

GLOBAL SUPPLY CHAINS IN TURBULENCE



International trade has grown significantly since the 1990s thanks to reforms and innovation in telecommunications and logistics. This has led to the deepening of global supply chains, which are characterised by geographically fragmented production and supply processes. The EBRD regions have benefited from these developments by increasing and diversifying their exports. Recently, however, disruptions in supply – particularly on account of Covid-19 and Russia’s invasion of Ukraine – have exposed some inherent weaknesses in supply chains. Firms across the EBRD regions, especially those with direct suppliers in China, have adjusted to these disruptions, primarily by increasing stocks of inputs and sourcing from larger numbers of suppliers. The climate crisis is likely to bring more disruption in the future.

Introduction

International trade has changed significantly since the early 1990s: the liberalisation of cross-border transactions, advances in information and communication technology (ICT), reductions in transport costs and innovations in logistics have all given firms greater incentives to break up production and supply processes across countries. These days, many firms choose to specialise in a specific task, rather than producing an entire product themselves.¹ As a result, global supply chains are very common, fostering technology transfer and access to capital and inputs along value chains.² At a global level, growth in supply chain-related trade stalled in 2008, with only intermittent periods of modest growth since then, but global supply chains still accounted for around half of all global trade in 2020.³

As countries in the EBRD regions have transitioned from command economies to market economies, they have opened up to the outside world and increased their productivity levels. On average, they are more entwined in global supply chains than the typical

¹ See Nicita et al. (2013).

² See World Bank (2020).

³ See World Bank (2020).

GLOBAL SUPPLY CHAINS ACCOUNTED FOR AROUND **HALF** OF ALL GLOBAL TRADE IN 2020

middle-income country. Their most important trading partners are advanced economies in the EU, but some have managed to successfully export large volumes of goods and services to other high-income economies, such as Israel, Switzerland and the United States of America. Economies in the EBRD regions differ in terms of their involvement in global supply chains: Central Asian economies still mostly produce commodities for further processing in other countries, while those that are members of the EU are tending to move towards advanced manufacturing and services and are more actively engaged in innovation. This chapter shows that, for EBRD countries in the EU (but not for other economies in the EBRD regions), greater participation in global supply chains and having trading partners with higher levels of income are both associated with more sophisticated exports (that is to say, trade in higher-productivity goods).

A system that is based on long supply chains needs all its parts to work like clockwork, making it inherently weak.⁴ The last couple of years have seen a great number of disruptions to the usual ways of doing business and international trade flows. Such supply-side disruptions – which have ranged from cyber-threats and the Russian invasion of Ukraine to systemic issues such as the Covid-19 pandemic and the climate crisis – have increased in frequency and will continue to destabilise global supply chains.⁵ At the same time, international political cooperation has begun to falter, and many people have become disenchanted with free trade. The combination of these trends has forced a rethinking of global supply chains and catapulted the resilience of supply chains to the top of countries' policy agendas (with some, for instance, considering friendshoring, whereby inputs are sourced from economies that share similar values). This chapter explores these developments in the context of the EBRD regions, both at an aggregate level and at firm level.

While specialisation on the basis of comparative advantages is optimal according to trade theory, policymakers are often concerned about the vulnerability that results from the concentration of exports and the volatility of export revenues. In 2021 (the most recent year for which data are available), all EBRD regions except Central Asia were, in terms of both export products and markets, more diversified than the average upper-middle and high-income economies.

The Covid-19 pandemic and the Russian invasion of Ukraine have disrupted deliveries of inputs to firms and international trade more broadly. Accordingly, the likelihood of supply chains being mentioned during firms' earnings calls has more than doubled, rising from 30 per cent in 2018 to 61 per cent in 2022.

A recent EBRD survey shows that more than three-quarters of all firms participating in global supply chains have implemented at least one measure aimed at strengthening the resilience of their supply chains (with the most common measure being an increase in stocks of inputs, followed by diversification of the supplier base). New suppliers tend predominantly to be from abroad, with only around a fifth of firms switching from an international supplier to a domestic equivalent. Despite pandemic-related disruption, relatively few firms have dropped Chinese suppliers, with the country remaining a key source of inputs for production in the EBRD regions.

One in ten firms report experiencing disruptions to supply on account of extreme weather events. In the future, firms may need to deal with such physical disruption more often and potentially on a larger scale, as well as responding to new policies and regulations that seek to mitigate the growing impact of climate change. For example, firms exporting certain key goods to the EU (including aluminium, fertilisers, iron and steel) will soon be subject to the Carbon Border Adjustment Mechanism (CBAM), a price correction applied at the border which seeks to level the playing field in terms of the effective carbon price that is faced by producers within and outside the EU. It has been estimated that the application of the CBAM may increase the price of goods imported into the EU by more than 50 per cent and will affect several countries in the EBRD regions. While firms' awareness of the CBAM and its consequences is limited in the EBRD regions, firms with better green management practices tend to be more aware of it and are more likely to have assessed the carbon intensity of their production as a result.

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⁴ See Javorcik (2020).

⁵ See World Economic Forum (2021).

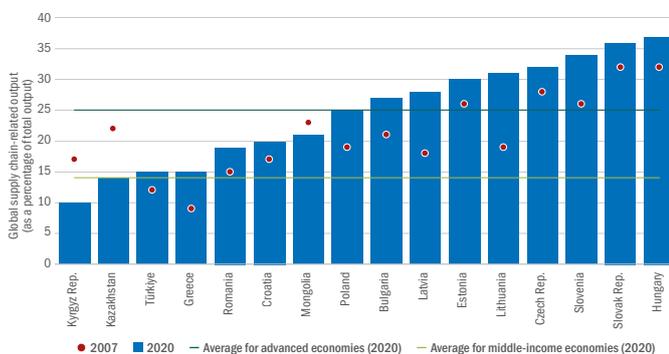
This chapter starts by providing an overview of participation in global supply chains in the EBRD regions, as well as other middle- and high-income economies. It then documents the changing patterns in international trade, starting with the recent changes in imports from China, before moving on to longer-term trends in export sophistication and diversification, as well as the impact that war has on trade outcomes. This chapter then analyses the supply chain challenges that have been faced by firms in the EBRD regions since the Covid-19 pandemic and the Russian invasion of Ukraine, before looking at the future of trade through the lens of the EU's Carbon Border Adjustment Mechanism. The chapter ends with a number of policy recommendations.

Participation in global supply chains

Global supply chains have existed for centuries, but they grew rapidly between the early 1990s and 2007 as technological advances and declining trade barriers incentivised manufacturers to extend production processes beyond national borders.⁶ In the EBRD regions, firms' participation in global supply chains varied across countries in the early 1990s. In some economies, such as Georgia, output relating to global supply chains was close to zero, while in others, such as the Czech Republic and Slovenia, it accounted for more than a fifth of total output.

In most EBRD economies, global supply chain-related output has increased substantially since 2007 as a share of total output (see Chart 3.1). The average level of participation in global supply chains across the EBRD regions is above the average for middle-income economies and roughly the same as the average for advanced economies. In 2007, global supply chain-related output accounted for an average of 21 per cent

CHART 3.1. In most EBRD economies, participation in global supply chains increased between 2007 and 2020



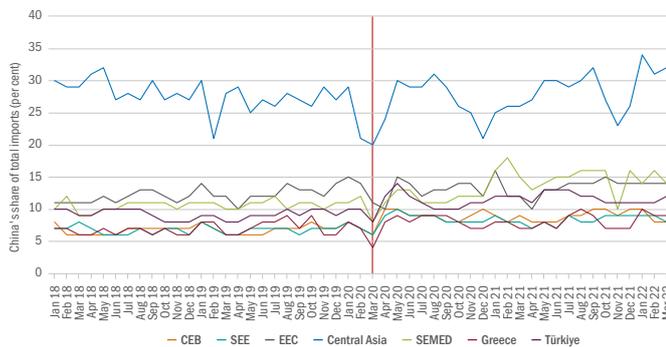
SOURCE: Asian Development Bank's Multi-Regional Input-Output (MRIO) database via the World Bank's World Integrated Trade Solution (WITS) website and authors' calculations.

NOTE: Data for other countries in the EBRD regions are not available from the same source.

⁶ See World Bank (2020).

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CHART 3.2. China's share of total imports in the EBRD regions is back to pre-Covid levels



SOURCE: UN Comtrade monthly data and authors' calculations.

of total output in the EBRD regions, compared with 16 per cent in middle-income economies. By 2020, the average for the EBRD regions had increased to 25 per cent, roughly equivalent to the average for advanced economies, whereas the figure for middle-income economies had dropped slightly to stand at 14 per cent.

However, in some countries, participation in global supply chains declined significantly between 2007 and 2020, notably in Kazakhstan, the Kyrgyz Republic and Mongolia. In other countries, such as Armenia, Azerbaijan, Serbia, Tajikistan and Uzbekistan, available data on participation in global supply chains are of poor quality but suggest that firms' involvement remained lower than in other EBRD countries.

Firms in EU member states are heavily involved in global supply chains. Hungary has the highest level of integration in global supply chains in the EBRD regions, with global supply chain-related output accounting for 37 per cent of total output in 2020, followed by the Slovak Republic (36 per cent) and Slovenia (34 per cent). In most EBRD economies in the EU, global supply chain-related output increased substantially between 2007 and 2020 as a percentage of total output, with the largest increases in percentage point terms being seen in Lithuania (12 percentage points) and Latvia (10 percentage points).

Changing patterns in international trade

Supply chain disruption can affect, in various ways, the overall value of international trade, the sophistication of exports, and diversification in terms of export products and markets. This section looks at each of those elements in turn.

Stabilisation of imports from China after the initial Covid-related disruption in March 2020

Looking at trade between China and the rest of the world, an average of more than 5 per cent of other countries' gross production is reliant on inputs from China (although advanced economies in the EU are the EBRD regions' most important trading partners). Moreover, between 2005 and 2015, China's reliance on foreign inputs declined, while other countries' reliance on Chinese inputs increased further.⁷ It is no surprise that when the pandemic first hit in March 2020, disruption to production resulted in a sudden dip in China's share of total imports across the EBRD regions (see Chart 3.2). However, imports from China recovered quickly and have remained remarkably stable since then, despite China's zero-Covid approach, which has continued to disrupt manufacturing and supply chains. Further dips have been observed subsequently in certain regions – in Central Asia in December 2020; and in both Central Asia and the southern and eastern Mediterranean (SEMED) in November 2021 – but none of these have been permanent.

Sophistication of exports

Most countries have firms that participate in global supply chains, but they do so in different ways. Most firms in western Europe participate in complex supply chains, producing advanced manufacturing and services, and engaging in innovative activities. In contrast, many firms in Central Asia export commodities for further processing in other countries, not adding much in terms of value. Firms in other EBRD regions typically fall somewhere between these two extremes.

Participation in global supply chains enhances efficiency through specialisation, with durable inter-firm relationships promoting the diffusion of technology and access to capital and inputs along the chain.⁸ Moreover, by participating in global supply chains, firms tend to develop skills and expertise, which – over time – enable them to move up the value chain and produce innovation of their own.⁹ In other words, participation in global supply chains has the potential to change what firms produce and export.

⁷ See Baldwin and Freeman (2021).

⁸ See World Bank (2020).

⁹ See EBRD (2014).

Some traded goods are associated with higher levels of productivity than others, and countries where firms produce these higher-productivity goods tend to perform better. Export sophistication ranks traded goods in terms of their implied productivity and is a strong predictor of economic growth.¹⁰ Products that are typically exported by rich countries are, by design, regarded as being more sophisticated than those exported by poor countries. However, among countries with the same GDP per capita, some have export baskets that are much more sophisticated than others. India and China, for example, have export baskets that are much more typical of rich countries than one might expect given their level of income.

Almost all EBRD countries in the EU saw increases in both global supply chain-related output (as a percentage of total output) and export sophistication between 2007 and 2020 (see Chart 3.3). Outside the EU, however, the picture is mixed. In the Kyrgyz Republic, the decline in global supply chain-related output was mirrored by a fall in the sophistication of exports, but Kazakhstan and Mongolia saw the two measures move in opposite directions. To some extent, this reflects variation in patterns of specialisation, with firms in some economies specialising mainly in commodities or lower-value-added manufacturing.¹¹

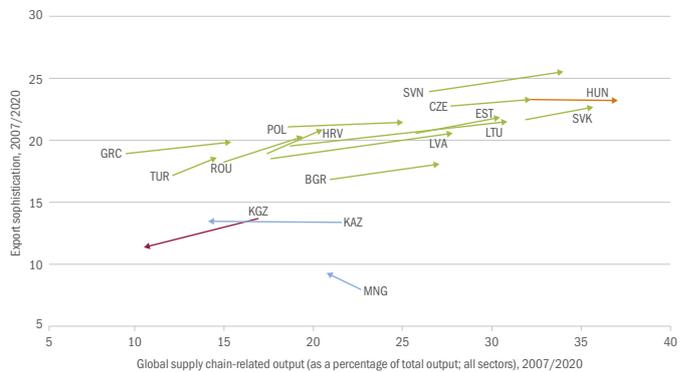
Over the same period, most EBRD economies in the EU observed increases in both the weighted average GDP per capita of export destinations and the sophistication of exports (see Chart 3.4) as firms moved up the value chain and reaped the benefits of innovation. Again, developments outside the EU were mixed.

Diversification of export products and markets

There is substantial variation across countries in terms of the average number of products that firms export and the average number of destinations that they export to. Firms in low-income economies typically export only a small range of products. While specialisation on the basis of comparative advantages is theoretically optimal, policymakers are often concerned about the vulnerability and income volatility that result from excessive concentration of exports.¹² As economies develop further, firms tend to start exporting a broader range of products to a wider set of countries. At income per capita levels of about US\$ 25,000 at PPP in constant 2005 international US dollars, firms tend to specialise again in line with their respective comparative advantages.¹³

One way of measuring the diversification of export products and markets is to use a modified Herfindahl-Hirschman index. This is calculated by squaring each destination's share in the total exports of a country, adding the resulting numbers together, subtracting the result from one and multiplying by 100. A similar measure can be calculated for product groups at the four-digit level of the Harmonised System (which includes groups such as chalk and imitation jewellery). The resulting measure ranges from 0 (full concentration) to 100 (full diversification).

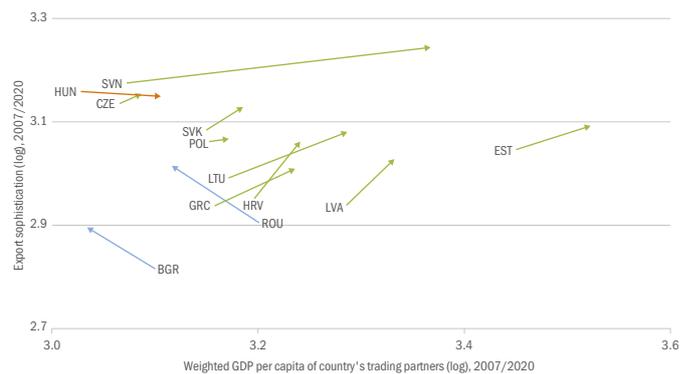
CHART 3.3. Greater participation in global supply chains is typically associated with more sophisticated exports



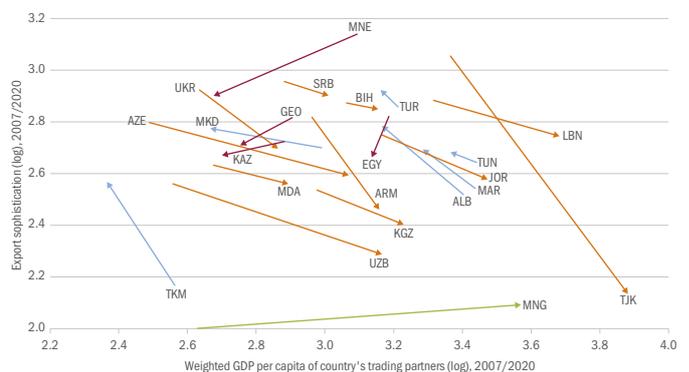
SOURCE: UN Comtrade annual data, the Asian Development Bank's MRIO database via the World Bank's WITS website, the World Bank's World Development Indicators and authors' calculations.
NOTE: Where data for 2020 are missing, 2019 figures have been used. The sophistication of exports excludes energy commodities. See also Box 3.1.

CHART 3.4. Export sophistication and weighted GDP per capita of trading partners

Panel A. EU member states



Panel B. Non-EU countries



SOURCE: UN Comtrade annual data, the World Bank's World Development Indicators and authors' calculations.
NOTE: Where data for 2020 are missing, 2019 figures have been used. The sophistication of exports excludes energy commodities. See also Box 3.1.

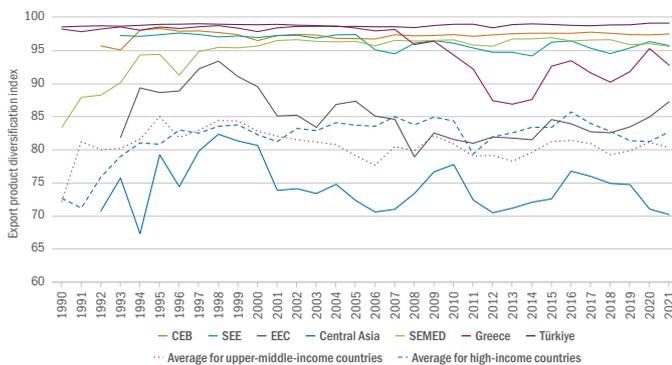
¹⁰ See Hausmann et al. (2007).

¹¹ See World Bank (2020).

¹² See Haddad et al. (2011).

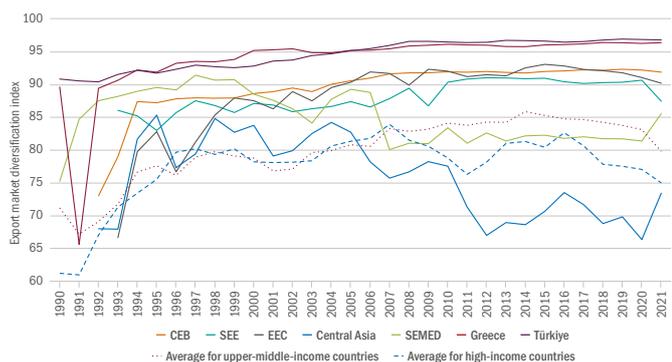
¹³ See Cadot et al. (2011).

CHART 3.5. The EBRD regions vary considerably in terms of the diversification of export products



SOURCE: UN Comtrade annual data and authors' calculations.
NOTE: Based on the Harmonised System at the four-digit level. Serbia and Montenegro are included as a single entity between 1993 and 2005, and separately thereafter (forming part of the SEE average). Data for the West Bank and Gaza are included in the SEMED average from 2000 onwards.

CHART 3.6. They also vary substantially in terms of export market diversification



SOURCE: UN Comtrade annual data and authors' calculations.
NOTE: Serbia and Montenegro are included as a single entity between 1993 and 2005, and separately thereafter (forming part of the SEE average). Data for the West Bank and Gaza are included in the SEMED average from 2000 onwards.

The EBRD regions differ considerably in terms of the diversification of export products and markets. Türkiye, central Europe and the Baltic states (CEB), south-eastern Europe (SEE) and the SEMED region are the most diversified in terms of export products (see Chart 3.5). Eastern Europe and the Caucasus (EEC) and Central Asia are the least diversified – indeed, they have seen a reduction in product diversification since 1998. Türkiye, Greece and the CEB region are the most diversified in terms of export markets, alongside the EEC region (see Chart 3.6). Central Asia and the SEMED region have seen considerable declines in export market diversification since about 2005. In 2021 (the most recent year for which data are available), all EBRD regions except Central Asia were, in terms of both export products and markets, more diversified than the average upper-middle-income and high-income economies.

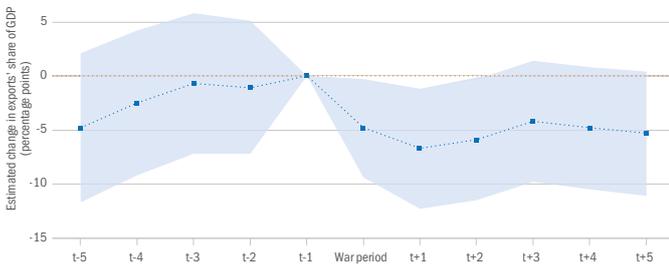
The impact that war has on international trade

This section looks at the impact of major disruptions to global supply chains and international trade, starting with wars. Chapter 1 explored the effect that wars have on GDP, inflation, external balances and investment using a database covering the period from 1816 to 2014. This section uses an event study to analyse the impact that wars have on international trade, focusing on the period from 1990 to 2020 and combining the Correlates of War database with UN Comtrade annual data. The event study looks at 43 economies (nine of which are in the EBRD regions) that experienced at least one war on their territory in the relevant period, considering various variables of interest. Where a country experienced multiple wars in that period, the years between those wars are excluded from the analysis.

The analysis focuses on differences between outcomes of interest in the years before and after the war. Regressions are used to link those outcomes to (i) dummy variables for each year before the start of the war (up to a maximum of five years), (ii) a dummy variable indicating the war period, and (iii) dummy variables for each year after the end of the war (again, up to a maximum of five years). To account for differences in countries' levels of development and global economic conditions at various points in time, all regressions include country and calendar year fixed effects.

EXPORT MARKET DIVERSIFICATION HAS DECLINED CONSIDERABLY IN CENTRAL ASIA AND THE SEMED REGION SINCE ABOUT 2005

CHART 3.7. International trade falls significantly during and after a war on a country's own territory



SOURCE: Correlates of War database, UN Comtrade annual data, WITS website, the World Bank's World Development Indicators and authors' calculations.

NOTE: This chart summarises the estimates derived from an event study regression covering the period between 1990 and 2020. The dots represent estimates for the years before, during and after the war, with data one year before the war acting as a baseline. The shaded area indicates the 95 per cent confidence interval. Regression includes country and calendar year fixed effects.

This analysis reveals that, on average, exports' share of GDP declines sharply during a war, falling by 4.8 percentage points, and remains below pre-war levels five years after the war has ended (see Chart 3.7). Trade is redirected towards allied nations, with the percentage of exports going to allies increasing by 1.8 percentage points during the war, before rising further after the war, although this effect is not statistically significant in such a small sample.

On average, a country's export product diversification index increases by 3 index points during a war and continues to rise thereafter, with the average level in the fourth year after the end of the war standing 8 index points above the pre-war level – a statistically significant difference. Thus, the basket of exported products becomes more diversified. A similar – albeit smaller – effect can be observed for export market diversification, although in that case the estimates are not statistically significant.

Overall, these results suggest that wars tend to suppress trade to a considerable extent, with some trade being redirected towards allies.

Firms adapt to supply chain disruption

The initial stages of the Covid-19 pandemic were a significant shock to firms' operations, both across the EBRD regions and beyond. Non-essential shops and service providers (including banks; see Chapter 4) were often forced to shut down for periods of time, while other firms faced reduced demand for their products and had to furlough workers. Firms that relied on inputs from other countries (especially China) often faced disruption to their deliveries, with international borders being partially or fully closed.

Growing risks relating to supply chains: evidence from earnings calls

Even before the pandemic, concerns about supply chains were on the rise. Indeed, when international trade wars intensified in 2018, many executives talked about reshuffling their supply chains. However, if earnings calls – conference calls where managers of a listed company, investors, analysts and journalists come together to discuss the relevant firm's performance in the last quarter – are any indication, the current squeeze on supply chains has executives more concerned about the sourcing of inputs than ever before.

Data on earnings calls become available before official statistics, and since most listed firms hold earnings calls, they can be used to supplement survey data, providing additional insights. The transcripts of earnings calls provide an opportunity to look at the ways in which business experts discuss supply chain issues and, by extension, see which firms are exposed to supply chain disruption.¹⁴

This section uses NL Analytics' platform and tools to analyse the transcripts of 194,000 earnings calls between 2013 and the second quarter of 2022.¹⁵ Those transcripts cover a total of 11,445 firms headquartered in 85 countries. Only around 1.2 per cent of the transcripts come from firms headquartered in the EBRD regions, but in many other instances managers and investors discuss economic developments in the EBRD regions in the context of their firms' operations, investments and sales.

The analysis identifies sentences relating to supply chain topics by checking for relevant keywords,¹⁶ which have been chosen with the help of NL Analytics' keyword tool. It then calculates the difference between the number of sentences involving positive sentiments (those containing words such as "good" or "opportunity") and the number containing negative words (such as "disruption" or "difficult").¹⁷ This measure of supply chain sentiment tracks whether management and investors feel that supply chains are contributing positively or negatively to firms' business performance and outlook. Lastly, the analysis tracks whether the terms "risk", "risky", "uncertainty" or "uncertain" (or any of their synonyms) are used in combination with supply chain keywords.¹⁸

¹⁴ Transcripts of earnings calls have been used, for example, to study firm-level exposure to shocks such as Brexit (see Hassan et al., 2020b), the Covid-19 pandemic (see Hassan et al., 2020a) and climate change (see Sautner et al., 2021).

¹⁵ See Javorcik et al. (2022a).

¹⁶ Those keywords are "global chain", "logistic chain", "logistical chain", "sub-supplier", "supplier", "supplier chain", "suppliers", "supply chain", "supply logistic", "supply network", "supply technologies" and "value chain".

¹⁷ A list of more than 2,500 positive and negative words has been used. That list, which is specific to financial texts, has been taken from Loughran and McDonald (2011).

¹⁸ For example, someone saying "we are balancing imports with local sourcing to de-risk the company from tariffs and supply chain risks" indicates that supply chains are contributing to uncertainty, whereas someone talking about "the disruption felt in India, where aggressive shutdown mandates were enacted, impacting market demand and supply chain infrastructure" indicates negative sentiment regarding supply chains.

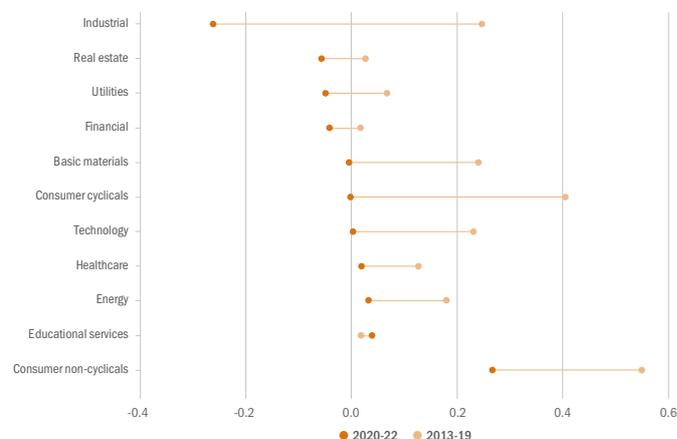
On the basis of this analysis, risks relating to supply chains were relatively stable from 2013 to 2019, but then increased sharply between 2020 and 2022. Similarly, the average sentiment around supply chains deteriorated significantly in 2020 and has not recovered since.¹⁹ These metrics suggest that the intensity of the current disruption is unprecedented. The upward trend observed for supply chain risk and the downward trend witnessed for sentiment have continued into 2022, despite earlier predictions that the squeeze on supply chains would be a short-lived phenomenon.

Almost all sectors covered by the data saw increases in risk and a deterioration in sentiment between 2013-19 and 2020-22 (with educational services being the sole exception), underlining the systemic nature of recent supply chain disruption (see Chart 3.8). The most dramatic changes were observed for the industrial sector, consumer goods and technology. For example, the average number of risk-related sentences on supply chains in the automobile and auto parts industry in 2020-22 was four times the level seen in 2013-19; for technological equipment it increased six-fold; and for personal and household products it rose 12-fold.

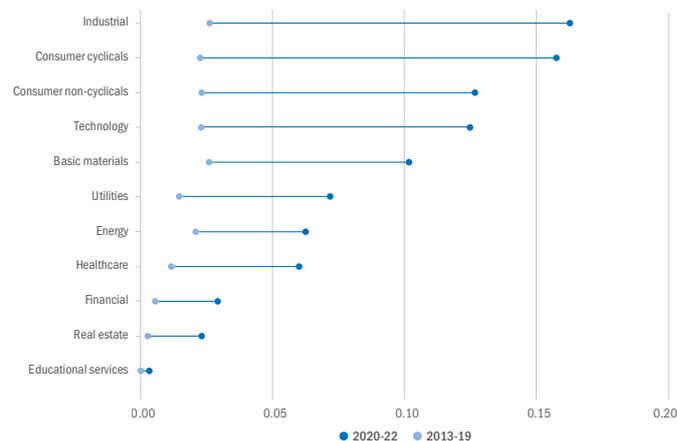
Supply chains are among the top causes of concern for global firms and investors (see Chart 3.9). For the purposes of comparison, similar measures of risk have been constructed for other major sources of concern, including Covid-19, climate change and the Russian invasion of Ukraine. At the peak of the pandemic in the second quarter of 2020, 12 per cent of all sentences containing a risk-related keyword concerned Covid-19. By the first half of 2022, there were almost as many risk-related sentences about supply chains (2.9 per cent) as there were about Covid-19 (3.7 per cent). On the basis of this metric, supply chains were a bigger concern for global firms and investors in the first half of 2022 than climate change and the war in Ukraine (which were cited in 1.7 per cent of risk-related sentences each). In a subsample relating only to firms headquartered in an EU member state or an EBRD economy, the Russian invasion of Ukraine played a larger role, featuring in 4.5 per cent of all risk-related sentences in the first half of 2022.

CHART 3.8. Across sectors, supply chain-related risks have increased and sentiment has deteriorated

Panel A. Average net number of positive sentences on supply chains



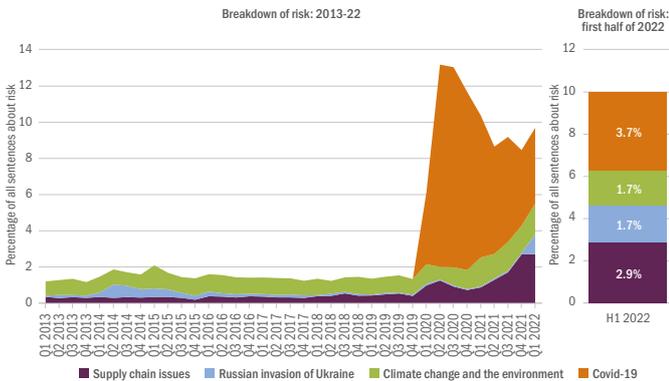
Panel B. Average number of sentences about supply chains and risks



SOURCE: NL Analytics and authors' calculations.
NOTE: Data are as at 13 July 2022. Panel A shows the average difference per earnings call between (i) the number of sentences containing a supply chain-related keyword and a positive word and (ii) the number of sentences containing a supply chain-related keyword and a negative word. Panel B shows the average number of sentences per earnings call that contain both (i) a supply chain-related keyword and (ii) a word conveying a sense of risk. "Industrial" comprises industrial and commercial services, industrial goods and transport; "consumer cyclicals" comprises automobiles and auto parts, retailers, cyclical consumer products and cyclical consumer services; "consumer non-cyclicals" comprises consumer goods conglomerates, food and beverages, and personal and household products and services.

¹⁹ These developments in text-based metrics closely mirror movements in the Global Supply Chain Pressure Index compiled by the Federal Reserve Bank of New York, which brings together a number of different supply chain-related metrics (such as the cost of shipping raw materials and container shipping rates).

CHART 3.9. Supply chain risks are among the top causes of concern for global firms and investors



SOURCE: NL Analytics and authors' calculations.

NOTE: Data are as at 13 July 2022. This chart shows the percentages of risk-related sentences that contain keywords relating to specific topics. Covid-19 keywords ("corona virus", "coronavirus", "covid", "covid19", "ncov" and "sarscov") were taken from Hassan et al. (2020a); keywords relating to the invasion of Ukraine were taken from Hassan et al. (2021) and NL Analytics' keyword tool; and keywords relating to climate change and the environment were taken from Sautner et al. (2021) and NL Analytics' keyword tool.

ACROSS NEARLY ALL SECTORS, SUPPLY CHAIN RISKS HAVE BEEN SIGNIFICANTLY HIGHER IN 2020-22 THAN THEY WERE IN 2013-19, UNDERLINING THE SYSTEMIC NATURE OF RECENT SUPPLY CHAIN DISRUPTION

Uncertainty relating to supply chains may weigh on the investment, profit margins and operating revenue of firms in the EU and the EBRD regions. In order to analyse the links between supply chain issues and firms' performance, the average sentiment and perceived risk for each year and industry (at the three-digit level of the Standard Industrial Classification (SIC)) was combined with data on more than 48,000 large manufacturing firms in the EU and the EBRD regions for the period 2013-21, taken from Bureau van Dijk's Orbis database.

Regression analysis (see Table 3.1) links various measures of firm-level performance (such as profit margins or employment) to various measures of risk and sentiment, both related and unrelated to supply chain disruption. That analysis takes account of any firm-specific changes in risk and sentiment in sentences not related to supply chains. In addition, firm and country-year fixed effects capture any factors that affect business outcomes across firms at a given point in time or influence the performance of a given firm throughout the period.

On average, a 1 standard deviation increase in supply chain risk, as reflected in the transcripts of earnings calls, is associated with a 0.4 per cent drop in investment (annual change in the log of fixed assets) and profit margins that are 0.14 percentage point lower six months later. In the EBRD regions, exposed firms have profit margins that are 0.2 percentage point smaller and operating revenues that are 0.9 per cent lower. These results suggest that insuring against supply chain risks (for example, through an increase in stocks or diversification of suppliers) may be worthwhile in terms of firms' bottom lines, despite the cost of implementing such measures.

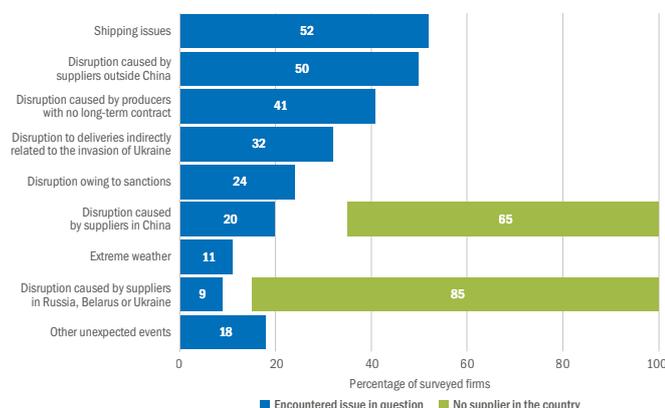
TABLE 3.1. Supply chain risk is negatively correlated with firm-level performance in the EU and the EBRD regions

	Investment _{t-6 months}		Profit margin _{t-6 months}		Operating revenue (log) _{t-6 months}		Employees (log) _{t-6 months}	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Supply chain risk _{t-6 months}	-0.004*** (0.009)	-0.004*** (0.009)	-0.137* (0.067)	-0.135* (0.072)	-0.004 (0.236)	-0.004 (0.253)	-0.004 (0.151)	-0.003 (0.156)
Supply chain sentiment _{t-6 months}	0.002 (0.270)	0.001 (0.648)	0.059 (0.179)	0.043 (0.340)	0.003 (0.303)	0.001 (0.795)	0.001 (0.654)	0.001 (0.761)
Non-supply chain risk _{t-6 months}		-0.001 (0.574)		-0.027 (0.657)		-0.001 (0.725)		-0.001 (0.736)
Non-supply chain sentiment _{t-6 months}		0.008*** (0.000)		0.113* (0.053)		0.015*** (0.000)		0.002 (0.459)
R ²	0.269	0.269	0.621	0.621	0.954	0.954	0.847	0.847
Firms	48,083	48,083	48,083	48,083	48,083	48,083	48,083	48,083
Observations	290,080	290,080	290,080	290,080	290,080	290,080	290,080	290,080

SOURCE: NL Analytics, Bureau van Dijk's Orbis database and authors' calculations.

NOTE: Data are as at 13 July 2022. All regressions use ordinary least squares estimation and include firm and country-year fixed effects. The sample spans the period from 2013 to 2021 and consists of all manufacturing firms in the EU and the EBRD regions with more than 100 employees for which data on all four outcomes are available. Risk and sentiment variables represent industry-year averages calculated on the basis of earnings call transcripts for industries at the three-digit level of the Standard Industrial Classification (SIC). Industry-sector measures are standardised for a 1 standard deviation increase in risk and sentiment measures. Dependent variables are winsorised at the 1st and 99th percentiles. Investment is defined as the annual change in the log of fixed assets. Profit margins are calculated as profit before tax as a percentage of operating revenue. Standard errors in parentheses are clustered at industry-year level, with *, ** and *** denoting statistical significance at the 10, 5 and 1 per cent levels, respectively.

CHART 3.10. More than half of all surveyed firms in the EBRD regions had encountered disruption to deliveries owing to shipping issues



SOURCE: EBRD survey and authors' calculations.

NOTE: Based on the responses of 815 firms that both export and import across 15 economies in the EBRD regions.

74%
OF SMES REPORTED
SUPPLY CHAIN
DISRUPTION

MORE THAN **HALF** OF
ALL FIRMS HAD BEEN
AFFECTED BY SHIPPING
ISSUES

MORE THAN A
10TH
OF FIRMS HAD
EXPERIENCED
DISRUPTION CAUSED
BY EXTREME WEATHER

Disruption faced by firms in the EBRD regions since the start of the Covid-19 pandemic

Listed firms are not the only ones that face supply chain risks and disruption – most firms do. Firms that both export and import directly – “two-way traders” – are potentially the most affected by supply chain disruption. In order to better understand the challenges that firms have faced on account of the Covid-19 pandemic and Russia’s invasion of Ukraine, the EBRD conducted a short telephone survey between May and July 2022, talking to businesses in 15 countries: Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Lithuania, Morocco, Poland, Romania, Serbia, the Slovak Republic, Slovenia, Tunisia and Türkiye (see Box 3.3 for more details). All of the participants had previously taken part in the most recent round of Enterprise Surveys, which was conducted by the EBRD, the World Bank and the EIB in 2018-20 and covered formal-sector firms with at least five employees in the manufacturing, construction and service sectors.

More than three-quarters of the firms surveyed had experienced at least one disruption to deliveries of inputs since the start of the pandemic. Disruption was not limited to large firms (defined as those with at least 100 employees, which are more likely to be deeply integrated into global supply chains), with 74 per cent of small and medium-sized enterprises (SMEs) reporting supply chain disruption. There was a broad geographical spread, with 80 per cent of surveyed firms in EU member states having been affected and 70 per cent of respondents outside the EU being affected.

Overall, 52 per cent of firms reported that they had encountered shipping issues, 50 per cent had experienced disruption to deliveries from suppliers outside China, and 41 per cent reported disruption to deliveries from wholesalers or producers with whom they did not have long-term contracts (see Chart 3.10). A fifth of firms had experienced disruption to deliveries from suppliers in China, while 18 per cent of firms reported disruption caused by other unexpected events, such as strikes, fire and cyber-attacks. Meanwhile, 11 per cent of firms had experienced disruption caused by extreme weather events.

Almost a quarter of firms reported disruption caused by Russia’s invasion of Ukraine and the resulting international sanctions. While only 15 per cent of surveyed firms had direct suppliers in Belarus, Russia or Ukraine, two-thirds of those firms had experienced disruption to the delivery of inputs originating in those countries. Meanwhile, a significant proportion of the remaining firms had experienced disruption to deliveries that was indirectly related to the invasion of Ukraine.

55%

OF FIRMS HAVE INCREASED STOCKS OF INPUTS IN RESPONSE TO SUPPLY CHAIN DISRUPTION

Steps taken by firms to increase the resilience of their supply chains

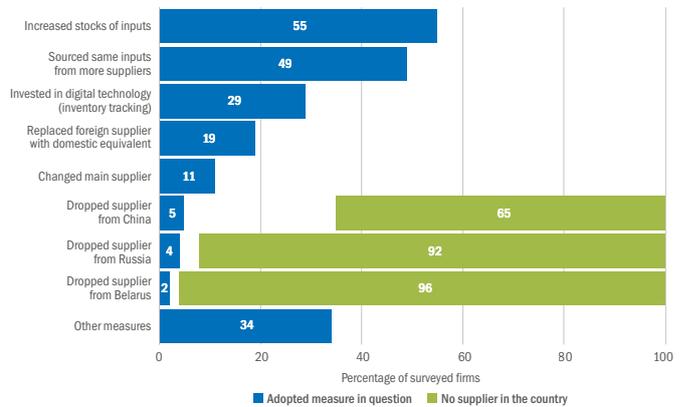
More than three out of four firms responded to disruption by adopting at least one measure in order to make their supply chains more resilient. Such action differed widely across firms, in line with variation in their circumstances. Similar variation in responses was observed in previous episodes. For example, firms affected by the 2011 Tōhoku earthquake and tsunami in Japan tended to diversify their suppliers, while the leading firm in Thailand’s hard disk drive industry responded to the Chao Phraya floods by further concentrating production in the river basin, finding that diversification was not its best option when it came to managing supply chain risk.²⁰

The survey results indicate that the two most popular measures were both relatively quick to implement and easy to reverse: increasing stocks of inputs (adopted by 55 per cent of respondent firms; see Chart 3.1.1) and sourcing the same inputs from more suppliers (49 per cent). New suppliers were predominantly from abroad, with only around a fifth of firms switching from an international supplier to a domestic equivalent.

Almost three in ten firms invested in digital technology (such as inventory tracking and optimisation, cargo tracking and automated warehousing), while 11 per cent of firms changed their main supplier of inputs.

Of the 34 per cent of firms with suppliers in China, only one in seven dropped such suppliers. While the percentage of firms with suppliers located in Belarus and Russia was low – less than 10 per cent – half of those dropped their suppliers in those countries.

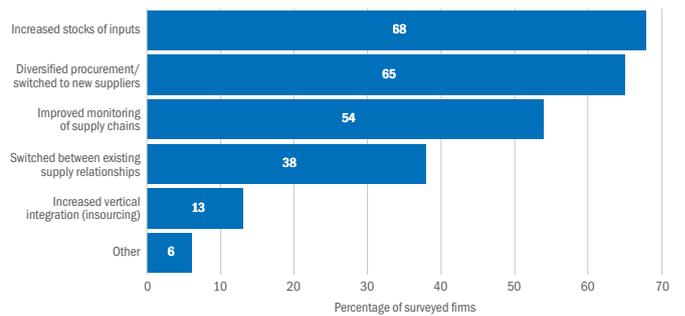
CHART 3.1.1. More than three-quarters of surveyed firms in the EBRD regions took steps to increase the resilience of their supply chains



SOURCE: EBRD survey and authors’ calculations.

NOTE: Based on the responses of 815 firms that both export and import across 15 economies in the EBRD regions.

CHART 3.1.2. Similar steps were taken by German manufacturing firms



SOURCE: ifo Business Survey (July 2022).

NOTE: Based on the responses of 3,000 manufacturing firms in Germany.

Similar trends were observed in Germany when equivalent questions were put to 3,000 manufacturers as part of the ifo Business Survey in July 2022. More than 87 per cent of those firms reported that they had taken steps to increase the resilience of their supply chains. Like firms in the EBRD regions, they mainly opted for measures that were quick to implement (see Chart 3.1.2): increasing stocks of inputs (adopted by 68 per cent of firms) and diversifying procurement (65 per cent). More than half improved their monitoring of supply chains, and over a third switched between existing supply relationships, while 13 per cent sought to produce inputs in house, having previously outsourced them to independent suppliers, thereby increasing the vertical integration of production through insourcing.

²⁰ See Inoue and Todo (2017), Matous and Todo (2017) and OECD (2020).

TABLE 3.2. Firms with direct suppliers in China were more likely to adopt most measures in order to increase the resilience of their supply chains

	Changed main supplier	Sourced same inputs from more suppliers	Increased stocks of inputs	Replaced foreign supplier with domestic equivalent	Invested in digital technology (inventory tracking)	Adopted other measures to increase resilience of supply chains
	(1)	(2)	(3)	(4)	(5)	(6)
Had direct supplier located in China in last three years (indicator)	0.011 (0.016)	0.051** (0.025)	0.054** (0.025)	0.051** (0.020)	0.067*** (0.023)	0.016 (0.024)
Firm led by a woman (indicator)	0.074* (0.039)	0.039 (0.061)	0.081 (0.060)	0.011 (0.050)	-0.011 (0.056)	0.024 (0.060)
Age of firm (log)	0.038 (0.025)	0.062 (0.039)	0.064* (0.039)	0.054* (0.032)	-0.020 (0.036)	0.087** (0.038)
SME (indicator)	0.012 (0.028)	-0.063 (0.044)	-0.025 (0.043)	-0.013 (0.036)	-0.085** (0.040)	-0.055 (0.043)
General management (z-score)	0.004 (0.014)	0.023 (0.022)	0.019 (0.021)	0.024 (0.018)	0.061*** (0.020)	0.047** (0.021)
Percentage of employees with university degree	0.001* (0.001)	-0.001 (0.001)	0.001 (0.001)	-0.000 (0.001)	0.002* (0.001)	0.000 (0.001)
R ²	0.093	0.105	0.117	0.090	0.143	0.091
Observations	619	619	619	619	619	619

SOURCE: Enterprise Surveys, EBRD survey and authors' calculations.

NOTE: Estimated using ordinary least squares. All regressions include country and sector fixed effects, as well as an indicator for missing information on the percentage of employees with a university degree. SMEs are defined as firms with fewer than 100 employees. Standard errors are indicated in parentheses, with *, ** and *** denoting statistical significance at the 10, 5 and 1 per cent levels, respectively.

ALMOST THREE IN TEN FIRMS HAVE INVESTED IN DIGITAL TECHNOLOGY SUCH AS INVENTORY TRACKING AND AUTOMATED WAREHOUSING

What can explain why firms opted for particular resilience-boosting measures? Table 3.2 shows the results of regression analysis looking at the factors that made it more likely that firms would adopt each type of measure, taking account of the sectors and countries where firms operate. A key finding is that firms with direct suppliers in China were more likely to adopt most measures in order to increase the resilience of their supply chains. It is possible that suppliers in China are particularly important and not easily replaceable in the short term, so firms, despite disruption, invest in multiple other measures in order to strengthen existing supply chains. Interestingly, firms led by a woman were more likely to change their main supplier.

Investment in digital technology (such as inventory tracking and optimisation, cargo tracking or automated warehousing) may be more costly and require more expertise than most of the other resilience measures. Unsurprisingly, these measures were more likely to be undertaken by firms that were better managed (based on the management z-scores derived from the extended Enterprise Survey questionnaire that firms answered prior to the Covid-19 pandemic).²¹ Those management z-scores reflect the quality of management practices in the areas of operations, monitoring, targets and incentives and are available for firms with at least 20 employees, with better-managed firms having higher scores. Additional analysis shows that, among firms which adopt at least one measure, better-managed firms are also more likely to adopt more supply chain resilience measures.

²¹ See Schweiger and Stepanov (2022).

Firms may not fully internalise the social cost of supply chain disruption

The actions of individual firms may not fully internalise the costs, benefits and risks associated with global supply chains for a number of reasons.²² First, society as a whole might have a lower tolerance for the risk of disruption than individual firms (when it comes to energy supplies used to heat homes, for example). Firms' greater tolerance of risk may also stem from them not internalising the risk that their actions pose to others. The welfare losses that are caused by a synchronised shock to the supply chains of a country's firms can greatly exceed the sum of individual losses – for example, through shortages of essential goods or rising unemployment. In certain sectors, such as food production, medical supplies and products relevant to national defence (such as semi-conductors), the tolerance of risk may be particularly low, even if that means a high cost of ensuring reliable supply.

Firms may also underestimate their exposure to global supply chain risks and the likelihood of systemic shocks. Direct suppliers visible to firms often make up only a small percentage of the full value chain. For example, a recent study found that General Motors had 856 direct suppliers, but a total of more than 18,000 second-tier suppliers (suppliers to direct suppliers) and third-tier suppliers (suppliers to second-tier suppliers). Similarly, Airbus has more than seven times as many second and third-tier suppliers as it does direct suppliers, while Apple has 12 times as many.²³

Sometimes – often in commodities – supply chain networks have a diamond shape, with a diverse set of suppliers across tiers but a single supplier at the beginning of the value chain. Such supply chains can be characterised by considerable vulnerability to shocks, despite a seemingly large number of suppliers being involved.²⁴

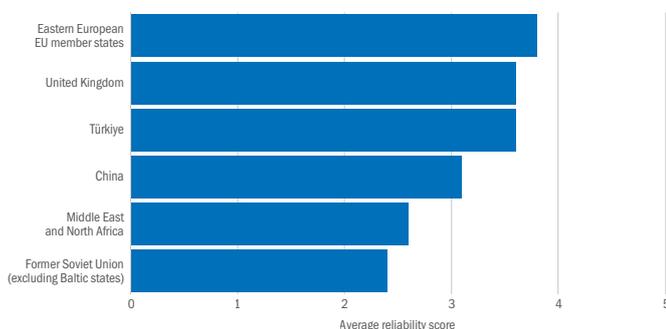
Firms' perceptions of the reliability of suppliers in the EBRD regions and China

When it comes to addressing the high social costs of supply chain disruption, "friendshoring" and "nearshoring" are often regarded as alternatives to a free-market offshoring approach (whereby operations are moved to countries with cheaper labour). Nearshoring involves shortening supply chains by sourcing production inputs from neighbouring economies, while friendshoring refers to a preference for sourcing inputs from economies that share similar values (for instance, when it comes to democratic institutions or maintaining peace).

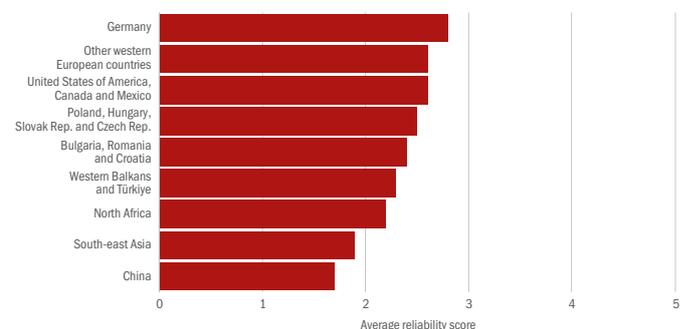
Friendshoring and nearshoring both involve certain constraints, so they are likely, in normal circumstances, to be less efficient than an approach to optimisation that is based purely on free trade. The resulting loss of GDP may be substantial in the medium term (see Box 3.2), but they could provide insurance against extreme disruption (for instance, as a result of a war) or increase the security of supply for vital inputs (such as energy). Policymakers face the task of assessing whether such insurance is socially optimal. Individual firms may not internalise the costs and benefits of such insurance, forming their own views about how to handle the risks implied by their participation in global supply chains. As part of the aforementioned surveys, firms in the EBRD regions and Germany were asked to assess the reliability of sourcing inputs from certain countries (on a scale of one to five) from the perspective of supply chain resilience. Firms in the EBRD regions regarded inputs from eastern European EU member states as being the most reliable, followed by inputs from suppliers in the United Kingdom and Türkiye. Suppliers located in the Middle East and North Africa, and the former Soviet Union (excluding the Baltic states) were regarded as being the least reliable, while Chinese firms were in the middle (see Panel A of Chart 3.13).

CHART 3.13. German manufacturing firms regard suppliers in central Europe as being more reliable than those in Asia

Panel A. Firms in the EBRD regions



Panel B. German manufacturing firms



SOURCE: EBRD survey, Ifo Business Survey (July 2022) and authors' calculations.

NOTE: Figures indicate the average perceived reliability of suppliers in particular locations on a scale of 1 (very unreliable) to 5 (very reliable).

²² This section draws on Baldwin and Freeman (2021).

²³ See Lund et al. (2020).

²⁴ See Sheffi (2015).

German manufacturing firms felt that suppliers in the EBRD regions (particularly in central Europe) were relatively reliable – albeit less reliable than suppliers from Germany itself, other countries in western Europe or the United States of America (see Panel B of Chart 3.13). Suppliers in China and south-east Asia were regarded as being the least reliable, showing that there was some scope for firms in the EBRD regions to benefit from a move to nearshoring in Europe.

Green transition: a game-changer for trade?

With the climate crisis likely to increase the frequency of disruption to global supply chains, environmental issues are increasingly becoming an integral part of supply chain management. For instance, the percentage of job adverts for supply chain managers that mention environment-related skill requirements (such as ISO 14001 standards), carbon reduction or environmental policy has been growing (see Box 3.4). On the flip side, bottlenecks in global supply chains may affect the pace of the transition to clean energy.²⁵

As policymakers respond to the climate emergency, producers will need to comply with new regulations aimed at levelling the playing field in terms of environmental standards. This section looks at one such measure, the EU's planned Carbon Border Adjustment Mechanism, examining its expected impact on the economies in the EBRD regions, as well as awareness of those plans among firms in EBRD economies.

The Carbon Border Adjustment Mechanism

The EU has set out plans to replace carbon subsidies in selected sectors with the CBAM as of 2027 as part of its European Green Deal. In July 2022, the Council of the EU and the European Parliament adopted positions on the draft CBAM regulations that the European Commission had proposed in July 2021. The regulations are expected to be finalised by the end of 2022.

Under the current European Parliament proposal,²⁶ affected firms importing into the EU in a number of key sectors (including aluminium, fertilisers, iron and steel) will need to register with an EU CBAM authority as of 2023 and will need to report emissions covered by the CBAM on the basis of carbon intensity data provided by exporters. Where exporters do not provide such data, importers will be required to apply the average carbon intensity of the least efficient 10 per cent of producers within the EU for that specific product, which is intended to correct for inaccuracies in carbon accounting and failures to achieve climate objectives as a result of firms not tracking their greenhouse gas (GHG) emissions.²⁷ In a set-up mirroring the European Trading System, importers will also be required to purchase carbon import permits in advance.

**PAYMENTS UNDER
THE CBAM MAY
INCREASE THE COST
OF AFFECTED GOODS
IMPORTED BY THE EU
BY MORE THAN
50%**

The impact of the CBAM will probably differ across producers and economies, as the carbon intensity of exports varies substantially within and across countries. Carbon intensity in economies exporting to the EU tends to be higher than it is in the EU itself. For instance, the carbon intensity of steel production in Kazakhstan is, on average, around twice the level seen in the EU. In Morocco, meanwhile, where natural gas plays a significant role in the energy mix and there is no significant use of coal, the carbon intensity of steel production is estimated to be below the EU average.

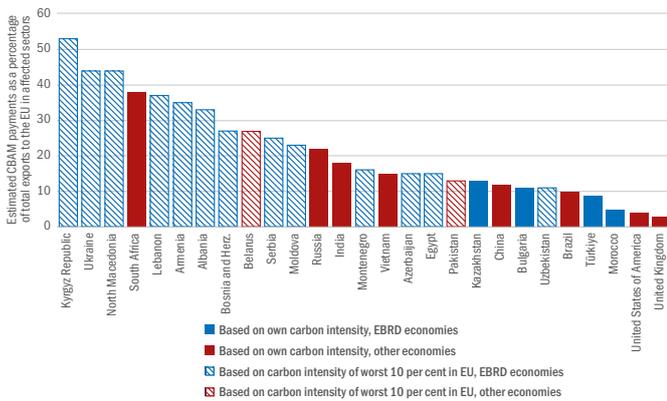
The payment that is due will be calculated as a product of the carbon content of imports and any difference between the price of carbon in the EU and the exporting country (which, in many cases, will be zero). Besides seeking to establish a level playing field for EU producers and exporters to the EU, the CBAM also aims to prevent “carbon leakage” arising from the relocation of pollution-intensive production to more lenient jurisdictions. If the EU's trading partners introduce carbon pricing at the domestic level, such carbon pricing income will go to domestic governments, rather than the EU, and the payments made under the CBAM will be lower. Thus, the CBAM should incentivise exporting countries to introduce domestic carbon-pricing instruments (such as carbon taxes or emissions trading systems).

²⁵ See Leruth et al. (2022).

²⁶ See European Parliament (2022).

²⁷ See European Commission (2021), Annex III, paragraph 4.1.

CHART 3.14. Estimated payments under the CBAM



SOURCE: OECD, ITC Trademap, IMF, E-PRTR, Bureau van Dijk's Orbis database and authors' calculations

NOTE: Economies in the EBRD regions are shown in blue; all others are shown in red. Where figures for an exporting economy are not available, calculations are based on (i) the average carbon intensity of the worst 10 per cent of emitters in the EU in 2015 for the relevant sector, (ii) the EU's current carbon price of €88 per tonne and (iii) the prevailing price in the exporting economy.

As Chart 3.14 shows, payments under the CBAM may increase the cost of affected goods imported by the EU by more than 50 per cent, with substantially higher prices being seen where penalty rates are applied. The estimates in that chart are based on the carbon price as at August 2022 (€88 per tonne), so the cost to producers will be higher if the price of emissions continues to rise.

That adjustment mechanism may have a major impact on the competitiveness of affected exporters. In the absence of any changes to their carbon intensity or the introduction of emissions trading, substantial carbon levies will be charged at the border. As a result, some exporting countries may become uncompetitive in the EU market, with their exports being replaced by domestic production within the EU or low-carbon exports from other economies. The United Nations Conference on Trade and Development (UNCTAD) estimates that output in the relevant sectors of the most affected economies will decline by between 5 and 15 per cent (on the basis of carbon prices of US\$ 44-88 per tonne).²⁸ The EU is anticipating a 12 per cent contraction in imports in the affected sectors and a 14 per cent reduction in associated emissions.²⁹

On balance, given the size of the CBAM-related costs and the EU's importance as a trading partner in the relevant sectors of EBRD economies, the countries that are likely to be most affected are the Kyrgyz Republic, Ukraine, North Macedonia and Lebanon.

Economies may adjust to the new regime by (i) finding alternative markets for their goods (where feasible), (ii) using low-carbon technology (including renewable energy) to reduce the carbon intensity of production, (iii) expanding domestic carbon pricing,

with carbon income going to their own governments, or (iv) moving along the value chain by upgrading their exports (moving, say, from steel to finished steel products). Moreover, supply chains may become shorter, thereby reducing transport-related emissions. For instance, shipment by road from a country neighbouring the EU would generate savings of between a third and a half in terms of GHG emissions per tonne shipped relative to shipment from China by sea. Those savings are equivalent to approximately 5 per cent of the emissions that are embedded in Chinese steel at the factory gates.³⁰

Firms' awareness of the CBAM

The CBAM is scheduled to come into force in 2027, with carbon intensity data being collected as of 2023, and thus firms in the EBRD regions need to get ready. In order to continue selling goods on the EU market, exporters need to understand their low-carbon transition pathways and manage their climate-related transition risks as a matter of urgency. However, fewer than four in ten firms have even heard of the CBAM – and of those that have, less than half expect to be affected. Around 30 per cent of firms have started preparing for the new regime by assessing the carbon intensity of their production or services – and of the remaining 70 per cent or so, less than a fifth plan to do it in the future. The estimates in Table 3.3 provide some further insights into firms' levels of preparedness, indicating the results of regression analysis linking data on firms' awareness with various firm-level characteristics.

FEWER THAN FOUR IN TEN FIRMS IN THE EBRD REGIONS HAVE HEARD OF THE CBAM

²⁸ See UNCTAD (2021).

²⁹ See European Commission (2021), Annex 9.

³⁰ These calculations draw on Hasanbeigi et al. (2016), European Environment Agency (2012), Oceana Europe (2010) and OECD data.

TABLE 3.3. Firms with better green management practices are also more likely to have assessed the carbon intensity of their production

	Has heard of the CBAM	Is likely to be affected by the CBAM	Has assessed the carbon intensity of its production/services	Promotes its products or services as being environmentally friendly
	(1)	(2)	(3)	(4)
Green management (z-score)	0.045** (0.019)	0.056* (0.033)	0.094*** (0.017)	0.054*** (0.019)
SME (indicator)	-0.081** (0.039)	-0.014 (0.076)	-0.182*** (0.034)	-0.057 (0.040)
Age of firm (log)	0.047 (0.035)	0.058 (0.065)	-0.001 (0.030)	0.042 (0.035)
Firm led by a woman (indicator)	0.044 (0.049)	-0.021 (0.099)	0.048 (0.044)	0.089* (0.051)
Had direct supplier located in China in last three years (indicator)	0.012 (0.022)	-0.045 (0.044)	-0.006 (0.020)	0.017 (0.024)
Percentage of employees with university degree	-0.000 (0.001)	-0.001 (0.002)	0.001 (0.001)	-0.000 (0.001)
R ²	0.179	0.141	0.184	0.108
Observations	729	261	787	787

SOURCE: Enterprise Surveys, EBRD survey and authors' calculations.

NOTE: Estimated using ordinary least squares. All regressions include country and sector fixed effects, as well as an indicator for missing information on the percentage of employees with a university degree. SMEs are defined as firms with fewer than 100 employees. The sample for column 1 consists of firms located in the EU and non-EU firms that export to the EU. The sample for column 2 consists of non-EU firms that export to the EU and have heard of the CBAM. The sample for columns 3 and 4 consists of all firms with no missing variables. Standard errors are indicated in parentheses, with *, ** and *** denoting statistical significance at the 10, 5 and 1 per cent levels, respectively.

Strikingly, firms with higher scores for green management are more likely to have heard of the CBAM (see column 1). Those green management scores were calculated using firms' answers to Enterprise Surveys conducted in 2018-20. They cover practices in four areas: strategic objectives relating to the environment and climate change; the existence of a manager with an explicit mandate to deal with green issues; the setting of clear and attainable environmental targets; and the monitoring of environmental objectives.³¹

Moreover, non-EU firms with good green management are more likely to report that they will probably be affected by the CBAM (column 2). Firms with better green management practices are also more likely to have assessed the carbon intensity of their operations and promote their products or services as being environmentally friendly. SMEs are less likely to have heard of the CBAM or assessed the carbon intensity of their operations than large enterprises, suggesting that smaller firms may require an additional information campaign giving them guidance on the steps that need to be taken in order to comply with the new regulations.

Conclusion and policy implications

Many economies in the EBRD regions have been keen participants in global supply chains and have benefited from that participation in terms of the sophistication and diversification of exports. However, while firms have experience of dealing with idiosyncratic shocks (such as natural disasters, strikes and suppliers going bankrupt), nobody was prepared for the kind of systemic shock that was seen at the onset of the Covid-19 pandemic, when many sectors and countries were affected at the same time. The survey evidence presented in this chapter indicates that many firms are already taking steps to make their supply chains more resilient, primarily by increasing stocks of inputs and sourcing from larger numbers of suppliers.

Policymakers can also take a number of steps to increase the robustness and resilience of global supply chains. For example, governments can help to address the information failures that prevent firms from correctly estimating the amount of risk that is embedded in their supply chains. Akin to the stress tests that were introduced in the banking sector after the global financial crisis of 2008-09, policymakers could introduce stress tests for supply chains in critical sectors.³² Requiring companies to report on their ability to deal with disruption in regular exercises would give them an incentive to continuously monitor and evaluate risks. Governments can review trade agreements for potential incentives to concentrate suppliers in certain locations and share that information with the private sector, as well as promote the use of digital technology for

³¹ See De Haas et al. (2022) for more details.

³² See Simchi-Levi and Simchi-Levi (2020).

risk management and real-time monitoring of input flows. Following a major shock, the reorientation of supply chains can be facilitated by reducing trade and transport barriers (for instance, by facilitating customs clearance and operation permits, expediting certification procedures or prioritising the shipment of essential goods).³³

The policy options that are chosen (be it taxation, the introduction of subsidies or administrative control of trade flows) need to match the type of supply chain shock (varying, for example, depending on whether supply is being squeezed, demand has surged or there has been a breakdown in transport). For instance, subsidies could be used to incentivise supply, but they might not be appropriate when facing a surge in demand or a transport outage.

Policymakers also need to distinguish between boosting robustness – the ability to continue production during a shock – and increasing resilience – the ability to return to previous production levels within a reasonable time frame after a shock. When it comes to food, energy, medicine and other essential supplies, robustness is key, whereas resilience may be prioritised in other sectors. Promoting robustness inevitably involves some degree of redundancy at the level of suppliers and production sites, whether it is within an individual firm, across multiple firms in the economy or both.³⁴

Policies that promote nearshoring, friendshoring or reshoring (which involves moving production back to the home country from abroad) may address some supply chain risks, but exacerbate other risks. For example, while decoupling from global supply chains reduces exposure to foreign supply shocks, it also limits the economy's ability to cushion the impact of local shocks (such as those arising from extreme weather or strikes) through trade, thus magnifying the negative impact that such shocks have on welfare.³⁵ Moreover, “friends” – countries with similar values and institutions – tend to have similar levels of income, so prioritising trade with such countries will eliminate any gains from the exploitation of comparative advantages and will be associated with welfare losses (as discussed in Box 3.2).³⁶ Policymakers should therefore think carefully about the balance of risks and costs when considering nearshoring, friendshoring or reshoring.³⁷

Lastly, due attention needs to be paid to environmental aspects of global supply chains and their role in facilitating the transition to a green economy. Climate-related risks to global supply chains are rising, with wide-ranging and complex implications for the production, manufacture and distribution of goods around the world. If governments do not act, extreme weather events and other climate shocks will become more common and severe. Consequently, environmental considerations need to become an integral part of firms' risk management.³⁸ There are various international initiatives aimed at promoting the disclosure and management of climate-related risks across the financial sector and developing the necessary reporting standards and criteria. At present, however, there is no clear standard for calculating a firm's carbon footprint. Strengthening national climate goals and developing a long-term transition pathway can not only reduce the risk of a highly disruptive transition process, but also create new opportunities for innovation and increase economic competitiveness and sustainability.

BOX 3.1.

Calculating the sophistication of exports

The UN Comtrade database often reports two values for a trade flow: exports from country A to country B as reported by country A; and imports to country B from country A as reported by country B. This chapter assumes that the larger of the two values is the more reliable. Since exports are reported on an FOB (free on board) basis, while imports are reported on a CIF (cost, insurance and freight) basis, the mean difference between the two values across the dataset is used to adjust the value of exports where no imports are reported.³⁹

In order to construct a measure of the sophistication of exports, we first need to calculate the average GDP per capita of all countries exporting the product in question, weighted by each country's share in total exports of that product (termed PRODY). This is calculated using annual trade and GDP per capita data for the period 2017-19, in order to ensure that the sophistication of exports is calculated on the basis of products traded by rich countries in recent years (rather than in the 1990s). Export sophistication is then calculated as the export-weighted average of all PRODY measures for products exported by a particular country, with weights equivalent to the share that each product has in the total exports of a particular country in each year between 1990 and 2020. All calculations exclude energy commodities. This measures the implied productivity level that is associated with a country's export basket.

³³ See OECD (2020).

³⁴ See Miroudot (2020).

³⁵ See Eppinger et al. (2021) and OECD (2021).

³⁶ See Rajan (2022).

³⁷ See OECD (2020).

³⁸ See IPCC (2022).

³⁹ This is roughly in line with the approach adopted by Head et al. (2010).

BOX 3.2.

The implications of friendshoring and sanctions in terms of international trade

Policies that affect trade need to be evaluated using general equilibrium frameworks, which consider the intricate linkages between economies and between sectors within economies. This box uses a model that accounts for the presence of international input-output linkages, using nested production functions to evaluate the implications of a shift towards friendshoring (which involves sourcing inputs predominantly from economies with shared cultural values – as regards democratic institutions or maintaining peace, for example).⁴⁰ In this model, each country produces a different range of products within a given industry. To produce this variety of products, a firm in a given country combines labour and other inputs from different industry bundles – which, in turn, are based on inputs from different countries. For example, the German automotive industry uses labour, as well as industry bundles such as steel and plastic. The steel bundle consists of German steel, Turkish steel, Chinese steel, and so on. Meanwhile, consumers in a country decide to spend their income on consumption bundles, which again consist of different ranges of products from different countries.

The model makes the following assumptions: (i) the ranges of products produced by countries are substitutable, with an industry-specific constant elasticity of substitution (CES);⁴¹ (ii) inputs are complementary to each other (with elasticities of 0.6 and 0.2 being assumed for goods production and intermediate bundle aggregation, respectively); and (iii) consumption is based on a Cobb-Douglas aggregation with an elasticity of 1. The model has been calibrated using the 2018 Inter-Country Input-Output (ICIO) Tables produced by the Organisation for Economic Co-operation and Development (OECD). It can capture developments in the medium term, as it allows for the movement of labour between sectors within a country, but not between countries. It does not allow for changes in productivity or capture the formation of new trade links between countries.

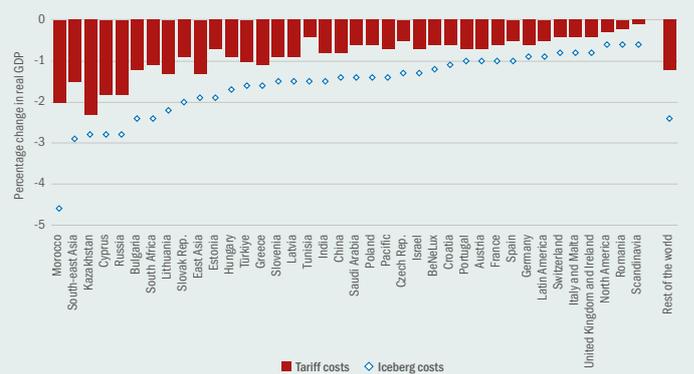
This model is used to study three different scenarios: (i) friendshoring, (ii) the sanctions imposed on Russia as a result of its invasion of Ukraine and (iii) severe Covid-19 lockdowns in China.

As part of these scenarios, the model differentiates between two blocs of economies: (i) the 141 countries that voted in favour of the UN General Assembly resolution condemning the aggression against Ukraine on 2 March 2022 and (ii) the 40 countries that voted against it or abstained.⁴² In these scenarios, countries in the former group are assumed to place value on sourcing production inputs from other countries that condemned the invasion of Ukraine.

Friendshoring

Globalisation has resulted in an integrated world, with many countries having highly accommodative trade policies. Recently, however, restrictive trade policies (such as high tariffs, strict import quotas and the need for administrative approval for exports of specific technologies), sanctions and trade bans have all been used extensively to limit the risk of disruptions to supply or to punish unfriendly countries. The friendshoring scenario that is modelled here assumes a 20 per cent increase in the cost of international trade between the two blocs of economies based on the UN resolution on the invasion of Ukraine. That increase in trade costs can be modelled as either (i) an increase in tariffs,

CHART 3.2.1. Friendshoring results in real GDP losses for everyone



SOURCE: OECD's ICIO Tables, WITS website and authors' calculations.
NOTE: Based on a modelling exercise. The countries that condemned the invasion of Ukraine are those that voted in favour of the UN resolution on 2 March 2022. To make the computations feasible in this model, the OECD's ICIO Tables data have been aggregated to 39 countries or 'country groups' and 16 industries. The groupings reflect the construction of this model and do not reflect the status of any country or its sovereignty.

⁴⁰ The model used here is based on Baqaee and Farhi (2019) and Çakmaklı et al. (2021). See Javorcik et al. (2022b).
⁴¹ These are taken from Caliendo and Parro (2015).

⁴² See UN General Assembly Resolution ES-11/1: <https://digitallibrary.un.org/record/3959039> (last accessed 21 September 2022).

which are paid by importers and generate revenues for the governments that apply them, or (ii) iceberg trade costs – costs that are assumed to be proportionate to the value of traded goods and do not feed into government revenues.

The rise in trade costs results in welfare losses. In the EBRD regions, the largest declines in GDP are experienced by Morocco (between 2 and 4.6 per cent of GDP, depending on whether some of the losses are offset by an increase in tariff revenues), Kazakhstan (between 2.3 and 2.8 per cent), Bulgaria (between 1.2 and 2.4 per cent) and Lithuania (between 1.3 and 2.3 per cent; see Chart 3.2.1). Kazakhstan and Morocco are both in the bloc of countries that declined to condemn the invasion of Ukraine; however, the common denominator among the economies that are the biggest losers is that they have strong trade links with economies in *both* blocs.

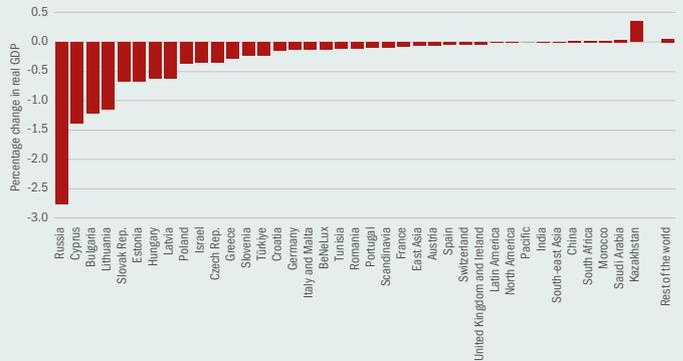
Sanctions imposed on Russia owing to its invasion of Ukraine

Following the invasion of Ukraine, many countries imposed trade sanctions on Russia. While these sanctions often concern specific products or industries, their economic impact can be modelled as a 20 per cent increase in the overall cost of trade between Russia and the bloc of economies that condemned the invasion of Ukraine. In this scenario, an increase in the cost of trade leads to a decline of nearly 3 per cent in Russia's GDP on the basis of constant prices (see Chart 3.2.2).⁴³ Countries where production is more reliant on imports from Russia also experience sizeable losses (with declines of more than 1 per cent of GDP estimated for Bulgaria and Lithuania, for instance). Kazakhstan, on the other hand, is poised to make a small gain (0.4 per cent of GDP) as it scales up exports of goods that were previously exported by Russia.⁴⁴

Severe Covid-19 lockdowns in China

The last scenario concerns the strict zero-Covid policy pursued by China, which is resulting in frequent lockdowns and stopping firms from producing. The model approximates an extreme version of these disruptions by means of a 20 per cent increase in iceberg trade costs between China and the bloc of countries that voted in favour of the UN resolution condemning the invasion of Ukraine. In this scenario, economies with heavy reliance on Chinese inputs are more likely to be negatively affected (with the Czech Republic, for example, losing an estimated 0.6 per cent of real GDP; see Chart 3.2.3). Economies that have the potential to replace China as suppliers of the necessary inputs enjoy small gains (with Kazakhstan and Morocco, for example, both gaining close to 0.05 per cent of real GDP). Most economies in the EBRD regions and the EU experience declines in real GDP.

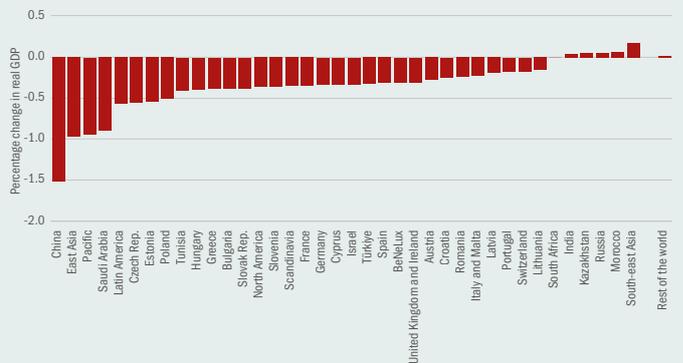
CHART 3.2.2. Real GDP losses following an increase in the cost of trade between Russia and countries that condemned the invasion of Ukraine are highest in Russia and countries where production is reliant on imports from Russia



SOURCE: OECD's ICIO Tables, WITS website and authors' calculations.

NOTE: Based on a modelling exercise. The countries that condemned the invasion of Ukraine are those that voted in favour of the UN resolution on 2 March 2022. To make the computations feasible in this model, the OECD's ICIO Tables data have been aggregated to 39 countries or 'country groups' and 16 industries. The groupings reflect the construction of this model and do not reflect the status of any country or its sovereignty.

CHART 3.2.3. Real GDP losses following an increase in the cost of trade between China and countries that condemned the invasion of Ukraine are highest in China and economies with heavy reliance on Chinese inputs



SOURCE: OECD's ICIO Tables, WITS website and authors' calculations.

NOTE: Based on a modelling exercise. The countries that condemned the invasion of Ukraine are those that voted in favour of the UN resolution on 2 March 2022. To make the computations feasible in this model, the OECD's ICIO Tables data have been aggregated to 39 countries or 'country groups' and 16 industries. The groupings reflect the construction of this model and do not reflect the status of any country or its sovereignty.

⁴³ Current estimates by forecasters point to a larger contraction in Russia in 2022 (see Guriev, 2022). The 20 per cent increase in the cost of trade that is applied here is just a proxy, as this modelling cannot fully capture the complexity of sanctions in the real world. Ultimately, the primary focus of our analysis is the impact that sanctions have on EBRD economies, rather than their impact on the Russian economy.

⁴⁴ These estimates are broadly in line with the findings presented by Baqaee et al. (2022), who used a similar model to estimate the impact that stopping energy imports from Russia would have on the EU's 27 member states. In their model, Lithuania, Bulgaria and the Slovak Republic experienced the largest declines in gross national income.

BOX 3.3.

A survey of firms that both export and import

Between 2018 and 2020, the EBRD, the EIB and the World Bank conducted the most recent round of Enterprise Surveys in the EBRD regions – face-to-face interviews with firms' senior executives. The majority of those interviews were completed before the onset of the Covid-19 pandemic and the subsequent disruptions to global supply chains.

A follow-up telephone survey was then conducted between May and July 2022, targeting 1,805 firms in 15 countries that were both direct exporters and directly imported inputs or supplies of foreign origin. A total of 815 firms participated in that follow-up survey, while the other 990 could not be reached, declined to take part or had gone out of business in the meantime. The 815 respondent firms were not statistically different from the other 990 in terms of the number of employees, the age of the firm, foreign ownership, listed status and sole proprietorship.

In addition to questions about supply chain disruption, respondents were also asked about the CBAM, their firm's financial situation, issues relating to the recruitment of workers and their views regarding refugees.

BOX 3.4.

Increased demand for supply chain managers and green skills

This box looks at the evolution of demand for supply chain managers in the United Kingdom using data on online vacancies that were collected by Burning Glass Technologies by means of web crawling.⁴⁵ The dataset includes information on more than 67 million job adverts over the period 2012-21, broken down by occupation. Although Burning Glass data do not cover all vacancies, they offer good overall coverage of vacancies in the United States of America and the United Kingdom, particularly for more highly skilled professional occupations.⁴⁶

While the number of vacancies for supply chain managers dropped sharply when Covid-19 lockdowns were at their most severe in the second quarter of 2020, demand quickly recovered, with vacancies reaching an all-time high in the middle of 2021, exceeding the average for the period 2012-19 by around 65 per cent (see Chart 3.4.1). This compares with a 44 per cent increase in vacancies for managers in general.

Those data on vacancies contain detailed information on the skill requirements that are associated with each job, with the average job advert listing six distinct skills. In the case of supply chain managers, for instance, the most commonly required skills include procurement, communication, planning, logistics, budgeting, and working with key performance indicators. In addition, a not insignificant percentage of adverts for supply chain manager positions list at least one skill relating to the green economy, such as environmental management (and the related ISO 14001 standards) or skills associated with carbon reduction, climate change, biomass or environmental policy.

Prior to mid-2020, the percentage of UK supply chain manager adverts that required green skills was fairly stable at around 2.5 per cent. Since then, it has increased considerably,

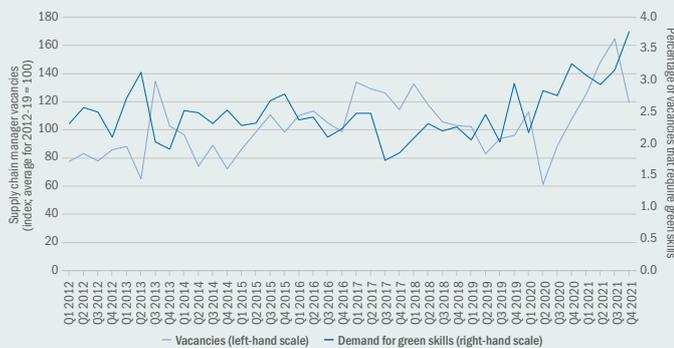
⁴⁵ See Chupilkin et al. (2022).

⁴⁶ See, for instance, Javorcik et al. (2019).

approaching 4 per cent in the second half of 2021 (see Chart 3.4.1). This increase has largely been driven by greater demand for experience of carbon reduction, climate change, environmental management and work with environmental agencies.

By contrast, in the 12 EBRD economies for which comparable data are available for the period 2019-21 (Bulgaria, Egypt, Greece, Hungary, Latvia, Lithuania, Morocco, Romania, Poland, the Slovak Republic, Tunisia and Ukraine), supply chain managers are not typically required to have green skills. For management positions in general, 2.2 per cent of vacancies in those 12 EBRD economies require green skills, close to the 2.6 per cent observed in the United Kingdom.

CHART 3.4.1. Demand for supply chain managers has increased markedly in the United Kingdom since late 2020, with greater emphasis on green skills



SOURCE: Burning Glass Technologies and authors' calculations.

NOTE: Supply chain managers correspond to Standard Occupational Classification categories 1133, 1161 and 1162 mapped to category 1324 of the European Skills, Competences, Qualifications and Occupations system.

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