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ORIGINAL PAPER

A STUDY OF MACROECONOMIC AND GEOPOLITICAL INFLUENCES AND SECURITY RISKS IN SUPPLY CHAINS IN TIMES OF DISRUPTIONS

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ABSTRACT. Background: The effect of macroeconomic and geopolitical disturbances affects the safety of logistics chains in the environment of their operation. Determining the parameters of the security of the logistics chain in the period of disruption is considered an important economic problem due to the growing threats to the economic security of the country and, in particular, to the security of the logistics sector. Supply chains in Ukraine were initially disrupted due to the COVID pandemic and then the Russian invasion. These two major disruptions have had a significant impact on logistics in Ukraine, which is why this article aims to explore their impact on supply chain operations.
Methods: The research comprises four main components: a bibliometric analysis employing the systematic literature review method, a statistical analysis of key macroeconomic indicators affecting the logistics sector in Ukraine and the global economy, survey research involving participants in supply chains, and a conclusion drawn from the analyses, addressing risks for the security of the supply chain environment. The bibliometric analysis aims to understand research trends and developments in the field, while the statistical analysis provides insights into economic factors impacting supply chains. The survey research offers valuable input from supply chain participants, contributing to a comprehensive understanding of their experiences. Finally, the conclusion draws implications from the analyses, identifying potential risks and proposing measures to enhance supply chain resilience and security.
Results: The research results indicate that the disturbances analyzed not only affected the fluctuations of global GDP but also, with a certain delay, the global supply chains, indicating the deepening of differences in the logistics sector. Industries that rely on global logistics supply chains are found to be highly susceptible to changes in transformation flexibility and changes in the configuration of supply chain networks. It has been established that the consequences of the unrest in Ukraine have exacerbated the financial, humanitarian, food, energy, social, and value of life crisis. In terms of impact on the Ukrainian logistics sector, they have led, among others, to the weakening/breaking of logistic links, the lack of potential to fully use them during wartime, and the intensification of security threats.
Conclusions: Among the logistics requirements, the safety and self-preservation function has become the most important. Therefore, an important task during wartime is to develop security mechanisms that ensure durability and efficiency, as well as operational and integrated supply chains with high adaptability to disruptions.

Keywords: COVID-2019, war, disruption, macroeconomic indicators, geopolitics, recession, supply chains, risk, security

INTRODUCTION

Given the dominance of radical uncertainties in certain regions of the world, along with local escalations of tensions, it is necessary to examine the parameters and influences on the security of global and local supply chains in highly competitive environments with various disruptions. Geopolitics is increasingly exerting pressure on all sectors of the economy. Consequently, the identification of dimensions of supply chain transformation during times of systemic disruptions is perceived as an important economic challenge due to the growing threats to the economic security of countries, especially their logistics sectors.

In Ukraine, there is a lack of economic instability, manifested through various

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disruptions: expectations of financial shocks related to high global debt levels (in 2021-2022), recession in economic sectors, the spread of the COVID-19 pandemic, climate change, food, energy, and humanitarian crises, as well as the ongoing hybrid war in Ukraine since 2014 and the active phase of the war conducted by the Russian Federation since 2022. These disruptions have a significant, multidirectional impact on the functioning of supply chains, thus determining their effectiveness. Often, these disruptions have an irresistible (force majeure) nature and are caused by factors and forces over which logistics chain participants have the least leverage and which are beyond their understanding and competencies. The unpredictability of the scale of negative consequences of such disruptions, and therefore the complexity of predicting scenarios for the development of events under conditions of instability, as well as the short periods for restoring logistics chains due to the action of local and territorially undefined centers of disruption in time and space, significantly complicate the mechanisms for making appropriate adaptive management decisions. Overcoming the uncertainty of the impact on the established mechanism of supply chain functioning is accompanied by a lack of both the participants' own experience in supply chains and an insufficient amount of theoretical and applied developments in the identification of mechanisms for adapting supply chains to the conditions of risk deployment caused by the researched disruptions. The outlined reveals the depth and relevance of solving the problem of identifying environmental factors for the development of logistics chains to solve the tasks of their effective functioning and development under the conditions of the action of various disruptions on them.

The article aims to examine the impact of major disruptions that destabilize global supply chains and supply chains in Ukraine and how they affect them. The research presented in the article focuses on the response of supply chains to disruptions in their environment. In this context, the issue of ensuring the security of supply chains becomes extremely important, which in the current reality is gaining special importance and is becoming the overriding goal of logistics. It should be remembered that the scope of broadly understood security is multifaceted. There are many factors that affect the security of supply chains. This article is an attempt to answer the following questions:

RQ1 – what are the main indicators of macroeconomic and geopolitical disruptions in global logistics chains and how do they affect fluctuations in world GDP?

RQ2 – how do current participants in supply chains assess the impact of disruptions on modern supply chains?

RQ3 – which types of security risk are connected with the logistics sector under disruptions?

To uncover research issues, this article is structured in a logically structured research framework: 1) presentation of types of disruption and substantiation of macroeconomic and geopolitical indicators of disruptions that affect the functioning of logistics supply chains; 2) survey research on the impact of disruptions on supply chain activities in Ukraine; 3) identification of the security risk associated with the logistics sector in a war environment.

RESEARCH METHODS

The subject of the study is the analysis of the main disruptions that destabilize supply chains. The research methodology of this article has been oriented towards a theoretical-utilitarian character of the conducted research and consists of the following stages (Fig. 1):

1. the bibliometric analysis conducted employing the systematic literature review method;
2. statistical analysis of the main macroeconomic indicators affecting the logistics sector in Ukraine and the global economy;
3. survey research conducted among respondents who are participants in supply chains;
4. conclusion – drawing conclusions in relation to the analyses made, e.g., including risks for the security of the supply chain environment.

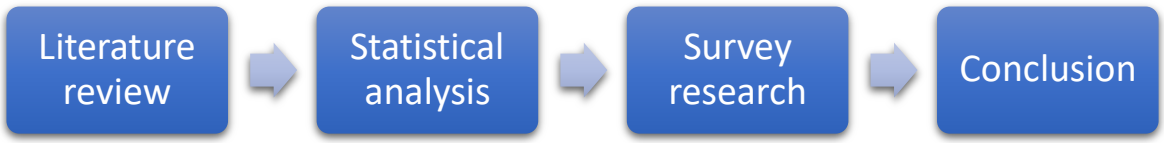

Fig. 1. Research methodology. Source: own elaboration.

The bibliometric analysis, conducted by employing the systematic literature review method, made it possible to present the current and fundamental aspects of the theory of economic activity of enterprises and the theory of crises. The impact of disruptions such as economic crises, financial instability, and risks related to the functioning of organizational units in the supply chain are discussed. The analysis underlines the need to study the economic and political environment during the disruption caused by the spread of COVID-19 and the active phase of the war in Ukraine with the RF, as well as their impact on logistics supply chains.

A statistical analysis was performed to analyze the dynamics of the main macroeconomic indicators of economic activity in Ukraine under the influence of various types of disturbances that are reflected in the logistics sector. Statistical data related to indicators such as GNP, Purchasing Managers' Index, Global Supply Chain Pressure Index, and Logistics Performance Index were analysed.

The structural element of the article was a survey. The study was aimed to analyze the opinions of the respondents about supply chain disruptions and their reactions to them. The empirical research of the authors in terms of conducting consumer survey research was directed at a group of the main market participants, specialized logistics operators of the "Transport, warehousing, postal, and courier activities sector and a group of stakeholders, and industry experts who have in-depth analytical information about the results of the researched sector, including specialists involved in scientific and educational activities in a given area.

The parameters of the survey research were:

- research method – survey of Ukrainian representatives of public organizations involved in logistics business, representatives of the scientific and educational sector, organizations using logistics services, and employees of enterprises representing the "Transport, warehousing, postal, and courier activities" sector according to the NACE[1];
- the questionnaire included 12 questions (of which the second question was divided into three blocks; the seventh question was divided into five blocks), regarding, among others, the most important factors affecting and hindering the operation of supply chains in individual sectors, response of supply chains to disruptions, ways to restore the stability of the supply chains
- types of questionnaire questions – open, closed, and closed with multiple choice answers (with the option of alternative answers), meaningful, and supporting questions;
- data collection tool – a Google Form questionnaire;
- according to the method of communication between the respondent and the researcher, the online mode was used in the survey process (given that the survey was conducted during the period of active hostilities in the country, which coincided with the period of restoration of functioning in the postwar period).

[1] NACE (The Statistical Classification of Economic Activities in the European Community) - is the industry standard classification system used in the European Union.

They used e-mail (60%), Facebook (30%), and LinkedIn (10%);
- by type of respondent – survey of top managers and midlevel managers, industry experts, and representatives of the scientific and educational sector (170 respondents);
- period of research – August–September 2022.

In the last stage of research work, based on the analyses carried out, as well as a survey, a discussion part was conducted, and conclusions were drawn on macro turbulence and geopolitical uncertainties to restore economic activity in logistics chains in Ukraine. Particular attention was also paid to the risk associated with the security of the logistics sector in the event of a disruption.

INDICATORS OF MACROECONOMIC AND GEOPOLITICAL DISRUPTIONS REFLECTED IN LOGISTICS SUPPLY CHAINS

During the development of economic systems under the influence of a large number of disruption factors, a 'crisis era' or a 'crisis society' is stated [Horbulin and Kachynskyi, 2010]. Therefore, it is fundamentally important to identify the causes and dynamics of crises in socioeconomic systems and to develop tools for effective management during disruptions in the context of security processes. For example, in Orel's work [Orel, 2019], the interrelation between system development and its security in the political plane is studied. The author stated that the depressed development of the political system leads to political destabilization and sociopolitical tension, and ensuring security in the political sphere is a prerequisite for the successful development of the examined system. As Orel notes, in the process of providing security, it is fundamental to clarify the essence of the factors that cause disruptions and dangers arising in economic systems.

Economic systems, according to the phases of their development, can be in unstable states in periods of economic decline outside the growth phase. It is known that in production and business cycles, the output curve describes a long upward trend with some upward and downward deviations with subsequent recovery to its crisis trend after a recession. Cerra and Saxena [2017] argue that recessions caused by different disruptions lead to irreversible output losses and 'landslides' in the output curve and differ depending on the frequency and depth of these disruptions. However, despite the factors that caused the disruptions, such as external political information influences (information aggression and asymmetry) or internal miscalculations in macroeconomic policy, as argued by Cerra and Saxena [2018], they are reflected in prolonging the duration of the recovery period and contribute to political polarization after systemic financial crises, which was also confirmed by Funke et al. [2016]. The high cost of financial crises and recessions calls for sound macroeconomic approaches and fiscal policies that shape the development environment of economic systems, that is:

a) financial regulation and compliance with prudential regulation to obtain an adequate level of leverage, studied by Blanchard et al. [2010], Caruana [2014], and Turner [2017];
b) promoting price stability, the main objective of monetary policy is dominant for central banks with a clear framework for inflation targeting to avoid financial bubbles and crises. This vector of research has interested Blanchard et al. [2010], who analyze how the Federal Reserve reacted to the 1987 stock market crash, the collapse of long-term capital management (LTCM), and the bursting of the technology bubble. In particular, Svensson argues [2016] that keeping interest rates above the required level to stabilize prices may increase the cost of the crisis due to a weakened economy and rising unemployment. For example, in Ukraine, the Roadmap of the National Bank of Ukraine (NBU) for the transition to inflation targeting (2016) has been established;
c) regulation of the amount of the accumulation of monetary reserves, which should become a buffer in case of a balance of payments crisis.

Supply chain risk management in an active and competitive environment deserves special attention. According to [Wu and Blackhurts, 2009; Samvedi et al., 2012], in a fuzzy business logistics environment, the absolute goal of structuring an efficient and effective supply chain makes it even more susceptible to risk. This can lead to a decline in product quality, loss of company image and reputation, supply disruptions [Cousins et al., 2004], stakeholder problems [Craighead et al., 2007], and a drop in company stock prices [Hendricks and Singhal, 2005]. Selected research works are related to supplier development [Nepal and Yadav, 2015; Hashim et al., 2017], identification of the supply chain input risk system [Garvey et al., 2015], and management of supply chain project risk [Mhatre et al., 2017; Sharma et al., 2017; Christopher and Peck, 2004] for many companies [Lücker and Seifert, 2017].

It should be noted that there is a significant legacy in the field of crisis theory and the development of applied tools to investigate the impact factors on the resilience of supply chains in the precrisis period. However, there is an acute need to study the economic and political environment during the disruptions caused by the spread of the pandemic and the active war phase in Ukraine with RF. There is also a need to study its impact on logistics supply chains, which have so far been little investigated and hence are relevant given the narrow horizon of the disruptions.

The sustainability process identified by the functioning of individual companies and supply chains during disruptions necessarily involves some transformation of resilient relationships within the object of study under the influence of the risk-formation environment triggered by these disruptions. Changes in the ways and methods of management in logistics chains under the influence of disruptions should be considered from the perspective of value creation at individual chain links. Such changes should also take into account the neutralization of the threat of these disruptions, aimed at increasing the profitability of the business in the long term for the partners involved in the chain or profit and reducing the costs of production in the short term. Examples of such disruptions include the 2008-2009 global financial crisis, Brexit, the spread of the COVID-19 pandemic, the RF's war in Ukraine (warfare since 2022 and hybrid information aggression since 2014 up to the present), which have transformed trade and investment linkages.

It is well known that the indicators of change that are inherent in the trend analysis of countries are levels of inflation, employment, investment expansion, the development of foreign exchange and capital markets, indicators of productive activity and enterprise competitiveness, etc. Among price increases and supply chain disruption, financial complications, declining trade, and investment flows, ensuring stability of production for domestic needs remains the dominant factor for which developed countries pay attention to ensure economic stability, while developing countries seek access to external commodity markets through active export activities.

Given the reflection of disruptions on the performance and security of global logistics chains, the authors believe that the main indicators of macroeconomic and geopolitical disruptions are:

- World GDP (Table 1) and Purchasing Managers' Index (PMI), which interpret the growth rate of global industrial and services production;
- Baltic Dry Index (BDI), which tracks prices in the dry cargo shipping sector;
- Capesize Index (CI), which tracks iron ore and coal cargoes of 150,000 tons;
- Panamax Index, which tracks shipments of 60,000 to 70,000 tons of coal or grain;
- The Baltic Supramax Index (BSI) is a price index for dry bulk cargo used in shipping. It is part of the Baltic Dry Index;
- Global Supply Chain Pressure Index (GSCPI) is a reflection of disruptions in the logistics supply chain. Positive values of this index indicate by how many standard deviations the index is above the average value, i.e., more supply chain disruptions are observed at higher Index points;
- Logistics Performance Index (LPI) as a factor of influence on trade in a

comparative analysis of countries. LPI consists of six components: efficiency of the customs clearance process (speed, simplicity, and predictability of formalities), quality of trade and transport infrastructure (ports, railways, and information support), ease of international transport clearance at competitive prices, quality of logistics services, cargo tracking criterion, and time criterion (timeliness). It should be interpreted as an identification tool to identify potential challenges and opportunities in trade logistics.

Table 1. Analysis of World GDP dynamics and Ukraine's GDP

Year	World GDP, trillion USD	Deviations from the previous period	Real GDP (year-earlier prices), million UAH	Deviations from the previous period
2008	63.71	-	-	-
2009	60.44	0.9487	-	-
2010	66.16	1.0946	-	-
2011	73.48	1.1106	-	-
2012	75.17	1.0230	1304064	-
2013	77.33	1.0287	1410609	1.0817
2014	79.47	1.0277	1365123	0.9678
2015	75.23	0.9466	1430290	1.0477
2016	76.42	1.0158	2034430	1.4224
2017	81.33	1.0643	2445587	1.2021
2018	86.34	1.0616	3083409	1.2608
2019	87.61	1.0147	3675728	1.1921
2020	84.71	0.9669	3818456	1.0388
2021	93.86	1.1080	4363582	1.1428
2022 (forecast)	95.00	1.0121	2395607	0.5490

Source: own elaboration based on [GDP in Ukraine, 2022; The World Bank Data, 2023]

Analysis of World GDP over the period 2008–2022 indicated its dynamic response to disruptions caused, for example, by the global financial crisis of 2008–2009, during the active period of which World GDP declined from 63.71 trillion USD to 60.44 trillion USD, a decrease of 5.13% compared to the previous period. Global GDP responded to the European migration crisis in 2015 by falling from 79.47 to 75.23 trillion USD, a decrease of 5.34%, compared to the previous year. In 2020, during the period of an active pandemic, the global GDP was 84.71 trillion USD, a decrease of 3.31% compared to 2019.

The Global Supply Chain Pressure Index (GSCPI) can be considered as one of the disruption indicators in global supply chains. The GSCPI summarizes 27 variables, including cross-border transport costs, production volumes in China, the EU, the UK, Japan, South Korea, Taiwan, and the USA, national purchasing managers' indices, global freight rates (including the container index), and airfreight price indices. The higher the positive GSCPI values, the more significant the supply chain disruption; negative values of this index indicate a standard deviation of the index below the average. The dynamics of PMI and GSCPI are shown in Figure 2 and Table 2.

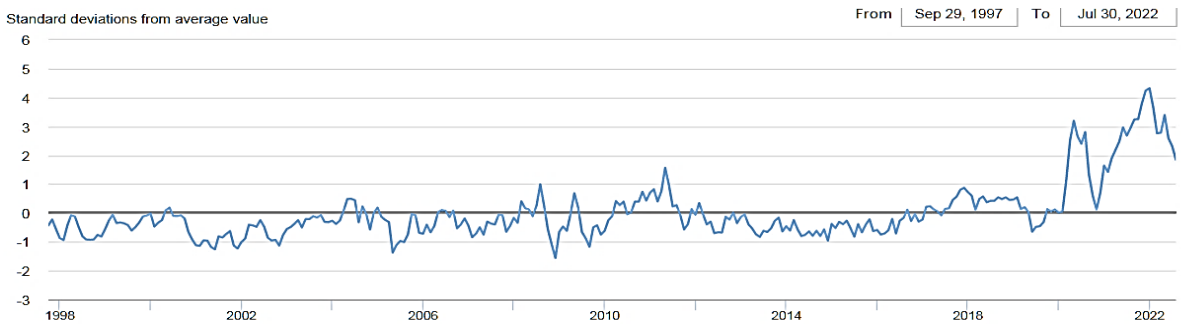

Fig. 2. Global Supply Chain Pressure Index: long-term trend. Source: [Cerra and Saxena, 2018].

The disruptions analyzed were not only reflected by fluctuations in global GDP but also, with a certain delay, in global supply chains. This was interpreted by GSCPI fluctuations, with the greatest deviation during the pandemic when the pressure peak reached a value of more than 4 points (October-December 2021).

Table 2. Analysis of trends in the GSCPI during a period of active disruptions (monthly)

Year	Month												12/1 (2021) 7/1 (2022)
	1	2	3	4	5	6	7	8	9	10	11	12	
2021	1.42	1.89	2.18	2.47	2.68	2.95	3.24	3.25	3.80	4.24	4.32	4.24	2.99
2022	3.65	2.76	2.78	3.39	2.59	2.31	1.84	-	-	-	-	-	0.50
2022/2021	2.57	1.46	1.28	1.37	0.97	0.78	0.57	-	-	-	-	-	- 2.00 r. c.

Source: own elaboration based on [Cerra and Saxena, 2018].

As shown in Table 2, the largest disruptions in supply chains for the period January 2021-July 2022 were observed with an increasing trend in October-December 2021 and with a further downward trend (with slight increasing fluctuations in March-April) until July 2022, where the GSCPI was 1.84 points. GSCPI is an integral part of PMI, and the relationship between them is shown in Figure 3.

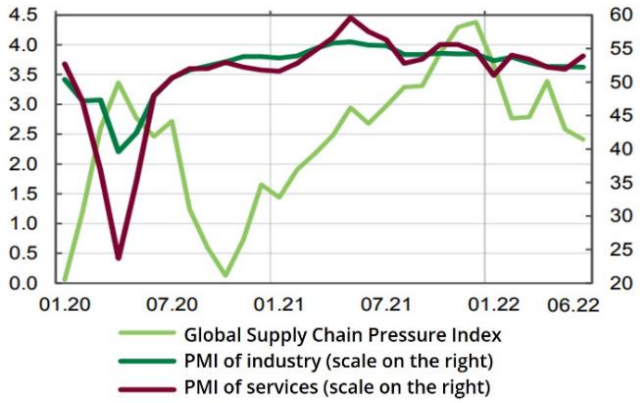

Fig. 3. Global PMI and GSCPI: an overview of trends. Source: [Global Supply Chain Pressure Index, 2022].

According to Figure 2, the global PMI indicates a deepening divergence caused by the spread of the pandemic and the war in Ukraine. For example, analysis of the effects of overcoming the COVID-19 pandemic indicated that industries relying on global logistics supply chains have a high vulnerability in terms of transformation elasticity and changes in supply chain configuration. This increased the relevance of reviewing the organizational principles of the global economic system and strengthening the role of local manufacturing, at least during the period necessary for the recovery of the economy, which is typical of a V-shaped recovery due to a recession with a short recovery in time.

Almost simultaneously, the period of economic recovery from the consequences of the pandemic coincided with downward trends due to the artificial (hybrid nature) escalation of energy price crises in Europe (autumn 2021). Due to the consequences of the financial assistance policy, a "price shock" with a certain time lag (March 2022) was reflected in the industry and service sectors, among other things, due to the increasing global oil and gas prices (Figure 4).

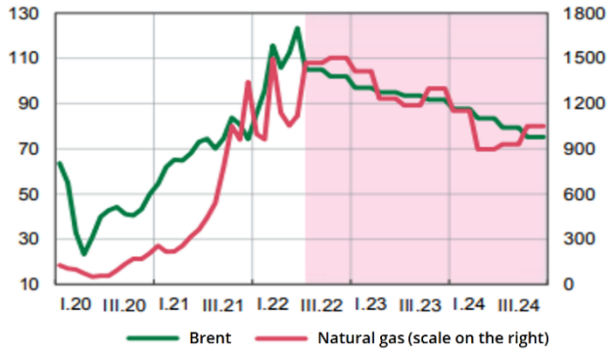

Fig. 4. World Brent crude oil prices (UAH/barrel), natural gas prices on the Dutch market (TTF UAH/kcm): an overview of the dynamics during the period of active disruptions. Source: [Minfin, 2022].

Narrow indicators which can indicate the development of online freight volumes are:

- Baltic Dry Index, which for example on 16 August 2022 for the fourth consecutive session, has shown a loss, falling by 1.2% to 1.387 points, the lowest level in more than six months in 2022;
- The Capesize Index declined for the fourth consecutive session on the same day, falling by 3.6% to 1,059 points—the lowest level since 27 January 2022;
- The Panamax Index declined for 16 consecutive sessions, dropping 35 points to 1.850 points and reaching the biggest drop in August 2022;
- Meanwhile, the Supramax Index rose for a third straight session, rising 19 points to 1,626 points—its best result of this index in nearly three months.

In Ukraine, according to the authors, indicators of macroeconomic and geopolitical disruptions, which are reflected with a certain time lag in the supply chain, should be indicators such as:

- real GDP, which takes into account the transformation of output while adjusting for changes in price levels (Table 3);
- the unemployment rate, which against the background of the war in Ukraine has a more pronounced conjunctural nature and reflects the reaction of internally displaced persons and forced emigration from Ukraine (Table 3);
- Consumer Sentiment Index (CSI), which is a projected indicator of the possible change in consumer demand in the future (Table 4);
- Business Activity Expectation Index (BAEI), which interprets the prospects of economic activity in various sectors of the economy at an equilibrium value of 50.0 (Table 4);
- Consumer Price Index (CPI) (inflation index) (Table 4);
- Basic Industry Production Index (BIPI) (Table 4).

With the ongoing war on the part of the RF, trade relations have become more difficult, mainly due to a decline in Ukrainian food exports. High import dependency and sanctions have accelerated food inflation in most countries. As a result, raising prices in world markets and creating grounds for hunger in more than 100 countries. All this has put pressure on logistics chains around the world and in Ukraine.

As shown in Table 3, real GDP in 2022 is projected to be 54.9% of the figure in 2021. The unemployment rate is projected to rise by 2.81% in 2022 relative to 2021. These figures indicated a negative trend relative to previous periods, which are related to country, war, migration, higher energy prices, and dealing with the effects of the pandemic. In 2021/2020, real GDP growth was 114.28% with a 104.04% increase in the unemployment rate. In 2020, real GDP rose by 3.88%, with a growth of 115.12% growth in the unemployment rate, compared to 2019. These periods were marked by the dominant impact of pandemic growth on economic activity in Ukraine. Other indicators to assess economic activity in Ukraine are summarised in Table 4.

Table 3. Main baseline indicators of economic activity identification in Ukraine during the period of active disruptions (by quarter)

Period	Real GDP, UAH mln	Deviations from the corresponding period of the previous year	The unemployment rate, %	Deviations from the corresponding period of the previous year
2018	**-**	**-**	**-**	**-**
1st quarter	766150	-	9.6	-
2nd quarter	875733	-	8.8	-
3rd quarter	1050095	-	8.4	-
4th quarter	983750	-	8.6	-
2019	**3675728**	**-**	**8.6**	**-**
1st quarter	821210	1.0719	8.9	0.9271
2nd quarter	842935	0.9625	9.6	1.0909
3rd quarter	1095567	1.0433	9.7	1.1546
4th quarter	1058744	1.0762	9.9	1.1512
2020	**3818456**	**1.0388**	**9.9**	**1.1512**
1st quarter	887884	1.0812	10.9	1.2247
2nd quarter	987871	1.1719	10.3	1.0729
3rd quarter	1243962	1.1355	10	1.0309
4th quarter	1243865	1.1749	10.3	1.0404
2021	**4363582**	**1.1428**	**10.3**	**1.0404**
1st quarter	753814	0.8490	27	2.4771
2nd quarter (forecast)	592723	0.600	35	3.3981
3rd quarter (forecast)	777476	0.6250	-	-
4th quarter (forecast)	777416	0.6250	-	-
2022 (forecast)	2395607	0.5490	28.9	2.8059

Source: own elaboration based on [State Statistics Service of Ukraine, 2022].

Table 4**.** Selected measures of economic activity in Ukraine during the period of active disruptions (by month)

Indicator	CSI, items	BAEI	CPI, %	CPI, cumulative, %	BIPI, %
		2021			
January	60.7	37.6	101.3	101.3	-3.5
February	69.1	48.8	101.0	102.3	-3.9
March	67.8	51.4	101.7	104.1	0.3
April	77.2	46.9	100.7	104.8	19.0
May	71.3	50.5	101.3	106.1	5.0
June	72.9	51.6	100.2	106.4	2.5
July	71.3	50.8	100.1	106.5	2.7
August	73.7	53.4	99.8	106.3	7.0
September	69.7	53.1	101.2	107.5	-3.8
October	68.8	51.4	100.9	108.5	20.6
November	66.0	48.9	100.8	109.4	14.4
December	67.2	48.6	100.6	110.0	-0.7
December/January (2021)	1.11	1.29	0.99	1.09	0.2
		2022			
January	62.3	40.5	101.3	101.3	7.5
February	64.1	-	101.6	102.9	-
March	92.4	-	104.5	107.6	-
April	85.6	-	100.3	110.9	-
May	84.5	-	102.7	113.9	-
June	78.1	41.3	103.1	117.4	-
July	73.2	43.6	100.7	118.2	-
August	75.6	44.1	101.1	119.5	-
September	86.0	46.1	101.9	121.8	-
October	83.6	44.9	102.5	124.8	-
November	85.2	42.7	100.7	125.7	-
December	83.9	42.1	100.7	126.6	-
December/January (2022)		1.0395			
		2023			
January	83.8	37.5	100.8	100.8	-

Source: own elaboration based on [State Statistics Service of Ukraine, 2022; National Bank of Ukraine, 2022; The World Bank, 2022].

The Consumer Sentiment Index (CSI) as an indicator reflecting the growth potential of consumer demand, and therefore the growth of demand in the logistics sector, shows the highest value in April 2021 – 77.2 p. and in March 2022 – 92.4 p. However, all rates are below 100 p., which means the prevailing negative trends in the assessment of consumer sentiment in society in the period under consideration.

The Business Activity Expectation Index (BAEI) in Ukraine in 2021 did not reach its equilibrium value in January-February, April, and November-December due to the spread of the pandemic and shows a negative assessment of the prospects for economic activity. From January to July in 2022, BAEI values were below the equilibrium value due to the war in Ukraine, the destruction of production and logistics capacities, the forced transformation of supply chains, blocked seaports, rising energy prices, increased production costs for companies, and worsening inflation expectations.

The cumulative Consumer Price Index (CPI) stood at 110% in 2021, compared to 117.4% in January-June 2022.

In January, February, and September 2021, the Basic Industry Production Index (BIPI) was negative: -3.5%; -3.9%, and -3.8%, respectively. However, it is not estimated for the year 2022 from February to the present due to the war.

The dynamics of the Logistics Performance Index (LPI) for 2007-2018, which comprehensively reflects changes in the logistics sector in Ukraine according to six factors, was analyzed (Table 5).

Table 5. Dynamics of the Logistics Performance Index: 2007–2018

Year	LPI rank	LPI Score	Customs	Infrastructure	International shipments	Logistics competence	Tracking & tracing	Timeliness
2007	73	2.55	2.22	2.35	2.83	2.41	2.53	3.31
2010	102	2.57	2.02	2.44	2.79	2.59	2.49	3.06
2012	66	2.85	2.41	2.69	2.72	2.85	3.15	3.31
2014	61	2.98	2.69	2.65	2.95	2.84	3.20	3.51
2016	80	2.74	2.30	2.49	2.59	2.55	2.96	3.51
2018	69	2.83	2.49	2.22	2.83	2.84	3.11	3.42

Source: own elaboration based on [The World Bank, 2022].

For example, in 2018, the on-time delivery subindex was 3.42—lower than its level in 2014 and 2016, which was 3.51. In addition, in this period, the trade and transport infrastructure subindex as a logistics priority parameter had the lowest value of 2.22. The analysis of the Logistics Performance Index indicated that the growing conjuncture of the Ukrainian logistics services market in the international transport segment requires urgent improvement of logistics infrastructure facilities and the development of an organization and economic mechanism in the context of automation of logistics processes.

RESEARCH ON THE IMPACT OF DISRUPTIONS ON THE FUNCTIONING OF THE SUPPLY CHAINS

Forced transformation processes caused by the Russian war in Ukraine have significantly changed the specifics of supply chain operations. The latter are now influenced by transformational processes in the global logistics environment, which is characterized by its uncertainty and magnitude of change. It is argued that the instability, uncertainty, complexity, and ambiguity caused by military action in Ukraine, as well as fierce global competition and the realization of challenges with low likelihood but with powerful forces of influence, only reinforce the trends that have emerged in global supply chains.

The logistics supply chain, the country's transportation system, the warehousing segment, and other actors involved in the logistics sector inevitably react to the emergence of crises and the need for economic actors to adapt to their consequences. Competition, economic development, and supply chain security are now integral tenets of the operating environment of all supply chain actors under disruptions. Recent disruptions have confirmed the restructuring of economies and the increasing uncertainty of market interactions under the influence of escalating geopolitical tensions, intensifying security challenges that have an exceptional impact. This has forced logistics chains to adapt, based on resilience and flexibility.

Creation and adaptation of the principles of organizational and technological cooperation of various modes of transport (based on modal interoperability and integration of existing modes of transport), coordination and synchronization of transport and logistics processes to overcome crisis phenomena, development of logistics mobility, creation of partnerships between participants in the cargo supply chain in qualitatively new market conditions, as well as a joint response of international institutions to the crisis, global solidarity, cross-border cooperation in creating new infrastructure facilities to increase mobility, etc. activate partnership in various dimensions and form a safe environment for the transport process to maintain individual territories and the entire country.

The purpose of the study is to present the results of the assessment of the adaptive reactions of supply chain participants to disruptions in the post-COVID-19 and war periods in Ukraine. To achieve the main goal, the following objectives must be met:

- identify the groups of the most important disruptions exerting active pressure on supply chains;
- identify the core of the multidimensional threats which accompany supply chains under disruption conditions;
- study the transformation of market conditions elements under the impact of disruptions, which require the adaptation of production and economic, including operational and logistics activities of supply chain actors;
- identify the most favourable logistics and other support measures to restore the economic efficiency of supply chains.

The target audience for the study was professionals involved in the logistics industry, industry experts, and representatives of scientific and educational activities. Responses were received from 220 respondents. The distribution of the respondents was as follows: specialised logistics operators (transport company, public warehouse, cargo terminal, customs broker, stevedore) – 57.1% of the respondents; the logistics division of a manufacturing/trading company that performs logistics operations independently – 14.3% of the respondents; integrated logistics 3PL operator – 7.1%; virtual logistics 5PL integrator – 2.4%; industry experts, including from the science and education sector– 19.1%. Respondents involved in foreign trade activities in supply chains were distributed as follows: carry out export and import operations – 26.2% of respondents; carry out export operations only – 9.5% of respondents; carry out import operations only – 4.8% of respondents; and do not carry out foreign economic transactions – 59.5% of respondents. The responses of the respondents on the issues discussed are presented below.

In the group of the most significant geopolitical and macroeconomic factors that affect the prospects of economic activity and the safety of logistics chains (1st question of research), the majority of respondents (82.1%) attributed the continuation of intensive hostilities in the war with Russia and the blocking of cargo exports through Ukrainian ports (74.4%). The second group distinguished by the respondents included factors such as the spread of the pandemic (35.9%); fluctuation of the exchange rate of hryvnia to Euro/USD/currency restrictions (25.6%); worsening of inflation expectations/increase of credit rates/rise in energy prices (23.1%); migration/migration during the war (23.1%). Respondents indicated a group of geopolitical factors as priority impact factors, and the issue of overcoming the effects of the spread of the pandemic in the conditions of war, which is seasonal for the target audience, is not among the priority forces of action.

Among the most significant threats requiring operational intervention during disruptions (2nd*a* question of research), 53.8% of the respondents indicated the threat of terrorism and crime, 30.8% of the respondents indicated the threat of politically motivated attacks, and 15.4% of the respondents indicated the threat of forced migration. Other responses included the factor of mobilizing workers to the front line. Among the latest hacker attacks (October 18, 2022) linked to the security environment was the spread of the Prestige computer virus to transport and logistics companies in Poland and Ukraine,

which are part of commercial, humanitarian, and military supply chains. Similarly, FoxBlade (a trojan horse wiper malware) activity was detected on 23 February 2022 at the start of the full-scale invasion of Ukraine, which is linked to the RF.

The disruption of considerable force of the action, which follows one after another in Ukraine (as a pandemic or war), has emphasized the economic component and the social focus of business. Among the economic threats accompanying supply chain participants during disruptions (2nd*b* question of research), 46.2% of respondents pointed to a drop in purchasing power, 35.8% to an increase in operating costs, 10.3% to a decrease in transactions in the supply chain, and 7.7% to a decrease in income of supply chain actors.

Among social threats to supply chain operations during the disruptions (2nd*c* question of research), 59% of the surveyed noted the loss of professional staff, 33.3% noted forced pay cuts by employees, and 5.1% and 2.6% noted factors such as forced labor migration and feelings of insecurity, respectively.

Among the market factors that affected supply chain operations during disruptions (3rd question of research), respondents identified the following factors: disruption of logistics links/ changes in transport capacity (41% of respondents); business closures in active combat areas (20.5% of respondents); inability to store goods in damaged locations (15.4%); steep price increases for goods and logistics services (10.3%); structural changes/loss of orders (7.7%); and damage/destruction/theft of goods at retail sites or distribution centers in occupied territories (5.1%).

As a response to supply chain disruptions, respondents outlined the following (4th question of research): forced rerouting of goods (38.5% of surveyed), the opening of new distribution centers, including in secure areas (28.2% of surveyed), finding consumers in new territorial markets (20.5%), forced change of product suppliers (10.3%), and recourse to new 3-PL operators (2.5%).

Among the problems that most affect operational activities in the supply chain (5th question of research), the respondents listed the following: ensuring security across all segments of the supply chain (38.5% of the respondents); further increase in supply chain costs (23.1%), financial and other types of risk (20.5%) customer centricity (7.7%); and lost productivity and flexibility (each 5.1%).

In the case of increased interaction with counterparties due to disruptions (6th question of research), respondents focused on interaction issues: in the B2B segment – 41.0% of respondents; in the E2E segment interaction (online interaction) – 28.2%; direct to the customer (D2C) – 20.5%; and between business and government (B2G) – 10.3% of respondents.

Among the factors that hinder logistics chains in the road transport sector during a period of disruptions (7th*a* question of research), respondents highlighted the following: a sharp increase in fuel and lubricant prices - 35.9% of the surveyed; shortage and fuel problems – 17.9% of the surveyed; problems with the formation of the lot of packages in the reverse direction – 15.4%; renegotiation of long-term contracts due to increasing costs – 12.8%; lack of established routes – 7.7%; an increase of freight rates by carriers and price pressure on Ukrainian producers – 5.2%; additional costs related to the need to obtain visas and limited capacity of customs offices – each factor 2.6% respectively.

To the question ‘What factors complicate the work of logistics chains in the period of disruptions in the railway transport sector?’ (7th*b* question of research) the answers of the respondents were distributed as follows: the closed market for private operators and the low involvement of intermodal operators in the sector business models – 41% of the respondents; different track width in Ukraine and Europe – 30.8%; significant tariff preferences for certain consumer groups – 17.9%; state regulation of tariff policy in the sector – 10.3% of the respondents.

To the question 'What factors complicate the work of logistics chains in the period of disruptions in the water transport sector?’ (7th*c*

question of research) the answers were distributed as follows: blocking of Ukrainian ports – 66.6% of the surveyed; shortage of port capacities with a mismatch of transshipment capacities, shortage of ships, leading to increased queues in ports/duration of cargo handling in ports/increased delivery time – 17.9% of the surveyed; further growth of freight rates (because of pandemic/war/vessel fuel excise) – 7.7%; non-compliance with the schedule of sea voyages – 2.6%; forced competition for empty containers with Turkey as a regional center of gravity for transport companies – 2.6%; shortage of ships leading to increased queues at ports/duration of cargo handling at ports/cargo delivery time – 2.6% of respondents.

In the period of disruptions, the development of export supply chains in shipping regions with the involvement of water transport is determined by exceptional institutional support and a competitive advantage between industries concerning rail transportation over long and especially short distances, regardless of the ports blocked by RF and the destruction of part of the water infrastructures and suprastructure facilities in the occupied territories. In the case of placing a significant share of industrial enterprises, processing/transshipment, and other capacities in remote areas from ports, factors that stimulate the development of short-distance road transport (which is determined in conditions of disruptions by greater mobility, flexibility, and safety of transportation) are the high cost of rail transportation on short distances, as well as the high cost of freight due to the presence of excise duty in marine fuel.

According to respondents, factors complicating supply chain operations during a period of disruptions in the warehousing sector (7th*d* question of research) were a shortage of warehouses with special storage conditions (pharmaceuticals, dangerous goods, etc.) – 38.5% of the surveyed; decreasing vacancy rates for large warehouse properties (class A, A+) in safe regions – 35.9% of the surveyed; and unfilled orders – 23.1%. Other responses included destroying 50% of storage space for cold logistics, theft of vehicles in damaged locations, raising rental rates for commercial cargo in secure areas and higher rental rates in Ukrainian warehouses compared to European countries – 2.6% of respondents. The analysis of secondary information indicates the active use of warehouses during the war for humanitarian and military needs, with preferences for cargo owners (temporary exemptions, deferrals, and discounts) and taking into account the social responsibility of the business; relocation of logistical hubs to a safer western region and dispersal of stocks there to diversify security risks; and development of demand-side industries for warehousing services, e.g., processing industry (including food processing, agribusiness, metallurgy, etc.) and online and retail sectors.

Generalizing factors of resistance to supply chain operations during the disruption period (7th*e* question of research) were as follows: increased logistics risks related to customs clearance procedures, transport, and product distribution (59.5% of respondents); high sensitivity to natural disasters and other force majeure events (23.8% of respondents); intentional cybercrime (phishing attacks, website hacking, malicious software corruption, ransomware attacks, insecure web services, etc.) (7.1%); the process of providing jobs and housing to some displaced staff (7.1%); and a shortage of containers (2.5%).

In the opinion of the surveyed, transformations in supply patterns, according to the manifestations of disruptions, have taken place as follows (8th question of research): activation of Internet sales (35.7% of respondents); the activation of hybrid delivery models without the accumulation of product residuals (21.4% of respondents); an increase in the number of supply chains and the provision of a narrow range of products through small cross-docking warehouses (19%); a shift from centralized supply and towards a delivery model involving regional warehouses (9.5%); expanding the pool of local suppliers and moving towards multiple sources of supply (7.1%); the regional warehousing model remained unchanged (4.8%); and the centralized supply model remained unchanged (2.4%).

To restore the stability of the supply chains during the period of disruptions, the respondents

are focusing on (9th question of research) improving the structural efficiency of the supply chain, including through the formation of optimal logistics systems, precise business processes, and dynamic organizational change (35.7% of respondents); creating a competitive cost/multichannel/flexibility/technology/human resource advantage (23.8%); combining customs, fiscal, and logistics support for international business with tactical know-how (11.9%); establishment of a risk management system to restore transparency and end-to-end management (9.5%); automation and digitalization of business processes (9.5%); applying sustainable growth principles to the logistics ecosystem (4.8%); and compliance with corporate social responsibility (4.8%).

According to the respondents, measures to liberalise the terms of trade and other preferences that would contribute to the recovery of economic activity of logistics chains would be (10th question of research) the abolition of import duties and quotas on Ukrainian exports for one year (2022) – 42.9% of the respondents; elimination of requirements to return budgetary funds by farmers in case of loss of assets during the war – 2.4% of the surveyed; state railway transport insurance if insurance companies refuse to provide it (from April 1, 2022) – 7.1%; and simplification of rules for declaration and control of transit movement of goods to the European region (EU, EFTA, Turkey, Macedonia and Serbia) using NCTS – 47.6%.

Among the most important institutional expectations during the disruptions (11th question of research), respondents indicated the following: the acquisition of full EU membership (45.2% of surveyed); establishment of an infrastructure rehabilitation program under the auspices of the G7 (23.8%); expansion of external financing of Ukrainian business by international financial institutions (European Bank for Reconstruction and Development, European Investment Bank, International Finance Corporation of the World Bank Group, German State Development Bank KfW) (21.4%); SME participation in the 'Affordable loans 5-7-9%' program and war risk insurance (7.1%); and establishment of a trust fund under the auspices of the World Bank for infrastructure rehabilitation projects (using the 'Register of Damaged and Destroyed Property' platform) (2.4%).

The drivers to restore resilience of supply chains during disruptions (12th question of research) in the opinions of the surveyed are improved security across all business segments (28.5% of respondents); supply chain automation (16.7% of respondents); growth in e-commerce (14.3%); increased demand for express deliveries (14.3%); efficient cost management (11.9%); and supply chain integration (7.1%). Retail trade development, expansion of broadband Internet coverage, and the development of cloud solutions each accounted for 2.4% of respondents' answers.

DISCUSSION

According to the results of the research, logistics supply chains respond significantly to a variety of economic (including financial) geopolitical, social, and other types of disruption, according to the specific nature of a particular disruption with a given time lag. Among the most significant disruptions affecting supply chain security are the impact of the pandemic and the war in Ukraine. While the pandemic changes consumption patterns towards meeting basic needs, where chains involved in foreign economic activities face the threat of border closures and longer delivery times, war entails an economic recession with associated inflation, higher energy costs, and threats to the security of people, cargo, and supra- and infrastructure facilities.

Current literature on supply chain disruptions caused by the Russo-Ukrainian War focus either on selected industrial sectors, such as food [Jagtap et al., 2022] or energy [Cui et al., 2023], on Western European enterprises such as Germany [Aksoy et al., 2023] or Italy [Ropele and Tagliabracci, 2023], or focus on global economics [Guénette et al., 2022; Paché, 2022; Nguyen et al., 2022]. This study focuses mainly on supply chains in Ukraine and complements and extends the knowledge of disruptions affecting the functioning of participating enterprises.

The following generalizations have been made regarding measures to liberalise trade conditions and other preferences that will contribute to the restoration of economic activity in logistics chains. Supply chains involved in external economic activities face high tariff and nontariff barriers in times of disruptions, exceeding the limitations for external exporters in the domestic market. Consequently, the level of tariff protection for chains entering the Ukrainian market is often higher than for domestic export-oriented logistics chains, creating a significant level of asymmetry for domestic supply chains relative to external supply chains. Examples include the excess of average import duty rates of foreign countries compared to Ukraine, disparities in import rates for food and non-food products, the practice of applying tariff quotas on certain goods, the exclusion of certain goods from the free import regime, and the availability of products subject to mandatory laboratory inspection.

The establishment of a free trade zone has a positive direct impact on supply chains, in terms of the application of nontariff barriers to trade and the liberalization of import duties on mutual trade between partners while maintaining a surplus in trade in goods and strong export growth over import growth for domestic supply chains. Among the constituent indirect effects, the growth of real GDP, welfare, and other macroeconomic indicators are worth mentioning. Income growth is expected to be strongest for unskilled labor and capital, given some rebalancing of the economy.

At the core of multi-vector threats that accompany logistics chains in conditions of disruptions, in addition to traditional operational threats, threats related to the security component at all stages of the value-added creation are becoming more relevant in the supply chain. The security environment of the supply chain operation proved that external disruptions have a specific impact on the activity of supply chains and contribute to the formation of force majeure risks, to which logistics chains can only adapt their activities. The effect of force majeure risks, amplified by the exacerbation of logistics risks in war, in particular those related to customs clearance procedures, transportation, storage, and distribution in the context of the need to assess the supply chain environment, requires the study of the specific impact of the combination of risks on individual segments of the logistics sector. This allows the formation of attributes of supply chain environment security risks such as:

- risks of loss/damage/restriction of access to infrastructure and suprastructure facilities;
- risks of loss/damage/theft of cargo;
- organizational and economic risks, structured into risks of forced structural changes in the supply chain (changes in counterparties in the network, terms of cooperation between them), and related risks of reduced economic efficiency and performance of the supply chain, affecting long-term business profitability;
- health and safety risks to employees, external counterparties, and other stakeholders.

CONCLUSION

The analysis of supply chain responsiveness to disruption showed that the sensitivity of supply chains to disruptions of a significant magnitude is direct, with a relatively high degree of responsiveness of supply chain mechanisms to disruptions and refers to short-term responsiveness and long-term recovery of economic efficiency at all stages of value addition. As noted in the study, with increasing macro turbulence and geopolitical uncertainties, there has been a cost-of-living crisis reflected in consumers' purchasing power and purchasing power levels and in the context of supply chains, security component issues and supply chain security concerns. Institutional support for the logistics business, in particular trade liberalization and other preferences, has a significant role to play given the urgent need to restore the economic activity of logistics chains in Ukraine.

The productivity and flexibility of operational activities in logistics chains under conditions of disruptions (under the influence of the artificial shortage of energy carriers formed in Europe, the convergence of the economies of Russia and China, and sanctions restrictions

concerning the destruction of Russian logistics chains) is aimed at meeting the needs of the client and is being restructured in the direction of strengthening the trend of localization and transfer of chains deliveries to the country of production or sale of own product. Against the backdrop of disruptions, companies are forced to rebuild their supply chain networks. The latter can resort to changing the size and number of points in retail networks, transforming the number of stocks or locations of warehouse facilities towards safe regions, deepening cooperation in the field of supplies, etc. In the case of global sourcing, the impact of the pandemic forced companies to resort to finding alternative sources of supply along with China (the leader in supply) resorting to a combination of global, regional, or local elements in the supply network.

The aspects discussed in this article are up-to-date, important, and require further research, namely: investigating the factors that contribute to the direct sensitivity of supply chains to disruptions of significant magnitude, and exploring the mechanisms that enhance the short-term responsiveness and long-term recovery of economic efficiency at different stages of value addition; examining the impact of increasing macro turbulence and geopolitical uncertainties on supply chain security and identifying strategies to mitigate these challenges to ensure smooth logistics operations; and exploring how companies are restructuring their networks and deepening supply cooperation to ensure operational continuity and resilience.

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