GEOECONOMICS

GLOBAL VALUE CHAINS IN THE AGE OF UNCERTAINTY: ADVANTAGES, VULNERABILITIES, AND WAYS FOR ENHANCING RESILIENCE

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In this paper, we seek to explain the fundamental vulnerability of global value chains (GVCs) to sudden shocks, as revealed by the COVID-19 pandemic crisis, and outline ways for enhancing their adaptability to the increased uncertainty at both conceptual and policy levels. We consider the concept and a typical multi-structural model of GVCs, highlighting the network complexity of the system of distributed production and trade in value added. Not only does this system bring competitive advantages to GVC partner countries, but also it entails risks of cascading production disruptions. We examine these risks by analysing the ripple effect of supply disruptions in GVCs when a sudden local shock can propagate globally through inter-firm supplier links, generating growing output losses across industries and economies. From this perspective, we describe the pandemic-induced breakdown in the global just-in-time supply system in spring 2020 and its role in the escalating global recession. In analysing the mechanisms of post-pandemic GVC adaptation to uncertainty, we look at the concept of economic resilience and properties of resilient systems (robustness, flexibility, redundancy, and dynamic sustainability). We scrutinise the supply chain resilience model used by leading MNEs (GVC organisers) in their disruption risk management at pre-disruption and post-disruption stages. We classify resilience strategies devised by MNEs after 2020 into three interrelated categories: namely, multi-structural GVC optimisation (diversification and relocation of suppliers), operational optimisation (building redundancy and production flexibility), and GVC digitalisation. We conclude by outlining windows of opportunity to improve international specialisation and growth patterns, which may open in the 2020s for developing economies, including Russia, due to the ongoing restructuring of GVCs and their global supplier networks.

Keywords:
global value chains, COVID-19 pandemic crisis, uncertainty, ripple effect, economic resilience, multinational enterprises, disruption risk management

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The rapid proliferation of global value chains (GVCs) since the early 1990s has formed a highly interconnected globalized world.[1] By the end of the 2010s, scholars had accumulated solid theoretical and empirical evidence that integration into GVCs was becoming a basic way of the participation of countries in the international division of labour. This benefits national economies in terms of strengthening competitiveness and achieving sustainable growth.[2] Meanwhile, the COVID-induced economic crisis of 2020 has exposed the underside of GVCs, their fundamental vulnerability to sudden shocks, which imposes risks of cascading disruptions upon the increasingly interconnected economies worldwide [1].

In the pre-pandemic times, despite the available knowledge on cascading disruptions in supply chains, as well as the scholarly insights into the associated business-risk management [2; 3], the ability of GVCs to rapidly transmit the crisis shocks from country to country was not sufficiently considered in global economic studies. As a result, in the spring of 2020, the reaction of countries to this challenge revealed major discrepancies in existing priorities concerning further participation in GVCs, thus divorcing importing economies from predominantly exporting ones, developed countries from developing ones, home countries of leading MNEs that organise GVCs from their host countries [4]. Academic and official circles alike began discussing dubious ideas of the inevitability of deglobalization [5; 6], dangers of sustaining further economic openness, the need to withdraw from GVCs, and bringing back most of production facilities, especially from China, inside national boundaries for the sake of technological, product and the rest types of national security [7; 8].

Most of these fears and ideas have had no further development or practical implementation due to their inconsistency with the objective logic of the economic advance of systems under the modern complexity of production and technological shifts. Instead, global business started to seek ways for eliminating weaknesses in the current GVCs' architecture, striving to adapt GVCs and the global supply system to the increased uncertainty.

Against this backdrop, we explore one of the pressing issues in the post-pandemic economic agenda — what is the nature of GVCs' vulnerability, and what might make them more resilient to sudden shocks? We look at both the conceptual and the practical aspects of this topic, touching upon the new area of risk management alongside with new economic strategies. We purposely omit reviewing the patterns of countries' involvement in GVCs, because this range of issues has been widely explored from different perspectives by modern economists, including Russian scholars [9—12].

[1] Interconnected economies: Benefiting from global value chains, 2013*, OECD*, Paris, OECD Publishing.

[2] *World development report 2020: Trading for development in the age of global value chains*, 2020, Washington, DC, World Bank.

We first examine the concept and organizational model of GVCs, describing typical features of the distributed production and value-added trade system as well as benefits that this system brings to countries and territories (*section 1*). We then illustrate the network complexity of distributed production and inquire into factors of its intrinsic vulnerability to idiosyncratic shocks, thus explaining the nature of disruption risks and their ripple effect in GVCs, also under the systemic pandemic shock of 2020 (*section 2*). Then we discuss the concept of economic resilience with regard to GVCs and examine the resilience-enhancing scheme of activities, applied by leading MNEs (organisers and coordinators of GVCs) for managing disruption risks and constraining ripple effects (*section 3*). Thereupon, we classify into three areas and closely examine the emerging resilient strategies of leading MNEs, aimed at adapting GVCs to the age of unpredictable shocks (*Section 4*). Finally, we outline windows of opportunity in improving international specialisation and growth patterns, which may objectively open in the 2020s for developing economies, including Russia, due to the ongoing restructuring of GVCs and their global supplier networks (*section 5*).

1. The concept of GVCs and the advantages of distributed production

The term 'GVC', adopted and conceptualized in economic literature by a group of international scholars in the early 2000s, denotes the full range of activities that firms carry out to bring a product or service from its conception to its end use, recycling or reuse [13].[3] In its modern meaning, the idea of GVCs reflects fundamental transformations in the production and international trade patterns, which happened over the last three decades under the proliferation of information and communication technologies (ICT).

The concept of GVCs

Firstly, the GVC concept reflects the world's transition since the late 1980s — early 1990s, to ***a distributed model of production,*** tailored to the growing complexity of products and the production cycle itself [11].

In geographic terms, production of final products (goods, services, technologies) has gone beyond the boundaries of a single major company and a single country, getting spatially dispersed among activities of numerous supplier and sub-supplier firms worldwide, networked as autonomous partners

[3] This term had supplanted a variety of previously used overlapping terms (like global commodity chains, international production chains, etc.) and emphasized the uneven nature of adding value at different stages of production [14]. Typically, in industrial GVCs, the largest value is added in knowledge-intensive service links, both at initial stages (elaboration of the product idea and design) and at end ones (distribution, marketing or after-sales activities).

within a GVC [15]. This process, equated in literature to *globalization of production* [16], has generated, in turn, the global competition that changed the context for defining competitiveness of national products: now it is increasingly determined by network spatial contours of GVCs, and less so by frames of national markets [17].

In functional terms, the three classical stages of production (extraction-processing-services) have got fragmented into increasingly narrow, knowledge-intensive and specialized operations (business tasks), each of which is performed by a particular GVC partner and corresponds to a particular GVC link [18]. Instead of traditional specialisation in producing final goods, countries are increasingly focusing on the production and export of innovative intermediates, which they can create more efficiently than their peers in the rest of the world. The production of highly profitable intermediates with unique qualities or specifications determines a *smart specialisation of economies in world markets*, which offers them fundamentally new growth opportunities as compared to the industrial age. As a result, distributed production provides *a continual deepening of the international division of labour,* which meets the ever-changing demands of technological progress, while making the world economy ever more diversified.

Secondly, the GVC concept reflects the world's transition to a ***network design of the industrial and economic landscape***. The proliferation of GVCs implies that the modern production process is organised by leading MNEs of different specialisation in the form of complex, multi-level networks of autonomous but functionally interconnected firms and their cross-border supplies [19]. GVCs are built by MNEs as *joint international project*s that have their particular time frame and operational sequence. Each supplier firm performs its business task that corresponds to a particular GVC node, with such individual specialisation usually shaped within a country's regional cluster, where the given firm is located [20]. The MNE itself participates in the common project through its branch office located in one of regional clusters, while not just delivering some intermediary inputs but also playing *a specific role of the lead firm* that coordinates the network. A successful coordination increases the cumulative project income so that the lead firm seeks to locate and regroup GVC nodes in optimal configurations, which ensure cost reduction and the highest value added of final products [21].

While highlighting the network and globalized nature of the world economy, the GVC idea unites its three levels — macro-level (global flows of goods, investment and finance), meso-level (national and regional flows) and micro-level, where firms directly operate and interact [4]. This motivates to view the modern world economy as a holistic ecosystem of numerous collaborating firms, where the production process gets decentralised (non-hierarchic), interactive and project-based. The ecosystem design is typical for the knowledge-based, or innovation-driven economy [22].

Thirdly, the GVC concept reflects the world's transition to a ***new pattern of international trade, concerned with value-added flows***. Within a GVC, intermediary exports from a certain country are purchased by another country as inputs for further processing and re-export to a third country, which generates an enlarging flow of value added [23]. Exports of each participating country contain both an external value added, imported from upstream partners, and an internal value added produced by the country itself for further sales of more complex and hence, more profitable intermediaries to downstream partners. This trade is conducted not by countries or industries (at which level empirical data are usually aggregated), but by individual supplier firms.[4]

In other words, under the distributed production, the system of bilateral export-import interactions between countries trading end products of industries is converted to a system of multilateral network interactions at the level of firms that trade exclusively intermediary products within GVCs. This shapes a complex system of value-added flows with numerous direct, backward and loop connections to permeate the global economy in a nonlinear way [24]. As known, a typical GVC contains both snakelike links, embracing first-tier suppliers involved in all production stages up to end markets, and many spiderlike links, embracing second-, third- and other-tier suppliers (fig. 1).

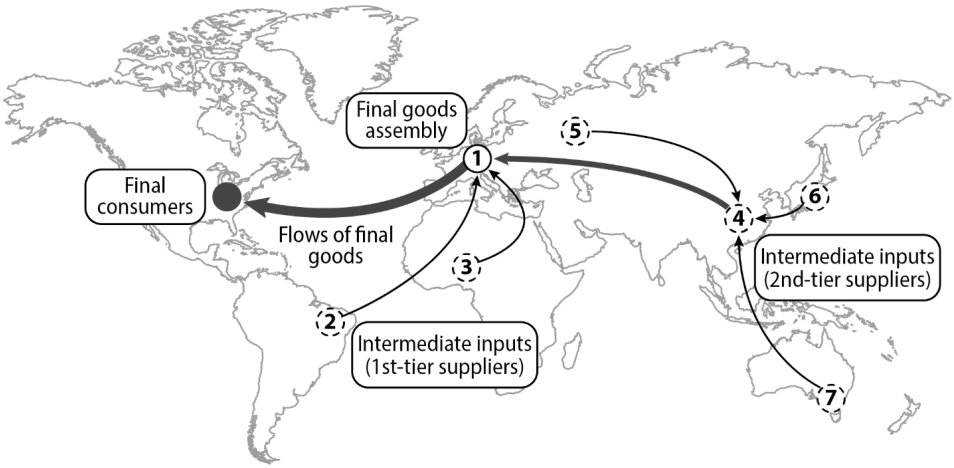

Fig. 1. Simplified scheme of value-added trade flows in a GVC

Note: Nodes 2, 3 and 4 (first-tier suppliers) create intermediate inputs that are assembled at the node 1 location to create a final product. Node 4 itself creates an intermediate product composed of inputs from nodes 5, 6 and 7 (second-tier suppliers).

Source: Interconnected economies: Benefiting from global value chains, Paris, 2013, OECD Publishing.

[4] *World development report 2020: Trading for development in the age of global value chains*, 2020, Washington, DC, World Bank.

The value chain organisational model

The concept of GVCs relies on the value chain organisational model used for mapping particular firms, activities, and geographic locations involved in the co-creation of a particular final product, be it a physical good, a service or an enabling technology [25]. This model is multi-structural, containing four key elements (fig. 2). They are:

1) *six main value-adding activities* representing basic operational functions that GVC firms are engaged in to bring a product from an idea to the end use.

2) *four main supply chain stages* (often termed in literature as 'supply chains' or 'global supply chains') illustrating the input–output structure of a product or the downstream flow of inter-firm interactions for its creation. Each stage represents supplier firms from a certain sector that can be further disaggregated into subsectors or intermediates delivered by second- or third-tier suppliers.

3) *end markets for final goods* (basically, an extension of the supply chain), classified into several categories within a given industry, such as producer-specific markets (e.g., for consumer electronics or automotive electronics in the electronics chains), buyer-specific markets (e.g., for retail consumers or industrial buyers in the apparel industry chains), and geographic markets [25].

4) s*upporting environment* uniting multiple local or global actors who do not directly produce and trade products but provide various supporting and regulative facilities enabling the chain's smooth functioning (from utility providers and financial institutions to governments and international organisations) [26].

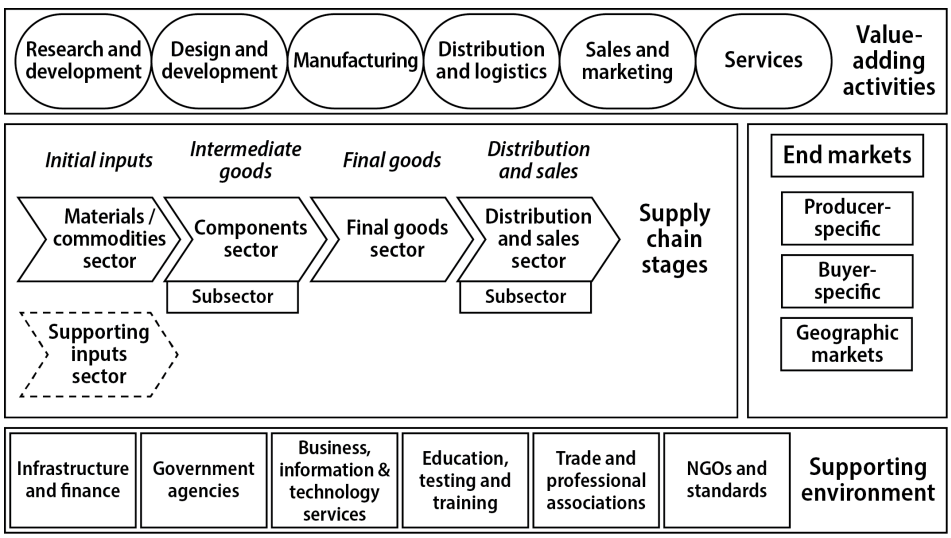

Fig. 2. A typical GVC organisational model (industry-neutral)

Source: adapted from [25].

Expansion of GVCs and their advantages for involved economies

Before the 2020 pandemic shock, the proliferation of GVCs had had two different periods, often referred to in literature as modern stages of globalization. The period from the early 1990s to the global recession of 2007—2009 was distinguished by intensive and turbulent geographical expansion of GVCs, with their links dispersed around the globe in lengthened configurations. During this period, marked by the liberalisation of markets (the foundation of WTO, the formation of NAFTA, etc.) and dissemination of cost-reducing ICT, the total world trade was growing more than twice as fast as the world GDP,[5] while value-added trade through GVCs had increased the world GDP by more than 10%, according to estimations.[6] After the Great Recession, due to a combination of factors,[7] the world trade growth relative to that of world GDP had slowed down, which is considered a natural sequel to the previous upsurge in globalization [5]. During the period from 2009 to 2019, the expansion of GVCs was less dynamic, while value-added trade had reached a plateau (fig. 3) with annual fluctuations of around 50% of total world trade.[8]

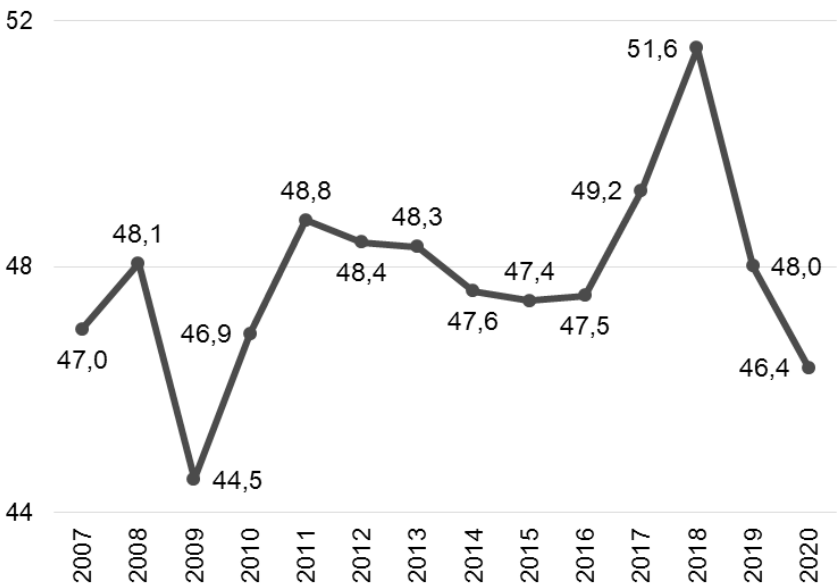

Fig. 3. The dynamics of GVC-related trade as a share of total international trade, 2007—2020,%

Source: authors' calculations based on the data from ADB MRIO database.

[5] *Global economic prospects: June 2020,* 2020, Washington, DC, World Bank.

[6] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

[7] *World development report 2020: Trading for development in the age of global value chains,* 2020, Washington, DC, World Bank.

[8] *World investment report 2020: International production beyond the pandemic,* 2020, New York, NY, United Nations.

Nevertheless, the increased complexity of products has formed a sustainable global trend of producing a growing share of each new final good within GVCs [27]. As a result, over the last 20 years (2000—2020), the value of intermediate goods traded via GVCs has tripled, amounting to more than USD 10 trillion per year.[9] By the 2020s, practically all countries around the world have been integrated into GVCs to this or that extent. For many of them, such integration has become a basic way to improve economic performance and accelerate growth, while for various middle- and low-income economies, a key development path that could provide access to global markets and the global circulation of technologies.[10]

Firstly, *trade through GVCs supports the growth of national economies better than traditional trade*. According to World Bank,[11] a one per cent increase of a country's participation in value-added trade can boost its per capita income by more than one per cent, which is about twice as much as the participation in trade in final goods. Besides, value-added trade reallocates global resource flows to their most productive uses not only at the country or industry (sectoral) levels but also within industries at the level of more narrow types of activities, which contributes to productivity growth in national economies.

Secondly, *deep division of labour under distributed production allows countries to extract mutual benefits from each other's individual comparative advantages*. In particular, catching-up economies no longer need to build the full-cycle national chains in various industries or to launch duplicative, import-substituting facilities, as was the case in the industrial age. Instead, countries can focus on shaping and deepening a narrow unique specialisation, while importing all the rest from their highly specialized GVC partners, both for final domestic consumption and as inputs for further processing of their own goods and exports [11; 28]. So, international collaboration and export-import trade in intermediates within GVCs helps national firms and entire economies *to reduce the level of costs and to develop increasingly profitable products*, thus enhancing productivity and sustainability of growth.[12]

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[9] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

[10] *World development report 2020: Trading for development in the age of global value chains,* 2020*,* Washington, DC, World Bank.

[11] Ibid.

[12] In the age of distributed production, the very diversification of a national economy is associated with its growing functional complexity, i.e., with an increase in the GDP structure of the share of complex, highly specialized types of activities bringing greater added value and hence higher incomes [29]

2. Vulnerability of distributed production to risks of cascading disruptions

For 30 years of evolution, the distributed production system has fundamentally enhanced functional interdependences among supplier firms, their industry domains and their countries of origin, thus making the world economy much more interconnected through transnational flows of trade, FDI and labour force.[13] This interconnectedness brings GVC partners not only mutual benefits but also risks of mutual losses under the rising global uncertainty.

In economic and business literature, ***uncertainty*** is viewed as the probability of risk occurrence, when unexpected events cause certain kinds of damage to systems' economic performance, with the scale of this damage being neither predicted nor insured against [30]. Indeed, participation in GVCs allows companies and economies to co-create increasingly complex products that they would never manufacture on their own. But at the same time, the involvement in value-added production and trade puts interdependent GVC partners at risk of rolling disruptions in their performance in case of a sudden idiosyncratic shock happening at the level of a certain supplier firm.

Vulnerability of GVCs to idiosyncratic shocks

Idiosyncratic shocks are the ones altering a particular firm's behaviour and performance as a result of any internal or external event happening in this firm's environment [31]. These are sudden shocks occurring at the level of a firm either due to its local event (for example, a working strike, a delay in shipment, a fire at a factory, a cyber-attack) or as this firm's reaction to a common systemic shock which all other firms in the given environment also face (for example, natural disasters, political conflicts, terrorism, transport infrastructure failures, etc.).

Risks of sudden idiosyncratic shocks are viewed as ***impacts of uncertainty***. Such shocks directly affect the supply chain component of GVCs, or just the process of inter-firm supplies. Quantitative analysis in this field [32] reveals that globally dispersed and decentralized value chains with lengthened configurations are much more exposed to impacts of uncertainty than value chains with less dispersed links and shorter configurations. High vulnerability of GVCs to rolling supply disruptions can be explained, in our view, by several types of ***multiple supply interdependences*** characterizing the complexity of distributed production.

Firstly, as shown in figure 2, the distributed production of complex products (like, say, Airbus or Boeing planes) is multi-stage. It relies on *consequent input-output relationships* between hundreds of intermediary producers in the

[13] *Interconnected economies: Benefiting from global value chains,* 2013, Paris, OECD Publishing.

given industry, embracing also numerous suppliers from other fields (logistics firms, business service companies, etc.). Due to such consequent and multiple interdependencies within a GVC, a sudden idiosyncratic shock to any individual supplier can cause massively amplified economic damage. The missing production capacities or inventory at the shocked facility may lead to a shortage of inputs and the resulting fall in production at the next supply stage while amplifying from a stage to a stage in terms of delivery delays and output losses. As a result, *value-added production and trade provide a channel for translation of an initial firm-level shock into cascading disruptions across the entire GVC and beyond*, affecting also other supply chains in the global economy [3].

Secondly, since the production of complex products is dispersed among narrowly specialized producers implementing their unique business tasks, each producer at each stage of production in the GVC critically depends on one or a few specific suppliers able to deliver very specific intermediates that meet the customer's requirements. Due to such input specificity in GVCs, their firms are exposed not just to traditional and predictable risks in the market availability of needed components but rather to risks of unpredictable individual disruptions in the functioning of these few particular suppliers [33]. This implies that *vulnerability of GVCs to sudden shocks is largely determined by the level of their functional complexity*, that is, by the number of specific suppliers and specific input items required for the creation of a given final product [34]. The higher the complexity of the GVC, the greater the risks of supply disruptions can be and hence, the risks of cascading production downfalls in the chain, as well as spillover effects of firms' output losses in related industries and economies.

Thirdly, the complexity of distributed production concerns not only the complexity of GVCs themselves and input-output interdependencies of their companies but also the *interconnectedness of firms involved in global supplier networks* (fig. 4). Such networks, having evolved around leading MNEs during three decades of GVCs' building, represent powerful production ecosystems that embrace an enormous number of supply connections and overlapping inter-firm linkages worldwide. They function as global business communities, from where lead firms are picking up new specialised project partners for the next GVCs. Configurations of these communities vary greatly even within the same industry, depending not just on the specialisation of a particular MNE but also on long-standing transnational partnerships among thousands of suppliers that work in parallel for customers from the ecosystems of other MNEs. For instance, in the case of integrated electronics, Dell's ecosystem encompasses over 4.7 thousand direct suppliers, while Lenovo's ecosystem, about 4 thousand, and above this, there are another 2.3 thousand suppliers that simultaneously belong to both ecosystems and participate in GVCs of both lead firms.

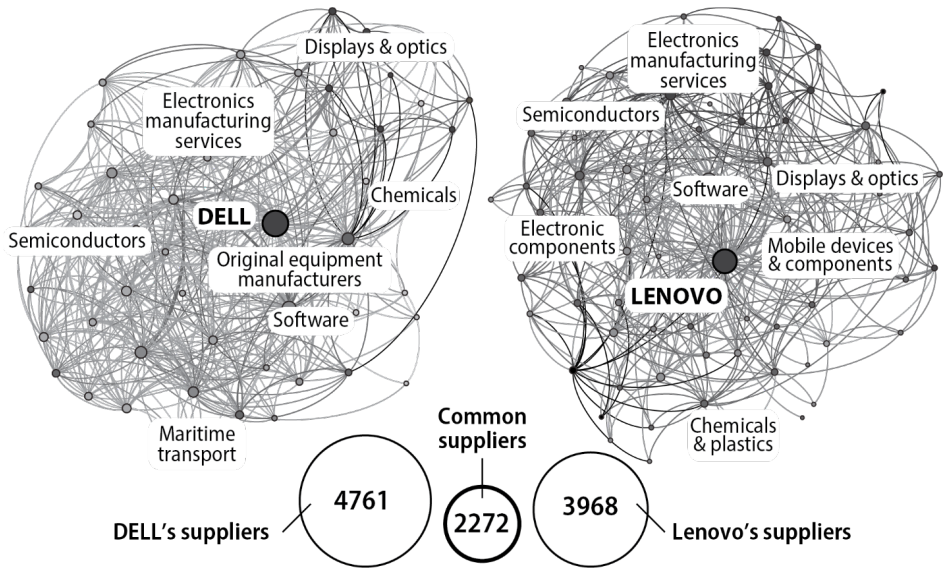

Fig. 4. Global supplier networks of lead firms: an example from integrated electronics

Source: *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

Due to interdependences in-between global supplier ecosystems, the risks of cascading disruptions within a GVC can emerge not just from its own supplier firms but also from these firms' partners and customers in other GVCs. Simply put, GVCs are exposed to *disruptions stemming from counterparty risks,* when a firm in the given network is also a supplier to a partner from an entirely different network, including value chains of other industries. Such multiple interdependences also lead to serious *hidden disruptions*: the GVC companies often have limited or no visibility of inter-firm connections existing beyond their direct first-tier suppliers, both in upstream and downstream links [35]. The same interdependences facilitate diffusion of disruptions across various GVCs, industries and economies, far beyond the shock-affected GVC.

Disruption risks and ripple effects in GVCs

The propagation of supply disruptions along the value chain is described in literature using several interchangeable terms, such as the contagious disruption effect [1], domino effect, snowball effect or ripple effect [3].[14] According to the risk management literature on supply chains, ***the ripple effect*** occurs when a disruption in inter-firm trade cannot be localized or contained within one supply stage of the chain, and instead, propagates in the downstream direction, causing shifts in the chain's multi-structural design and producing a negative impact on

[14] The term 'ripple effect' in relation to value chains derives from an analogy to computer science, where the ripple effect determines the disruption-based scope of changes in the system [3].

its aggregate performance [2; 35]. A severe supply disruption can temporarily switch off some nodes and links in the chain, thus undermining its network architecture and value-added production process [3].

In other words, the ripple effect of supply disruptions can generate disruptions in all GVC structural components presented in figure 2. *The longer this effect lasts, the larger is the scale of structural disruptions*, up to a complete breakdown of the whole GVC system. According to econometrical estimations, the chain's key performance indicators (sales, output, total profit, market share, stock returns, etc.) are adversely affected if it remains under the ripple effect, i.e., in the supply disruption mode, longer than some critical period of time, known as the 'time-to-survive' [3]. Similar estimations suggest that a drop in the strength of interfirm relationships below a certain critical level leads to a complete stop of production in the entire chain [32]. Relevant agent-based modelling and network analysis [36] provide evidence that in tightly coupled chains, having higher levels of dependencies among partners, the rate at which disruptions ripple through the network is higher.

However, the vulnerability of GVCs to devastating ripple effects *should not be taken as their inherent structural fragility or as a fixed feature of their network architecture*. Rather it is damage to the chain's productivity, caused by a disruption in certain input supplies, that makes robust value chains structurally fragile and exposed to cascading output losses [32].

So, the ripple effect in GVCs is a relatively new phenomenon typical of the digital age. It is usually associated with fundamental global uncertainty, non-predictable shocks, and a special type of economic risks known as ***disruption risks***. In literature and management practice, this effect is distinct from the traditional and well-explored *'bullwhip effect'* in value chains, associated, on the contrary, with random uncertainty and casual operational risks (fluctuations in daily or weekly demand and supply), which can be shortly eliminated without affecting the chain's structure and output [37].

Noticeably, due to non-linearity of GVCs and a high dependence of one partner on another, the rippling of downstream disruptions can emerge not just in the case of sudden, low-probability systemic shock but also in the case of everyday high probability occurrences. This implies that GVCs are exposed to ***systemic risk*** — the possibility of breakdowns in the entire system, evidenced by correlation among most or all of its components [35]. Moreover, econometric modelling suggests that *ripple effects in value-added trade can spread along GVCs and across economies in a similar fashion as information diffusion, or bank failures, or biological epidemics* [38].

GVCs under the pandemic shock

Since the start of the digital age, GVCs and their supplier ecosystems have been facing increasingly frequent and severe systemic shocks of various origins, causing rippling supply disruptions and imposing damage on international

business and national economies.[15] So, the propagation of shocks through supply chains and its macroeconomic implications have been widely studied even before the COVID-19 pandemic, both in economic and management literature, both theoretically and empirically [2; 40—42]. According to McKinsey Global Institute, over the past decade**,** at least one-month-long disruptions in supplier networks occurred on average every 3.7 years, with one major disruption capable to stop production in a GVC for 100 days, thus depriving firms in a number of industries of annual revenues.[16] In the year of 2019 alone, the supply disruptions caused only by natural disasters had imposed damage on the world economy up to USD 40 billion [43].

However, the 2020 pandemic crisis has brought ***the worst shock to the distributed production system for its entire 30-years evolvement.*** The crisis has demonstrated that increased interconnectedness of economies as GVCs' partners can put them at enormous destabilizing risks in case of a sudden fall in deliveries from just a single country, particularly from China.[17] It has become clear that with all its advantages the modern system of production and trade is yet not tailored to safely meet powerful unpredictable shocks and should be seen *fundamentally vulnerable* to impacts of rising uncertainty. Among the biggest disruption risks that had fully realized at the start of the crisis was a combination of two factors — the involvement of GVCs' country partners in the just-in-time delivery practices that had critically increased their interdependences and the revealed dependence of a significant share of these countries on intermediary imports from China, that had been steadily growing through over the past decade.

For 18 years of its participation in WTO before the COVID-19 pandemic (2001—2019), China has significantly increased its share in imports of the fifteen largest economies across all groups of traded goods, except for raw materials. Geographically this expansion encompassed Asian-Pacific, European and North American regions. Such trend is fully in line with stylized facts that indicate the concentration of GVCs in these macro regions, in particular, around China, Germany and USA as the three largest global hubs where export-import flows intersect [18]. According to our estimates, during this period Asian-Pacific countries have mostly increased imports of capital and intermediate goods from China, while European countries and North American ones have mainly raised imports of capital and consumer goods (table 1).

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[15] For example, in 1998, two strikes at General Motors plants caused shutdowns of 126 other plants, thus reducing the company's earnings by nearly USD 3 billion. In March 2000, a fire at Philips Semiconductor plant in New Mexico halted its production, thus depriving Ericsson from sourcing critical components, which turned for Ericsson in such huge sales losses that it had to exit the mobile phone business [39]. In March 2011, after the earthquake in Japan, Toyota lost its market leader position and had to fully redesign its GVCs [3].

[16] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

[17] *Global economic prospects: June 2020,* 2020, Washington, DC, World Bank.

Table 1

Rising dependence of largest economies on imports from China
(China's import share in each product group,%)

Country	Capital goods			Consumer goods			Intermediate goods			Raw materials		
	2000	2019	δ p.p.	2000	2019	δ p.p.	2000	2019	δ p.p.	2000	2019	δ p.p.
USA	6.1	24.4	18.2	14.6	22.3	7.7	3.9	8.1	4.2	1.3	1.7	0.5
Canada	1.5	15.2	13.7	7.2	15.4	8.2	1.9	7.2	5.3	0.8	1.9	1.1
Mexico	1.2	25.8	24.6	2.5	15.0	12.5	1.7	11.0	9.4	0.7	1.0	0.3
Germany	3.6	16.7	13.1	6.2	10.7	4.5	1.6	4.2	2.6	1.1	1.5	0.4
UK	3.1	14.8	11.7	8.4	12.0	3.6	1.8	3.0	1.2	0.9	1.5	0.5
France	2.9	14.2	11.3	5.6	10.6	5.0	1.2	3.3	2.1	0.6	1.0	0.4
Italy	2.0	13.1	11.1	5.6	8.3	2.7	1.7	5.4	3.7	1.1	1.1	–0.1
Spain	1.5	12.7	11.2	5.7	11.8	6.1	1.9	6.0	4.1	0.8	1.1	0.3
Japan	10.5	40.6	30.1	28.4	26.9	–1.5	9.5	19.8	10.3	5.6	2.6	–3.0
Korea	5.8	33.7	27.9	11.7	20.4	8.7	10.8	27.3	16.5	6.6	2.5	–4.0
Australia	3.7	32.1	28.4	15.2	26.7	11.5	4.1	20.7	16.6	1.8	2.8	1.0
Indonesia	3.6	38.0	34.4	6.1	22.0	15.9	5.6	24.5	18.9	10.4	9.6	–0.8
Brazil	2.3	30.5	28.1	2.6	15.6	13.0	2.3	16.9	14.6	0.6	2.3	1.7
Russia	1.2	28.4	27.2	5.3	21.2	15.9	3.3	17.4	14.0	2.4	6.8	4.3
India	4.0	31.2	27.2	2.6	17.4	14.9	5.0	15.5	10.6	1.2	0.4	–0.8

Note: δ denotes growth/decline of China's share for the given period (percentage points)

Source: authors' calculations based on data from WITS database.

In 2020, trade through GVCs has become *a key channel*[18] *both for the global dissemination of supply disruptions at the level of companies and for the resulting global transmission of production downfalls from a country to country*.[19] Rippling disruptions in the just-in-time supply system began to propagate around the world as early as in February 2020, when quarantines and lockdowns in the Chinese city of Wuhan, the domain of branch-offices of different MNEs, were introduced. It was the breakdown of this system that had sharply plunged the world economy into the deepest and the most synchronous recession, embracing simultaneously 90% of countries in the spring of 2020.[20] Along with China, where numerous GVCs intersect, the largest contribution in amplification of the ripple effect and in escalation of the recession was made by lockdowns of businesses in two

[18] Other major channels for the global dissemination of downfalls were the labour market (a massive drop in employment due to factory closures), as well as abrupt drops in demand in two sectors requiring close personal interactions — international tourism and services.

[19] *Global economic prospects: June 2020,* 2020, Washington, DC, World Bank.

[20] Ibid.

other ***major world hubs of GVCs' intersection*** — Germany and the USA [18]. What is also noticeable, due to complexity of distributed production, involving thousands of multi-tier suppliers and interconnected global supplier ecosystems, the pandemic shock and associated lockdowns have caused *the record high surge of uncertainty* in global markets, with its level having risen two times higher than during the Great Recession of 2007—09 [44] (fig. 5).

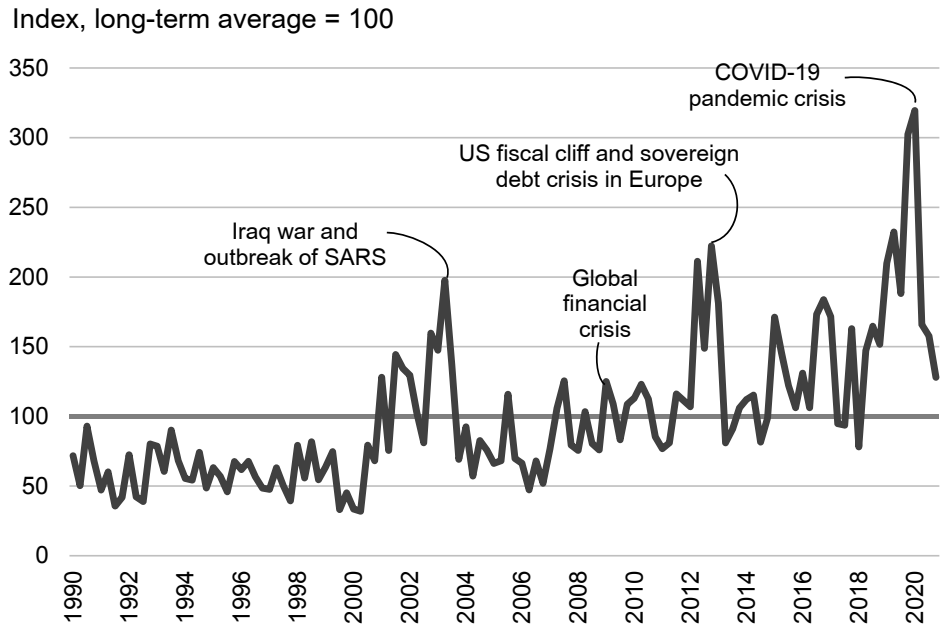

Fig. 5. The dynamics of the World Uncertainty Index, 1990—2020

Source: World Uncertainty Index data, 2021.

In 2020, many leading MNEs faced huge financial losses. However, this damage did not force them to turn away from benefits of distributed production. Rather they intend to mobilize all existing policy measures for ensuring a sound after-shock recovery and a better protection of their GVCs against possible future disruptions. To this end, they are turning to strategies for enhancing GVCs' resilience, aiming to adapt them to the new, post-pandemic realities.

3. The concept of economic resilience and its model for GVCs

The concept of resilience derives from systems sciences and the complexity theory, dealing with complex non-linear (or complex adaptive) systems to ensure their sustainable functioning. Since early-mid 2010s, this concept has been increasingly applied by scholars and practitioners to various fields of activity, including ecology, political science and management [45]. In relation to national

economies, the idea of building resilience has been raised under the OECD global research initiative of 2015 'New Approaches to Economic Challenges" (NAEC Initiative), calling scholars, governments and all other interested parties to renew traditional economic thinking and jointly respond to the challenge of unpredictable changes.[21]

According to the OECD descriptions,[22] ***'resilience'*** denotes the ability of a complex system to flexibly recombine its elements and resources for achieving *dynamic sustainability under high uncertainty*, which means keeping on at an equilibrium either at the previous or at a new development level in response to sudden external or internal disturbances.[23] A system is considered resilient if it is able to absorb unpredictable shocks and quickly recover after them, with this resilient state being an opposite to the state of its fragility.[24]

With respect to GVCs, the idea of resilience concerns *building resilience to disruption risks*. In the pre-pandemic times, conceptual approaches and policy-oriented modelling in this field could be found primarily in the risk management literature [45] and in the management literature on supply chains [36; 2], with both research streams having incorporated valuable insights from the complexity theory and network analysis.

According to these literature streams, the resilient state of a system, particularly of a GVC, results from achieving by it an optimal dynamic balance between two structural properties — ***robustness and flexibility***. While robustness concerns maintaining structural stability and functionality under a sudden shock (that is, 'being safe'), flexibility implies restoring effective performance after a shock by adapting the system to shock-induced changes in the environment (that is, 'performing safely') [3]. Differently put, *a resilient system is typically robust enough to safely absorb shocks, and simultaneously, flexible enough to self-adapt to the shock-induced changes through recombination of its structural elements and key resources*.

To obtain greater robustness and flexibility, and ultimately, adaptability to sudden shocks, the system needs some surplus (additional) resources, production facilities or functional capabilities. This variety of surplus assets is placed in resilience-related research under an overarching term ***'redundancy'*** [47]. Redundancy is not about the traditional increase in material stocks or the creation of additional production facilities to address operational risks. In relation to disruption risks and resilience in GVCs, building redundancy implies a wide

[21] *Final NAEC synthesis: New approaches to economic challenges,* 2015, Paris, OECD Publishing.

[22] *Resilience systems analysis: Learning and recommendations report,* 2017, Paris, OECD Publishing.

[23] As follows from complexity economics, the equilibrium of complex systems concerns their dynamic sustainability under constantly changing environment [46].

[24] *Resilience systems analysis: Learning and recommendations report,* 2017, Paris, OECD Publishing.

variety of measures that extend from multiple input sourcing and diversification of suppliers to improving the chain's network configuration and introduction of new digital technologies [3].

Creating redundancy in complex systems is opposed to the process of deepening leanness, usually associated with traditional systems that benefit from 'frugal' behaviour and cost-saving priorities [3]. Indeed, through decades, firms and economies have been improving their production efficiency through such cost-saving policies as minimizing current inventory, maximizing capacity utilization or, lately, involving themselves in the just-in-time supplies. However, in the age of uncertainty, *a system's economic efficiency depends not so much on increasing its current profitability but rather on achieving its long-lasting resilience*. This goal requires availability of surplus assets and free capacities to be activated in the event of a shock, thus enabling the system to flexibly recombine all existing resources and facilities.

After the pandemic shock, the leading MNEs are looking for a better adherence to these new conceptual approaches. They associate enhancement of their GVCs' resilience with a new kind of risk management — ***the disruption risk management,*** aimed at controlling the ripple effect in case of a shock. Such control typically encompasses both pre-disruption and post-disruption stages in the GVC functioning (fig. 6).

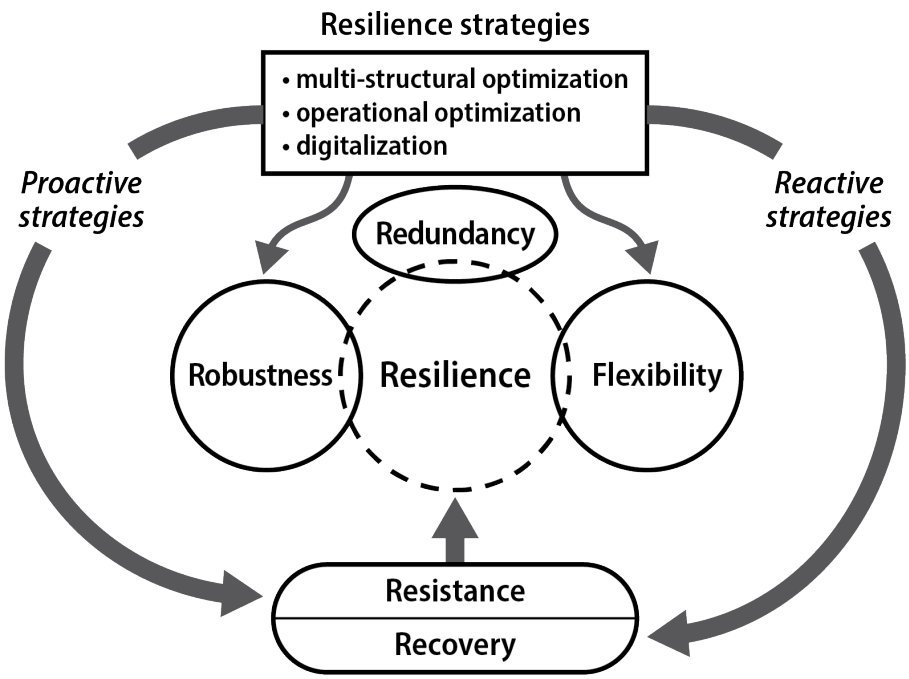

Fig. 6. Disruption risk management in GVCs: model for building resilience

Source: authors' design based on [2; 3].

Pre-disruption stage concerns implementation of ***proactive planning strategies,*** or the GVC development plan accounting for probability of shocks and supply disruptions (conditionally, the plan A). Such strategies are meant to improve *the GVC resistance to possible shocks*, that is, to ensure its ability either to prevent ripple effects or to curb them. Curbing of ripple effects implies containment of spatial propagation and duration of supply disruptions along the chain, as well as mitigating their adverse impact on both the GVC performance (output, sales, profits, etc.) and on its multi-structural design (composition of supplier firms, production structure, structure of input sourcing, transportation routes, end markets, etc.).

At this stage, the lead firm deploys a wide variety of complementary measures, aiming to proactively boost both robustness and flexibility of the GVC. *Strengthening of GVC robustness* is achieved by optimizing the chain's multi-structural design and by building some operational redundancy in the production process (the disruption risk mitigation inventory, buffer production facilities, etc.). *Enhancement of GVC flexibility* also concerns both structural and operational chain's parameters, implying similar and overlapping measures for building redundancy assets that can render the chain a room for maneuver in adaptation to possible post-shock changes.

Post-disruption stage appears if in case of a shock the lead firm has still failed to prevent ripple effect by proactive measures. It concerns implementation of ***reactive control strategies,*** or a certain reactive contingency plan that is used instead of an original plan to account for the actual scale of disruptions happened in various chain's components (conditionally, the plan B). Reactive measures are meant to ensure *a quick after-shock recovery of the GVC*. To this end, the lead firm activates the early built redundancies and flexibilities, aiming to lessen financial losses of GVC's firms from disruptions and to restore the chain's efficient performance. Simply put, it bridges proactive resistance strategies with reactive recovery policies [2].

In sum, as shown in figure 5, GVCs can self-adapt to non-predicable shocks and demonstrate the best possible performance under high uncertainty in the state of an optimal dynamic balance between robustness and flexibility. Resistance to sudden shocks and a safe after-shock recovery are two crucial properties of resilient GVCs and, at the same time, two critical elements of the ripple effect control [3]. This control requires building redundancies, as well as *coordination of pre-disruption and post-disruption resilience measures over time and space,* which leads to the GVC restructuring and replanning its performance on a new development level [48].

4. Post-pandemic resilience strategies of global companies

The task of remaining resilient under upsurged uncertainty urged leading MNEs *to improve ways of enhancing robustness and flexibility of GVCs, with putting a stronger emphasis on sustaining the GVC efficient performance in the state under and after a shock.*

Upon reviewing recent economic and business literature on GVCs,[25][26][27][28] we classify possible resilience strategies of leading MNEs into ***three parallel and overlapping complementing areas of action*** that may pass through both proactive and reactive stages of the ripple effect control. As shown in figure 5, they are the GVC multi-structural optimization, the GVC operational optimization, and the GVC digitalization. In all three areas, different resilience tools can be applied either separately or in various complementary combinations.

Multi-structural optimization in GVCs

The first area of activities concerns optimization of GVC structural parameters by means of the following policy tools:

(1) ***Diversification and geographic relocation of suppliers*** — the basic line, containing a diversified package of measures:

- *Expansion of geography and number of suppliers, up to dual and multiple input sourcing,* aimed at providing redundancy (substitutable) sourcing options for each essential input at each stage of production. This measure is meant to reduce the risky dependence of GVC firms on one or two partners and locations, especially their overdependence on supplies of Chinese intermediates. According to UNCTAD forecasts, the post-pandemic diversification of suppliers will be essential for service GVCs, as well as GVCs in medium- and low-technology manufacturing;[29]
- *Nearshoring,* or switching from long-distance offshoring to choosing suppliers from geographically closer locations (or to relocating there MNE's own branches), aimed at shortening length of GVCs and hence, at reducing scope of ripple effects;
- *Partial reshoring,* or a return of certain offshore GVC links (especially middle manufacturing links located in China) back to the country of origin, usually a developed one. This will concern 'strategically important' sectors (like

[25] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

[26] *Global economic prospects: June 2020,* 2020, Washington, DC, World Bank.

[27] *World investment report 2020: International production beyond the pandemic,* 2020, New York, NY, United Nations.

[28] *Shocks, risks and global value chains: Insights from the OECD METRO model,* 2020, Paris, OECD Publishing.

[29] *World investment report 2020: International production beyond the pandemic,* 2020, New York, NY, United Nations.

pharmaceuticals) and some labour-intensive industries (like clothing production) [4]. Contrary to the immediate assumptions after the pandemic shock, *no large-scale re-shoring involving* many *industries is expected:* according to the OECD estimations,[30] the over-localization of production brings neither greater security nor greater efficiency to national economies, but just undermines GVC's resilience through lowered structural flexibility and decreased diversity of suppliers.

(2) ***Regionalization of GVCs*** — switching from their globally dispersed configurations to more geographically concentrated, macro-regional ones, without reducing the number of their functional links. Before the pandemic shock, macro-regional GVCs have already dominated in the highly integrated EU and in the East Asia, whereas in North America and in the rest parts of the world, on the contrary, a distinctly global configuration of GVCs has prevailed, with their firms relatively more dependent on distant partners than on supplier from their macro-regions.[31] But in the coming years, the task of reducing disruption risks will lead to a wider spreading of macro-regional GVCs, especially in the extraction and manufacturing sectors.[32] In other words, the number of suppliers and nodes in GVCs will continue to grow, yet within more concentrated spaces.

(3) ***Smart-sourcing strategies*** — building such GVC configurations that ensure a continual innovation process along the entire chain to sustain its competitive advantages. Many leading MNEs began to cultivate smart-sourcing since the 2010s: in order to develop advanced manufacturing, they were increasingly allocating the manufacturing GVC nodes among territories with highly skilled labour, world class universities or clusters with a unique specialisation [49]. In the 2020s, such innovation-driven considerations will only expand to ensure GVCs' robustness and effective functioning under sudden shocks. Moreover, global companies will increase their own investments in formation of innovation clusters in different locations worldwide, including partnerships in related industries. Finally, they will continue to wider allocate R&D nodes of GVCs beyond developed countries, switching to developing and transition economies (R&D offshoring), which is a relatively recent trend, untypical for previous stages of globalization [50].

[30] *Shocks, risks and global value chains: Insights from the OECD METRO model,* 2020, Paris, OECD Publishing.

[31] *World development report 2020: Trading for development in the age of global value chains,* 2020, Washington, DC, World Bank.

[32] *World investment report 2020: International production beyond the pandemic,* 2020, New York, NY, United Nations.

Operational optimization in GVCs

The second area concerns optimization of the GVC product development process (the cycle of value-adding operations and related supply stages, as shown in Fig. 2), embracing the following policy tools:

(1) ***Building redundancy along the GVC links*** — usually implies building such reserve assets, as the risk mitigating material inventory, reserve production capacities or backup supply sources. The pandemic shock has put leading MNEs before a management dilemma: should they sacrifice the obvious cost-saving benefits of just-in-time supplies for the benefits of counteracting future shocks through additional investment in redundancy? While proactively made before a possible shock, such investments turn out quite expensive both for the lead firm and for other chain's partners in case of no shock event [3]. Many MNEs still decided to create redundancies either at the level of certain GVC nodes producing critical inputs or even along the entire chain.[33] To avoid risks of stockpiling too much reserve assets (which may result in decreasing rather than increasing resilience), lead firms will apply digital technologies helping to find out where exactly, in what form and how much redundancy should be built.

(2) ***Reducing current production costs and increasing operational flexibility*** — through applying advanced technologies (digital platforms, modular solutions, 3d printing, etc.). To ensure a quick after-shock recovery of GVCs, lead firms must combine the proactive investment in operational redundancy, aimed at preventing rippling supply disruptions, with sustaining the flow of production process in case such disruptions did occur. To this end, they will increasingly apply various applications of traditional ICT, which can help to reduce different current costs (in communication, manufacturing, logistics, customs procedures, etc.) and simultaneously, to enhance flexibility of value-adding operations throughout the production cycle (by recombination or better coordination of business tasks, etc,).[34] Cost reduction is especially important for GVCs in manufacturing, considering their high transaction costs in cross-border shipments.[35]

The survey of 60 leading MNEs, conducted by McKinsey Global Institute in May 2020,[36] confirmed that almost all global companies (93%) intend to take

[33] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

[34] For example, additive manufacturing, which complements traditional manufacturing and thus expands trade through GVCs [51], allows not just to save time on prototyping but also to reduce disruption risks due to 3D-printing of missing components. It can also reduce the number of GVC links, and hence, the scope of ripple effect, thus enhancing the GVC resilience on pre- and post-disruption stages [52].

[35] *World trade report 2018: The future of world trade. How digital technologies are transforming global commerce,* 2018, Geneva, World Trade Organization.

[36] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

action for improving their GVCs' resilience through either multi-structural or operational optimization, or through both. On average, 44% of surveyed lead firms are ready to sacrifice short-term profitability of GVCs, based on 'just-in-time' supply model, for their long-lasting sustainability to be achieved by building different redundancies, dual sourcing and diversification of suppliers. At the same time, the survey also confirmed research findings on institutional and technological limitations of relocation of GVC nodes, especially in high-tech industries [4]. In particular, relocation can undermine long-lasting inter-firm partnerships within global supplier networks, where thousands of firms have built up over years a certain level of mutual trust, tacit knowledge, and a wide access to highly specialized producers in various regional clusters around the world.

Digitalization of GVCs

The third area concerns deriving the potential benefits from the in-depth digitalization of GVCs. Digitalization is considered a fundamental way to simultaneously reduce disruption risks, production costs and large additional costs imposed by investments in redundancy.[37]

New ICT and ICT-based production technologies, such as *big data analytics, advanced trace and tracking systems, Blockchain*, *decentralized agent-driven control systems, advanced robotics,* and *Industry 4.0 applications* (like cyber-physical production systems or additive manufacturing) [53], provide real time data sharing and the real time coordination of firms' activities along the GVC. They fundamentally raise the transparency of cross-border supply flows and visibility of available resources in the chain, making it possible *to track sources of disruptions in good time and quickly cut short the ripple effect of their propagation.*

Different combinations of digital technologies can *fully upgrade the quality of both production management and ripple effect control in GVCs,* creating the possibility of simulation modelling regarding the negative impact of disruptions, scenarios of GVCs' after-shock recovery and variants of their restructuring [48; 52]. Although at present some latest digital technologies are still immature or not properly tested [53], literature predicts that the advance in digitalization may push the emergence of ***a new generation of GVCs with low sensitivity to uncertainty.*** This will be achieved due to GVCs' reliance on digital analytics algorithms and their increasing focus on data trading (product design, software, etc.) [52].

[37] An example is a joint 3D printing technology of American logistics service provider United Parcel Service and German SAP, allowing to save time and lessen supply risks through manufacturing items directly at UPS distribution centres worldwide. Another example is a joint development by Maersk shipping network and IBM of Blockchain-based platform for smart collaboration among GVCs' partners, which makes container shipping between Africa and Europe cheaper, faster and more reliable [3].

In sum, the post-pandemic digitalization of GVCs will seemingly become a general trend allowing to radically reduce the current vulnerability of distributed production. Meanwhile, a recent pre-pandemic survey of global companies on strengthening the GVC resilience through digitalization [53] has identified ***the need for enhancing trust*** among GVC firms to ensure their efficient collaboration and transparent information exchange. An important contribution in this area can be made by the introduction of *digital platforms for interactive dialogue among GVC partners* [3]. Moreover, building resilience requires not just material investments in redundancy and new assets but also intangible investments *in strengthening each interfirm relationship throughout the GVC* [45; 54], considering that trust allows to bring down firms' negative expectations of ripples effects, similar to expectations during a financial panic.

5. The windows of opportunity for national economies

Although the COVID-19 pandemic shock caused a sharp temporary decline in international trade, including GVC-related trade (Fig. 3), it did not result in disintegration or large-scale deglobalisation of the world economy, as many politicians feared in the spring of 2020. The latest research on GVCs [38][39] offers numerous quantitate proofs that advantages of distributed production and value-added trade overweigh the risks of rippling supply disruptions in case of sudden shocks [55].[40] In other words, ***globalisation as such is not increasing the fragility of economic systems.*** Rather, the growing complexity of products and rising global uncertainty are urging decision-makers of all levels to revise their traditional perceptions of systems' sustainability, with refocusing strategic priorities from maximizing current profits to ensuring long-lasting resilience.

Indeed, in the coming decades, the world will be increasingly network-based, getting both more interconnected globally and more diversified locally. Such a world is likely to face ever more intense and cascading global shocks (epidemics, disasters as a result of climate change, failures deriving from new disruptive technologies, financial crises, etc.) that will repeatedly test resilience and adapt-

[38] *World development report 2020: Trading for development in the age of global value chains,* Washington, 2020, DC, World Bank.

[39] *Global value chains: Efficiency and risks in the context of COVID-19*, 2020, OECD Policy Responses to Coronavirus (COVID-19). doi: https://doi.org/10.1787/67c75fdc-en

[40] For example, simulations based on the OECD's global trade model show that if at the start of the pandemic governments had insisted on mass reshoring policies of global firms and on "re-localization" of GVC links to their country domains, national economies would be less exposed to foreign shocks, but they would be also less efficient in terms of productivity and less able to cushion sudden domestic shocks through international trade (see *Shocks, risks and global value chains: Insights from the OECD METRO model,* 2020, Paris, OECD Publishing.).

ability of existing systems. This implies that since 2020s, efforts for enhancing resilience will be *both the strategic imperative and the key source of competitive advantages* for all types of businesses and economies.

At the moment, GVCs are one of the first segments of the world economy, where the appliance of resilient strategies is vividly pronounced. Partly deployed by leading MNEs even before the pandemic crisis, such strategies will only gain momentum in the years ahead, generating increasingly perfect management of disruption risks. What growth opportunities and policy implications can this trend bring for national economies?

In our view, resilience strategies of global companies are redirecting globalisation towards a new historical stage — less turbulent and better arranged as compared with its previous phases. In its turn, globalisation of the 2020s, termed in literature as 're-globalisation' [4], may offer ***new development prospects for a good part of catching-up economie***s through improving their connectivity with world markets. The recent World Bank's study on GVCs[41] assumes that in the 2020s, an increasing range of countries and territories will benefit from their enlarged engagement in distributed production.

Firstly, in the next five years, the ongoing reconfiguration of GVCs and relocation of their links from present domains to other jurisdictions may involve up to a quarter of the world manufacturing facilities for traded goods.[42] Such *tremendous shifts in the global industrial landscape*. can open a chance for certain developing territories to quickly upgrade their specialisation and find a new niche in various GVCs. Upon entering the world export markets, these economies may well squeeze out the previously dominant positions of China, while China itself is expected to drift from the largest world supplier of relatively cheap intermediates to the largest end market for final consumption and sales.[43]

Secondly, the expected switching of GVCs from globally dispersed design to more compact configurations (through regionalization, nearshoring, partial reshoring, etc.) may *amplify economic integration within the world macro-regions* (Europe as a whole, Baltic Sea Region, South-East Asia, Latin American regions, etc.), which can refine their specialisation and the specialisation of their member-countries. Basically, new interconnected sub-regions and networked economic communities will increasingly appear across the world. This will make the globalized economy increasingly diversified and multipolar, thus working for closing the gap between the so-called centre and periphery in Wallerstein's terms.

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[41] *World development report 2020: Trading for development in the age of global value chains,* 2020, Washington, DC, World Bank.

[42] *Risk, resilience, and rebalancing in global value chains,* 2020, Washington, DC, McKinsey & Company.

[43] *World development report 2020: Trading for development in the age of global value chains,* 2020, Washington, DC, World Bank.

Thirdly, the prospective advance in digitalization of GVCs will be accompanied by *further servicification of the manufacturing sector,* that is, when innovative goods are increasingly exported together with supply of innovative services [56]. Moreover, the service-based globalisation is expected to increasingly outpace the emergence of new manufacturing-based GVCs.[44] This trend may allow such transition economies as Russia, who are combining their resource-based specialisation with a rapid domestic development of the ICT sector, to improve their position in world markets through integration in high-profitable service links of GVCs, rather than through shifting from present raw materials' exports to exports of higher processed manufacturing items.

Finally, what also looks promising for such countries as Russia in post-pandemic times, the R&D and other knowledge-intensive GVC nodes, earlier concentrated in developed countries, will be increasingly located in developing and emerging market economies.

However, the *realization of these development opportunities cannot be automatic*. According to World Bank,[45] in the 2020s, GVCs can continue to be a force for sustainable growth of many developing and transition economies but provided they speed up reforms to improve business climate, liberalize trade and foreign direct investment. In parallel, advanced economies are required to pursue more predictable policies to avoid trade conflicts (such as the pre-pandemic US-China conflict) and keep their markets open. All nations should take care of the ecological environment, as well as avoid the introduction of any additional trade barriers to ensure that the benefits of GVC participation are shared and sustained.

To conclude, studies on the resilience of systems go beyond the framework of traditional mainstream economics. In this sense, they refer to perspective research that incorporates insights from complexity economics [46]. Our paper touches upon some ideas of complexity but their deeper consideration in relation to GVCs and the post-pandemic world as a whole remains a subject of future investigation.

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[44] *World trade report 2019: The future of services trade,* 2019, Geneva, World Trade Organization.

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