Chapter 5

G20's Roles in Improving the Resilience of Supply Chains

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1. Introduction

About half of the total global output of goods and services is sold as intermediate inputs (Baldwin and Lopez-Gonzalez, 2015), and more than two-thirds of all international trade flows involve trade in global value chains (GVCs) (World Bank and WTO, 2019). In the past two decades, the value of intermediate goods traded worldwide has risen threefold to more than $10 trillion annually (McKinsey Global Institute, 2020).[1] Falling information and communication technology (ICT) costs led to the proliferation of GVCs at diversified production sites. The shares of GVC-related trade in the manufacturing sector relative to total trade rose sharply from 2000 to 2008 in all major regions of the world during the period considered as the golden age of globalisation.

The pandemic lockdowns and limited activities lowered global demand and supply simultaneously, which halted production and trade. The disruption caused shortages of a wide variety of consumer and industrial goods, ranging from health supplies and medical equipment to microchips and semiconductors. About 28% of firms in 62 countries reported at least 20 supply chain disruptions during 2020 compared with 5% in 2019 (BCI, 2022). Furthermore, not only did the coronavirus disease (COVID-19) disrupt firms' direct immediate supplies, but it also affected about 40% of their tier 2 suppliers and beyond. Supply-side shocks were also recorded in sectors with domestic production capacity in which there was little vertical integration and thus high reliance on imported inputs (OECD, 2021a). The disruptions hit not only labour-intensive sectors such as apparel and furniture, but also capital-intensive sectors such as automotives and aerospace (McKinsey Global Institute, 2020).

Section 2 explains how supply shocks affect trade and the economy. Section 3 observes trends in supply chains and challenges. Section 4 concludes and draws policy recommendations for the G20.

[1] Based on another measurement using the Organisation for Economic Co-operation and Development (OECD) Trade in Value Added (TiVA) database (OECD, n.d.), total trade in intermediate products globally has also more than tripled – from US$2 trillion in 2002 to US$6.7 trillion in 2018.

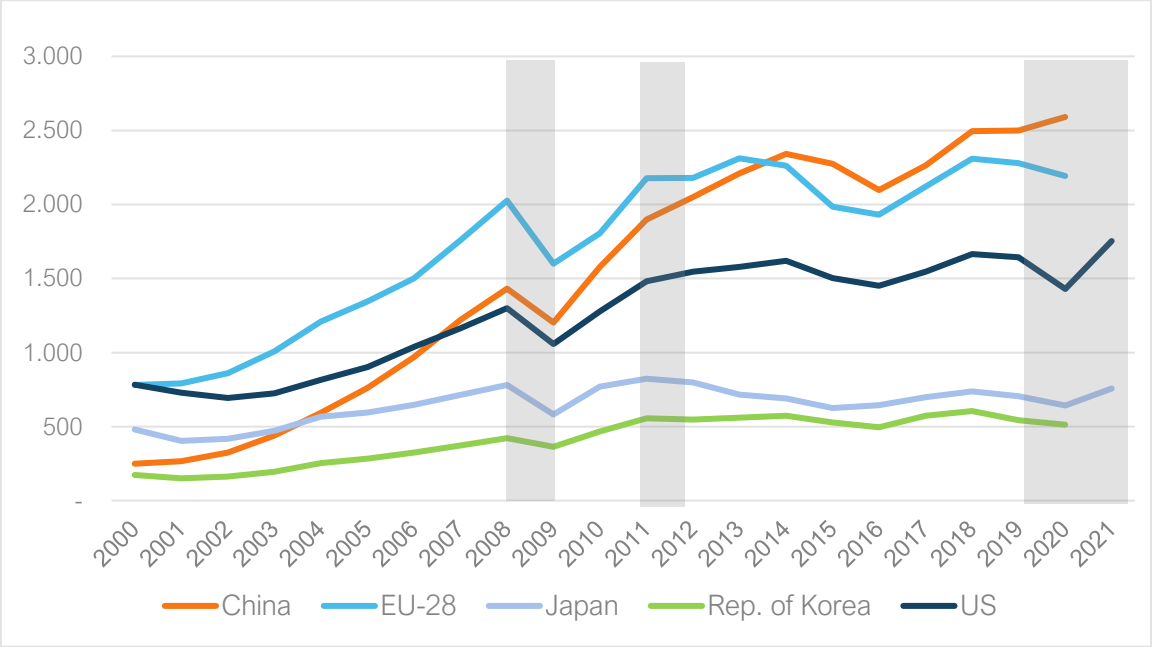
2. How Do Supply Shocks Affect Trade and the Economy?

2.a. What Do the Data Tell Us?

Since 2000, the world has experienced two massive global shocks – the financial crisis in 2008 and the COVID-19 pandemic starting in 2020. The Great East Japan Earthquake in 2011 disrupted supply chains within Japan and between Japan and its trading partners. Figure 5.1 shows the value of exports from China, the 28 Member States of the European Union (EU), Japan, the Republic of Korea (henceforth, Korea), and the United States (US) from 2000 to 2021. World exports dropped by 16.7% in 2009 due to the financial crisis, although they increased by 21.9% in 2010. Compared with the financial crisis, the impacts of the Great East Japan Earthquake on the world economy were limited. But, not surprisingly, it caused significant and prolonged damage to the Japanese economy. Japan was on the path to recovery from the financial crisis when the earthquake hit. Its exports plunged by 3.0% in 2012 and its gross domestic product (GDP) grew by only 0.02% in 2011 and 1.37% in 2012. Its average annual export growth rate was –2.5%, while that of GDP was as small as 0.4% between 2012 and 2020. Even country-specific shocks, such as the Great East Japan Earthquake, affected production in other countries such as Korea, China, and the US.

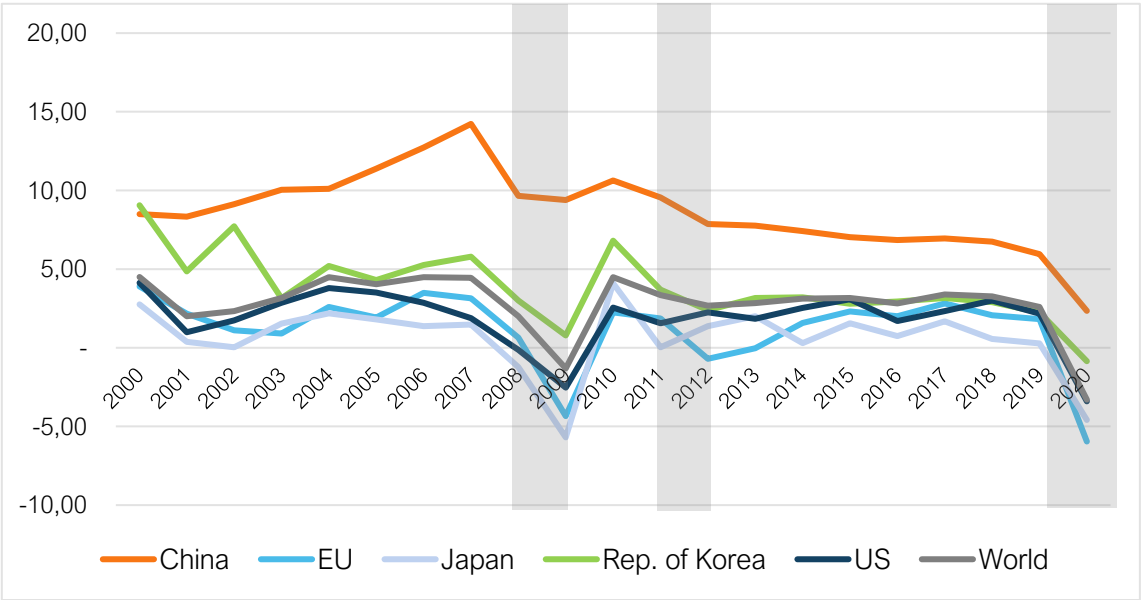
Figure 5.2 illustrates that GDP growth rates also dropped significantly in the aftermath of the global financial crisis; the worldwide growth rate dropped to –1.3% in 2009. The damage caused by the financial crisis persisted after 2007/2008, as evidenced through slower trade and GDP growth. The average annual growth rate of world exports fell from 11.4% (2001–2008) to 1.8% (2011–2020), while that of worldwide GDP dropped from 3.4% (2001–2008) to 2.4% (2011–2020).

Figure 5.1: Value of Exports by Major Trading Countries, 2000–2021 (US$ billion)



EU-28 refers to the 28 EU member states, US = United States.
Notes: Grey shading indicates the global financial crisis in 2008-2009, the Tohoku Earthquake in Japan in 2011, and the COVID-19 pandemic in 2019-recently.
Source: United Nations (n.d.), UN Comtrade Database. https://comtrade.un.org/data/ (accessed 14 March 2022).

Figure 5.2: GDP Growth of Five Countries, 2000–2020 (%)



GDP = gross domestic product, EU = European Union, US = United States.
Notes: Grey shading indicates the global financial crisis in 2008-2009, the Tohoku Earthquake in Japan in 2011, and the COVID-19 pandemic in 2019-recently.
Source: World Bank (n.d.), DataBank, GDP Growth (annual %).
https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG (accessed 18 March 2022).

2.b. Supply Chains and Shocks: A Simple Framework

To examine firms' strategies to cope with supply chain disruptions and government policies to mitigate their economic impacts, we consider a simple economic model with two countries – home and foreign (that can be considered the rest of the world) – which trade goods produced in a representative industry. A large number of firms operate in a monopolistic competition market where firms can sell products and procure inputs without incurring trade costs. A firm can procure customised input from a supplier, domestic or foreign, to produce goods that are differentiated from other firms' products (the framework is in the Appendix).

The competitiveness of the market is a key measure to assess social welfare. It consists of the competitiveness of both the domestic and foreign firms. On the one hand, the domestic firms' aggregate profits increase with the ratio of the competitiveness of the domestic firms to that of the foreign firms. On the other hand, the price index falls as the competitiveness of the market increases. Thus, given the foreign firms' competitiveness, social welfare increases with the domestic firms' competitiveness, both by increasing the domestic firms' aggregate profits and lowering the price index – thereby benefitting consumers.

Since domestic firms choose their sourcing strategies to minimise the total cost of production, such firms' behaviour tends to increase domestic firms' aggregate profits and competitiveness. Consequently, the objective of the government is more or less aligned with the firms' objectives. Nevertheless, the government can give incentives to firms to diversify their input sources or reshore their sourcing to the home country if firms can increase the domestic firms' competitiveness. Such policies also affect the foreign country. An increase in the home firms' competitiveness would decrease the foreign firms' aggregate profits but lower the price index that faces foreign consumers.

Governments seek to maximise their countries' social welfare. This increases with domestic firms' aggregate profits and decreases with the price index, which is an aggregate measure of product prices and decreases with the competitiveness of the market. We examine firms' sourcing strategies and the home government policies under the supply chain-disruptive risks. Five types of shocks will be discussed below. We argue that finding an appropriate policy is difficult when various types of risks coexist, since different policies are optimal against different types of risks. Inducing firms to diversify can be a good policy against idiosyncratic shocks and country-specific shocks, but it is rather harmful against industry-specific shocks and global shocks.

i. Idiosyncratic shocks

Idiosyncratic shocks disrupt firms' supply chains randomly and independently across firms. Firms can partially hedge the risk through diversification. It is important to note that risks disappear in aggregate and the price index will not fluctuate over time due to the law of large numbers. If the fixed sourcing costs are in an intermediate range, firms are indifferent between single sourcing and diversification (i.e. sourcing from two suppliers), so some firms choose single sourcing to save fixed sourcing costs while others choose diversification to reduce the likelihood of being exposed to the supply chain disruption.

The government can increase the number of domestic firms that diversify by providing a subsidy for diversification. Such policies reduce the number of domestic firms whose supply chains are disrupted and hence increase the domestic firms' competitiveness. Therefore, they lower the price index and benefit consumers. However, the subsidy will also lower the domestic firms' aggregate profits (inclusive of aggregate fixed costs) because the domestic firms have chosen their sourcing strategies optimally, so the subsidy can actually harm market-driven competitive (or natural competitive) firms. This creates a dilemma as to whether the government should encourage firms to diversify their input sources by providing such a subsidy or not.

Government subsidies that enhance domestic firms' competitiveness harm foreign countries through profit-shifting from foreign firms to domestic firms but benefit foreign consumers through a decline in the price index. Such policy externalities call for policy coordination between and among countries.

ii. Country-specific shocks

Country-specific shocks hit individual countries independently. An effective way to hedge the risk is diversification of sourcing, as in the case of idiosyncratic shocks. The impact on the economy of a subsidy to induce diversification is similar. It is noteworthy, though, that even if all firms diversify to minimise the risk, aggregate risks will not completely disappear in the case of country-specific shocks.

In this case, governments can enhance domestic firms' competitiveness – hence the overall competitiveness of the market – by inducing them to reshore if and only if the chance of supply chain disruption is greater in the foreign country than in the home country. Such policies benefit consumers but may not increase the aggregate profits of domestic firms since their competitiveness would be lower if a shock hits the home country, which hosts more suppliers for the domestic firms than before. Reshoring is often considered an appropriate policy to reduce exposure to supply chain disruptive shocks. But whether reshoring should be encouraged depends on which countries are more exposed to such negative shocks.

iii. Geopolitical shocks

Geopolitical shocks are caused by geopolitical tensions between or amongst countries. In choosing suppliers, the presence of geopolitical risks is not an issue unless firms' production costs would be lower with foreign inputs rather than domestic ones. An effective way to hedge geopolitical risk is reshoring. Sourcing inputs from a domestic supplier would lower firms' marginal costs in the case of disruption but increase them in normal circumstances. Therefore, reshoring is a good strategy for firms if the likelihood of geopolitical shocks is large and the cost advantage of offshoring in normal circumstances is not large compared with the cost disadvantage in the case of disruption. Government incentives to induce reshoring are also high in such situations. It is noteworthy that geopolitical risks do not automatically make reshoring more appealing than offshoring.

iv. Industry-specific and global shocks

Industry-specific shocks disrupt the supply chains of a particular industry. Global shocks can be considered massive shocks that disrupt all industries across countries. In our one-industry model, these two shocks are equivalent, therefore we only discuss global shocks here. When a global shock hits the world, all supply chains are disrupted, so diversification or reshoring are of no use. Firms and governments can do nothing to mitigate the effects by restructuring the supply chains. In such cases, diversification is an inferior policy because it only increases the burden of sourcing costs for firms.

3. Global Supply Chains: Trends and Challenges

First, one of the trends in global supply chains (GSCs) is related to the heavy reliance on a very small number of countries as the sole suppliers for a variety of critical inputs and products. Exports are more concentrated in fewer countries than imports, indicating supply-side concentration, with a few countries specialising in producing and selling certain goods abroad (OECD, 2021b).

East Asia has replaced the EU as the largest exporter of intermediate products, primarily driven by China and, to a lesser extent, Japan and Korea. East Asia has also replaced the EU as the largest importer of intermediate products since 2011. By 2018, China already imported almost as many intermediate products as the 27 EU countries combined, cementing its dominant role globally as both exporter and importer of intermediate goods. Some products even have inputs that are made by only one or two suppliers in the world, further limiting the possibility of sourcing diversification. A few countries also play a dominant role in the global production of some critical inputs for modern industries, such as solar panels, rare earth minerals, and lithium-ion batteries (Nakano, 2021).

Second, prior to the pandemic, firms typically used a just-in-time operations strategy, where inventory is sourced and received only when and to the degree it is needed for production in response to orders. The just-in-time strategy is highly efficient in good times, but also prone to even small disruptions affecting the suppliers. Given that the pandemic represents both demand and supply shocks, some firms have started to consider switching their supply chain strategy to the 'just-in-case' model, particularly those that have experienced supply chain issues during the pandemic. The just-in-case supply chain model stocks up some inventory and hence builds up some redundancy ahead of time. In addition, some companies are also considering 'local for local' supply chains to stock up their inventories and switch to a more localised supply chain model (Masters and Edgecliffe-Johnston, 2021). It is argued that shifting to the just-in-case model might help improve firms' supply chain resilience and increase their ability to respond quickly to disruptions. In this model, companies can have sufficient backup inventory (as they pile up the inventories), and the stock will then be used as a buffer to reduce the negative impact of disruptive events (McKinsey Global Institute, 2020).

Third, the pandemic also saw the rising use of export restraints as countries attempted to secure the domestic supply of goods deemed critical. Global Trade Alert showed that governments issued as many as 257 measures of export restrictions in 2020, almost a sevenfold increase from the previous 4-year average (Global Trade Alert, 2020). Furthermore, subtle measures of export restrictions are sometimes hidden behind health-security arguments allowed as an exception to the World Trade Organization (WTO) prohibition on export bans in general. Such actions may not be included in the official statistics of trade-related measures. The proliferation of export restrictions creates uncertainties for producers in other countries relying on inputs from the imposing countries, and thus threatens supply chain stability.

Fourth, significant recent events and developments have amplified the call for the restructuring of GSCs. These include the COVID-19 pandemic; the ongoing trade war and geopolitical tensions, especially between China and the US; the rising number of export restraint measures; and the higher frequency of disruptions expected in the future due to climate change and natural or health disasters, amongst other things. Taken together, such developments increase the demand for supply chain resilience amongst both policymakers and companies.

Fifth, there are typically two broad policy suggestions to reduce the risk from engagement in GSCs: (i) a call for shortening the supply chain by moving production back to the domestic home country (reshoring)/region (nearshoring), or (ii) a call for diversification of suppliers and markets.

Shortening supply chains and reshoring

The supply chain disruptions caused by trade tensions and the pandemic also magnified the intention of many countries to reduce their dependence on foreign suppliers for critical inputs and raw materials and increase their own domestic production capacity. From the perspective of developed countries, reshoring becomes even more appealing as advances in automation and artificial intelligence make labour cost savings from offshoring production in the context of GVCs less necessary. Reshoring is under way – according to a survey by Kearney (2021) of US manufacturing executives, two out of five respondents indicated that their company has reshored at least a portion of their manufacturing operations to the US in the past 3 years, while another 22% plan to do so in the next 3 years. Another survey in September 2020 suggested that 66% of firms in the world were considering reshoring to some degree (ADB, 2021). It is also estimated that 16%–26% of world exports could be moved either via reshoring, nearshoring, or an additional round of offshoring to new locations (McKinsey Global Institute, 2020).

However, despite the perceived benefit of reshoring amongst companies, some studies find that reshoring could exert negative effects on economic outcomes and supply chain resilience (ADB, 2021; Bonadio et al., 2021; OECD, 2021b). Localisation and reshoring of supply chains through tariffs and production subsidies would not only exert high efficiency costs, but also make them more vulnerable to shocks due to lack of adjustment channels. As a result, localisation of supply chains is unlikely to improve the resilience or stability of supplies. Incentives for reshoring also distort the market, leading to lower welfare and economic activities, as we argue in our simple economic model.

Supply chain diversification

Apart from reshoring or nearshoring, an alternative response from many countries to the rising US–China geopolitical tensions and trade frictions is to reduce their economic dependence on inputs from China and to diversify their sourcing origins. For instance, in 2020, Japan established a fund to subsidise firms that diversify away from China for their inputs (Jiang, Rigobon, and Rigobón, 2021; Bloomberg, 2020). Increasingly, other manufacturing leaders (e.g. Korea, the EU, the US, and India) have been contemplating policies to facilitate a shift away from China.

Another strategy is vertical integration, which is often considered an alternative solution as efforts to mitigate supply volatility and strengthen the market position are intensified during disruptive events such as the pandemic. Through vertical integration, companies can acquire factories or suppliers, allowing them to streamline their operations by obtaining ownership of various production process stages – resulting in more reliable internal chains (Kiers et al., 2022). Some big businesses are pursuing this vertical integration approach. Amazon and Tesla exemplify this trend, as they are actively seeking to expand their range of operations – both forward and backward – in their supply chains (Mihm, 2022). However, we should note that shocks such as natural disasters can disrupt internal supply chains as well as external ones with other firms.

4. G20 Roles in Ensuring Supply Chain Resilience without Subtle Protectionism

The literature on how supply chain resilience (SCR) can be improved at the firm level from the operational or managerial point of view is extensive. However, we focus on government policies and international cooperation to improve SCR.

First, governments need to ensure that the private incentives for resilience and/or diversification are properly aligned with the market and only respond to market failures. If private incentives for SCR fall below the social benefits of SCR, governments may need to deploy policies to incentivise greater investment in resilience through regulatory schemes, diversification subsidies, or other fiscal/tax incentives. In the current absence of a well-functioning multilateral trading system, regionalisation of supply chains via nearshoring might result in better SCR than purely domestic supply chains. Regionalisation of supply chains tends to have security advantages relative to optimised supply chains in distant locations. Therefore, regional trade agreements could and should be extensively used to bolster regional SCR.

Second, strategic stockpiling of some essential goods and critical inputs or raw materials is becoming increasingly necessary to mitigate the effects of shocks and disruptions in the future. An optimal risk management strategy could determine whether stockpiling should involve the final good or its critical inputs. Further work is needed to determine the socially optimal size and allocation of stockpiles to manage. However, what is clear is that there is a need for international cooperation and coordination in this area in case countries revert to hoarding or export restrictions when crisis hits. For this purpose, building greater transparency on availability – particularly of medicines (vaccines), medical supplies, and key inputs – would help in managing global supply chain resilient.

Third, there is a strategic need for investment in digital technologies to improve SCR. Digital transformation can help to boost SCR in several ways. On the one hand, digitalisation of supply chains (e.g. blockchain technology) can improve traceability from beginning to end. It can assist policymakers in identifying where they are vulnerable and perform effective risk assessment in all tiers. Some early warning indicators and information on alternative sourcing origins can be developed. On the other hand, aiding firms' participation in digital supply chains and digital trade, and improving their uptake of digital technologies, are likely to improve SCR.

Fourth, the long-term solution to improve SCR is unlikely to be either renationalisation (reshoring) of supply chains or the previous arrangement of offshoring. Instead, it is more likely to be a mix of domestic, regional, and international production in the context of global cooperation to ensure open trade in times of crisis. In this case, when crisis hits, countries can still rely on trade instead of having to produce domestically in isolation. A policy to promote supply chain diversification (i.e. goods being produced both domestically and abroad) is often more socially optimal than a policy promoting pure reshoring or offshoring. It is worth noting that subsidies are not the only way to incentivise supplier diversification. It is crucial to keep trade and investment regimes open to increase the potential number of countries or suppliers that companies can use as an alternative sourcing origin or production site in times of disruption. To the extent that diversification is possible in a particular value chain, an open trade and investment regime also promotes supply chain diversification and, in turn, resilience.

Last, and the most important one, what governments can and should do is reduce the risks in the first place. They can reduce the likelihood of idiosyncratic shocks by expanding safety nets for suppliers, country-specific shocks by building more resilient infrastructure, geopolitical shocks through peace and conducive discussions between and amongst countries' leaders and providing full support to international organisations that facilitate international cooperation.

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Appendix: A Theoretical Framework of Shocks

Here, we present a simple model to represent firm optimisation in facing and managing shocks. Suppose there are two countries (domestic and foreign) in which a representative industry is a typical monopolistic firm with a constant-elasticity-of-substitution (CES) utility function, with $\sigma > 1$ being the elasticity of substitution. To produce a product, each firm j procures a customised input from a supplier to realise the marginal cost of $c_j = c$. The marginal cost would be higher at $c_j = \gamma c$, where $\gamma > 1$, if a firm fails to obtain the customised input due to a supply chain disruption.

Each firm j's profits depend on the worldwide market size (E); the price of the product (p_j); the price index (summary statistics of the prices of all products; P); the price elasticity (which takes the same value as the elasticity of substitution; σ); and the fixed sourcing costs (F_j); and can be expressed as

$$\pi_j = \frac{E}{\sigma}\left(\frac{p_j}{P}\right)^{1-\sigma} - F_j.$$

Profits decrease with the firm's own price relative to the price index.

Profit-maximising firms engage in constant markup pricing such that $p_j = (\sigma/\sigma - 1)c_j$, while the price index P is defined as $P^{1-\sigma} = \sum_j p_j^{1-\sigma}$, which aggregates the prices for all products sold by home and foreign firms in the home market. Suppose n_i, where $i = H, F$, and $C_i = \left(\frac{1}{n_i}\sum_{j=1}^{n_i} c_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ denote the number of firms and average marginal costs of firms in country i, we can express the price index in the home country by

$$P^{1-\sigma} = \left(\frac{\sigma}{\sigma - 1}\right)^{1-\sigma} \Phi,$$

where

$$\Phi = n_H C_H^{1-\sigma} + n_F C_F^{1-\sigma}$$

measures the competitiveness of the market. Each firm j's profits can be rewritten as

$$\pi_j = \frac{E}{\sigma}\frac{c_j^{1-\sigma}}{\Phi} - F_j.$$

In the presence of supply chain-disruptive risks, each firm chooses the optimal sourcing strategy: domestic sourcing, foreign sourcing, or diversification (i.e. sourcing from both domestic and foreign suppliers). Firms incur sourcing costs for F if they choose either domestic or foreign sourcing. They incur $2F$ if they choose diversification.

The objective of governments is to maximise the expected social welfare. Social welfare can be considered as a function of aggregate profits for domestic firms and an inverse measure of the price index: $W(\Pi_H, P^{1-\sigma})$, where

$$\Pi_H = \sum_{j=1}^{n_H} \pi_j = \frac{E}{\sigma}\frac{n_H C_H^{1-\sigma}}{n_H C_H^{1-\sigma} + n_F C_F^{1-\sigma}} - \sum_{j=1}^{n_H} F_j.$$

Social welfare increases with Π_H and $P^{1-\sigma}$, both of which in turn increase with the domestic firms' competitiveness, measured by $\Phi_H = n_H C_H^{1-\sigma}$.

The reduction in the average marginal costs of domestic firms, denoted by C_H, enhances social

welfare both by increasing the aggregate profits and by decreasing the price index –thereby increasing the consumer surplus. Indeed, taking n_H and $n_F C_F^{1-\sigma}$ as given, the home country benefits from a reduction in C_H as it increases both Π_H and $P^{1-\sigma}$. Since each domestic firm chooses its sourcing strategy to minimise its expected total cost of production, the objectives of the government and the firm are aligned.

Idiosyncratic shocks disrupt firms' supply chains randomly and independently across firms, so q denotes the probability that each buyer–supplier relationship that is hit by an idiosyncratic shock and θ_H denotes a fraction of the domestic firms that diversify. Then the market competitiveness measure can be written as

$$\Phi = n_H[(1-\theta_H)(1-q) + \theta_H(1-q^2)]c^{1-\sigma} + n_H[(1-\theta_H)q + \theta_H q^2](\gamma c)^{1-\sigma} + n_F C_F^{1-\sigma}.$$

This measure will depend on the realisation of shocks in general. In case of country-specific shocks, with q_H and q_F the probabilities of a shock that hits the home and foreign country, respectively, the expected market competitiveness is written as

$$\begin{aligned} E\Phi = (1-q_H)(1-q_F)(n_H c^{1-\sigma} + n_F C_F(0,0)^{1-\sigma}) \\ + (1-q_H)q_F[n_H \eta_H c^{1-\sigma} + n_H(1-\eta_H)(\gamma c)^{1-\sigma} + n_F C_F(0,1)^{1-\sigma}] \\ + q_H(1-q_F)[n_H \eta_H (\gamma c)^{1-\sigma} + n_H(1-\eta_H)c^{1-\sigma} + n_F C_F(1,0)^{1-\sigma}] \\ + q_H q_F[n_H(\gamma c)^{1-\sigma} + n_F C_F(1,1)^{1-\sigma}], \end{aligned}$$

where η_H denotes the fraction of domestic firms that source from a domestic supplier; $C_F(s_H, s_F)$ varies with the realisation of shocks, with $s_i = 1$ if country i is hit by a shock and $s_i = 0$ otherwise. In the presence of geopolitical risks that materialise with the probability q, the expected market competitiveness is written as

$$\begin{aligned} E\Phi = (1-q)[n_H \eta_H c^{1-\sigma} + n_H(1-\eta_H)(\beta c)^{1-\sigma} + n_F C_F(0)^{1-\sigma}] \\ + q[n_H \eta_H c^{1-\sigma} + n_H(1-\eta_H)(\gamma c)^{1-\sigma} + n_F C_F(1)^{1-\sigma}], \end{aligned}$$

where βc (where $\beta < 1$) denotes the marginal costs when sourcing from abroad in normal times; $C_F(0)$ and $C_F(1)$ denote the foreign firms' average marginal costs when a shock does not and does materialise, respectively.