of all suppliers in the production network, facilitating co-ordinated and co-operative responses. For these firms, therefore, flexibility is seen as the key to resilience.

In the "new (ab)normal" (Sheffi, 2020[4]) that characterises the environment in which supply chains have evolved since the pandemic, several authors have proposed revisiting this framework. For example, Cohen and Kouvelis (2021[22]) suggest a new "triple-R" model that would emphasise robustness, resilience and realignment. Robustness is the capacity to continue to produce during a crisis (Brandon-Jones et al., 2014[23]; Miroudot, 2020[24]). The realignment envisaged by Cohen and Kouvelis (2021[22]) involves taking into account new contractual forms and business models along supply chains to create better co-ordination.

In 2021, Lee (2021[25]) proposed an updated version of his triple-A framework, highlighting that agility, adaptability and alignment are needed even more than before. With new digital technologies, such as the Internet of Things (IoT), big data and artificial intelligence (AI), supply chains can adjust more than before to any change in demand or supply and achieve "super-agility". Moreover, adaptability in the supply chain is needed more than before with the rise of economic security concerns. Adaptability strategies should also cover the whole supply chain, now that supply chains have become more complex and international. Finally, the alignment of interests may have to go beyond all suppliers in a given value chain and be extended to a broader ecosystem involving a variety of stakeholders, such as governments and NGOs. More than just cost and resilience, alignment is increasingly about environmental and social issues (Section 4.2).

The next chapter outlines the characteristics of policy environments that enable the capacity of firms to operate within agile, adaptable and aligned supply chains.

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Note

[1] In the classic children's story, Goldilocks enters the home of three bears and samples their porridge to select the one which is neither too hot or too cold but just right, and then consumes her preferred choice.

6 Policy environments that enable agility, adaptability and alignment

While firms have their own strategies for enhancing resilience, governments can play a key supporting role. This chapter reviews policy actions to enable agility, adaptability and alignment in supply chains. These include trade facilitation policies to reduce friction at borders, service sector regulations that facilitate the smooth operations of supply chains and to allow companies to adopt digital tools, and mechanisms to foster international and public-private co-operation on supply chain issues

Not every disruption or delay is a market failure requiring government intervention. Policy does, however, play a key role in fostering the enabling environment in which firms pursue agile, adaptable and aligned supply chains. Public policy facilitates, integrates and provides infrastructure and emergency resources in co-operation with the private sector. Government action also addresses major risks or disruptions that exceed firms' capabilities of routine risk management.

Several policy areas can have a high impact on the agility and adaptability of supply chains, as well as the required alignment of interests among stakeholders:

- *Trade facilitation measures for goods.* The ability for firms to quickly adapt the organisation of their supply chains (including in the case of major crises) depends on efficient logistics and a reduction of trade frictions. Through trade facilitation measures (the streamlining of import and export processes), governments can reduce the costs associated with moving goods, meaning firms have less need for excessive inventory. Frictionless trade is particularly important during emergencies, when expedited import and export of goods can save lives.
- *Efficient services regulations that smooth supply chain operation*. The reduction of trade frictions and transaction costs can more broadly come from efficient services regulations that enable the smooth operations of agile manufacturing supply chains, not only for transport and logistics, but also for a series of support services that are needed at the various production stages (e.g. IT services, professional services, financial services, etc.).
- *Policies that enable the wider adoption of digital technologies* by firms and an enabling digital trade policy environment can also help firms' agility in reacting to disruptions. The digitalisation of supply chain operations offers avenues for better forecasting of demand and a better flow of information to anticipate risks and identify bottlenecks.
- *International co-operation, and co-ordination with the private sector*. Aligning strategies between governments, and between firms and governments, is another vital key to resilient supply chains. International co-operation is fundamental to addressing the systemic nature of supply chain vulnerabilities and the cross-border nature of regulatory challenges. Co-ordination with the private sector can align stakeholders' interests and is a practical way governments to effectively influence firms' strategies. It also increases the level of preparedness and the speed at which firms and governments respond to shocks and create emergency supply chains.

This chapter reviews specific policy options to: reduce trade frictions; to improve the regulation of services, facilitating the smooth operations of supply chains; to support the adoption of digital tools by companies; and to foster public-private co-operation on supply chain issues.

6.1. Trade facilitation measures for goods increase the agility and adaptability of supply chains

Trade facilitation policies for goods aim to make trade and customs laws, regulations, documents and procedures simpler and more efficient. They play a key role in streamlining and simplifying the technical and legal procedures at the border for intermediate and final products to be traded internationally. Such policies proved essential during the COVID-19 pandemic, with trade facilitation measures taken at the border making it possible for supply chains to continue to deliver goods where they were needed.

When the COVID-19 pandemic struck, disruptions in cross-border trade led to higher trade costs. These were linked to new protocols, additional border controls, and new administrative requirements for traders and carriers. Impacts varied by product, trade route, mode of transport, and country, affecting the functioning of supply chains in uneven ways across sectors and regions. The urgency of the crisis prompted many economies to implement measures such as "green lanes" for streamlining border controls or exchanging specific trade documents electronically. These trade facilitation measures enabled complex

supply chains to adapt in record time to provide the specialised inputs needed for the large-scale production of COVID-19 vaccines and other medical goods (UNESCAP, 2021[1]; OECD, 2022[2]; WTO, 2022[3]).

Trade facilitation measures also play an important role in boosting competitiveness, as inefficient processes at the border add to the cost of doing business internationally. This can benefit all stakeholders, but particularly developing economies and small and medium-size enterprises (SMEs), which face relatively higher costs when engaging in international trade.

As we emerge from the COVID-19 crisis, geopolitical tensions, climate change and other disruptions to global logistics are, however, all increasingly affecting how we trade. At the same time, new regulations linked to environmental and social sustainability – often enforced at the border – are increasingly impacting firms across their entire value chain (Chapter 4).

Against this background, trade facilitation measures can contribute to policy environments that enable agility, adaptability and alignment in three main ways:

- *Enhancing agility in the face of more frequent, high-impact supply chain shocks and disruptions.* This can be done by designing co-ordinated approaches between points of entry and exit, such as ports, in response to shocks or prolonged disruptions to logistics operations. These approaches need to rely on transparent and predictable trade-related information, streamlined border processes, and co-operation between public and private stakeholders. Reducing costs and frictions through trade facilitation reforms will also support traders in identifying new suppliers or new buyers when confronted with disruptions.
- *Being adaptable as sustainability regulatory requirements proliferate and have an impact at the border*. Firms are increasingly being requested to track and provide information to meet market demands aimed at ensuring that global value chains comply with environmental and social objectives (Chapter 4). Trade facilitation policies can play an increasing role in meeting these requirements to prove compliance at the border.
- *Supporting alignment across stakeholders through enhanced consultations with traders and co-operation between agencies at the border.* Trade facilitation measures, such as consultations with traders on new and updated border regulations, provide the necessary framework for informing industry about regulatory changes, as well as for compiling first-hand insights into recurring delays, inefficiencies, or inconsistencies at border crossings. Enhanced mechanisms for collaboration between border agencies – domestically and internationally – are also essential for streamlining processes and improving the predictability of shipments.

The OECD's Trade Facilitation Indicators (TFIs) (Box 6.1) are used in this section to assess areas of progress, as well as strength and weakness, in countries and regions' trade facilitation policies. The TFIs are also used in the country-by-country annex assessing ease of border processes, as well as regulatory transparency and alignment.

Box 6.1. Using the OECD's Trade Facilitation Indicators to monitor and support policy reforms

The 11 OECD's Trade Facilitation Indicators (TFIs) are each composed of several specific, precise and fact-based variables related to existing administrative processes at the border and their implementation in practice (e.g. the average time between publication and entry into force of new or adjusted trade-related regulations, the proportion of trade transactions that can be processed in advance of the arrival of goods at the border, or the coverage of certified trader programmes). The OECD TFIs cover the full spectrum of border procedures for more than 160 economies across different income levels, geographical regions, and levels of development. The 11 TFIs cover four main policy areas.

Transparency and predictability

- TFI (A) Information availability: Publication of customs and trade-related regulations and information, feedback mechanisms, and specific functions for businesses (e.g. dedicated webpages/portals, user manuals).
- TFI (B) Involvement of the trade community: Structures, guidelines, and frameworks for consultations between border agencies and traders or other relevant stakeholders on proposed or amended trade-related regulations.
- TFI (C) Advance rulings: The rules and processes applying to prior statements by the administration to requesting traders concerning, for example, the classification, origin, and valuation method applied to specific goods.
- TFI (D) Appeal procedures: The possibility and modalities to appeal administrative decisions made by border agencies.
- TFI (E) Fees and charges: Disciplines on the fees and charges imposed on imports and exports.

Automating and streamlining procedures

- TFI (F) Documents: Harmonisation and simplification of trade-related documents in accordance with international standards.
- TFI (G) Automation: Aspects such as the electronic exchange of data and use of automated risk management.
- TFI (H) Procedures: Aspects such as the streamlining of border control (inspections, clearance), implementation of trade single windows, or certified trader programmes.

Border agency co-operation

- TFI (I) Internal border agency co-operation: institutional frameworks, mechanisms, and IT systems for domestic co-operation between various border agencies.
- TFI (J) External border agency co-operation: institutional frameworks, mechanisms, and IT systems for co-operation between various border agencies with neighbouring economies and other trading partners.

Governance and impartiality

- TFI (K) Governance and impartiality: transparency of customs structures and functions, as well as accountability and ethics policies.

The indicators can help policymakers in developed and developing countries alike to assess the state of their trade facilitation efforts, pinpoint challenges and identify opportunities for progress. They also support governments' ability to mobilise technical assistance and capacity building in a more targeted way. The TFIs Policy Simulator helps identify the key measures driving the performance of a selected country in a specific indicator and simulates the effects of potential policy reforms on overall performance.

Source: OECD (2023[4]), *OECD Trade Facilitation Indicators: Monitoring facilitation reforms up to 2023*, https://issuu.com/oecd.publishing/docs/oecd-trade-facilitation-update-2023.

6.1.1. Agility in response to shocks and disruptions can be enhanced through streamlined, transparent and automated border processes

Since the COVID-19 pandemic, disruptions to global logistics, in particular shipping and ports, have continued to impact trade flows and supply chains. Disruptions to maritime operations during the pandemic caused severe delays and congestion that rippled through global supply chains (for more on maritime transport, see the case study in Box 6.2). Exposure to shocks is also increasingly affecting ports and shipping routes worldwide: for instance, in 2023, droughts reduced traffic through the Panama Canal by almost 40%. The Panama Canal's diminished capacity also affected between 10% to 25% of trade flows across ports in Panama, Nicaragua, Ecuador, Peru, El Salvador and Jamaica in 2023. More recently, shipping through the Suez Canal, linking Europe to Asia, has come to a near standstill due to Houthis attacks on commercial ships in the Red Sea since the end of 2023, affecting mainly trade in fossil fuels and agricultural products.

While there are alternatives to such shipping routes (in terms of corridors, ports, or other modes of transport), rerouting can involve longer distances and thus increase the requirement for more vessels and ship carrying capacity. Relying on multiple routes for the transportation of goods to reduce vulnerability or support rerouting in response to shocks will not only depend on the infrastructure for handling extra capacity, but also on a respective economy's trade facilitation policy environment. Streamlined and automated border processes will allow for more straightforward swapping between ports and other border posts in response to disruptions, while ensuring that any new points of entry and exit do not become bottlenecks. Moreover, transparency and predictability can help map bottlenecks and risks across points of entry and exit of goods and across supply chains, while also transmitting good practices.

Transparency and predictability refer not only to the availability of trade-related information, but also to areas such as advance rulings, fees and charges, and appeal procedures, where differences in regulatory frameworks and operational practices across countries can add significant costs. Analysis of the OECD TFIs (Box 6.1) highlights that transparency of trade-related information has progressed considerably since the entry into force of the WTO's Trade Facilitation Agreement (TFA) in 2017 (Figure 6.1), by increasingly making necessary information available on import and export procedures, trade documentation required and enquiry points. On the other hand, the COVID-19 pandemic has slowed down the speed of reforms in areas such as advance rulings, appeal procedures on trade-related matters, and streamlining fees and charges, which progressed more rapidly in 2017-19.

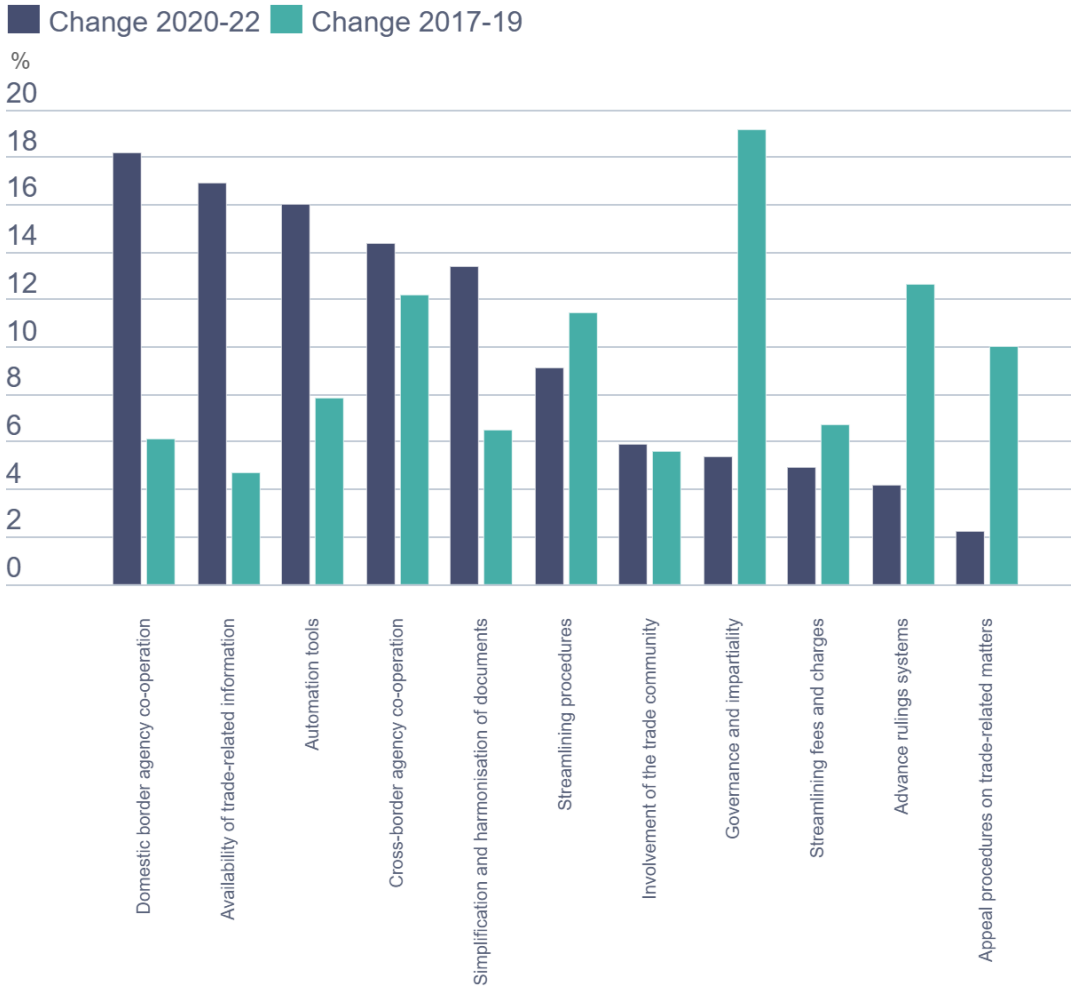
In practice, importing and exporting involve a wide range of documents, processes and agencies – this is an even more significant challenge when formalities at the border vary across countries. Measures such as automating and streamlining trade-related documents and border processes, together with border agency co-operation and involvement of the private sector, are important to support the design of co-ordinated approaches between points of entry and exit in responding to shocks and disruptions.

Automation of border processes has been one of the areas that has most improved since the COVID-19 pandemic. Improvements in automation have been driven by the introduction of tools such as automated pre-arrival processing, automated risk management, electronic payments of duties and charges, and digital single windows for trade. The simplification and harmonisation of trade documents and the streamlining of border processes have also continued to improve strongly since the entry into force of the TFA, driven by progress in establishing the regulatory frameworks for trade facilitation.

However, in practice, implementation of several measures is proving more challenging and impacts the speeds at which regions are advancing across the different trade facilitation policy areas (Figure 6.2). Implementation in practice concerns aspects such as the share of documents and trade procedures that can be processed electronically, the coverage of certified trader programmes (i.e. the number of traders and SMEs covered by a programme), and the proportion of trade transactions that can be processed in advance of the arrival of goods at the border.

Figure 6.1. There has been important progress in improving the trade facilitation policy environment

Percentage change (%) by TFI area, 2020-22 versus 2017-19



Note: The figure shows the percentage change in the respective TFI for each area. An increase means improved trade facilitation.
Source: OECD Trade Facilitation Indicators, https://sim.oecd.org/default.ashx?ds=TFI.

Figure 6.2. Progress in trade facilitation implementation varies across regions and policies

Average TFI score by main policy area, with 2 being the maximum performance per area.

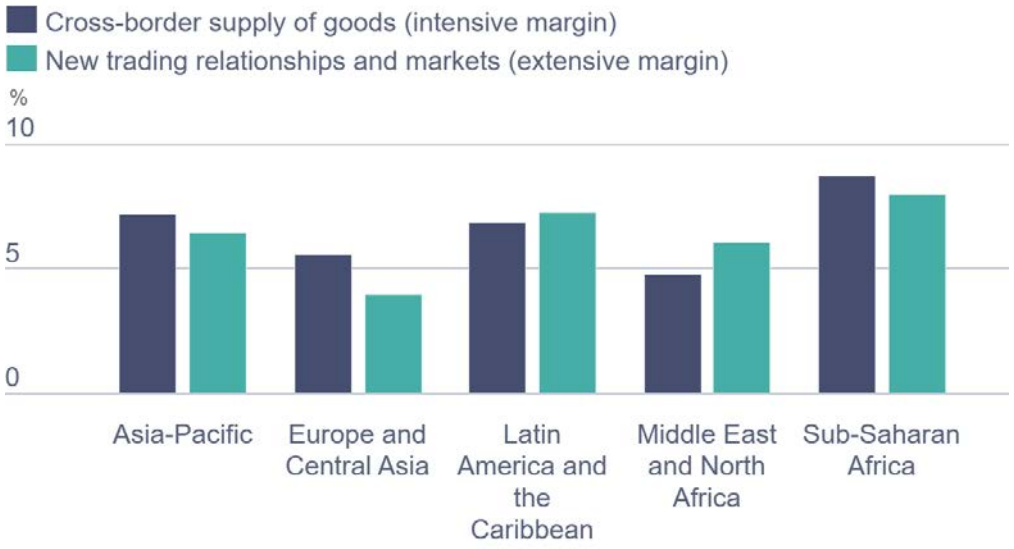
Note: 2 is the maximum performance for each of the three main policy areas (transparency and predictability; automating and streamlining documents and processes; border agency co-operation). Transparency and predictability are based on the average scores of TFI (A) Information availability, TFI (B) Involvement of the trade community, TFI (C) Advance rulings, TFI (D) Appeal procedures, and TFI (E) Fees and charges. Automating and streamlining trade-related documents and processes is based on the average of TFI (F) Formalities – documents, TFI (G) Formalities – automation, and TFI (H) Formalities – procedures. Border agency co-operation is based on the average of TFI (I) Internal border agency co-operation and TFI (J) External border agency co-operation.
Source: OECD Trade Facilitation Indicators, https://sim.oecd.org/default.ashx?ds=TFI.

Trade facilitation policies can also help maintain supply in case of shocks and enable new trade relationships

The ability to identify and rely on a new supplier or buyer is not automatic when importing and exporting involve a wide range of documents, processes and agencies, and goods cross borders multiple times (increasingly to include recycling and reuse). OECD TFI analysis shows that, on average, a 10% improvement in trade facilitation policies is associated with an increase in the number of export markets

by more than 6% (Figure 6.3) and in new sectors by almost 15% in some regions (OECD, 2023[5]). This underscores the contribution of trade facilitation reforms to finding new markets and sectors (referred to as "extensive margins"), which is important as they have potential to address disruptions and support diversification in supply chains as a risk management strategy. Increased access to more comprehensive trade-related information, streamlined documentary requirements and border processes, and an enhanced use of digital tools by border agencies can all facilitate access to new markets as they reduce the costs of entering those markets.

Figure 6.3. Trade facilitation reforms can help maintain supply in case of shocks and enable new trade relationships



Note: The figures highlight the percentage increase in exports from a 10% improvement in the average trade facilitation performance as measured by the TFIs (average across the 11 areas shown in Box 6.1). The results for the intensive and extensive margins rely on different explained variables and modelling approaches.
Source: OECD (2023[5]), *OECD Trade Facilitation Indicators: Monitoring facilitation reforms up to 2023*, https://issuu.com/oecd.publishing/docs/oecd-trade-facilitation-update-2023.

Trade facilitation policies can also play an important role in boosting existing trade relationships (referred to as "intensive margins"), with analysis showing that a better trade facilitation policy environment can enhance the intensive margin of trade by up to 9% across different regions (Figure 6.3) (OECD, 2023[5]). This can be particularly important for those supply chains where changing suppliers during a shock can be more challenging, such as when using customised inputs (i.e. inputs designed to meet the exact requirements of a final product). For instance, in smartphone manufacturing, a company might request custom-sized OLED screens with specific resolutions and touch sensitivity, while in the aeronautics industry, custom-engineered alloys or composite materials can be designed for specific weight, strength, or heat resistance for an aircraft component. Simplifying documentary requirements relevant to such customised inputs or including their suppliers in certified trader programmes can help reduce the costs and time involved in trading these inputs, maintaining access during shocks and enabling traded volumes to be increased swiftly to meet demand spikes.

6.1.2. Adapting to increasing sustainability regulatory requirements can be aided by regulatory and technical interoperability across borders

As a result of both voluntary initiatives and mandatory requirements, firms are increasingly being requested to track and provide information on their environmental and social sustainability footprint, often across the entirety of their supply chain, as discussed in Section 4.2.

For many of these requirements, the point of enforcement will be at the border,[1] which raises several challenges. First, this demands that a relevant institutional architecture be in place where customs authorities and other border agencies will have a role. It also has implications for the specific requirements for demonstrating compliance (e.g. the type of information that needs to be provided, new or adjusted documentary requirements) and for processes to enable companies to report the information as well as for actors providing certification. Second, in addition to the regulatory interoperability needed to underpin the information required on environmental and social sustainability impacts themselves (i.e. knowing what information needs to be collected and the quality of that information), technical interoperability is then required to support the data elements and documents that need to be exchanged and verified (OECD, 2025 forthcoming[6]).

The same set of key trade facilitation policies discussed above – automating and streamlining trade-related documents and processes, as well as border agency co-operation – thus play a growing role in increasing sustainability standards enforced at the border. Together with behind-the-border processes, such as those linked to conformity assessment procedures, they can support technical interoperability and help reduce costs relating to compliance with trade-related regulations.

Technical interoperability can then contribute to reducing transaction costs and operational inefficiencies (e.g. the requirement to fill in different surveys or spreadsheets to share emissions data) in the sharing of data across different actors and borders. The lack of technical interoperability may be especially burdensome for export-intensive companies operating across multiple jurisdictions, and for smaller firms. Smaller firms often do not have the resources for upfront investments in a data collection and sharing system, or the in-house expertise to prepare Scope 3 emissions data.[2] This situation is exacerbated in developing and low-income countries, which typically have less capacity to address these interoperability challenges than developed countries.

6.1.3. Alignment of stakeholders is boosted through consultations between border agencies and traders and co-operation among border agencies

Since the COVID-19 pandemic, strong emphasis has been placed on enhancing communication and co-ordination among domestic border agencies. This has involved a wide range of government institutions and has aimed to enable swift responses to disruptions and ensure the continued flow of essential goods at borders. Improvements in various mechanisms for collaboration – from risk management systems and co-ordinated inspections, to co-ordinated certified trader programmes – have been driving the progress in domestic border agency co-operation.

While improvements are more modest for the area of co-operation with border agencies in neighbouring economies and other trading partners, the TFIs highlight that the overall pace of reform appears to be more ambitious than when the TFA came into force in 2017. However, there is scope to build on the COVID-19 inter-agency co-operation structures to enhance crisis responsiveness and resilience, as well as international co-operation more broadly.

The scope of co-ordination with private sector stakeholders over border processes also needs to expand to devise solutions that can be mobilised when needed to act under pressure and time constraints. In this sense, collaboration between port authorities, shipping companies, logistics providers and border authorities is crucial in managing the overall flow of goods. The OECD TFIs highlight that consultations

between border agencies and traders on proposed or amended trade-related regulations are increasingly based on established guidelines and procedures, but could benefit further from widened discussions with a larger pool of stakeholders and from timelier publication of draft legislations prior to their entry into force (OECD, 2023[5]).

The automation and streamlining of trade-related documents and processes are also increasingly interlinked with the digital trade policy environment, such as frameworks for enabling electronic transactions (e.g. electronic transferrable records, e-authentication, e-signatures, e-payments, or e-invoicing) and cross-border exchange of data (Section 6.3). While this provides new opportunities to reduce trade costs and increase visibility of transactions across supply chains, the TFIs show that many of the areas that require sharing of data – such as shared risk management systems and interconnected or shared computer systems between border agencies – are among those with the lowest levels of implementation (OECD, 2025 forthcoming[6]).

In addition, reducing regulatory heterogeneity in trade facilitation policies is crucial for enhancing cross-border trade efficiency, lowering costs and improving supply chain resilience. This is discussed further for trade in services in the section below.

6.2. Supporting services can underpin adaptable supply chains

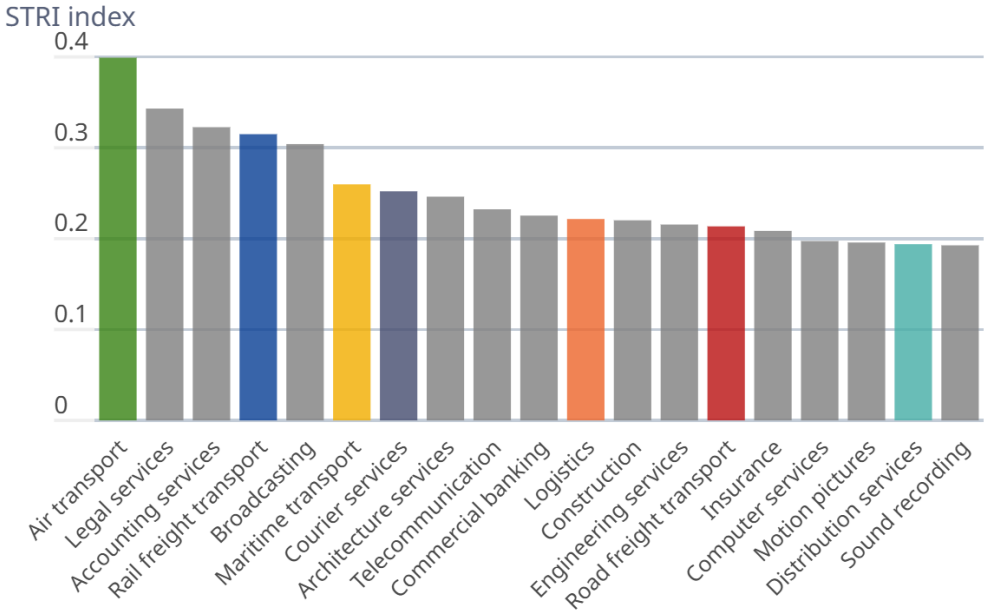
Services are essential to the functioning of global supply chains, enhancing efficiency, cutting costs and ensuring smooth connectivity from producers to consumer .Transport services, including air, sea, road and rail transport, help carry goods across countries, while logistics services help manage the complex flow of goods, optimising inventory management and allocation of capacity and resources. Maritime transport services are particularly crucial for global supply chains as they facilitate the efficient and cost-effective movement of goods across vast distances, ensuring timely delivery and supporting international trade (Box 6.2). Meanwhile, distribution and courier services offer last-mile delivery solutions, crucial for reaching end consumers swiftly, especially in the context of the growing volumes of trade in parcels (López González and Sorescu, 2021[7]). In addition, digitalisation is streamlining supply chains by enhancing communication, improving efficiency, enabling real-time tracking and fostering better decision making through advanced data-driven technologies. Together, these key supply chain services not only streamline commercial operations – they also strengthen supply chain resilience by diversifying transportation routes and modes, mitigating risks associated with disruptions or emergencies, and keeping costs at a minimum.

Transport and logistics services are also pivotal for enhancing environmental sustainability within supply chains. Environmentally sustainable logistics practices, such as the use of fuel-efficient transportation modes, route optimisation and sustainable packaging, significantly reduce the carbon footprint of supply chain activities. By leveraging these services, companies can meet regulatory requirements and fulfil corporate social responsibility goals, enhancing their brand reputation and competitiveness in a market increasingly concerned with sustainability.

Optimal cross-border transport and logistics activities closely depend on good regulatory approaches that minimise unnecessary trade barriers and ensure regulatory interoperability for services providers. Evidence from the OECD Services Trade Restrictiveness Index (STRI)[3] shows that there are still substantial barriers to trade across these sectors (Figure 6.4).

Figure 6.4. Barriers to trade across logistics and related services are relatively high

Average STRI score for all services sectors covered, 2024



Note: Average STRI score for all countries and sectors.
Source: OECD STRI database (http://oe.cd/stri-db).

Figure 6.5 illustrates the drivers of these barriers. For instance, foreign entry barriers (which limit the ability of foreign services providers to enter domestic markets) are high in most transport sectors (e.g. close to 60% of all barriers in air transport) as well as in courier services (half of all barriers). Barriers to competition contribute around 30% of all restrictions in air and rail freight transport but also make a substantial contribution to restrictions in courier and distribution services. Barriers for regulatory transparency are higher in logistics services (28%) than in other sectors, driven by measures related to customs procedures, licences and entry requirements for transport crew.

Figure 6.5. Barriers exist across key supply chain services sectors

Composition of STRI by share of policy area, 2024

Source: OECD STRI database (http://oe.cd/stri-db).

Box 6.2. Case study: Maritime transport services and supply chain resilience

Maritime transport is a key sector for efficient connections across supply chains. It is estimated that more than 80% of the volume of goods traded worldwide is carried by sea (UNCTAD, 2024[8]). The market is highly concentrated, with the top five ship-owning countries accounting for half the world's fleet tonnage in 2024.

Geopolitical tensions, unrest, and protectionist measures can disrupt international trade flows and affect maritime transport routes and operations. Uncertainty surrounding trade policies and trade barriers can also deter investment and reduce potential efficiency gains from streamlining shipping operations. The maritime industry is also facing growing pressure to reduce its environmental footprint, particularly its air and water pollution, and greenhouse gas emissions.

Drawing on STRI data, the following key challenges can be identified that affect international trade in maritime transport services (Figure 6.6):

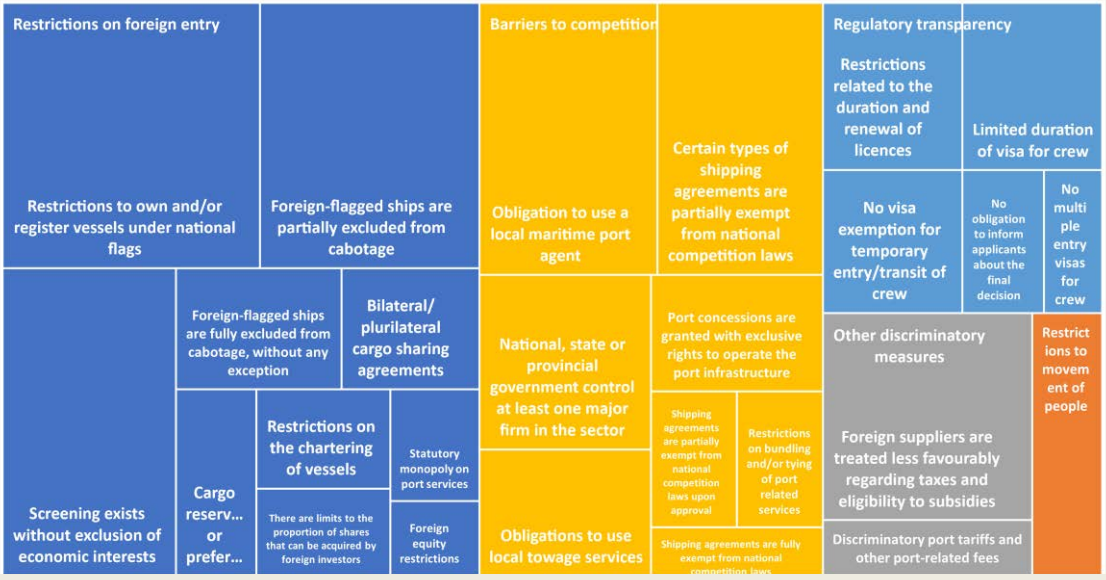
- *Restricted access to certain market segments and cabotage operations:* Conditions on flying the national flag are not considered a trade restriction *per se*, but in cases where flying the flag is linked to accessing certain segments of the market, discrimination in registering under the national flag creates restrictions on foreign entry. 93% of the countries covered in the STRI for maritime services(1) impose various conditions to registering vessels in their national registry, thereby limiting the provision of maritime cabotage. 78% of countries prohibit certain cabotage

operations for foreign-flagged vessels, while 27% prohibit all cabotage for foreign operators. Cargo-sharing agreements and cargo reservations or preferences for ships under national flag exist in over 20% of the countries covered. Such measures, together with strict cabotage policies, considerably limit the operation of foreign vessels even when this is beneficial to improving efficiency in cargo distribution, alleviating capacity constraints on domestic vessels, and providing incentives for investments in port infrastructure.

- *Barriers in port services*: Ports are often publicly owned, while port services are usually provided by private companies operating under concession agreements. 13% of the countries in the STRI continue however to restrict the provision of such services, including through statutory monopolies that preclude the entry of other port operators. Moreover, concessions for port services granted with exclusive rights to operate exist in 29% of these countries, thus limiting the scope of other services providers at ports. Discriminatory tariffs for port services exist in major ports(2) across 18% of the countries covered and several countries include obligations to use only local auxiliary services, such as towage (29% of the countries covered) or local maritime port agents (13% of the countries covered).
- *State ownership and market competition:* Government ownership or control of major domestic maritime transport operators exist in over 40% of the countries covered, highlighting the high degree of government involvement in this sector. 11% of countries fully exempt shipping agreements from competition law and 16% provide for partial exemptions. In addition, more than half of the countries (58%) have tax relief measures or other incentives for domestic shipping companies to increase the competitiveness of the national fleet.
- Reducing these regulatory barriers could help to strengthen the resilience and flexibility of global supply chains by improving efficiency in maritime operations, easing potential capacity constraints and promoting greater investment in port infrastructure and services.

Figure 6.6. Key trade barriers affecting maritime transport services

Composition of key trade barriers in maritime transport across the 45 countries covered, 2024



Source: OECD STRI database (http://oe.cd/stri-db). Based on OECD (2024[9]), *Revitalising Services Trade for Global Growth: Evidence from Ten Years of Monitoring Services Trade Policies through the OECD STRI*. https://doi.org/10.1787/3cc371ac-en.

Notes: (1) Landlocked countries are not covered by the STRI in maritime transport services. In 2025, the STRI for maritime services covers 45 countries. (2) The STRI captures regulations applicable in the largest port in the country, in terms of cargo tonnage.

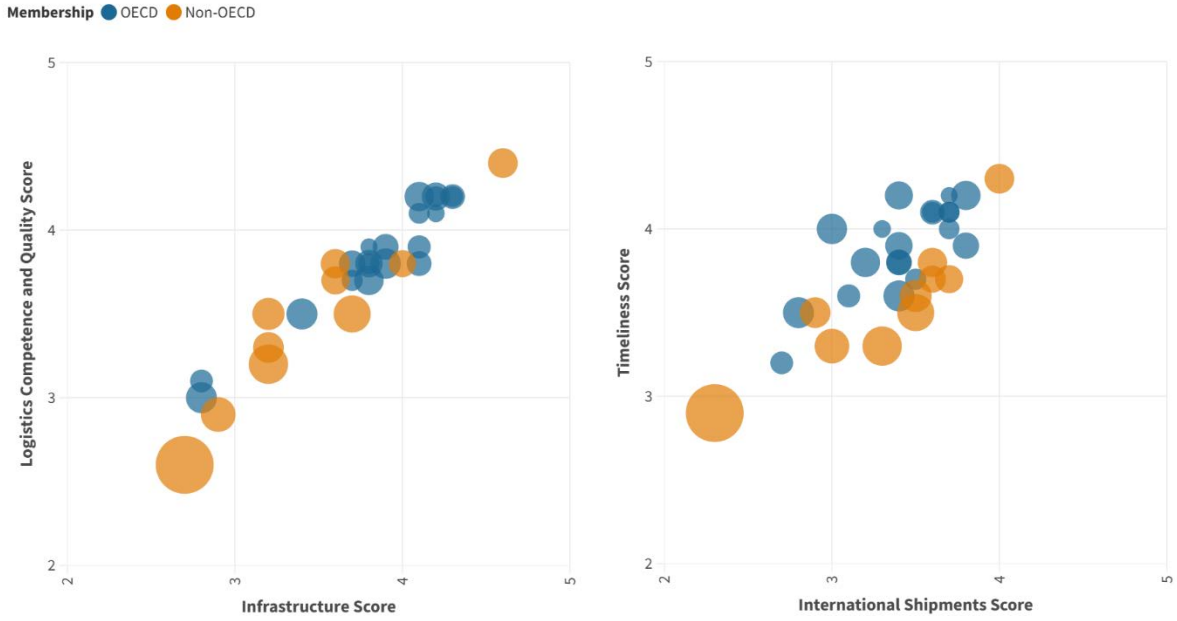
There appears to be a consistent negative correlation between the restrictiveness of both logistics and maritime transport services and various logistic performance indicators measured by the World Bank's Logistics Performance Index (LPI) (World Bank, 2023[10]). Figure 6.7 highlights correlations between the STRI for these two sectors and relevant World Bank LPI scores for logistics infrastructure, competence and quality, international shipments, and tracking and tracing. Countries with lower trade restrictiveness scores in these areas tend to score more highly across all these indicators, meaning better overall logistics performance. This is especially relevant for non-OECD Member countries, where the level of restrictiveness in logistics and transport sectors tends to be higher.

Moreover, OECD research finds that ambitious efforts to ease barriers to trade in services could yield substantial benefits by reducing trade costs for firms that provide services across borders and by enhancing productivity in manufacturing. In a hypothetical scenario in which countries improve their STRI halfway to the STRI of the best performer in each sector, trade costs in supply chain services could drop by between 5% and 14% on average (Table 6.1). The improvement would be greatest in air transport, with estimated trade cost reductions in the range of 9% to 24%.

Although logistics services are not among the most restricted sectors, any barriers can substantially affect logistics companies' ability to provide services and thus increase costs. For instance, burdensome customs and border processes can raise uncertainties around scheduled deliveries, and restrictive policies on certain types of logistics activities (e.g. cargo handling, customs mediation, or storage) can affect the ability of suppliers to offer integrated logistics solutions. Thus, even the lowest estimations of trade cost reductions to logistics customs brokerage services (4%) could represent substantial savings for businesses (Table 6.1).

Figure 6.7. Open transport and logistics markets matter for global supply chain networks

Relationship between STRIs for logistics services (left) and maritime transport (right) and components of the WB Logistics Performance Index (LPI), 2023



Note: Each bubble represents a country in the STRI sample. The size of the bubble shows the STRI value, where a bigger bubble depicts a higher STRI value (i.e. more restrictive). The left panel plots the LPI infrastructure score and logistics competence and quality score against the STRI for logistics services in selected OECD and non-OECD economies for 2023. The right panel plots the LPI international shipments scores and timeliness scores against the STRI for maritime transport services in selected OECD and non-OECD economies for 2023. LPI scores can be read as the higher the value, the better the performance in the index.
Source: World Bank (2023[10]) and OECD (2024[9]).

Table 6.1. Closing the STRI gap with best-performing countries by half could see significant reductions in trade costs

Estimated trade cost reduction of policy reforms in the STRI, 2023 (% of export values)

STRI sector	Lower estimate (%)	Higher estimate (%)
Air transport	9	24
Courier services	7	15
Logistics (cargo handling)	5	13
Maritime transport	5	13
Logistics (storage)	5	13
Road freight transport	4	12
Rail freight transport	4	12
Logistics (freight forwarding)	4	11
Logistics (customs brokerage)	4	10
Average	**5**	**14**

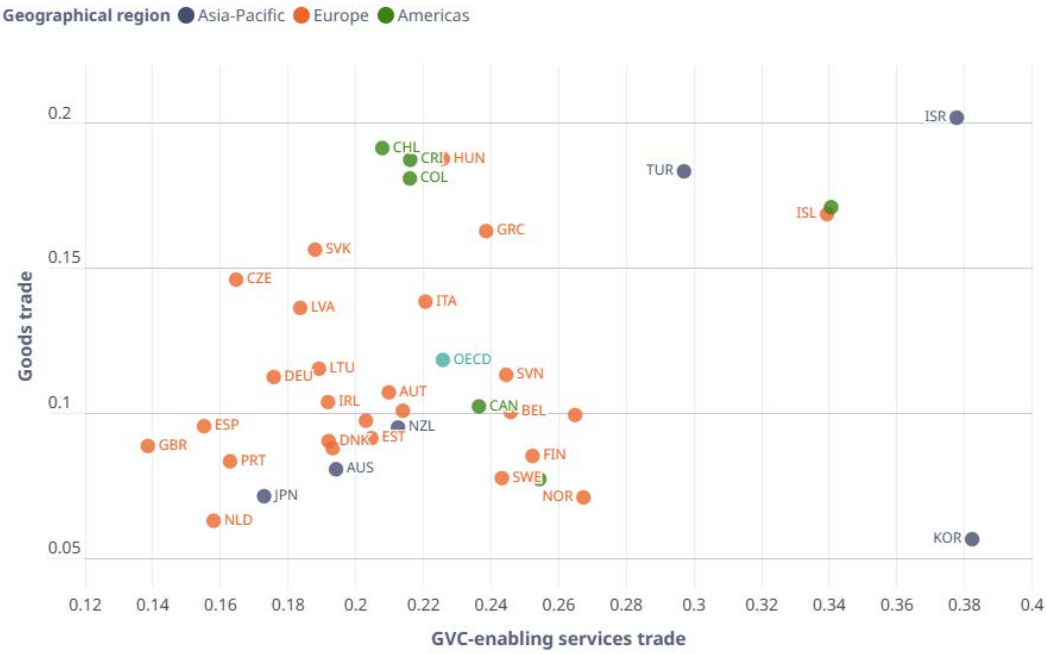
Note: This table presents the trade cost implications of closing 50% of the gap in their Services Trade Restrictiveness Index (STRI) score with the best-performing countries. All estimates correspond to the median for 50 countries. Calculations based on the methodology in Benz and Jaax (2020[11]).
Source: OECD (2024[12])

Regulatory disparities across countries are another source of impediment that affects the fluidity of international trade in goods and services and undermines alignment and co-ordination across value chains. They breed uncertainty among firms and stifle efforts for alignment and co-ordination across global networks. Heterogenous regulatory frameworks can also increase compliance costs and administrative burdens, deterring companies from venturing into new markets. Closer regulatory alignment among countries can help minimise delays at borders through more efficient and predictable trade facilitation procedures. For services providers, greater regulatory integration enables smoother cross-border service delivery, enhanced market access and competition.

Evidence from the OECD TFI and STRI shows that growing regulatory divergence remains a concern (Figure 6.8). The figure plots countries based on their regulatory environment in trade in services (x-axis) and goods trade facilitation (y-axis), with lower values indicating greater alignment with norms that are considered international best practices. It shows that in general there is closer global alignment on trade facilitation regulations than on services trade. Moreover, regulatory fragmentation is more pronounced in regions such as the Americas and Asia-Pacific, although closer neighbouring countries tend to have more similar regulatory approaches. Countries with higher divergence on both trade facilitation and services trade could benefit from greater regulatory co-operation to help reduce trade costs and improve market access.

Figure 6.8. Regulatory fragmentation is more pronounced in services trade than in goods trade

Alignment of regulation with international TFI and STRI best practice



Note: The lower the score for both indices the closer the regulation of individual countries to international best practices. OECD's 2024 Services Trade Restrictiveness Index (STRI) of GVC-enabling services (transport services (air, maritime, rail freight and road freight), logistics services, postal and courier services, distribution services and telecommunications services) takes values between zero and one, with one indicating the most restrictive regulatory environment for services trade. The OECD's 2022 TFIs [to be updated with the 2024 information] take a value between zero and 22 (2 represents the maximum possible performance across each of the 11 policy areas covered), with 22 indicating the best trade facilitation performance overall. To enable comparison between the STRI and TFI, the TFI was transformed as follows: (([Country score] -22)/22)*-1. This results in a value between zero and one, with one indicating the least facilitating environment for goods trade.

Source: OECD Trade Facilitation Indicators (2022), https://sim.oecd.org/default.ashx?ds=TFI and OECD STRI (2024), https://doi.org/10.1787/3cc371ac-en.

Looking ahead, reducing services barriers will be key for strengthening supply chain resilience by enhancing access to foreign inputs, improving regulatory interoperability and encouraging supplier diversification. Countries with fewer barriers in transport and logistics services typically have better logistics infrastructure and more efficient processes. Possible policy considerations might include:

- Lifting market access barriers for critical services sectors, notably transport, logistics, financial and telecommunications services.
- Working towards greater regulatory interoperability across countries by strengthening common regulatory standards and expanding tools such as mutual recognition of qualifications and permits.
- Fostering international co-operation to create a more predictable, transparent and efficient regulatory environment, thereby enhancing global trade in services, driving innovation and promoting economic growth.

6.3. Better digital transformation policies will make supply chains more resilient and agile

Digital transformation plays a critical role in enhancing supply chain resilience, as discussed in Chapter 4. For this, the regulatory environment for digital trade is of primary importance. There are four regulatory areas that affect access to the digital tools and data for supply chain resilience – each of these is discussed in the sections that follow:

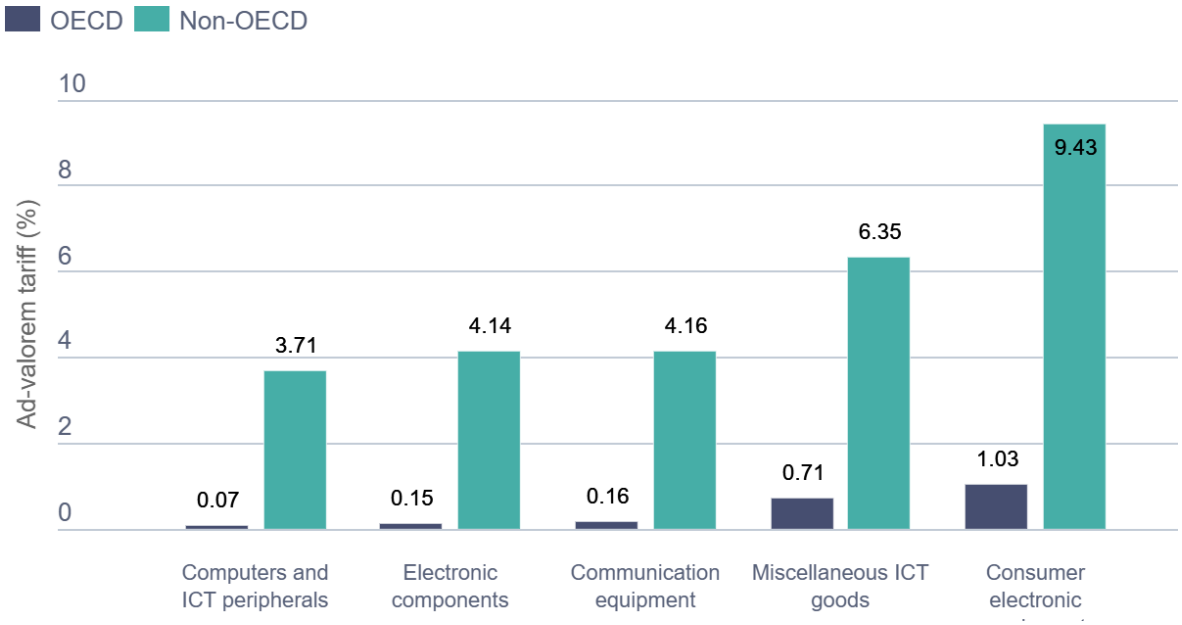
- *Tariff and non-tariff measures that affect access to goods critical for the digital transformation.* Such measures can affect the cost of devices that power digitalisation, automation and traceability within supply chains. These goods include computers, laptops, smartphones, sensors and other connected devices. The same is true of any measures affecting the costs of building and maintaining the hard digital infrastructure on which digital networks are built, including access to cables, wires and masts.
- *Services barriers that affect access to competitive services that underpin digitalisation.* Reliable and competitively priced telecommunications services that ensure fast and uninterrupted digital connectivity are key for supply chain resilience (Ivanov, 2024[13]). So is access to top-of-the-range computer services that form the soft digital infrastructure and digital solutions that enable resilience (such as cloud computing services).
- *Regulatory barriers that affect cross-border data flows.* Data that flow across international borders are the lifeblood of modern supply chains (Casalini and López González, 2019[14]). Firms require real-time access to data on ongoing activities across the entirety of the supply chain to proactively monitor, anticipate, manage and respond to emerging shocks. Measures affecting the free and safeguarded flow of data will therefore affect supply chain resilience.
- *Digital trade openness and integration initiatives.* The ability to switch or consolidate suppliers depends strongly on the openness of markets. Common approaches to digital trade facilitation tools, including the recognition of e-contracts and e-signatures, and the ability to pay electronically, as well as common approaches to privacy, data protection or source code, can help reduce transaction costs and enable greater supply chain resilience. Ongoing negotiations under the Joint Initiative on e-commerce, digital trade provisions in regional trade agreements (RTAs), and the Information Technology Agreement (ITA) are the most prominent examples of such initiatives.

6.3.1. Lowering tariffs on ICT goods will boost resilience

Digital transformation hinges on access to hardware: from high performance computing and network equipment, to desktops, laptops, smartphones, data sensors, IoT devices and communication units. These goods underpin the ability of firms to adopt digital technologies as well as the digital infrastructure of the countries in which they operate. Although ICT goods are some of the most internationally traded items, manufacturing is concentrated in only a few countries, particularly in Asia and especially in China (2020[15]).

Tariffs and non-tariff measures on ICT goods can hinder the adoption of digital technologies, potentially affecting the ability of firms to digitise processes and therefore respond to supply chain shocks. While tariffs on ICT goods tend to be relatively low in OECD Member countries, many non-OECD Member countries maintain relatively high tariffs (Figure 6.9).[4] This is particularly the case for consumer electronic equipment, but also applies to communication equipment. Reducing tariffs would enable actors within internationally dispersed supply chains to more efficiently source ICT goods for more resilient responses to emerging shocks.

Figure 6.9. Tariffs on ICT goods remain high in many countries, especially outside the OECD



Note: ICT goods identified using UNCTAD classification, which includes 115 products at the HS-6 digit level. Data for 2021 or latest available year.
Source: Own calculations based on tariff data extracted from the World Integrated Trade Solution database, available at https://wits.worldbank.org.

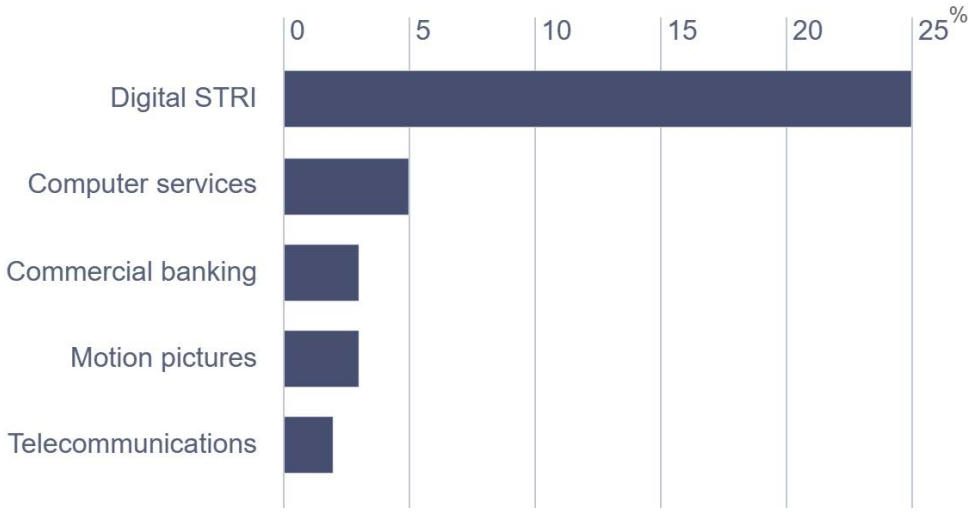
6.3.2. Ensuring an enabling services regulatory environment will free up digital trade

Services are instrumental in supporting the digital transformation of modern economies and therefore in providing the enabling environment, or soft infrastructure, that facilitates supply chain resilience. Telecommunications services, for instance, are the backbone upon which digital networks are built. In parallel, computer services can grant access to solutions that enable greater resilience. These include cloud computing and related services that help firms and other actors across the supply chain to store, process and access data from different locations. Such services can also help firms develop digital capacity quickly, in new locations, without the need for upfront capital costs. An enabling regulatory environment for services which minimises undue barriers to the uptake and use of digital technologies, safeguards competition, data privacy and cybersecurity concerns, and ensures a level playing field, is therefore key to supporting supply chain operations across different markets.

However, evidence from the OECD's Services Trade Restrictiveness Index (STRI) and Digital STRI (DSTRI) suggests that the global regulatory environment for digital trade has become increasingly tight (Figure 6.10). Barriers to digitally enabled services, as captured by the DSTRI, have grown by 25% in the last decade, as countries take diverse approaches to government digital economy issues. At the same time, barriers to computer and telecommunication services have also risen by 5% and 2% respectively. Overall, this increasingly tight regulatory environment is likely to have a strong negative impact on firms' ability to react to changes in circumstances as a result of unforeseen shocks. Continued streamlining of these regulations is necessary to enhance the ability of firms to be more agile and adaptable in responding to shocks.

Figure 6.10. Barriers to services that underpin digital networks are growing

Percentage change in average Digital STRI and in the STRI across selected sectors, 2014-23



Source: OECD (2024[12]); and Ferencz (2019[16]).

6.3.3. Enabling data flows and transfers will allow for agile supply chains

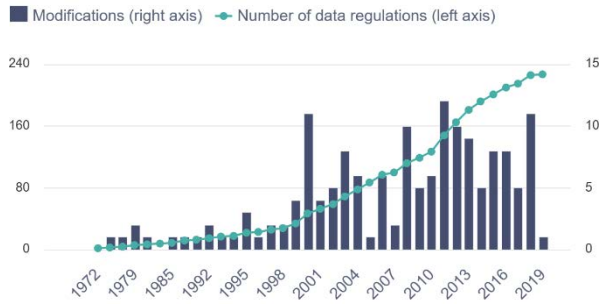
Cross-border data flows are the lifeblood of today's international trade and supply chain transactions. They allow real-time monitoring of goods and services as they pass through suppliers and borders, helping supply chain managers anticipate disruptions. They also enable the deployment of proactive measures to mitigate risk through more efficient co-ordination and synchronisation of activities, including between suppliers, manufacturers, distributors and retailers.[5]

However, the emerging landscape as it relates to data, and especially cross-border data flows, is becoming increasingly complex. Concerns about privacy protection, cybersecurity, national security, regulatory reach, competition and industrial policy have all led to growing number of data regulations which either conditions the transfer of data abroad or mandates that data are stored domestically (Casalini and López González, 2019[14]) (Figure 6.11a). The growing number and restrictiveness of data localisation measures (Figure 6.11b) puts additional pressures on firms to duplicate data solutions across different markets and can affect the ability of companies to access real time information about supply chain risks, particularly when data localisation is accompanied by data flow prohibitions.[6]

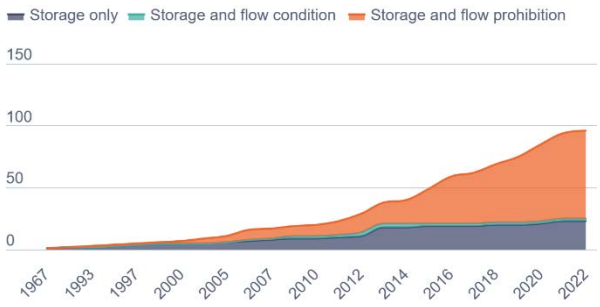
Getting it right on cross-border data flows is key. Recent evidence from a joint OECD-WTO report suggests that the absence of data flow regulation would be associated with negative economic outcomes. While trade costs would fall, so too would trust, leading to a near 1% reduction in GDP. The economic costs of the full fragmentation of approaches to cross-border data flows would also be high, leading to losses in GDP of 4.5%. By contrast, approaches to cross-border data flows which balance the trade costs associated with data regulation with the trust benefits of data safeguards can deliver important benefits, increasing global GDP by 1.7% and exports by over 3.5% (OECD/WTO, 2025[17]).

Figure 6.11. Measures affecting cross-border data flows are on the rise

Panel A. Data regulation



Panel B. Data localisation measures



Source: Casalini and López González (2019[14]), and OECD (2023[18]).

The increase in digital trade openness and integration needs to continue

Countries have increasingly been engaging in international regulatory co-operation over digital trade. This includes trade discussions, notably ongoing negotiations between 91 WTO Members under the Joint Initiative (JI) on e-commerce; growing digital trade provisions in regional trade agreements (RTAs); and new Digital Economy Agreements (DEAs) touching on new and more diverse issues, including digital identities, AI and SMEs (López-Gonzalez, Sorescu and Kaynak, 2023[19]). Beyond the trade discussions, co-operation also involves the more widespread adoption of instruments with implications for digital trade across different fora, including at the Asia Pacific Economic Co-operation (APEC), the OECD and the United Nations Commission on International Trade Law (UNCITRAL) (Nemoto and López-González, 2021[20]).

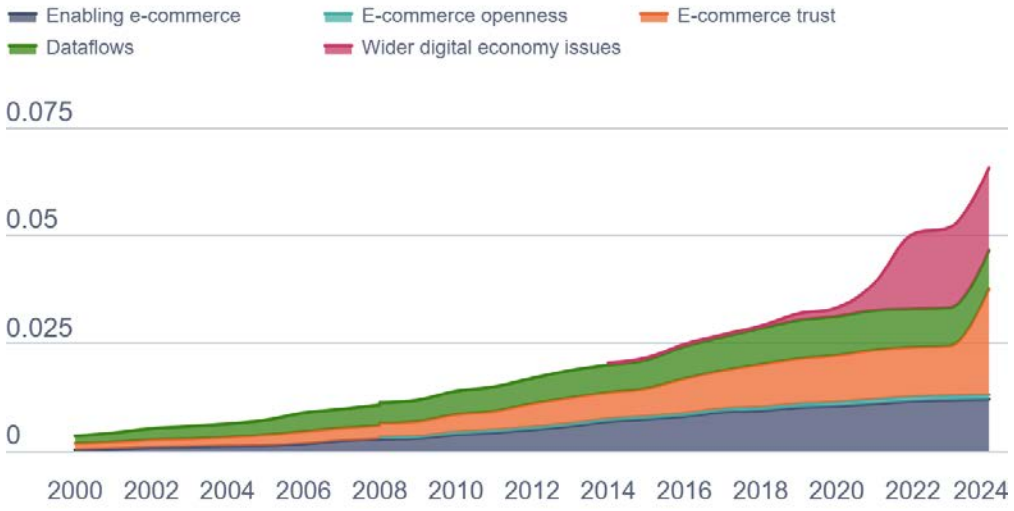
These discussions matter because they will improve the ability of businesses to deploy digital solutions and operate across different markets. Two messages emerge from tracking these discussions using the new OECD Index of Digital Trade Integration and Openness (INDIGO).

The first message is that digital trade integration and openness, whether in the context of trade or non-trade discussions, has been growing. In the area of trade (Figure 6.12a), most progress is on issues related to market openness, thanks to existing WTO instruments such as the E-commerce Moratorium, the Information Technology Agreement and the Telecoms Reference Paper. Progress in digital trade integration has also been steady, thanks to the introduction of digital trade provisions in trade agreements. From 2017 onwards, the enabling of e-commerce started to grow as countries continued to implement the Trade Facilitation Agreement. Since 2000, nearly half of new agreements have some sort of digital trade provision (López-Gonzalez, Sorescu and Kaynak, 2023[19]). Where international discussions on non-trade instruments are concerned (Figure 6.12b), there has been strong progress to recognise e-signatures and e-contracts through the adoption of United Nations Commission on International Trade Law (UNCITRAL) instruments which helped enable e-commerce. OECD Privacy Guidelines and the Asia Pacific Economic Co-operation Cross Border Privacy Rules (APEC CBPR) has helped build trust in e-commerce. There has also been great success in establishing the regulatory frameworks to allow data to flow freely but with trust, including through the Global Cross-Border Privacy Regulation, and the Council of Europe's Convention 108. Lastly, wider digital economy issues reflect recent instruments on competition, digital identity, base erosion and profit shifting (BEPS) in taxation, and artificial intelligence.

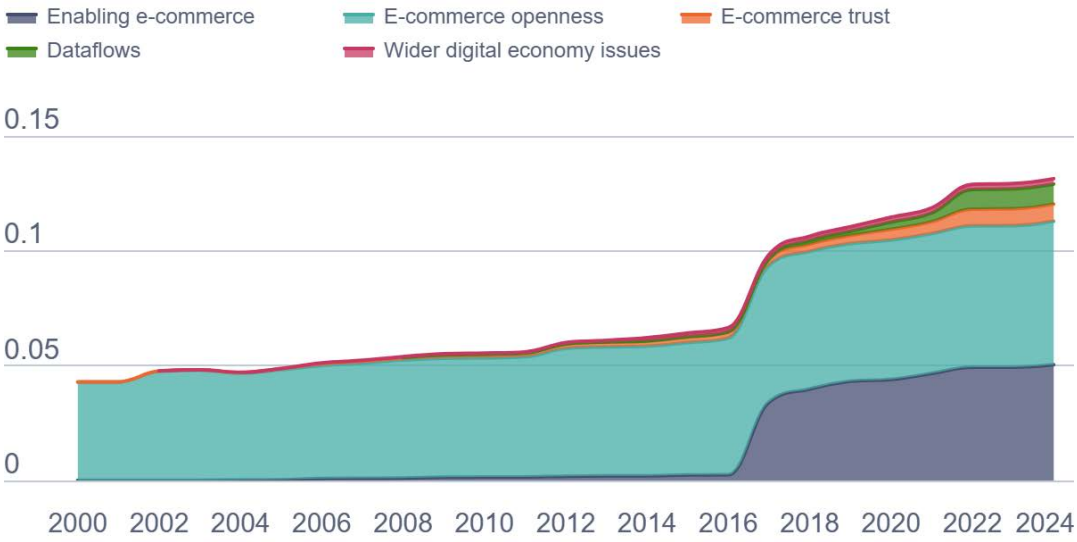
The second message is that there is still some way to go to fully integrate the global economy; despite the progress, fragmentation remains the norm rather than the exception. The indicators suggest that, taking into account all existing trade initiatives, global digital trade integration and openness is only 8% of the way towards what could be considered as full openness (an INDIGO of 1).

Figure 6.12. Digital trade integration and openness are increasing thanks to international regulatory co-operation

A. Trade instruments - Global INDIGO-t



B. Non-trade instruments - Global INDIGO-i



Note: The OECD Index of Digital Trade Integration and Openness (INDIGO) maps progress towards global digital trade integration and openness. An index of 0.1 highlights that the world is 10% of the way towards global digital trade integration and openness. Preliminary results are based on the existing framework and scoring, without prejudice to future changes arising from discussions in the run up to the finalisation of the OECD INDIGO. Enabling e-commerce: Including issues related to electronic transaction frameworks, electronic authentication and electronic signatures, electronic contracts, electronic invoicing, electronic payments, digitalising border processes and paperless trading. E-commerce openness: Including customs duties on electronic transmissions, as well as access to the internet, telecommunications, ICT goods and open government data. E-commerce trust: Including online consumer protection, unsolicited commercial electronic messages, personal data protection, source code, cryptography, and cybersecurity. Dataflows: refers to cross-border data flows and data localisation, including location of computing facilities. Wider digital economy issues: Including competition in the digital economy, digital inclusion, digital identities, artificial intelligence, taxation and FinTech.
Source: OECD calculations.

6.4. International co-operation, and co-ordination with the private sector bolster resilience

Supply chains that are “aligned” are supply chains where all partners have incentives to improve the performance of the entire chain. If we include governments among the stakeholders involved in international supply chains and their regulatory environment, aligning strategies among governments and between firms and governments is another important key to resilient supply chains (Figure 3.16).

International co-operation is fundamental for addressing the systemic nature of supply chain vulnerabilities and the cross-border nature of regulatory challenges. The first objective of such co-operation is to improve transparency and build confidence in supply and trust in global markets to avoid harmful policy choices, such as panic buying or hoarding by governments. The Agricultural Market Information System (AMIS) is a good example of an initiative that reduces market uncertainty and prevents harmful policies when there are disruptions in agriculture and food supply chains (Deconinck et al., 2023[21]). A second objective of international co-operation is to collectively set rules and co-ordinate and harmonise regulations to put in place the trade facilitation measures, pro-competitive rules for services supporting supply chains and the digital trade integration discussed in the previous sections. Such co-operation can be bilateral, regional or multilateral, through trade and investment agreements or through international fora. While levels of ambition may vary, what is important is the concerted policy alignment, continued dialogue and shared investment to promote resilience.

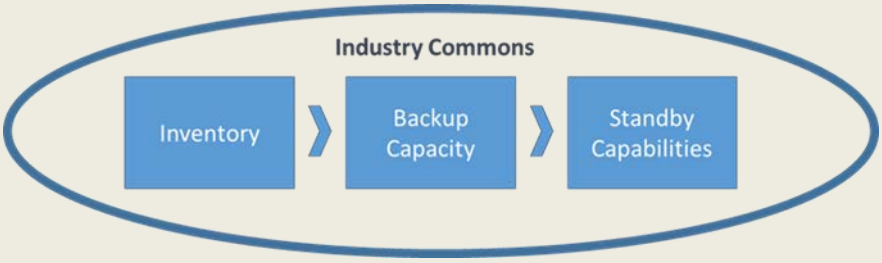
While regional trade agreements often cover policies that have been identified to create agility and adaptability, some specific agreements on supply chains have been recently introduced. For example, the Indo-Pacific Economic Framework (IPEF) for Prosperity Supply Chain Agreement (signed on 14 November 2023) presents an innovative approach to enhancing supply chain resilience at a regional level. Although not binding in terms of trade commitments, the agreement sets shared expectations for partners to: (1) identify and monitor supply chains for critical sectors and key goods; (2) improve co-ordination and response during crises; (3) strengthen supply chain logistics; (4) enhance the role of workers and boost workforce development; and (5) identify opportunities for technical assistance and capacity building. The agreement foresees the creation of an IPEF Supply Chain Council in charge of overseeing the development of action plans for specific critical sectors to help companies address bottlenecks in supply chains. Moreover, a Crisis Response Network will be established to provide an emergency communications channel for IPEF partners during supply chain disruptions. This new approach relies on the commitment and collaborative efforts of member countries to be operationalised.

However, one should keep in mind that it is firms that operate supply chains and that have direct control over sourcing strategies, inventory management and distribution networks. This is why co-ordination between governments and the private sector is key for building resilient supply chains. Public-private partnerships (PPPs) offer a structured mechanism to align the efforts of firms and governments. They can incentivise firms to invest in resilience (Hajarath and Vummadi, 2024[22]). Co-ordination with the private sector can also be about exchanging data and creating visibility and can also focus on strategies to enhance preparedness for unpredictable major crises (Box 6.3).

Box 6.3. Co-ordinating resilience via industrial commons and preparedness conferences

The creation of an "industrial commons" involving stakeholders from the government and private sector can be a useful tool to establish integrated forms of emergency preparedness (Sodhi and Tang, 2021[23]). This approach combines redundancy and flexibility to address supply chain disruptions effectively (Figure 6.13). The first layer in the strategy consists of agreeing on levels of inventories that allow for the absorption of small fluctuations in demand. These stockpiles can also ensure supply at the beginning of an emergency before activating the second and third layers. For the second layer (major crises), firms and the government have organised in advance some backup capacity with an agreement on who will deploy the additional capacity. The third layer is for extreme crises where inventories and backup capacity are not enough to meet peak emergency demand. These unforeseen needs have to be met by standby capabilities, including upfront agreements on the reconversion of manufacturing facilities and the creation of additional capacity (with investments and funding arrangements already in place). This approach requires assembling members, mechanisms and protocols in advance and maintaining them through regular rehearsals to ensure readiness.

Figure 6.13. An industrial commons involves three components



To facilitate the creation of an industrial commons – and more generally to integrate independent decision making and align interests between firms and governments – "preparedness conferences" can be convened involving public-private stakeholders. These conferences would allow firms and governments to exchange information and co-ordinate their respective risk management strategies. They would also involve the collaborative design of playbook templates for specific crisis scenarios where participants would describe their preparedness in terms of human resources, knowledge management, process management, resources and community (the five components of preparedness). The preparedness conferences could also be used to stress-test the industrial commons through regular reviews to update and rehearse the plan for specific emergencies

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Notes

[1] Examples include: Australia bill banning imports made using forced labour (2021); US Customs and Border Protection Forced Labour Trade Law (2022); Canada BILL S-211 enacting the Fighting Against Forced Labour and Child Labour in Supply Chains Act (2023); Mexico Forced Labour Law (2023); EU ban on products made with forced labour (2024); UK Environment Act; EU Deforestation regulation (2023); EU Carbon Border Adjustment Mechanism (2023).

[2] Scope 3 emissions are the result of activities from assets not owned or controlled by the reporting entity, but that the entity indirectly affects in its value chain (both its upstream and downstream activities).

[3] The OECD Services Trade Restrictiveness Index (STRI) is an evidence-based tool that offers an overview of regulatory barriers across 22 major sectors and 51 countries. Updated annually, the STRI also monitors recent regulatory trends, facilitates benchmarking of services policies against global best practices, and enables analysis of the impact of reform options. For more information, see https://www.oecd.org/en/topics/services-trade-restrictiveness-index.html.

[4] This is despite 80 countries taking part in the Information Technology Agreement.

[5] This was the subject of a new initiative to improve supply chain data flow (American Presidency Project, 2022[24]).

[6] See Del Giovane, Ferencz and López González (2023[25]) for a discussion of issues around data localisation in cloud computing.

7 Policies can balance sustainability, efficiency and resilience

The previous chapter has listed specific policy actions and areas that can underpin resilient supply chains. This chapter takes a more strategic overview, exploring how policy design needs to balance sustainability, efficiency and resilience, while dealing with trade-offs among them.

In addition to the specific policies outlined in the previous chapter, in order to promote agile, adaptable and aligned supply chains, policy design must account for the interplay between resilience and other objectives, including sustainability and efficiency. Policymakers may face the challenge of aligning these objectives in ways that foster long-term economic stability and sustainable development while ensuring the capacity to withstand disruptions. While it is possible to achieve synergies across these dimensions, trade-offs are also inherently involved. This chapter examines these issues through a policy lens.

7.1. Synergies between resilience, efficiency and sustainability can be captured

From the perspective of governments regulating supply chains, many policies not only strengthen the capacity to withstand disruptions, but also contribute to sustainability and efficiency. For example, investments in renewable energy infrastructure enhance energy security while reducing carbon footprints. Similarly, promoting circular economy practices—such as recycling, resource efficiency, and waste reduction—bolsters both resilience to resource supply shocks and achieves sustainability objectives.

Efforts to implement circular economy practices are particularly illustrative of these synergies. For instance, industries that prioritise the reuse of materials reduce their dependence on virgin resource inputs, thereby decreasing exposure to supply chain disruptions. At the same time, such efforts lower waste and pollution, contributing directly to sustainability. Furthermore, the adoption of energy-efficient technologies—such as smart grids or decentralised renewable energy systems—enhances both the reliability of energy supplies and environmental outcomes. Firms that build resilience through dynamic capabilities such as flexibility, agility and visibility in their supply chains are often better positioned to enhance efficiency as well (Sheffi, 2015[1]). Moreover, efforts to mitigate sustainability risks through responsible business conduct (RBC) and due diligence generally benefit firms' sustainability performance and resilience (OECD, 2021[2]).

7.2. Trade-offs need to be addressed when balancing objectives

Despite these synergies, achieving a balance between resilience, efficiency and sustainability often involves trade-offs (Ivanov, 2017[3]; Rajesh, 2021[4]). Firms designing resilient supply chains must weigh the costs of redundancy against efficiency and environmental considerations. For instance, maintaining buffer stocks, diversifying suppliers, or investing in additional production capacity increases costs and resource use. These measures, while essential for resilience, can contradict sustainability goals by generating waste and depleting resources. Policymakers also face several goals that are difficult to tackle together when they promote security of supply, incentivise firms to adopt cleaner production processes and develop a policy environment that maintains competitive neutrality (OECD, 2023[5]).

The trade-offs become even more apparent in industries with high resource intensity. For example, adding redundancy in production facilities to ensure resilience may lead to increased energy consumption and emissions, conflicting with climate targets. Similarly, maintaining extensive inventories for risk mitigation can lead to resource inefficiencies, including overproduction and waste. These challenges underscore the need for policies that optimise the balance among these objectives rather than pursuing them in isolation.

Fortunately, such trade-offs can be mitigated. As noted, dynamic capabilities enable firms to reduce costs and resource use while enhancing resilience. Strategies such as flexibility within the production processes, improved supply chain visibility, and co-operative relationships with suppliers allow firms to adapt quickly to disruptions without over-reliance on resource-intensive measures. Moreover, advances in technology can play a pivotal role in reducing these trade-offs. Digital tools such as predictive analytics and blockchain enhance supply chain visibility and transparency. This enables firms to identify vulnerabilities and implement targeted measures that strengthen resilience without significantly increasing resource use or costs. Additionally, the use of renewable energy in operations and transportation can offset the environmental impacts of redundancy, aligning sustainability with resilience.

7.3. Targeting sustainability requires protecting resilience and efficiency

When sustainability is the primary objective, policies can be designed to safeguard resilience and efficiency. Synergies and trade-offs between these goals should inform governance strategies aimed at improving sustainability in supply chains. Section 4.2.1 has highlighted how supply chain sustainability laws can put pressures on economic actors, potentially leading to inefficiencies and disruptions in trade relationships. Without empirical analysis on the effects of these new regulatory developments at this juncture, providing robust and detailed evidence-based policy advice is not an easy task. However, two general principles can guide policymakers aiming to minimise unintended negative impacts of supply chain sustainability laws on efficiency and resilience: (1) least possible distortionary policy design and implementation; and (2) international co-ordination and co-operation.

7.3.1. Aim for the least possible distortionary policy design and implementation

Supply chain sustainability laws should minimise distortions to ensure trade continues to flow and deliver economic benefits with proven spillovers for sustainability objectives. To this end, governments can:

- Enact trade facilitation measures to minimise the costs of implementing sustainable practices, especially for micro, small and medium-sized enterprises (SMEs).
- Minimise certification costs for supply chain actors required to comply with sustainability standards, including by providing clear guidance to avoid uncertainty over how compliance should be verified.
- Promote stakeholder participation in the development and implementation of these policies.
- Assess periodically the adequacy and effectiveness of implementation mechanisms.
- Exploit synergies with other policies, instruments and initiatives in the broader ecosystem for sustainability governance (Section 4.2.2), allowing the development of policy mixes where every objective is tackled with the most effective and least distortionary tool.

7.3.2. Pursue international co-ordination and co-operation

Governments designing and implementing supply chain sustainability laws can foster international co-ordination and co-operation at every stage. Policymakers can consider several best practices, for example:

- Align sustainability requirements in supply chain sustainability laws with international standards.
- Base guidelines for companies on responsible business conduct and due diligence on existing international standards, such as the OECD Guidelines for Multinational Enterprises on Responsible Business Conduct (OECD, 2023[6]), the related OECD Due Diligence Guidance (OECD, 2018[7]) and the OECD Recommendation on the Role of Government in Promoting Responsible Business Conduct (OECD, 2022[8]).
- In the context of policy mixes where sustainability initiatives can be used as a form of proof of compliance with sustainability requirements in supply chain sustainability laws, design methods to assess and recognise credible initiatives building upon existing tools such as the OECD Methodology for Alignment Assessment of Sustainability Initiatives (OECD, 2024[9]).
- Promote harmonisation, mutual recognition and general co-operation on supply chains sustainability laws through multilateral fora such as the OECD or other forms of international regulatory co-operation.

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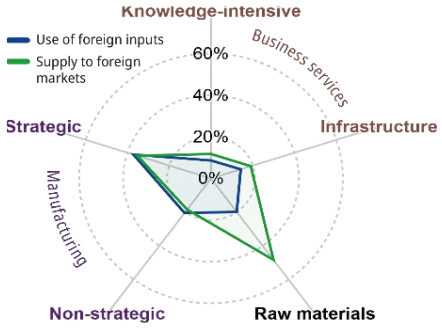
Annex A. A guide to using the country by country data

The country profiles in this annex complement the *OECD Supply Chain Resilience Review* and build on data and analysis carried out under the OECD Trade Committee to give a unique country specific perspective. The section on *Monitoring supply chain interdependencies* gives a snapshot of a country's integration into global supply chains by looking at global linkages of key industries while also presenting how the significance of import and export concentration has evolved over time. The section on *Agile, adaptable and aligned supply chains* showcases a set of OECD indicators to assess the transparency and ease of border processes, the level of regulatory barriers to services and digital trade, as well as the overall level of international integration and alignment with best practices. Together, these insights aim to guide governments and the private sector in creating an enabling environment for the agility, adaptability and alignment of their supply chains.

Monitoring supply chain interdependencies

Global linkages of key industries

This figure illustrates key industries' reliance on: (i) inputs imported from abroad through the percentage share of an industry's use of foreign inputs (blue line); and (ii) output exported to foreign markets through the percentage share of an industry's output that is supplied to foreign markets (green line).



The key industries are as follows:

- Raw materials refer to agriculture and mining.
- Strategic (defined in terms of potential importance for national and economic security) and non-strategic industries manufacturing sector.
- Infrastructure (such as transport and retail) and knowledge-intensive business services (such as corporate, scientific or IT services).

See Table A A.1 for more details.

How to interpret the chart: The blue line shows the percentage use of foreign inputs. The nearer the blue line is to the centre of the chart (0%), the smaller the share of the industry's use of foreign inputs. The

green line shows supply to foreign markets. The nearer the green line is to the centre of the chart (0%), the smaller the share of the industry's output that is supplied to foreign markets. For more context around this indicator, see Chapter 2 of the *OECD Supply Chain Resilience Review*.

Data sources and variables construction

The figure presents two indicators of exposure to foreign production. Use of foreign inputs (blue line) is based on foreign product exposure for imports (FPEM) and supply to foreign markets (green line) is based on foreign product exposure for exports (FPEX) (Baldwin, Freeman and Theodorakopoulos, 2022[1]). It can be interpreted as the percentage of a country's sector that could be exposed to foreign disruptions, both upstream (FPEM) and downstream (FPEX). These indicators are on gross trade terms and account for direct linkages (i.e. the supplier of an input) and indirect linkages (i.e. the supplier's supplier). Calculations are based on the 2023 vintage of OECD's Inter-Country Input-Output (ICIO) tables.

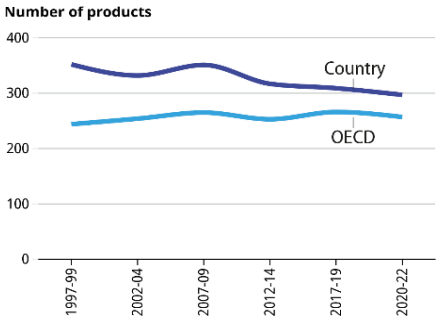
The table below shows the industries within each category of key industries. This categorisation builds on the International Standard Industrial Classification of all economic activities (ISIC) revision 4. The split of business services draws from the digital intensity taxonomy of industries developed by the OECD (see Calvino et al. (2018[2]). The manufacturing sector is split into two aggregates: strategic and non-strategic industries, following the definition in IMF's *World Economic Outlook*, online annex to Chapter 4 (International Monetary Fund, 2023[3]).

Table A A.1. Industries covered in the global linkages indicator

Category	Industry code (ISIC Rev. 4)	Industry description
Raw materials	A (01 to 03)	Agriculture
	B (05 to 09)	Mining
Manufacturing, non-strategic	C10 to 18	Food, textiles, wood and printing
	C 22	Rubber and plastics
	C 24 to 25	Basic and fabricated metals
	C 27	Electrical equipment
	C 31 to 33	Other manufacturing
Manufacturing, strategic	C 19 to 21	Petroleum and chemicals
	C 23	Other non-metallic mineral products
	C 26	Computers and electronics
	C 28 to 30	Machinery and transport equipment
Services, infrastructure	G (45 to 47)	Wholesale and retail trade
	H (49 to 53)	Transport
	I	Accommodation and food
	J 58 to 61	Publishing and telecommunications
Services, knowledge-intensive	J 62 to 63	IT and other information services
	K	Finance and insurance
	L	Real estate
	M	Professional, scientific and technical activities
	N	Administrative and support services

Significantly concentrated imports

This figure illustrates the evolution of the number of products that have significant import concentration, i.e. where a country imports a certain product from fewer than half of the globally available suppliers, in a market where supply is already concentrated, in the period 1997-2022.



How to interpret the chart: The dark blue line shows the country's values, the light blue line represents the OECD average. The y-axis shows the number of products that have significant import concentration. The higher the line is plotted, the greater the number of products imported featuring significant import concentration. For more context around this indicator, see Chapter 3 of the *OECD Supply Chain Resilience Review*.

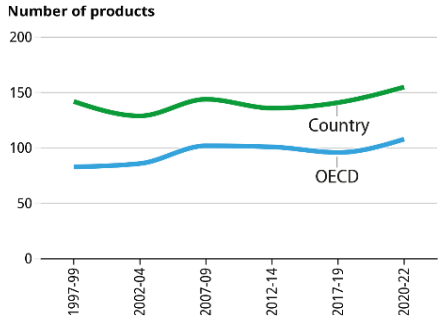
Data sources and variables construction

Significant import concentration is defined as cases of bilateral trade links at the product level where the value of the country-level Herfindahl-Hirschman Index of concentration (HHI) for imports is more than double the value of the corresponding HHI for global exports. The concentration indices are calculated across all trading partners, including, intra-EU trade.

To further constrain the spectrum of cases of significant concentration, an additional minimum cut-off value of the HHI calculated for global product-level exports was set at 0.2, as current OECD work uses HHI value of 0.2 to indicate relatively high concentration (see Section 3.3 of the report). This means that only products with a global exports HHI of at least 0.2 and products with country-level imports HHI of at least 0.4 were considered.

Significantly concentrated exports

This figure illustrates the evolution of the number of products that have significant export concentration, i.e. where a country exports a certain product to fewer than half of the globally available markets, in a market where demand is already concentrated, in the period 1997- 2022.



How to interpret the chart: The green line shows the country's values, the light blue line represents the OECD average. The y-axis shows the number of products that have significant export concentration. The higher the line is plotted, the greater the number of products exported featuring significant export concentration. For more context around this indicator, see Chapter 3 of the *OECD Supply Chain Resilience Review*.

Data sources and variables construction

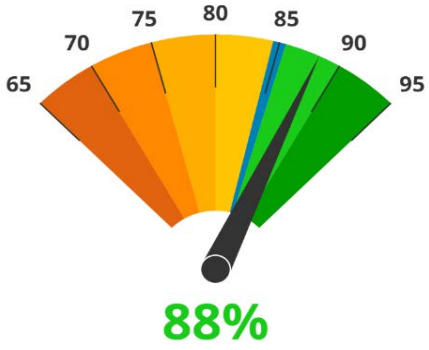
Significant export concentration is defined as cases of bilateral trade links at the product level where the value of the country-level Herfindahl-Hirschman Index of concentration (HHI) for exports is more than double the value of the corresponding HHI for global imports. The concentration indices are calculated across all trading partners, including intra-EU trade.

To further constrain the spectrum of cases of significant concentration, an additional minimum cut-off value of the HHI calculated for global product-level imports was set at 0.2, as current OECD work uses HHI value of 0.2 to indicate relatively high concentration (see Section 3.3 of the report). This means that only products with a global imports HHI of at least 0.2 and products with country-level exports HHI of at least 0.4 were considered.

Agile, adaptable and aligned supply chains

Transparency of regulations

This figure indicates overarching levels of transparency in regulatory approaches affecting trade in goods and services that enable global value chains (GVCs). Regulatory transparency allows firms to foresee and adjust to changes in regulations, thereby enhancing the agility and adaptability of their supply chain.



How to interpret the chart: The closer the needle is to the right of the gauge, the more aligned a country's legislative approaches are with international best practices on regulatory transparency. The light blue stripe on the gauge represents the OECD average. The range of the gauge represents the maximum and minimum of the OECD sample. For more context around this indicator, see Chapter 6 of the *OECD Supply Chain Resilience Review*.

Data sources and variables construction

This indicator synthesizes qualitative information reported in the OECD's 2024 Trade Facilitation Indicators (TFI) in the policy area of "information availability" and the OECD's 2024 Services Trade Restrictiveness Index (STRI) in the policy area of "regulatory transparency".

The TFI "information availability" policy area reflects the level and type of information available for border processes of goods, including publication of customs and trade-related regulations and information, feedback mechanisms, and specific functions for businesses (dedicated webpages/portals, user manuals, etc.).

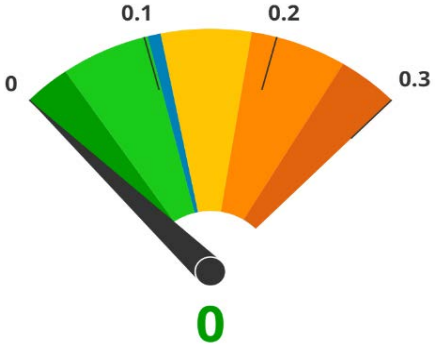
The STRI "regulatory transparency" policy area covers, among others, obligations to communicate regulations to the public prior to entry into force, the existence of adequate stakeholder consultation for legislative initiatives, and transparency on licensing conditions and procedures.

Data from the STRI are limited to those sectors that are classified as "GVC-enabling" services: transport services (air, maritime, rail freight and road freight), logistics services, postal services, courier services, distribution services; and telecommunications services.

This cohesive indicator of regulatory transparency for GVCs was calculated as follows. The score of the policy areas were standardised, so that the score is shown as a percentage of the maximum attainable score. Then they were combined by taking the average of the two, i.e. Transparency of regulations = ((% of TFI's "information availability" attained) + (% of STRI's "regulatory transparency" attained))/2.

Barriers to digital services trade

This figure indicates regulatory barriers that inhibit firms' ability to supply services using electronic networks, regardless of the sector in which they operate.



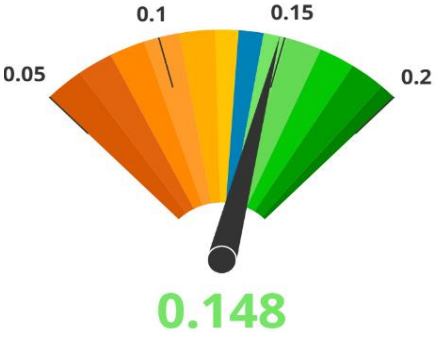
How to interpret the chart: The closer the needle is to the right of the gauge, the less open the regulatory environment is for digitally enabled trade. 0 indicates an open regulatory environment for digitally enabled trade. The light blue stripe on the gauge represents the OECD average. The range of the gauge represents the maximum and minimum of the OECD sample. For more context around this indicator, see Chapter 6 of the *OECD Supply Chain Resilience Review*.

Data sources and variables construction

Country results are based on the OECD's 2024 Digital Services Trade Restrictiveness Index (DSTRI). The DSTRI is a composite index that includes five categories of measures: 1) infrastructure and connectivity; 2) electronic transactions; 3) e-payment systems; 4) intellectual property rights; and 5) other barriers to trade in digitally enabled services. The information evaluated under each of these categories can be found at http://oe.cd/dstri.

Digital trade integration and openness

This figure indicates a measure of evolving international discussions and commitments on issues that matter for digital trade.



How to interpret the chart: The closer the needle is to the right of the gauge, the more open and integrated the county's digital trade environment. The light blue stripe on the gauge represents the OECD average. The range of the gauge represents the maximum and minimum of the OECD sample. For more context around this indicator, see Chapter 6 of the *OECD Supply Chain Resilience Review*.

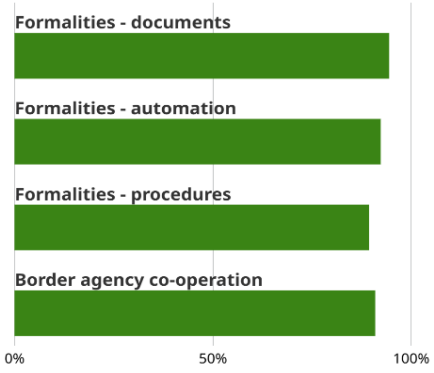
Data sources and variables construction

The OECD's 2024 Index of Digital Trade Integration and Openness (INDIGO) index distinguishes between two dimensions: (i) INDIGO-i tracks non-trade-related international instruments, including agreements on privacy, cybersecurity, and AI governance; and (ii) INDIGO-t focuses on trade-related instruments, including commitments in WTO agreements, regional trade agreements, and dedicated digital economy agreements.

The data in the figures are drawn from INDIGO-t. It ranges from zero – no international commitments – to one – commitments across all areas covered and with all partners. It can be thought of as a measure of distance towards full trade commitments on issues that matter for digital trade.

Ease of border processes

This figure shows the level of streamlining and simplification of technical and legal procedures for goods at the border, allowing for more agile supply chains. This is assessed through four policy areas from OECD's Trade Facilitation Indicators (TFI) to reflect the extent to which countries have introduced and implemented trade facilitation measures.



How to interpret the chart: The green bar shows the level of streamlining and simplification, as a percentage, in the four policy areas. The closer the bar is to 100%, the closer the country is at operating at par with best trade facilitation performance. For more context around this indicator, see Chapter 6 of the *OECD Supply Chain Resilience Review*.

Data sources and variables construction

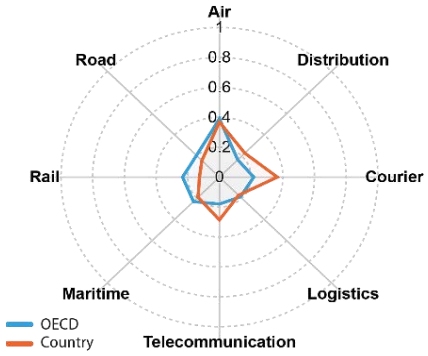
The data are drawn from the OECD's 2024 Trade Facilitation Indicators (TFIs), which follow closely the structure of the policy areas covered by the WTO Trade Facilitation Agreement.

The TFIs used here to illustrate the ease of border processes cover four policy areas: formalities in documents, automation and procedures, and border agency co-operation. Formalities-documents (TFI-F) refers to the harmonisation and simplification of trade-related documents, in accordance with international standards; formalities – automation (TFI-G) refers to aspects such as the electronic exchange of data and use of automated risk management; formalities–procedures (TFI-H) includes aspects such as the streamlining of border controls (inspections, clearance), implementation of trade single windows, or certified trader programmes; border agency co-operation is the simple average of internal (TFI-I) and external (TFI-J) border agency co-operation and refers to the institutional frameworks, mechanisms, and IT systems for co-operation between domestic and cross-border agencies.

The indicators are depicted as a percentage of the top TFI score (2) for each area. The information evaluated under each of these areas can be found here: oe.cd/sim-tfi.

Barriers to trade in GVC-enabling services

This figure illustrates the level of regulatory restrictiveness in a country for global value chain (GVC) enabling services (e.g. logistics services, transport, courier, telecommunications, etc.). The higher the restrictions are, the more costly it is for foreign firms to access these services.



How to interpret the chart: The orange line shows the country's level of restrictiveness in each GVC-enabling services sector. The light blue line represents the OECD average. The nearer the lines are to the centre of the chart (0), the less restrictive the regulatory environment for GVC-enabling services is. For more context around this indicator, see Chapter 6 of the *OECD Supply Chain Resilience Review*.

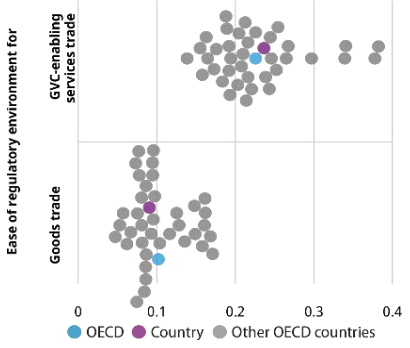
Data sources and variables construction

The data is drawn from the OECD's 2024 Services Trade Restrictiveness Index (STRI) covering eight services sectors that play a key role in connecting global supply chains, namely: transport services (air, maritime, rail freight and road freight), logistics services, postal and courier services, distribution services and telecommunications services.

The indices take values between zero and one, with one indicating the most restrictive regulatory environment for services trade. The information evaluated under each of these sectors can be found at https://sim.oecd.org/.

Regulatory alignment

This figure illustrates the disparities in the ease of the regulatory environment for goods trade and to GVC-enabling services trade across OECD Member countries.



How to interpret the chart: The chart shows where the country (purple dot) lies compared to other OECD countries (grey dots) and the OECD average (light blue dot), therefore showing the level of regulatory alignment on trade facilitation and policies impacting GVC-enabling services. The lower the value (the further left the dot is), the more aligned the country's regulatory environment is to international best practice. The vertical spread of the dots indicates other OECD Member countries that are at the same level of the indices. For more context around this indicator, see Chapter 6 of the *OECD Supply Chain Resilience Review*.

Data sources and variables construction

The OECD's 2024 Services Trade Restrictiveness Index (STRI) of GVC-enabling services takes values between zero and one, with one indicating the most restrictive regulatory environment for services trade.

Ease of GVC-enabling services trade regulations is depicted by the simple average of the sectoral STRIs for GVC-enabling services (transport services (air, maritime, rail freight and road freight), logistics services, postal and courier services, distribution services and telecommunications services).

Ease of goods trade is depicted by the OECD's 2024 Trade Facilitation Indicator (TFI). The TFI takes a value between zero and 22, with 22 indicating the best trade facilitation performance overall.

To enable comparison between the STRI and TFI, the TFI was transformed as follows: (([Country score] - 22)/22)*(-1). This results in a value between zero and one, with one indicating the least facilitating environment for goods trade.

References

Baldwin, R., R. Freeman and A. Theodorakopoulos (2022), *Horses for Courses: Measuring Foreign Supply Chain Exposure*, National Bureau of Economic Research, Cambridge, MA, https://doi.org/10.3386/w30525. [1]

Calvino, F. et al. (2018), "A taxonomy of digital intensive sectors", *OECD Science, Technology and Industry Working Papers*, No. 2018/14, OECD Publishing, Paris, https://doi.org/10.1787/f404736a-en. [2]

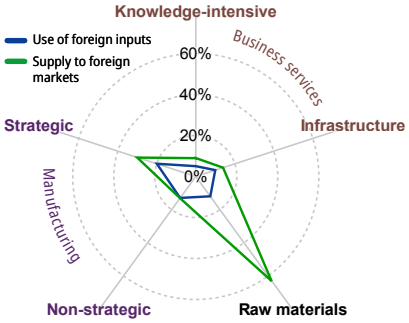
International Monetary Fund (2023), *World Economic Outlook*, IMF, Washington, D.C., https://www.imf.org/-/media/Files/Publications/WEO/2023/April/English/ch4annex.ashx. [3]

Annex B. Country by country data

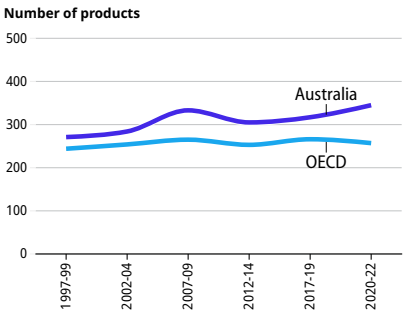
Australia

Monitoring supply chain interdependencies

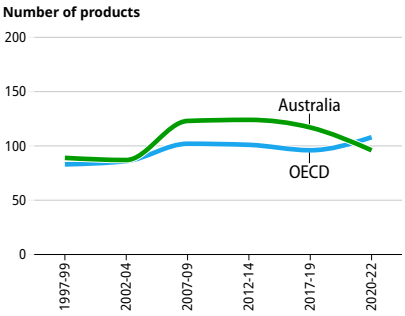
Global linkages of key industries



Significantly concentrated imports

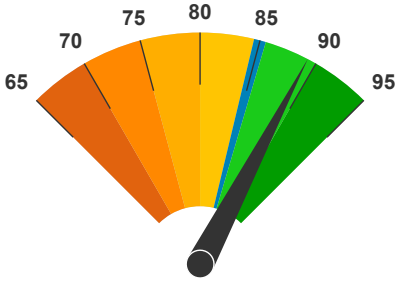


Significantly concentrated exports



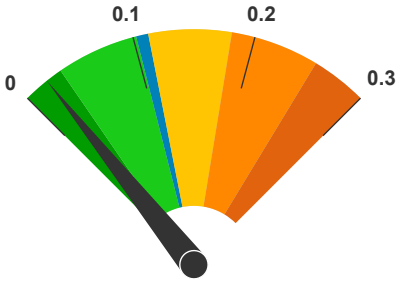
Agile, adaptable and aligned supply chains

Transparency of regulations



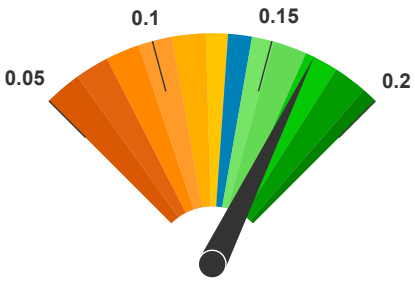
89%

Barriers to digital services trade



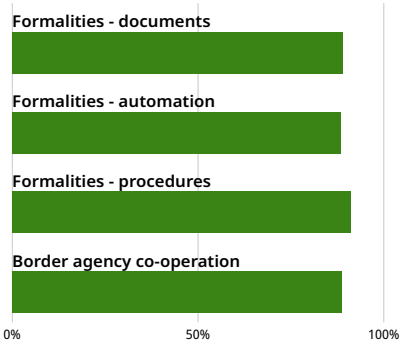
0.02

Digital trade integration & openness

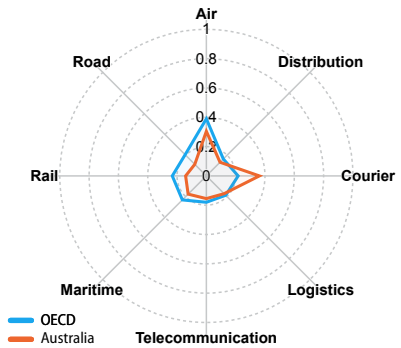


0.169

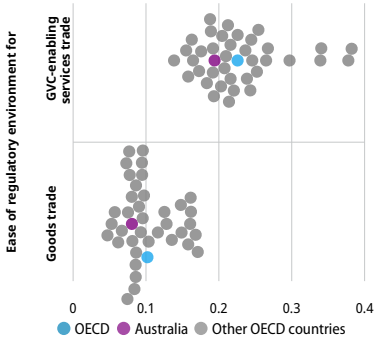
Ease of border processes



Barriers to trade in GVC-enabling services



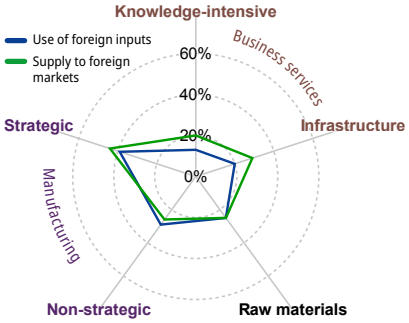
Regulatory alignment



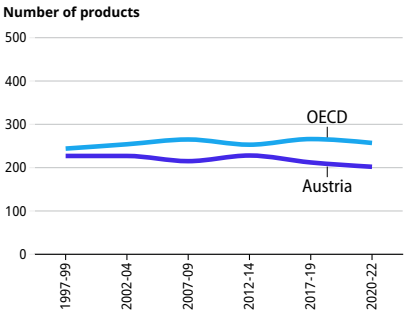
Austria

Monitoring supply chain interdependencies

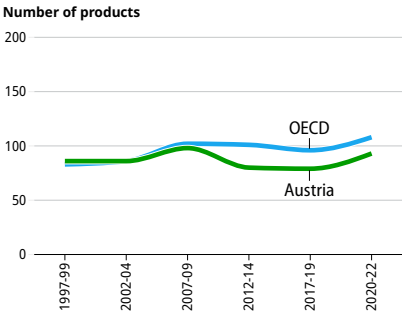
Global linkages of key industries



Significantly concentrated imports

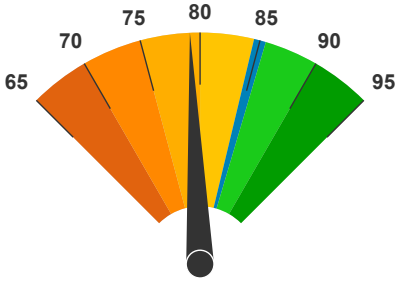


Significantly concentrated exports



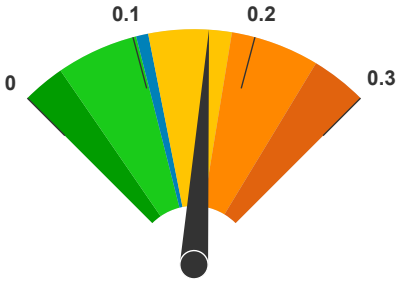
Agile, adaptable and aligned supply chains

Transparency of regulations



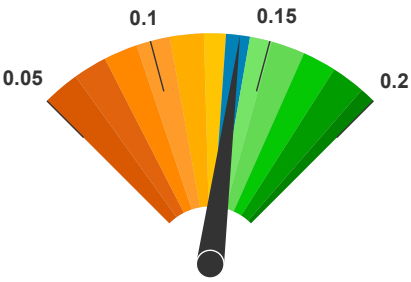
79%

Barriers to digital services trade



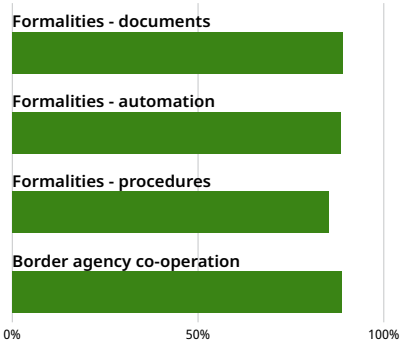
0.16

Digital trade integration & openness

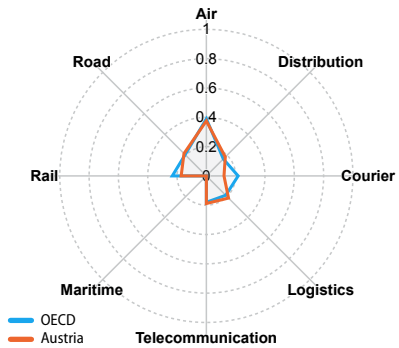


0.137

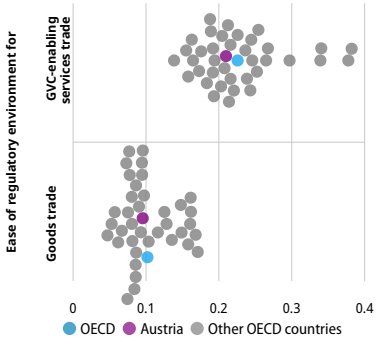
Ease of border processes



Barriers to trade in GVC-enabling services



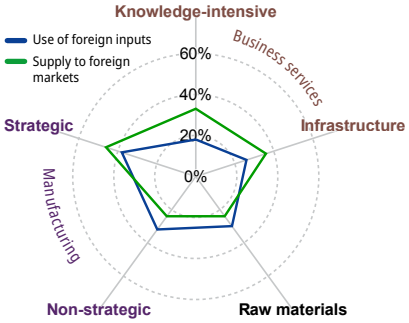
Regulatory alignment



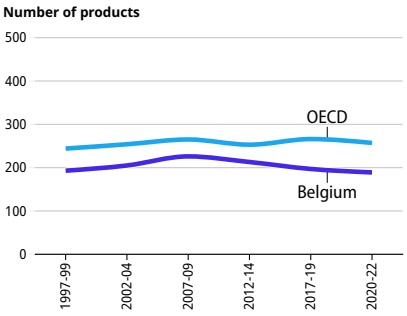
Belgium

Monitoring supply chain interdependencies

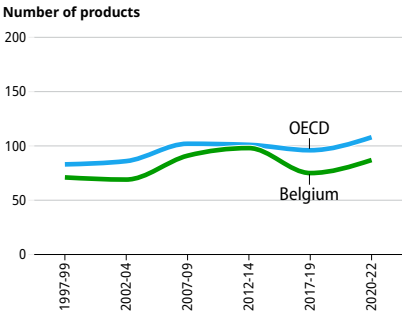
Global linkages of key industries



Significantly concentrated imports

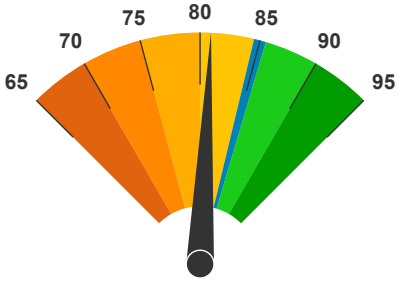


Significantly concentrated exports



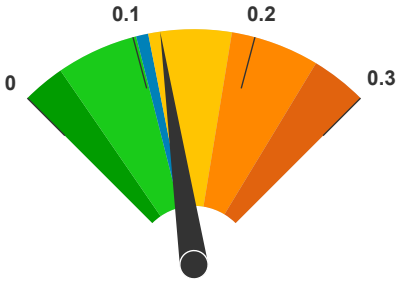
Agile, adaptable and aligned supply chains

Transparency of regulations



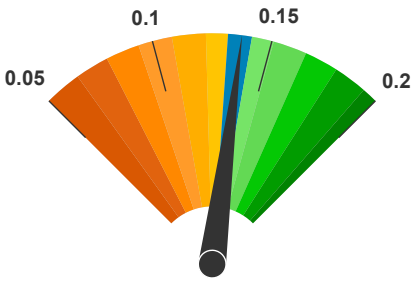
81%

Barriers to digital services trade



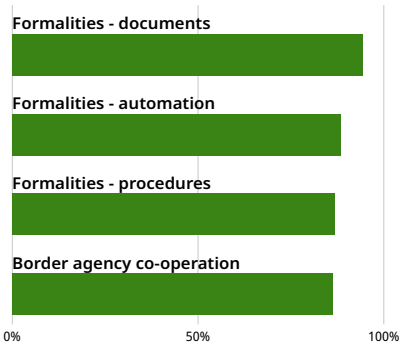
0.12

Digital trade integration & openness

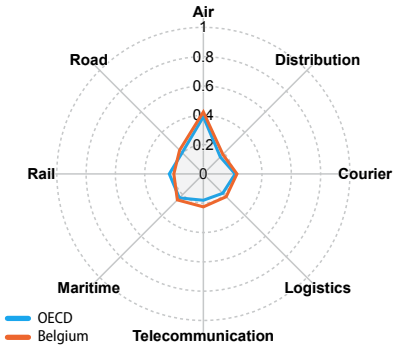


0.137

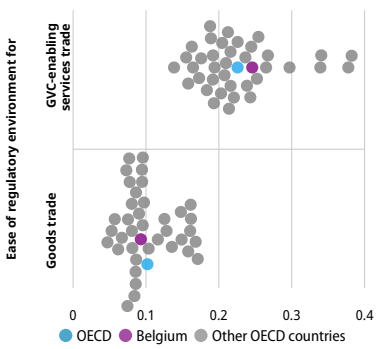
Ease of border processes



Barriers to trade in GVC-enabling services



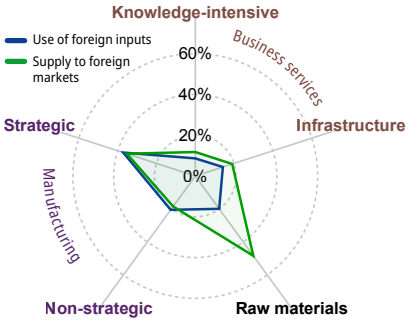
Regulatory alignment



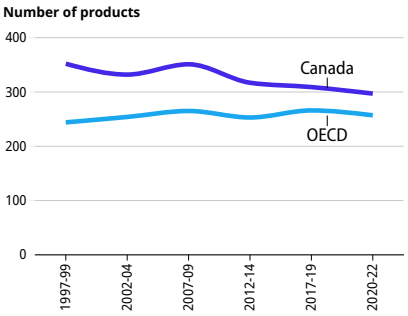
Canada

Monitoring supply chain interdependencies

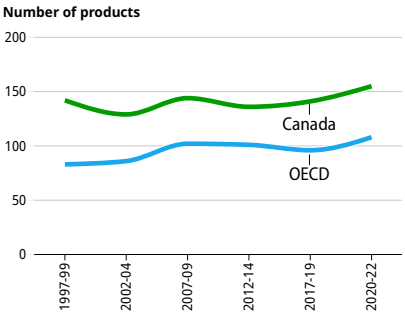
Global linkages of key industries



Significantly concentrated imports

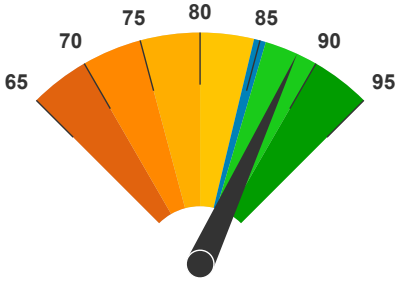


Significantly concentrated exports



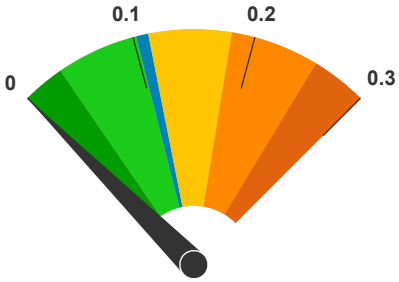
Agile, adaptable and aligned supply chains

Transparency of regulations



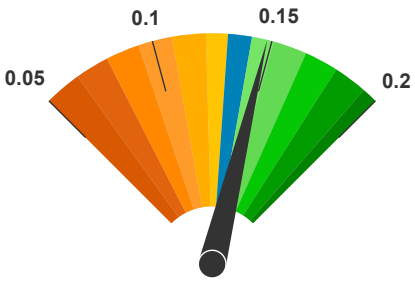
88%

Barriers to digital services trade



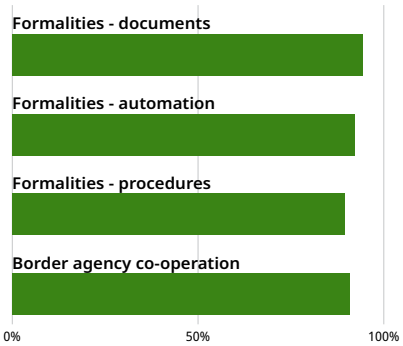
0

Digital trade integration & openness

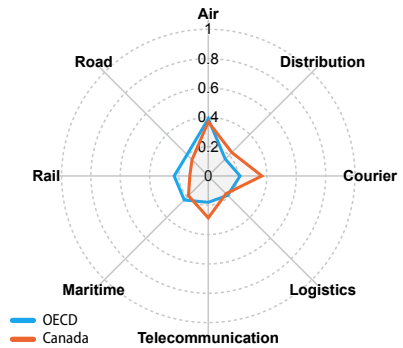


0.148

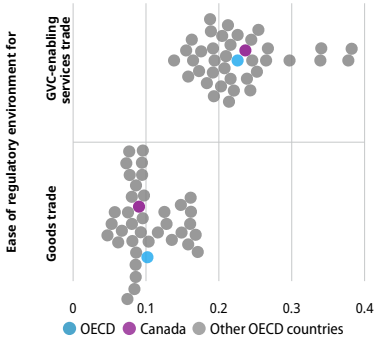
Ease of border processes



Barriers to trade in GVC-enabling services



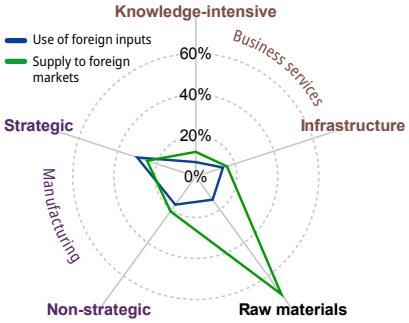
Regulatory alignment



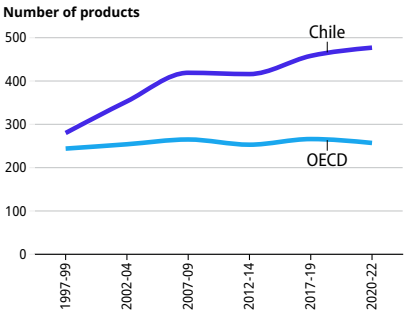
Chile

Monitoring supply chain interdependencies

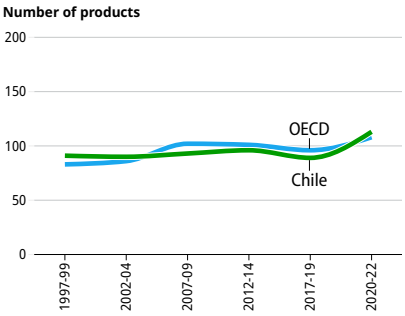
Global linkages of key industries



Significantly concentrated imports

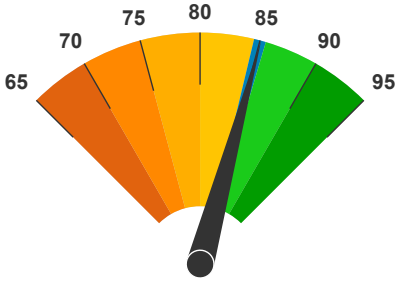


Significantly concentrated exports



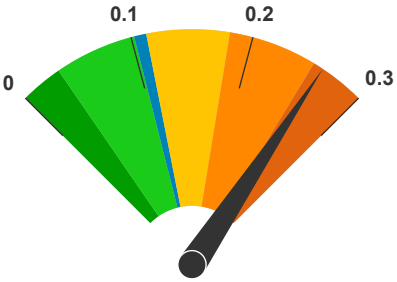
Agile, adaptable and aligned supply chains

Transparency of regulations



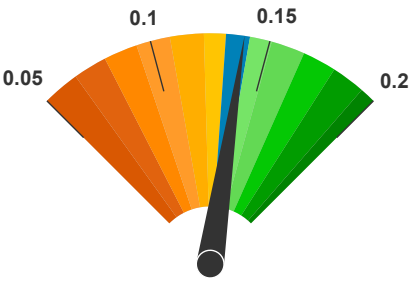
85%

Barriers to digital services trade



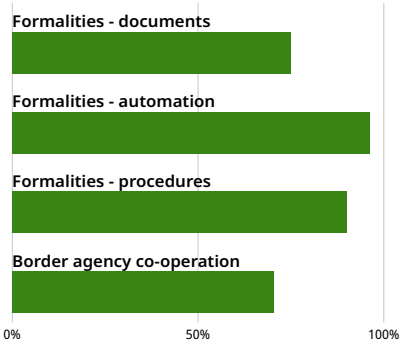
0.26

Digital trade integration & openness

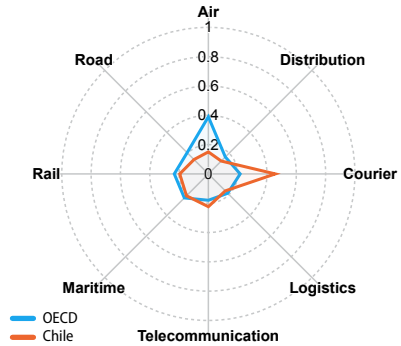


0.139

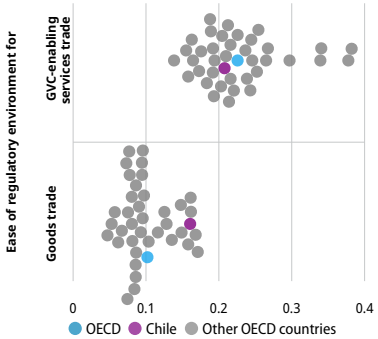
Ease of border processes



Barriers to trade in GVC-enabling services



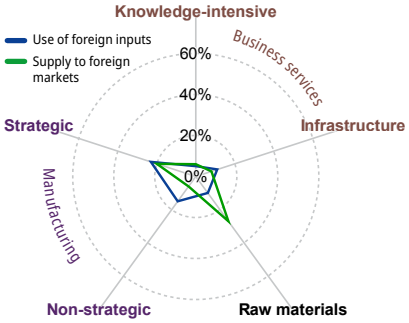
Regulatory alignment



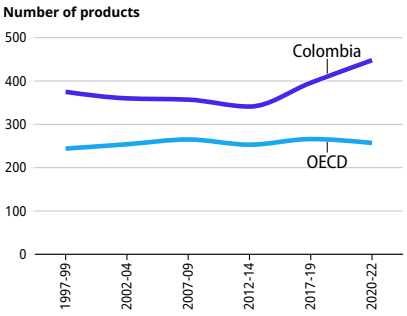
Colombia

Monitoring supply chain interdependencies

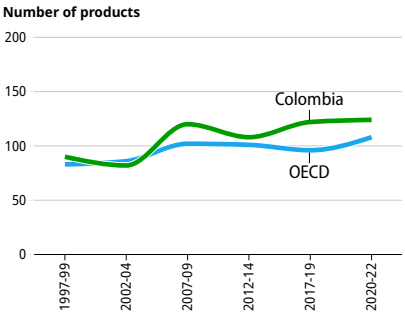
Global linkages of key industries



Significantly concentrated imports

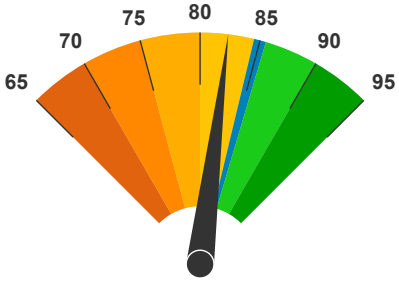


Significantly concentrated exports



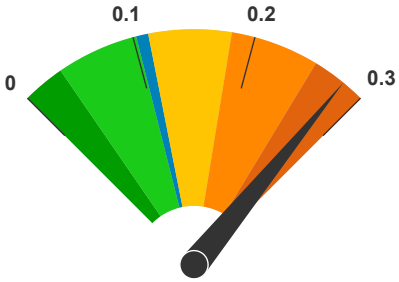
Agile, adaptable and aligned supply chains

Transparency of regulations



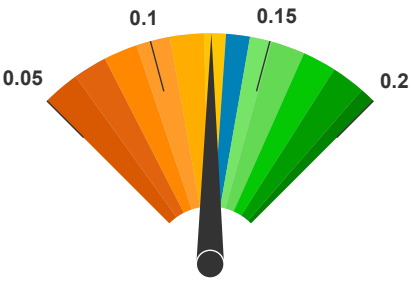
82%

Barriers to digital services trade



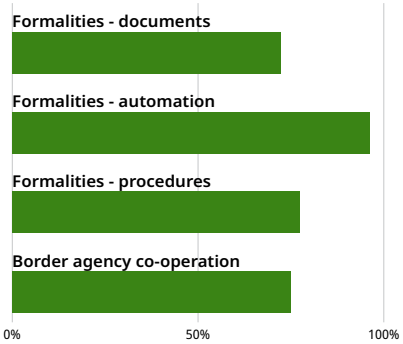
0.28

Digital trade integration & openness

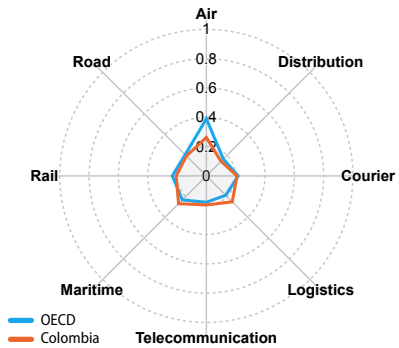


0.126

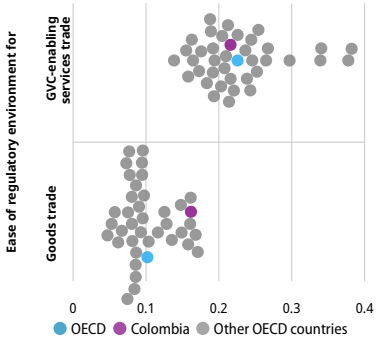
Ease of border processes



Barriers to trade in GVC-enabling services



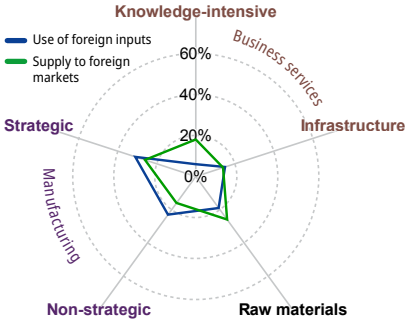
Regulatory alignment



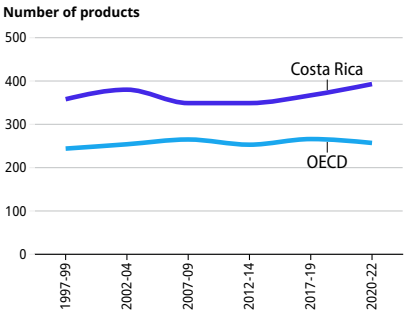
Costa Rica

Monitoring supply chain interdependencies

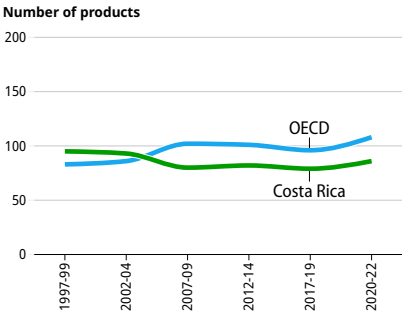
Global linkages of key industries



Significantly concentrated imports

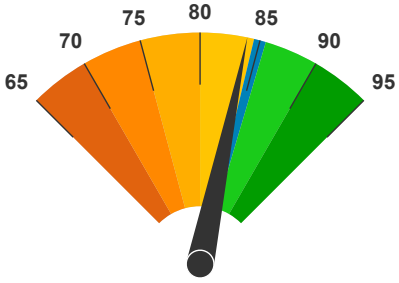


Significantly concentrated exports



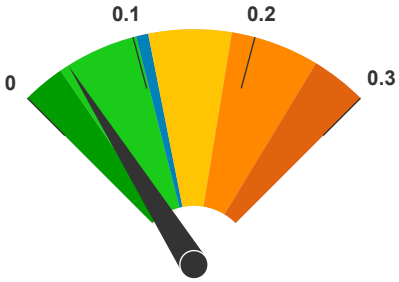
Agile, adaptable and aligned supply chains

Transparency of regulations



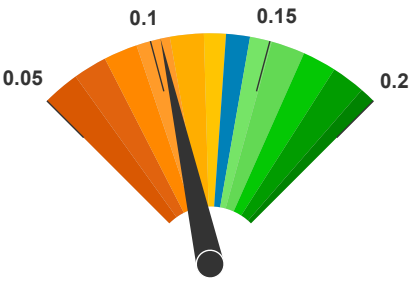
84%

Barriers to digital services trade



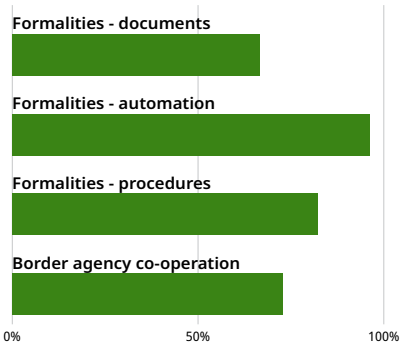
0.04

Digital trade integration & openness

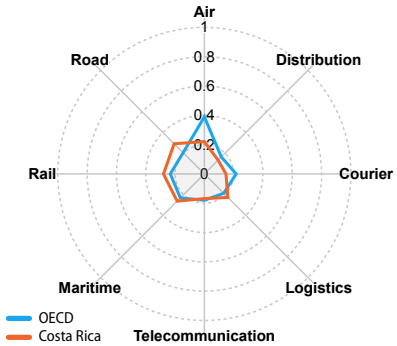


0.104

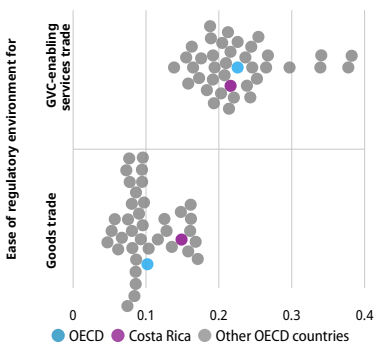
Ease of border processes



Barriers to trade in GVC-enabling services



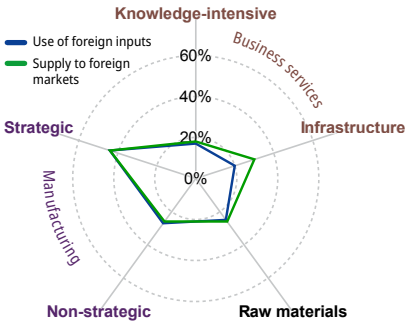
Regulatory alignment



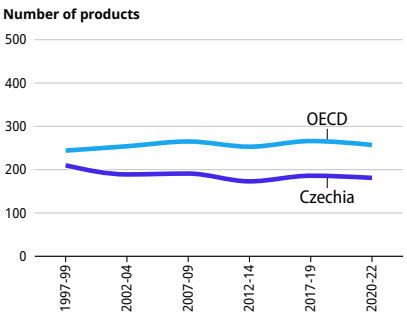
Czechia

Monitoring supply chain interdependencies

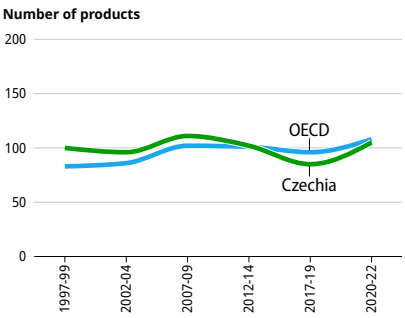
Global linkages of key industries



Significantly concentrated imports

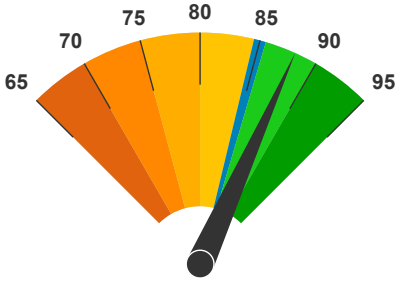


Significantly concentrated exports



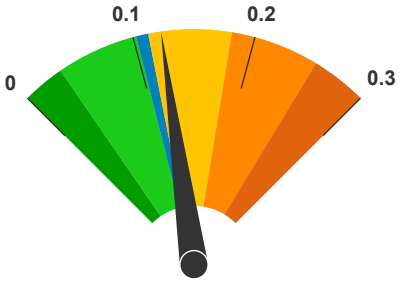
Agile, adaptable and aligned supply chains

Transparency of regulations



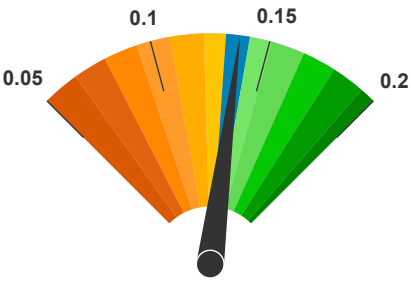
88%

Barriers to digital services trade



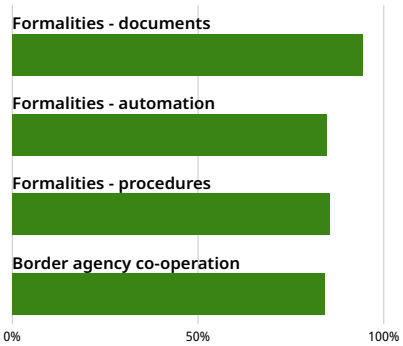
0.12

Digital trade integration & openness

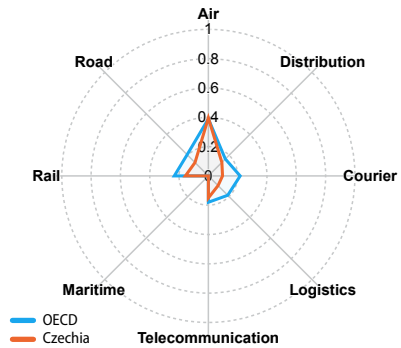


0.137

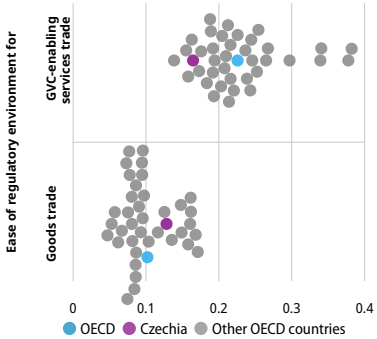
Ease of border processes



Barriers to trade in GVC-enabling services



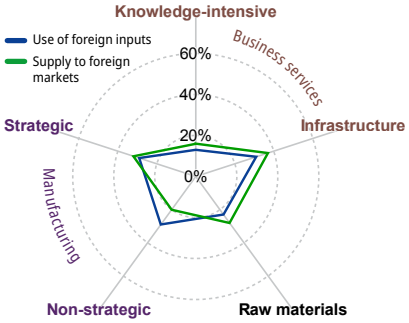
Regulatory alignment



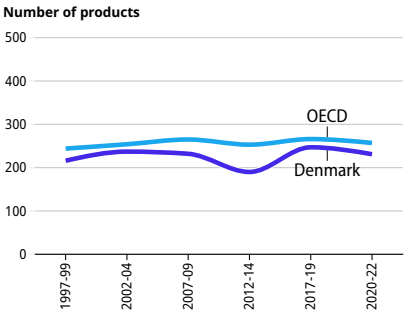
Denmark

Monitoring supply chain interdependencies

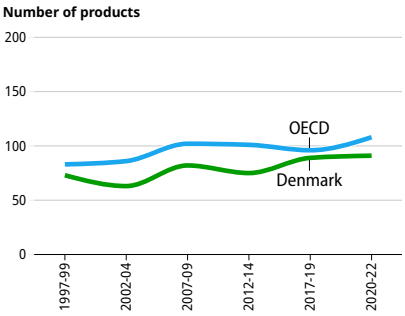
Global linkages of key industries



Significantly concentrated imports

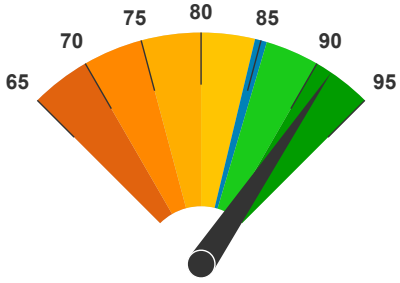


Significantly concentrated exports



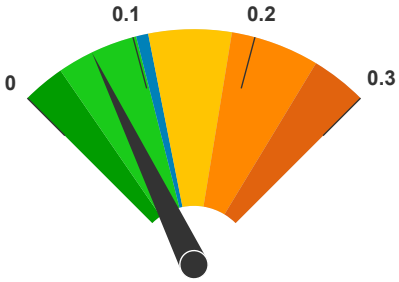
Agile, adaptable and aligned supply chains

Transparency of regulations



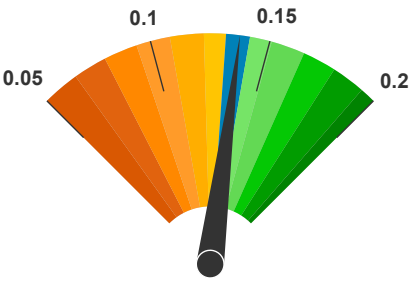
91%

Barriers to digital services trade



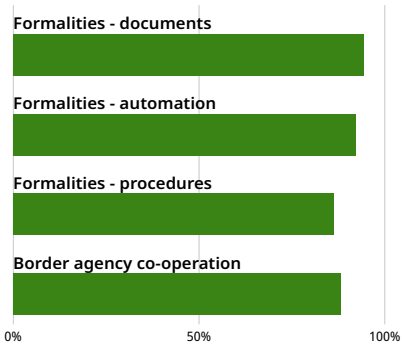
0.06

Digital trade integration & openness

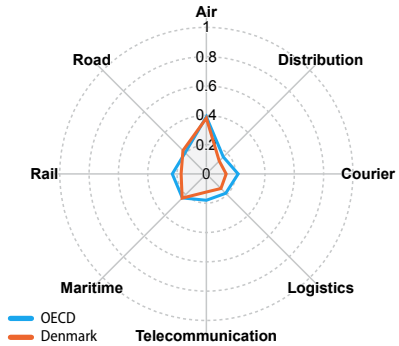


0.137

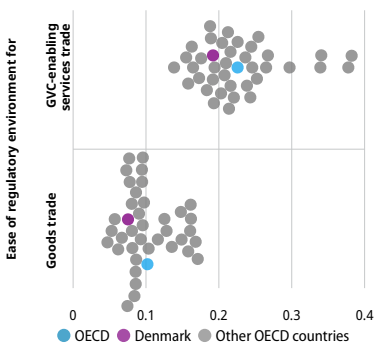
Ease of border processes



Barriers to trade in GVC-enabling services



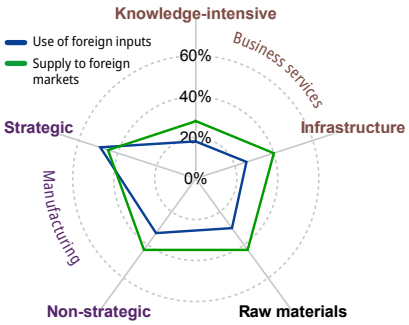
Regulatory alignment



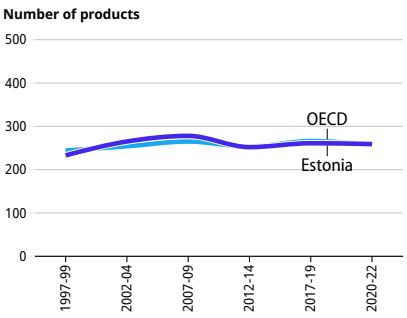
Estonia

Monitoring supply chain interdependencies

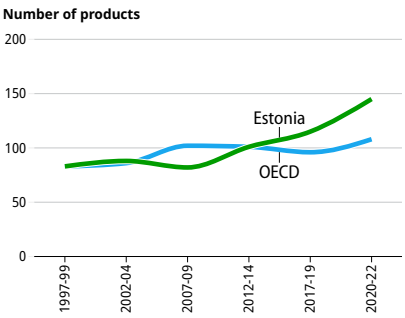
Global linkages of key industries



Significantly concentrated imports

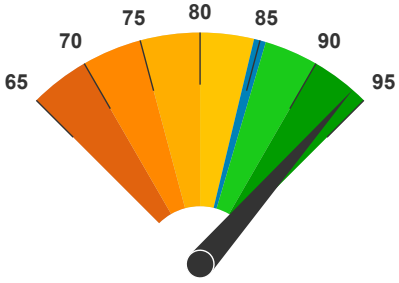


Significantly concentrated exports



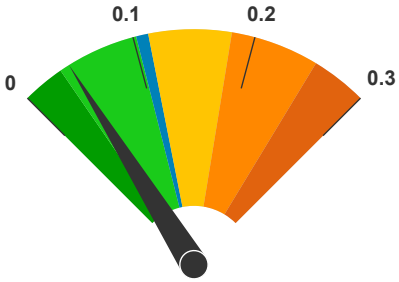
Agile, adaptable and aligned supply chains

Transparency of regulations



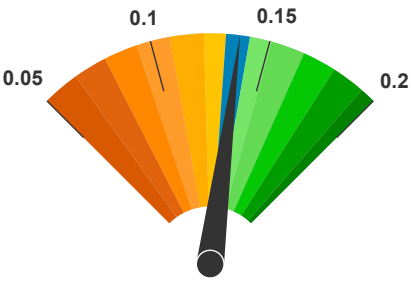
94%

Barriers to digital services trade



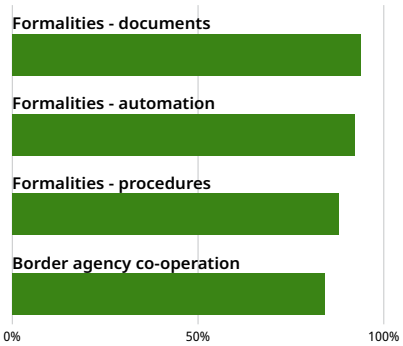
0.04

Digital trade integration & openness

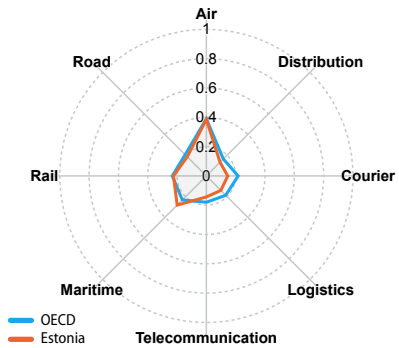


0.137

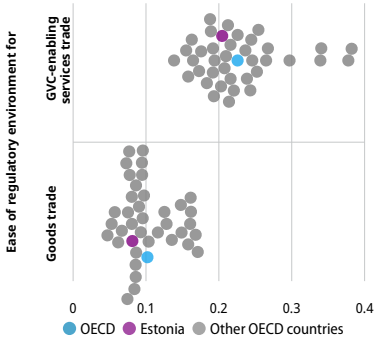
Ease of border processes



Barriers to trade in GVC-enabling services



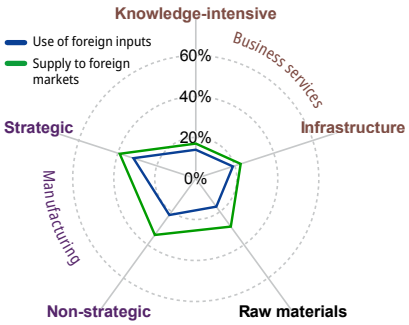
Regulatory alignment



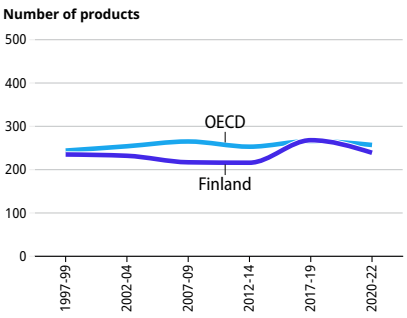
Finland

Monitoring supply chain interdependencies

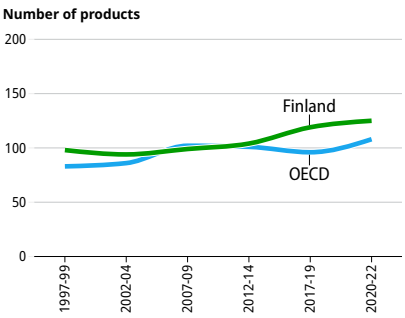
Global linkages of key industries



Significantly concentrated imports

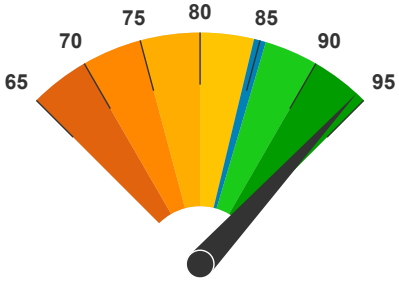


Significantly concentrated exports



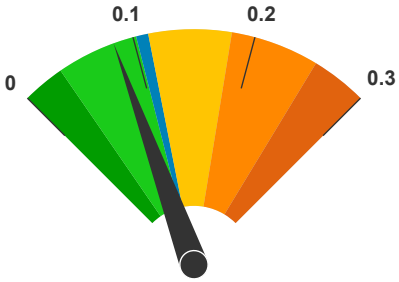
Agile, adaptable and aligned supply chains

Transparency of regulations



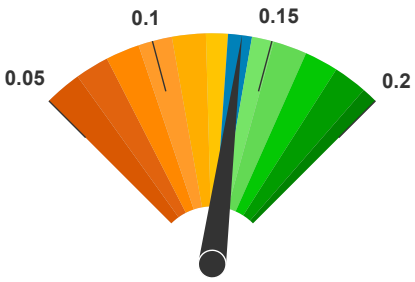
94%

Barriers to digital services trade



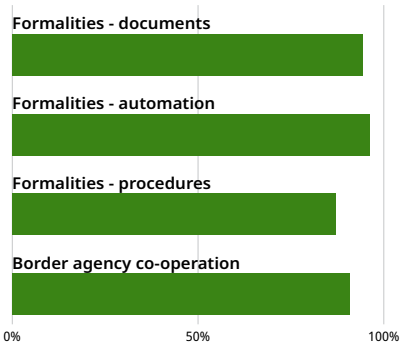
0.08

Digital trade integration & openness

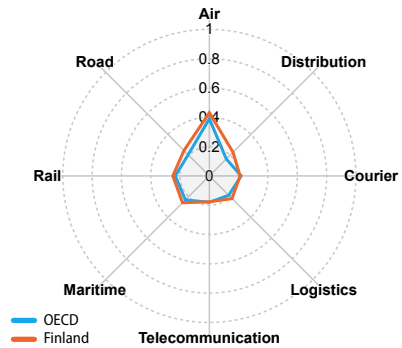


0.137

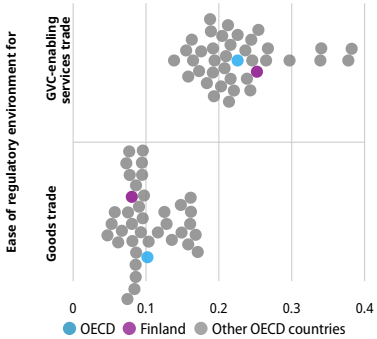
Ease of border processes



Barriers to trade in GVC-enabling services



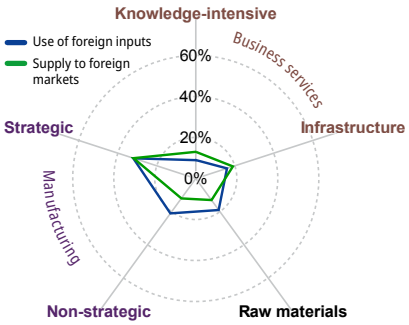
Regulatory alignment



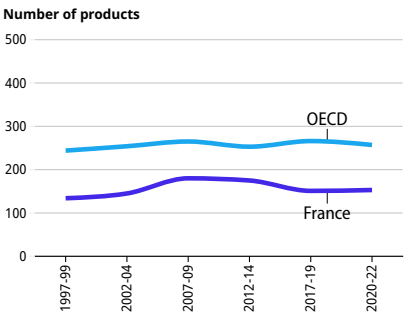
France

Monitoring supply chain interdependencies

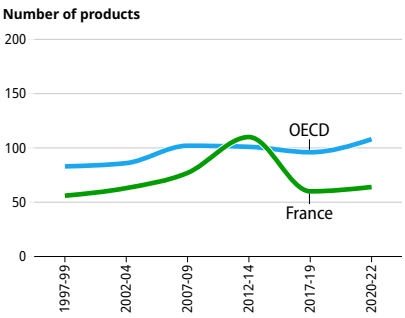
Global linkages of key industries



Significantly concentrated imports

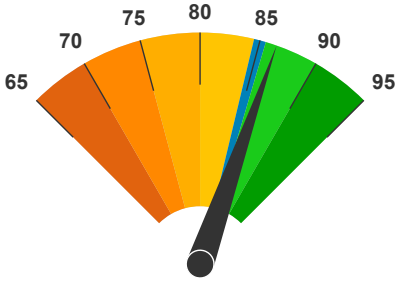


Significantly concentrated exports



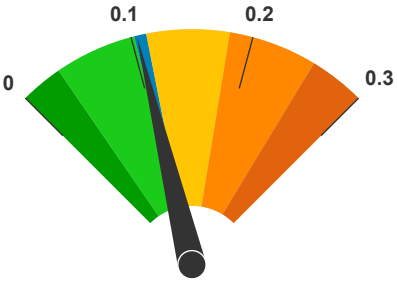
Agile, adaptable and aligned supply chains

Transparency of regulations



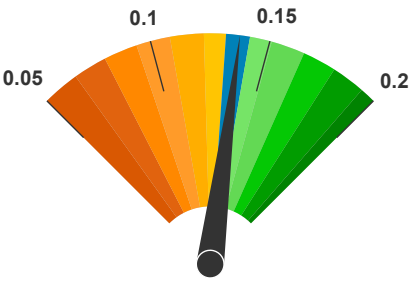
86%

Barriers to digital services trade



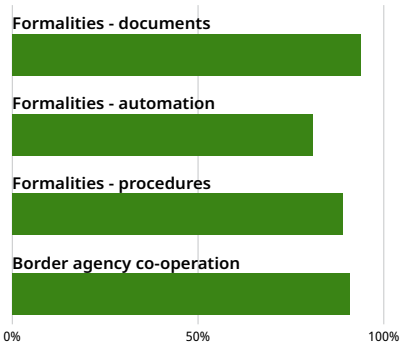
0.1

Digital trade integration & openness

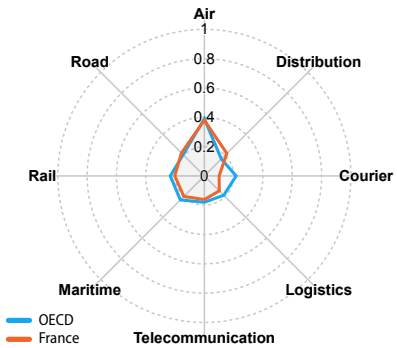


0.137

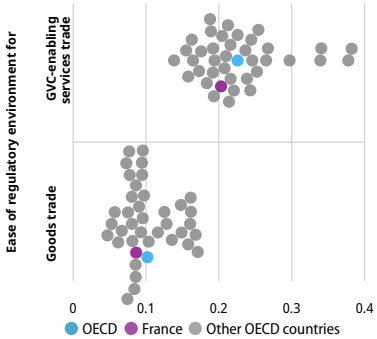
Ease of border processes



Barriers to trade in GVC-enabling services



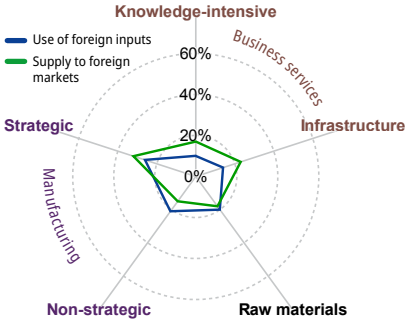
Regulatory alignment



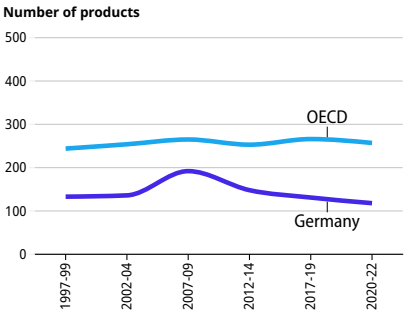
Germany

Monitoring supply chain interdependencies

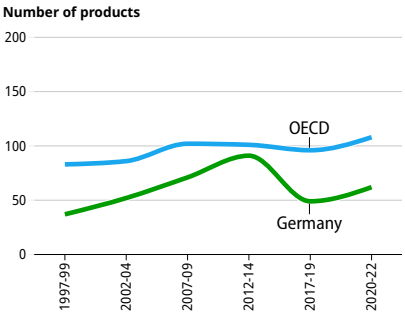
Global linkages of key industries



Significantly concentrated imports

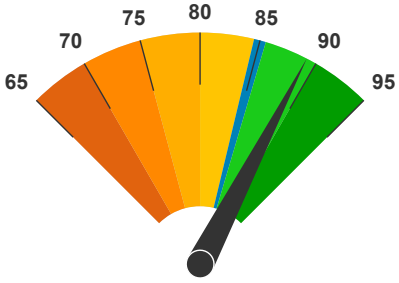


Significantly concentrated exports



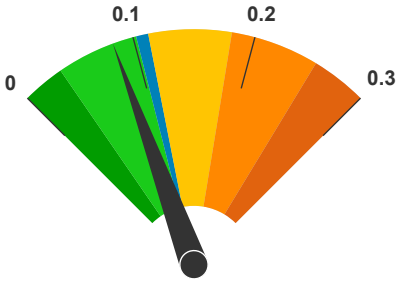
Agile, adaptable and aligned supply chains

Transparency of regulations



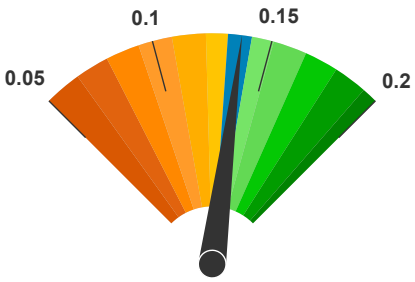
89%

Barriers to digital services trade



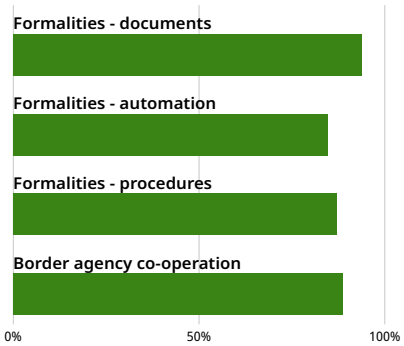
0.08

Digital trade integration & openness

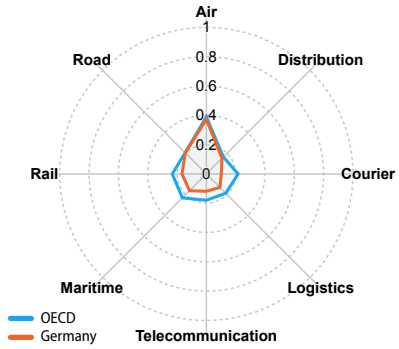


0.137

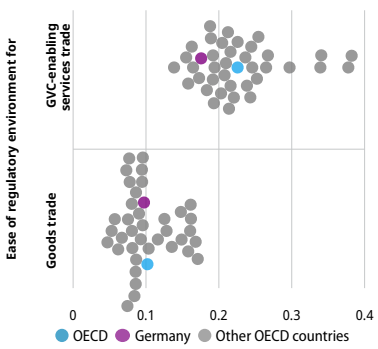
Ease of border processes



Barriers to trade in GVC-enabling services



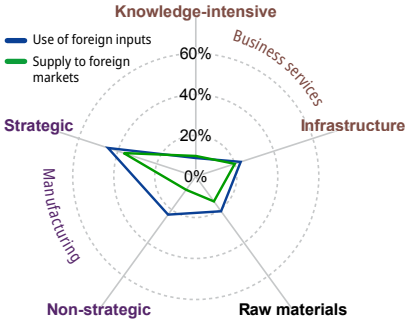
Regulatory alignment



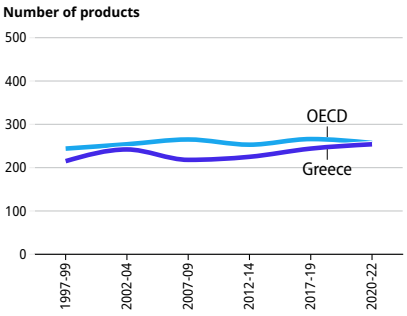
Greece

Monitoring supply chain interdependencies

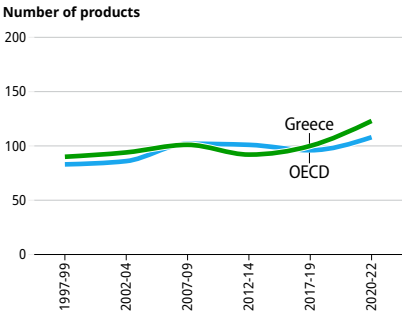
Global linkages of key industries



Significantly concentrated imports

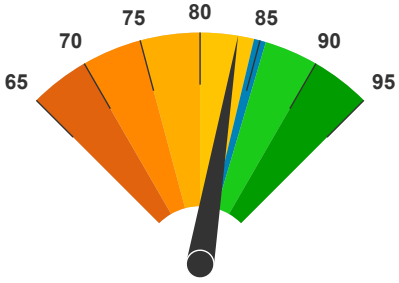


Significantly concentrated exports



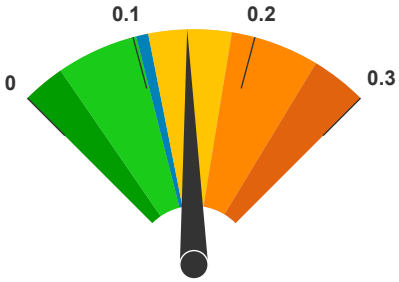
Agile, adaptable and aligned supply chains

Transparency of regulations



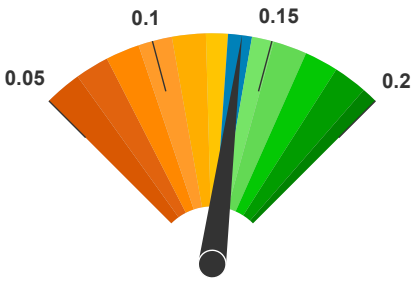
83%

Barriers to digital services trade



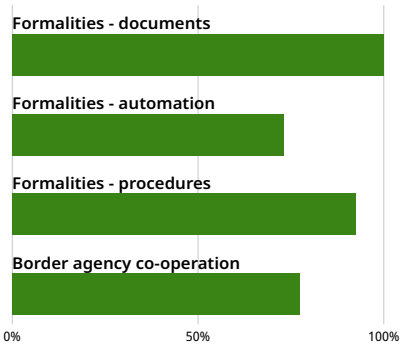
0.14

Digital trade integration & openness

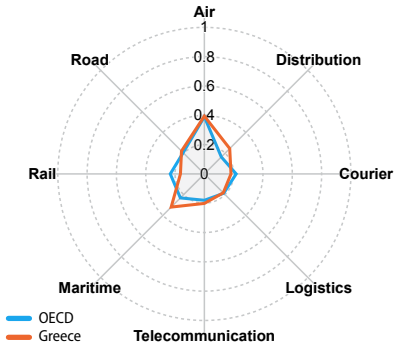


0.137

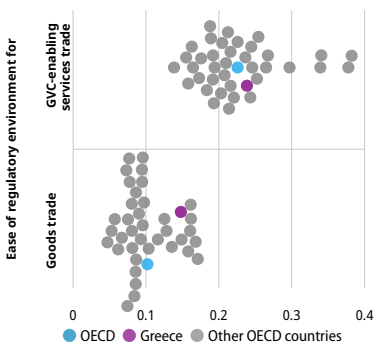
Ease of border processes



Barriers to trade in GVC-enabling services



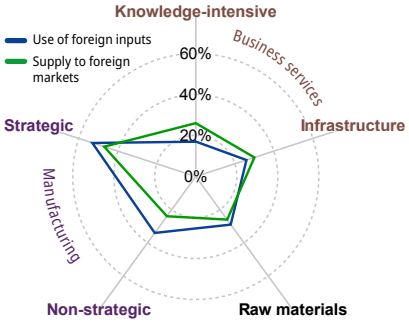
Regulatory alignment



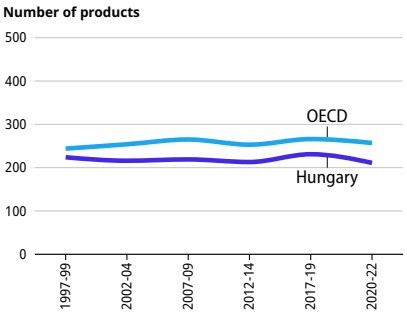
Hungary

Monitoring supply chain interdependencies

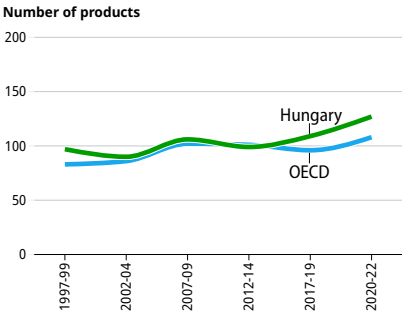
Global linkages of key industries



Significantly concentrated imports

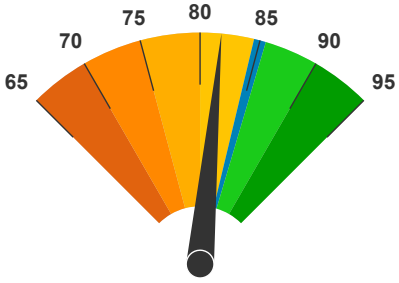


Significantly concentrated exports



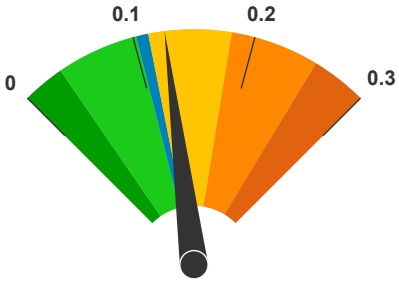
Agile, adaptable and aligned supply chains

Transparency of regulations



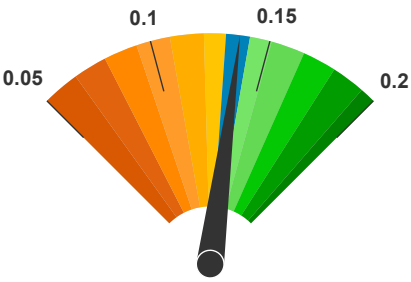
82%

Barriers to digital services trade



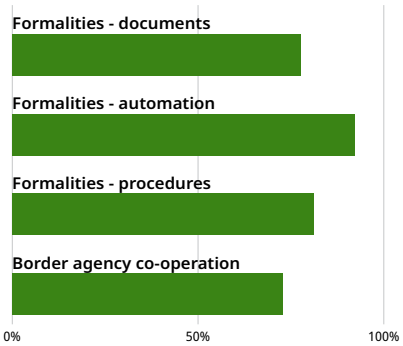
0.13

Digital trade integration & openness

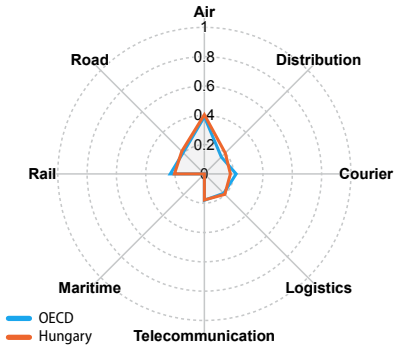


0.137

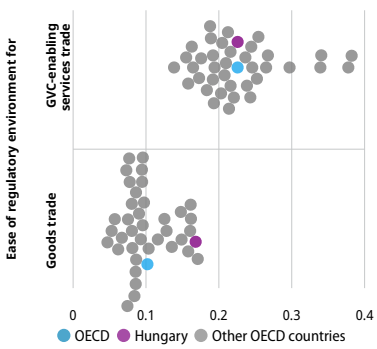
Ease of border processes



Barriers to trade in GVC-enabling services



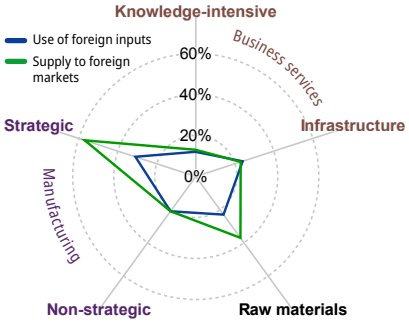
Regulatory alignment



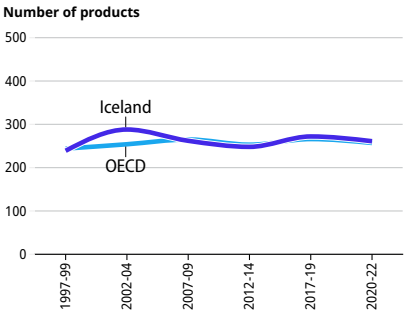
Iceland

Monitoring supply chain interdependencies

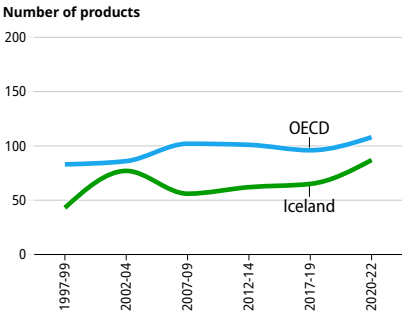
Global linkages of key industries



Significantly concentrated imports

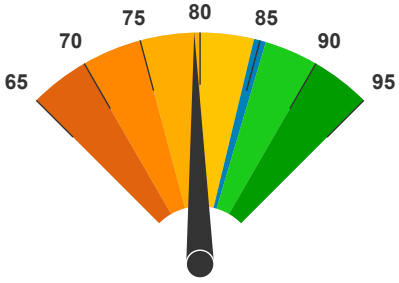


Significantly concentrated exports



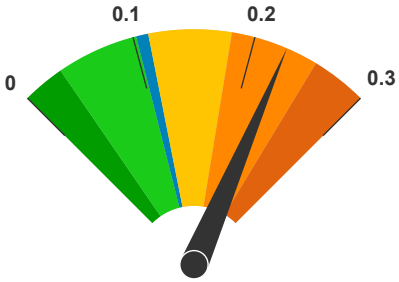
Agile, adaptable and aligned supply chains

Transparency of regulations



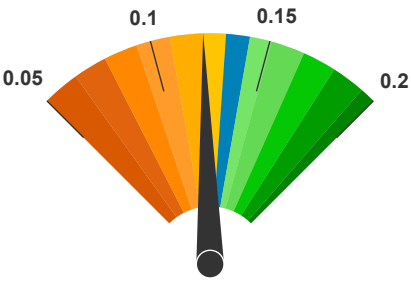
80%

Barriers to digital services trade



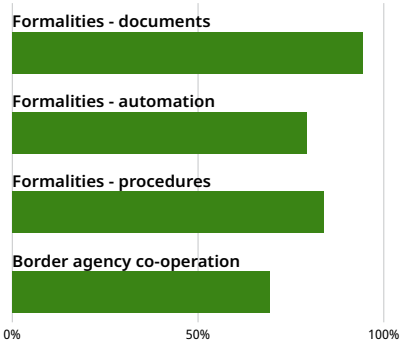
0.23

Digital trade integration & openness

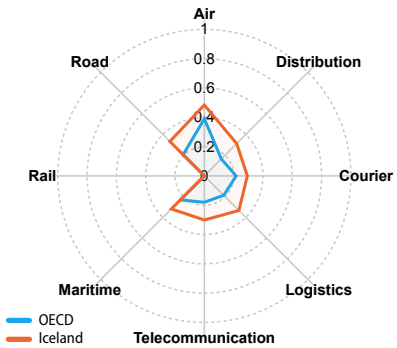


0.122

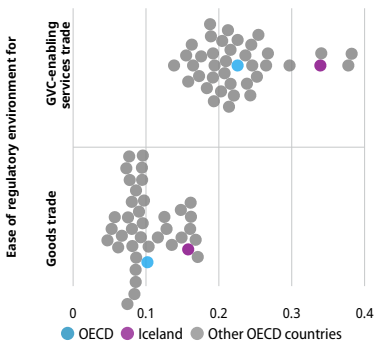
Ease of border processes



Barriers to trade in GVC-enabling services



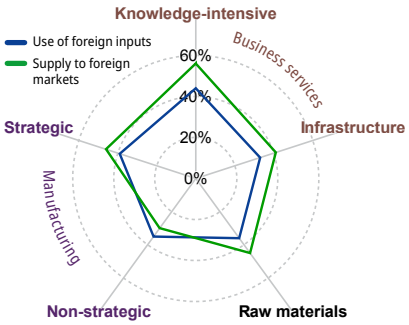
Regulatory alignment



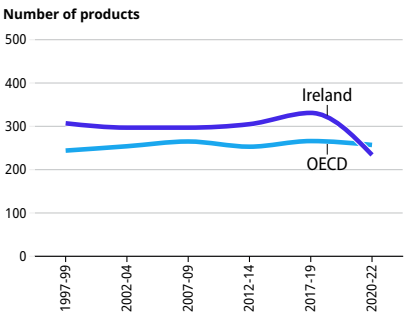
Ireland

Monitoring supply chain interdependencies

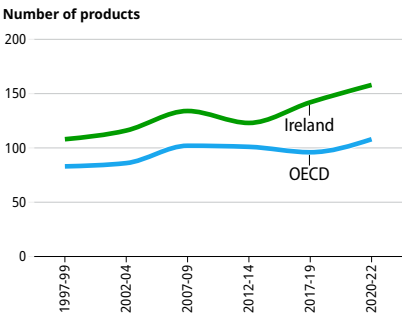
Global linkages of key industries



Significantly concentrated imports

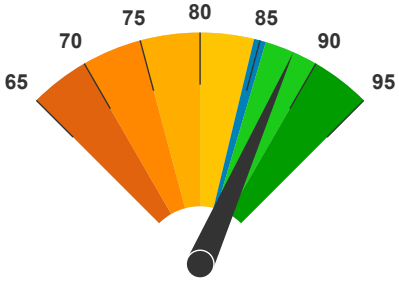


Significantly concentrated exports



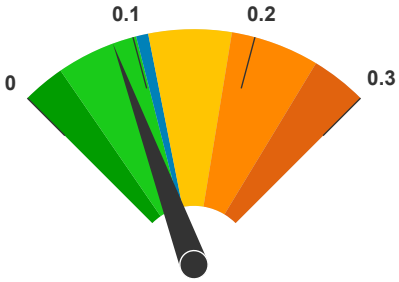
Agile, adaptable and aligned supply chains

Transparency of regulations



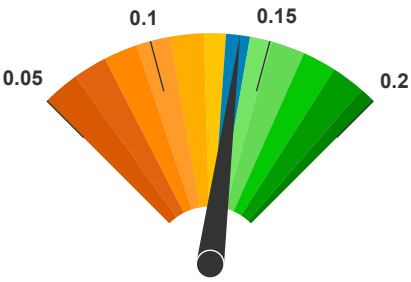
88%

Barriers to digital services trade



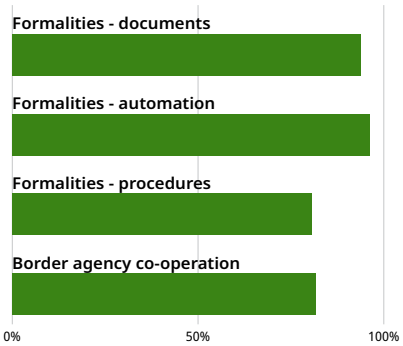
0.08

Digital trade integration & openness

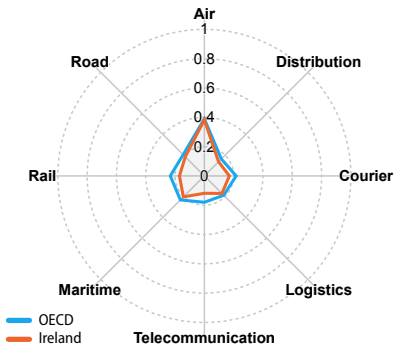


0.137

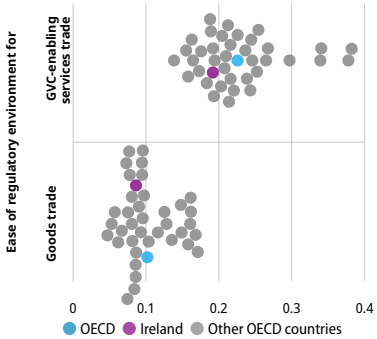
Ease of border processes



Barriers to trade in GVC-enabling services



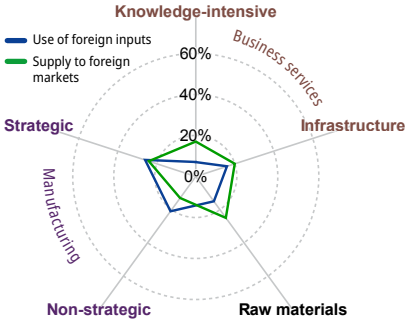
Regulatory alignment



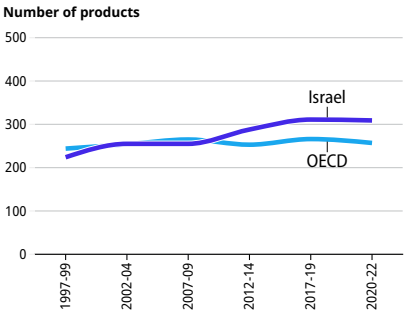
Israel

Monitoring supply chain interdependencies

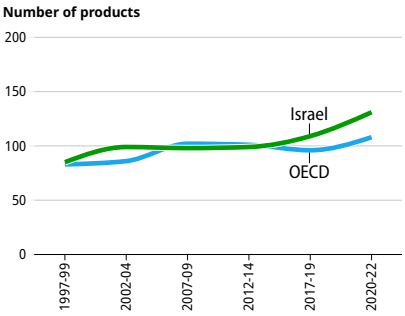
Global linkages of key industries



Significantly concentrated imports

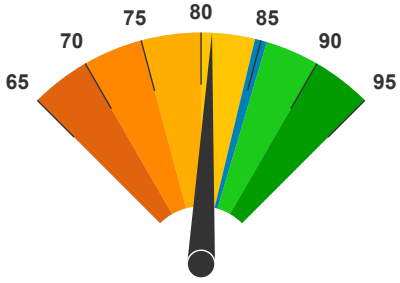


Significantly concentrated exports



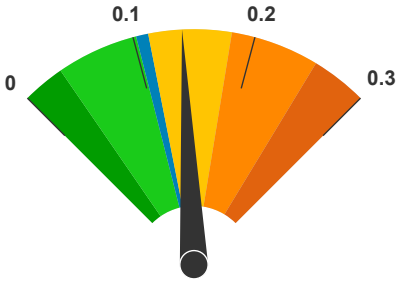
Agile, adaptable and aligned supply chains

Transparency of regulations



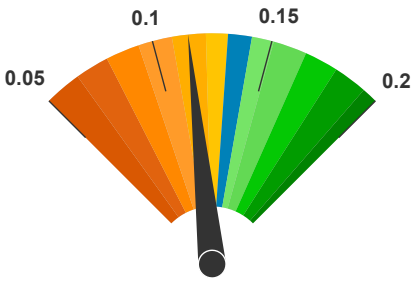
81%

Barriers to digital services trade



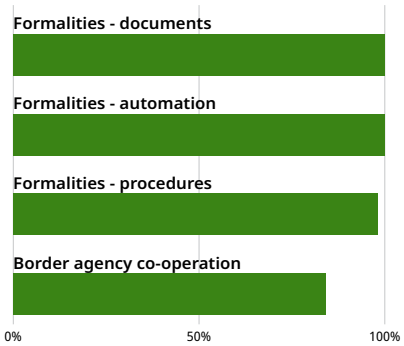
0.14

Digital trade integration & openness

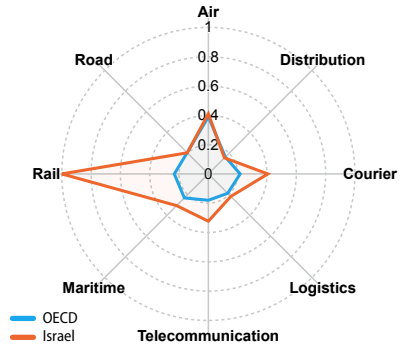


0.115

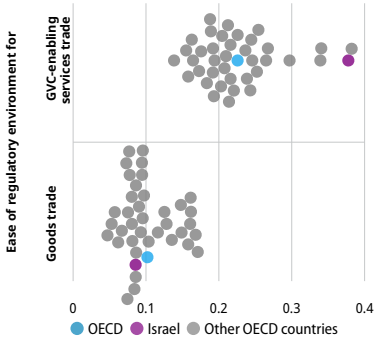
Ease of border processes



Barriers to trade in GVC-enabling services



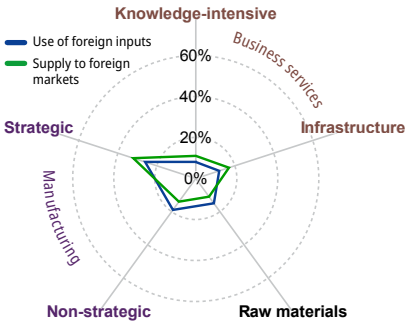
Regulatory alignment



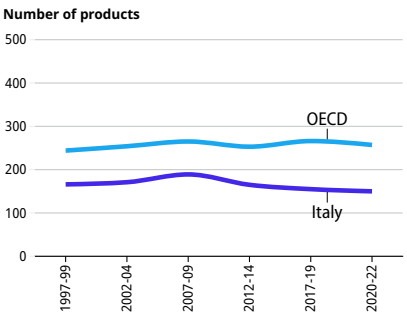
Italy

Monitoring supply chain interdependencies

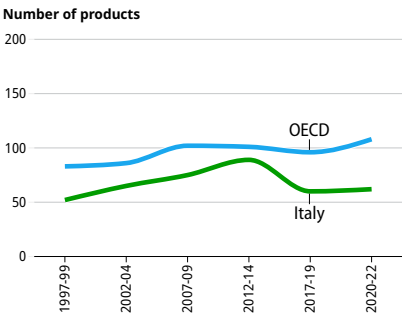
Global linkages of key industries



Significantly concentrated imports

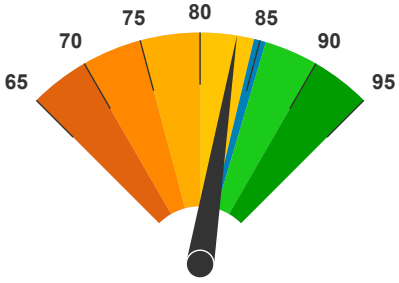


Significantly concentrated exports



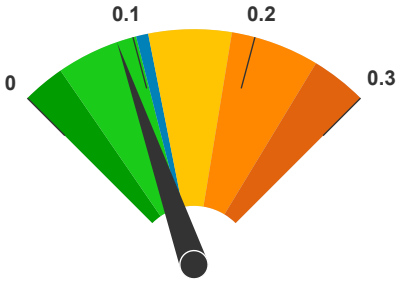
Agile, adaptable and aligned supply chains

Transparency of regulations



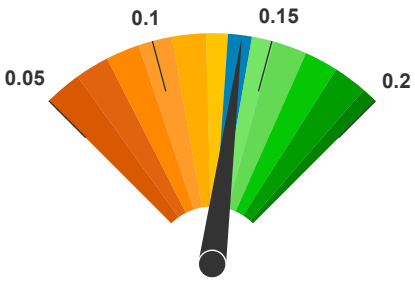
83%

Barriers to digital services trade



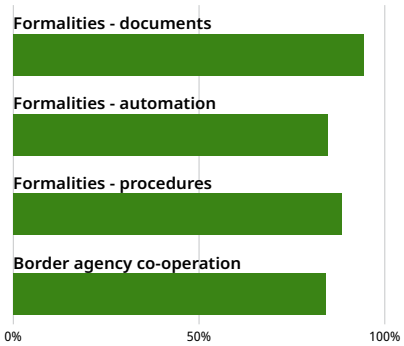
0.09

Digital trade integration & openness

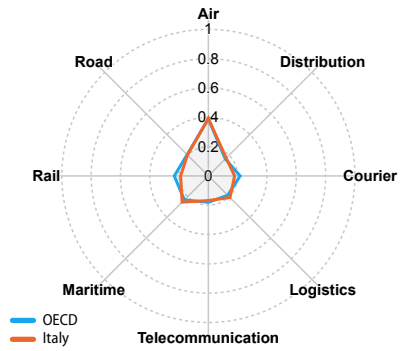


0.137

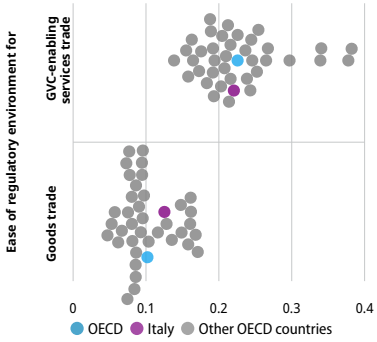
Ease of border processes



Barriers to trade in GVC-enabling services



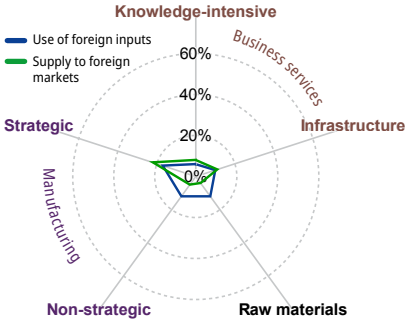
Regulatory alignment



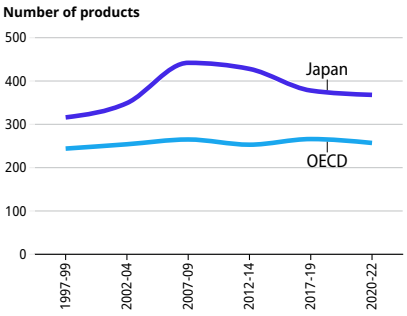
Japan

Monitoring supply chain interdependencies

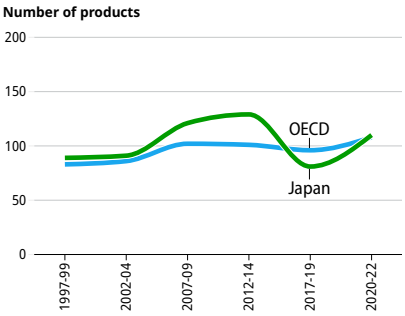
Global linkages of key industries



Significantly concentrated imports

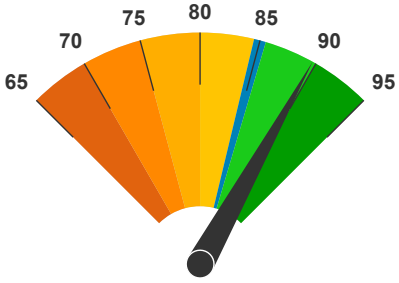


Significantly concentrated exports



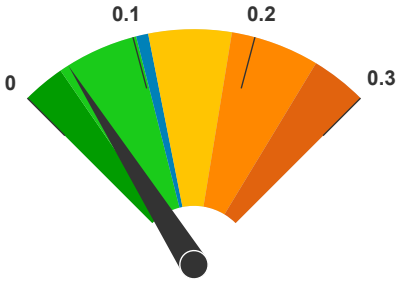
Agile, adaptable and aligned supply chains

Transparency of regulations



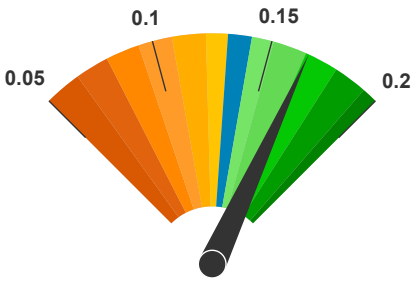
90%

Barriers to digital services trade



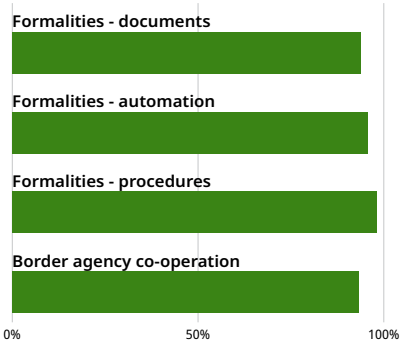
0.04

Digital trade integration & openness

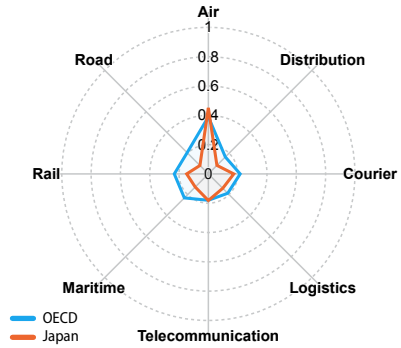


0.166

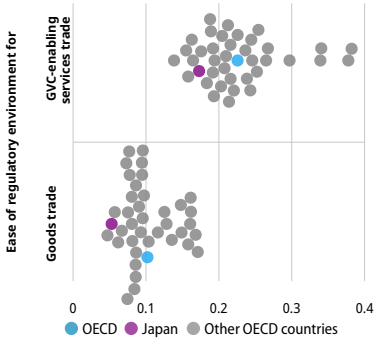
Ease of border processes



Barriers to trade in GVC-enabling services



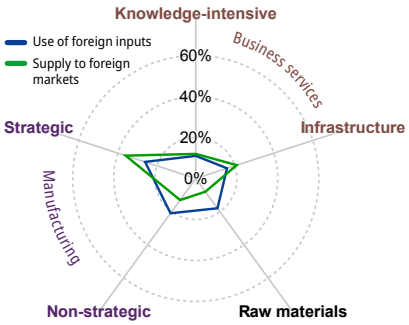
Regulatory alignment



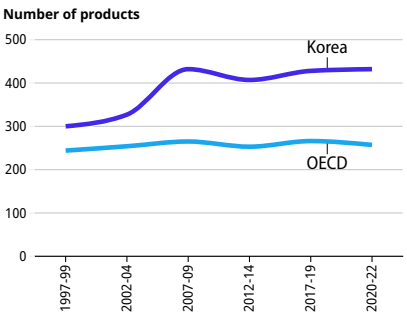
Korea

Monitoring supply chain interdependencies

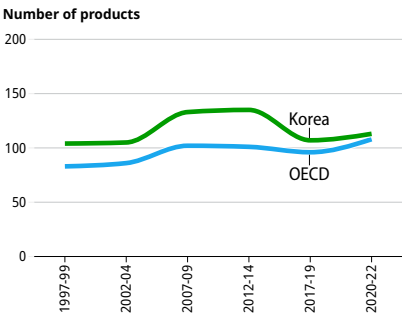
Global linkages of key industries



Significantly concentrated imports

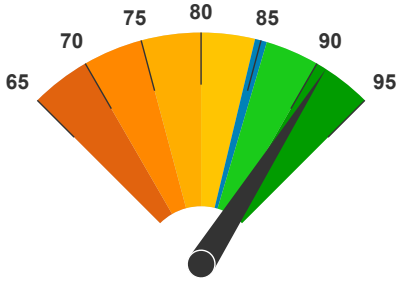


Significantly concentrated exports



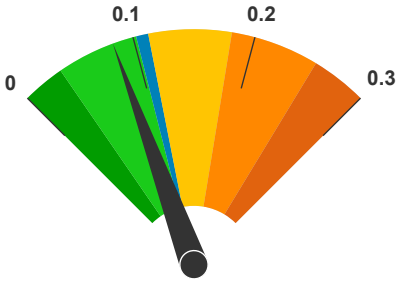
Agile, adaptable and aligned supply chains

Transparency of regulations



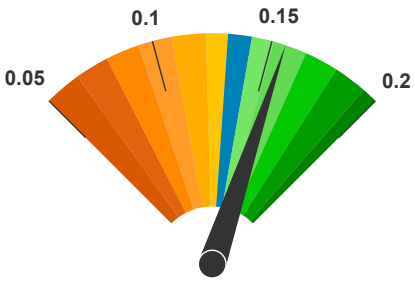
91%

Barriers to digital services trade



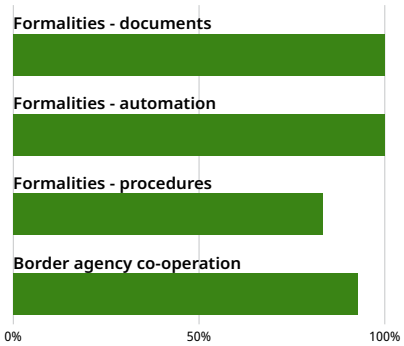
0.08

Digital trade integration & openness

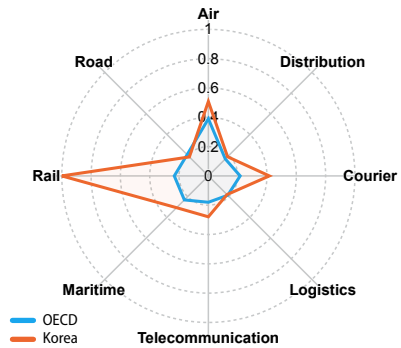


0.156

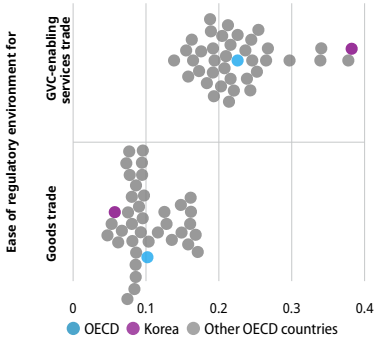
Ease of border processes



Barriers to trade in GVC-enabling services



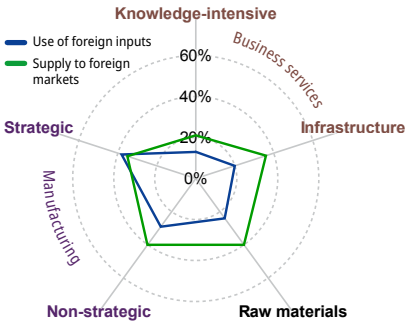
Regulatory alignment



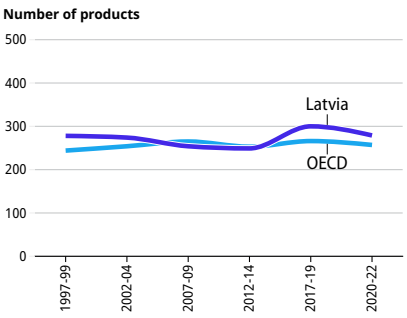
Latvia

Monitoring supply chain interdependencies

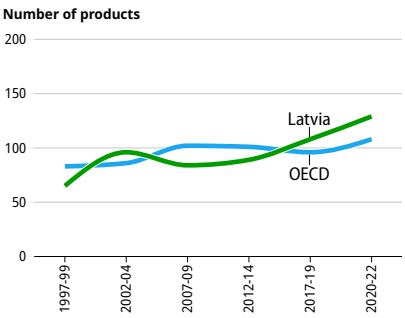
Global linkages of key industries



Significantly concentrated imports

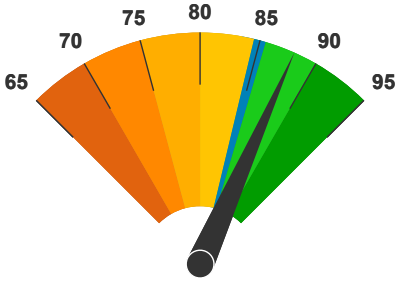


Significantly concentrated exports



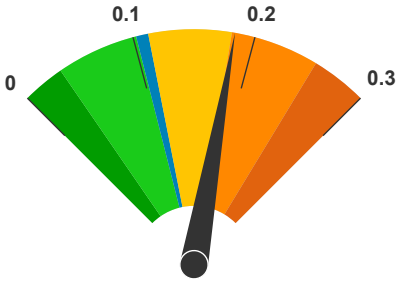
Agile, adaptable and aligned supply chains

Transparency of regulations



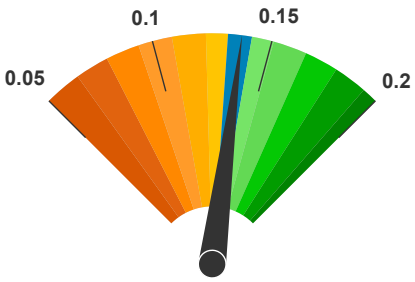
88%

Barriers to digital services trade



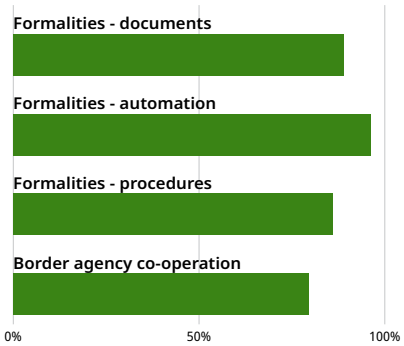
0.18

Digital trade integration & openness

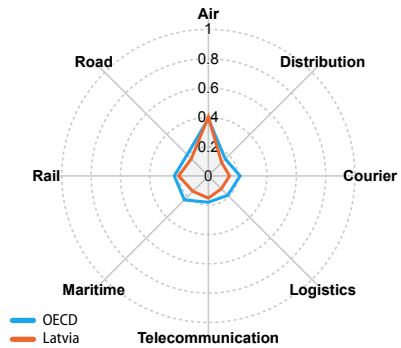


0.137

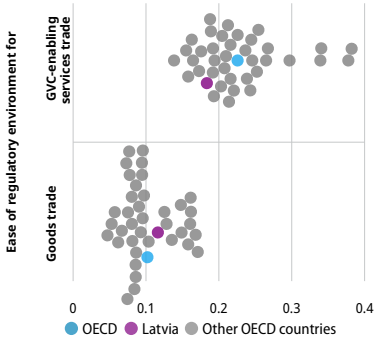
Ease of border processes



Barriers to trade in GVC-enabling services



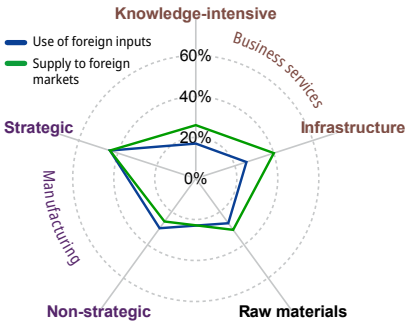
Regulatory alignment



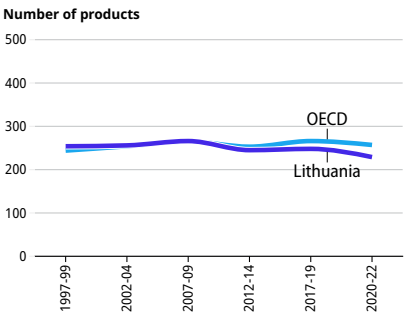
Lithuania

Monitoring supply chain interdependencies

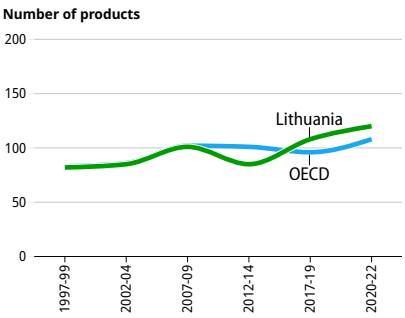
Global linkages of key industries



Significantly concentrated imports

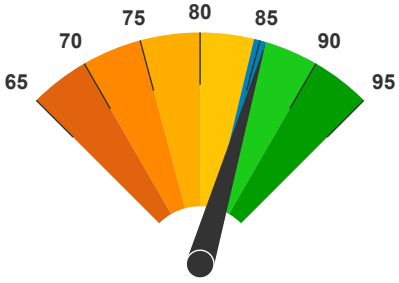


Significantly concentrated exports



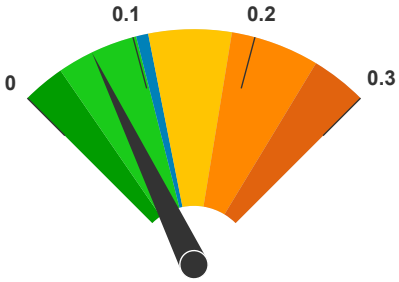
Agile, adaptable and aligned supply chains

Transparency of regulations



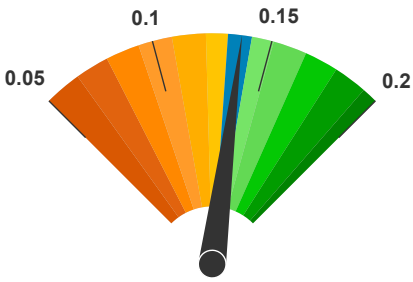
85%

Barriers to digital services trade



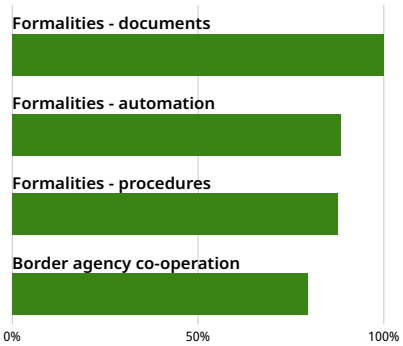
0.06

Digital trade integration & openness

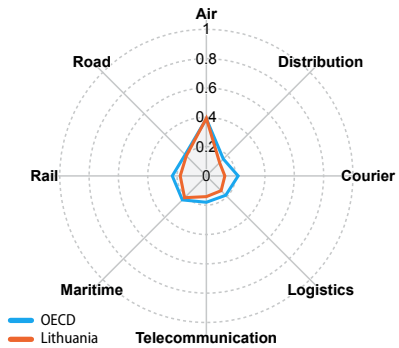


0.137

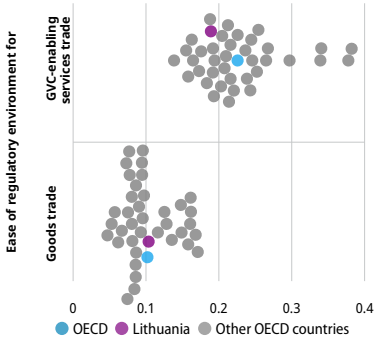
Ease of border processes



Barriers to trade in GVC-enabling services



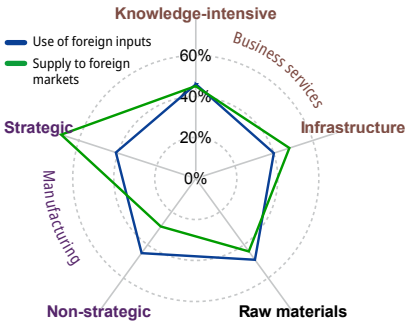
Regulatory alignment



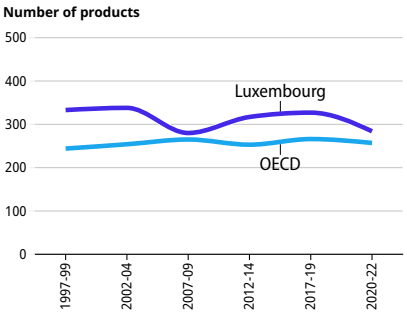
Luxembourg

Monitoring supply chain interdependencies

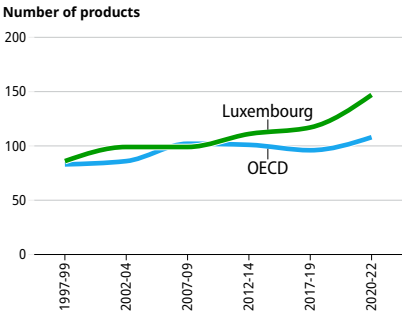
Global linkages of key industries



Significantly concentrated imports

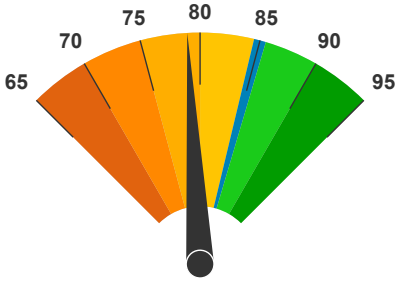


Significantly concentrated exports



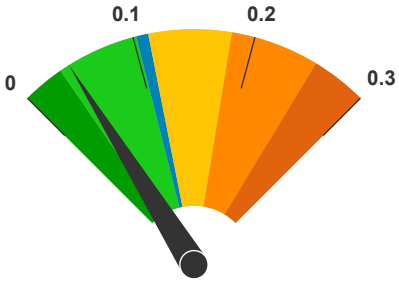
Agile, adaptable and aligned supply chains

Transparency of regulations



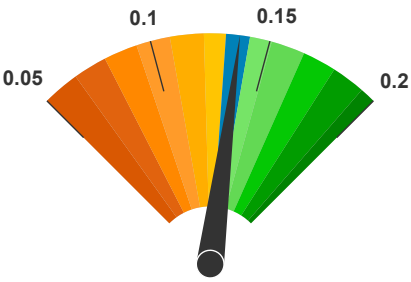
79%

Barriers to digital services trade



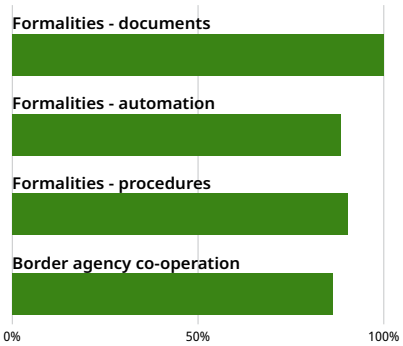
0.04

Digital trade integration & openness

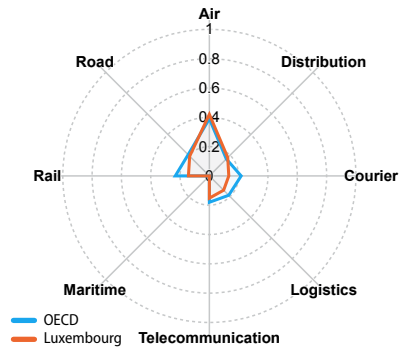


0.137

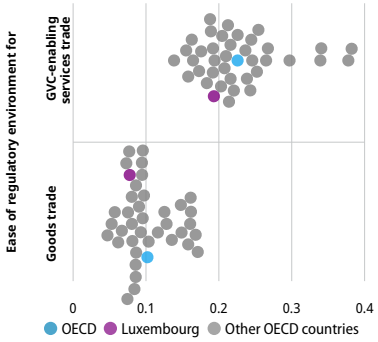
Ease of border processes



Barriers to trade in GVC-enabling services



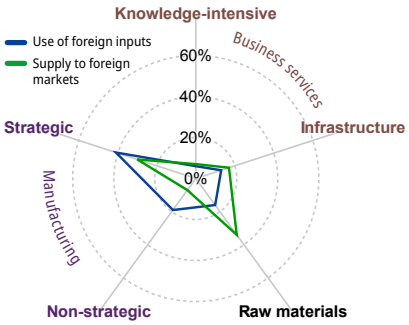
Regulatory alignment



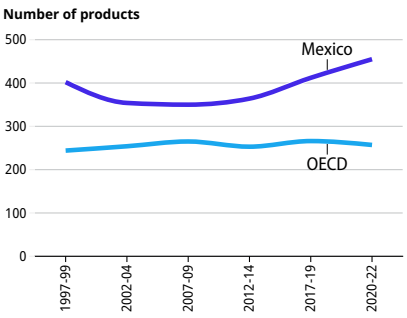
Mexico

Monitoring supply chain interdependencies

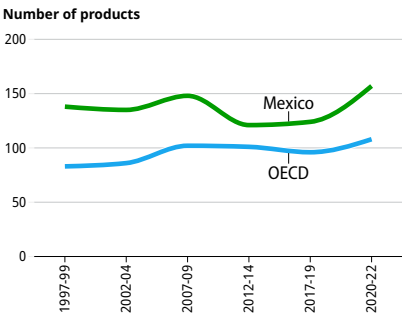
Global linkages of key industries



Significantly concentrated imports

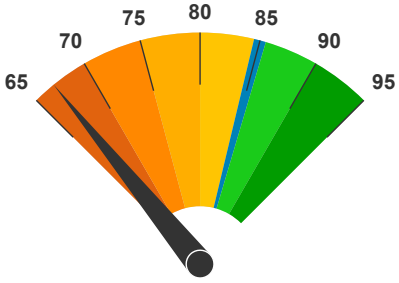


Significantly concentrated exports



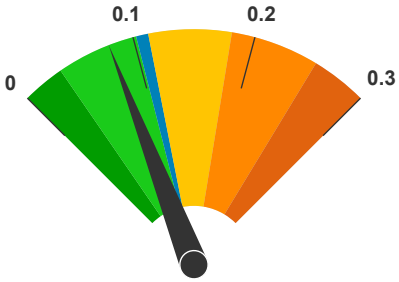
Agile, adaptable and aligned supply chains

Transparency of regulations



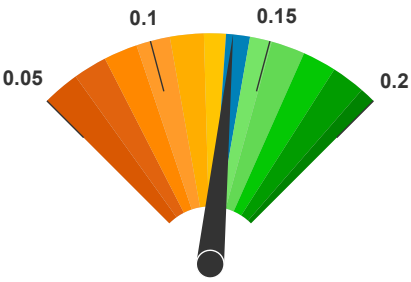
67%

Barriers to digital services trade



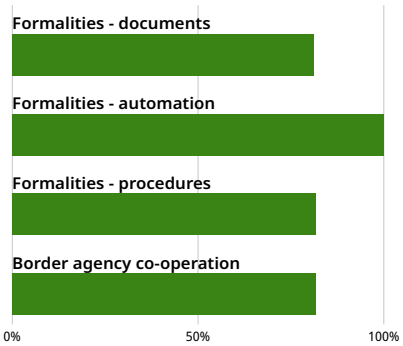
0.08

Digital trade integration & openness

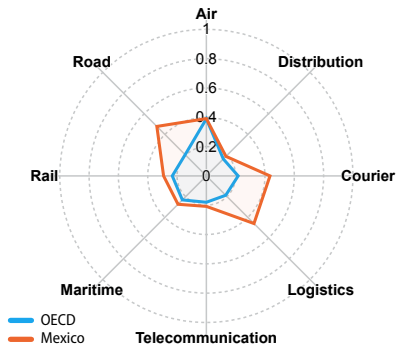


0.135

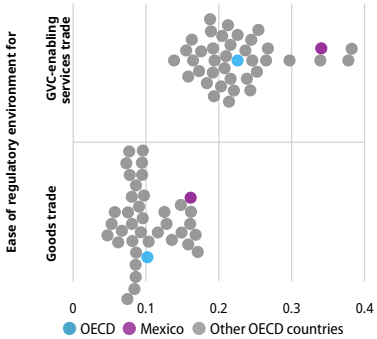
Ease of border processes



Barriers to trade in GVC-enabling services



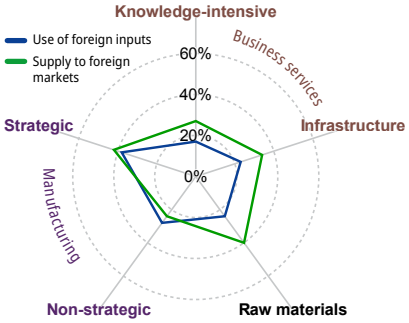
Regulatory alignment



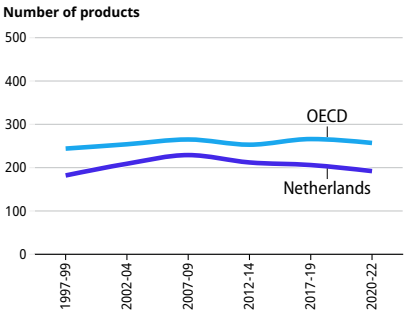
Netherlands

Monitoring supply chain interdependencies

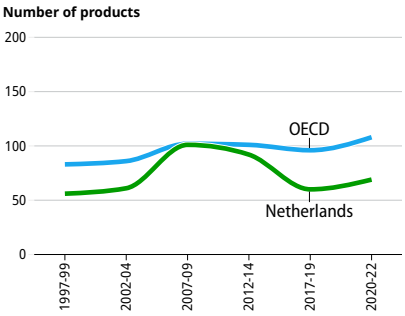
Global linkages of key industries



Significantly concentrated imports

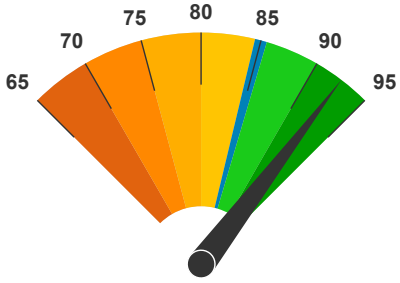


Significantly concentrated exports



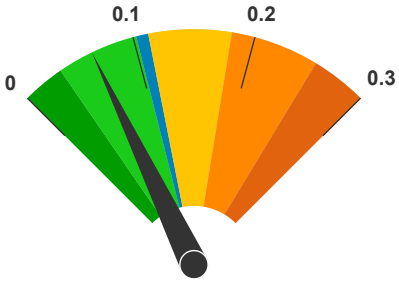
Agile, adaptable and aligned supply chains

Transparency of regulations



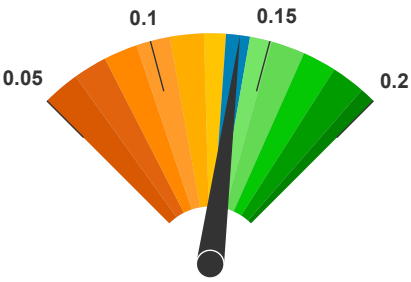
92%

Barriers to digital services trade



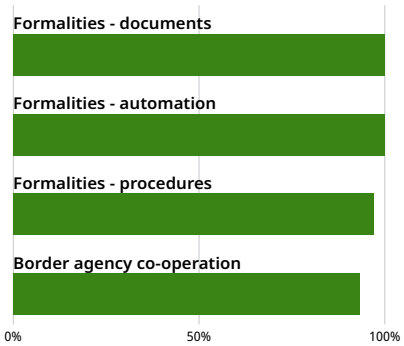
0.06

Digital trade integration & openness

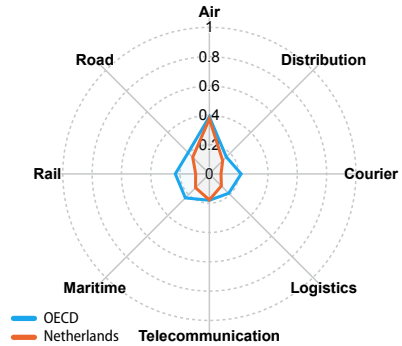


0.137

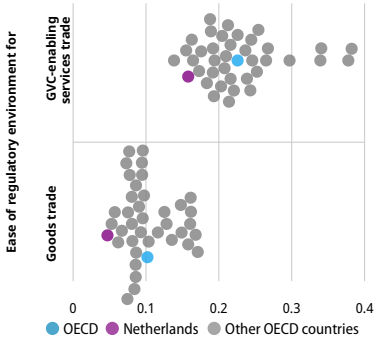
Ease of border processes



Barriers to trade in GVC-enabling services



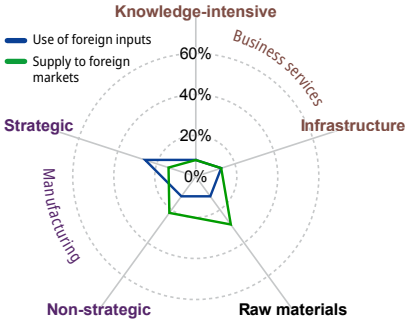
Regulatory alignment



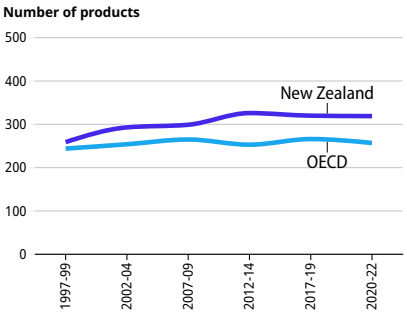
New Zealand

Monitoring supply chain interdependencies

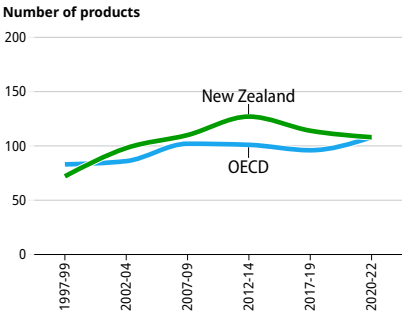
Global linkages of key industries



Significantly concentrated imports

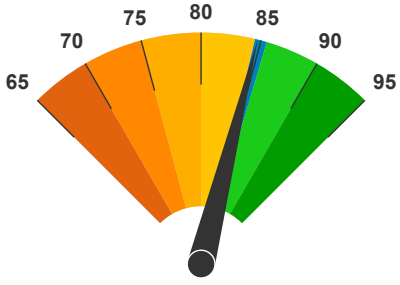


Significantly concentrated exports



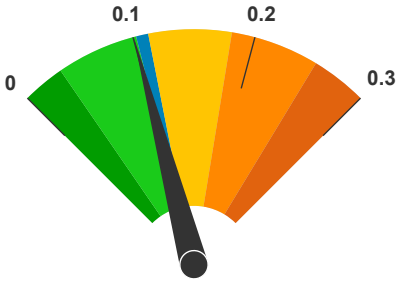
Agile, adaptable and aligned supply chains

Transparency of regulations



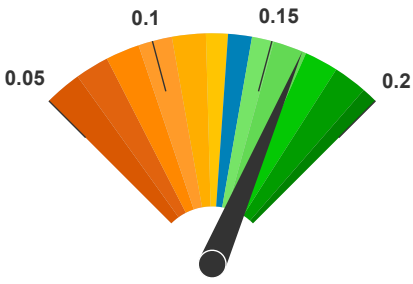
85%

Barriers to digital services trade



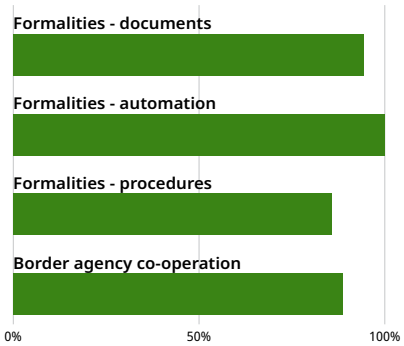
0.1

Digital trade integration & openness

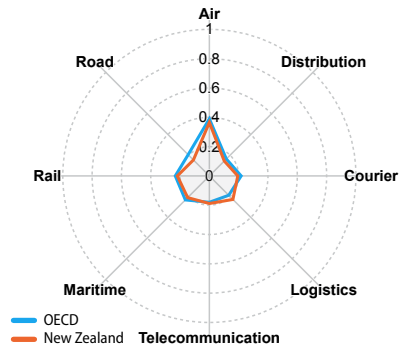


0.163

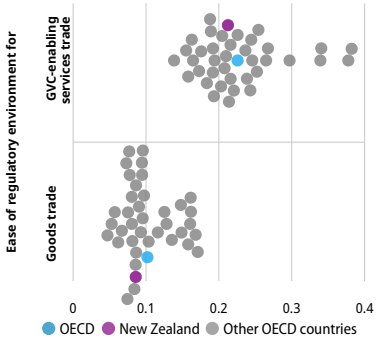
Ease of border processes



Barriers to trade in GVC-enabling services



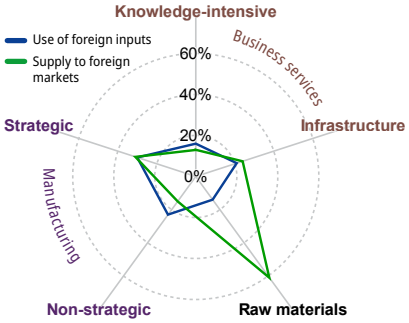
Regulatory alignment



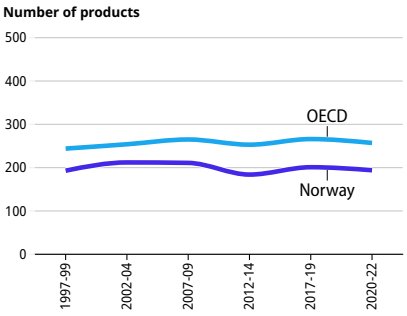
Norway

Monitoring supply chain interdependencies

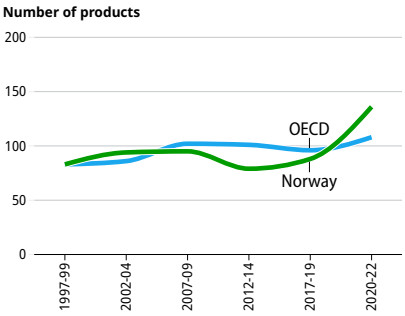
Global linkages of key industries



Significantly concentrated imports

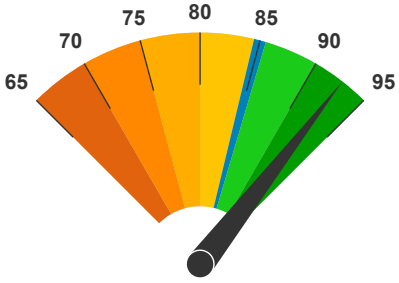


Significantly concentrated exports



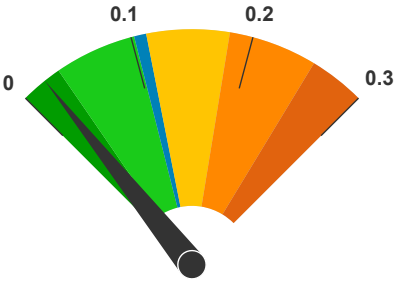
Agile, adaptable and aligned supply chains

Transparency of regulations



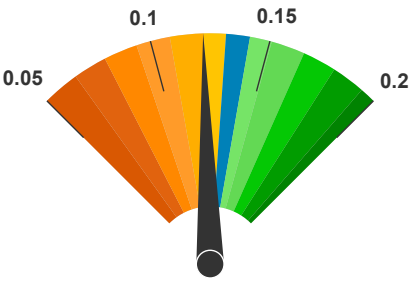
93%

Barriers to digital services trade



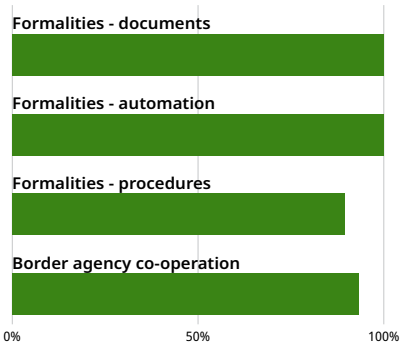
0.02

Digital trade integration & openness

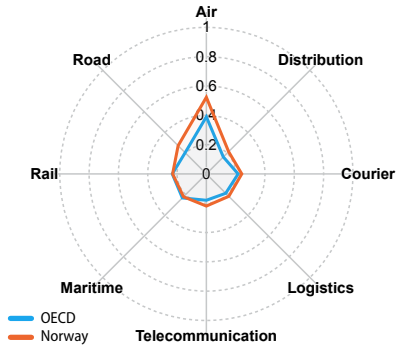


0.122

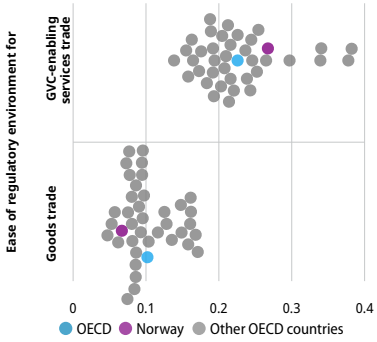
Ease of border processes



Barriers to trade in GVC-enabling services



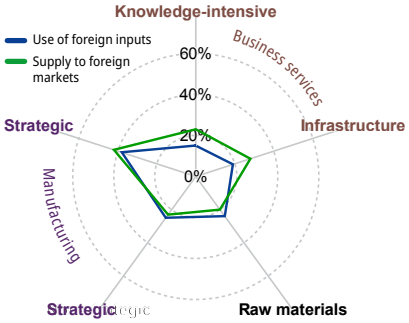
Regulatory alignment



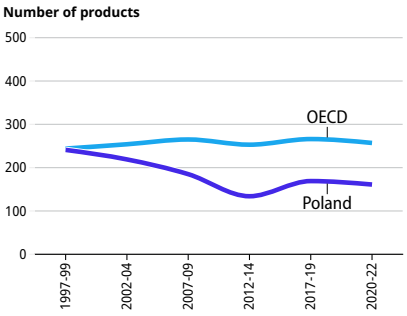
Poland

Monitoring supply chain interdependencies

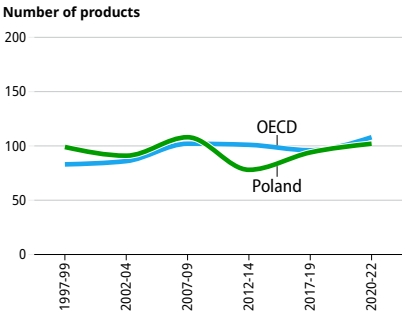
Global linkages of key industries



Significantly concentrated imports

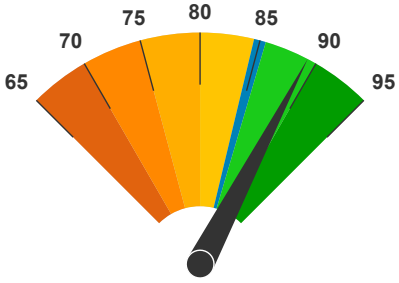


Significantly concentrated exports



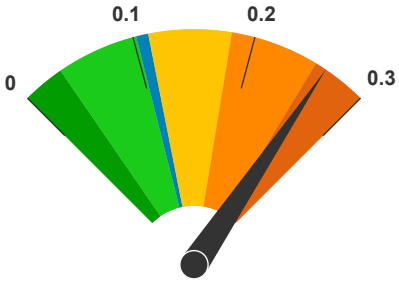
Agile, adaptable and aligned supply chains

Transparency of regulations



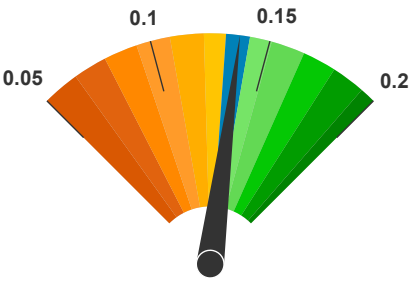
89%

Barriers to digital services trade



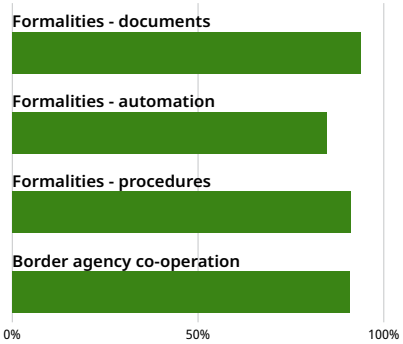
0.26

Digital trade integration & openness

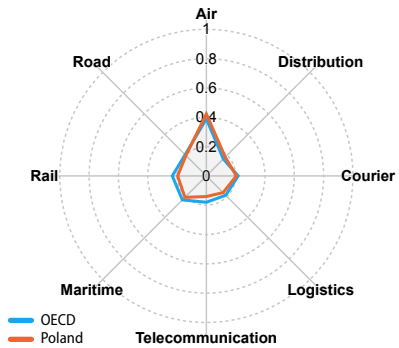


0.137

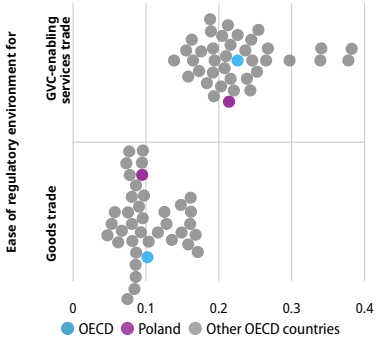
Ease of border processes



Barriers to trade in GVC-enabling services



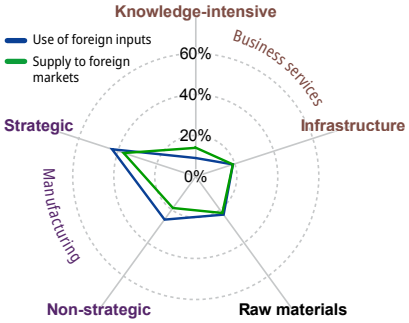
Regulatory alignment



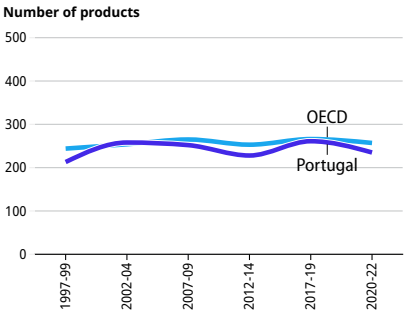
Portugal

Monitoring supply chain interdependencies

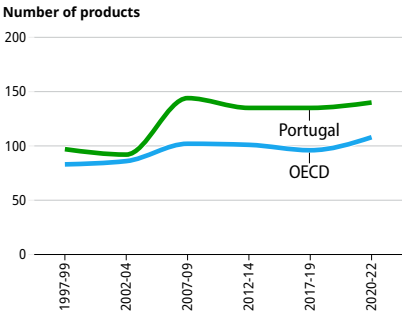
Global linkages of key industries



Significantly concentrated imports

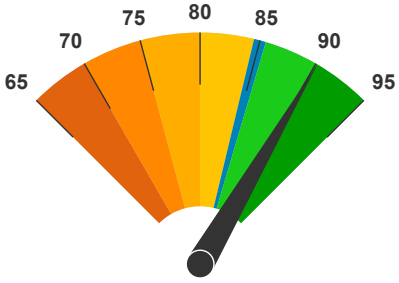


Significantly concentrated exports



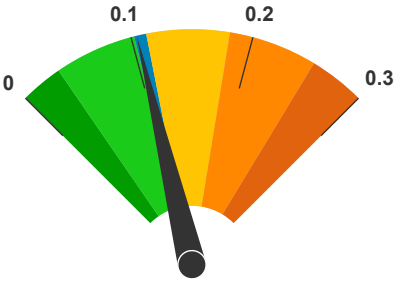
Agile, adaptable and aligned supply chains

Transparency of regulations



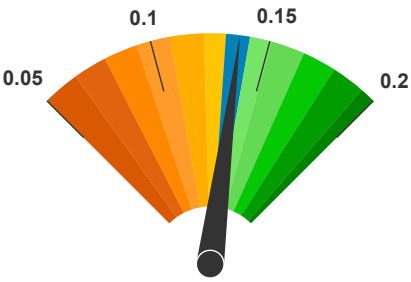
90%

Barriers to digital services trade



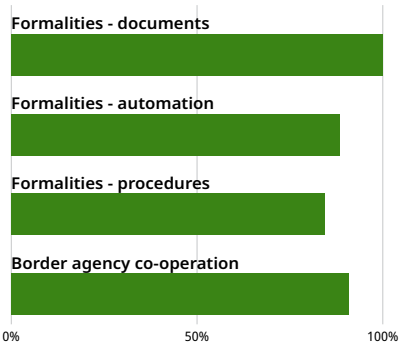
0.1

Digital trade integration & openness

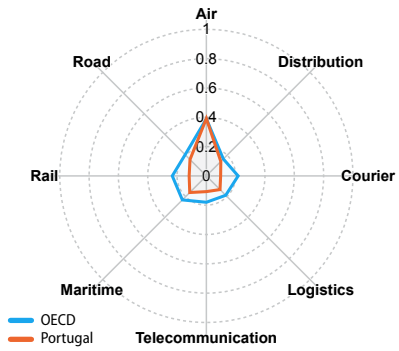


0.137

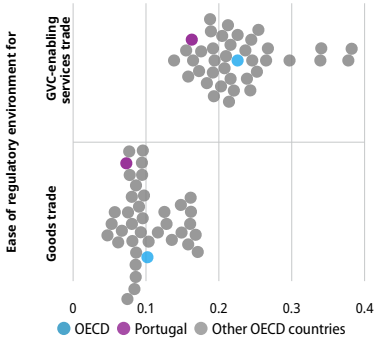
Ease of border processes



Barriers to trade in GVC-enabling services



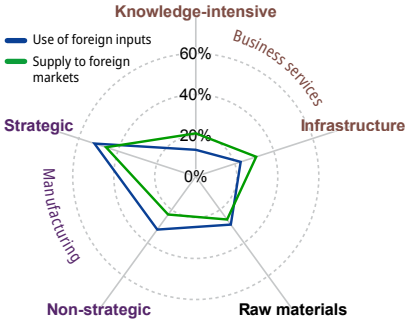
Regulatory alignment



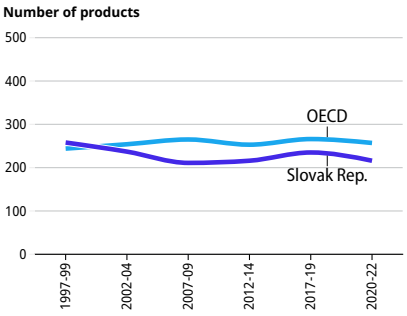
Slovak Republic

Monitoring supply chain interdependencies

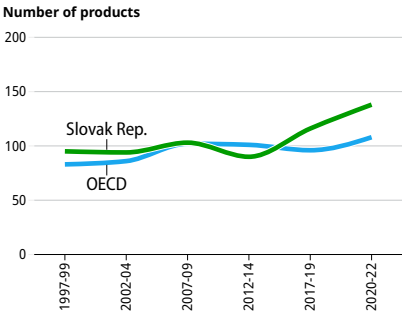
Global linkages of key industries



Significantly concentrated imports

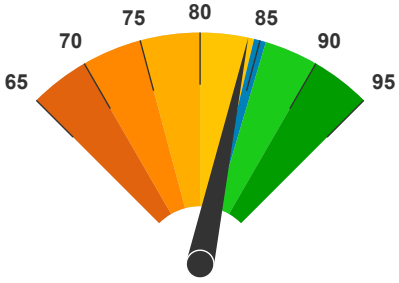


Significantly concentrated exports



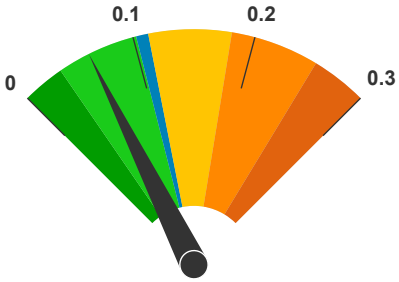
Agile, adaptable and aligned supply chains

Transparency of regulations



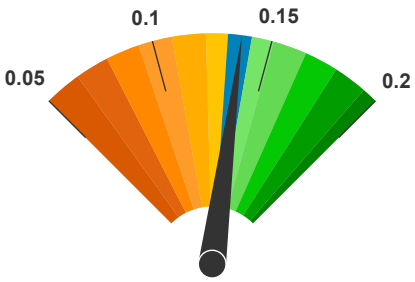
84%

Barriers to digital services trade



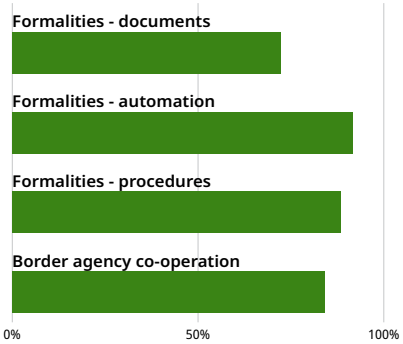
0.06

Digital trade integration & openness

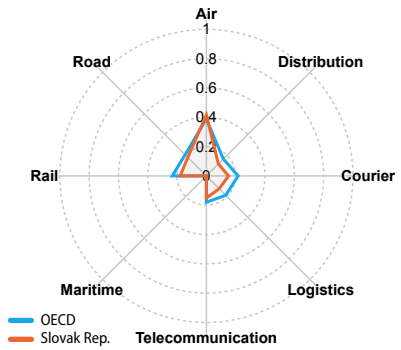


0.137

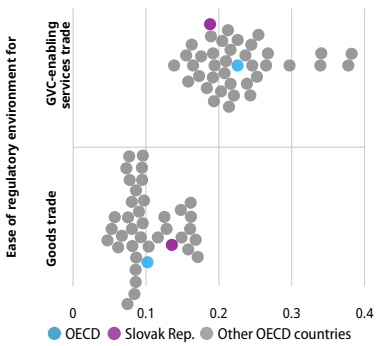
Ease of border processes



Barriers to trade in GVC-enabling services



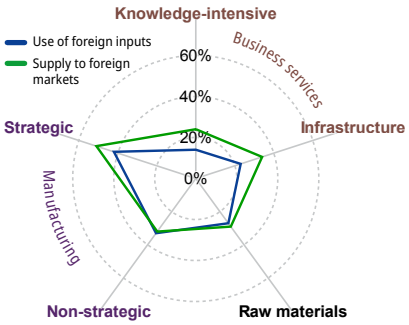
Regulatory alignment



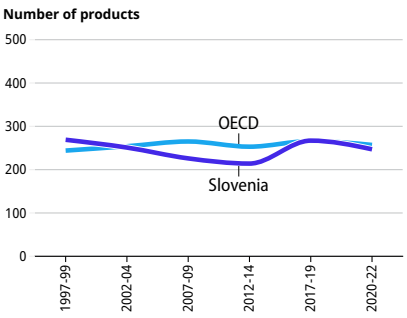
Slovenia

Monitoring supply chain interdependencies

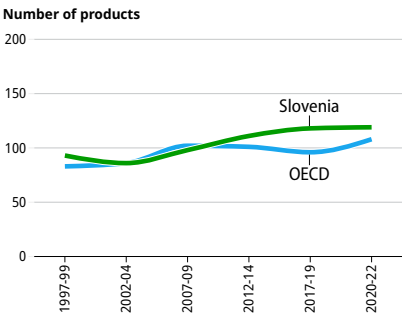
Global linkages of key industries



Significantly concentrated imports

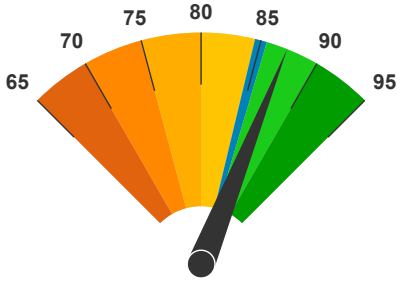


Significantly concentrated exports



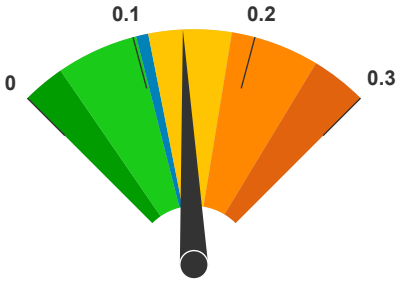
Agile, adaptable and aligned supply chains

Transparency of regulations



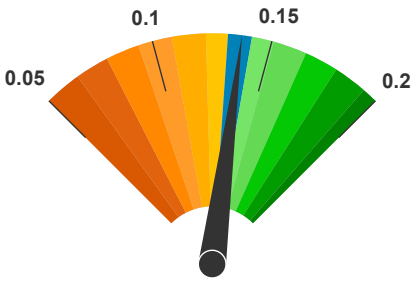
87%

Barriers to digital services trade



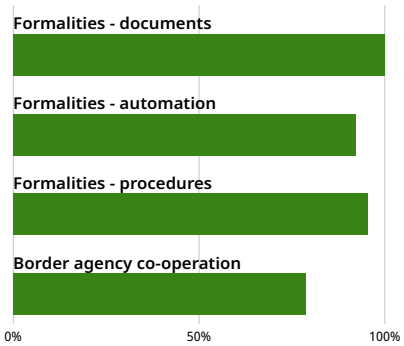
0.14

Digital trade integration & openness

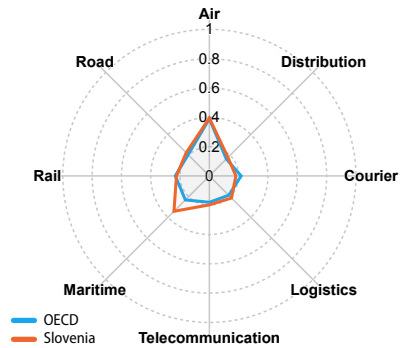


0.137

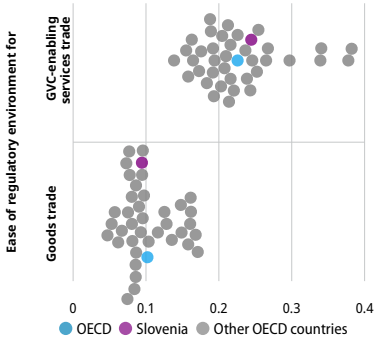
Ease of border processes



Barriers to trade in GVC-enabling services



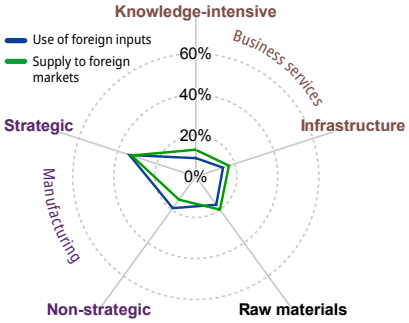
Regulatory alignment



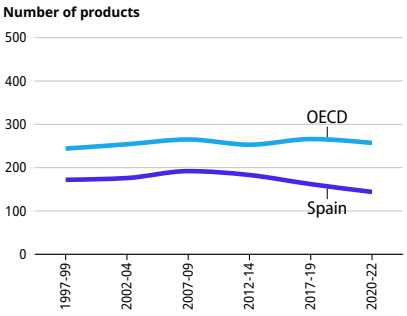
Spain

Monitoring supply chain interdependencies

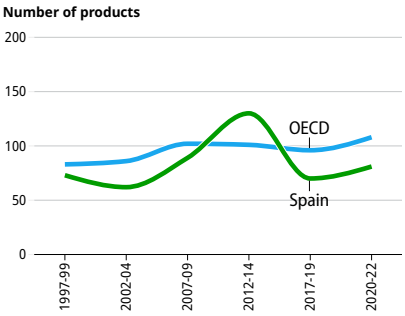
Global linkages of key industries



Significantly concentrated imports

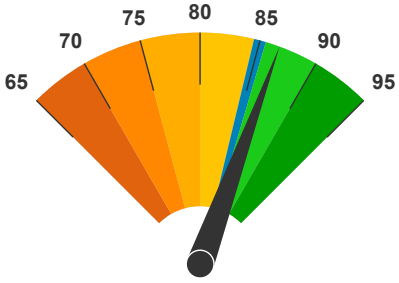


Significantly concentrated exports



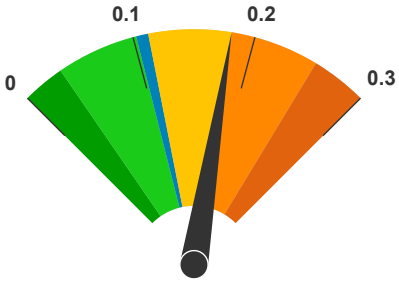
Agile, adaptable and aligned supply chains

Transparency of regulations



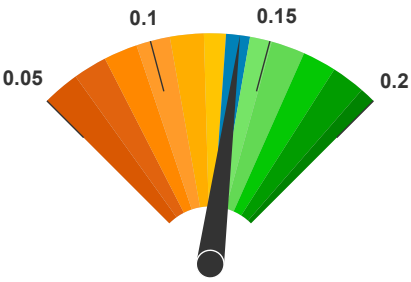
87%

Barriers to digital services trade



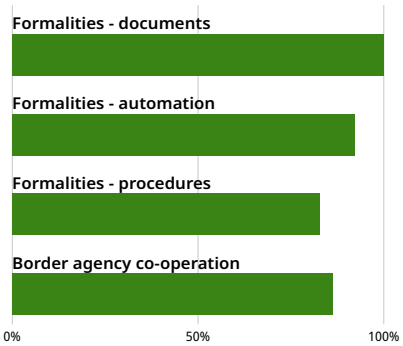
0.18

Digital trade integration & openness

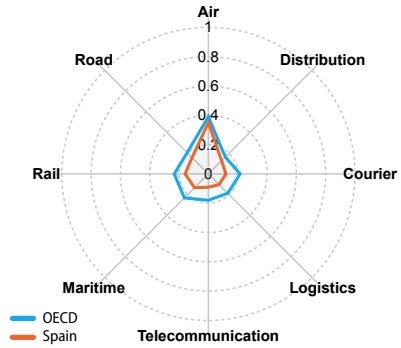


0.137

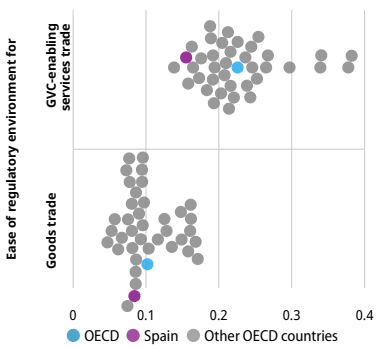
Ease of border processes



Barriers to trade in GVC-enabling services



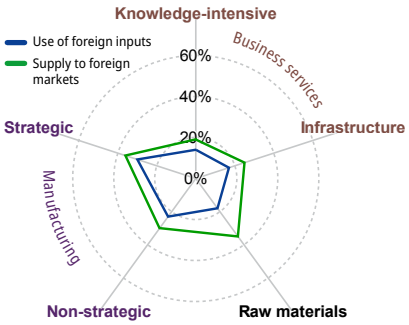
Regulatory alignment



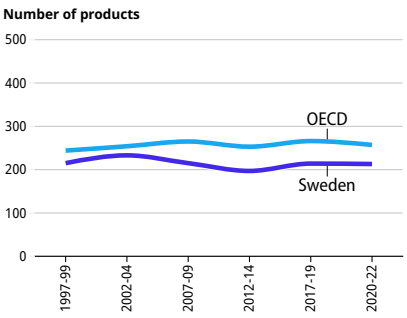
Sweden

Monitoring supply chain interdependencies

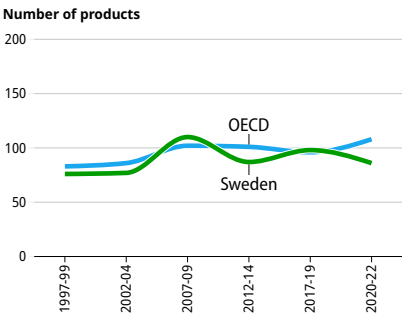
Global linkages of key industries



Significantly concentrated imports

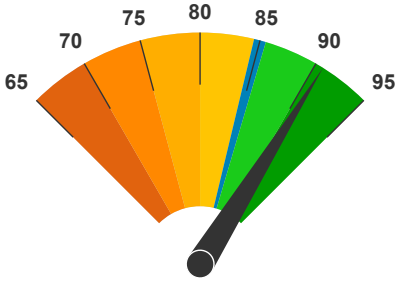


Significantly concentrated exports



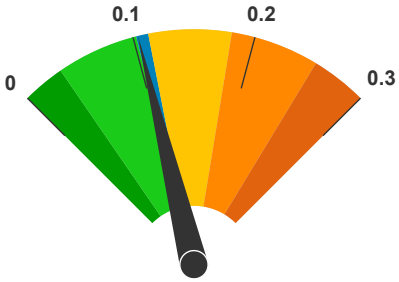
Agile, adaptable and aligned supply chains

Transparency of regulations



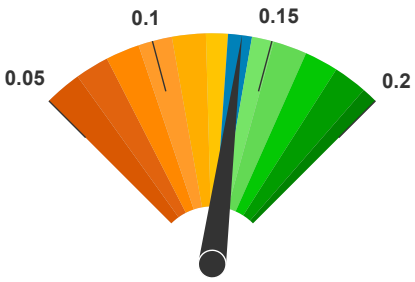
91%

Barriers to digital services trade



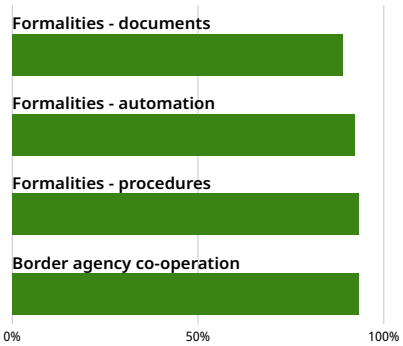
0.1

Digital trade integration & openness

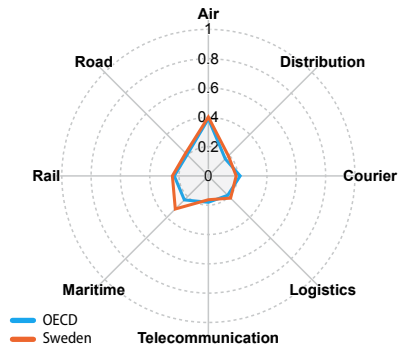


0.137

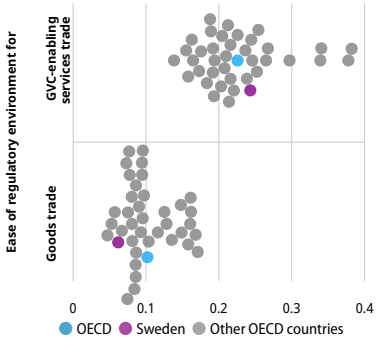
Ease of border processes



Barriers to trade in GVC-enabling services



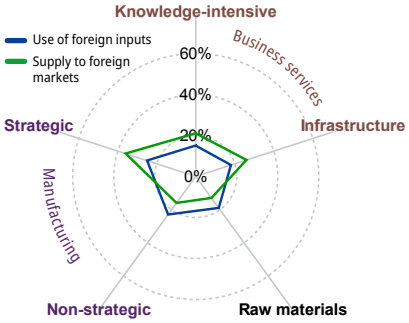
Regulatory alignment



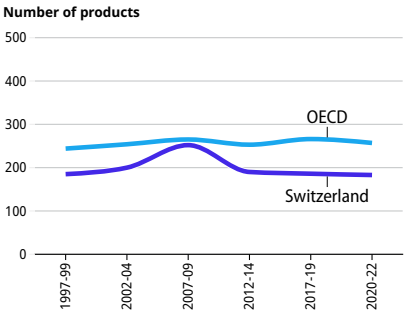
Switzerland

Monitoring supply chain interdependencies

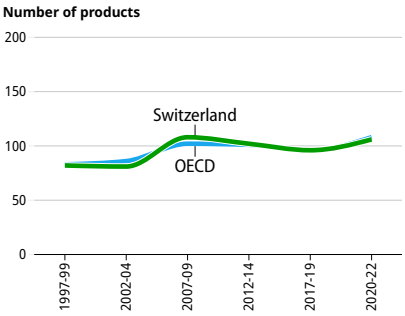
Global linkages of key industries



Significantly concentrated imports

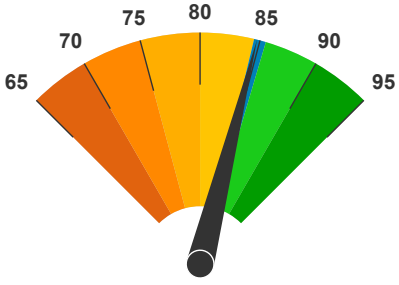


Significantly concentrated exports



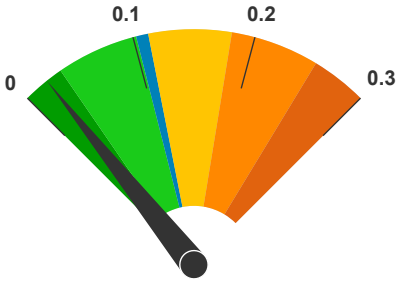
Agile, adaptable and aligned supply chains

Transparency of regulations



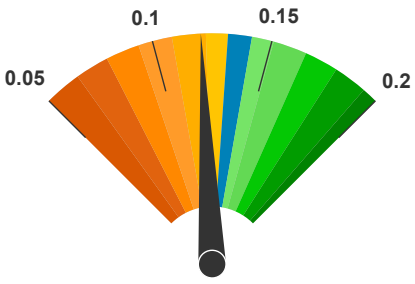
85%

Barriers to digital services trade



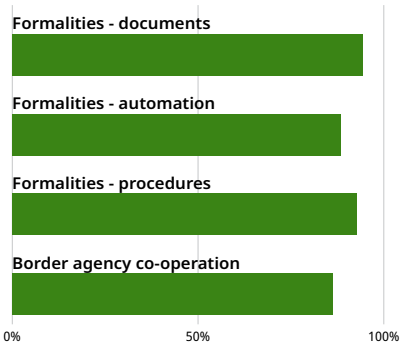
0.02

Digital trade integration & openness

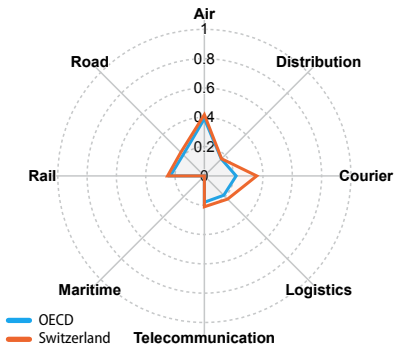


0.12

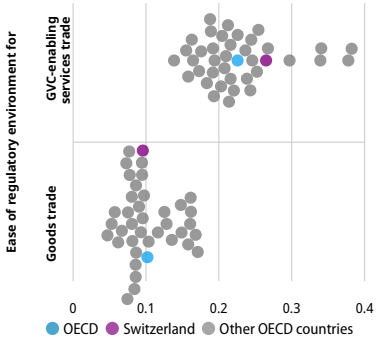
Ease of border processes



Barriers to trade in GVC-enabling services



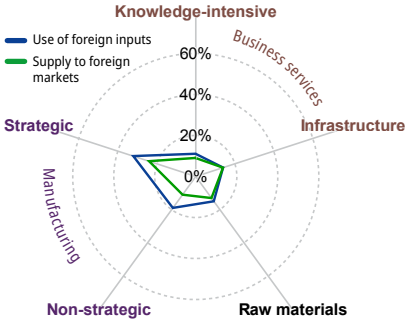
Regulatory alignment



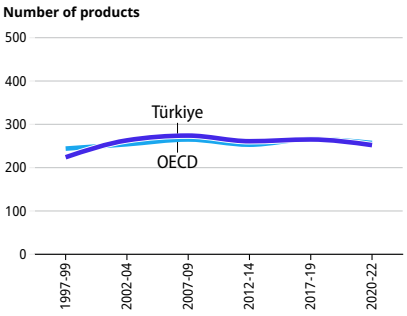
Türkiye

Monitoring supply chain interdependencies

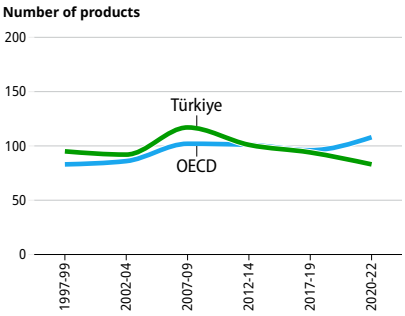
Global linkages of key industries



Significantly concentrated imports

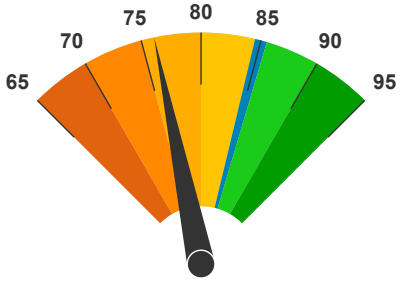


Significantly concentrated exports



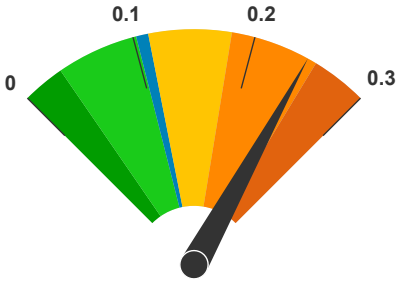
Agile, adaptable and aligned supply chains

Transparency of regulations



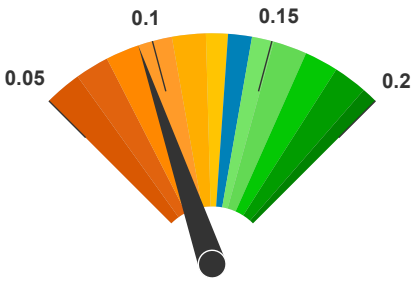
76%

Barriers to digital services trade



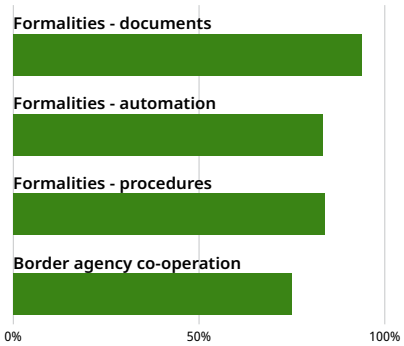
0.25

Digital trade integration & openness

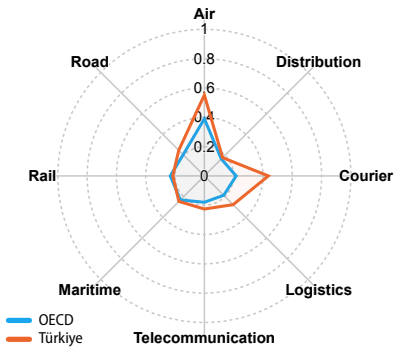


0.094

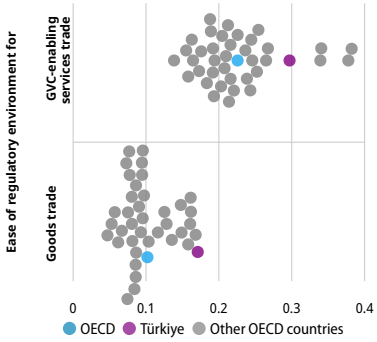
Ease of border processes



Barriers to trade in GVC-enabling services



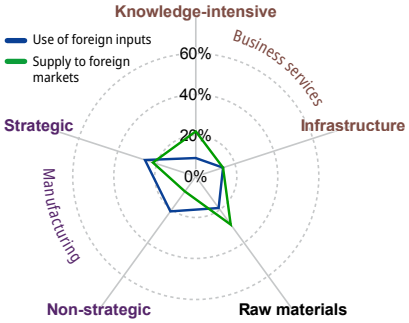
Regulatory alignment



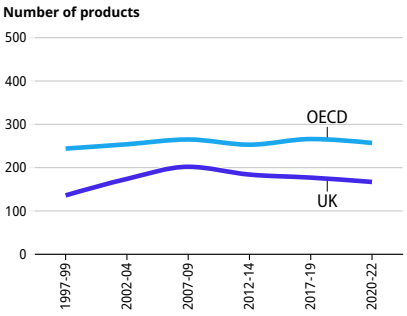
United Kingdom

Monitoring supply chain interdependencies

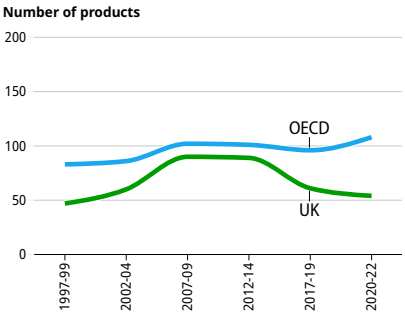
Global linkages of key industries



Significantly concentrated imports

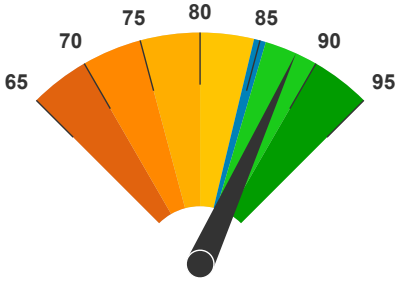


Significantly concentrated exports



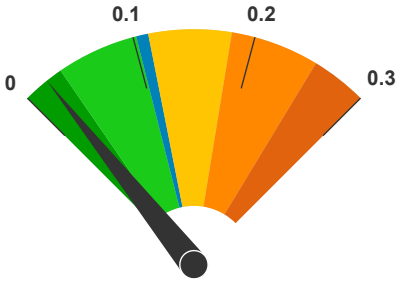
Agile, adaptable and aligned supply chains

Transparency of regulations



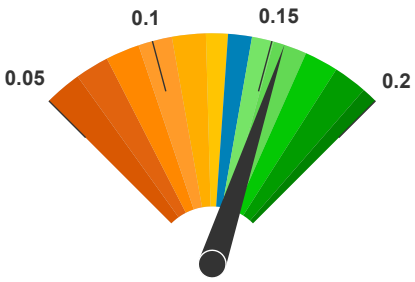
88%

Barriers to digital services trade



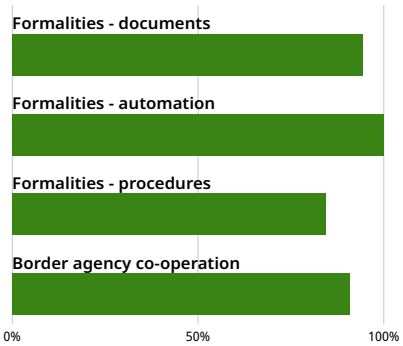
0.02

Digital trade integration & openness

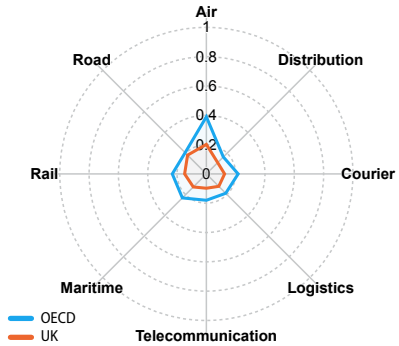


0.155

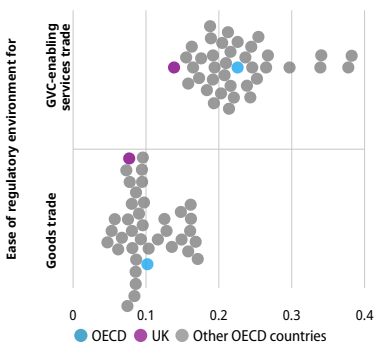
Ease of border processes



Barriers to trade in GVC-enabling services



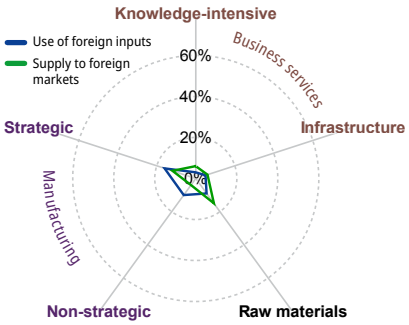
Regulatory alignment



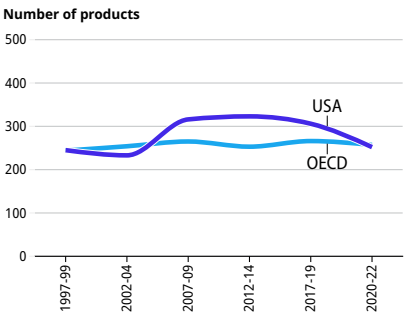
United States

Monitoring supply chain interdependencies

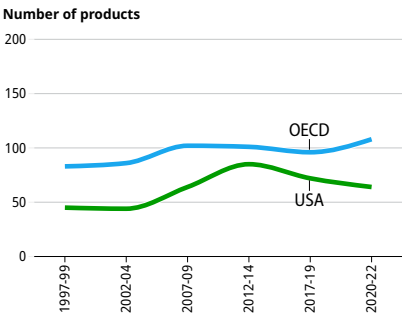
Global linkages of key industries



Significantly concentrated imports

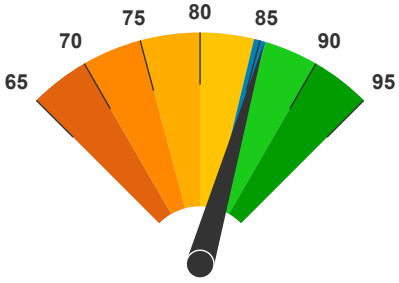


Significantly concentrated exports



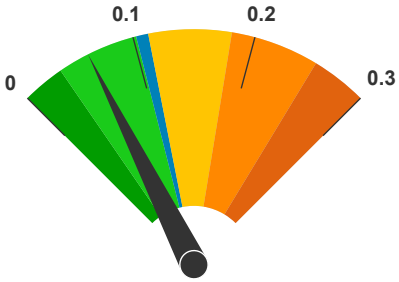
Agile, adaptable and aligned supply chains

Transparency of regulations



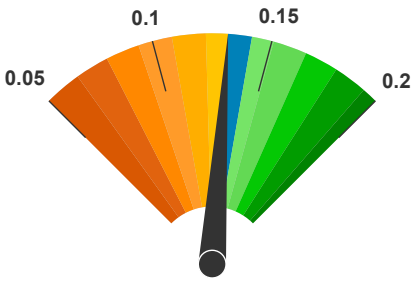
85%

Barriers to digital services trade



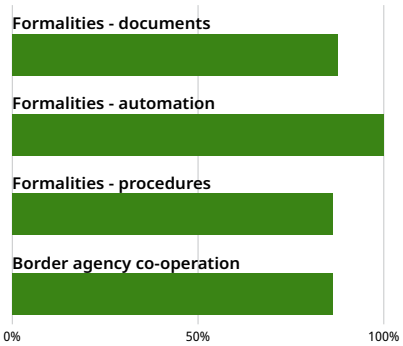
0.06

Digital trade integration & openness

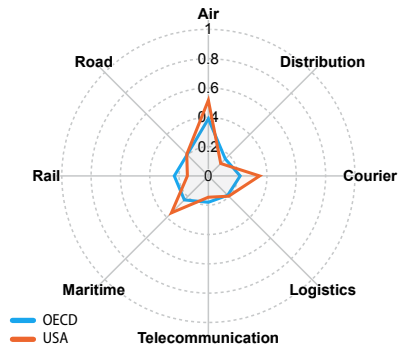


0.132

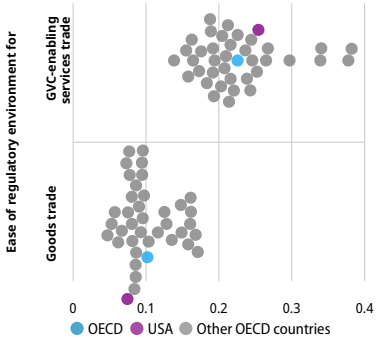
Ease of border processes



Barriers to trade in GVC-enabling services



Regulatory alignment



OECD Supply Chain Resilience Review

Navigating Risks

The key to supply chain resilience is not found in the elimination of risk, but in the effective navigation of risk. This is best accomplished by working together, through public, private and international co-operation with trusted partners. Policy environments that enable agility, adaptability and alignment are an essential antidote to a fragile, frozen and fractured international trading system.

The *OECD Supply Chain Resilience Review* encourages the strategic use of policy tools related to trade facilitation, digitalisation, trade in services and emerging data and analytical capacities to create the conditions for stronger, safer and more prosperous trade.

PRINT ISBN 978-92-64-92970-8
PDF ISBN 978-92-64-61386-7