The Future of Global Supply Chains in a Post-COVID-19 World

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SUMMARY

Supply-chain disruptions caused by the COVID-19 pandemic are of unparalleled magnitude because of a confluence of circumstances: a sudden rise in demand for some products, unforeseen shifts in demand points, supply shortages, a logistical crisis, and an unprecedentedly quick recovery in major economies. This article maps the changes that will occur in supply-chain planning and management in a post-COVID-19 world. It also reflects on the articles included in this special issue and draws key conclusions about how configurations of global supply chains might change. Automation and digitalization are likely to play a key role in these transitions.

KEYWORDS: COVID-19, coronavirus, pandemic, supply chains, resilience, reshoring, global value chains, GVCs

Millions of deaths, job losses, and a multi-trillion dollar decline in economic output. Since its outbreak, the COVID-19 pandemic has inflicted an unprecedentedly profound and pervasive shock upon our social and economic systems. The global research community and the media have been consumed by conjecturing what life will be like in what has been dubbed a *post-COVID world*. Many argue that we will live in a markedly different society; others counterargue that it is just a short blip in the passing; and those eschewing these extreme positions behold that some, but only marginal, changes will occur. Management thinkers, too, have devoted considerable energy to anticipating and analyzing the impact of the COVID-19-caused disruption on organizations, especially on the global supply chains they are part of. Long entrenched practices such as just-in-time delivery and lean manufacturing have sure led to highly efficient supply chains, but disruptions in these chains have been a major source of supply shortages of a vast

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array of products such as electronics, clothes, and toys, which saw a huge surge in demand due to the lockdowns. Although some cogs in supply chains stopped functioning for a short period only, huge spikes in demand, due to media-infused buying frenzies, led to continual shortages for many products.[1] Moreover, as the pandemic erupted, remote production facilities closed down and the mobility of goods came to a virtual halt. An average consumer, particularly in Western countries, realized that their essential supplies—such as protective equipment and medicines—came from elsewhere in the world. Their knee-jerk response, largely borne out of day-to-day frustration, was that such heavy reliance on foreign suppliers to meet daily basic needs was imprudent and that a switch to local production and supply networks was necessary.[2]

It is, however, not a matter of public outcry alone. Ninety-four percent of Fortune 1000 companies have experienced supply-chain disruptions from the pandemic, with three-fourth of them reporting negative or strongly negative impacts on their businesses.[3] In fact, large-scale supply-chain disruptions were a cause of concern even before the pandemic because of the looming environmental threats. Iceland's volcanic eruption in 2010 and Japan's tsunami in 2011 already exposed the vulnerabilities of extended supply chains.[4] Looking into the future, a McKinsey report contends that

> the probability of a hurricane of sufficient intensity to disrupt semiconductor supply chains may grow two to four times by 2040 . . . [and] the probability heavy rare earths production is severely disrupted from extreme rainfall may increase 2 to 3 times by 2030.[5]

Needless to mention, a disruption in the semiconductor supply chain can trigger a knock-on effect in a large number of prominent industries. The report models two hypotheticals to show that a *well-prepared* downstream player in the semiconductor supply chain will experience only a 5% decline in sales due to a supply-chain disruption. In contrast, an *unprepared* company will suffer a 35% decline in sales from a normal year. In this analysis, a "well-prepared" company is defined as one that does dual sourcing (i.e., sources raw materials from multiple suppliers); increases supplier resiliency through due diligence and collaboration with suppliers on asset hardening; puts in place best practice emergency procedures; and discounts cross-selling of substitute products (e.g., premium models or older product versions) to end consumers. Evidently, preparedness as well as supply-chain planning and governing could make a difference, and so it is critically important to draw lessons from companies' experiences dealing with the COVID-19-induced supply-chain disruptions to avert future pandemic disruptions or, at a minimum, handle them better.

In this editorial, we first explain how the COVID-19 pandemic impacted global supply chains. It has now become clear that a whole range of coalescing factors related to both supply and demand have led to a perfect storm, disrupting supply chains across the globe. Since the cause of the disruption is so multifaceted,

there will not be a simple solution to managing these supply chains in a post-COVID world. This special issue builds on the latest management thinking in the field of supply-chain management and global value chains (GVCs) to draw important lessons and potential solutions for persisting supply-chain disruptions. Using the insights from the five articles included in this special issue, we shed light on the critical matter of how GVCs could be redesigned to make them more resilient to future shocks. The key takeaway is that building future-fit GVCs requires fundamental changes in all four pillars of GVC, namely, geographic scope, upgrading, governance mechanisms, and company-state relationships.

How the Pandemic Impacted Global Supply Chains

Consumption Shocks

It is not an exaggeration to say that the onset of the COVID-19 pandemic triggered the most dramatic shift in consumer behavior and consumption patterns in recent history. Demand for household cleaning products, disinfectants, vitamins and health supplements, and face masks shot up due to health reasons, whereas demand for products such as home hair colors increased due to closed businesses.[6] As the pandemic unfolded, unprecedented demand patterns emerged.[7] Demand for freezers went up as many chose to buy food in bulk and freeze it. Dumbbells were in high demand as gyms were closed and people were setting up home gyms. As working from home became the norm, demand for at-home caffeine products and home-office equipment (e.g., webcams and office furniture) sharply increased. Flour was in high demand, too, due to an increase in home baking.

As the lockdowns eased, but infections continued to rise, ridesharing dropped, leading to an unprecedented rise in the demand for used cars. In many cases, points of consumption dramatically shifted: restaurants were not ordering food supplies, nor were airlines and cruise ship companies. Instead, home food intake was on the rise. Thus, even in those cases where total demand may not have changed substantially, points of demand did. This caused significant disruption to entrenched supply chains.

Supply Shortages

Supply shortages during the COVID-19 pandemic have been both a cause and a manifestation of supply-chain disruptions. Supply shortages occurred due to a host of reasons, first among which are the above-mentioned consumption shocks. Most companies were not ready to produce at the level needed to meet new demand or to deliver at new demand points. Worse yet, companies could not sustain their normal production levels. Initially, productivity declined (or halted) due to lockdowns that essentially led to a closedown of factories. At this juncture, many companies stopped ordering upstream supplies because they stopped receiving downstream orders. In some cases—especially in developing countries—factory workers returned to their hometowns, hundreds or thousands of miles away from factory locations. These two issues created disruption

because factories became devoid both of raw materials and workers, even when they began to receive orders. This created a backlog at production sites.

To make matters worse, halted production cascaded into a trade route disruption and a logistics crisis because many shipping companies reduced the number of vessels at sea to keep their logistics costs from skyrocketing.[8] While some Asian countries (e.g., China) recovered from the initial disruption and resumed supplies, Europe and North America were still reeling under the pandemic. Containers did head out to those routes, but they just got stuck there. At one point, the United States had a 40% container imbalance, meaning that for every 100 containers that arrived there, only 40 were exported back. A shortage in containers quickly resulted in increased shipping costs. According to the *Financial Times*, the price of a typical 40-foot container routed from Asia to Northern Europe has more than quadrupled during the pandemic (from $2,000 to $9,000),[9] making it cost-prohibitive for many small and medium-sized exporters and importers to continue to serve their markets. In December 2021, nearly 100 ships are estimated to have been piled up off the coast of Southern California alone.[10] This means hundreds of thousands of containers (a cargo ship typically holds between 10,000 and 15,000 containers; large ones can hold as many as 24,000). A *New York Times* article aptly sums up the relenting shipping crisis: "products are stuck in the wrong places and separated from where they are supposed to be by stubborn and constantly shifting barriers."[11] The problem is so profound that large, big-box retailers (e.g., Ikea) are acquiring their own containers, while others (e.g., Walmart, Target, and Home Depot) are chartering ships.[12] As an International Monetary Fund analysis shows, suppliers' delivery times in the United States and the European Union have hit record highs since late 2020.[13]

Unexpectedly Quick Economic Recovery

A key reason for logistical complications is that major economies had a quick bounce back from the pandemic-induced economic decline. In the United States, for example, the National Retail Federation's Global Port Tracker estimates an 18% increase in the volume of goods imported in 2021 relative to a normal year. Although the economic recovery has been uneven, many consumers have accumulated savings during the pandemic, driving high demand: new home sales are at their highest level in 14 years and auto sales are at their highest level in 15 years.[14] At a global level, imports and exports of major trading economies experienced a significant increase in the first quarter of 2021. Notably, China, India, and South Africa have been at the forefront of economic recovery. In fact, China's exports increased not just from 2020 levels but even from pre-pandemic levels.

According to UNCTAD economist Alessandro Nicita,[15] "Global trade has recorded a faster recovery from the recession caused by the pandemic than in the last two trade recessions," worsening an already imbalanced demand-supply equation. Nicita says, "it took four quarters after the start of the pandemic-induced recession for world trade to return to pre-recession levels." By the fifth quarter—Q1 2021—global trade was higher than pre-crisis levels, with an increase of about

3% relative to the fourth quarter of 2019. By contrast, it took 13 quarters for global trade to recover from the 2015 recession, which resulted from structural changes in East Asian economies and declines in commodity prices, and nine quarters to bounce back from the 2009 recession caused by the global financial crisis. There was a quick bouncing back of global trade after the pandemic disruption relative to previous economic downturns.[16] Evidently, the fiscal stimuli that most major economies injected into their systems gushed them out of an economic slump, but it widened the chasm between how much consumers demanded and how much companies were able to supply.

A Perfect Storm of Supply-Chain Disruption

Dramatically quick changes in consumption patterns, persistent supply shortages, and a swift economic turnaround all coalesced to create a perfect storm that even companies with the most sophisticated supply chains could not withstand. A July 2020 survey of senior supply-chain executives reveals that 93% plan to increase supply-chain resilience; 54% expect changes to supply-chain planning; and a staggering 90% plan to enhance digital supply-chain talent in-house. When asked how resilience can be increased, 53% say through dual sourcing of raw materials; 47% say through increasing inventory of critical products; 40% emphasize near-shoring and increasing supplier base; and 38% say through regionalizing supply chains. When asked what specific changes they foresee in supply-chain planning, 58% say centralized supply-chain planning; 50% say faster sales and operations planning (S&OP) cycles; and 60% say use of advanced analytics. Finally, when asked how they plan to increase digital supply-chain talent in-house, 70% say through reskilling current employees, whereas 55% say through new recruitments.[17]

A follow-up survey was conducted a year later (in the second quarter of 2021).[18] At this point, the vast majority of executives (about 92%) say that they had already taken steps to make supply chains resilient. However, they could meet (or exceed) the intentions they stated a year ago in the inventory increase category only. Not many executives could pursue regionalization and reshoring, although 60% of the executives surveyed from the health care sector say that they had regionalized supply chains. Regionalization trends were much less common in the automotive sector (about 22%) and even lower in the chemicals and commodity sectors. Overall, though, almost 90% of executives surveyed in this mid-2021 follow-up "expect to pursue some degree of regionalization" within the next three years.

Why Bringing Manufacturing Back Home Might Be Misguided

Calls to Create Resilient Supply Chains through Reshoring and Regionalizing

Against this backdrop of a multifaceted supply-chain disruption, it is not surprising that there have been many calls for rethinking how countries should organize global supply chains to reduce the heavy reliance on foreign suppliers

and bring production activities back home. At some level, these sentiments to make supply chains more resilient by regionalizing and reshoring manufacturing are compelling. In fact, they resonate with earlier calls from economists, geographers, and development scholars who have long made the case for a need to consider shortening supply chains. These sentiments have also influenced government policies. On February 24, 2021, President Biden issued an executive order to make U.S. supply chains more resilient:

> The United States needs resilient, diverse, and secure supply chains to ensure our economic prosperity and national security. . . . Resilient American supply chains will revitalize and rebuild domestic manufacturing capacity, maintain America's competitive edge in research and development, and create well-paying jobs. They will also support small businesses, promote prosperity, advance the fight against climate change, and encourage economic growth in communities of color and economically distressed areas.[19]

Infusing a national security narrative in the analysis of supply-chain disruptions is an intriguing phenomenon that has both economic and geopolitical underpinnings. Unsurprisingly, then, the Biden administration has continued with its emphasis on reshoring. In June 2021, the White House issued a report that systematically assesses supply-chain vulnerabilities in four critical product categories: semiconductor manufacturing and advanced packaging; large capacity batteries (e.g., those used for electric vehicles); critical minerals and materials; and pharmaceuticals and advanced pharmaceutical ingredients. The report raises several concerns: insufficient U.S. manufacturing capacities; misaligned incentives and short-termism in private markets; aggressive industrial development policies of other countries, especially China; geographic concentration in global sourcing; and limited international coordination.[20] The report makes numerous recommendations, which, in the final analysis, boil down to increasing domestic production capacities in these areas. Furthermore, the Biden administration has identified six industrial base sectors that are being assessed from a supply-chain resilience perspective. These industrial base sectors are defense, public health and biological preparedness, information and communications technology, energy, transportation, and supply chains for production of agricultural commodities and food products.

The Impracticalities of Reshoring and Regionalizing

The push for reshoring is only one side of the story, though. Uprooting and upending entrenched global supply chains might neither be practical nor benignant for global society. While Biden's executive order was received with some enthusiasm, supply-chain experts and industry groups were skeptical and called it naive for showing a lack of understanding of the sheer complexity of supply chains, especially those of pharmaceuticals.[21] Reshoring manufacturing is not practical because a large-scale economic localization would require a radical overhaul—in fact, reversal—of the global economic system, which is a quixotic idea. Let us be mindful that it was because of global supply chains that the shortages of face masks, personal protective equipment (PPE), and critical medical

supplies (e.g., ventilators) could be overcome in a relatively short timeframe and that COVID-19 vaccines are available in practically all parts of the world.

Dismantling global supply chains would also cause immense economic and social hardships for many countries that rely on international trade as they leverage their unique competitive capabilities to deliver goods and services globally.[22] Glimpses of such hardships were evident when export-reliant production facilities in developing countries shut down due to the pandemic. A recent survey of Bangladeshi garment suppliers reported that a widespread cancelation of orders, where buyers refused to pay for the costs that suppliers had already incurred, had devastating consequences for garment workers. The workforce was rendered unemployed without any financial safety net.[23] Dismantling global supply chains would sever sustainable development in those countries where most of the world's impoverished population resides. This would dampen the poverty eradication agenda as well as efforts to promote gender equality in those areas, as female workers in supply chains have been disproportionately affected by the COVID-19.[24] The economic, social, and technological advancements in these countries hinge upon effective participation in the global economy. Global supply chains afford them these opportunities. The issue of significance, then, is not whether we should reduce our reliance on global supply chains in a post-COVID world. Rather, it is the lessons we can learn from the COVID-19 experience to make global supply chains more resilient, so they can restore functionality after any disruption in the future, and more robust, so they remain functional during such future disruptions. The focus should be on redesign, not on abandonment of global supply chains.

A Global Value Chain Analysis of COVID-19-Induced Disruption

Global Value Chains: A Primer

Long before the pandemic started, a redesign of global supply chains and its consequences for the developmental trajectories of industries worldwide was already a topic of interest to scholars who study what is referred to as global value chains (GVCs). A GVC is a form of organizing economic activities that emerged out of the ashes of the Fordism model and is characterized by a functional integration of activities of independent yet interconnected companies worldwide. A GVC perspective on global supply chains highlights the need to go beyond analyzing single companies and reckon with the interconnected network of companies involved in the production and supply of products and services. It thus provides a useful perspective to understand the impacts of a global crisis like the COVID-19 pandemic. GVC scholars have long been discussing the need to redesign supply chains because a changing world economic order, changing geopolitical dynamics, and looming threats from climate change and biodiversity collapse had already signified imminent—and to an extent, ongoing—changes in GVCs. The COVID-19 pandemic has accelerated these conversations and forced us to think, more urgently, about whether and how we can develop more resilient, and possibly better and more equitable, GVCs.

Starting in the 1960s, when several major corporations shifted their production abroad, GVCs have emerged as a key feature of the global economy.[25] An increasing number of products and services are now ushered to end consumers through GVCs. What used to be produced locally can now come from anywhere in the world. Even seemingly simple products pass through many tiers of suppliers located in countries across the world. Pre-production, production, and post-production activities take place within complex networks that span national borders.[26] Take the example of the hazelnut spread Nutella,[27] produced by the Italian firm Ferrero. While it has only a few key ingredients—cocoa, hazelnuts, and palm oil—these come from various countries in Africa, the Middle East, and Asia and involve numerous suppliers. While each GVC is composed of numerous suppliers across several tiers, powerful lead firms like Ferrero, Apple, and Ikea are at the helm of these networks. Lead firms orchestrate the global networks in their search for efficiency and flexibility gains, impacting not only the trajectories of their suppliers, but also of whole industries—as the standards they impose on their suppliers spread widely, also affecting sub-suppliers, which are often subject to the same audits as first-tier suppliers. Participating in those global networks often represents an important economic developmental opportunity for the countries from which they source the raw materials and the intermediate or final products sold worldwide under the lead-firm brand name.

Notwithstanding the economic benefits GVCs generate, they increase trade interdependencies that can render them vulnerable to external shocks. This is precisely what happened when the COVID-19 pandemic erupted. While fingers are often pointed at lead firms' push for efficiency (the core principle governing GVCs) as a major cause for disruption and supply shortages, undoubtedly this push is only one of the many reasons for disruptions. Indeed, the pandemic has affected GVCs, but in what way exactly and how deep and lasting these effects will be is not so clear. Will these effects lead to an end of the GVC as the dominant system to organize economic activities, or will changes be of a much lesser magnitude? We suggest that answers to these questions can best be explored by looking into the four pillars of GVC analysis: geographic scope; upgrading; governance; and state-firm relationships.[28]

Planning the Geographic Scope of GVCs

The first pillar pertains to the decision as to where to geographically locate processes and activities involved in the global value chain.[29] This decision concerns how a lead firm geographically distributes activities based on locational advantages, either due to (cheap) labor or access to valuable resources. However, the pandemic has made evident that lead firms' exploitation of locational advantages comes at a cost, especially in complex and lengthy GVCs.[30] It makes economic systems vulnerable, as any disruption along the value chain can stop the supply of products. Interestingly, as Kano, Narula, and Surdu argue (in this special issue), lead firms' locational choices were already undergoing remarkable shifts before COVID-19 struck. These shifts are attributable to various factors such as a changing socio-economic context, technological advancements, geopolitical

dynamics, internal political environments, and, indeed, lead firms' own strategic responses.[31] In 2018, for example, Apple signaled a noteworthy geographical reorientation by committing to invest $30 billion in capital expenditures with an aim to create 20,000 new jobs in the United States[32]; while Walmart, heralded as the icon of geographical distribution of production, recently made a $350 billion commitment to reshoring production back to the United States.[33] Even if a reshoring trend is not new,[34] the question remains whether COVID-19 has further altered our thinking about the appropriate geographical scope of GVCs.

The articles in this special issue provide several answers. Gereffi, Pananond, and Pedersen argue that choosing the right geographical scope to ensure resilience very much depends on the nature of the products mobilized through a specific GVC. Analyzing the GVCs of four medical supply products, they show how for relatively simple products like rubber gloves, the objective to achieve operational efficiency—that is, low cost, high volume—has kept production activities offshore. For more complex products like ventilators and vaccines, though, national security concerns have been more prevalent. Here, governments have exerted pressure on lead firms to reshore activities that were previously performed by offshore suppliers. Phillips, Roehrich, and Kapletia argue that reshoring is easier nowadays due to the availability of new production technologies that support redistributed manufacturing such as additive manufacturing and micro-factories, which enable production close to the point of need. For GVCs to change their geographical scope and move manufacturing closer to the point of consumption is not only a matter of responding to disruption, therefore, but also of seizing an opportunity granted by new technologies that give more control over the supply chain.

While Kano et al. also note an increased influence of national security concerns on location decisions, they still expect actual reshoring to be limited. Reshoring is simply too costly for GVCs that are capital-, knowledge-, or natural resource-intensive. They argue that lead firms' location choice is based on a unique blend of locational advantages, not easily replicated elsewhere. Lead firms have not moved production to offshore locations simply to cut costs but for strategic reasons such as accessing know-how and tapping into lucrative growth markets. Recently, Elon Musk reiterated Tesla's intentions to further expand investments in China, for example, claiming the country is a "global leader in digitalization."[35] Presence in China is an imperative for Tesla so it can be at the forefront of R&D for digital technologies and boost sales.

Ryan, Buciuni, Andersson, and Giblin found that, for some companies, reshoring might not be necessary. Based on a longitudinal case study of medical technology firm Medtronic, they show how this lead firm has managed to create a balance between efficiency and resilience by putting trust in one foreign subsidiary to maintain supply to the United States, even when the pandemic hit. It provides a good example of Kano et al.'s argument that good managerial governance can be instrumental in both keeping GVCs efficient and making them more resilient. Sytch, Kim, and Page's findings further reinforce this argument. Their

simulation model shows that regionalizing supplier selection can significantly enhance the robustness of GVCs. Interestingly, this includes not only choosing suppliers geographically close to lead firms, but also suppliers close to current suppliers. The case of Apple aptly illustrates this logic: while Apple made a move toward diversifying its supply chain away from China, it nevertheless kept its suppliers in the region by mainly moving to other Southeast Asian countries.[36] If lead firms are indeed to go for further regionalization along such a trajectory, COVID-19 could become a catalyst for another ongoing trend: polycentric trade, particularly South-South transactions, and intensification of intra-regional trade,[37] especially in the context of Asia and the Pacific.[38] Still, China remains the most important production location for Apple because the country has managed to recover so quickly from the pandemic.[39]

Clearly, it would be ingenuous to conclude that occasional sights of reshoring, even if recurring, signify an imminent de-globalization. Decades of offshoring have so profoundly shaped specialization capabilities of specific locations and regions that a complete reversal to local or regional production seems implausible.

> The COVID-19 pandemic could catalyze reshoring in some regions and in some product categories, but GVCs are here to stay.

Upgrading in GVCs

The second pillar of GVC analysis is upgrading. Upgrading is typically understood as building capacities of developing countries' suppliers thanks to the engagement with lead firms. Suppliers learn how to perform higher value-added activities, moving, for example, from being an Original Equipment Manufacturer (OEM) to an Original Brand Manufacturer (OBM).[40] Participating in GVCs provides profound learning opportunities for firms in developing regions and a channel for technological advancement and economic development. For example, Apple's decision to move its iPhone supply chain to China many years ago led to an upgrading of local suppliers. As these suppliers also started to provide their services to domestic smartphone manufacturers or developed their own brands, this move eventually helped the Chinese smartphone industry to become world-leading.[41] Upgrading can take different forms (i.e., product, process, or functional),[42] but they all seek to develop suppliers' capabilities and enable them to better compete within GVCs. Upgrading allows suppliers to capture a higher share of the value created along GVCs. The question arises whether the pandemic will change the dynamics of upgrading or whether it might lead to a downgrading of capabilities instead?

Kano et al. get to the heart of this question. The authors foresee that suppliers' capabilities related to information sharing, dependability, and agility are gaining importance, while capabilities for efficiency are given room. A shift away from efficiency would have significant consequences for who gets to participate in GVCs. If the focus on efficiency leads to a consolidation of production within large transnational first-tier suppliers,[43] we would expect lead firms to start diversifying

their suppliers to better manage supply-chain risks. This diversification could create space for smaller suppliers in developing countries. Furthermore, Sytch et al.'s simulation results show that lead firms' quest for more robustness could be achieved by further regionalizing supplier selection. These results reinforce the idea that a wider set of suppliers in developing countries could benefit from lead firms' attempts to get better at managing disruption in a post-COVID era.

However, upgrading is not necessarily beneficial only for suppliers in developing countries. As Phillips et al. show, technological advancements in redistributed manufacturing and small-scale local production have enabled lead firms to produce close to the point-of-need. In fact, this trend was already growing when the pandemic struck.[44] Recently, Roland Busch, the CEO of Siemens, argued that "[a]utomation is the great equalizer that makes European and U.S. factories more economically attractive."[45] Looking into the future, Phillips et al. predict a rise in what they call the "Local Customizer." Instead of facilitating supplier upgrading in developing countries, these technological advancements could create new local suppliers in Western countries that provide customizable products at a low cost. An interesting example is Packhelp, a custom packaging design platform from Poland.[46] Packhelp provides custom packaging to customers, mainly across Europe, with batch sizes as low as 30. The company, founded in 2016, has benefited from the pandemic as it has become an important supplier for the booming food deliveries business.

Phillips et al. argue, too, that COVID-19 has laid bare another trend that could bolster an upgrading of local suppliers in Western countries: increased concerns about social and environmental sustainability. Global lead firms that have experienced the effects of the pandemic might also realize the need to make sustainability concerns more central and to reduce their global footprint. Upgrading local production could help them achieve this goal. Ryan et al.'s case study of Medtronic shows that upgrading does not apply only to external suppliers. They show that Medtronic effectively applied the process of upgrading to one of its own internal subsidiaries located in another Western country. In a similar vein, Kano et al. also suggest that COVID-19 might become a catalyst for better working conditions along GVCs and that cooperation and knowledge-sharing with stakeholders might lead to social upgrading.

> Efficiency will no longer be the core tenet of upgrading; technology-enabled customization and enhancing suppliers' risk management capabilities will grow in importance.

Governing Value Chains

GVCs are essentially dynamic systems that transcend a company-centric perspective of value creation, capture, and sharing. The third pillar of GVC analysis involves understanding not only the activities that create value, but also their appropriation along the chain. Previous research shows that value is distributed unevenly across the chain.[47] Take Apple's iPod value chain as an illustrative example. Apple as the lead firm gains the most value, whereas iPod producers that

manufacture or assemble the product receive a far more modest share. Lead firms hold not only advanced technological capabilities, but also the ability to shape consumption owing to their brand recognition, market savvy, and consumer insights. Due to this extraordinary power inequality in GVCs, lead firms essentially govern the upstream chain by implementing captive, relational, or modular governance. They decide what is produced, by whom, and under which circumstances. Will COVID-19 drastically change this entrenched practice in GVCs?

Of course, the word "drastically" does most of the heavy lifting in this question, but none of the articles in this special issue considers this a plausible outcome of the pandemic. Indeed, power dynamics might change, especially because supplier selection is likely to be based on new parameters and the number of suppliers having desired capabilities might not ramp up fast enough. Still, all these articles do stress a need for GVC redesign to improve resilience and robustness. The governance structure could thus shift away from a dependence on market-driven relationships toward a higher degree of explicit as well as informal coordination between lead firms and their suppliers, a trend already in place given the mounting pressure on lead firms for higher social and environmental performance.[48] Kano et al. argue that lead firms should pursue both large-scale structural changes while also making finer-grained managerial governance adaptations. They argue that there is a need to facilitate suppliers in learning how to manage disruption. Lead firms will have to become more "developmental" in their GVC governance structure because supplier inertia in adjusting to disruptions puts the whole GVC at risk. They provide an intriguing example of the semiconductor firm ASML that engaged in value sharing with suppliers. Instead of squeezing suppliers, this lead firm allowed them to have a healthy part of the profit. Due to these beneficial contractual terms, suppliers are more inclined to prioritize the lead firm's interests in times of crisis, thereby improving the GVC's resilience. Ryan et al.'s case study shows that Medtronic also put more trust in a capable international subsidiary, which enabled their GVC's resilience when COVID-19 hit. At the same time, suppliers in automobile industries are receiving the shorter end of the stick despite automakers making higher profits due to rising retail prices.[49] Some suppliers are beginning to assert their concerns and demanding contract renegotiations. For example, Michigan-based Cooper-Standard Automotive is asking for a price increase totaling approximately $100 million.[50]

> Governance mechanisms balancing power dynamics between lead firms and suppliers are likely to gain greater prominence.

State-Firm Relationships

The final pillar of GVC analysis pertains to the role of the state in GVCs. How do lead firms manage their relationships with the state in co-governing GVCs, and how does state action influence the functioning of GVCs? As GVCs have profoundly important roles in social, economic, and industrial development in modern societies, they operate within expansive policy frameworks that include hard laws and soft laws. These laws can be macro-level such as a

country's foreign direct investment policies, and micro-level such as stipulations about waste disposal in a particular community.[51] Furthermore, these laws can be both prohibitive and facilitative for GVCs. Will state-firm relationships change in a post-COVID-19 world, as initiatives taken by various governments at the peak of the pandemic would suggest?

Two articles in this special issue explicitly address this question. Gereffi et al. explicate that the state can play various roles in GVCs, either indirectly serving as a facilitator and regulator, or more directly as buyer and producer. They note that state-firm relationships underwent a remarkable shift during the pandemic. Throughout the world, the state ramped up its role as buyer of medical supplies, facilitator of local industry, and producer of vaccines. It is more doubtful, though, whether this heightened influence would sustain in a post-COVID world. When the urgency diminishes, it would no longer be viable to produce relatively simple products like face masks in high-wage countries. Moreover, the authors note that state intervention might hinder resilience, too. In the case of vaccines, state intervention was partly motivated by so-called "vaccine nationalism," which distorted the normal functioning of GVCs.

Kano et al. approach the issue of state-firm relationship from a management perspective instead. They are hopeful that COVID-19 can catalyze better working conditions throughout GVCs as lead firms take on more responsibility to help affected communities recover from the pandemic. They also call for lead firms to engage in corporate diplomacy to strengthen relationships with stakeholders, including governments. A conspicuous example here is unprecedented collaborations that have spurred in the R&D realm between firms and non-market stakeholders such as government institutes and universities to develop vaccines and medical equipment. Their argument is well aligned with the broader case for enlightened self-interest that corporate social responsibility scholars have long been making—which, of late, has taken a notable turn toward corporate political responsibility.[52] Thus, lead firms would likely enhance their broader engagement with the state, and the state itself is likely to be a more engaged GVC participant in the future.

State involvement in GVC governance is likely to deepen.

Visualizing Tomorrow's Supply Chains

How would supply-chain management practices be different in a post-COVID 19 world? Profoundly different, we think. Not only do we expect meta-level changes through GVC reconfigurations, as elucidated above, but, more critically, we think also that these meta-level changes will shape supply-chain management practices both in the near and long term.

The foremost change we expect to see is a rather paradoxical co-evolution of surveillance and collaboration wherein companies will be more watchful of their suppliers' actions and capabilities while collaborating with them to strengthen

their capabilities. Developing visibility into suppliers' inventories and actions will be a key priority for companies. This can best be achieved through technology-enabled integration. It is in this vein that the Dutch clothing retailer G-Star RAW signed on to Nedap's new iD Cloud platform, which uses the radio-frequency identification (RFID) technique to gather all inventory data into one place to create full inventory visibility across the supply chain.[53] This will be a marked difference from the current reality wherein, according to a recent survey, a meager 2% of companies have visibility into their supply chains beyond the second tier.[54] In fact, sometimes companies do not even know the country of origin of their products.[55] This problem is compounded by rampant unauthorized subcontracting in many sectors and parts of the world.[56]

We expect companies to also strengthen demand forecasting capabilities, something that went amiss in handling the COVID-19 induced supply-chain disruptions. The role of machine learning is critically important in this realm. Machine learning (ML) tools can pick changes in retail trends in as short a timeframe as three-to-four weeks and swiftly adjust demand projections.[57] Investing in developing in-house ML capabilities will be important for supply-chain resilience. More broadly, investment in automation to bolster such technologies as the Internet of Things, cloud computing, and 5G can make it possible to create new sources of data from the physical attributes of a supply chain (e.g., machine vibration tolerance, truck route deviations). Furthermore, artificial intelligence (AI) and robotics can help in improving efficiency and productivity.[58] Splice Machine, a San Francisco-based company, has created a predictive platform that follows a learn-predict-plan-and-act cycle to inform inventorying decisions.

We also anticipate increased investments in the development of "micro-supply chains" that are characterized by "finite, decentralized, agile "mini operating models," with flexible supplier contracts and relationships, and manufacturing closer to the point of purchase."[59] Micro-supply chains can help companies reduce complexities and avoid long-term contractual commitments. These ad hoc arrangements proved to be extremely useful in meeting unusual demands for personal protective equipment, and demand in other sectors as well. We do not expect micro-supply chains to emerge as primary strategies but rather as parallel, complementary approaches to handle the COVID-19 pandemic like *just-in-case* scenarios. Some companies, we think, will also adopt product restructuring strategies, similar to what Mondelez did in handling the pandemic-caused supply-chain disruptions. Although demand for Mondelez's products was rising during the pandemic, operating expenses to manage supply chains were causing concern and eroding profit margins.[60] The company decided to reduce its stock-keeping units (SKUs) and focus on the most important ones. CEO Dirk Van de Put announced cutting 25% SKU counts (representing just 2% of the company's sales) to reduce costs, complexity, and inventories. In addition, the company sought to leverage its direct-store-delivery (DSD) capabilities, which, according to CFO Luca Zaramella, give the company a unique advantage.[61] Other food sector companies (e.g., Coca-Cola and Proctor & Gamble) also focused on an SKU reduction strategy during the pandemic to simplify their supply chains.

Finally, we envisage lasting transformations in last-mile delivery strategies. E-commerce deliveries increased by 25% in 2020 with a sizeable proportion of this increase likely to persist in a post-COVID 19 world.[62] Despite a 38% drop in total sales during the fourth quarter, Nike's digital sales grew 75% owing to targeted efforts to leverage its online sales platforms and capabilities.[63] Relatedly, investments in autonomous delivery vehicles (ADVs) are increasing. Nuro, an American robotics company that develops such vehicles, recently raised $600 million from a group of investors that includes such prominent companies as Kroger and Google.[64] Nuro aims to transport e-commerce orders to customers without relying on human workers, an automation trend we expect to see rising throughout supply chains. Changes in last-mile delivery strategies are also leading to innovative collaborations. For example, the United Kingdom's grocery giant Tesco recently entered into a partnership with Germany-based Gorillas to use the latter's mini-warehouses in the London area so that Tesco can reduce the shopping time for its customers.[65] Startups that could deliver goods from small warehouses to end consumers in population-dense areas within a few minutes have sprung up in many parts of Europe.[66]

At the time of this writing, in December 2021, a post-COVID-19 world is more a hope than an expectation. The emergent newly discovered Omicron variant is pushing the world into yet another episode of uncertainty. Amid many uncertainties, one thing can be said with certitude: the long-held tenets of managing and governing global supply chains will give way to new practices.

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