

The Invasion of Ukraine by Russian Troops: A Violent Shock for Supply Chains

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Abstract

Since the outbreak of the war between Ukraine and Russia in February 2022, supply chains have been deeply disrupted, notably with the multiplication of shortages and the significant increase in the price of many components and raw materials. It is possible to talk about a violent shock for supply chains, especially for European companies, whose sources of supply, but also their means of transport, suffer from insufficient capacity to meet their needs. The objective of this research note is to propose a summary of the issues at stake and to examine the possible reconfiguration of supply chains at the end of the conflict, in the context of a “new normal”. To do so, the author relies on secondary data dedicated to the supply chain dimensions of the war between Ukraine and Russia. This study aims to contribute to the understanding of how companies can be resilient in the face of an external shock, thus preparing themselves to better manage the next shocks they may face.

Keywords: Crisis, France, Global value chain, Shortage, Supply chain, Ukraine-Russia war.

1. Introduction

In the middle of November 2021, the possibility of war on Europe’s doorstep is beginning to be discussed in the chancelleries of several countries. American and French diplomatic officials are concerned about a disturbing Russian military activity on the border between Russia and Ukraine. Indeed, U.S. satellites confirm the deployment of several tens of thousands of military personnel just a few miles from Ukraine, leading to multiple diplomatic attempts to avoid conflict. Several political leaders, including French President Macron, negotiate with President Putin for many weeks, until the morning of February 24, 2022, at 5:48 AM (Moscow time). Sitting behind his desk in the Kremlin, President Putin announced in a TV address the beginning of the Russian invasion: “I have made a decision on a special military operation”. He emphasized the urgency of a “denazification of Ukraine” and the cessation of the “genocide” orchestrated by the Ukrainian authorities against the pro-Russian separatists in the Donbass, in the east of the country. The intervention of President Putin marks the beginning of the war in Ukraine and the first bombings of Kiev, Mariupol, Donetsk, Kharkiv and Odessa. Convoys of Russian troops entered the country from the north, the east and the annexed Crimea.

While history books will certainly devote many pages in the coming years to the geopolitical dimensions of the war between Ukraine and Russia, we can also imagine that supply chain management studies will focus on the logistical impacts of a shock of unprecedented violence for global value chains, which have been weakened for many months by the Covid-19 health crisis. To escape the war zones, companies have adopted a strategy of bypassing the west, via Scandinavia, or the east, via China, with a direct consequence: higher costs and limited and uncertain transport capacities. In a world that is more vulnerable, uncertain and complex than ever, supply chains must become more resilient and be able to adapt permanently to major risks, both health and geopolitical. The objective of this research note is to propose a first reflection on how the war between Ukraine and Russia impacts supplies chains in depth, notably with the multiplication of shortages that we will have to learn to manage, at the cost of a possible total reconfiguration of supply chains in the “new normal”.

2. Shortages Description

Over the last 20 years, major crises have occurred, with significant impacts on the organization and management of supply chains: the eruption of a volcano in Iceland in March 2010, the violent tsunami in Japan in 2011 and, of course, the Covid-19 crisis from the beginning of 2020 to name only the most significant crises.

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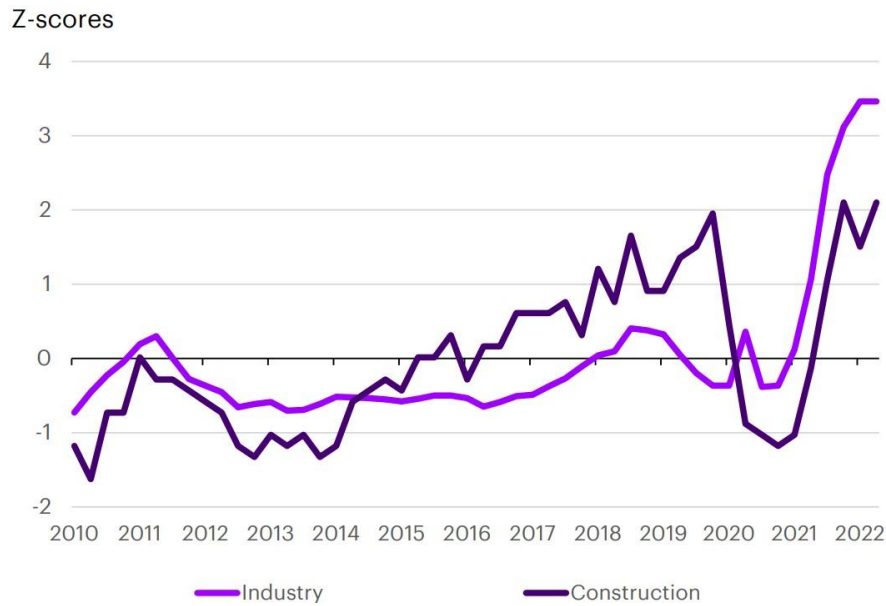
These events have highlighted the difficulty supply chains have in coping with external shocks without causing –more or less– lasting stockouts, a sharp increase in lead times and a corresponding deterioration in service levels. The dysfunctions are mainly of two kinds: (1) a shortage of raw materials and components, following the reduction in the industrial capacity of many suppliers; and (2) logistical restrictions on product transport, given the limited access to the affected areas. These problems are not new, as many past crises have had the same impacts (Ponis & Ntalla, 2016). However, the acceleration of the globalization of value chains is leading to serious consequences that are spreading extremely rapidly across entire continents. Russia's invasion of Ukraine is no exception to the rule.

Following the invasion, the first shortages were felt in Europe for convenience goods. The blocking of Ukrainian ports on the Black Sea prevented the country from exporting its food products. The country, which before the war exported 98% of its grain via the Black Sea, had to urgently seek alternative routes. Rail transport was considered for a time, but the rail gauge differences between Poland (4-foot 8.5-inch broad gauge track) and Ukraine (5-foot broad gauge track), inherited from the Soviet era, complicated the transfer between sea and rail, since the wagons had to be unloaded and reloaded on the Polish side, about 30 minutes per wagon. In addition to Poland, Ukraine is negotiating with the Romanian port of Constanta on the Black Sea to export grain, but again, part of the journey must be made by train to river ports on the Danube. The cost of shipping to Constanta is estimated at US\$120-150 per ton, compared to the pre-war cost of US\$20-40 per ton to ship wheat to Ukrainian ports. The Ukrainian economy is dependent on its exports, particularly agricultural exports: grain sales brought in US\$12.2 billion in 2021, or one fifth of the total volume exported, and any deterioration in competitiveness due to a price increase could have a dramatic impact on sales.

The invasion of Ukraine, and the political sanctions adopted against Russia by the international community in response, however, are impacting supply chains far beyond the Ukrainian area. Within a few days, the outbreak of war disrupted the transport of products throughout the European Union. Germany, which supplies one third of the products purchased by Russia from the European Union, is particularly affected in various sectors of activity, especially in the automotive, machine tool, chemical, pharmaceutical and energy sectors. The road transport industry in Germany is indeed experiencing a major shortage of truck drivers, as Ukrainian drivers, who are largely present, have returned to their families or are engaged in the defense of their country. Other countries are also affected. In Poland and Lithuania alone, the authorities grant tens of thousands of work-permits each year to Ukrainian drivers, who have become indispensable for ensuring the security of supplies in Central Europe. Since the outbreak of the crisis, most of them have returned to Ukraine.

The violent shock to supply chains is not limited to basic agricultural products, such as cereals, or to road transport. On the contrary, as the study conducted by Accenture on material shortages in May 2022 shows, it is a rising concern for many industrial activities (Ollagnier *et al.*, 2022). Figure 1 shows the evolution of European top managers' concern about material shortages in industry and construction since 2010. For this, a Z-score as a numerical measurement is used; it describes a value's relationship to the mean of a group of values and indicates the extent to which reported shortages have risen by historical standards. The results show that the concerns of top managers are much higher than they were during the Covid-19 crisis, while academic works spoke of major risks of paralysis of global value chains (Ivanov & Dolgui, 2020). The war between Ukraine and Russia therefore presents a much higher level of potential disruption that questions many companies about the emergence of a "new normal". The reason for this is probably that top managers had much more trust in 2020 in the ability of scientists to find medical treatments for Covid-19 than in the ability of Presidents Zelensky and Putin to find common ground in 2022 to stop the fighting.

Figure 1. Material shortages: A rising concern in Europe



Source: Ollagnier *et al.* (2022).

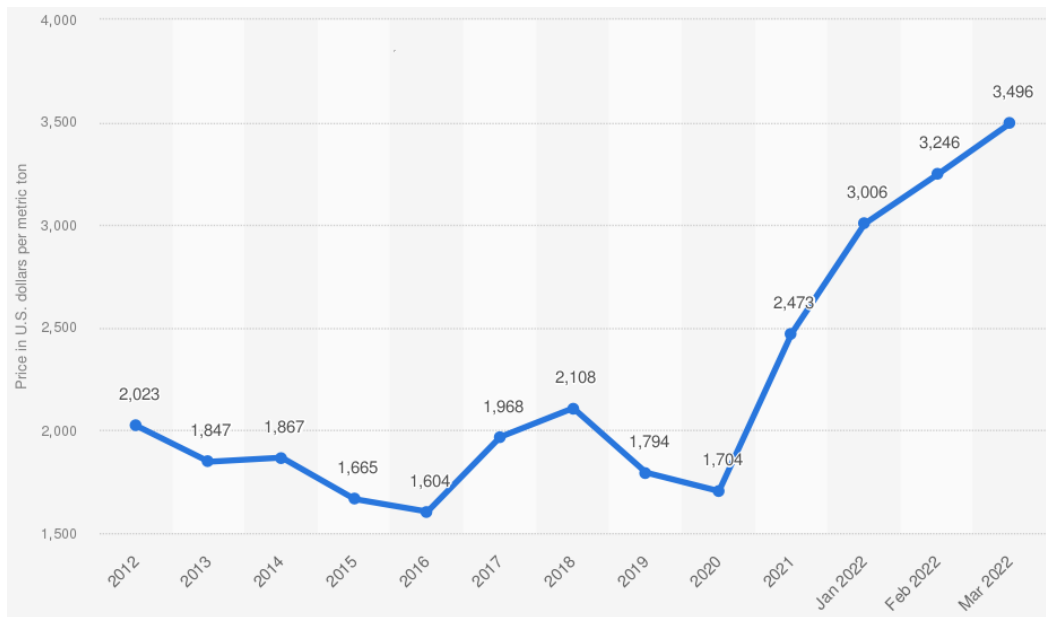
The concern of European top managers as expressed in the analysis of Ollagnier *et al.* (2022) seems to be confirmed by the facts. Indeed, the manufacturing industry will have to find other sources of supply than Russia for palladium, ruthenium, iridium and rhodium; these rare metals, which are certainly present in South Africa, are used in fuel cells and hydrogen electrolyzers. As for the European aeronautics and shipbuilding industries, they remain highly dependent on Russian titanium. Simchi-Levi & Haren (2022) cite the case of neon gas, used massively in the manufacture of semiconductor chips. Ukraine supplies about 50% of the world's neon gas, which highlights the scale of future shortages in the event of a lasting conflict. Gas imports from Russia, which remain moderate but receive remarkable media coverage (Geletukha *et al.*, 2022), do not ultimately pose a significant risk to European gas-intensive industries (chemicals, fertilizers, glass, cement, paper, etc.). It should be noted, however, that the effects of shortages have already been evident since the spring of 2022, as Volkswagen and BMW have been forced to reduce their production levels due to a shortage of electrical harnesses, with Ukrainian suppliers have stopped manufacturing them (Campbell & Miller, 2022).

3. Financial Impacts

It would be clumsy to attribute the significant rise in oil prices solely to the war between Ukraine and Russia. The impact on supply chains is obviously significant, with consequences for the cost of transport; the price of a container shipment from Ningbo, in the eastern Chinese province of Zhejiang, to Los Angeles was around US\$20,000 just before the Russian invasion –compared to US\$1,000 in January 2020– and is expected to rise significantly. This has a huge impact on manufacturers in all sectors of activity, as they will have to pass on the additional costs to their customers, taking the risk of no longer being able to pursue a sustainable strategy of cost leadership in the sense of Porter (1980). But in highly competitive supply chains, such as the automotive industry, it is the increase in the price of many components and raw materials that represents the greatest danger. For example, although it is essential for the creation of catalytic converters for motor vehicles, the price of palladium rose by 80% one month after the start of the conflict between Ukraine and Russia (Kilpatrick, 2022).

We can cite dozens of other examples of price pressures and, by mechanical effect, a return to a period of high inflation (in Germany, the inflation rate in April 2022 reached the historic level of 7.4% over one year). These developments are due to a drying up of supply while demand remains high. European aluminum production is thus highly dependent on alumina imports from Russia and the dominant supplier Rusal. In March 2022, the price of a ton of aluminum traded above US\$3,400 per ton for the first time, compared to US\$2,400 at the end of 2021 (see Figure 2). Given that manufacturers have little stock on hand –as direct consequence of their well-known just-in-time logistics policy– the repercussions are almost immediate for many products, such as soft drink cans. Russia is also a major producer of copper (for electronics and construction), nickel (for electric batteries and steel manufacturing) and synthetic rubber (for tires), raw materials whose prices have risen significantly in a few weeks.

Figure 2. Average aluminum prices from 2012 to March 2022
(in US\$ per metric ton)



Source: Statista (2022).

Early macroeconomic projections provide important data on the financial impact of the difficulties experienced by supply chains following Russia's invasion of Ukraine. According to Ollagnier *et al.* (2022), a cumulative loss of GDP in the order of US\$910 billion is likely in 2023 for the Eurozone as a whole, or about 7.7% of GDP. The authors note that shortages in supply chains due to Covid-19 had already cost the Eurozone US\$110 billion in GDP losses by 2021. Prior to the war triggered by Russia, difficulties in the supply of raw materials and components had significantly weakened the European economic recovery, although it is not possible to speak of a total catch-up with the economic collapse observed in the year 2020 (Paché, 2021). Russia's invasion of Ukraine has exacerbated the situation, and the shortage of semiconductors, which was initially expected to end in the second half of 2022, is likely to persist until 2023, thus increasing the pressure on prices.

One of the main explanations is Russia's historical specialization in the energy and metal sectors, which are largely located upstream of supply chains. Disruptions to supplies from Russia therefore spread down the supply chain to European countries whose companies have specialized in assembly activities. Given that Russian inputs are involved in a very large number of supply chains, the implications of disruptions could potentially be long-lasting in Europe. As Winkler *et al.* (2022, p. 58) underline, "the disruption of Russia's exports will feed into [supply chains] via major global production hubs for trade and will especially affect regional economies that are highly dependent on these exports. While virtually all [supply chains] are affected by rising energy prices, [supply chains] that are especially reliant on other (notably metals and fertilizer) commodity inputs from Russia for their export production include transport equipment, machinery, electronics, agribusiness, transportation, and business services". Figure 3 summarizes Russia as a seller, and the implications for supply chain partners.

Figure 3. Russia as a seller: Key sectors/products, and implications for supply chain partners

Sector	Key Products	Key Global / Regional Value Chains	Largest direct partners	Most dependent partners
Fuels	Crude oil	Many	CHN, DEU, NDL, POL, BLR	MNG, BLR, SVK, EST, KAZ
	Petroleum products	Many	USA, TUR, DEU, GBR, KOR	MNG, KAZ, KGZ, BLR, TJK
	Natural Gas	Many	ITA, JPN, BLR, SVK, CZE	BLR, SVK, EST, LVA, SRB
Metals	Palladium	Transp. equipment (catalytic converters)	USA, JPN, DEU, CHN, ITA	CAN, JPN, USA, ITA, KOR
	Iron and steel	Transport equipment, machinery	TUR, USA, BLR, ITA, BEL	KAZ, BLR, KGZ, AZE, UZB
	Copper, aluminum	Electronics, trans. equip, machinery	CHN, DEU, TUR, JPN, USA	BLR, KAZ, ARM, UZB, AZE
	Nickel	Metal (alloying), auto (batteries), electronic	CHN, FIN, DEU, NLD, USA	FIN, BLR, UKR, LVA, MDA
Chemicals	Fertilizers	Agribusiness	BRA, USA, CHN, IND, MEX	MNG, BLR, AZE, KAZ, MDA
Electronics	Cell phones, receivers, etc.	Electronics	BLR, KAZ, AZE, CHN, GEO	BLR, ARM, GEO, TJK, KAZ
Transport Equipment	Metal, auto parts	Transport equipment, machinery	CHN, FIN, DEU, NLD, USA	FIN, BLR, UKR, LVA, MDA
Services	Transport, business serv.	Business services, agribus., transport	DEU, NLD, JPN, AUT, USA, FIN	LIT, LVA, EST, SLV, FIN

Source: Winkler *et al.* (2022).

According to Ollagnier *et al.* (2022), before the outbreak of the war between Ukraine and Russia, most economic experts expected a “new normal” in the functioning of supply chains by the end of 2022. The most pessimistic estimates now point to 2023, or even 2024, depending on the evolution of the conflict, which depends directly on geopolitical dimensions that are very difficult to anticipate. It is indeed a question of an arm wrestling between Presidents Zelensky and Putin whose hard-nosed attitudes can be expected. However, resolving supply-related difficulties is essential for Europe’s competitiveness and growth, since up to 30% of the Eurozone’s total added value depends on the smooth functioning of supply chains between countries in the zone and cross-border countries. By way of illustration, it is possible to take the case of France, whose structural weaknesses in the context of global value chains have already been identified (Fulconis & Paché, 2020), particularly in terms of the dependence of its industries on foreign suppliers, without the existence of robust alternative solutions at the national level.

4. The French Case

As the anxieties generated by Russia’s invasion of Ukraine continued to grow in France, at the same time as preparations were being made for the presidential elections to see whether or not President Macron would remain in power, the French Ministry of Industry organized several meetings in March 2022 with representatives of the 19 “strategic chains” (*filères stratégiques* in French) that make up the National Industry Council. There are no surprises here. France is historically a Colbertist country, as Zysman (1983) clearly noted in the 1980s, and the State has always been at the center of the economic game, especially in times of dramatic crisis. During the meetings, the “strategic chains” of the aeronautics, automobile, agri-food and metallurgy industries raised a large number of questions and concerns. In addition to the very tense geopolitical context, it appeared to the representatives of the “strategic chains” that the sanctions targeting Russia would indeed lead to major shortages of raw materials and essential components.

The choice made is that of an interventionism equivalent to that implemented during the Covid-19 crisis. Faced with the exceptional scale of the consequences of the epidemic, the State then developed an economic strategy based on three main instruments: partial activity, State-guaranteed loans and a solidarity fund. The partial activity plan allowed the State to cover salaries up to 60% of their gross amount, or even 70% for the most affected sectors (hotels, restaurants, tourism), while the State-guaranteed loans allowed companies to obtain credit lines up to 25% of their turnover, provided that they met solvency ratios so as not to fall under the ban on State aid in application of the European regulations.

Finally, a solidarity fund was intended to cover the loss of turnover; implemented in March 2020, and extended until June 30, 2021, two million French companies have benefited. In line with this interventionism, the Ministry of Industry has affirmed the State's willingness to support companies that will suffer the consequences of the conflict between Ukraine and Russia in terms of additional costs and lasting supply disruptions.

During the March 2022 meetings, all the consequences were discussed, examining the levels of available stocks and the suppliers likely to replace the sources of supply to which French companies are accustomed. It appears that while Russian gas imports are relatively low for France, unlike many European Union countries, the suspension of deliveries of certain Russian minerals and the shortage of components produced in the war zone are having a significant impact on certain strategic sectors. This is particularly true of the aeronautics and automotive industries, which are the "flagships" of French industry. A Dun & Bradstreet study revealed that 390 companies worldwide rely on critical suppliers in Russia, while 210 companies have critical suppliers in Ukraine. In France, Renault will have to do without its sources of palladium, which is necessary for the manufacture of catalytic converters, while Airbus will have to do without its traditional imports of titanium, palladium and titanium, which come massively from Russia.

Other French companies are experiencing difficulties in their supply chains. For example, since the beginning of March 2022, the Michelin plant in Cholet, near Nantes, has suspended production for eight days. The reason is a supply shortage of carbon black—an essential form of carbon in tire production—which can no longer be sourced from Russia and Ukraine. If shortages are particularly visible on the BtoB markets, they also appear on the BtoC markets. Throughout France, several hypermarkets and supermarkets are out of stock; according to Nielsen, 3.1% of products have run out at some point since the beginning of 2022, for an average of four days. The phenomenon reflects multiple tensions, between consumer anxiety, war in Ukraine, rising production costs and high inflation. For oils and even flour, the phenomenon of precautionary purchases is multiplying. Consumers, worried that the Russian offensive in Ukraine could affect stocks of wheat or sunflower oil, of which the country is a major exporter, have decided to anticipate by buying more than usual. The bullwhip effect, conceptualized by Forrester (1958), which is widely used to understand the multiplication of shortages in supply chains (Yang *et al.*, 2021), remains a highly topical model.

5. Reconfiguring Supply Chains

Faced with the violent external shock of Russia's invasion of Ukraine and its effects on supply chains, the first reaction of European companies was to find alternatives that did not fundamentally challenge the logistics architectures of global value chains. For example, as early as February 2022, Hapag-Lloyd announced that it was looking for an alternative route for its Black Sea Mediterranean Express line, which links the Greek port of Piraeus to the Russian container terminal of Noworossiisk. At the same time, the company HHLA, which manages the port of Hamburg, closed its terminal in Odessa, looking for an alternative shipping route. Drawing on their disruptive experience during the Covid-19 pandemic, companies continued their adaptive approaches, including implementing new supply chain risk management practices (Elbaz & Ruel, 2021), while increasing their inventories of critical products and components. The dominant idea remains that of managing as soon as possible a "new normal", a configuration that applies to a supply chain after a crisis, when this configuration differs from the one that prevailed before the crisis began, but without any radical change.

The analysis conducted by Korn & Stemmler (2022) takes the opposite view by showing how the invasion of Ukraine by Russia could, on the contrary, durably modify supply chains on a global scale. This is in line with the analysis of Gerald (2014), who emphasizes how much the international shipping industry must learn to manage risk factors while doing business abroad. According to Korn & Stemmler (2022), the significant damage inflicted on industrial and logistical facilities and the forced migration of millions of people have led to the shutdown of a significant part of Ukraine's production, while the sanctions taken against Russia block the use of supply chains resulting from decades of economic cooperation. In a world dominated by global value chains, these negative effects are reverberating like a "shock wave" over dozens of countries. For example, the Horn of Africa is heavily dependent on wheat imports from Ukraine and Russia, at the risk of exacerbating severe food shortages, particularly in Ethiopia and Somalia, which are already suffering from drought. Lacking the capacity to produce these essential foodstuffs themselves, these countries will have to turn to other exporters such as India or the United States.

Korn & Stemmler (2022) put the long-term consequences of the war between Ukraine and Russia into historical perspective. To do so, they rely on the impact of past civil wars on the organization and monitoring of supply chains. Their statistical analysis is based on civil conflicts, which have been more frequent in recent decades than international wars. Korn & Stemmler (2022) then find that during a civil conflict, which causes economic disruptions similar to those experienced with the war between Ukraine and Russia, the belligerents reduce their exports by up to 8% on average per year.

Importers respond to this disruption by increasing imports from other countries with similar production portfolios by an average of 6%, with supplier substitution most evident for agricultural products and minerals. For manufactured goods, however, changes in global sourcing take time and are more likely to be implemented during conflicts lasting several years but remain in place after a civil war has ended.

It is therefore possible to mention a deep reconfiguration of supply chains, the reasons for which stem mainly from a renegotiation of commercial agreements involving new suppliers; in order to reduce the famous “switching costs”, in other words the multiple material and immaterial constraints linked to the change of a business partner (Monteverde & Teece, 1982), a stabilization of trade is sought, without any envisaged return to the previous situation. Following the argumentation of Korn & Stemmler (2022), it is likely that the reconfiguration of supply chains following the war between Ukraine and Russia, as is the case at the end of a civil war, will produce a new “logistical order” based on new exchange nodes with new suppliers. On a macro-level, the need to find alternative suppliers during a war could lead the global economy to integrate markets that might not have been integrated without the war: in brief, the current situation is probably conducive to a radical transformation of supply chains. This does not mean the triumph of regional supply chains, but globalized supply chains based on different spokes than those that were dominant a decade ago.

It will probably also be necessary to consider a more political approach to supply chains, and not solely a technical one. For decades, academics and practitioners alike have emphasized the importance of new logistical technologies as facilitators of globalized and unhindered exchanges. Today, many works are still dedicated to the blockchain to underline its capacity to recreate the trust necessary to make supply chain members collaborate, sometimes as partners, sometimes as competitors, while guaranteeing security, traceability and confidentiality of data. Each event concerning a product –whether it is manufactured, stored and delivered– is recorded as a transaction in the blockchain, and accessible to all. Even if we recognize a major technological advance linked to blockchain, the war between Ukraine and Russia reminds us of the importance of geopolitical stakes that “parasitize” the functioning of global value chains. It is thus possible that the conflict will lead to supply chain relationships between countries sharing the same humanistic values, but as Ganeshan & Boone (2022) note, who can say with certainty that a country that shares common values today will not become hostile tomorrow?

6. Conclusion

It is too early to draw the contours of the logistics world that will emerge more or less quickly from the war between Ukraine and Russia, whose economic and human effects are already dramatic. Certainly, some authors such as Korn & Stemmler (2022), Ollagnier *et al.* (2022), Simchi-Levi & Haren (2022) or Toraman (2022) wonder about the future of supply chains in the post-war period, underlining the importance of geopolitical dimensions to understand the probable reorganization of global value chains. Admittedly, the war between Ukraine and Russia is not the first violent shock the world has experienced in the last 20 years. However, it indicates that companies and national and international authorities have underestimated the structural fragilities to which supply chains are subject, particularly in France, but more widely in Europe. More than ever, resilience requires a prior reflection on the supply chain risks that it is important to map, for example in terms of critical shortages, including by conducting “stress tests”, like in the bank industry. This is the only way companies will be able to better face future crises, and in particular the inevitable climate crisis, which they will not be able to escape.

From a managerial perspective, a five-point roadmap is suggested by Terino & Guarraia (2022): (1) assess risks along the global value chain, focusing on key points of potential failures; (2) establish indicators to predict changes in the nature of supply chain risks and monitor them; (3) counter persistent trends of returning inflation; (4) improve mitigation strategies for the most dramatic risks; and (5) improve traceability by accurately mapping the supply base. While this roadmap is interesting, its recommendations are not original, as they are largely consistent with long-standing supply chain risk management recommendations, as if the war between Ukraine and Russia did not constitute a major disruption. The other limitation of Terino & Guarraia’s (2022) roadmap is also that it reduces the logistics issue to technical and economic questions. This is not satisfactory in a vulnerable, uncertain and complex world, which requires a continuous scanning on the coming upheavals of political ecosystems, for example with the inexorable rise of China and its desire to take control of Taiwan, which is a key element of many global value chains. This is undoubtedly a major challenge for supply chain management research.

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