









“Logistics potential to ensure the resilience of the Ukrainian economic system facing global challenges”

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LOGISTICS POTENTIAL TO ENSURE THE RESILIENCE OF THE UKRAINIAN ECONOMIC SYSTEM FACING GLOBAL CHALLENGES

Abstract

The aim of this paper is to assess the logistics potential to ensure the resilience of the economic system of Ukraine in the face of global challenges. The methods used in the study include: structural-dynamic, determinological, correlation analysis, index method, graphical and cartographic methods. The calculations were based on open data from analytical studies on the development of transport and logistics, as well as data from the State Statistics Service of Ukraine. The results of the study confirmed the hypothesis that high logistics potential, which is determined by the effectiveness of customs and border control, the quality of trade and transport infrastructure, the ease of organization of delivery, and the quality of logistics services, is the driver of the resilience of socio-economic systems of countries. The reduction of the logistical potential of the economic system of Ukraine in the conditions of a full-scale war is shown. This decrease resulted from blocked operation of a number of logistics routes and branches of the transport and logistics sphere and destroyed transport infrastructure objects as a result of hostilities and missile attacks.

A change in the vector of export-import flows and their reorientation by means of transport was noted. Drivers of strengthening the logistics potential of the Ukrainian economic system are the transformation of the transport and logistics system, deepening cooperation with neighboring countries, systematic state support for the development of freight transportation by rail, compliance with European standards, and creation of Ukrzaliznytsia's own freight carrier company that will work outside Ukraine.

Keywords

logistics, potential, resilience, economic system,
transport services, logistics services, global challenges,
war in Ukraine

JEL Classification

R40, F01

INTRODUCTION

The resilience of the country's economic system in modern conditions of external shocks and challenges, which are associated with global economic crises, institutional economic and political transformations, competitive struggle, wars, and pandemics, is a competitive advantage for the economic system. It is also the basis for the formation of the adaptive ability of the economic system to quickly respond to possible challenges in the future and restore the vector of economic growth.

A country's resilience is determined by its ability to respond to external challenges and continue to function despite losses and damage. In the conditions of global challenges, an important component of ensuring the resilience of the economic system of Ukraine is the logistical sector since Ukrainian business is included (integrated) in both internal and external chains of added value. Some industries, such as metallurgy and agriculture, produce most of their products for con-

sumers in other countries. On the other hand, logistics and flexible transport networks not only help the economy to function but also help the country to successfully and overcome hostilities and their consequences. Delivery of foreign military equipment and servicemen, evacuation of the civilian population, delivery of humanitarian aid – all this takes place using transport.

At the moment, Russia's military aggression against Ukraine is one of the biggest challenges and shocks for the country's economic system. It led to the destruction and loss of part of the country's production and infrastructural potential, interruption of supply chains, growth of production and export losses due to changes in logistics routes, etc. The logistics potential of the economic system, as its ability to integrate into global logistics systems and effectively manage external and internal logistics flows based on the use of best practices of a strategic, integrative, and innovative approach to the organization of logistics processes, also shows a downward development trend. These prerequisites actualize the need to study the transformation of the role and influence of logistics potential on ensuring the resilience of the economic system of Ukraine, as well as the development of tools and justification of mechanisms for increasing the efficiency of the use of logistics drivers to ensure the resilience of the system to global challenges.

1. LITERATURE REVIEW AND HYPOTHESES

The theoretical aspects of economic system resilience are revealed by Friedman (1993), Simmie and Martin (2010), Martin (2012), Scott (2013), and Carriere (2016). In particular, Walker (2020) considers resilience as the ability of an ecosystem, business, or society to overcome shocks and continue to function in approximately the same way. Melnyk et al. (2023a) study resilience as the ability of the socio-economic system to recover and reorient after the impact of external global shocks and challenges. The driving force of this recovery and reorientation are internal adaptive drivers, that is, mechanisms built into the system that catalyze impulses for protection, renewal, and structural transformations. They consolidate various assets at the appropriate stage using vertical and horizontal ties, changing the economic situation in the country.

Boiko and Shkuropadska (2019) emphasize that a resilient national economy is a necessary condition for a country's attractiveness to international business.

Many applied studies are devoted to assessing the level of resilience of economic systems as a whole or their individual elements in the face of specific global shocks and challenges. Doran and Fingleton (2016) studied the impact of financial and economic crises on resilience. Eshel et al.

(2020) and Haldane et al. (2021) researched the impact of the Covid-19 pandemic. Heyets (2022), Saputro and Suwito (2022) targeted the impact of wars and other deviations. Gajewski's (2022) study is devoted to a comparative analysis of the socio-economic resilience of Poland's NUTS-4 regions during the 2008 financial crisis and the Covid-19 pandemic.

The studies of the resilience of separate spatial and social systems in terms of certain aspects of their life are also widespread in the scientific literature: Walker et al. (2004), Boorman et al. (2013), Rizzi et al. (2018), Mulska et al. (2022), and Voznyak et al. (2023).

There is no clearly defined list of drivers for ensuring the resilience of nations during global challenges. However, Clark et al. (2010) and Krachunov et al. (2021) identified logistics and transport potential among such drivers. Huang and Farboudi (2021) stressed that resilience is determined by the ability of the economic system to survive, adapt, and develop when a crisis disrupts its activities. At the same time, achieving high resilience in the economy is possible with the high efficiency of the implementation of the logistics potential available in the country.

Chornopyska and Stasiuk (2021) emphasize the importance of a country's logistics potential in ensuring the resilience of its economy. Researchers focus on the symbiosis of professional manage-

ment and digitalization in transport and logistics to achieve effective implementation of logistics potential. Tkach and Voloshchuk (2017) define material elements (telecommunications and warehouse-transport infrastructure) and knowledge (necessary skills and qualifications of logistics workers) as factors for the development of the country's logistics potential.

Cherevatskyi (2023) notes that economy resilience depends on the economic and political situation, as well as natural, technological, and geographical factors. The study refers to geographical factors as proximity to ports and the development of railway connections. In fact, these categories are crucial for the country's logistics potential.

Kalicheva (2017) highlighted that proper transport and logistics systems will allow to ensure a more complete use of the resources and opportunities available in the country to achieve a high level of quality logistics services, introduce modern technologies, including information, and thus, create favorable conditions for the stabilization of the national economy.

Mihai (2022) reached similar conclusions. Analyzing the main structural components of the logistics potential of the Mykolaiv Oblast (Ukraine), the study proves that the logistics potential is a reliable means of strengthening the country's international influence. Countries with a high logistics potential attract investments and advanced technologies and innovations. Accordingly, high-tech and innovative production strengthens the country's resilience and increases its competitive position in the international arena.

Li et al. (2023) determined that transport and logistics affect not only the resilience of the national economy (macro level) but also the city economy (micro level). That is, the development of transport and logistics is a factor feature, and the resilience of the economy is a resulting feature. At the same time, many studies have considered logistics productivity to be a result of the influence of certain factors. For example, for Bernardino and Tavares (2022), such factor characteristics are socio-economic, political, and institutional factors, and for Khan and Yu (2020) – terrorism and military-political aggression.

The aim of this paper is to study the logistics potential of ensuring the resilience of the economic system of Ukraine in the face of global challenges. The research hypotheses were elaborated as follows:

- H1: High logistics potential, which is determined by the effectiveness of customs and border control, the quality of trade and transport infrastructure, the ease of organizing delivery, the quality of logistics services, etc., is a driver of the resilience of the socio-economic systems of countries.*
- H2: In the pre-war period, the transport and logistics sector made a significant socio-economic contribution to the formation of Ukraine's GDP and was characterized by high attractiveness among Ukrainian and foreign investors.*
- H3: The full-scale war unleashed by the Russian aggressor led to a decrease in the logistical potential of ensuring the resilience of Ukraine's economic system.*

2. METHODOLOGY

The study used structural and dynamic analysis to assess the structure of export and import of goods by types of transport in the war and pre-war period.

Determinological analysis was used to confirm the hypothesis that high logistics potential is a driver of the resilience of socio-economic systems of the countries of the world. The Logistic Performance Index is an interactive benchmarking tool created to help countries identify the challenges and opportunities they face in their performance on trade logistics and what they can do to improve their performance. Global Resilience Index FM is an equally-weighted composite measure of three core resilience factors: economic, risk quality and the supply chain itself. These indices were used in this study as factor and resulting features, respectively. The Microsoft Excel spreadsheet (point diagram) was used to visually represent the functional relationship between the two investigated indices. A correlation analysis was carried out

between the Logistic Performance Index and the Global Resilience Index.

The paper also uses a cartographic method to analyze and characterize the reorientation and distribution of cargo flows from Ukraine between seaports and changes in export-import flows in conditions of full-scale war, as well as visualize the infrastructure of land multimodal cargo transportation in Ukraine. The vector graphics editor CorelDraw has been used to develop digital cartographic illustrations.

To assess the level of concentration of the sector of transport and related services (section H. Transport, warehousing, postal and courier activity in accordance with the classification of types of economic activity KVED DK 009:2010) in the region compared to the entire country, the study has calculated the Location quotient (LQ):

$$LQ = \frac{E_{ij} \div E_j}{E_{in} \div E_n}, \quad (1)$$

where E_{ij} is the number of business entities (volume of production, number of employed population) in the i -th type of economic activity in the j -th region; E_j is the number of economic entities (volume of production, number of employed population) in general in all types of economic activity in the j -th region; E_{in} is the number of business entities (volume of production, number of employed population) in the i -th type of economic activity in the country in general (n); E_n is the number of business entities (volume of production, number of employed population) in general in all types of economic activity in the country (n).

To measure the level of shadow economy in the transportation and logistics sector, the relevant Methodological recommendations approved by the Ministry of Economy of Ukraine (Ministry of Economy of Ukraine, 2009) are taken as a basis. Its level L_{SE} was calculated according to the formula:

$$L_{SE} = \frac{L_{SEmin} + L_{SEmax}}{2}, \quad (2)$$

where L_{SE} is the level of the shadow economy in the transportation and logistics sector in the i -th year; L_{SEmin} is the marginal minimum level of the shadow economy in the transportation and logis-

tics sector in the i -th year; L_{SEmax} is the marginal maximum level of the shadow economy in the transportation and logistics sector in the i -th year.

The calculation of the marginal minimum level of the shadow economy in the transportation and logistics sector in the i -th year (L_{SEmin}) is based on the following assumptions (Ministry of Economy of Ukraine, 2009):

- 1) all loss-making enterprises, according to official statistical data, are actually profitable, which is considered an overestimation of the size of the shadow economy. The profitability of loss-making enterprises is equal to the profitability of profitable enterprises in the period under analysis;
- 2) the ratio of expenses of loss-making and profitable enterprises is identical to the ratio of the number of such enterprises.

Therefore:

$$L_{SEmin} = \frac{P_{PE} \cdot R_{L/P} \cdot L_{LE}}{GVA_{TLS}} \cdot 100\%, \quad (3)$$

where P_{PE} is profit of profitable enterprises in the transportation and logistics sector in the i -th year, mln UAH; $R_{L/P}$ is the ratio of the number of loss-making and profitable enterprises in the transportation and logistics sector in the i -th year; L_{LE} is loss of loss-making enterprises in the transportation and logistics sector in the i -th year, mln UAH; GVA_{TLS} is gross added value of the transportation and logistics sector in the i -th year, mln UAH.

At the same time, taking into account the assumptions mentioned above, the numerator of formula (3) actually characterizes the amount of shadow profit of enterprises in the transportation and logistics sector in the i -th year (mln UAH).

The marginal maximum level of the shadow economy in the transportation and logistics sector in the i -th year (L_{SEmax}) is calculated taking into account the assumption that all profitable enterprises display only undistorted data in their reports, and all loss-making enterprises hide the entire volume of gross added value of their products, and not only profit. Therefore:

$$L_{i \max} = \left(\frac{N_{LE}}{N_{PE} + N_{LE}} \right) \cdot 100\%, \quad (4)$$

where N_{LE} is the number of loss-making enterprises in the transportation and logistics sector in the i -th year; N_{PE} is the number of profitable enterprises of the transportation and logistics sector in the i -th year.

3. RESULTS AND DISCUSSION

High logistics potential is a driver of resilience of socio-economic systems of countries. The study confirmed (H1) using a determinological analysis of the Logistic Performance Index and the Global Resilience Index. The feasibility of choosing the Logistic Performance Index for determinological analysis has been justified by its wide use in analytical studies (for example, International Transport Forum (2015), Suki et al. (2020), Dimitrievska et al. (2020)). International freight forwarders are the direct evaluators of logistics efficiency in countries. Their activities are closely related to the industry of road freight transportation. Thus, the countries' scores according to the Logistic Performance Index are an objective and up-to-date assessment of the development of the national logistics sector. The calculation of the Global Resilience Index

takes into account a number of parameters characterizing the economic resilience of the country, the security and geopolitical situation, and the resilience of supply chains. Global Resilience Index FM provides stakeholders with a comprehensive assessment of the resilience of the national economy of a certain country in the world.

The coefficient of determination between the Logistic Performance Index and the Global Resilience Index FM $R^2 = 0.772$ (Figure 1), which indicates that logistics potential is one of the important drivers of the resilience of socio-economic systems of countries.

Correlation coefficient between the Logistic Performance Index and the Global Resilience Index $r = 0.878$.

The comparative analysis indicate that for logistics, the most significant influence on the resilience of the socio-economic system of countries is exerted by the quality of logistics services in the country, the efficiency of the registration process by customs and border control authorities, and the quality of trade and transport infrastructure.

The transportation and logistics sector makes a significant socio-economic contribution to the

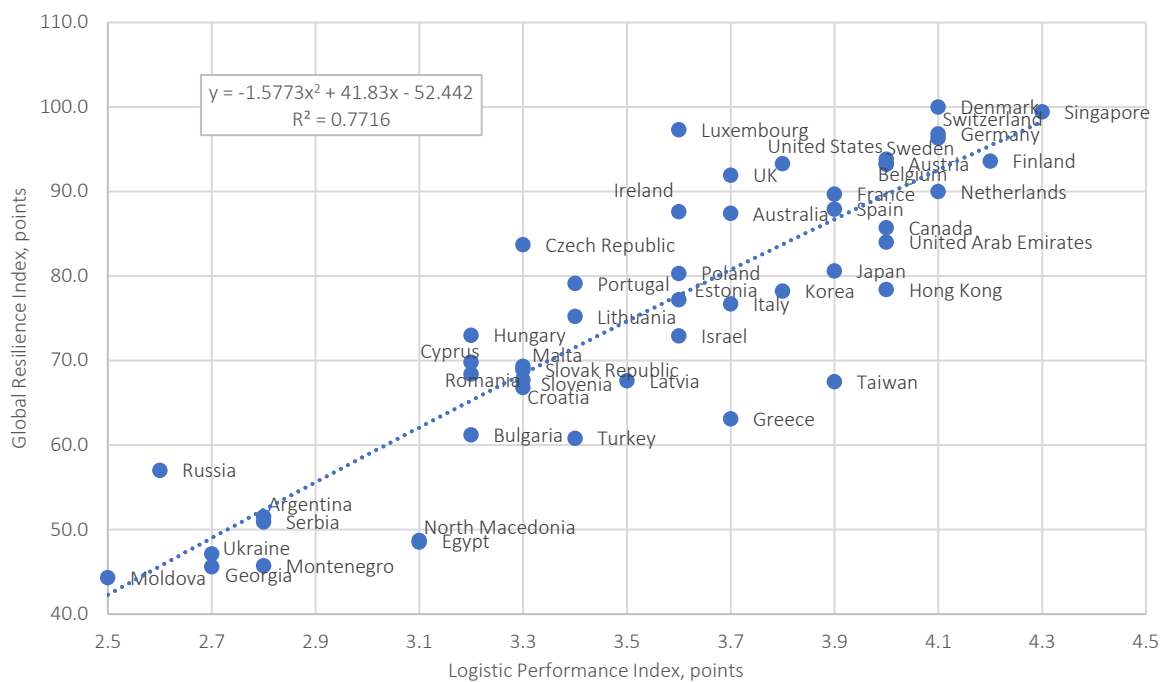


Figure 1. Logistics Performance Index and the Global Resilience Index, 2022

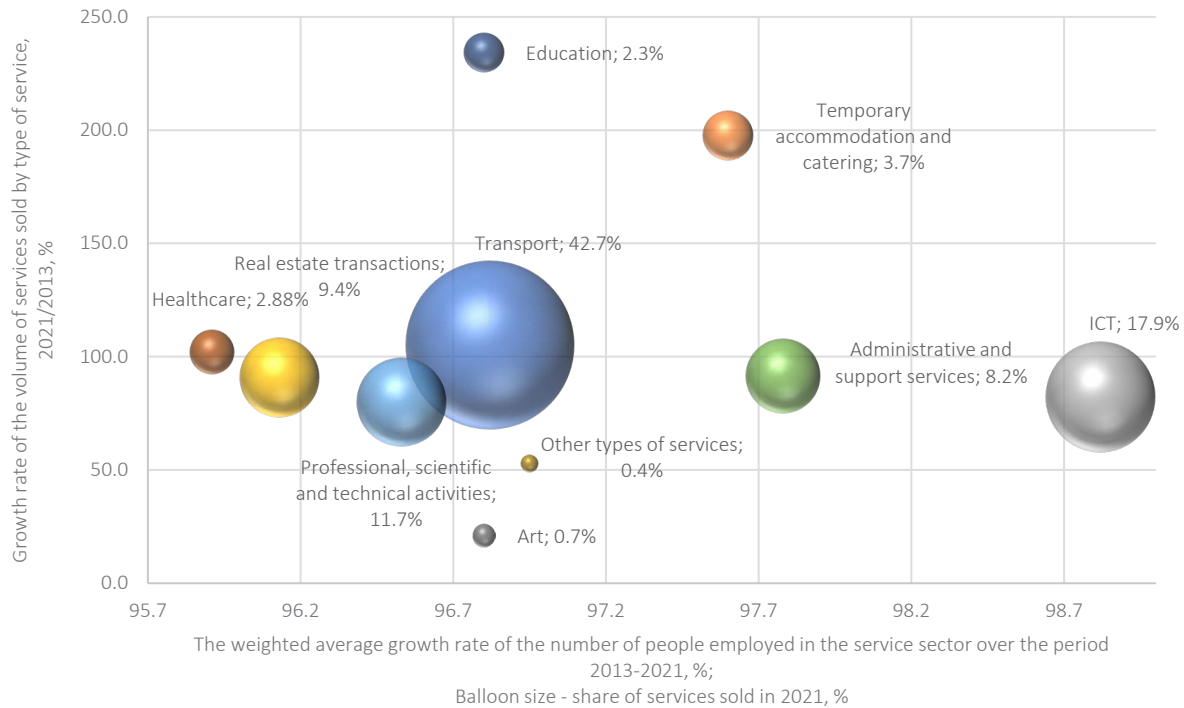


Figure 2. Change in the role of certain types of services in the economy of Ukraine for 2013–2021

formation of Ukraine’s GDP. Transport and logistics services occupy the largest share in the total volume of realized services in Ukraine, which as of 2021 amounted to 42.7% (Figure 2). This confirms the importance of the transportation and logistics sector in ensuring the resilience of the country’s economic system.

Despite the less dynamic development of the transport sector during 2013–2021, compared to other sectors, such as ICT, education, restaurant and hotel business, it was still characterized by an increase in the volume of realized services (even taking into account inflation).

The importance of the transportation and logistics sector in ensuring the resilience of the economic system of Ukraine is also indicated by the high level of its concentration in the regional economies. According to the number of active business entities in the field of transport, warehousing, postal and courier activities, about half of the Ukrainian regions have an LQ greater than 1. In the Vinnytsia Oblast, the Location quotient is the largest and is 1.46 (Appendix A, Table A1).

The transportation and logistics sector of Ukraine is characterized by high attractiveness among

Ukrainian and foreign investors, which indicates its high potential for ensuring the resilience of the economic system, because the priority of investment is related to the strategic competitiveness of the specified sector and potential growing returns.

In 2021, the share of capital investments in the transportation and logistics sector of Ukraine in the total volume of investments was 7% (Figure 3).

In logistics, a disincentive and destructive factor in ensuring the resilience of the economic system of Ukraine is a high level of shadow activity in the transportation and logistics sector. At the end of 2021, according to the data of the Ministry of Economy of Ukraine, the level of the shadow economy, calculated by using the loss-making method of enterprises, was 23% of the official GDP. Its level in the transportation and logistics sector was 17.4%, which is 5.8% less compared to a similar indicator in 2013 (Figure 4).

In the anti-rating of the sectors of the Ukraine’s economy in terms of the level of shadow activity, the transport sector occupied the 4th-5th position during 2013–2021. Traditionally, the most shadowed sectors are financial and insurance activities, real estate transactions, construction, and mining.

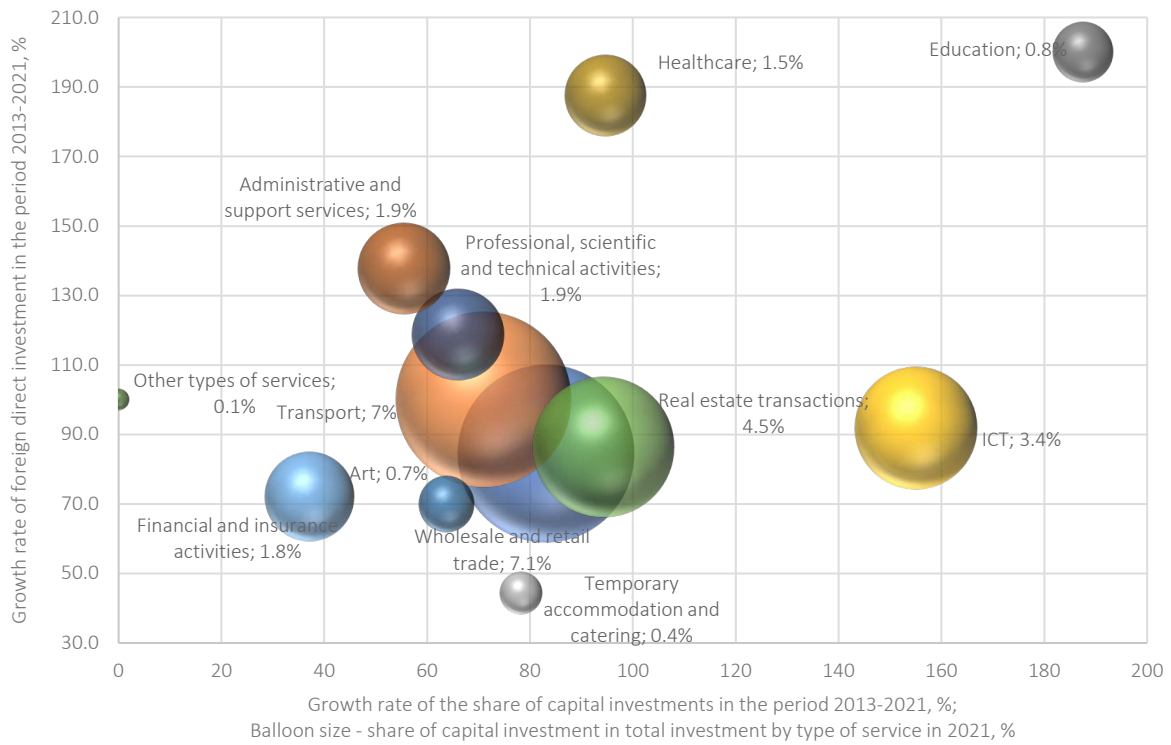


Figure 3. Dynamics and attractiveness of domestic and foreign investment by type of services in Ukraine

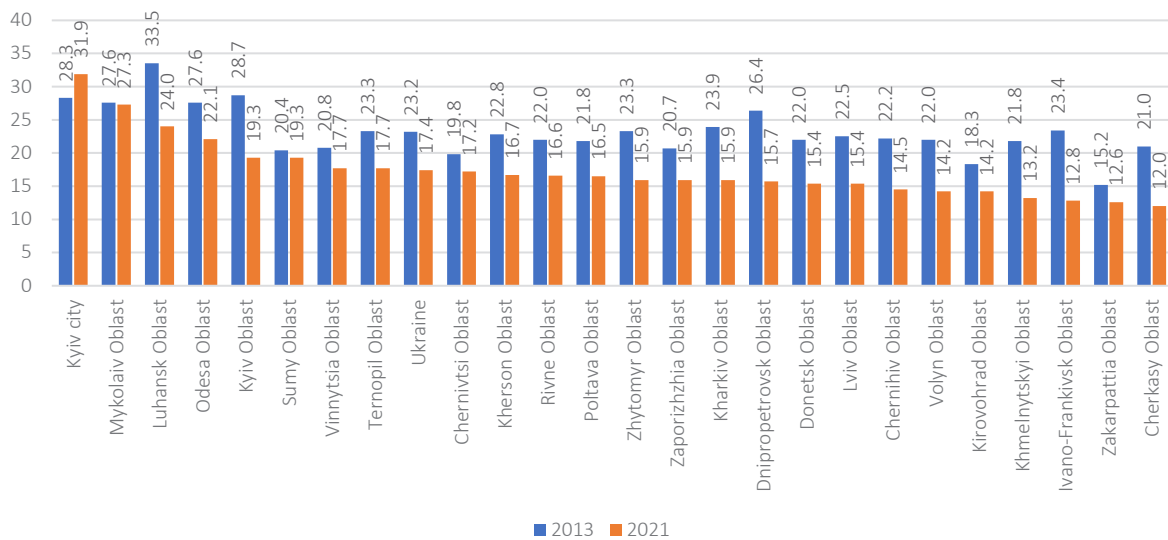


Figure 4. Coefficient of the shadow economy in the transportation and logistics sector, % in Gross Added Value

Figure 4 demonstrates a higher level of shadowing of the transport sector in the border regions of Ukraine, especially in those that specialize in the provision of transport and logistics services and, accordingly, concentrate the largest share of transport and logistics flows. Seaports, multi-

modal terminals, and more developed logistics infrastructure are located in these regions (Kyiv city, Mykolaiv, Odesa, and Kyiv Oblasts), etc. However, despite the unstable socio-economic and political situation in Ukraine during 2013–2021, there is still a noticeable positive trend toward a decrease

in the level of shadowing of the transportation and logistics sector in all regions of Ukraine.

A destructive factor affecting the development of the transportation and logistics sector is the high level of depreciation of fixed assets. In particular, the specified indicator during 2015–2020 fluctuated within 50% with the value of the renewal coefficient of fixed assets at the level of ~10%.

Depreciation rate of fixed assets and intangible assets of enterprises by type of economic activity “Cargo road transport, provision of transportation services” (Code 49.4 according to the classification of types of economic activity (KVED-2010)) is shown in Appendix A, Table A2.

Enterprises of Donetsk, Zhytomyr, and Sumy Oblasts, including the city of Kyiv, showed the highest depreciation rate during 2015–2020. There are changing trends in terms of the depreciation rate of fixed assets across regions, while its level generally remains high.

The analysis of rolling stock of railway transport proved the low level of its renewal and modernization, which directly affects the efficiency of freight transportation and the prospects for its increase. As of the end of 2020, about 52% of the entire wagon fleet was owned by Ukrzaliznytsia JSC. At the same time, if the rest of the owners had an idle fleet of about 10%, Ukrzaliznytsia JSC showed 50.23% as of the beginning of 2022 (Appendix A, Table A3).

As of January 1, 2022, refrigerators, cement trucks, grain trucks, dump trucks, and mineral trucks owned by Ukrzaliznytsia JSC, as well as privately owned refrigerators and hopper-dispensers (but only up to 100 such units) were 100% worn out. Hopper dispensers, which are used in track maintenance and repair, are 98% worn out. They are the oldest type of rolling stock that has been in use for twice as long as the standard term – more than 44 years, compared to the 25 provided by the manufacturer. Dump trucks are also worn out by an average of 98%. Moreover, the indicated trend is approximately identical, both for the cars of Ukrzaliznytsia JSC and for the rolling stock of other owners. Universal platforms and roller conveyors also have a wear rate of more than 95%. The newest wagons

in the general fleet in Ukraine are grain trucks and semi-wagons. They are worn, respectively, by 67% and 69%. Such indicators were achieved mostly thanks to the renewal of the rolling stock of private owners. In Ukrzaliznytsia JSC, almost all types of cars are worn out by 94–100%. Semi-wagons are the least worn by age, by 83% (Kopylov, 2022).

Full-scale war unleashed by the Russian aggressor is a global challenge. This led to a decrease in the logistical potential of ensuring the resilience of the economic system of Ukraine.

First, during the war, the operation of a number of logistics routes and branches of the transportation and logistics sector was blocked. In particular, the threat of air attacks “grounded” all air transport in Ukraine. The occupation of part of the Kherson and Zaporizhzhia Oblasts, as well as the destruction of the Kakhovska HPP, stopped the movement of river transport along the Dnipro. Russian warships in the Black Sea are blocking Ukrainian seaports. In addition to the obvious loss of income, the blockade of Ukrainian ports led to the disruption of logistics chains. For Ukrainian seaports, this caused the loss of some customers. Instead, companies that sold their products by sea were forced to look for new intermediaries and new sales markets (Melnyk & Leshchukh, 2023).

Second, as a result of hostilities and rocket attacks, the destruction of transport infrastructure has occurred (and continues to occur). As of September 1, 2022:

- 25 thousand kilometers of roads were destroyed and 315 bridges and overpasses were damaged;
- 19 civil aviation airports were damaged or destroyed; runways were destroyed in 12 airports. The amount of the specified damage is estimated at 2.1 billion US dollars;
- the total amount of damaged railway track is up to 500 km. 111 railway stations were damaged. Direct losses on the railways are estimated at 4.3 billion US dollars;
- the port infrastructure lost 496 million US dollars; this is both the infrastructure of sea-

ports and the objects of inland water transport that were destroyed as a result of the war.

Third, there was a change in the vector of export-import flows. In 2022, the EU countries dominated foreign trade with Ukraine. The share of Ukrainian exports to the EU countries reached 63.2%, which is 23.9% more compared to 2021. In 2022, Ukraine increased its merchandise exports to the EU countries by 4.2% compared to 2021 (from 26.8 billion USD to 28 billion USD, respectively), despite the fact that in 2022, Ukrainian exports decreased by 35.1% (Melnyk et al., 2023b).

Fourthly, there was a reorientation of export and import flows by types of transport. In particular, in

January 2022, the share of exports transported by sea transport was 80%, but in April 2022, it was only 13%. The majority of export flows from sea transport were reoriented to railway transport (Figure 5).

According to the State Customs Service of Ukraine, the share of railway transport in the structure of export cargo shipments in January-July 2023 increased by 11.3% compared to the same period in 2021 and reached 33.6%. In absolute terms, against the background of a general decrease in good exports from Ukraine during 2023, the export cargo flows by railways decreased by almost 50%.

The triggers for the reduction of the export cargo flows by railways in Ukraine in 2022–2023 were:



Figure 5. Dynamics of cargo transshipment by types of transport from December 2021 to July 2023

- loss of cargo weight due to the decrease in production of agricultural and metal products;
- imperfect current tariff system for railway transportation;
- significant increase in the price of transport and logistics services;
- limited capacity of border crossing points and transport and logistics infrastructure in Ukraine;
- technological limitations associated with a different size of the track (change of wagon bogies from 1520 mm Ukrainian to 1435 mm European);
- restrictions related to the conduct of control procedures by border, customs, and phytosanitary services, both from the Ukrainian side and from the side of neighboring countries;
- limited capacity of railway and transport-logistics infrastructure of neighboring countries (capacity of tracks and routes, number of rolling stock, sorting stations, and warehouses for handling and storage/accumulation of cargo);
- complicated interaction between different modes of transport and a shortage of cargo handling capacity in the process of transshipment.

In September 2022, the Agreement between Ukraine, Russia, Turkey, and the UN on the introduction of a maritime corridor in the Black Sea for the export of Ukrainian grain was signed. This returned the primacy of sea transport in terms of transshipment volumes for export. However, as early as May 2023, Russia continued to actively block the Port of Pivdennyi, which again led to a decrease in cargo transshipment by sea transport.

In the conditions of the war, road transport showed high resilience compared to a number of other types of transport. The share of goods exported by road transport increased from 4.2% in January-July 2021 to 9.8% in January-July 2023. More valuable goods are transported by road transport – 1 ton of goods exported by

road transport cost 1510 USD in 2023, while the cost of exporting goods by sea transport was 284 USD/ton, and by rail – 220 USD/ton.

As for imports, the application of sanctions against Russian and Belarusian companies and goods zeroed out imports from these countries, which were mainly delivered by railways. The share of railway transport decreased in the structure of freight transportation. Road transport took first place in terms of transportation volumes.

Thus, in January-July 2023, 53.1% of the total volume of cargo transportation was brought into the country by trucks, which amounted to 25.6 billion US dollars.

Fifthly, military operations, blockades of seaports, damage to transport and logistics infrastructure, etc., caused a decrease in the physical volume of cargo transportation and a change in its structure by types of goods.

In January-September 2023, compared to the same period of pre-war 2021, the value of exported goods from Ukraine decreased by almost 42%. First of all, this happened due to a drop in the volume of exports of metal products (the value of exported ferrous metals decreased by almost 80%), as well as ores, slag, and ash (the value of exports decreased by 78.4%).

Such a sharp decrease in the export of the specified groups of goods was a consequence of the occupation by the Russian army of Ukrainian regions-industrial giants, and with them, accordingly, powerful industrial plants, damage to the logistics infrastructure, occupation of a number of powerful ports, blocking of the operation of Ukrainian-controlled ports, etc.

Instead, the limitation of opportunities to export metallurgical products and some other groups of goods due to the so-called “grain agreement” led to changes in the structure of Ukrainian exports. In January-September 2023, compared to the same period of pre-war 2021, the share of grain crops in Ukrainian exports increased from 15.3% to almost 25%. In absolute terms, during the specified period, the value of grain exports still decreased by almost 330 million US dollars (Table 1).

Table 1. Structure of goods export of Ukraine in January-August 2023 (the war lasts 1.5 years), compared to January-August 2021 (the pre-war period)

Product	January-August		Change (+/-), 2023 to 2021, percentage points
	2021	2023	
Cereal crops	15.3	24.9	9.5
Animal fats and oils	9.8	15.4	5.5
Black metals	21.3	7.4	-13.9
Seeds and fruits	2.1	6.2	4.2
Electric machines	4.9	5.1	0.3
Ores, slag and ash	13.4	5.0	-8.4
Wood, wood products; charcoal	3.2	4.3	1.2
Others	30.0	31.7	1.6

The main drivers of ensuring the resilience of the economic system of Ukraine in the context of logistics should include several factors.

The first is the flexibility of logistics potential (infrastructure). It is about the ability to quickly overcome the risks caused by war. The transport and logistics system must be able to withstand possible destruction, due to the rapid repair of damage, the construction of alternative routes, that is, be able to quickly reorient the directions of cargo flows.

For example, during the outbreak of war, the seaports of Great Odesa, Mykolaiv, and Kherson were blocked. The ports of the Sea of Azov are still occupied. However, the potential of the transport and logistics system allowed businesses to quickly reorient the direction of cargo flows to the Danube ports, which are located significantly further from the front line (Figure 6).

The Danube ports (before the war, were one of the smallest seaports in the country in terms of the volume of cargo transferred), in the conditions of

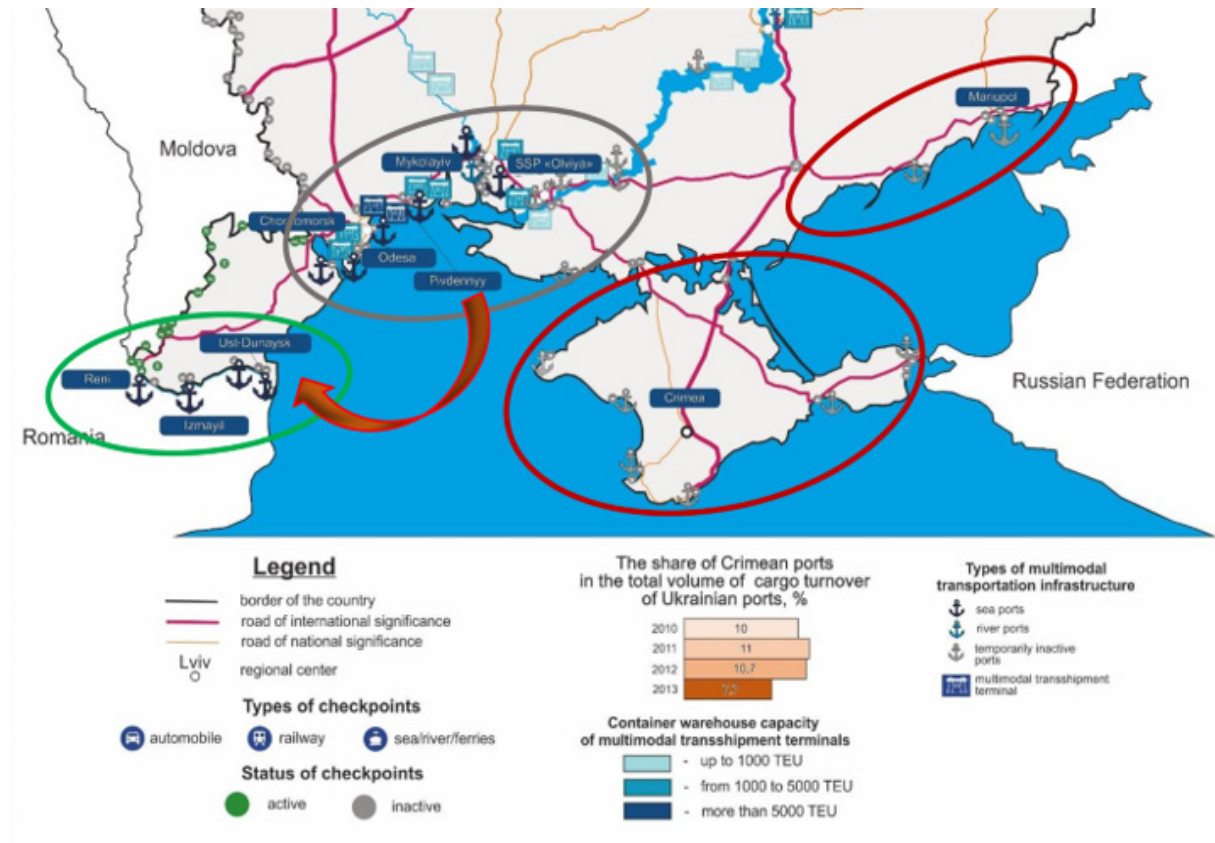


Figure 6. Reorientation of cargo flows from Ukraine between seaports in conditions of full-scale war

a full-scale war in 2022, handled three times more cargo than in the pre-war 2021.

The Western Terminal launched a regular train from Ternopil to Constanta, which helped transport many containers, including critical imports and essential products. Today, Ukraine delivers goods by rail to Gdańsk, Gdynia, Swinoujście (Poland) and Constanta (Romania), which are then sent by sea to the final consumer. The first container train to Klaipėda (Lithuania) was launched (Trade Master Group, 2022).

The conclusions regarding the need to ensure the flexibility of the logistics infrastructure to form the resilience of the economic system of Ukraine in the conditions of war are consistent with previous research results. For example, Hryniv and Ravlikovska (2022) note that the operational restructuring of the logistics system, the formation of new cargo delivery chains, the change in the direction of trade flows due to the blockade of Ukrainian seaports and the partial loss of the railway network are essential to preserving the resilience and competitiveness of Ukraine in the international arena.

The second factor is multimodality, the ability to quickly transfer goods from one mode of transport to another (for example, in containers). This approach requires multimodal terminals in the west and south of the country that will serve as integrated transport and logistics centers and customs points. Such terminals should provide an easy transition from rail to water transport in order to stimulate the development of river transport and the reorientation of part of the cargo flow from roads to water transport.

The war in Ukraine only increased the urgency of developing multimodal transportation and, accordingly, multimodal infrastructure. At the moment, the logistics potential of multimodal terminals in Western Ukraine is growing. The expediency and timeliness are also determined by the wartime construction of new multimodal terminals in the west (Figure A1) and south of the country, which will serve as integrated transport and logistics centers and customs points. Such is, for example, the container terminal “Mostyska.”

International Transport Forum (2015) emphasizes multimodality as a driver of ensuring the resilience of the economic system in the context of logistics. Despite the development of seaports and the expansion of sea transport capacities, for the provision of high-quality logistics services, it is important to provide the country with internal land logistics facilities (transshipment terminals, warehouse infrastructure, etc.) with high capacity, as well as transport connectivity between such facilities and seaports. A similar thesis is defended by Shelest (2023), noting that multimodality ensures the technological unity of various types of transport and improves the quality of logistics services.

The third factor is the transformation of the transport and logistics system, the priority directions of which in the conditions of war, first of all, are:

- restoration of the destroyed railway infrastructure should take into account possible changes in the location of large industrial enterprises and sources of cargo flows;
- restoration of the capacity and cargo capacity of seaports (today, their work is blocked) by attracting investments (for demining, dredging, clearing, repair, and modernization of port infrastructure). They will not immediately be able to reach the pre-war volume of transshipment of goods; therefore the importance of road and rail transport in the western direction will remain;
- reorientation of the development of the transport network to support the development of western routes. After the war, the focus should be shifted to the development of the capacity of logistics centers near the border crossing points with EU countries, taking into account the requirements of interoperability and effective use of the railway infrastructure of the 1435 mm and 1520 mm track;
- development of warehouse management. In addition to the physical transportation of goods, today, there is a growing demand for their handling, storage, and sorting services, especially in places close to border crossings with Poland, Hungary, Romania, and Slovakia;

- growth of investments in the construction of elevators. For example, out of 1,200 grain elevators, granaries, grain processing plants, and grain receiving points in Lviv Oblast, only 27 are working, in Ivano-Frankivsk – 11, in Zakarpattia – 2, in Chernivtsi – 7, in Volyn – 22, which is a total of slightly more than 5% of all granaries country (Bno-Airian, 2022).

The fourth is the deepening of cooperation with neighboring countries. Ukraine should continue to develop cooperation and coordination in transport with neighboring countries – Poland, Hungary, Romania, Slovakia, and Moldova – regarding joint customs control, unification of cargo movement information systems, paperless technologies, 24-hour work, modernization, and increase of railway capacity of the respective countries the entire volume of cargo offered by Ukraine. In the long term, Ukraine should also build railways with European gauge (1,435 mm) to the largest cities of Ukraine (Haidai et al., 2022).

On June 21, 2023, EU member states approved a list of 107 projects with a total budget of 6.2 billion euros aimed at the development of the Trans-European transport network (European Commission, 2023). Nine of them, with a total EU support of almost EUR 250 million, will involve improving cross-border connectivity between neighboring EU member states (Poland, Slovakia, Hungary, and Romania) and Ukraine/Moldova with the aim of promoting Ukrainian exports and bilateral trade.

The fifth factor is comprehensive and systematic state support for the development of freight transportation by rail. It should consider, on the one hand, the lower cost of such transportation compared to road transportation, and on the other hand, their higher environmental friendliness.

In general, the thesis regarding the need to form a state policy to support the development of logistics in the conditions of war and post-war recovery is not new in the scientific debate. Schults and Lutskiv (2022) call such support decisive in the context of ensuring the country's vital activities in conditions of shocks and upheavals. The authors emphasize the need to improve the legal framework for the development of transport and road

management, implement state control during the movement of goods and vehicles across the state border, and develop complex management solutions in the field of spatial planning to increase transport productivity.

The sixth factor is compliance with European standards. Ukraine aspires to become a member of the European Union. Accordingly, it must apply EU standards when rebuilding and modernizing its infrastructure. For example, it must provide access to passenger infrastructure for people with special needs and other groups with reduced mobility, meet environmental and health safety requirements for demolition and restoration of buildings and engineering structures, produce freight cars of European dimensions, and consider the transition to alternative energy sources (Haidai et al., 2022).

Finally, the last factor is establishment of own freight carrier company by Ukrzaliznytsia for operating abroad. This will facilitate access to the European market of passenger and cargo transportation and increase the volume of cargo transportation in EU countries (Ivanova, 2023).

Thus, the conducted analysis has confirmed the hypothesis H1 that high logistical potential, determined by the efficiency of customs and border control, the quality of trade and transport infrastructure, ease of delivery organization, quality of logistical services, etc., serves as a driver of the resilience of the socio-economic systems of countries worldwide. This is also confirmed by testing the hypothesis H2 regarding the significant contribution of the transport logistics sector to the formation of Ukraine's GDP and its high attractiveness to Ukrainian and foreign investors in the pre-war period. The results of the study also confirm the hypothesis H3 that the full-scale war unleashed by the Russian aggressor led to a decrease in the logistical potential of ensuring the resilience of Ukraine's economic system. Such reduction was a result of blocking various logistic routes and sectors of the transport-logistics industry, destruction of transport infrastructure objects due to combat actions and missile strikes, blockage of maritime ports, shifts in export-import flows, redirection of export and import flows by types of transport, and so forth.

Therefore, in the context of post-war recovery, to ensure the resilience of Ukraine's economic system regarding logistics, it is relevant to stimulate the flexibility of logistical potential (infrastructure), restore the destroyed transport logistics and warehouse infrastructure, develop infra-

structure for shifting goods from one mode of transport to another, provide comprehensive and systematic state support for the development of freight transportation by rail, and deepen cooperation with neighboring countries in the context of logistics.

CONCLUSION

This paper aimed to study the logistics potential of ensuring the resilience of the economic system of Ukraine in the face of global challenges. The hypothesis that the logistic potential plays an important role in the process of ensuring the resilience of the economic systems of the countries was proved based on the determinological analysis between the Logistic Performance Index and the Global Resilience Index. High-quality logistics support and developed logistics infrastructure contribute to the country's integration into global supply chains and the formation of a single logistics space.

Logistics potential is one of the important drivers of ensuring the resilience of the economic system of Ukraine. This is evidenced by: 1) a significant share of transport and logistics services in the total services of Ukraine (42.7%); 2) annual increase in the logistics services (even taking into account inflation); 3) a high level of concentration of the transportation and logistics sector in the regional economies of Ukraine; and 4) high attractiveness of the sector among Ukrainian and foreign investors.

The results testify to the presence of a number of disincentive and destructive factors in the development of the logistics potential of Ukraine in the pre-war period, which negatively affected the resilience of the national economic system. Among them is a high level of shadow activity in the transport and logistics services sector (according to the calculations, it is 17.4% of the official GDP in 2021). This level was especially high in the border regions of Ukraine, as well as regions where seaports and multimodal terminals are located and logistics infrastructure is more developed (Kyiv city, Mykolaiv, Odesa, and Kyiv Oblasts), etc. Another destructive factor influencing the development of the logistics potential of Ukraine in the pre-war period was the high level of wear of rolling stock of railway transport and the low level of its renewal and modernization.

The conducted research made it possible to confirm the hypothesis of a decrease in the logistical potential of ensuring the resilience of the economic system of Ukraine in the conditions of a global challenge – full-scale Russian military aggression. This decrease was influenced by blocking the operation of a number of logistics routes and branches of the transport and logistics sphere, destruction of transport infrastructure facilities as a result of hostilities and rocket attacks, change in the vector of export-import flows, reorientation of export and import flows by types of transport, decrease in physical volumes of cargo transportation, as well as change in the structure of cargo transportation by types of goods.

Considering the above, the transportation and logistics sector needs well-founded measures of state policy to increase its resistance to the challenges of war and form the basis for long-term growth. At the same time, the key drivers of ensuring the development of the transportation and logistics sector in war conditions and, accordingly, the formation of the resilience of the economic system of Ukraine in the context of logistics should be the flexibility of the logistics potential (infrastructure), multimodality, the transformation of the transport and logistics system, the deepening of cooperation with neighboring countries, and compliance with European standards.

Prospects for further research include the study of specific mechanisms and tools for increasing Ukraine's logistics potential in the conditions of war and post-war recovery.

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APPENDIX A

Table A1. LQ by the number of active business entities in the field of transport, warehousing, postal and courier activities, 2015–2020

Oblasts	Years			
	2015	2017	2019	2020
Vinnitsia Oblast	1.48	1.53	1.50	1.46
Volyn Oblast	1.22	1.39	1.41	1.43
Dnipropetrovsk Oblast	1.11	1.06	1.02	1.00
Donetsk Oblast	0.86	0.91	0.96	0.95
Zhytomyr Oblast	1.05	1.05	1.09	1.10
Zakarpattia Oblast	1.27	1.18	1.17	1.14
Zaporizhzhia Oblast	0.80	0.74	0.73	0.71
Ivano-Frankivsk Oblast	0.94	0.91	0.88	0.81
Kyiv Oblast	1.17	1.13	1.16	1.13
Kirovohrad Oblast	1.09	1.12	1.17	1.20
Luhansk Oblast	1.03	1.35	1.44	1.34
Lviv Oblast	0.90	0.89	0.92	0.95
Mykolaiv Oblast	1.15	1.16	1.17	1.22
Odesa Oblast	1.04	1.05	1.08	1.10
Poltava Oblast	1.17	1.14	1.13	1.11
Rivne Oblast	1.34	1.34	1.37	1.36
Sumy Oblast	0.91	0.96	1.04	1.03
Ternopil Oblast	1.24	1.20	1.25	1.23
Kharkiv Oblast	0.80	0.78	0.74	0.74
Kherson Oblast	1.07	1.12	1.14	1.12
Khmelnitskyi Oblast	0.98	1.01	1.06	1.05
Cherkasy Oblast	1.08	1.19	1.23	1.25
Chernivtsi Oblast	0.89	0.86	0.85	0.81
Chernihiv Oblast	1.13	1.21	1.33	1.34
Kyiv city	0.65	0.67	0.65	0.68

Note: If LQ = 1, the region is characterized by the same level of industry concentration on a certain characteristic as at the national level; if LQ = 1.1, the concentration of the industry in the region is greater than the national average. A location quotient of less than one (LQ < 1) indicates that the concentration of the industry at the regional level is less than the national average.

Table A2. Depreciation rate of fixed assets and intangible assets of enterprises by type of economic activity “Cargo road transport, provision of services for transportation of goods” (Code 49.4 according to KVED-2010)

Source: State Statistics Service of Ukraine (2022).

Regions	Depreciation rate of fixed assets and intangible assets of enterprises, %			
	2015	2017	2019	2020
Ukraine	51.91	55.24	57.07	56.54
Vinnitsia Oblast	55.05	45.74	45.96	47.54
Volyn Oblast	55.21	49.42	45.37	46.88
Dnipropetrovsk Oblast	49.53	39.78	41.33	43.79
Donetsk Oblast	69.84	73.67	90.97	89.33
Zhytomyr Oblast	69.21	71.24	68.35	68.63
Zakarpattia Oblast	54.71	46.28	47.79	53.71
Zaporizhzhia Oblast	65.33	54.64	46.64	43.75
Ivano-Frankivsk Oblast	21.96	38.88	39.36	45.61
Kyiv Oblast	56.07	46.99	47.45	49.06
Kirovohrad Oblast	39.80	40.44	47.08	53.14
Luhansk Oblast	58.40	54.30	45.08	46.08
Lviv Oblast	65.60	57.33	34.59	41.82
Mykolaiv Oblast	49.41	46.68	47.19	46.74
Odesa Oblast	47.42	35.77	44.33	46.74

Table A2 (cont.). Depreciation rate of fixed assets and intangible assets of enterprises by type of economic activity “Cargo road transport, provision of services for transportation of goods” (Code 49.4 according to KVED-2010)

Regions	Depreciation rate of fixed assets and intangible assets of enterprises, %			
	2015	2017	2019	2020
Poltava Oblast	47.99	45.40	40.17	44.76
Rivne Oblast	58.97	43.22	41.46	45.87
Sumy Oblast	67.16	66.87	60.68	56.88
Ternopil Oblast	44.98	37.73	38.47	37.52
Kharkiv Oblast	63.18	58.72	55.12	52.87
Kherson Oblast	69.33	50.10	43.77	44.96
Khmelnyskyi Oblast	52.94	42.08	45.04	45.49
Cherkasy Oblast	59.29	59.62	45.13	49.90
Chernivtsi Oblast	52.21	40.30	41.37	42.36
Chernihiv Oblast	44.93	46.01	43.43	47.28
Kyiv city	56.02	67.89	64.87	60.57

Table A3. Fleet of wagons of Ukrzaliznytsia JSC as of January 21, 2022

Source: Open Data Portal (2022).

Kind of wagon	Number, units	Working fleet, units	Non-working fleet	
			units	%
20 – Covered universal	5652	1935	3717	65.76
40 – Universal platforms	4957	2509	2448	49.38
60 – Hatch semi-wagons	49513	26247	23266	46.99
70 – Eight-axle and four-axle tanks	7064	2032	5032	71.23
72 – 8-axle oil and gasoline tanks	1536	8	1528	99.48
80 – Thermos wagons	256	4	252	98.44
87 – Refrigerators	198	107	91	45.96
90 - Specialized wagons	6867	2846	4021	58.56
91 – Car transporters	729	60	669	91.77
92 – Mineral trucks	2123	174	1949	91.80
93 – Cement trucks	4603	2612	1991	43.25
95 – Grain carriers	11615	6813	4802	41.34
96 – Fitting platforms	4035	2914	1121	27.78
97 – Dumpcars	942	676	266	28.24
98 – Hopper dispensers	1454	1096	358	24.62
99 – Transporters	306	35	271	88.56
In total	104587	52048	52539	50.23

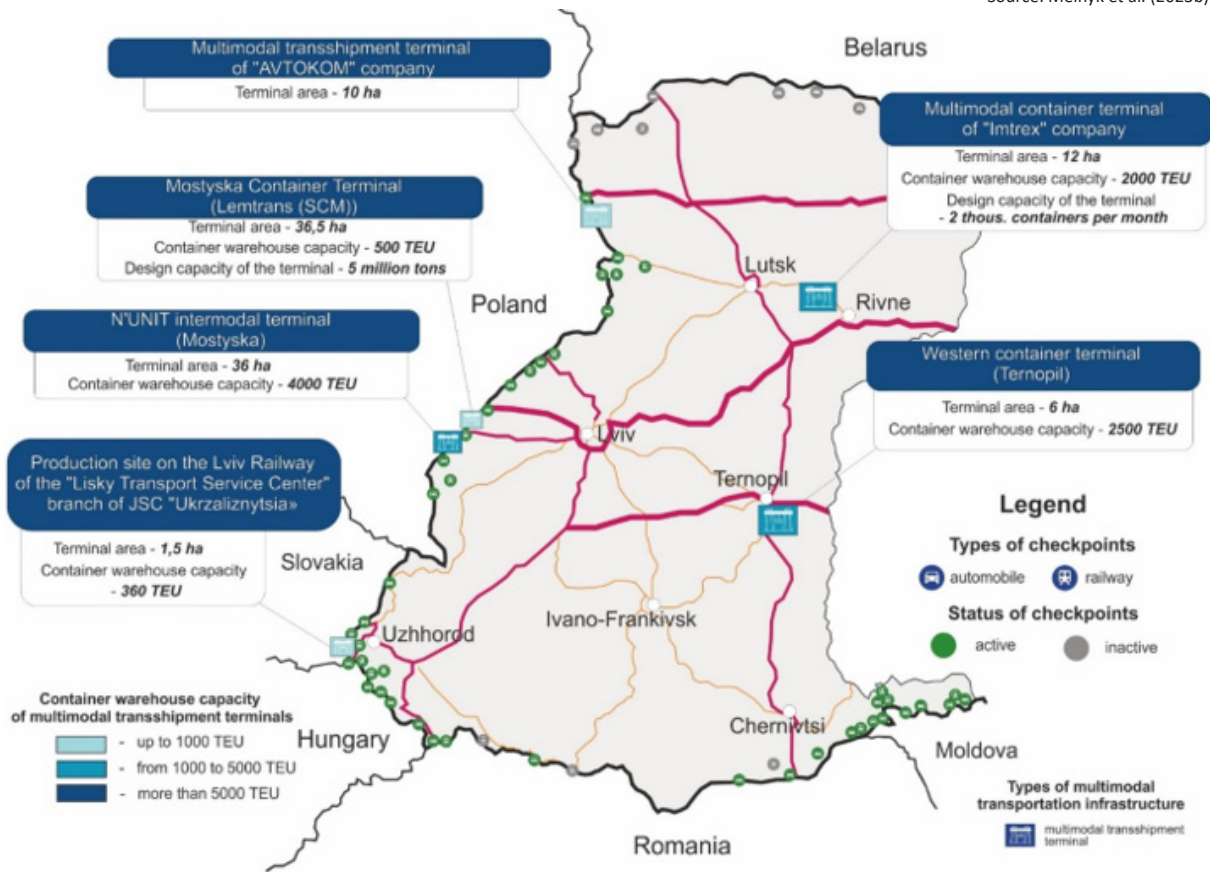


Figure A1. The infrastructure of overland multimodal freight transportation in Ukraine