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**World Trade Organization**

Economic Research and Statistics Division

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**COVID-19 AND GLOBAL VALUE CHAINS**

**A DISCUSSION OF ARGUMENTS ON VALUE CHAIN ORGANIZATION  
AND THE ROLE OF THE WTO**

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## COVID-19 AND GLOBAL VALUE CHAINS

### A discussion of arguments on value chain organization and the role of the WTO

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#### ABSTRACT

Since the outbreak of the COVID-19 pandemic there has been a discussion among researchers and policy makers about changes to global value chains, both about expected changes and changes that should be promoted by government policies. In this paper we conduct an in-depth analysis of the reasons for changes in global value chains as a result of COVID-19 both from a positive angle, analysing expected changes in the behaviour of firms, and from a normative angle, assessing the different arguments for policy interventions by governments. After this analysis international cooperation of trade policies and the role of WTO in crises like the COVID-19 pandemic is explored. The analysis generates three main conclusions. First, the COVID-19 pandemic could contribute to diversification of sources of supply whose extent will vary by sector depending on the costs of value chain reorganization. The pandemic, by contrast, is not likely to contribute much to re-shoring, the return of manufacturing activities to industrialized countries, which is more likely to be driven by pre-existing trends such as rising factor costs in emerging countries, increasing uncertainty about trade policy, and robotization and automation of production. Second, the pandemic has led to increased attention to the provision of essential goods in situations of crisis and our analysis concludes that to achieve this objective, global cooperation should be preferred to national policies such as domestic production and export restrictions. Third, the largest risk for the global economy in the aftermath of the pandemic is a move away from open, non-discriminatory trade policies, which would jeopardize the large benefits of open trade regimes in the current global economy characterized by scale economies, innovation spillovers, and a global division of labour.

**Keywords:** COVID-19, global value chains, provision of essential goods, export restrictions

**JEL-codes:** F1

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## 1 INTRODUCTION

The COVID-19 pandemic led to shortages of medical equipment and pharmaceutical products in many countries as demand spikes exceeded existing supply and production capacity. For their supplies of personal protective equipment (PPE) and generic drugs, countries are dependent on imports from a relatively small number of countries.<sup>1</sup> When worldwide production capacity was unable to meet the demand spike, bidding wars and export restrictions raised the price of several medical goods essential in the fight against the pandemic. At the same time transport delays and differences in timing of COVID-19 lockdowns have led to interruptions of production in complex value chains because of missing intermediates.

The COVID-19 pandemic brought to the attention of the public the risks associated with fragmented production process as managed across the planet. As a result, many policy makers and analysts argue for interventions in favour of reorganization of value chains to limit the dependence on imports for essential goods and to increase the resilience of value chains. Often these pleas favour so-called re-shoring, a return of manufacturing activity and jobs which were previously offshored to industrialized countries. [Robert Lighthizer \(2020\)](#), the US Trade Representative, for example argued in the New York Times that "the era of offshoring US jobs is over." And Peter Altmaier ([Nienaber, 2020](#)), German Economy Minister, called for less dependence of Europe on imports from non-European countries for medical equipment. [Beata Javorcik \(2020\)](#), Chief Economist at the European Bank for Reconstruction and Development, observed that the COVID-19 pandemic together with uncertainty about future trade policy will force companies to think about re-shoring and diversifying sources of supply.

At the same time many economists are sceptical about the need for intervention and a reorganization of value chains as best policy response to the problems raised by the pandemic. [Caroline Freund \(2020\)](#), Director of Trade, Regional Integration and Investment Climate at the World Bank, for example argues that bringing supply chains back home "would defy economic logic" and [Sebastian Miroudot \(2020\)](#), OECD economist, argues that self-sufficiency or domestic production will not increase robustness of global value chains.

Some of the pleas for re-shoring seem to be in line with some countries' policy objectives already existing before the pandemic, such as the objective to bring manufacturing jobs back home or to reinvigorate industrial policy. Therefore, it is important to consider reasons related or unrelated to the pandemic when analysing the current discussion on value chain organization. Furthermore, the analysis of national policies in response to the pandemic shows that there has been a lack of international coordination at times. Some countries imposed export restrictions on essential medical goods in response to supply shortages and got involved in bidding wars for such goods. Both policies have driven up world prices of these essential goods, making them more complicated to obtain for import-dependent low-income countries. International organizations could play a role to limit the effects of such events and coordinate policies to guarantee the availability of essential goods.

In this paper we provide an analysis of the arguments on the reorganization of value chains related to the COVID-19 pandemic and discuss the possible role of the WTO in coordinating national policies. We distinguish between a positive and normative approach. The positive approach, discussed in Section 2, will explore whether changes can be expected in the organization of value chains in response to the COVID-19 pandemic. A crucial question is whether firms will perceive a changed trade-off between efficiency and risk in value chain production because of this pandemic. Many observers have referred to a shift from the principle of "just-in-time" to "just-in-case" in this respect. Section 2 will describe economic forces leading to a reorganization of value chains related to COVID-19 and other trends, such as robotization and rising trade policy uncertainty. In the normative approach, addressed in Section 3, the question is whether government intervention in the economy is needed to induce firms to reorganize value chains. From an economic perspective, government intervention is typically justified when the allocation of resources by the free market is not optimal. We discuss market failures in the organization of value chains due to information problems in complex value chains, possible externalities of firms' decisions on other firms in the value chain, and firms' potentially incorrect assessments of the risks of extreme events (crises).

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<sup>1</sup> [World Trade Organization \(WTO\) \(2020b\)](#) shows that Germany, the US, and Switzerland supply 35% of medical products to the world, whereas China, Germany, and the US export 40% of personal protective products.

Government policies may also pursue other non-economic objectives as the primary purpose of the government is to ensure the well-being of society, such as guaranteeing sufficient supply of essential goods. Important questions in this context are: how to define essential goods? What types of emergencies should be taken into account to define essential goods? How does reshoring of production activities compare with the alternatives such as diversification of the sources of essential goods, increasing the size of inventories, or promoting flexible manufacturing?

Section 4 examines the potential role of international cooperation, including through the World Trade Organization (WTO), in addressing the use of export restrictions and in helping to enhance the supply of essential goods in times of crises. Section 4 also briefly addresses other areas in which the WTO could play a role during crises, in particular monitoring of trade policies and limiting the disruption of restrictions to international transport and travel to promote the mobility of essential workers and a smooth operation of the logistics sector. Section 5 draws some conclusions on the organization of value chains in relation to the COVID-19 pandemic.

Since many of the emerging questions are still up for debate, we cannot provide definitive answers to all questions raised. Rather, the purpose of this paper is to suggest a possible framework for policy discussions on the topic of supply chain reorganisation in the wake of COVID-19. We intend to be comprehensive in our overview of the relevant questions emerging during the COVID-19 pandemic and the most important factors playing a role in answering those questions.

## 2 REORGANIZATION OF VALUE CHAINS: POSITIVE APPROACH

The COVID-19 pandemic has intensified the debate about the organization of value chains. Since the Global Financial Crisis of 2008, the growth of global value chains has halted. Although it is too early to determine the impact of COVID-19, many observers argue that the pandemic could promote reshoring and near-shoring. In this Section we will describe the different reasons associated with COVID-19 that could lead to changes in the organization, or reorganization of value chains by firms. Then we will turn to trends already existing before COVID-19 driving changes to global value chains. We will draw some conclusions on the possible changes in value chains in Section 2.4.

### 2.1 Reorganization of value chains and COVID-19

In the discussion about value chains, three main reasons are given on why the COVID-19 pandemic are expected to result in changes in the way firms organize value chains:<sup>2</sup>

1. Higher trade costs  
International value chains are more costly if it takes longer or becomes riskier to ship components. Therefore, to the extent trade costs are expected to go up, firms have an incentive to concentrate production or diversify to less uncertain locations to limit increases in trade costs.
2. Shock propagation and vulnerability of supply chains  
If components are complementary, a shock in one stage halting production will also halt production in other stages. If COVID-19 hits supply at different moments in time in different continents (first China, then Europe and later the US), production in global value chains will be paralyzed the entire period ([Baldwin and Freeman, 2020](#)).
3. Diversification to enhance robustness and resilience of value chains  
To limit the negative impact of location specific shocks or uncertainties, firms can diversify sources of supply. A significant share of global manufacturing production is concentrated in China ([Baldwin and Freeman, 2020](#)). The COVID-19 pandemic could accelerate a trend of production relocation outside of China that already emerged in response to the US-China trade conflict.

Each of the three factors will be discussed now in turn.

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<sup>2</sup> While most of the reasons can lead to a decline of global value chains, in some sectors such as business services, value chains can also become more international. [Baldwin \(2020a\)](#) argues that working from home and the rise in digitalization could foster the offshoring of high-skilled services tasks leading to more so-called remote intelligence, one of the two phenomena of the globotics revolution ([Baldwin, 2019](#)) with the other being robotization and the increased use of artificial intelligence.

### 2.1.1 Rising trade costs and COVID-19

Historically, the fragmentation of global production has risen on the wave of declining transportation and communication costs and a well-established and stable trade policy environment. Lower transportation costs have made it economically rational to move goods over long distances. Lower communication costs have facilitated the geographical unbundling of stages of production by enabling coordination and management of activities in multiple countries. Lower trade policy barriers and a stable trade policy environment secured by commitments in international agreements have kept the costs of moving value added across several borders low and predictable. The COVID-19 pandemic has raised trade costs across a broad spectrum of components. How long these higher trade costs will persist remains to be seen.

The policy responses to the COVID-19 crisis have directly increased both transportation and communication costs. Border closures and border checks have increased transit times. Port closures and changes in port protocols, such as restrictions on crew changes, have created imbalances in the shipping networks, leading to a lack of capacity where it is needed. To keep shipping rates from collapsing, ship operators have reacted to the drastic fall in the demand for shipping by restricting the supply. This has resulted in an increase of shipping costs.<sup>3</sup> Moreover, travel restrictions have indirectly increased the cost of air cargo. So-called belly cargo – goods transported in the cargo area of passenger planes – constitutes a large share of global air cargo capacity. Hence, as air travel came to halt, this capacity considerably shrunk.<sup>4</sup> Combined with an increased demand for fast delivery of essential items to fight the pandemic, this has led to the prices of air cargo, especially out of China, to rise substantially.<sup>5</sup>

Travel restrictions have halted not only services trade delivered by personal travel (through mode 2 and mode 4) but also business travel that is often crucial to ensuring a smooth functioning of the value chain and establishing new business relationships. While the ICT revolution enabled the fragmentation of production across borders and long distances, the movement of key personnel across factories remains key to multinational production, especially when there are changes or problems. For example, a Korean manufacturer of smartphones saw its production of the latest models disrupted by a COVID-19 outbreak in its Korean production site. The company could promptly shift this production process to other sites in Vietnam and China where it was manufacturing older models, but it needed to send engineers to update the production lines. With border closures and travel restrictions this plan was delayed and, eventually, the South Korean government helped the company negotiate special travel exemptions for its engineers.<sup>6</sup> The company's ability to fly engineers to its factories around the world was instrumental to its resilience.

Finding new customers and suppliers also depends on business travel. Face-to-face contact helps build trust and overcome search and contracting frictions ([Startz, 2017](#)). Business travel for in-person business meetings is thus a way of investment that generates relationship-specific capital and adds value to the traded goods. Following this concept, [Cristea \(2011\)](#) finds that R&D intensive manufactures and goods facing contractual frictions are most dependent on face-to-face meetings. Disruptions to business travel may thus lead to less internationalized supply chains and a lower quality of business relationships.

The large shock across different components of trade costs is one aspect that makes the COVID-19 crisis distinctly different from the 2008/2009 crisis and consequently has the potential to make this crisis more damaging to GVCs. While most of these trade costs can be expected to decrease again as the pandemic abates and/or as we learn how to effectively mitigate its impact, travel restrictions may linger in the global policy landscape for some time.<sup>7</sup> Moreover, the way we travel by air and conduct business generally, may change as it did after the 9/11 terrorist attacks, but this time due to a changing health security environment.

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<sup>3</sup> See for instance <https://fbx.freightos.com/>.

<sup>4</sup> Annually, global air cargo capacity shrank by 24.6% in March 2020 ([IATA, 2020](#)).

<sup>5</sup> See [World Trade Organization \(WTO\) \(2020a\)](#) for more details on how the COVID-19 crisis affects trade costs.

<sup>6</sup> [White Edward \(2020\)](#).

<sup>7</sup> Out of all measures taken by the US government, restrictions on international travel had the [highest approval](#) among US respondents ([OECD, 2020d](#)). Furthermore, the demand for passenger flights may remain low until a vaccine is found (see for instance [Azurite Consulting \(2020\)](#)).

Unlike during the Great Depression of the 1930s, protectionism has not been a main driver of trade costs in this crisis so far. Most trade policy changes during the pandemic were limited to COVID-19-related goods. These included both trade restrictive (e.g. export restrictions) and trade facilitating (e.g. elimination of tariffs) measures. More broadly, many governments put in place measures to lessen the impact of COVID-19-related policies on trade costs. These include priority lanes for road cargo transport, exempting staff operating cargo transport services from travel restrictions and quarantine requirements, and facilitation of border clearance by automating procedures and eliminating the need for personal contact. In this way, the pandemic has provided a big push to the digitalization of customs procedures which could prove to be a positive long-term outcome. On the other hand, in some countries the crisis might strengthen calls for protectionist policies which have been on the rise in the past couple of years (as discussed in Section 2.2.3).

### 2.1.2 Vulnerability of supply chains

Shortly after the outbreak of COVID-19, the vulnerability of international value chains during crises such as a pandemic was put in the spotlight. The debate highlighted two positions. On the one hand international trade can help countries to absorb the impact of shocks during a crisis, while on the other hand GVCs can lead to vulnerable dependencies. These positions appear contradictory and this subsection will describe the two views and compare them explaining what is driving the differences.

#### *Trade as an insurance policy*

Various scholars ([Freund, 2020](#); [Miroudot, 2020](#)) have argued in the debate on value chains and COVID-19 that trade can serve as a shock absorber: if a country is hit by a negative production shock or positive demand shock, it can obtain supplies of necessary goods by importing. As such, trade cushions the impact of country-specific shocks and thus reduces income volatility. For example, if a country is not able to produce the needed amount of medical goods or pharmaceutical products, it can turn to the international market to obtain such goods.

A number of empirical studies have shown that trade decreases volatility ([Bejan, 2006](#); [Buch, Döpke and Strotmann, 2006](#); [Burgess and Donaldson, 2012](#); [Cavallo, 2008](#); [Haddad et al., 2013](#); [Parinduri, 2012](#)). [Burgess and Donaldson \(2012\)](#) find, for instance, that the decline in transportation costs due to the expansion of railroads in India lowered the impact of productivity shocks on real income, implying a reduction in volatility. More recently, [Caselli et al. \(2020\)](#) show that openness to international trade can lower income volatility by reducing exposure to domestic shocks and allowing countries to diversify the sources of demand and supply across countries, as long as country-wide shocks are important (as opposed to sector-specific shocks). [Caselli et al. \(2020\)](#) also noted that for trade openness to lower income volatility, the shocks affecting trading partners cannot be too large magnitude or correlated across countries. Similarly, ([OECD, 2020a](#)) shows that a localised trade regime would be more vulnerable to shocks than the current trade regime with production fragmentation. Employing a CGE-model, OECD finds that there is more variation in real consumption and real GDP in the case of country-specific trade cost shocks in a localised trade regime featuring higher initial tariffs and thus less trade and lower substitution elasticities between domestic goods and imported goods.

#### *Trade as a conduit of shock propagation*

The view that trade can cushion the impact of country-specific shocks is implicitly based on the assumption that domestic purchases and imports are substitutable. If domestic production is interrupted or there is a sudden surge in domestic demand (like during COVID-19 for PPE), international trade helps countries deal with a scarcity of supplies, because countries can substitute to other sources of supply. In value chain production though, different stages might be complementary and, hence, production interruptions can occur more often if production is spread across different locations and shocks are location specific.<sup>8</sup>

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<sup>8</sup> Using a simulation exercise, [Henriet, Hallegatte and Tabourier \(2012\)](#), find that economies are resilient to natural disasters when networks are localized and clustered, in other words, firms in the same area interact with each other, and thus are isolated from disasters affecting other networks. This would imply that a world economy without trade, that is under autarky, would be more resilient to negative shocks than an interconnected one.

While the previous paragraphs argue that, on average, countries benefit from geographical diversification of suppliers and customers, a given negative shock can also propagate through the trade network and have a negative impact on the whole value chain. For instance, ([Baldwin, 2020b](#)) has argued that the trade collapse during the COVID-19 pandemic could be larger than during the great financial crisis because of supply chain disruption. The reason is that negative shocks to labour supply take place at different moments in time in different locations. First, China was hit, then Europe, then the US and Latin America. If the global production chain is characterized by complementarity, it will be paralyzed when production is disrupted in one location. As explained more formally in Box 1, with complementarity between intermediate inputs, a geographically dispersed production chain will be more often interrupted than a concentrated production chain if shocks across locations are uncorrelated. Real-world examples are car producers stopping production in Korea and Japan after the negative supply shock in China (Hyundai and Honda) and in Sweden after lockdowns in other European countries (Volvo).

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*Box 1: complementarity of production stages and geographically uncorrelated shocks*

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In the standard model of offshoring (or vertical FDI) the choice for offshoring is driven by a trade-off between transport and coordination costs of offshoring on the one hand and benefits of factor price differences on the other hand (see for example [Antràs and Yeaple \(2014\)](#)).<sup>9</sup> Rising trade and coordination costs because of COVID-19 as described in the previous subsection reduce the incentive for offshoring. To model complementarity of components, we can add risk to the standard model. Suppose there are two countries and two production stages (components and assembly) which are complementary. Technically this means that production is equal to the minimum of components and assembly, reflecting that a value chain is only as a good as its weakest link. Suppose shocks are uncorrelated in the two production locations.

In this setting with perfect complementarity and uncorrelated shocks, production is less often interrupted if it is concentrated in one location, because output is equal to the minimum of components and assembly. If assembly and components take place in separate locations, output will be equal to zero if there is a shock in one of the two locations. This illustrates that the decision of a firm whether to offshore does not depend only on the trade-off between trade/coordination costs and factor costs advantages, but also on the trade-off between enhanced efficiency and the increased exposure to the risk of disruptions.

The COVID-19 crisis could raise the expected frequency of shocks halting production or make firms more aware of the costs of supply shocks in one of the chains of the production process. This would lead them to focus on how to reduce the risk of disruptions. In our simple setup, an alternative for concentrating components and assembly in one location is to diversify and do assembly in two locations. With two locations for assembly, production is still more often interrupted than with concentration, but if the shocks are uncorrelated across locations the probability of a negative shock in both assembly locations taking place at the same moment will be small. We discuss the rationales and costs of diversification in Section 2.1.3.

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Empirical evidence supports the notion that production can be affected in complex value chains because of disruptions in the upstream sectors.<sup>10</sup> [Barrot and Sauvagnat \(2016\)](#) show that input specificity is a key driver of the propagation of firm-level shocks. Firms' sales growth and stock

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<sup>9</sup> Offshoring through independent suppliers also enables companies to benefit from sharing the fixed costs of producing specialized varieties.

<sup>10</sup> [Miroudot \(2020\)](#) argues there is no current empirical evidence supporting the perception that more complex value chains are more impacted during the COVID-19 crisis. To illustrate this point, [Miroudot \(2020\)](#) cites the results of a computable general equilibrium (CGE) simulation to show that there is no correlation between import intensity of production (which can be interpreted as the level of fragmentation) across sectors and projected reduction of output. In our view, this claim is not fully supported in quantitative analysis or empirical evidence on shocks before COVID-19. Furthermore, it is important to note that the CGE simulation results are based on a model with long run trade elasticities featuring higher degree of substitutability, which may not be realistic in the short run. Simulations with the WTO Global Trade Model in February 2020 showed that, using small trade elasticities reflecting complementarity, countries more dependent on imports of intermediates from China are projected to have larger output reductions in response to negative supply shock in China.

prices significantly drop when a major disaster hits one of their specific suppliers. [Carvalho et al. \(2016\)](#) study the Great East Japan Earthquake of 2011 and document that the disruption caused by the disaster propagated upstream and downstream along supply chains, affecting the direct and indirect suppliers and customers. [Di Giovanni, Levchenko and Mejean \(2014\)](#) show that sectors with stronger input-output linkages tend to exhibit a significantly greater correlation of firm-specific shocks, leading to the propagation of productivity shocks to downstream firms.

This evidence corroborates a low elasticity of substitution within global value chains. [Boehm, Flaaen and Pandalai-Nayar \(2019\)](#) provide one of the few studies that estimates this elasticity in the short run. The authors study the imports of US-based Japanese multinationals in the months following the 2011 Japanese earthquake. They find that the output of Japanese multinationals fell by a comparable magnitude to the drop in imports without a lag, which indicates a very rigid supply chain relationship for the Japanese affiliates. For Japanese multinationals, the elasticity of substitution across material inputs is 0.2, pointing to a strong complementarity.<sup>11</sup> For non-Japanese firms using inputs from Japan, the elasticity of substitution across material inputs ranges from 0.42 to 0.62. This rigidity is likely due to the substantial presence of intra-firm trade in what is presumably highly specialised inputs. See Box 2 for a discussion about the different estimates of the elasticity in the literature.

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*Box 2: empirical evidence on the elasticity of substitution between goods from different locations.*

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Trade economists typically estimate that the value of substitution elasticities is five or larger, suggesting a high degree of substitutability.<sup>12</sup> Macroeconomists typically work with substitution elasticities between domestic and imported goods around one, implying neither complementarity nor substitutability. This difference is explained by the fact that trade economists estimate elasticities based on long-run changes (tariffs, production costs), whereas macroeconomists tend to estimate elasticities based on short-run changes (exchange rates). This suggests that there can be complementarity in the short-run related to adjustment costs of switching suppliers, but that there is substitutability in the long-run.<sup>13</sup>

Some papers have attempted to differentiate between final goods and intermediates or a goods' position in the value chain in estimating the trade elasticity. [Antras and de Gortari \(2020\)](#) distinguish between final goods and intermediates finding a significantly smaller elasticity of trade flows with respect to distance. [Jakubik and Stolzenburg \(2020\)](#) show that the estimated trade elasticity is larger for goods with a larger share of foreign value added in exports, rising from 1.46 for industries in the bottom twenty-fifth percentile of foreign value added to 3.46 in the seventy-fifth percentile. Hence, for goods with a larger domestic value-added content the trade elasticity is smaller. However, except for goods with a very low foreign value-added share, the substitution elasticity, equal to one plus the trade elasticity, is larger than one for most goods.

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[Bonadio et al. \(2020\)](#) show that the global GDP effects of the COVID-19 shock are similar under the current trade regime as under autarky. Employing a quantitative trade model with some macro-features such as endogenous labour supply, they find that the average drop in GDP is 29.6% with the global economy calibrated to real-world data and 30.2% under an initial situation of autarky. Importantly, [Bonadio et al. \(2020\)](#) assume that the elasticity of substitution between intermediates from different sectors and countries of origin is 0.5, reflecting complementarity in the short-run and following the estimates in [Boehm, Flaaen and Pandalai-Nayar \(2019\)](#). Hence, even under complementarity of intermediates autarky would not lead to a lower GDP loss.<sup>14</sup>

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<sup>11</sup> If the elasticity of substitution between two goods is below 1, there is complementarity between these goods. That is, if demand (supply) for one of the goods increases, so does demand (supply) for the other. In contrast, if the elasticity of substitution is above 1, there is substitutability. That is, if demand (supply) for one of the goods increases, demand (supply) for the other one decreases.

<sup>12</sup> [Head and Mayer \(2014\)](#)

<sup>13</sup> [Johnson and Moxnes \(2019\)](#)

<sup>14</sup> An interesting question is what would happen in the case shocks would be country specific or take place at different moments in time. In such situations the average impact of shocks could be smaller under autarky if intermediates are complements, as discussed above. Obviously, countries with smaller labour supply shocks because of the COVID-19 pandemic will be affected less under autarky than open trade. However,



The structure of the supply chain network also matters in how much shocks propagate throughout an economy. [Acemoglu et al. \(2012\)](#) posit that, in a balanced network, such as an economy where each sector is self-reliant or relies equally on the outputs of all other sectors, independent shocks average out. On the contrary, if intersectoral input-output linkages exhibit asymmetries, for example in a "star network" where one sector is the sole input supplier to all other sectors, a sectoral shock propagates strongly to the rest of the economy and affects aggregate outcomes.

A key question is whether such asymmetric input-output linkages are present in the real economy. [Acemoglu et al. \(2012\)](#) analyse the intersectoral network corresponding to the input-output linkages between 474 US industries in 1997. Even though the pattern of sectoral interconnections does not centre around one sector, a small number of sectors play a disproportionately important role as input suppliers to others. A similar exercise can be done using world input-output tables, which illustrate the intersectoral network across countries.

In conclusion, trade can help firms and more broadly countries to cushion country-specific shocks by substituting to other sources of supply or demand. The extent of such substitution is often quite limited in the short run but more likely in the long run. At the same time, long geographically dispersed value chains and trade networks where a small number of large suppliers plays a central role can be vulnerable to disruptions. In what follows we focus on diversification and other strategies that decrease the short-run rigidity in value chains and thus enhance their robustness and resilience.

### **2.1.3 Diversification to enhance robustness and resilience of value chains**

The COVID-19 pandemic underlines that even if firms are not directly affected by the virus or relevant quarantine measures, they nevertheless need inputs originating from a potentially affected area. Such risks are often referred to as supply chain risk and they are commonly recognised by business executives: when asked about challenges that their firms face, over one-quarter of surveyed executives report that supply-chain disruption is one of their top concerns ([Economist Intelligence Unit, 2009](#)). COVID-19 has highlighted at least two supply chain risks associated with a lack of diversification. First, a lack of diversification could lead to the breakdown of a supply chain if one firm or country from which components are sourced is hit by an adverse labour supply shock and, second, dependence on one or a small number of dominant suppliers can expose firms to the risk of policy changes in these suppliers' countries. We discuss these risks in more detail in Box 3.

#### *Box 3 – supply chain risks associated with a lack of diversification*

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When production is organised sequentially and intermediate inputs are complementary, one negative shock causing a disruption (such as a factory closure) could lead to ripple effects down the supply chain. Just as a chain is only as strong as its weakest link, problems along a production chain can sharply reduce output in the entire chain ([Acemoglu et al., 2012](#); [Kremer, 1993](#)). A negative shock to one of the key suppliers could significantly impact the supply network, affecting other producers and consumers downstream. In contrast, when firms can source from a diversified network of suppliers, a disruption to one factory would not significantly impact the whole supply chain, as firms can replace disrupted production with inputs sourced from another supplier. As long as adverse shocks do not occur at the same time, the risk of supply chain disruption can be significantly reduced when firms have diversified suppliers.

Another risk for supply chain production is dependence on one or a small number of dominant supplier(s) or customer(s), which could expose firms to the risk of policy changes. During the COVID-19 pandemic, many countries put in place restrictions on exports or equivalent measures such as the compulsory purchase by governments to address domestic shortages of medical supplies. The lack of diversification can thus expose firms and countries to policy changes, leading to higher trade costs or supply chain disruptions.

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countries with bigger shocks will be affected more under autarky. This reflects the role of trade as an insurance mechanism that reduces economic volatility.

In considering the ways to manage supply chain risks, the business literature makes a distinction between resilience and robustness. Robustness is defined as the ability to maintain operations during a crisis ([Brandon-Jones et al., 2014](#)), and resilience is defined as the ability to return to normal operations over an acceptable period of time ([Miroudot, 2020](#)). Modern industrial organisation faces a trade-off between short-run robustness to negative shocks and high efficiency in normal times. Resilient firms tend to reduce their risks but do not invest significantly to anticipate and avoid all types of disruptions. [Miroudot \(2020\)](#) argues that robustness is important for the supply of essential goods (such as face masks during a pandemic) and can be achieved through building redundancy in suppliers, alternative locations of production, as well as information systems that give accurate real-time information on the level of inventories and output along the supply chain. The example of the Korean mobile phone manufacturer in section 2.1.1 is illustrative in this context.

Empirical evidence shows that firms with more diversified suppliers display a lower volatility ([Kelly, Lustig and Van Nieuwerburgh, 2013](#)), and diversification also makes firms more resilient following a one-off shock such as an earthquake ([Todo, Nakajima and Matous, 2015](#)) or an epidemic ([Huang, 2019](#)), see Box 4 for more details. Simulation analysis also points out that output losses from a natural disaster are smaller when firms have more redundant ties with suppliers and clients, as they can easily compensate the loss of their partners ([Henriet, Hallegatte and Tabourier, 2012](#)).

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*Box 4 – Diversification enhances firm resilience to adverse shocks*

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[Todo, Nakajima and Matous \(2015\)](#) examine how supply chain networks affected the resilience of firms (defined as the amount of time required to recover production) after the 2011 East Japan earthquake. Two opposing effects are at play: on the one hand, firms connected with more firms through supply chain networks are more likely to experience disruptions in supply and demand, which delays recovery. On the other hand, firms can benefit from diversified networks with suppliers and clients, because they can substitute the surviving firms in the network for the damaged partners and receive support from them. The authors find that the latter, positive effect exceeds the negative effect. Consequently, Toyota and other automobile manufacturers have diversified their suppliers, departing from their traditional keiretsu relations ([Matous and Todo, 2017](#)).

[Jain, Girotra and Netessine \(2016\)](#) find that supplier diversification is associated with slower recovery from disruptions, while the use of long-term relationships is associated with faster recovery. They thus conclude that single sourcing and a long-term relationship with a single supplier but may facilitate recovery and improve supply chain resilience. It is worth noting however that the result may be explained by the way the authors define diversification, as firms sourcing very specific, complementary inputs (a specific type of bolt and nut, for example) from different suppliers may be considered diversified but in reality one input is useless without the other.

Similarly, [Huang \(2019\)](#) studies the resilience of Chinese firms after the 2003 SARS epidemic focusing on the diversification of global sourcing. He finds that firms which are more geographically diversified in sourcing are more resilient to supply chain disruptions. Further, high productivity firms are more likely to source from diversified import routes and connectivity to transportation networks increases sourcing diversification.

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In the wake of the COVID-19 pandemic, China's position at the heart of many supply chains generated difficulties for production in other countries when production was disrupted in China.<sup>15</sup> The country's exports dropped by 17 per cent in January and February 2020, implying that vital production parts were missing in other countries relying on Chinese intermediate inputs. For instance, ten percent of all of Germany's imported inputs come from China, and this reliance on Chinese intermediates is particularly strong in the electronics, computing and textile manufacturing sectors ([Seric et al., 2020](#)). Diversifying sourcing patterns would make it easier to deal with country specific shocks.

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<sup>15</sup> When COVID-19 first broke out in Wuhan, China, it was estimated that at least 51,000 companies worldwide, 163 of which are in the Fortune 1000, have one or more direct suppliers in the impacted region ([Dun & Bradstreet, 2020](#)).

Preliminary analyses since the start of the pandemic indicate that trade is rather diversified at the country and regional level. [Cernat and Guinea \(2020\)](#) examine EU imports of over 9,000 different products and find that most products imported by the EU come from more than one supplier. In fact, only 1% of total EU imports relies on one sole supplier. Yet the extent of diversification is less obvious at more disaggregated levels. Looking at the extent of diversification at firm level, [Kramarz, Martin and Mejean \(2020\)](#) find that more than 90% of French exporters derive more than half of their sales in one destination from a single partner. The extreme concentration of trade flows among a few large suppliers and a few large foreign buyers makes trade vulnerable to adverse shocks hitting large players in international markets.

While diversification can mitigate the risks of adverse production shocks and policy changes, the decision to diversify involves a trade-off between higher costs of setting up and maintaining supply chains and the risk of negative shocks and disruptions. In particular, the costs associated with diversification hinge on three economic characteristics, which vary across sectors.

First, some manufacturing sectors are very capital-intensive, featuring significant economies of scale ([Lund et al., 2020](#)). Production in certain supply chains requires high upfront investment, including developing new products and production processes, purchasing machinery as well as recruiting and training specialised employees. The upfront investments are considered sunk cost and can only be recovered when the output reaches a certain amount. Additionally, enterprises with a large scale of operation also have the possibility of purchasing inputs at a lower per-unit cost when they are purchased in large quantities. Consequently, it is very hard to diversify suppliers in complex supply chains, because significant upfront investment in production limit the number of suppliers. For example, South Korea is the major exporter of memory chips. In the event of a shock affecting the supply of South Korean producers, other countries cannot produce sufficient quantities to meet global demand ([Leering, Spakman and Konings, 2020](#)).

Second, supply chain relationships are complex and require relationship-specific investments. Participants of international supply chains often undertake numerous relationship-specific investments such as purchasing specialized equipment or customizing products ([Lund et al., 2020](#)). This means that suppliers and buyers need to develop specific relationships to configurate production through repeated interactions, especially in the presence of weak contract enforcement ([Antràs, 2020](#)). Identifying new suppliers and managing the production process can be costly and time-consuming, resulting in certain "stickiness" in supply chain relationships ([Huneus, 2018](#); [Martin, Méjean and Parenti, 2018](#)).

Third, the intangible component of production may render diversification costly. In sectors where significant amounts of intellectual property and knowhow are involved in the production process, diversifying suppliers and transferring the tactic and knowhow of the production process can take significant time and effort. More importantly, as knowledge is non-codifiable and non-rivalrous, the fear of expropriation of the intellectual property or imitation may prevent companies with intangible assets from engaging with a wide range of suppliers, and rather opt for vertical integration where the company owns or controls its suppliers ([Antràs and Yeaple, 2014](#); [Bolatto et al., 2017](#)).

In conclusion, the COVID-19 pandemic has illuminated risks of a lack of diversification in the sourcing of intermediates. At the same time more diversification in supply chains involves additional costs, particularly in sectors with large scale economies, relationship-specific investments, and in knowledge-intensive sectors. Hence, the costs of more diversification depend on the characteristics of supply chains and vary significantly across sectors. In sectors such as electronic equipment or automobiles significant upfront investments, complex supply chain relationships and high values of intangible asset may prohibit firms from diversifying their sourcing of supplies ([Beattie, 2020](#)). In contrast, the COVID-19 pandemic could possibly lead to more diversification in value chains of sectors with more homogenous inputs. A crucial variable in this respect is the risk of trade policy becoming more restrictive.

#### **2.1.4 Other strategies to enhance robustness and resilience of value chains**

As diversification may be too costly for some value chains, alternative strategies can be followed by firms to foster supply chain resilience. [Miroudot \(2020\)](#) argues that resilience can be built through different approaches, such as buffer stocks and easy-to-replace standardised inputs, resilience monitoring and identifying locations and suppliers less subject to risk. The business literature

recommends practices to enhance the short-term resilience of supply chains during the COVID-19 pandemic, including creating transparency in supply chains, estimating available inventory to keep production running, assessing and anticipating consumer demand, optimising production and distribution capacity, identifying and securing logistics capacity, and managing cash and working capital by running stress tests ([Alicke, Azcue and Barriball, 2020](#)). As described in Box 5, individuals, firms, and governments have more broadly shown to be capable to adjust their behaviour showing their creativity in dealing with the pandemic.

#### *Box 5 – Adjustments at the micro-level to deal with the effects of the pandemic*

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Individuals, firms and governments have been able to adjust their behaviour in response to the pandemic, showing their creativity and resilience. This box describes examples of such resilience relevant for the organization of value chains.

First, many companies were quick to come up with measures to encourage employees to work from home, which required a reorganization of production and management processes. The degree to which a job can be performed remotely depends on the requirement of a job and economic circumstance of a country. Estimates on the share of jobs that can be done from home vary from 37% in the US ([Dingel and Neiman, 2020](#)) to one fourth in developed and one sixth in developing countries ([Bloomberg News, 2020](#)). As discussed by [Baldwin \(2020a\)](#), since companies have already invested in remote working, the could trigger further shifts in the trend towards offshoring of high-skilled services tasks. Since the pandemic, some technology companies such as Facebook and Twitter have committed to continuing remote work, citing benefits such as a more diverse hiring pool and reduced office space demands ([Wittenberg, 2020](#)). This phenomenon could lead to more so-called remote intelligence and changes in services value chains.

Additionally, companies responded swiftly to changes in patterns of demand. For example, food processing companies quickly reorganized their production processes to sell directly to consumers instead of to restaurants. Companies reorganize their business networks setting up new alliances in response to falling demand from restaurants and rising demand for delivery food. In the US, the largest supermarket chain, Kroger, set up a partnership with big players in the foodservice market, such as Sysco and U.S. Foods to guarantee supply to stores ([Behsudi and McCrimmon, 2020](#)). India food-tech business Zomato used its platform to work with grocery start-ups to meet surging online-order demand ([Fitzpatrick et al., 2020](#)).

To respond to the surging demand in medical goods, many companies were able to rapidly reorganize production processes to supply medical goods. [Florini, Hoekman and Yildirim \(2020\)](#) describe a couple of examples of this rapid response. A consortium of US apparel makers reorganized their production into producing reusable and washable all-cotton 3-ply face masks, sold to the US Department of Health and Human Services. In Europe the French company Chargeurs reorganized its technical-textile-fibre production facilities into selling over one million sanitary masks per week. 3D printing technology has also enabled on-demand solutions for a wide spectrum of needs ranging from personal protection equipment to medical devices and isolation wards ([Choong et al., 2020](#)).

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There is some empirical evidence showing that certain supply chain management strategies can reduce risks and increase resilience in production. These strategies include coordination and information sharing, and business contingency plans.

Coordination and information sharing are crucial to increase both robustness and resilience. Studying just-in-time supply chain management, [Pisch \(2020\)](#) argues that all supply networks, regardless of their organisational structure or management, will see an increase in inventory holdings to cushion negative shocks in the future. In just-in-time supply chains, production is predicated on a downstream demand signal, which is shared between the supplier and the customer in real time. The diligent information sharing and coordination along the value chain will make managing those additional inventories cheaper and more efficient.

Anecdotal evidence from previous incidences of natural disasters also confirms this view. Following the 2011 East Japan Earthquake, Japanese firms started to change their supply chain management

by increasing supply chain visibility. Toyota Motor Corporation, for example, created the Reinforce Supply Chain Under Emergency (RESCUE) database for full information of direct and indirect suppliers and their products. Using this database, Toyota can easily search for alternative suppliers when supplies of certain materials and parts are disrupted due to a disaster. In addition, large Japanese manufacturers have encouraged their suppliers to prepare business continuity plans to minimise their risk of supply disruption. Before the East Japan Earthquake, Japanese firms were not prepared for shocks from natural disasters. Enterprise surveys indicated that only 9% of small and medium enterprises in the region affected by the earthquake were equipped with business continuity plans ([Hamaguchi, 2013](#)). In contrast, in the wake of the Kumamoto earthquake in 2016, firms in affected areas recovered relatively quickly thanks to the use of business continuity plans and production substitution ([Inoue and Todo, 2019](#)).

Importantly, advancements in information and communication technologies can significantly facilitate information management and coordination along supply chains, thus reducing the cost of business continuity. New technologies such as artificial intelligence (AI) promise to improve autonomous driving and real time itinerary mapping, driving down transportation and tracking costs. Internet of Things (IoT) sensors can be used to optimise cargo and shipment logistics. Combined with AI, the use of advanced robotics can minimise the cost of warehousing and container uploading ([World Trade Organization \(WTO\), 2018](#)). Blockchain and AI can further decrease transaction and compliance costs and increase transparency of supply chains ([Francisco and Swanson, 2018](#)). Additive manufacturing, or 3D printing, may allow companies to swift conversion to new products ([World Trade Organization \(WTO\), 2018](#)). These factors are likely to enable firms to improve visibility across their supply chain and increase supply chain resilience without the traditional costs associated with risk management ([Deloitte, 2020](#)).

## 2.2 Other factors driving changes in value chain organization

The discussion on reshoring and supplier diversification in GVCs did not start with COVID-19. The rapid expansion of GVCs ended after the Global Financial Crisis as a result of pandemic-unrelated factors that have and continue to affect the trend towards a reorganization of supply chains. These include mainly changes in

- factor price differentials between countries (i.e. the erosion of wage differences),
- technological progress reducing the importance of factor prices (e.g. the role of robotization),
- changes in the trade policy environment increasing trade costs and policy uncertainty,
- structural changes in the world economy (e.g. changes in consumer preferences and incomes).

This subsection discusses what these longer-term trends imply for the reorganization of value chains. It argues that most trends can explain the lack of growth in GVC trade observed over the past years and point to a continued stagnation or even decline of GVC levels and complexity in the future. These trends combined are likely to have a much stronger effect on a changing GVC landscape than COVID-19.

### 2.2.1 Rising factor costs in emerging countries

An important factor behind the rise of GVCs have been global productivity differences leading to substantial differences in factor costs. GVCs allow companies from advanced economies to combine their advanced production technology with low wages commanded in developing countries to optimize production efficiency ([Baldwin and Robert-Nicoud, 2014](#)). Organizing production in GVCs is however only optimal if the factor cost differences between home and supplier economy are large enough to compensate for the additional trade and coordination costs that international supply chains entail. This explains why the success of the GVC production model leads, in a manner of speaking, naturally to its own obsolescence.

There is a large literature showing that GVC integration on average facilitates technology transfer and diffusion from advanced to developing economies (See, e.g., [Piermartini and Rubínová \(forthcoming\)](#)). In line with this, different studies and reports have found that GVC participation increases productivity and output in developing countries ([Stolzenburg, Taglioni and Winkler, 2019](#); [World Bank Group, 2020](#)). One study suggests, for instance, that 20% of Chinese labour productivity

increases from 1995 until 2011 were driven by GVC integration ([Stolzenburg, 2018](#)). This econometric evidence is supported by descriptive evidence that shows that developing countries engaged in GVCs have enjoyed large growth rates and convergence of income to high-income country levels ([United Nations Conference on Trade and Development \(UNCTAD\), 2013](#)).

These spectacular growth rates translate into rising factor costs, most notably wages. From 2008 to 2018, average wages doubled in Thailand, almost tripled in China, and quadrupled in Vietnam according to [statista.com](#). In contrast, wage increases in major GVC hubs like the United States or Germany increased only by a factor of about 1.25.<sup>16</sup> As a result, factor costs are converging between GVC trading partners and firms from advanced economies have less incentives to organize production within Global Value Chains. One report has estimated that in labour-intensive goods manufacturing the share of trade based on labour cost differences has fallen from 55% to 43% from 2005 to 2017 ([McKinsey & Company, 2019](#)).

Firms continuously re-evaluate their production networks and processes and factor price differences are an important aspect in these considerations. Convergence in factor prices between major actors in GVCs will cause firms to respond by shifting production to other locations or increase capital intensity of production. In that regard, it is important to highlight that many countries with relatively low wages have not integrated extensively into GVCs yet and, thus, offer untapped potential for firms from advanced economies. Vietnam has, for instance, benefitted from rising wages in China. The conclusion of the negotiations on the African Continental Free Trade Agreement is likely to increase the attractiveness of Africa to participate in European value chains. Hence, factor price convergence might lead to shifts in the geographic setup of value chains rather than reshoring. Another important point is that factor price differences are more important to some value chains than others. Price-competitive industries with low margins such as textiles or agriculture will respond faster to changes in wages than industries with high sunk investment costs that compete more on quality such as transport equipment or electronics.

## 2.2.2 Technological progress and the automation of production

Closely linked to the impact of factor price convergence is the role of technological progress and automation for GVCs. As mentioned above, higher factor prices in emerging economies reduce incentives to locate production abroad. This process is accelerated if domestic production becomes cheaper due to technological progress and changes in the financial environment. While wages in high-income economies have increased in the past decades, prices of robots and other automation technologies have been declining and robot adoption has increased thanks to innovation ([International Federation of Robotics, 2019](#)). Moreover, the global financial crisis has led to a new normal with very low interest rates. This makes investments into capital more attractive as it lowers the cost.

There is substantial anecdotal evidence of technology-induced reshoring to developed countries. For instance, Adidas' two almost completely robotic "speedfactories" established in the United States and Germany in 2016 have been widely covered by the media. However, more rigorous evidence with respect to reshoring and new technologies is mixed ([World Trade Organization \(WTO\), 2018](#)). This is consistent with the fact that GVC integration has stagnated rather than receded. In fact, the most recent evidence points to a further expansion of GVCs prior to 2020 and the decline in GVCs due to COVID-19 ([World Trade Organization et al., 2019](#)). The reason for this mixed effect so far could be difficulties in measuring reshoring and connecting it to automation.

However, there are also reasons why automation might not lead to a relevant decline in GVC participation. Firstly, automation is not yet a large-scale phenomenon and limited to certain industries such as transport equipment or machinery ([United Nations Conference on Trade and Development \(UNCTAD\), 2020](#)). This implies that, at least in the short to medium run, automation will affect only a select set of GVCs in which robot adoption is feasible. Secondly, the use of advanced robotics requires advanced human capital and automation-specific skills combined with an infrastructure and network of suppliers that can service robot-intensive establishments ([Lund and Steen, 2020](#)). These conditions are rare and exist only in a few locations. Thirdly, automation can increase productivity and quality which allows for reductions in quality-adjusted prices. It can also allow for greater differentiation and specialization in niche markets. Both these effects will raise demand and can compensate for reshoring effects. Finally, while reshoring would bring production

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<sup>16</sup> <https://data.oecd.org/earnwage/average-wages.htm>.

closer to consumers, it would also move it further away from established supplier networks and the know-how of the workers that have so far produced these goods. The case of Adidas' speedfactories is particularly instructive for this point as Adidas mentioned exactly these two factors when it decided to move its two speedfactories to China and Vietnam in 2019 ([Ziady, 2019](#)). This shows that technological progress can not only reduce production costs in high-income countries but also in emerging economies.

In line with this, a recent empirical study on 3D printing of hearing aids finds that this new technology has increased trade rather than reducing it by boosting global demand which both strengthened existing producers but also allowed for the entry of new producing countries. The study observes similar results for other products in which 3D printing is increasingly deployed but qualifies that positive effects decrease with the weight of the product and could turn negative for very heavy and trade-cost-intensive products ([Freund, Mulabdic and Ruta, 2019](#)). The results of the study broadly correspond to evidence from simulation exercises which show that automation is unlikely to lead to significant reshoring in the near term. Rather, trade and GVCs are estimated to expand since technological progress leads not only to automation but also to lower trade and coordination costs. New technologies such as blockchain or mobile payment systems can facilitate documentation and compliance requirements within GVCs and greatly increase access to affordable trade finance. Other innovations, such as e-commerce platforms or video and translation technologies, reduce international coordination and governance costs and reduce face-to-face requirements ([World Trade Organization \(WTO\), 2018](#)).

In contrast, some studies have observed a positive relationship between automation and reshoring. Combining input-output data with robotization data, one study finds a positive correlation between reshoring and robot adoption in a panel of developed countries. It estimates that an increase by one robot per 1000 workers is associated with a 3.5% increase of reshoring activity ([Krenz, Prettnner and Strulik, 2018](#)). Another study reports a decrease in offshoring of about 1% due to automation from 2005 to 2014 ([Carbonero, Ernst and Weber, 2018](#)). COVID-19 might move the scale to some extent in favour of technology-induced reshoring. The pandemic makes the use of robots more attractive as they are not affected by health concerns or lockdowns. Reports indicate that logistics firms such as Amazon are increasingly relying on robots in their warehouses as a result of the pandemic ([Thomas, 2020](#)). COVID-19 has also increased policy uncertainty and led to a decline of interest rates. One study estimates that the combined effect of these two trends is an acceleration of robot adoption by 76% ([Kilic and Marin, 2020](#)).

Beyond the level of GVC integration technological progress changes the structure and value distribution within value chains. The share of value generated by services tasks and related to intellectual property is set to increase as manufacturing processes and products become more technology-intensive. Advanced robots and 3D printing are likely to allow for the re-bundling of certain production stages, making value chains shorter independent of where these technologies will be deployed. Lower transaction and coordination costs allow lead firms in value chains to exert more control over suppliers even through arm's length relationships which might lead to less tractable supply chains. Rising technology-intensity of value chains is also likely to increase the geographic concentration of value chains, at least with respect to value generation, since the majority of firms providing digital infrastructure, technologies or platforms reside in only a few countries ([United Nations Conference on Trade and Development \(UNCTAD\), 2020](#)).

Overall, the evidence on the relationship between technological progress and reshoring does not allow for stark conclusions regarding the short- or medium-term. While new technologies can be deployed in high-income countries and accelerate reshoring, they might also strengthen GVCs by lowering trade and coordination costs as well as production costs in supplying countries. Which effects eventually prevail remains to be seen but innovation will certainly be a major driver for future trends in GVCs.

### **2.2.3 Changes in trade policy and rising uncertainty**

Changes in the policy environment that raise trade costs and uncertainty about future policy have been a third major trend shaping GVCs over the past years. The headline event for rising trade costs has been the trade conflict between the United States and China. In addition to a series of stricter non-tariff measures, it has caused US average tariffs on imports from China to increase to above 26% in September 2019 from 3.1% in 2017 while Chinese average tariffs on US imports increased from 8% to 21.8% ([Bown, 2019](#)). Less visibly, other policy developments related to the resurgence

of industrial policy and new policy goals such as the reestablishment of manufacturing employment have and continue to impact trade costs or shift incentives for actors in GVCs. One report shows that at least 110 countries have recently engaged in new industrial policy strategies of which many contain special economic zones and other tools that affect trade ([United Nations Conference on Trade and Development \(UNCTAD\), 2019](#)). New or updated regional trade agreements, such as USMCA, contain non-tariff provisions targeted at reorganizing supply chains. This trend is reinforced by the shift towards greener and more sustainable economies that is supported by various policy instruments.

Rising trade costs affect the level and structure of GVC integration. The direct effect of higher trade costs is that factor price differences between home and supplier economy are effectively reduced making production abroad less attractive and leading to shorter supply chains. Recent research shows that this affect is not homogeneous across the value chain. Instead, low value-added tasks and downstream tasks are affected stronger than high value-added tasks ([Antras and de Gortari, 2020](#); [Jakubik and Stolzenburg, 2020](#)). The reason is that trade costs accumulate in complex value chains with each border crossing and are larger relative to profit margins achievable in low value-added and downstream tasks ([Diakantoni et al., 2017](#)). In addition, high value-added tasks require large fixed costs investments which are often highly relationship-specific and knowledge-intensive, making them harder to relocate. Hence, changes in trade costs lead primarily to a relocation of simple low-skilled tasks taking place later in the production process. This is in line with the relocation of primarily assembly stages out of China in response to US policy changes.

The trade conflict has not only increased trade costs but also, together with the United Kingdom's decision to withdraw from the European Union, trade policy uncertainty. Moreover, policy uncertainty regarding future trade costs arises not only out of changes in trade policy. The response to climate change is, for example, likely to increase the price of carbon emitted in the production process including transportation. Higher demand for sustainable production might raise compliance and production costs. This makes it harder for companies to predict future policy developments. A newspaper-based measure of US trade policy uncertainty has increased by the factor of 7.7 when comparing the 2013 to 2015 average to the March 2018 to July 2019 average with similar results found for indices capturing uncertainty in Japan and China ([Baker, Bloom and Davis, 2019](#)).

Changes in policy uncertainty have effects similar to actual changes in trade policy but they also have additional effects. Uncertainty leads, for instance, to deferred investment decisions and thus lowers FDI which is key to GVCs. One study estimates that the anticipation of higher trade barriers with the European Union has gradually decreased investment in the United Kingdom by 11% and reduced productivity by 2% ([Bloom et al., 2019](#)). It has also reduced the entry of UK firms into the EU market and EU production networks ([Crowley, Exton and Han, 2019](#)). A recent study has furthermore shown that policy uncertainty causes a decline in long-term supplier relationships within GVCs even though such relationships increase supply chain resilience ([Schott et al., 2017](#)).

Past economic crises have often led to increases in trade-restricting measures ([Baldwin and Evenett, 2009](#)). Given the severe recession caused by COVID-19, expectations about such an increase are likely to increase uncertainty about future trade costs. In fact, current estimates suggest that COVID-19 has already increased economic policy uncertainty by a factor of 3 ([Kilic and Marin, 2020](#)). This is reinforced by expectations about policy changes addressing sustainability issues. As a result, it is reasonable to assume that this trend reduces GVC growth and reduces long term relationships within GVCs.

#### **2.2.4 Other important drivers for Global Value Chains**

There is a set of further trends that have driven and continue to drive developments in GVCs. Firstly, rising incomes in emerging Asian economies have led to a stronger regionalization of Asian supply chains between 2000 and 2017. At the same time, European and American value chains integrated more closely with Asian countries to benefit from this development. As demand in Asia grows, Asian supply chains increasingly produce for regional demand which lowers cross-regional supply linkages with the opposite holding for non-Asian supply chains ([McKinsey & Company, 2019](#); [World Trade Organization et al., 2019](#)). In the aggregate, higher domestic demand in the world's manufacturing hubs in Asia has led to a lower share of GVC trade in GDP, a trend that will continue as consumption growth in Asian GVC economies outpaces growth elsewhere.



Secondly, structural change across the world shifts demand and supply increasingly towards the less-traded services sectors, such as the Information Technology sector, which feature shorter supply chains and asset-light operations. This coincides with manufacturing firms becoming more service-intensive both related and unrelated to the digital revolution ([World Trade Organization \(WTO\), 2019](#)). To give an example, tech and digital firms are steadily increasing their share among the top 100 multinational enterprises globally and now make up for 18% of foreign sales in this group. At the same time, their share of foreign assets amounts only to 11% since they can deliver their products digitally from anywhere in the world ([United Nations Conference on Trade and Development \(UNCTAD\), 2020](#)). This implies that their growth will lower the share of GVC trade in global trade.

Thirdly, demand for products for which sustainable and green production can be guaranteed is on the rise. According to the International Trade Centre, 85% of surveyed retailers from France, Germany, Italy, the Netherlands, and Spain have reported increased sales of sustainable products and 92% expect demand to increase in the next five years ([International Trade Centre, 2019](#)). Complex GVCs make it more costly to ensure that all inputs are produced in line with sustainability standards. They also require extensive transportation links which can threaten firms' green production targets. New technologies, such as blockchain, can ease some of the burden to produce in line with sustainability standards, but they are unlikely to fully compensate for the rising costs in the near future ([World Trade Organization \(WTO\), 2018](#)). Hence, this trend is also likely to reduce the current level and change the structure of GVC integration towards shorter value chains.

Finally, climate change increases the frequency of extreme weather events and the likelihood of other risks to international trade and GVCs. Between 1980 and 2016, the risk of hydrological events such as floods has increased, for instance, by 400% in Europe ([European Academies' Science Advisory Council, 2018](#)). Extreme weather events can severely affect production within GVCs and transmit local shocks globally as was shown in the context of the 2011 Tohoku earthquake ([Boehm, Flaen and Pandalai-Nayar, 2019](#)). An increase in the likelihood of such events can change the organization of GVCs away from locations that are deemed particularly risky and it can also lead to shorter GVCs to limit the exposure to local shocks.

### 2.3 Concluding remarks on positive approach

We described three potential reasons for the reorganization of firms' value chains associated with COVID-19: rising trade costs; shock propagation and the vulnerability of supply chains; and the need for diversification to enhance robustness and resilience. COVID-19 will raise awareness of firms about a lack of diversification in the sourcing of their intermediates and the problems associated with complementarity of tasks in complex international value chains. However, complementarity in production is probably not a reason for many firms to concentrate production, since long-run trade elasticities do not reflect complementarity of intermediates from different sourcing countries. The COVID-19 pandemic might accelerate the trend towards diversification already visible in Asia in the sourcing of intermediates. This would enable firms to better deal with short-run interruptions in deliveries and in particular with uncertainty about trade policy. However, this tendency will vary by sector, because the costs of diversification vary significantly given variation in the size of fixed costs, relationship-specificity, and the importance of intellectual property rights across sectors.

Empirical evidence supports the notion that diversification contributes to the resilience of value chains. After previous shocks to production such as the 2011 East Japan Earthquake, companies have diversified their sources of supply. Additionally, the business literature shows that also other policies can contribute to resilience such as the improvement of information systems on the size of inventories and logistics capacities.

Hence, we can conclude that the COVID-19 pandemic could contribute to further diversification of sourcing patterns in value chains. Trends already existing before the COVID-19 pandemic are likely to play a bigger role in the reorganization of value chains, such as rising factor costs in emerging countries, increasing uncertainty about trade policy, and structural change, changing demand patterns and rising incomes in Asia.<sup>17</sup> The extent to which COVID-19 will contribute to rising trade

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<sup>17</sup> See in this regard also a recent survey by the Korea Trade-Investment Promotion Agency indicating that COVID-19 ranks as reasons for value chain reorganization behind trade policy, technological advancement, and access to emerging consumer markets ([Min-hee, 2020](#)).

costs and uncertainty about trade policy and thus to possible re-shoring is still an open question and depends on the policy choices of governments. In the next section we turn to the optimality of policy choices, by analysing the organization of value chains from a normative perspective.

### 3 REORGANIZATION OF VALUE CHAINS: NORMATIVE APPROACH

We will discuss three potential reasons for government intervention in the organization of value chains associated with the COVID-19 pandemic:

1. The existence of market failures.  
Market failures are a reason for government intervention. Potential market failures in the organization of value chains associated with the COVID-19 pandemic are:
  - a. Bounded rationality leading to a wrong assessment of risks: firms do not assess the risks of extreme events correctly and invest too little in strategies to mitigate risks of value chain interruption.
  - b. Imperfect information: firms cannot oversee the implications of the complexity of their value chains and the costs of shocks.
  - c. Externalities along the value chain: in the decision how much to diversify and what size of inventories to hold, firms do not take into account the impact of their decisions on firms downstream.
2. The provision of essential goods in crises  
Governments will want to ensure sufficient supplies of essential goods in a crisis.
3. Social, environmental, and geo-political considerations  
Governments could intervene in the organization of value chains for other reasons: to promote manufacturing employment, to limit emissions from transportation of goods and services and to limit the dependence on imports from specific countries for geopolitical reasons.

#### 3.1 Market failures in supply chains

The existence of market failures provides an economic rationale for government intervention. The COVID-19 pandemic has highlighted various market failures in the organization of value chains. A first potential market failure is a wrong assessment of risk: firms do not assess the risks of extreme events correctly and invest too little in strategies to mitigate risks of value chain disruption. As COVID-19 is an extreme event that hardly occurs in a generation, individuals and firms tend to underestimate the probability of such an event. The perception of this risk is one factor that determines the degree to which firms invest in mitigation strategies such as diversification, spare capacity, and/or inventories. In a sequential value chain, this can lead to the halt of the entire production.

The behavioural literature suggests that the perception of risk related to rare but impactful events can be biased. For instance, [Hong, Wang and Yang \(2020\)](#), work with the assumption that when such an event hits, economic agents "overreact" in updating their beliefs and become pessimistic, overestimating the risk, thus reflecting bounded rationality. As the time passes without any such event happening, their beliefs become increasingly optimistic, underestimating the risk. In such framework, we would expect that most global firms have underestimated the risk of a pandemic and invested too little in mitigation strategies. In the case of COVID-19, hospitals seem to have suffered from the same bias. It would also follow that their post-pandemic reactions would be to over-invest in them. However, in the model by Hong, Wang and Yang investment in mitigation benefits everyone in the economy by curtailing aggregate risk and, therefore, it constitutes a public good that would be underprovided by private actors. According to this view there is a potential role for the government to stimulate investment into strategies to mitigate risks of value chain interruption ([Mehran, Morrison and Shapiro, 2012](#)).

A second potential market failure is imperfect information about the value chain. Firms have difficulty overseeing the implications of the complexity of their value chains and the costs of shocks. Examples of disruptions of the value chain during the COVID-19 pandemic as described in Section 2.1 has led to attention for this potential market failure during the pandemic.

A prerequisite for an efficient mitigation strategy is acquiring full information about the structure of the value chain. Suppose that an EU company has an arm's length supplier in China and this supplier sources a crucial input from Thailand. While the company knows that it is exposed to disaster risk

in China, it may not be aware that it is indirectly exposed to disaster risk in Thailand. Moreover, companies may be able to mitigate a disaster impact by switching to alternative suppliers (in the case of non-customized inputs) but for that they need to know about their options. Searching for suppliers is costly and, hence, few firms will have invested into the full mapping of potential suppliers ([Bernard, Moxnes and Saito, 2019](#)). Market failures associated with information problems should be addressed by promoting transparency, possibly helping companies with information problems about the organization of value chains and alternative suppliers (an example of such an effort is the ADB's supplier database for medical products).<sup>18</sup>

A third potential market failure in the organization of value chains is the presence of externalities along the value chain: in the decision how much to diversify and what size of inventories to hold, firms do not take into account the impact of their decisions on firms up- and downstream. A class of models emphasizes that some firms are large enough to impact aggregate outcomes and/or are important suppliers to other firms in the economy, serving as hubs for shocks to propagate throughout the production network ([Acemoglu et al., 2012](#); [Acemoglu, Ozdaglar and Tahbaz-Salehi, 2017](#)). In the decision about how much to diversify and what size of inventories to hold, firms do not account for the impact of their decisions on other firms in their value chain. Even with a correct risk perception and investment in mitigation, the Chinese supplier from the previous example will take into account only the impact on its own operations and not on the operations of its European customer. In the case of suppliers that are very central in the production network this can create a negative externality on the entire economy.

These arguments apply to any supply chain irrespective of whether it is international or not. Nevertheless, the risk of disruptions does get magnified in sequential supply chains when there are local shocks which are not synchronized across production locations as discussed in Section 2.1.2 and by [Baldwin and Freeman \(2020\)](#).

To identify other potential market failures, it is useful to make a comparison with risks in the financial sector ([Baldwin, 2012](#)). The three market failures discussed above also play a role in that context: an incorrect assessment of the risk of extreme events (tail risk), especially when risks are systemic; a lack of information about the financial position of financial institutions, because of structured financial products; and externalities of the behaviour of big systemic banks. Much financial regulation addresses the issue of systemic importance of banks. It is well recognized that the complexity of their operations and the multiplicity of stakeholders makes banks prone to information asymmetries. Combined with the issue of too-big-to-fail, the finance industry has been prone to excessive risk taking ([Mehran, Morrison and Shapiro, 2012](#)). The extensive research into the causes of excessive risk taking prior to the Financial Crisis in 2008/2009 could motivate new research into potentially excessive risk taking of key suppliers in the economy.

In conclusion, there are some reasons why the organisation of supply chains by the firms alone does not lead to optimal outcomes for the entire economy. These market failures include: first, firms do not correctly assess the risk of extreme risk events which could have spillover effects to other firms; second, firms do not have full information about the structure of the value chain; third, firms do not take into account the impact of their decisions on downstream firms in the value chain. In such instance, some degree of government intervention may be desired.

However, our analysis of the literature on market failures on value chain organization suggests that it is difficult to assess whether such market failures justify government intervention. The literature on such market failures is small and not well-developed. Government interventions may not be the most effective way to remedy the market failures, as government can fail too. In the case of assessment of extreme risk events, in most cases as long as governments have the same information as firms, governments are not necessarily in a better position to assess the risks. Governments do not necessarily have more complete information about the structure of the value chain than firms. After all, many governments were also not well prepared for the COVID-19 pandemic leading to shortages of medical equipment. Furthermore, firms are responsible for maintaining long-term relationships with their suppliers and consumers, which will incentivise them to internalise the impact of supply chain disruptions on their downstream firms. Based on this, we conclude that more research is needed on market failures in the organization of value chains to determine whether government intervention is justified.

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<sup>18</sup> [ADB \(2020\)](#)

### 3.2 The provision of essential goods in a crisis

Although the analysis of market failures in value chain organization is insufficiently developed to justify government intervention in supply chain organisation in general, an active government policy may be required in the supply of essential goods. Essential goods can be defined as goods that are indispensable in situations of crises. This means that it is not possible to substitute their consumption with other goods or with consumption later (intertemporal substitution). The timely and adequate supply of essential goods is crucial for the welfare of citizens, and thus governments see it as a public objective to ensure the provision of essential goods in emergencies.<sup>19</sup>

Trade of medical goods considered to be essential in the current COVID pandemic has grown substantially in the first half of 2020. These products include medical equipment, medical supplies, medicines and personal protective product (facemasks, hand sanitizers, hand soaps, etc). In the first half of 2020, trade of personal protective products grew by 50%, followed by medicines 12%, medical supplies 10% and medical equipment 5.5% ([World Trade Organization \(WTO\), 2020b](#)).

An example of essential goods during the COVID19 pandemic is surgical facemasks. Facemasks are essential for health workers who are in direct contact with infected patients. China was the main producer of masks at the start of the crisis, accounting for approximately half of world production. The concentration of production in one country means that any unforeseeable adverse shock or policy change could significantly impact the supply of critical goods. In particular, the main bottleneck in the value chain of facemasks has been the non-woven fabric manufactured with polypropylene (PP). Although PP is one of the most commonly produced plastics in the world, the PP electret melt-blown non-wovens used in the production of facemasks is a specialised fabric, produced by a limited number of companies globally due to the high initial investment required in heavy machinery, such as hoppers, extruders and melt spinning systems. For this reason, it has been more difficult to increase supply during the crisis, or to find companies that can start production of this good ([OECD, 2020b](#)). In the first half of 2020, total imports of facemasks had reached 74 bn US\$, an 90% increase from the same period last year. China is the world's top supplier of face masks with an almost monopolistic share of 56% of world exports (WTO, 2020b).

More systematically, in guaranteeing the supply of essential goods two pertinent questions ensue. First, how to define essential goods? Second, what is the best way for the government to guarantee the supply of essential goods?

To develop a list of essential goods, it would be useful to define situations of crises and to determine the ease with which consumption of goods can be reduced, because of substitution in time or to other goods. Currently, governments around the world are proposing plans to enhance the self-sufficiency of critical, essential goods to be better prepared for crises situations. Many of the proposals go beyond what is necessary to tackle immediate needs during a crisis and include products and industries that are of strategic value out of national security concern.<sup>20</sup> Although adverse shocks such as an epidemic and climate-change related natural disasters are expected to be on the rise, the exact type and nature of random shocks are difficult to predict. Future emergency situations could include but are not limited to public health crises, natural disasters, food shortages, energy crisis, and cyber security breaches. It is also hard to foresee how often such emergencies will take place, although this is highly relevant to determine the optimal level of expenditure of governments to guarantee the supply of essential goods in crises.

Which goods are indispensable in such crises is difficult to determine. [Leibovici and Santacreu \(2020\)](#) include food, defense goods, and medical goods in the list of essential goods. During the COVID -19 pandemic, the World Customs Organisation (WCO) and World Health Organisation (WHO) provided guidance on the types of products that matter for the fight against COVID-19. As new issues arise,

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<sup>19</sup> As will be analysed below the provision of essential goods is mainly jeopardized because of policies of other governments. Therefore, an active role of the government is not warranted because of potential market failures, but because of the interaction of policies of different countries.

<sup>20</sup> For instance, the UK government is reported to be drawing up a strategy to reduce the UK's reliance for key imported goods. The list of essential goods considered include critical medical supplies, such as protective equipment, vaccines, and certain chemicals, as well as vital equipment such as transformers and telecoms kit. The government is identifying areas where Britain will need to ensure critical supplies in a "green economy", including guaranteeing the availability of lithium used in batteries. Similar discussions are taking place in the United States, where a proposed list of "critical products" would include pharmaceuticals, medical devices, semiconductors, automotive, aerospace, textiles and chemicals, among others ([Bloomberg News, 2020](#)).

new products are likely to be added.<sup>21</sup> However, a completely different set of essential goods may be proposed in anticipation of situations such as energy crises or cyber security emergencies.

In assessing the best policy option to guarantee the supply of essential goods, four sets of policies may be considered: (1) establishing domestic production capacity, (2) building strategic stocks of essential goods, (3) diversifying sources of supply, and (4) adopting flexible manufacturing to be able to quickly expand the production of essential goods. Each of these policy options has benefits and costs which will now be discussed. An effective and cost-efficient approach is likely to be a combination of these options.

Let us start by looking at the option to establish domestic production of essential goods via reshoring. While domestic production can guarantee supply during times of crisis, it is likely to have several potential drawbacks. First, only the largest and most advanced countries will have the manufacturing capacity, specialized machinery, and access to inputs to seek self-sufficiency. Countries with less advanced production capacity or limited access to intermediate inputs cannot just rely on domestic production. In particular for countries with a pattern of specialization in other types of goods, it would be very costly to set up a domestic production capacity of medical goods. Second, even if countries have the capacity to produce essential goods, they are not likely to be able to produce a full range of essential goods required during a crisis. An OECD study shows that no single country produces efficiently all the goods it needs to fight COVID-19. While the United States and Germany tend to specialise in the production of medical devices, China and Malaysia are most specialised in producing protective garments ([OECD, 2020c](#)).<sup>22</sup> Third, trade allows production to locate where it is most efficient which increases access to more goods at affordable prices. On the contrary, government policies to guarantee domestic production of essential goods would require a mix of subsidies and import protection, which could be costly in terms of government revenues and higher consumer prices. Furthermore, self-sufficiency is not in itself a guarantee of greater security. Eliminating reliance on foreign production and inputs means increased reliance on domestic production, which are also subject to adverse shocks. As discussed in Section 2.1 trade enables firms to absorb shocks by being able to shift sources of supply. This also holds for the supply of essential goods in crisis situations.

A second policy option to guarantee the supply of essential goods - increasing inventory stocks and redundancy in production - also comes with drawbacks. In recent decades, "lean" and just-in-time production has been adopted in many sectors, which has successfully delivered cost-effective production. However, during times of crisis the availability of essential goods is of primary concern. This has led to the emergence of "agile" supply chain management, focusing on buffer stocks of raw materials, intermediate inputs and finished products ([Christopher and Towill, 2001](#)). Governments at both national and regional levels could play a primary role in maintaining stockpiles of essential goods and distributing them to serve public needs during a crisis. Additionally, policy measures such as minimum inventory requirements, tax breaks or subsidies to cover expenses associated with inventory holding can also incentivise companies to build up stocks of raw material and intermediate inputs necessary to manufacture essential goods. Coupled with an effective, transparent information management system, stockpiling can ensure the availability and accessibility of essential goods. The potential costs of inventory-holding and stockpiling involve warehousing costs and information management costs. Besides, maintaining stockpiles of perishable goods such as food items or pharmaceuticals with expiry date is more costly since stockpiles will have to be replenished frequently.

Thirdly, governments may play an important role in diversification both at the level of government procurement and in providing incentives for firms to diversify in order to limit dependence on a small number of countries. Diversification of suppliers at the various levels of a value chain increases its robustness and resilience, as a negative shock hitting one location can be offset by substitute production in other locations. However, diversification may be costly in industries that feature high upfront investment and complex supply chains, as discussed in Section 2.1. In terms of public procurement, governments could ensure that tenders from a wide range of geographical locations are considered and take measures to ensure transparency on the degree of diversification at the

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<sup>21</sup> The [WCO and WHO \(2020\)](#) on 9 April issued a revised indicative list of HS classification reference for COVID-19 medical supplies, including test kits and instruments, protective garment, disinfectants and sterilisation products, oxygen therapy equipment and other medical devices, equipment and consumables.

<sup>22</sup> For instance, for every euro of German exports of COVID-19 goods, Germany imports EUR 0.72 of COVID-19 goods. In the United States, for every dollar of COVID-19 good imports, the US exports USD 0.75 of COVID-19 goods.

level of their suppliers. With regard to firms, empirical evidence shows that the level of diversification is positively related to firm size and productivity ([Huang, 2019](#); [Kramarz, Martin and Mejean, 2020](#)). Hence, small and medium enterprises or younger firms are less likely to diversify. Government policies could incentivise producers to diversify their suppliers, by providing subsidies to partially cover the costs of building alternative supplier relationships. Additionally, governments could help bridge the information gap by providing information on and help facilitate connections with potential suppliers in different countries.

Lastly, innovative solutions may be explored to quickly switch production to essential goods when needs arise. During the COVID-19 pandemic, companies retooled production plants and repurposed idle manufacturing capacity to supply personal protection equipment and medical supplies ([Fiorini, Hoekman and Yildirim, 2020](#)), and 3D printing technology has been widely used to manufacture face shields and ventilators ([Statt, 2020](#)). The possibility to swiftly convert manufacturing capacity to the production of essential goods offers a cost-effective alternative to the other options. While most of the innovative solutions have been initiated by businesses, government policies can provide the incentives for companies to invest more in flexible production capacity. For instance, governments may have upstream agreements with manufacturers to rapidly convert assembly lines during crises. Governments can also speed up product testing, approval, and certification for innovative products to tackle emergency needs during a crisis. Product standards and standardised intermediate inputs can greatly facilitate the conversion of production capacity and ensure the compatibility of products across companies and countries. It is also important for firms to be able to source requisite intermediate inputs from both domestic and foreign suppliers.

To determine the costs and benefits of the four policy options to guarantee the provision of essential goods, the type of shocks causing temporary shortages matters. For example, in case of a global surge in demand like with medical goods during the current pandemic, domestic production could be a feasible albeit expensive option to guarantee the provision of essential goods. However, in case of a domestic adverse supply shock, the presence of domestic production capacity will not suffice to guarantee the provision of essential goods.

[Leibovici and Santacreu \(2020\)](#) develop an economic model to study the impact of trade policies on essential goods. The model features two sectors, essential and non-essential goods, and two-countries, with one country being a net exporter of essential goods, because of a relatively higher productivity in essential goods. Essential goods are characterized by a reference utility level and consumption below the reference level is very costly for welfare. Furthermore, there are transition costs of moving capital and labor between the essential and non-essential goods sectors. A pandemic is modelled as a sudden increase in the reference level of consumption, thus raising demand for the essential good. A pandemic raises the relative price of essential goods and leads to an increase in the welfare of the net exporter of essential goods and a decrease in the welfare of the net importer.<sup>23</sup> Hence, [Leibovici and Santacreu \(2020\)](#) observe that there is a time-inconsistency problem in setting trade policy of essential goods. Before a crisis hits, net exporters of essential goods benefit from low trade barriers, whereas after a crisis has hit, net exporters have an incentive to raise export barriers. For net importers the incentives display the reverse pattern.<sup>24</sup>

The different features modelled by [Leibovici and Santacreu \(2020\)](#) provide valuable insights for the comparison between the different instruments. First, their analysis provides an explanation for the tendency of countries to strive for national production of essential goods. The analysis shows that net importers of essential goods can avoid negative welfare effects in situations of crisis by becoming more self-sufficient imposing already ex ante higher trade barriers. However, the authors do not compare the benefits of higher trade barriers because of less dependency on imports in case of a

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<sup>23</sup> The negative welfare effects for the net importer can be reduced ex ante by setting higher trade barriers and thus becoming less dependent on the net exporter of essential goods in situations of crisis. This is however not in the interest of the net exporter of essential goods. Ex post, so after a crisis has hit and demand for essential goods increased, the incentives are opposite. Ex post the net exporter has an incentive to impose export restrictions to guarantee the domestic supply of essential goods. This policy would aggravate the losses for the net importer.

<sup>24</sup> The time-inconsistency problem has implications for negotiations about trade policy and in particular about exemptions from trade policy commitments in case of emergency. Net importers of essential goods, with a comparative disadvantage in the production of essential goods, have an incentive not to agree with the reduction of trade barriers of essential goods when exporters have the flexibility to raise export restrictions in emergency situations. Hence, such flexibilities will make it more difficult to achieve an outcome in which countries specialize according to their comparative advantage and refrain from trade barriers, also in situations in crisis. Although not discussed by [Leibovici and Santacreu \(2020\)](#) this seems the first best outcome.

crisis with the structural costs of higher trade barriers, because of intervention in the global division of labor and the implied distortions. Second, [Leibovici and Santacreu \(2020\)](#) show that dropping the assumption of myopic firms and introducing time-adjusting discount rates does not have a big impact on the main predictions of the model. This suggests that governments of net importers of essential goods do have an incentive to intervene in market outcomes, since even forward looking firms with adjusting discount rates will not invest sufficiently to prevent negative welfare effects in case of a crisis in net importers of essential goods. Third, they show that low adjustment costs make the welfare effects for the net exporter and net importer more symmetric. This suggests that the fourth policy option, adopting flexible manufacturing to quickly switch production to essential goods, is a viable alternative for national production of essential goods. Fourth, since the model features only two countries, it cannot shed light on the value added of stimulating diversification of sources of supply of essential goods.

In conclusion, the adequate and timely provision of essential goods - those that are hard to substitute intertemporally or with other goods - is crucial for the well-being of citizens in times of crisis. The analysis of [Leibovici and Santacreu \(2020\)](#) shows that net importers of essential goods have an incentive to intervene in the economy to prevent welfare losses in situations of crises when the demand for essential goods suddenly rises. Additionally, several policies have been discussed to guarantee the supply of essential goods in situations of crisis: domestic production, increased inventories, diversification of sources of supply and flexible manufacturing to switch production to essential goods. Establishing domestic production would involve large costs in the form of production subsidies and barriers to trade. Hence, various economists ([Freund, 2020](#); [Stellinger, Berglund and Isakson, 2020](#)) argue that the other three options are more cost-effective. In the case of medical products, international trade and cross-border supply chains not only lead to higher efficiency and lower cost, but also enable large scale R&D to develop new medicines and medical technology ([Stellinger, Berglund and Isakson, 2020](#)). Across all policy options, information sharing and coordination - at both national and international levels - are essential to increase the effectiveness of these policies and minimise negative spillovers. Section 4 will discuss this further, as well as the time inconsistency of optimal trade policy and its implications for flexibility of commitments in situations of emergency.

Before turning to the next reason for government intervention, it should be emphasized that our discussion of the different policy options to guarantee the supply of essential goods has focused on the medium and long run. As will be discussed in more detail in Section 4, trade policy intervention in the midst of a crisis in the form of export restrictions and other barriers will be counterproductive given the complexity of current production structures in the production of essential goods with large interdependencies.<sup>25</sup>

As multiple vaccines are in the trial stage and are scheduled to roll out, policies are being considered to guarantee the production and distribution of essential vaccines. Countries are negotiating with pharmaceutical companies about the supply of vaccines against COVID-19. Through financing mechanisms such as the Advance Market Commitment (AMC), governments commit funds to guarantee the price of vaccines, thereby helping to remove some of the risks associated with investing in increasing manufacturing capacity for vaccine producers. Similar financing mechanisms are proposed for COVID-19 vaccines ([Okonjo-Iweala, 2020](#)). [Bollyky and Bown \(2020\)](#) describe the risk that export restrictions and other barriers will be imposed on inputs needed to produce vaccines if countries try to guarantee the supply of vaccines individually instead of through international cooperation. Global initiatives such as the COVAX Facility aims to gather participating governments' resources and use the collective purchasing power in order to negotiate competitive prices from manufacturers. The Facility also ensures equitable access by allocating available vaccines to participating countries at a rate proportional to their total population size ([Berkley, 2020](#)).

Furthermore, the analysis has made clear that an active role for the government to guarantee the supply of essential goods can be motivated for three reasons. First, according to the definition we have used essential goods are indispensable in consumption and difficult to substitute intertemporally or with other goods. Therefore, the government will see it as their responsibility to guarantee the supply of such goods. This motivation for an active role of the government does not have any implication for how the government should achieve the supply of such essential goods. Since such goods are indispensable the government will see provision of such goods as their responsibility, even if provision is organized entirely through the market. For example, food is

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<sup>25</sup> See also [Freeman and Saiedi \(2020\)](#) on this point.

provided by the private sector in most countries, but in many countries governments are surveilling the provision of it. A second reason for an active role is that there might be market failures in the provision of essential goods, related to the fact that firms might not anticipate the occurrence of crises correctly. Hence, they will not invest sufficiently in production capacity to satisfy demand for essential goods in situations of crises when demand is very high. The fact that consumers are willing to pay high prices in situations of crises might not give sufficient incentive to firms to invest in spare capacity in normal times. A third reason for an active role of the government is the interaction of policies of different countries. The risk of changes in trade policies such as sudden export restrictions has to be considered by governments when determining their policy to guarantee the provision of essential goods. For example, a government of a net importing country of essential goods will want to make sure that such essential goods will be available in sufficient amounts even if net exporters impose trade restrictive measures.

### 3.3 Social, environmental and geo-political considerations

Governments could intervene in the organization of value chains for other reasons: to promote manufacturing employment, to limit emissions from transportation of goods and services and to limit the dependence on imports from specific countries for geopolitical reasons.

First, some policy makers advocate re-shoring to reverse the trend of declining manufacturing employment in advanced economies. As is well-known from the trade literature, the first-best intervention to address employment would take place in the labour market, such as retraining of workers and policies to reduce job market frictions. Trade policy is a second-best option to pursue these objectives because it generates other distortions. Furthermore, most economists agree that the decline in manufacturing jobs in industrialized countries follows a long term trend driven by structural change ([Kehoe, Ruhl and Steinberg, 2018](#); [Stern and Stiglitz, 2017](#)). Also, reshoring may be accompanied by increased automation with limited impact on employment. Finally, the adverse labour market effects of offshoring are to a large extent caused by the changes in the organization of international production with people in specific locations and with specific skills and age losing their job. Reorganizing value chains again, now in the direction of re-shoring, would again come with transition costs.

Second, there have been calls for a reorganization of value chains to limit pollution associated with the production and transportation of goods. Popular media argue that reshoring and nearshoring could provide an opportunity for advanced economies to boost capacity of recycling<sup>26</sup> and reduce the pollution and greenhouse emissions of long-distance transportation. Economists agree that the first best policy to address environmental issues is to use policy instruments such as carbon prices that incentivize the changes needed in investment, production, and consumption patterns, and to induce the kind of technological progress that can bring down future abatement cost ([Stern and Stiglitz, 2017](#)). Research on this topic suggests that a reduction in trade is a very inefficient way to limit greenhouse gas and other emissions ([Bellora and Fontagné, 2020](#); [Shapiro, 2016](#)). [Shapiro \(2016\)](#) examines carbon emissions from transportation and production as a result of trade opening compared to a situation without trade and estimates that international trade increases global emissions by 5 percent or 1.7 gigatons of CO<sub>2</sub> annually, and that this effect is almost equally driven by production and transportation. It also points out that the global gains from international trade exceed the environmental cost arising from CO<sub>2</sub> emission by a factor of 161.

Third, the COVID-19 pandemic has made many developed economies more aware of their dependence on a small group of countries for the supply of essential goods in a crisis, thus affecting their ability to conduct foreign policy. Therefore, government policies on the organization of value chains do not only depend on economic objectives but also on geopolitical ones. As such the COVID-19 pandemic could accelerate the trend that geopolitical objectives are gaining momentum in decisions about trade policy. Investment screening policies are on the rise ([Kowalski, 2020](#)), national security arguments play an increasing role in trade policy decisions ([Petri, 2019](#)) and many countries have an increased interest in industrial policy with an aim to become a dominant player in vital industries. Approaching trade policy more from a geopolitical perspective means that trade policy will be seen more as a zero-sum game instead of a policy on economic transactions as a result of which all players can be made better off. The shift towards geopolitical objectives would come with

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<sup>26</sup> [Kaminska \(2020\)](#)



large costs to the current global economy featuring a high degree of international labour division, scale economies and innovation spillovers, as discussed in the next subsection.

### 3.4 Concluding remarks on normative approach

Our analysis shows that there are potential market failures related to imperfect information on value chain risks, the incorrect assessment of the risk of extreme events, and externalities of the decision of one firm on other firms in the value chain. However, correcting these market failures calls for government policies to provide more information about the organization of value chains and potential regulations such that firms take the risks of extreme events into account. More research is needed to identify the size and scope of these market failures. In any case, the potential market failures do not call for domestic production and the disintegration of international value chains.

Guaranteeing the provision of essential goods - those that are hard to substitute intertemporally or with other goods - can be a reason for government intervention. Governments have various options to guarantee the provision of essential goods: domestic production, stockpiling, diversification of sources of supply, and flexible manufacturing capacity. In the aftermath of the COVID-19 pandemic countries will be inclined to promote domestic production of essential goods to limit the dependence on a small number of exporters. However, to guarantee the provision of essential goods and limit political dependence, building up or extending production capacity in essential goods sectors requires hiring away resources from other sectors, which is costly. More generally, domestic production would reduce the benefits of international specialization. The trade literature has identified several advantages of international specialization including:

1. Gains from exploiting comparative advantage differences
2. Sharing of fixed costs in production
3. Innovation spillovers between regions fostered by trade

The gains from trade through specialization according to comparative advantage were first described by David Ricardo. Paul Krugman and Wilfred Ethier were the first to formally describe the benefits of sharing the fixed costs of developing new varieties, respectively for consumer and intermediate goods. Innovation spillovers are described for example by [Sampson \(2016\)](#) and [Buera and Oberfield \(2020\)](#). The gains from trade have also been quantified in the literature. [Costinot and Rodriguez-Clare \(2014\)](#) show that the welfare gains from trade, comparing autarky with free trade, in a standard model with multiple sectors and intermediate linkages featuring only the comparative advantage channel, are substantial. On average welfare would fall by 27% across countries by eliminating trade and moving to autarky. These losses would increase to 40% when taking into account the benefits from sharing the fixed costs of developing new varieties in a firm heterogeneity monopolistic competition model. [Buera and Oberfield \(2020\)](#) show that the welfare gains from trade (and thus also the costs of autarky) roughly double when also considering the beneficial effect of trade through the diffusion of ideas.

Hence, from an economic perspective domestic production seems a very costly policy option to guarantee the supply of essential goods. Instead, international coordination to ensure the provision of essential goods under a regime of open trade comes with large economic benefits.<sup>27</sup> This requires addressing the time inconsistency problem of trade restrictions for essential goods identified by [Leibovici and Santacreu \(2020\)](#), disciplining policies restricting exports during crises which make net importers of essential goods more hesitant to rely on imports of essential goods. Furthermore, in the aftermath of the pandemic there is a risk that geopolitical objectives become more important in the trade policy of governments, which would jeopardize the described large benefits of open trade regimes.

## 4 ROLE OF INTERNATIONAL COOPERATION

So far, we have analysed possible changes in the organization of value chains in response to the pandemic (Section 2) and reasons for national governments to intervene in the economy (Section

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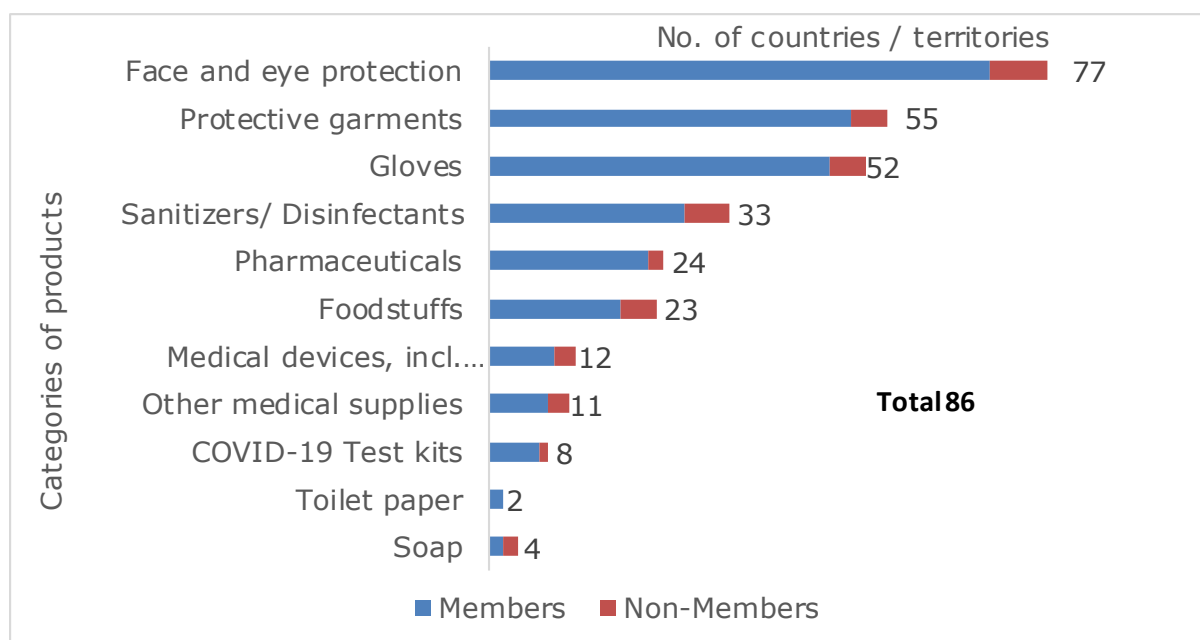
<sup>27</sup> A proper quantitative exercise should also consider that the welfare costs of domestic production increase further because they would require costly government intervention. The exercise in [Costinot and Rodriguez-Clare \(2014\)](#) only compares autarky with free trade without considering the costs of government intervention in the form of domestic subsidies and import tariffs. On the other hand, not all goods are essential, so domestic provision of essential goods would not correspond with a move to full autarky.

3). This analysis has implications for international cooperation and the role of the WTO, which will be addressed in this section. The section starts with a discussion of the role that international cooperation can play in addressing the threat of export restrictions during times of crisis. Export restrictions were introduced by several governments faced with a sharp increase in the demand for medical supplies in an attempt to secure the supply of certain essential goods. At the same time, they are one of the reasons why national governments see reshoring and the reorganisation of supply chains as recipes to ensure the provision of essential goods. The section then further explores how the various options to guarantee the provision of essential goods available to governments are covered by existing WTO disciplines and how international cooperation can help avoid costly policy responses and help enhance the supply of such goods. Furthermore, we will also address other potential functions of the multilateral trading system related to COVID-19 such as the monitoring of trade costs preventing disruptions of the logistics sector and promoting digital trade and e-commerce.

#### 4.1 International cooperation on export restrictions

The use of export restrictions on essential goods has increased sharply during the COVID-19 crisis ([World Trade Organization \(WTO\), 2020b](#)). This has been one of the leading factors to inflame the debate over the need to reshore production of essential goods as it exposed the fragility of supply chain production in a situation of critical shortage. Available information (as of November 2020) indicates that 86 countries and separate customs territories have introduced export prohibitions or restrictions as a result of the COVID-19 pandemic, including 46 WTO members (72 if EU member states are counted individually) and eight non-WTO members (see Figure 1).

**Figure 1. Number of countries and separate customs territory introducing export prohibitions and restrictions as a result of COVID-19, by categories of products**



Source: WTO-Secretariat

Although a government may introduce export restrictions with the intention to avoid critical shortages of essential goods and keep their domestic prices low, there are several reasons why export restrictions are not a good response in face of a pandemic. A first problem with imposing export restrictions (whether this is a measure introduced by a large country or several small countries) is that these are beggar-thy-neighbour policies and will bring negative effects to trading partners. By reducing the world supply of essential medicines, protective gears or else, export restrictions push their world prices up. Importers will suffer, and in particular poor countries with limited production capacity. This is true both in the case of an isolated emergency (if the exporter is a large country) and in a global crisis (for the collective action of small exporters). In the case of a global crisis the negative effects of export restrictions on importing countries are magnified. Since exports of some medical products are concentrated in a small number of countries, export

restrictions on medical products by the large suppliers of these products imply that populations in countries that do not produce them will not have access to essential medicines and medical equipment ([Piermartini, 2004](#)).

A second problem with export restrictions is that they can be counterproductive and reduce the domestic supply of essential goods. By reducing domestic prices, export restrictions reduce the incentives for domestic firms to increase production and invest in new capacity and rather foster smuggling ([Fisman and Wei, 2004](#); [McDonald, 1985](#)). In the long run, export restrictions can trigger a dynamic loss of comparative advantage as they induce other countries to take measures to encourage domestic production.

In addition, export restrictions may generate tit-for-tat retaliation from trading partners and trigger a trade war. Exporters of medical equipment, say, that face retaliatory restrictions in the supply of inputs from their trading partners may experience disruptions in their own production chain. When a crisis is global, this domino effect can magnify the impact of export restrictions on world prices. Prices may spiral up, thus undermining the very reason they may have been first introduced by the exporting country. Export restrictions can trigger restrictions also in other markets. For example, during the COVID-19 crisis, some countries, fearing food shortages, have introduced export restrictions in agricultural commodities. The unilateral actions give rise to a "multiplier effect": when a shock drives up the price of food, exporters respond by imposing restrictions, while importers wind down protection, thus exacerbating the initial shock and soliciting further trade policy activism ([Giordani, Rocha and Ruta, 2016](#)).

WTO rules offer some flexibilities to the use of export restrictions. While Article XI of GATT 1994 broadly prohibits export bans and restrictions, it allows members to apply them temporarily to prevent or relieve critical shortages of foodstuffs or other essential products. If members move to restrict exports of foodstuffs temporarily, the Agreement on Agriculture requires them to give due consideration to the food security needs of others. WTO rules also contain more general exceptions, which could be used to justify restrictions provided that they do not constitute a means of arbitrary or unjustifiable discrimination between countries, or a disguised restriction on international trade. In addition, as a form of general exception, WTO agreements (GATT Article XX) allow countries to adopt export restrictions in case of critical shortage and for human health reasons.

Although exemptions from disciplines on export restrictions for emergency reasons seem to provide scope for governments to apply such policies, the economic analysis of the impact of export restrictions and the time inconsistency of trade policy in situations of crisis in Section 3.2 suggest that such exemptions can backfire. Export restriction can lower domestic production of the essential goods and trigger a trade war. In addition, net importers of essential goods will be hesitant to commit to a low level of trade barriers if net exporters can impose export restrictions during crises. From a global perspective cooperation is a better solution than unilateral action.

The need for more international coordination in the use of export restrictions clearly emerged in the context of the current pandemic. In response to a surge in export restrictions, G20 Trade Ministers, international organisations, and some joint government initiatives at the WTO appealed to keep the trade of essential goods flowing, including by removing export restrictions on essential goods as soon as possible. In the G20 statement of 14 May 2020, trade ministers indicated a number of actions to support world trade and investment in response to COVID-19. Several of these actions target export restrictions ([G20, 2020](#)). In a joint statement, the heads of the IMF and WTO called on governments for lifting trade restrictions on medical supplies and food; and expressed concerns for the decline in the supply of trade finance. In a number of other initiatives with other international organizations the WHO, the FAO and the WCO pledged to work together to minimize the impact of policy measures on the flow of medical supplies and food.<sup>28</sup>

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<sup>28</sup> (i) WTO, WHO and FAO called on governments to minimise the impact of COVID-19 related border restrictions on trade in food. (ii) WTO and World Customs Organization pledged to work together to facilitate trade in essential goods such as medical supplies, food, and energy, so that essential goods can quickly reach those most in need, including in least developed and land-locked countries. WCO and WTO members have already been invited to increase transparency by sharing information on new trade and trade-related measures introduced in response to the COVID-19 pandemic. (iii) WTO and WHO are working together to support efforts to ensure the normal cross-border flow of vital medical supplies and other goods and services, promoting them where possible, and to resolve unnecessary disruptions to global supply chains, (iv) WTO and International Chamber of Commerce call for increased action on trade to ensure an effective response to COVID-19 pandemic and announce virtual business roundtable to provide concrete advice to governments.

A number of collective initiatives have been circulated by WTO members aiming at fostering greater international cooperation to keep markets open for essential goods. These consisted of: (i) the Singapore-New Zealand declaration of principles to keep their markets open, joined by five other WTO Members; (ii) a Canadian-led initiative of 47 countries (counting the EU Member States separately), pledging openness and good practices with respect to world agricultural trade; and (iii) a Swiss-led initiative, supported by 42 countries, pledging to lift export restrictions imposed in response to the crisis as soon as possible, encouraging the WTO to work on concrete actions to foster the cross-border flows of medical supplies, services and equipment, and to preserve agriculture supply chains and enhance food security. The signatories, supported by most mid-level countries including Saudi Arabia, pledge not to impose export restrictions on food.

Going forward, the international community needs to engage in a discussion on how policies and international rules can be designed to help the world get prepared for a future crisis. Strengthening the disciplines on the use of export restrictions is not the only option. And it is hard to envisage how to prevent governments to use these measures in emergency situations. However, the WTO may play an important role through other channels. At a time of crisis there is a deficit of trust between countries. The G20 and WTO play a key role in supporting this trust as a chamber for countries to discuss trade policy. During the current crisis WTO has stepped up its monitoring function. More can be done in the future to reinforce this function of the multilateral institution and to ensure that emergency measures are promptly addressed in appropriate fora with the view to minimize disruption. Furthermore, cooperation among international organizations may be strengthened. The WTO and WHO together for example could coordinate on how strategic stockpiles of medical supplies should be used in case of emergency so as to guarantee supplies of essential goods in regions with the largest needs and how to guarantee that supplies reach destination at the lowest trade costs.

## **4.2 International cooperation on the supply of essential goods in crisis situations**

Section 3 showed that there are potential market failures related to imperfect information on value chain risks, the incorrect assessment of the risk of extreme events, and externalities of the decision of one firm on other firms in the value chain. It argued that correcting these market failures does not call for reshoring and the disintegration of international value chains, but rather for government policies that incentivize the provision of more information about the organization of value chains and potential regulations such that firms take the risks of extreme events into account. At the same time, section 3 also argued that governments have a role to play in guaranteeing the provision of essential goods by encouraging stockpiling, diversification of sources of supply, and flexible manufacturing capacity rather than by encouraging reshoring and domestic production. This subsection discusses how existing international disciplines cover each of these policies and how international cooperation can help address some of the market failures to boost the robustness of value chains and how it can help improve the effectiveness of government interventions aimed at securing the supply of essential goods.

### **4.2.1 International cooperation on policies to improve the supply of essential goods**

Besides export restrictions, policy instruments typically used to reorganize value chains and implement reshoring policies or to secure the supply of essential goods include tax incentives, cost-sharing programmes, local-content measures, trade remedies, tariffs, and investment measures. The WTO and other international organizations have gone to considerable lengths to document the use of those measures by governments since the outbreak of the pandemic (WTO Report on G20 trade measures, 18 November 2020).<sup>29</sup> Most of these instruments are in principle covered by multilateral disciplines. Existing disciplines, however, leave considerable space for governments to implement all the policies aimed at enhancing the robustness of value chains or at securing the supply of essential goods. First, the legality of the measures typically depends on their design and implementation. To bring a case against a "reshoring" subsidy or a subsidy aimed at encouraging the diversification of sources of input supply, the building of inventories or the adoption of flexible production technologies, a Member would need to show that such a subsidy involves a financial contribution, confers a benefit and is specific and that it is either prohibited under Article 3 of the SCM or that it is causing adverse effects to his interests.

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<sup>29</sup> With regard to support measures in particular, the International Monetary Fund and Organization for Co-operation and Development have introduced and updated policy trackers and the International Labour Organization has maintained a webpage on Country policy responses. Further information on resort to economic support measures can also be found in the Global Trade Alert database.

Second, the general exceptions provision of GATT Article XX(b) or the security exceptions provision of GATT Article XXI could be invoked to introduce certain measures. For example, local content requirements that would force or encourage domestic producers to use local instead of imported inputs would in principle be subject to the disciplines of the TRIMS Agreement. However, the general exceptions provision or the security exceptions provision, which apply in the context of the TRIMS Agreement (see Article 3), permit the use of otherwise prohibited TRIMS that are necessary to protect respectively human, animal, or plant life, or health (Article XX(b)) or security interests (Article XXI).<sup>30</sup>

Third, some flexibility may be available to certain countries with regard to the use of instruments such as tariffs or government procurement. For countries with applied tariffs below their bound rate, applied tariffs could be raised in a WTO-compliant way. As for government procurement, WTO members who are not party to the Government Procurement Agreement are not bound by its disciplines and parties to the Agreement could invoke Article III on Security and general exceptions.

Beyond the existing multilateral disciplines, some coordinated responses to reshoring policies are taking place between countries ([Stellinger, Berglund and Isakson, 2020](#)). A group of seven countries – New Zealand, Singapore, Canada, Australia, Chile, Brunei, and Myanmar – committed in a statement at the end of March to keeping supply chains open and removing any existing trade restrictive measures on essential goods, especially medical supplies.<sup>31</sup> They also committed to working with like-minded countries to ensure uninterrupted trade flows. A few days later, the G20 countries issued a ministerial statement promising to work to ensure the flow of vital medical supplies and equipment and “take immediate necessary measures to facilitate trade in those essential goods.”<sup>32</sup>

#### **4.2.2 How could international cooperation further contribute to the supply of essential goods?**

International cooperation can play an important role in helping governments secure the supply of essential goods during crises. In particular, international cooperation can help governments avoid the use of costly and ineffective reshoring policies by increasing the robustness of GVCs and the effectiveness of other interventions. In turn we discuss capacity monitoring and information sharing concerning the production of essential goods; trade facilitation and mutual recognition of standards, in particular for emergency goods; and cooperation in holding inventories to prevent excessive stockpiling.

First, governments can take a variety of measures to increase the robustness of GVCs. Given the international dimension of GVCs, governments may cooperate to collect and share information on potential concentration and bottlenecks upstream and/or develop stress tests for essential supply chains ([Fiorini, Hoekman and Yildirim, 2020](#); [OECD, 2020d](#)).<sup>33</sup> Firms need systems to monitor market conditions and identify slack and chokepoints in their global network so that they can adjust production and respond to changes in demand. Governments need information systems that allow them to determine where supply capacity exists ([Fiorini, Hoekman and Yildirim, 2020](#)). To anticipate disruptions, it is important to know exactly the level of inventories, as well as output all along the value chain. Firms generally can assess demand and their supply options, but governments often do not have direct access to such information. Identifying bottlenecks in supply chains and measures to address them requires cooperation between industry and government, as well as among governments.

While governments do not typically have much information on supply chains and production capacity, individual lead firms know their supply chains but do not share this information which they consider to be sensitive business information. Governments may require firms to share more information on the value chains of essential products and such information may be shared with other governments. As noted by [Fiorini, Hoekman and Yildirim \(2020\)](#), some regulators – notably the New Zealand Medicines and Medical Safety Authority – require approved product marketers to disclose the supply

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<sup>30</sup> Whether the general exceptions under GATT Art XX or Art XXI would apply to justify inconsistencies with the provisions of the Subsidies and Countervailing Measures Agreement is an open question.

<sup>31</sup> [Joint ministerial statement \(2020\)](#)

<sup>32</sup> [Ministerial statement \(2020\)](#)

<sup>33</sup> [OECD \(2020d\)](#)

chain, including where active ingredients for medicines are made and where they are packaged ([Roos, 2020](#)). It would be interesting to assess if and how such requirements have contributed to enhance the robustness of value chains and to ensure the supply of essential products during the COVID crisis. If the requirements prove to be useful, other countries may impose them and the collected information may then be shared. Traceability has also become an element of the production process for food products. Moreover, in the case of agri-food production, a system to facilitate collecting and sharing information on global agricultural markets already exists. It is called the Agricultural Market Information System ([FAO et al., 2011](#)) and was established by the G20 after the Great Crisis. The system has helped countries generate valuable information and created an international expertise network to inform coordinated policy responses to shocks ([Fiorini, Hoekman and Yildirim, 2020](#)).

Second, governments may also cooperate to facilitate trade in essential products ([Stellinger, Berglund and Isakson, 2020](#)). Border crossings must guarantee supply-chain continuity and speed up the transport of critical goods. Formal recognition and equivalence arrangements for certification and acceptance of foreign standards would help prevent rigid enforcement of national standards with their detrimental trade-restricting effects ([Fiorini, Hoekman and Yildirim, 2020](#)). Cooperation on technical standards and regulatory regimes can take various forms including mutual recognition, international regulatory cooperation, agreements of good manufacturing practices, and agreements to facilitate joint learning, and determine whether national regulatory regimes have similar goals and are equivalent in attaining desired outcomes.

Countries can further explore the coordination of emergency programmes for relevant agencies to speed up the clearance and release of medicines, medical supplies, and food in times of crises. Such items will have to be clearly defined, and simplifications in customs procedures could reduce the administrative burden on businesses. Moreover, governments need to ensure that people with key competences can cross borders safely when needed. Collective global measures are still needed to make the unilateral, temporary measures to liberalise trade in medicines and medical supplies permanent ([Stellinger, Berglund and Isakson, 2020](#)).

Third, as demonstrated by the European experience during the COVID crisis, international cooperation is also very important with regard to stockpiling. Stockpiling practices in anticipation of possible shortages can further contribute to the actual appearance of such shortages. While a certain level of stockpiling of essential medicines for emergency use is useful, the more localised the stockpiling, the greater the risk that an unsustainable increase in aggregate anticipatory demand will lead to shortages in places where needs have materialised. This has led the European Commission to recommend that stockpiling is coordinated at the EU level and that any stockpiling by Member States should be at the national level and for moderate quantities based on epidemiological indications.<sup>34</sup>

International cooperation could take place at different levels. Multilateral cooperation may be possible in some cases but cooperation at the regional level may be easier to achieve. Reactions to the COVID crisis have shown that after a short non-cooperative episode, EU members have quickly reverted to cooperation. Also, since 2017, groups of WTO members have begun talks that may lead to open plurilateral agreements on specific trade and investment policies. The current crisis suggests that plurilateral cooperation on technical regulations and related production processes could have substantial payoffs for participating countries in both normal times as well as in emergencies ([Hoekman and Sabel, 2019](#)).

### **4.3 Concluding remarks on the role of the WTO**

There is scope for cooperation on international trade policy in various areas in crisis situations such as a pandemic. An important theme is the regulation of export restrictions, which are typically used by governments in crisis situations to guarantee domestic supplies. In our analysis we have argued that export restrictions are oftentimes counterproductive, because, being beggar-thy-neighbour, they tend to provoke responses of trading partners. They also stifle incentives to produce and make production more complicated in international value chains. Furthermore, export restrictions imposed during crises will make net importers of essential goods hesitant to commit to a low level of trade barriers outside of crises.

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<sup>34</sup> [European Commission \(2020\)](#)

We have also discussed the importance of: (i) monitoring capacity to produce essential goods and information sharing between governments on this capacity; (ii) trade facilitation and mutual recognition of standards to facilitate the production of essential goods; and (iii) cooperation on inventories of essential goods to prevent excessive stockpiling in some countries during crises which could generate shortages in other countries.

There are other areas in which the WTO can play a role during crises such as a pandemic. We briefly discuss three of them.<sup>35</sup> First, the WTO has an important role in monitoring trade policies to guarantee the smooth flow of goods and services and essential goods, in particular in times of crises. The WTO is important as a forum for countries to discuss trade. More can be done in the future to reinforce this function of the WTO. One option could be to build a mechanism by which countries can raise a concern about a trade distortion or inequity and stress the need for it to be resolved to avoid disruptions in a certain industry.

Second, the disruption of the logistic sectors raised trade costs during the crisis. Countries can coordinate their restrictions to international transport and travel to make the logistics sector more resilient to shocks, thus reducing the impact of the crisis on supply chains. One could think of protocols to make the logistics sector more robust to shocks and best practices to facilitate the mobility of essential workers – from transport and logistics personnel, to health care professionals and seasonal agricultural workers. Institutionally, WTO, WHO, ILO and WCO may coordinate their actions to this purpose.

Third, in the current crisis digital technologies are a very useful tool to promote resilience of supply chains. Business services are a critical component of the functioning of supply chains, since more services have been delivered online, which avoided larger disruptions. But this crisis shows that there are still important challenges: a regulatory environment that remains underdeveloped and the digital divide. The WTO is key in this respect as there are ongoing negotiations on e-commerce. But, inclusive gains from ecommerce negotiation would require a coordinated effort of International Organizations to supplement an international regulatory environment with adequate infrastructures.

## 5 CONCLUSIONS

The shortages of medical equipment at the beginning of the COVID-19 pandemic and bottlenecks in global value chains have sparked a discussion about the organization of global value chains. Policymakers have raised questions whether global value chains have become too vulnerable to shocks and whether their countries should be more self-sufficient in the production of essential goods. In this paper we have provided a structured overview of the discussion on the organization of value chains in relation to the COVID-19 pandemic, distinguishing between a positive approach, analysing possible changes to value chains in response to the COVID-19 pandemic, and a normative approach, evaluating arguments for governments to intervene in the organization of value chains.

Our analysis has led to three main conclusions. First, the COVID-19 pandemic has led to a reassessment of the trade-off between efficiency and risk in decisions about the organization of value chain. Therefore, the pandemic could contribute to the diversification of sources of supply as companies attempt to limit the risks of short-run interruptions in deliveries and cope with uncertainty about trade policy. However, the costs of diversification will vary by sector, because of variation in the size of fixed costs, relationship-specificity, and the importance of intellectual property rights across sectors. Contemplating changes to the organization of their value chains in the aftermath of the COVID-19 pandemic, firms will realize that trade cannot only be a conduit of shock propagation in value chains but can also act as an insurance policy when shocks occur. Pre-existing trends such as rising factor costs in emerging countries and increasing uncertainty about trade policy are likely to play a bigger role in re-shoring, the return of manufacturing activities to industrialized countries.

Second, because of a spike in demand for medical goods the pandemic has led to temporary shortages in the supply of essential goods, which provoked a broader discussion about policies to guarantee the provision of essential goods in situations of crisis. Our analysis concludes that global cooperation in times of crises is preferred over national policies such as domestic production and export restrictions, because of three main reasons: (i) global cooperation and maintaining patterns

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<sup>35</sup> A potential policy issue emerging during the COVID-19 pandemic requiring international coordination is the prevention of bidding wars between countries. At the height of the pandemic governments raised prices of essential medical equipment by overbidding other governments

of international specialization comes with important benefits and is more efficient than re-shoring and domestic production; (ii) global cooperation is better for low-income import dependent countries who do not have capacity to build their own industries for the production of essential goods; (iii) national emergency policies such as export restrictions generate negative spillover effects onto other countries that then tend to respond in kind.

Third, the extent to which COVID-19 will contribute to rising trade costs and uncertainty about trade policy and thus to possible re-shoring is still an open question and depends on the policy choices of governments. However, the largest risk for the global economy in the aftermath of the pandemic would be a move away from open trade policies guided by economic considerations to policies driven by political-strategic considerations. Such a shift would jeopardize the benefits of open trade regimes which are particularly large in the current global economy characterized by high levels of specialization exploiting the benefits from the division of labour, economies of scale, and innovation spillovers.

In the second part of the paper we have discussed the potential role of the WTO in the organization of value chains in crises like the COVID-19 pandemic, discussing two areas of cooperation in detail. First, there is a need for more cooperation in crisis situations in areas such as information sharing on the production capacity of essential goods, mutual recognition of standards to facilitate the production of essential goods and cooperation in holding inventories of essential goods to prevent shortages in countries most in need of essential goods.

Second, the WTO can play a role to keep the use counterproductive export restrictions to a minimum, as they tend to provoke trade restrictive responses of trading partners, stifle incentives to produce and make production more complicated in international value chains. It is particularly important to keep the use of export restrictions to a minimum during crises since it will make countries dependent on imports of essential goods hesitant to agree to low trade barriers in normal times.

The WTO can also play a role in other areas: (i) monitoring trade policies to guarantee the smooth flow of essential goods in times of crises; (ii) coordinating restrictions to international transport and travel to make the logistic sector more resilient to shocks and to facilitate the mobility of essential workers; (iii) developing a regulatory environment to promote digital trade and close the digital divide between countries.

This paper does not provide definitive answers to all the questions raised on value chain organization and more research is needed in various areas. We mention the three most important areas: (i) market failures in the organization of value chains; (ii) the possible design of international cooperation in the provision of essential goods; (iii) other potential roles of the WTO such as in preventing bidding wars between governments.

## REFERENCES

- Acemoglu, D., Carvalho, V. M., Ozdaglar, A. and Tahbaz-Salehi, A. (2012), 'The network origins of aggregate fluctuations', *Econometrica* 80(5):1977-2016.
- Acemoglu, D., Ozdaglar, A. and Tahbaz-Salehi, A. (2017), 'Microeconomic Origins of Macroeconomic Tail Risks', *American Economic Review* 107(1):54-108.
- ADB. (2020), 'Supply Chain Maps for Pandemic-Fighting Products'.
- Alicke, K., Azcue, X. and Barriball, E. (2020) *Supply-chain recovery in coronavirus times—plan for now and the future*, McKinsey & Company.
- Antràs, P. (2020), 'Conceptual aspects of global value chains'.
- Antràs, P. and de Gortari, A. (2020), 'On the Geography of Global Value Chains', *Econometrica* 88(4):1553-1598.
- Antràs, P. and Yeaple, S. R. (2014), 'Multinational firms and the structure of international trade', *Handbook of international economics*: Elsevier.
- Azurite Consulting. (2020), 'Impact of Covid-19 On Business Decision Making, Spending & Recovery'.
- Baker, S., Bloom, N. and Davis, S. (2019), 'The extraordinary rise in trade policy uncertainty', *VoxEU*(17 September).
- Baldwin, R. (2012), 'A new eReport: Excessive risk-taking by banks', *VoxEU*.
- Baldwin, R. (2019), *The Globotics Upheaval: Globalization, Robotics, and the Future of Work*, NY: Oxford University Press.



- Baldwin, R. (2020a), 'Covid, hysteresis, and the future of work', *VoxEU*(29 May).
- Baldwin, R. (2020b), 'The Greater Trade Collapse of 2020: Learnings from the 2008-09 Great Trade Collapse', *VoxEU*(07 April).
- Baldwin, R. and Evenett, S. (2009), 'The collapse of global trade, murky protectionism, and the crisis: Recommendations for the G20', *VoxEU*.
- Baldwin, R. and Freeman, R. (2020), 'Supply chain contagion waves: Thinking ahead on manufacturing 'contagion and reinfection' from the COVID concussion'.
- Baldwin, R. and Robert-Nicoud, F. (2014), 'Trade-in-goods and trade-in-tasks: An integrating framework', *Journal of International Economics* 92(1):51-62.
- Barrot, J.-N. and Sauvagnat, J. (2016), 'Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks', *The Quarterly Journal of Economics* 131(3):1543-1592.
- Beate, J., Baldwin, R. and Evenett, S. (2020), 'Resilience versus robustness in global value chains: Some policy implications', *COVID-19 and Trade Policy: Why Turning Inward Won't Work.* : VoxEU & CEPR.
- Beattie, A. (2020), 'Will coronavirus pandemic finally kill off global supply chains?', *Financial Times*.
- Behsudi, A. and McCrimmon, R. (2020), 'Food goes to waste amid coronavirus crisis', *Politico*.
- Bejan, M. J. (2006), 'Trade openness and output volatility', *SSRN Electronic Journal* 965824.
- Bellora, C. and Fontagné, L. (2020), 'Carbon Border Adjustment and Alternatives', *The 23rd Annual Conference on Global Economic Analysis (Virtual Conference)*.
- Berkley, S. (2020), 'COVAX explained', *Gavi, the Vaccine Alliance*.
- Bernard, A. B., Moxnes, A. and Saito, Y. U. (2019), 'Production Networks, Geography, and Firm Performance', *Journal of Political Economy* 127(2).
- Bloom, N., Bunn, P., Chen, S., Mizen, P., Smietanka, P. and Thwaites, G. (2019), 'The Impact of Brexit on UK Firms', *National Bureau of Economic Research*.
- Bloomberg News. (2020), 'Can the U.S. End China's Control of the Global Supply Chain?', *Bloomberg*.
- Boehm, C., Flaaen, A. and Pandalai-Nayar, N. (2019), 'Input Linkages and the Transmission of Shocks: Firm-Level Evidence from the 2011 Tōhoku Earthquake', *The Review of Economics and Statistics* 101(1):60-75.
- Bolatto, S., Naghavi, A., Ottaviano, G. I. and Zajc, K. (2017), 'Intangible assets and the organization of global supply chains', *SSRN Electronic Journal*.
- Bollyky, T. J. and Bown, C. P. (2020), 'The Tragedy of Vaccine Nationalism: Only Cooperation Can End the Pandemic', *Foreign Affairs*.
- Bonadio, B., Huo, Z., Levchenko, A. and Pandalai-Nayar, N. (2020), 'The role of global supply chains in the COVID-19 pandemic and beyond', *VoxEU*.
- Bown, C. P. (2019), 'US-China Trade War: The Guns of August', *Trade and Investment Policy Watch*(September 20, 2019).
- Brandon-Jones, E., Squire, B., Autry, C. W. and Petersen, K. (2014), 'A contingent resource-based perspective of supply chain resilience and robustness', *Journal of Supply Chain Management* 50(3):55-73.
- Buch, C. M., Döpke, J. and Strotmann, H. (2006), 'Does trade openness increase firm-level volatility?', *Deutsche Bundesbank*.
- Buera, F. J. and Oberfield, E. (2020), 'The global diffusion of ideas', *Econometrica* 88(1):83-114.
- Burgess, R. and Donaldson, D. (2012), 'Railroads and the demise of famine in colonial india',
- Carbonero, F., Ernst, E. and Weber, E. (2018), 'Robots worldwide: The impact of automation on employment and trade',
- Carvalho, V. M., Nirei, M., Saito, Y. and Tahbaz-Salehi, A. (2016), 'Supply chain disruptions: Evidence from the great east japan earthquake', *Columbia Business School Research Paper*(17-5).
- Caselli, F., Koren, M., Lisicky, M. and Tenreyro, S. (2020), 'Diversification Through Trade', *The Quarterly Journal of Economics* 135(1):449-502.
- Cavallo, E. A. (2008), 'Output volatility and openness to trade: A reassessment', *Economia* 9(1):105-152.
- Cernat, L. and Guinea, O. (2020), 'On ants, dinosaurs, and how to survive a trade apocalypse',
- Choong, Y. Y. C., Tan, H. W., Patel, D. C., Choong, W. T. N., Chen, C.-H., Low, H. Y., Tan, M. J., Patel, C. D. and Chua, C. K. (2020), 'The global rise of 3D printing during the COVID-19 pandemic', *Nature Reviews Materials* 5(9):637-639.
- Christopher, M. and Towill, D. (2001), 'An integrated model for the design of agile supply chains', *International Journal of Physical Distribution & Logistics Management* 31(4):235-246.
- Costinot, A. and Rodriguez-Clare, A. (2014), 'Trade Theory with Numbers: Quantifying the Consequences of Globalization', in Gopinath, G., Helpman, E. and Rogoff, K. (eds.), *Handbook of International Economics*: North Holland.

- Cristea, A. D. (2011), 'Buyer-seller relationships in international trade: Evidence from U.S. States' exports and business-class travel', *Journal of International Economics* 84(2):207-220.
- Crowley, M., Exton, O. and Han, L. (2019), 'Renegotiation of Trade Agreements and Firm Exporting Decisions: Evidence from the Impact of Brexit on UK Exports',
- Deloitte (2020) *COVID-19: Managing supply chain risk and disruption*, Deloitte Canada.
- Di Giovanni, J., Levchenko, A. A. and Mejean, I. (2014), 'Firms, destinations, and aggregate fluctuations', *Econometrica* 82(4):1303-1340.
- Diakantoni, A., Escaith, H., Roberts, M. and Verbeet, T. (2017), 'Accumulating trade costs and competitiveness in global value chains',
- Dingel, J. and Neiman, B. (2020), 'How many jobs can be done at home?', *VoxEU*(07 April).
- Dun & Bradstreet. (2020), 'COVID-19 Impact Index', *Dun & Bradstreet*.
- Economist Intelligence Unit (2009) *Managing supply-chain risk for reward*, The Economist.
- European Academies' Science Advisory Council (2018) *Extreme weather events in Europe*, Brussels: European Academies' Science Advisory Council.
- European Commission (2020) *Guidelines on the optimal and rational supply of medicines to avoid shortages during the COVID-19 outbreak*, Brussels:
- FAO, IFAD, IMF, OECD, UNCTAD, WFP, World Bank, WTO, IFPRI and UN HLTF (2011) *Price volatility in food and agricultural markets: Policy responses*, Paris: OECD.
- Fiorini, M., Hoekman, B. and Yildirim, A. (2020), 'COVID-19: Expanding access to essential supplies in a value chain world', in Baldwin, R. E. and Evenett, S. J. (eds.), *COVID-19 and Trade Policy: Why Turning Inward Won't Work*, Geneva: CEPR.
- Fisman, R. and Wei, S. J. (2004), 'Tax Rates and Tax Evasion: Evidence from "Missing Imports" in China', *Journal of Political Economy* 112(2).
- Fitzpatrick, M., Gill, I., Libarikian, A., Smaje, K. and Zimmel, R. (2020), 'The digital-led recovery from COVID-19: Five questions for CEOs', *McKinsey & Company*.
- Francisco, K. and Swanson, D. (2018), 'The supply chain has no clothes: Technology adoption of blockchain for supply chain transparency', *Logistics* 2(1):2.
- Freeman, R. and Sajedi, R. (2020), 'Covid-19 Briefing: International Trade and Supply Chains', *Bank Underground*.
- Freund, C. (2020), 'Governments Could Bring Supply Chains Home. It Would Defy Economic Rationality', *Barron's*.
- Freund, C., Mulabdic, A. and Ruta, M. (2019), 'Is 3D Printing a Threat to Global Trade? The Trade Effects You Didn't Hear About.', *The World Bank*.
- G20 (2020) *G20 Actions to Support World Trade and Investment in Response to COVID-19*,
- Giordani, P. E., Rocha, N. and Ruta, M. (2016), 'Food prices and the multiplier effect of trade policy', *Journal of International Economics* 101:102-122.
- Haddad, M., Lim, J. J., Pancaro, C. and Saborowski, C. (2013), 'Trade openness reduces growth volatility when countries are well diversified', *Canadian Journal of Economics/Revue canadienne d'économique* 46(2):765-790.
- Hamaguchi, N. (2013), 'Impact of the Great East Japan Earthquake on local industries: Synthesis and analysis from a survey', *Research Institute of Economy, Trade and Industry (RIETI)*.
- Head, K. and Mayer, T. (2014), 'Gravity Equations: Workhorse, Toolkit, and Cookbook', *Handbook of International Economics*: Elsevier.
- Henriet, F., Hallegatte, S. and Tabourier, L. (2012), 'Firm-network characteristics and economic robustness to natural disasters', *Journal of Economic Dynamics and Control* 36(1):150-167.
- Hoekman, B. and Sabel, C. (2019), 'Open plurilateral agreements, international regulatory cooperation and the WTO', *Global Policy* 10(3):297-312.
- Hong, H., Wang, N. and Yang, J. (2020) *Mitigating Disaster Risks to Sustain Growth*,
- Huang, H. (2019), 'Germs, roads and trade: Theory and evidence on the value of diversification in global sourcing', *SSRN Electronic Journal*.
- Huneus, F. (2018), 'Production network dynamics and the propagation of shocks', *Princeton University*.
- IATA (2020) *IATA Economics' Chart of the Week. Cargo capacity contracts sharply despite higher freighter utilization*, IATA.
- Inoue, H. and Todo, Y. (2019), 'Mitigating the propagation of negative shocks due to supply chain disruptions', *VoxEU*.
- International Federation of Robotics. (2019), 'Strong growth in robot adoption in the US and Europe drives 2018 sales of industrial robots', *IFR Secretariat Blog*.
- International Trade Centre (2019) *The European Union Market for Sustainable Products*, Geneva: International Trade Centre.
- Jain, N., Girotra, K. and Netessine, S. (2016), 'Recovering from Supply Interruptions: The Role of Sourcing Strategy', *SSRN Electronic Journal*.

- Jakubik, A. and Stolzenburg, V. (2020), 'Footloose Global Value Chains: How Trade Costs Make A Difference', *Review of Industrial Organization*:1-17.
- Johnson, R. C. and Moxnes, A. (2019) *GVCs and Trade Elasticities with Multistage Production*, Joint ministerial statement. (2020), 'Joint ministerial statement by Australia, Brunei Darussalam, Canada, Chile, the Republic of the Union of Myanmar, New Zealand and Singapore'.
- Kaminska, I. (2020), 'There is green gold in shorter supply chains and reshored rubbish', *Financial Times*.
- Kehoe, T. J., Ruhl, K. J. and Steinberg, J. B. (2018), 'Global imbalances and structural change in the United States', *Journal of Political Economy* 126(2):761-796.
- Kelly, B., Lustig, H. and Van Nieuwerburgh, S. (2013) *Firm volatility in granular networks*, Research, N. B. o. E.
- Kilic, K. and Marin, D. (2020), 'How COVID-19 is transforming the world economy', *VoxEU*.
- Kowalski, P. (2020), 'Will the post-COVID world be less open to foreign direct investment?', in Baldwin, R. and Evenett, S. (eds.), *COVID-19 and Trade Policy: Why Turning Inward Won't Work*: VoxEU.
- Kramarz, F., Martin, J. and Mejean, I. (2020), 'Volatility in the small and in the large: The lack of diversification in international trade', *Journal of International Economics* 122:103276.
- Kremer, M. (1993), 'The O-ring theory of economic development', *The Quarterly Journal of Economics* 108(3):551-575.
- Krenz, A., Prettner, K. and Strulik, H. (2018), 'Robots, Reshoring, and the Lot of Low-Skilled Workers', *SSRN Electronic Journal*.
- Leering, R., Spakman, T. and Konings, J. (2020), 'Covid-19 calls for more resilient production chains, but that's easier said than done'.
- Leibovici, F. and Santacreu, A. M. (2020), 'International Trade of Essential Goods During a Pandemic'.
- Lighthizer, R. E. (2020), 'The Era of Offshoring U.S. Jobs Is Over', *The New York Times*.
- Lund, H. and Steen, M. (2020), 'Make at home or abroad? Manufacturing reshoring through a GPN lens: A Norwegian case study', *Geoforum* 113:154-164.
- Lund, S., Manyika, J., Woetzel, J., Barriball, E., Krishnan, M., Alicke, K., Birshan, M., George, K., Smit, S., Swan, D. and Hutzler, K. (2020) *Risk, resilience, and rebalancing in global value chains*, McKinsey & Company.
- Martin, J., Méjean, I. and Parenti, M. (2018), 'Relationship stickiness: Measurement and applications to international economics'.
- Matous, P. and Todo, Y. (2017), 'Analyzing the coevolution of interorganizational networks and organizational performance: Automakers' production networks in Japan', *Applied Network Science* 2(1):5.
- McDonald, D. C. (1985), 'Trade Data Discrepancies and the Incentive to Smuggle: An Empirical Analysis', *Staff Papers (International Monetary Fund)*.
- McKinsey & Company (2019) *Globalization In Transition: The Future Of Trade And Value Chains*, Mehran, H., Morrison, A. and Shapiro, J. (2012), 'Corporate governance and banks: Have we learned from the crisis', *The crisis aftermath: new regulatory paradigms*, Centre for Economic Policy Research.
- Min-hee, J. (2020), 'Global Value Chain Adjustment Underway in Large Number of Enterprises', *Business Korea*.
- Ministerial statement. (2020), 'G20 Trade and Investment', *World Trade Organization*.
- Miroudot, S. (2020), 'Resilience versus robustness in global value chains: Some policy implications', in Baldwin, R. E. and Evenett, S. J. (eds.), *COVID-19 and Trade Policy: Why Turning Inward Won't Work*, Geneva: VoxEU & CEPR.
- Nienaber, M. (2020), 'Germany's Altmaier wants Europe to be less dependent on other countries. ', *Reuters*.
- OECD (2020a) *Shocks, risks and global value chains: insights from the OECD METRO model*, OECD.
- OECD (2020b) *The face mask global value chain in the COVID-19 outbreak: Evidence and policy lessons*,
- OECD (2020c) *Trade interdependencies in Covid-19 goods*, OECD.
- OECD (2020d) *COVID-19 and global value chains: Policy options to build more resilient production networks*,
- Okonjo-Iweala, N. (2020), 'Finding a vaccine is only the first Step: No one will be safe until the whole world is safe', *Foreign Affairs*.
- Parinduri, R. (2012), 'Growth volatility and trade: evidence from the 1967-1975 closure of the Suez Canal'.
- Petri, P. A. (2019), 'United States-China Technological Rivalry', Available at *SSRN 3441035*.
- Piermartini, R. (2004), 'The Role of Export Taxes in the Field of Primary Commodities', *WTO*.

- Piermartini, R. and Rubínová, S. (forthcoming), 'How much do Global Value Chains boost innovation?', *Canadian Journal of Economics*.
- Pisch, F. (2020), 'Managing Global Production: Theory and Evidence from Just-in-Time Supply Chains',
- Roos, R. (2020), 'Experts say COVID-19 will likely lead to US drug shortages'.
- Sampson, T. (2016), 'Dynamic selection: an idea flows theory of entry, trade, and growth', *The Quarterly Journal of Economics* 131(1):315-380.
- Schott, P., Pierce, J., Schaur, G. and Heise, S. (2017), 'Trade Policy Uncertainty and the Structure of Supply Chains',
- Seric, A., Görg, H., Mösle, S. and Michael, W. (2020) *Managing COVID-19: How the pandemic disrupts global value chains*, (UNIDO), U. N. I. D. O.
- Shapiro, J. S. (2016), 'Trade Costs, CO<sub>2</sub>, and the Environment', *AMERICAN ECONOMIC JOURNAL: ECONOMIC POLICY* 8(4):220-254.
- Startz, M. (2017), 'The value of face-to-face: search and contracting problems in Nigerian trade',
- Statt, N. (2020), '3D printers are on the front lines of the COVID-19 pandemic', *The Verge*.
- Stellinger, A., Berglund, I. and Isakson, H. (2020), 'How trade can fight the pandemic and contribute to global health', in Baldwin, R. E. and Evenett, S. J. (eds.), *COVID-19 and Trade Policy: Why Turning Inward Won't Work*, Geneva: CEPR.
- Stern, N. and Stiglitz, J. E. (2017), 'Report of the high-level commission on carbon prices'.
- Stolzenburg, V. (2018), 'Global Value Chains, Labor Productivity, and GDP',
- Stolzenburg, V., Taglioni, D. and Winkler, D. (2019), 'Economic upgrading through global value chain participation: which policies increase the value-added gains?', in Ponte, S., Gereffi, G. and Raj-Reichert, G. (eds.), *Handbook on Global Value Chains*, Cheltenham, UK: Edward Elgar Publishing.
- Thomas, Z. (2020), 'Coronavirus: Will Covid-19 speed up the use of robots to replace human workers?', *BBC News*.
- Todo, Y., Nakajima, K. and Matous, P. (2015), 'How do supply chain networks affect the resilience of firms to natural disasters? Evidence from the Great East Japan Earthquake', *Journal of Regional Science* 55(2):209-229.
- United Nations Conference on Trade and Development (UNCTAD) (2013) *World Investment Report 2013: Global Value Chains: Investment and Trade for Development*, Geneva: UNCTAD.
- United Nations Conference on Trade and Development (UNCTAD) (2019) *World Investment Report 2019*, Geneva: UNCTAD.
- United Nations Conference on Trade and Development (UNCTAD) (2020) *World Investment Report 2020*, Geneva: UNCTAD.
- WCO and WHO. (2020), 'Joint WCO/WHO HS classification list for COVID-19 medical supplies issued'.
- White Edward. (2020), 'Inside Samsung's fight to keep its global supply chain running', *Financial Times*.
- Wittenberg, A. (2020), 'The Economics of Remote Work', *Bloomberg*(23 July).
- World Bank Group (2020) *World Development Report 2020: Trading for Development in the Age of Global Value Chains*, Washington D.C., USA: World Bank Group.
- World Trade Organization, IDE-JETRO, OECD, RCGVC-UIBE and World Bank (2019) *Global Value Chain Development Report 2019: Technological innovation, supply chain trade, and workers in a globalized world*, Geneva: WTO.
- World Trade Organization (WTO) (2018) *World Trade Report 2018: The future of world trade: How digital technologies are transforming global commerce*, Geneva: WTO.
- World Trade Organization (WTO) (2019) *World Trade Report 2019: The future of services trade*, Geneva: WTO.
- World Trade Organization (WTO) (2020a) *Trade costs in the time of global pandemic*, Geneva: WTO.
- World Trade Organization (WTO) (2020b) *Trade in Medical Goods in the Context of Tackling COVID-19*, Geneva: WTO.
- Ziady, H. (2019), 'Adidas is closing hi-tech sneaker factories in Germany and US', *CNN Business: edition.cnn.com/2019/11/12/business/adidas-speedfactory-plants-closing/index.html*.