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Impact of logistics disruptions on the business models of regional food producers

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Abstract. The aim of the study was to determine the features of adaptation of the production and sales strategies of food industry enterprises in Ukraine to the challenges caused by crisis phenomena in logistics chains. The methodology was based on an empirical approach with an analysis of fuel costs, the level of inflation, foreign trade and the financial results of leading companies. Economic-statistical, comparative and financial-analytical methods were used to examine the average prices of diesel and petrol, which rose from 24.54 and 25.18 UAH/l in 2020 to 52.66 and 58.49 UAH/l in 2024. The consumer price index in 2022 reached 126.6%, which, together with higher energy prices, sharply increased enterprise costs. Foreign trade in 2022 declined, exports of processed food products decreased to USD 2.5 billion, whereas in 2023-2024 there was a recovery: exports rose to USD 3.27 billion in 2023 and about USD 41 billion in 2024. Financial analysis showed that the revenue of Myronivsky Hliboproduct increased from USD 1,414 million in 2020 to USD 2,262 million in 2024, while net profit in 2022 was negative (-USD 269 million), but in 2024 recovered to USD 141 million. Kernel recorded a record profit of USD 513 million in 2021, but in 2022 incurred a loss of USD 41 million, partially restoring its indicators to USD 168 million in 2024. Regional examples – the Bashtanskyi cheese factory and the Haisyn dairy plant – were additionally considered; these enterprises demonstrated different resilience to logistics challenges, which made it possible to assess the vulnerability of local producers compared with holdings. The practical significance lies in the possibility of using the results to develop strategies for minimising logistics risks and increasing the financial resilience of enterprises

Keywords: supply; costs; exports; profitability; competitiveness; revenue

Introduction

The food industry is under the influence of numerous challenges, among which interruptions in the operation of the transport system, shortages of raw materials and rising energy costs play a key role. The most vulnerable to these processes are regional-level enterprises, which have limited possibilities for rapid response to changes

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compared with large national or transnational structures. Changes in logistics schemes lead to higher production costs, a narrowing of the product range, a reduction in export opportunities and a transformation of the competitive environment.

In the production of bakery products, obstacles to stable functioning remain interruptions in supplies caused by damage to transport infrastructure, port blockades, rising fuel costs and unstable demand. In the study by V. Nidelchu (2025) it was shown that these factors directly increase production costs, reduce profitability and complicate the maintenance of continuity in production processes. The author emphasised the impact of shortages of critical resource stocks and delivery delays on the quality of the final products, and also found that the lack of adaptive approaches in logistics strategies often leads to production stoppages. In the food supply system, a key challenge remains, ensuring the preservation of quality and minimising losses of perishable products. I.O. Mukharovska & M.V. Shkrobot (2021) considered the application of the principles of integrated logistics in cold supply chains, focusing on the need to coordinate the interests of all participants, adaptability, and the use of information technologies. The authors emphasised that cold logistics requires investment in refrigeration equipment, timely technical maintenance and the introduction of innovative control systems, including Radio Frequency Identification (RFID) tags, which make it possible to monitor the condition of cargo in real time.

The functioning of small businesses in the food industry of Ukraine is under pressure due to military actions, economic instability, infrastructure destruction, rising costs and the outflow of labour. In the study, P. Tishakov (2025) outlined structural and dynamic trends in the development of small enterprises during the war, focusing on such factors as inflation, reduced purchasing power of the population, increased tax burdens and a shortage of staff due to mobilisation and emigration. The author stressed the importance of state and international support programmes that make it possible to mitigate the effects of the crisis on entrepreneurs and partially restore the activities. Food production in Ukraine faces numerous challenges, including infrastructure destruction, blocked transport routes, shortages of raw materials, rising costs and loss of labour resources. V.L. Yevstakhevich *et al.* (2024) investigated logistics, financial, personnel and technological risks for enterprises during an armed conflict, emphasising the need for comprehensive risk management that covers supplier diversification, improved quality management and the creation of emergency response plans. The authors found that war leads to a significant increase in costs, delivery delays and a shortage of skilled labour.

In the sale of crop products, one of the key challenges is the high cost of transport and storage, which directly affects purchase prices and the level of enterprise profitability. This issue was examined by D. Semenda *et al.* (2021), who focused on the structure of logistics costs and proved that exporters' expenditure on transporting and storing grain reduces producers' profitability, as it forms lower selling prices. The authors emphasised the advisability of optimising the use of silo capacities and determining the most advantageous periods for selling products, taking into account fluctuations in the exchange rate and the costs of storage and transport.

The efficiency of logistics systems in times of military challenges is accompanied by a number of difficulties that complicate the maintenance of supply continuity and require the search for new approaches to flow management. In the study by O.M. Kovryga (2024), the features of the development of the transport and logistics system in Ukraine under conditions of instability were analysed, and the key factors affecting its performance were identified, in particular infrastructure limitations, customs barriers and the need for innovative management technologies. The author concluded that improvements in logistics processes are possible through the integration of digital solutions, increasing the level of coordination between participants and the formation of adaptive strategies. Y. Ivanov *et al.* (2025) investigated the role of logistics in forming enterprises' competitive advantages and increasing the efficiency of production and sales processes, emphasising that effective management of logistics systems contributes to higher productivity, improved customer service quality and stronger market positions for companies. The study defined the importance of innovative technologies, including automation, artificial intelligence and blockchain, for optimising transport and warehousing processes.

The operation of transport and logistics companies under martial law is accompanied by difficulties, including infrastructure destruction, blockades, the need to use longer routes and rising costs. A. Kholodenko & N. Petrusyk (2024) studied the impact of martial law on the quality of logistics services in Ukraine and noted that uncertainty and risks significantly complicated the maintenance of a high level of service. The authors emphasised that the optimal level is not the maximum but an economically justified quality of services, which enables companies to remain competitive without excessive costs.

The aspects of the long-term effectiveness and scaling of innovative logistics solutions, the integration of digital technologies and the impact on the resilience and competitiveness of enterprises in the post-war period remain insufficiently studied. The purpose of this study was to clarify transformational changes in the production and sales approaches of food industry enterprises at the regional level under the influence of disruptions in the supply system, since these approaches form the basis of business models and directly reflect companies' ability to adapt to logistics challenges. The tasks of the study were: to investigate the main types of interruptions in transport and logistics processes and the impact on enterprise functioning; to analyse producers' adaptation strategies for maintaining efficiency and competitive positions under conditions of unstable supplies.

Materials and Methods

The study was empirical in nature and covered the period 2020-2024; it was also extended to August 2025 to track the latest trends and the dynamics of enterprise recovery. This interval was chosen because of its representativeness: it combined different stages of the development of Ukraine's economy – from relative stability to crisis phenomena caused by the pandemic and military events, as well as an initial recovery period characterised by the gradual rebuilding of logistics infrastructure, increased export volumes and stabilisation of domestic production. This made it possible to trace the impact of logistics factors on the resilience of food industry enterprises in a changing environment. For the assessment of the dynamics of logistics service costs, an economic-statistical approach was used, within which the average prices of fuel in Ukraine in 2020-2024 were examined (MinFin, n.d.). The task of this stage was to identify the relationship between rising fuel prices and increased costs of transporting products. The problem of inflationary pressure was analysed using the comparative method, which made it possible to compare consumer price index indicators over the study period (Summary table of consumer price..., 2020; 2021; 2022; 2023; 2024). The analysis was conducted in order to determine the scale of the impact of macroeconomic fluctuations on production and logistics processes.

The application of the structural-dynamic method made it possible to trace changes in foreign trade in processed food products (Ukraine's Foreign Trade in Goods..., 2023; Ukrainian exports in 2024 grew by 13.4%..., 2024). The method was used to analyse the dependence of the food industry on export markets and the impact of changes in logistics infrastructure on trade flows. A descriptive approach was used to characterise modern digital tools applied in logistics, in particular RFID technologies (RFID in Supply Chain Management..., n.d.), as well as Warehouse Management System (n.d.) (WMS) warehouse management systems. The possibilities of Microsoft Dynamics 365 (n.d.) CRM and SMART WMS (Warehouse at your fingertips..., 2024) as examples of integration solutions for improving the efficiency of logistics processes were examined separately. This made it possible to outline the possibilities of digitalisation in reducing costs and increasing the efficiency of resource management. The statistical method, based on the use of descriptive statistics and comparison of average tariff values and sales indicators, was applied to assess changes in the structure of producers' logistics costs (Freight transportation tariff will..., 2024) and the volume of products sold in 2020-2024 (Smolinska *et al.*, 2025). The analysis made it possible to compare the dynamics of transport tariffs with sales indicators and the financial resilience of enterprises.

To specify the results, a financial-analytical approach was applied, focusing on two leading companies in the sector – Myronivsky Hliboproduct (MHP, n.d.) and Kernel (n.d.), which were selected because of the market leadership, high export volumes and representativeness for assessing the impact of logistics challenges. In the case of MHP, the lines of activity and export geography were examined (Export brands of MHP, n.d.; MHP is the leader in Ukrainian food exports..., 2025). Indicators of revenue, profitability, and margins in 2020-2024 were analysed separately on the basis of the company's financial reports (Financial results for the third quarter and nine..., 2021; 2022; 2023). Additional information was used from the 2024 report (Financial results for the third quarter and nine months..., 2024), which made it possible to track financial dynamics under conditions of military events. For MHP, the elasticity of profits with respect to the growth of logistics costs was assessed using a descriptive-analytical method by comparing financial results with the dynamics of fuel prices and transport tariffs. The absence of detailed data on transport and warehousing costs complicated precise calculations, so the analysis relied on aggregated indicators – fuel tariffs, inflation levels and increases in rail freight charges.

The analysis of Kernel's financial reporting was carried out on the basis of the company's official documents. The company's annual reports (Kernel Holding S.A. annual report..., 2020; 2021; 2022; 2023), which reflected activity dynamics in the pre-war and crisis periods, were used. Additional analysis was carried out based on the 2024 report (Kernel Holding S.A. annual report..., 2024), which outlined the company's recovery trends. This made it possible to trace key trends in changes in revenue, costs, and profitability under the influence of logistics transformations. In the case of Kernel, data on export volumes (Kernel exported 4.4 million tons..., 2025) were also considered, which made it possible to compare transformations in the logistics structure with the dynamics of foreign economic activity. The analysis of profit elasticity was carried out in accordance with the company's financial results, changes in the logistics structure and on the basis of data from annual reports.

Within the framework of the study, the activities of the Bashtanskyi cheese factory (Bashtanskiy cheese factory, n.d.) were analysed using financial-analytical and comparative methods, in particular its financial reporting, trading activity, number of employees, volumes of raw materials and production and sales indicators in the stability period of 2020-2021 and in the crisis period of 2022-2024. Data on the use of the raw material base, changes in transport support and logistics barriers associated with infrastructure destruction and the redirection of supplies were additionally taken into account. Information on the company proved to be limited, particularly regarding the full structure of logistics processes, which complicated the formation of a comprehensive picture of the enterprise's functioning (A well-known cheese factory plans to resume..., 2024; ALC "Bashtanskyi cheese factory", n.d.). The choice of this enterprise was justified by its status as a regional producer of dairy products that suffered direct destruction as a result of military actions, lost access to its raw material base and demonstrated critical dependence on local logistics routes.

The Haisyn dairy plant (Haisyn Dairy, n.d.) was considered separately, for which an analysis of financial reporting was carried out: the dynamics of revenues and profits, production capacities and the features of logistics infrastructure in 2020-2024. Among the indicators, the scale of milk purchases from local farmers, the operation of the raw material reception facility, the presence of a fleet of isothermal bodies and refrigerated lorries, as well as cold stores for finished products, were assessed. As in the case of the Bashtanskyi cheese factory, information on the company was limited, primarily regarding the structure of suppliers, logistics flows and partnership relations (LLC "Gaisinsky Dairy Plant", n.d.). The criteria for including this enterprise were its status as a medium-sized regional producer of cheese products, dependence on local raw materials and the demonstration of relative resilience to crisis challenges thanks to the presence of its own logistics infrastructure. A comparative analysis of the differences in the impact of logistics disruptions on regional food industry enterprises and large integrated holdings was also carried out.

Results and Discussion

Foundations of the impact of logistics crises on the activities of food industry enterprises

Logistics disruptions in the current economic conditions of Ukraine constitute a complex multifactor phenomenon that combines interruptions of transport routes, disruptions in the supply of raw materials and finished products, constraints on exports and imports, as well as a sharp rise in the costs of ensuring the continuity of production and sales processes. The essence lies in the fact that any element of the supply chain may be thrown out of balance under the influence of external or internal factors, which leads to reduced efficiency of enterprises, a slowdown in the circulation of goods and an increase in production costs. A distinctive feature of the current situation is the combination of global and local challenges, which mutually reinforce one another and create complex threats for the economy in general and for the food industry in particular.

Military actions, accompanied by the destruction of transport infrastructure, port blockades and restrictions on the use of traditional export routes, have an impact on logistics processes. This has led to the reorientation of freight flows to road and rail transport, which has resulted in an overload of existing corridors and longer delivery times. Rising energy prices have become one of the key factors determining the level of logistics costs for food industry enterprises. Table 1 presents the dynamics of average fuel prices in Ukraine in 2020-2024.

As shown in Table 1, in 2020 fuel remained relatively affordable, but price growth was already observed in 2021. In 2022, due to Russia's full-scale invasion, prices doubled, and as of August 2025, the price had already reached a record high for the years under review. In parallel, the rise in fuel costs took place against the background of inflationary pressure. The inflation index amounted to 105.0% in 2020, 110.0% in 2021, 126.6% in 2022, 105.1% in 2023 and 112.0% in 2024 (Fig. 1).

Table 1. Average fuel prices in Ukraine in 2020-2024

Year	Diesel, UAH/l	Petrol A-95, UAH/l
2020	24.54	25.18
2021	29.40	30.21
2022	55.13	51.94
2023	51.50	51.48
2024	52.66	58.49
2025 (as of 15.08)	56.06	58.94

Source: compiled by the author on the basis of MinFin (n.d.)

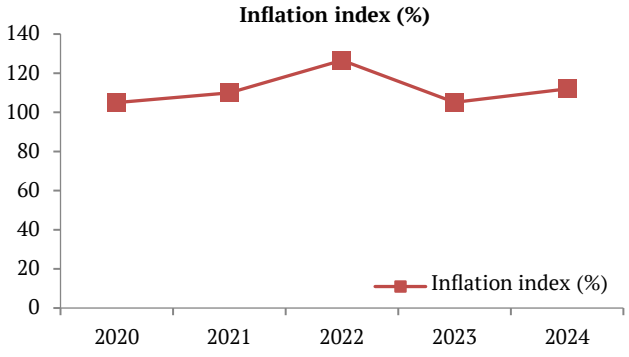

Figure 1. Dynamics of the inflation rate in Ukraine in 2020-2024

Source: compiled by the author on the basis of consumer price index indicators (Summary table of consumer price... 2020; 2021; 2022; 2023; 2024)

The graph demonstrates a wave-like dynamic of inflationary processes, which indicates the instability of the macroeconomic environment and its direct impact on the cost structure of producers. The largest leap occurred in 2022, which, together with record increases in energy prices, significantly raised enterprise costs and reduced the profitability. Subsequent fluctuations in the indicator reflected the complexity of business adaptation to conditions of uncertainty and the need for flexible approaches to cost management.

Another characteristic feature of current logistics challenges is dependence on imported resources. Some food industry enterprises require the import of packaging materials, auxiliary components and certain ingredients, which creates additional risks in the event of delays during customs clearance or disruptions in foreign currency settlements. Such factors reduce the predictability of

supplies and complicate production planning. Against this background, there is a growing trend towards the search for local suppliers, which stimulates the gradual restructuring of business models and helps to reduce dependence on external sources. In 2020, the volume of exports of products from Ukraine's agro-industrial complex and food industry amounted to about USD 20 billion, which almost matched the 2019 level with a minimal decrease of 0.3%. The main sales markets remained the European Union countries, which accounted for 28.9% of total exports (about USD 5.8 billion), as well as China (USD 3.1 billion) and India (USD 1.3 billion). The largest share in the export structure comprised grain crops, oils (primarily sunflower), poultry meat, honey, fruit, nuts and also bakery and confectionery products. Imports of food products during this period tended to decline due to pandemic restrictions. Total imports of goods into Ukraine in 2020 amounted to USD 54.2 billion, of which food products formed a smaller part, mainly in the form of specific ingredients and auxiliary components required to supply the domestic market (Infographic: TOP-5 products of export and import…, 2021; In 11 months of 2020, Ukraine exported…, 2021).

In 2021, exports of processed food products grew by 30.5% and reached USD 3.79 billion, while total agri-food exports amounted to USD 27.7 billion. The largest groups were residues and waste from the food industry, sugar and confectionery products, grain-based products, beverages, and products made from meat and fish. Imports amounted to USD 3.58 billion, which indicated the domestic market's dependence on external supplies. Overall trade became more active: exports grew by 25% compared with 2020, and imports by 27.6% (Us, 2022). The military events of 2022 caused a sharp reduction: exports of processed products fell to USD 2.5 billion (64.9% of the previous year's level), total exports amounted to USD 44.15 billion, and imports to USD 55.27 billion, with a negative balance of USD 11.12 billion. In the second quarter of 2025, exports of goods amounted to USD 10,077 million, decreasing by 1.12% compared with 2024 (How Ukrainian exports…, 2025). Imports of food products totalled USD 2.65 billion, reflecting reduced demand and logistics problems. The export structure was dominated by residues from the food industry, sugar, grain products and beverages, but volumes declined due to corridor constraints (Ukraine's Foreign Trade in Goods…, 2023).

In 2023, signs of recovery appeared: exports of processed products rose to USD 3.27 billion (+31% compared with 2022), but were 13.6% below the 2021 level; these products accounted for about 9% of exports. The main groups were residues from the food industry (USD 1.4 billion), sugar and confectionery products (USD 596 million), grain-based products (USD 314 million) and alcoholic beverages (USD 283 million). Imports amounted to more than USD 3.25 billion, which was 23% higher than in 2022, but below 2021 (In 2023, exports of prepared food products…, 2024). In 2024, exports increased due to the restoration of ports and access to markets: total exports reached USD 41 billion (+13.4% compared with 2023). The largest export flows were sunflower oil (over USD 5 billion), sunflower meal (over USD 1 billion), poultry meat (USD 945 million) and sugar (USD 408 million). Imports also grew, offsetting logistics and production imbalances (Ukrainian exports in 2024 grew by 13.4%…, 2024). Alongside this positive dynamic, internal logistics challenges, particularly the functioning of cold chains, became more acute, since a stable temperature regime determines product quality. Any disruptions lead to direct losses and additional costs. To minimise risks, enterprises invest in refrigerated warehouses, automated monitoring and modern technologies (Pajić *et al.*, 2024).

RFID technologies are actively being introduced in the food industry to control production stages and storage conditions. RFID chips are used to track goods, including at meat-processing enterprises where each trolley has a tag. This makes it possible to determine the production stage and the duration of a batch's stay in cooling or smoking, minimising losses. Further development is associated with the integration of temperature and humidity sensors to maintain appropriate conditions. GPS technologies are used to organise logistics and track cargo movements, which is especially important during post-war recovery (RFID in Supply Chain Management…, n.d.). WMS systems (Warehouse Management System, n.d.) are gaining popularity, including Ukrainian solutions based on Microsoft Dynamics 365 (CRM from Microsoft, n.d.) – SMART WMS (Warehouse at your fingertips…, 2024), which automate receipt, storage and dispatch, reducing labour costs and errors. At the same time, labour shortages caused by mobilisation and migration create a need for broader automation to support logistics operations (Ionin & Zagorodny, 2024). In 2020-2024, the structure of logistics costs changed significantly. The greatest impact came from higher rail freight tariffs due to Ukrzaliznytsia's annual indexation: in 2021-2022 tariffs for various classes rose by 8-20%, and in summer 2022 by almost 70%. In 2024, the supervisory board approved a new indexation of 37% because of higher energy and repair costs (Freight transportation tariff will… 2024). Loss of access to ports in 2022 caused a shift towards rail and road transport, which increased demand and tariffs. Road haulage routes lengthened by 10-40%, increasing delivery time and cost (Optimisation of transport logistics…, 2022). Overall logistics costs also rose due to higher customs payments, insurance and security services. In 2024, the State Customs Service transferred UAH 591.7 billion in customs revenues, which was one third higher than the previous year. This was due to an increase in import volumes, higher rates of value added tax (VAT), duties and excise taxes. At the same time, insurance company tariffs and costs for securing infrastructure increased because of heightened risks in wartime conditions (Budget revenues from customs payments…, 2025).

In 2020-2024, the production of food products in Ukraine developed unevenly under the influence of the COVID-19 pandemic and military events, which directly affected the state of logistics chains. The total volume

of sold products rose from UAH 480 billion in 2020 to UAH 708.27 billion in 2022, which indicated the ability of enterprises to adapt rapidly to crisis conditions, in particular through the search for new logistics routes and cost optimisation. However, in 2024 the indicator fell to UAH 522 billion, which was due to further complications in the transport sector, rising transport costs and deepening economic instability. The dynamics of the production index confirm these fluctuations. In 2020, it stood at 99.2%, exceeding the average industrial level (95.5%), which indicated the relative resilience of the sector even in the context of initial logistics disruptions. In 2022 the index sharply decreased to 78.4% because of large-scale damage to transport infrastructure and the blocking of export corridors. Already in 2023, thanks to the partial restoration of logistics channels and diversification of supplies, it rose to 106.8%. In the first half of 2024, the indicator reached 115.9% compared with the same period of 2023, which points to the active recovery of production capacity in close connection with the gradual stabilisation of logistics processes (Smolinska *et al*., 2025).

The present study and the work of F.A. Ghapar (2024) coincide in the conclusions about the multifactor nature of logistics disruptions and the impact on production costs, financial resilience and the competitiveness of enterprises. Both emphasise the importance of supplier diversification, flexible strategies and digital solutions to maintain efficiency. The difference lies in the context: F.A. Ghapar considered the global consequences of the COVID-19 pandemic – panic buying, labour shortages and problems in international flows. This study focuses on war-related risks, infrastructure destruction and the energy crisis, confirming its conclusions with statistics on fuel prices, inflation, and exports. A similar comprehensive perspective can be seen in the work of J.J. Rojas-Reyes *et al*. (2024). The authors systematised scientific literature, highlighting a wide range of factors threatening food chains – from climatic to socio-political. This study, in turn, reveals the local dimension of these threats, showing, on the example of Ukraine, how military events transformed producers' business models. Whereas J.J. Rojas-Reyes *et al.* mainly provided a conceptual framework, here the focus is on empirical data and examples of RFID and WMS implementation to support process continuity.

Another angle on the problem was proposed by J. Sun & Y. Ma (2024), who, summarising international experience, emphasised the critical role of logistics in the functioning of food chains. The conclusions also touched on the impact of the Russian-Ukrainian war, which caused disruptions in grain exports and higher transport costs. However, while J. Sun & Y. Ma focused on global-scale recommendations – the introduction of Delivered at Frontier, development of cold chains and digital monitoring platforms – this study presents practical examples of Ukrainian companies' adaptation, supported by statistics and analysis of the implementation of modern warehouse management systems. The research of N. Li *et al*. (2023) broadened the discussion with an environmental and long-term dimension. The authors focused on global risks – from climate change to structural imbalances – and considered the prospects of "green logistics" as a basis for sustainable development. This study offers another perspective: Ukraine's wartime realities, port blockades, rising fuel prices and infrastructure destruction, which created immediate economic challenges for producers.

The present study and the work of P. Haessner *et al*. (2024) share a common view of the multifactor character of logistics disruptions and the impact on the financial resilience and competitiveness of enterprises. Both emphasise the importance of digital technologies, automation, and supplier diversification for risk reduction and increased efficiency. Both works also share an understanding that supply disruptions directly affect production costs, profitability, and export opportunities for food producers. At the same time, differences concern the analytical context. P. Haessner *et al.* examined logistics challenges mainly through the prism of global value chains, stressing how digitalisation, standardisation and stronger resilience can enhance system adaptability under conditions of pandemics, geopolitical tensions or climate threats. This study instead concentrates on Ukraine's wartime realities, analysing infrastructure destruction, port blockades, rising fuel prices and inflationary fluctuations, confirming its conclusions with statistical data.

In the work of A.Z.A. Muzamiln *et al.* (2024), the key idea was also to highlight the role of digital tools in strengthening supply resilience. The authors focused on a bibliometric analysis of global literature, which allowed constructing worldwide scenarios of digital and "green" logistics. This study is consistent with these conclusions, as it also notes the importance of digitalisation for maintaining the effectiveness of business models. However, it differs in its applied orientation: unlike the review character of A.Z.A. Muzamiln *et al.*, here attention is paid to statistical data and real examples of enterprises adapting to the conditions of a wartime economy. Another interesting perspective was offered by G. Chavez-Miguel *et al*. (2024), who examined the resilience of agro-ecological systems in Peru, Germany, and the USA. The analysis centred on farmers who confronted crises by developing local markets and social networks. This approach resonates with the findings of the present study, since in both cases the multifactor nature of crisis challenges and the need for diversification and adaptive strategies are recognised. At the same time, the Ukrainian context is distinctive: infrastructure destruction, inflationary pressure and logistics blockades posed more acute threats that required technological solutions and rapid restructuring of business models. Thus, logistics disruptions in Ukraine in 2020-2024 were driven by a combination of war risks, inflation, rising fuel prices and imbalances in foreign trade. These disruptions led to higher costs of transport and warehousing, disruptions in cold chains and increased dependence on imported resources. The dynamics of exports and imports showed a decline in 2022 and gradual recovery in 2023-2024, which confirms the vulnerability of food flows to external shocks.

Analysis of operating costs and profitability of regional food producers

In 2020-2024, Ukraine's agro-industrial companies faced large-scale economic and geopolitical challenges that significantly affected the financial performance and logistics strategies. Among the largest food producers are MHP (n.d.) and Kernel (n.d.), which are at the same time leading Ukrainian exporters, supplying poultry, grain, and sunflower oil to global markets. For both companies, the logistics factor became decisive in shaping operating costs and profitability, as over 50-90% of the output was exported. During 2020-2024, MHP remained Ukraine's leading agro-industrial company, combining poultry production, crop farming, processing of grain and oilseeds, as well as the development of retail and culinary businesses. The company's main areas of activity remained the production of poultry meat and ready-to-eat foods, the cultivation of maize, wheat, sunflower, soya and rapeseed, and the operation of feed mills and silos. An important strategic step was the launch of new sales formats: "Myasomarket" shops, "Döner Market" street food outlets and the "Sekrety shefa" gastro studio, which strengthened the company's presence in the domestic market and simultaneously diversified its profitable segments (Export brands of MHP, n.d.).

External challenges in 2020-2024, including the COVID-19 pandemic, military actions and the blockade of Ukrainian seaports, significantly affected MHP's business model. Loss of access to traditional export routes through the Black Sea in 2022 forced the company to develop alternative logistics routes actively, particularly by using land border crossings and international subsidiaries. Perutnina Ptuj in the Balkans played an important role in this, providing production and distribution in Slovenia, Croatia, Serbia, and Bosnia and Herzegovina. This strategy made it possible to maintain a presence in European markets even during logistics crises (MHP is the leader in Ukrainian food exports..., 2025).

Geographically, the company's exports in 2024 covered 86 countries. The main importers remained the European Union (the Netherlands, Ireland, Belgium, Poland, Italy, Greece), the United Kingdom, markets in the Middle East (UAE, Saudi Arabia) and Africa. North American markets (USA, Canada) also remained important, while the Balkans were seen as a springboard for further expansion in Central and Eastern Europe. Through market diversification, MHP generated record export revenues of USD 1.7 billion in 2024, confirming the adaptation of its business model to difficult conditions. The company's financial results during this period show cyclicality caused by changes in logistics and energy costs and the availability of transport infrastructure (MHP considers the EU, Great Britain, Japan, the USA..., 2025). Table 2 presents MHP's key financial indicators for 2020-2024.

Table 2. Key financial indicators of MHP in 2020-2024 (USD million)

Indicator	2020	2021	2022	2023	2024
Income	1,414	1,647	1,876	2,294	2,262
Operating profit	194	416	176	247	346
Operating profitability, %	14	25	9	11	15
Net profit / (loss)	-109	377	-269	122	141
Net profit margin, %	-8	18	-14	5	6

Source: compiled by the author on the basis of official MHP reports (Financial results for the third..., 2021; 2022; 2023; 2024)

The table shows that in 2020-2021, the company demonstrated a significant increase in profitability, with operating profit more than doubling. In 2022, military actions and logistics disruptions led to a deterioration in performance: net loss amounted to USD 269 million and profitability turned negative. However, by 2023-2024 the company managed to stabilise the situation: operating profit rose to USD 346 million and net profit to USD 141 million, confirming MHP's ability to adapt its business model to challenges. In 2020-2024, MHP experienced a significant impact from logistics challenges related to rising transport tariffs, higher fuel prices and route reorientation as a result of Ukrainian port blockades. It is known that transport costs traditionally account for 15-25% of the cost of agricultural products in Ukraine, and in wartime this indicator approached the upper bound. This makes it possible to estimate conditionally the elasticity of the company's profitability with respect to changes in logistics costs. For example, in 2022, a sharp increase in Ukrzaliznytsia tariffs (by 70%) and a doubling of diesel prices led to a substantial rise in logistics costs. As a result, MHP's operating profit fell to USD 176 million (compared with USD 416 million in 2021), and the operating margin decreased from 25% to 9%. Thus, it can be argued that the increase in logistics costs had an elastic effect: each significant increase in transport tariffs and fuel prices led to a disproportional drop in profitability. At the same time, in 2023-2024, despite further tariff indexation, the company showed improved financial results. Operating profit rose from USD 247 million in 2023 to USD 346 million in 2024, and the operating margin – from 11% to 15%. This is explained by the introduction of digital solutions that reduced the sensitivity of financial results to logistics cost increases. In other words, profit elasticity with respect to logistics costs gradually declined, as process optimisation and automation compensated for external price shocks. Taking these data into account, it is possible to conclude that for MHP in 2020-2022, profitability elasticity with respect to logistics cost growth was high, whereas in 2023-2024 the company demonstrated greater resilience thanks to digitalisation and market diversification. This confirms that in a crisis, effective logistics management is a key factor in maintaining profitability even under rising transport costs.

Alongside financial results, investment in digitalisation remained an important factor. In 2020-2024, the company implemented GPS tracking of transport, warehouse management systems (WMS) and the Smart Maintenance platform for predictive equipment servicing. This allowed logistics costs to be reduced, storage and transportation of products to be optimised, downtime to be minimised and resources to be used more efficiently. In the poultry segment these solutions helped to maintain export volumes even when production was reduced, while in the grain segment these solutions increased margins by reducing losses during storage and processing (How Adaptation, Efficiency ..., 2025). An important addition was the creation of the "MHP-Logistics" division (MHP Logistics Branch of Private Joint-Stock..., n.d.), which serves not only internal needs but also external clients, turning into a separate business direction. This marked the company's transition from a classical agro-producer model to an integrated structure where logistics became a profitable sphere. In 2020-2024, MHP demonstrated its ability to adapt to global and domestic challenges: after a decline in financial results in 2022, by 2024 the company had already returned to growing profitability, ensuring market diversification, logistics digitalisation and the development of international chains. This confirmed that innovation in management and a strategic focus on external markets became key factors of competitiveness under conditions of instability.

Kernel remains a key player in the agricultural market, focusing its activities on three areas: production and export of sunflower oil, cultivation, and sale of grain crops, and trading and logistics. The company provides about 9% of global sunflower oil exports and is the largest exporter of Ukrainian grain. In 2020-2024, its activities were shaped by fluctuations due to global market conditions and military events. In 2024, Kernel launched a new plant in Western Ukraine, increasing processing by 24% compared with 2023, yet profitability declined because of more expensive logistics and losses from asset impairment. Despite this, oil sales in the 2024 financial year reached 1.09 million tonnes (+40% year-on-year) and grain exports 6.3 million tonnes (+80%). After Russia's withdrawal from the "grain initiative" in July 2023, the company lost access to Black Sea ports, which caused a sharp drop in meal shipments (159 thousand tonnes in Q1 2024), although by Q2 volumes had increased to 399 thousand tonnes. Dependence on port logistics confirmed the vulnerability of Kernel's business model (Kernel Holding S.A. annual report..., 2024).

To minimise risks, the company invested in the development of port infrastructure and alternative routes. In 2024, transhipment of grain and oilseeds through Kernel's terminals increased by 51% and reached 6.7 million tonnes. Danube ports (Reni, Izmail, Ust-Dunaisk) and EU transport corridors became particularly important. The company also expanded its fleet of rail wagons and containers, which made it possible to maintain export volumes, albeit at a higher cost of production (Kernel exported 4.4 million tons..., 2025). The company's financial results for 2020-2024 reflect these challenges and adaptation efforts (Table 3).

Table 3. Key financial indicators of Kernel in 2020-2024

Indicator	2020	2021	2022	2023	2024
Revenue (USD million)	4,107	5,647	5,332	3,455	3,581
Operating profit (USD million)	443	929	220	544	381
Operating margin (%)	10.8	16.4	4.1	15.8	10.6
Net profit / (loss) (USD million)	118	513	-41	299	168
Net profit margin (%)	2.9	9.1	-0.8	8.7	4.7

Source: compiled by the author on the basis of official Kernel reports (Kernel Holding..., 2020; 2021; 2022; 2023; 2024)

In 2020-2021, logistics costs remained under control thanks to the operation of Black Sea ports and the company's well-developed own infrastructure. This enabled Kernel to demonstrate high profit elasticity: even with rising transport costs, operating profit more than doubled – from USD 443 million in 2020 to USD 929 million in 2021, while net profit increased from USD 118 million to USD 513 million. The situation changed radically in 2022, when, after the start of Russia's full-scale invasion, logistics through the Black Sea ports were severely restricted. Kernel was forced to reorient shipments to rail and road transport and to use alternative routes through Danube ports and EU countries. This led to a three- to four-fold increase in transport costs, which directly affected profitability: operating profit fell to USD 220 million, and the net financial result turned negative and amounted to -USD 41 million, while the operating margin dropped to 4.1%. In 2023, the situation partially stabilised thanks to the functioning of the "grain corridor". Although transport costs remained significant, the company managed to restore profitability: operating profit increased to USD 544 million, net profit reached USD 299 million, and the operating margin rose to 15.8%. This demonstrated the flexibility of Kernel's business model: the company offset part of the cost increase through route optimisation, the use of its own silos and terminals, and sustained demand for oil and grain from key importers. In 2024, despite the opening of the "maritime corridor" under the protection of the Ukrainian armed forces, logistics costs remained high due to rising insurance payments and the limited throughput of alternative routes. This led to a decrease in operating profit to USD 381 million (down 30% compared with 2023) and a reduction in net profit to USD 168 million, with the net profit margin falling from 8.7% to 4.7%. Another important factor was the change in export geography. The traditional Black Sea ports remained under threat of shelling, so Kernel made

more active use of routes through the European Union (EU) and the Danube region. The main importers of sunflower oil were India, EU countries, China, Türkiye, Iraq and Egypt, which together accounted for up to 80% of global demand. At the same time, rising transport and insurance costs reduced the profitability of transactions (Kernel Holding S.A. annual report..., 2024). As a result, in 2020-2024 Kernel demonstrated high adaptability to wartime and logistics challenges, but at the same time suffered a tangible loss in profitability compared with pre-crisis years. The company retained its leadership in the global sunflower oil and grain market, yet its financial results reflect a significant dependence on logistics infrastructure and geopolitical risks.

Bashtanskiy cheese factory (n.d.) (Bashtanka, Mykolaiv region), known under the trademark "Slaviya", is an example of a regional dairy producer that has undergone substantial transformations under the impact of logistics disruptions and military action. In 2020-2021, the plant recorded stable revenue (UAH 906.9 thousand and UAH 826.7 thousand respectively) and employed more than 400 workers. Its products were represented in most retail chains in Ukraine, which required an extensive distribution system and resilient logistics. The situation changed sharply in 2022. Due to hostilities in the Bashtanka district and a significant reduction in livestock numbers (by up to 60-70%), the plant lost access to the necessary raw material base: to reach at least break-even, the enterprise needed 100 tonnes of milk per day, whereas actual volumes were several times lower. Logistics challenges were exacerbated by road destruction and a reduction in the number of milk tankers delivering raw materials (from nine vehicles in the pre-war period to two after 2022). Part of the milk began to be transported to Kryvyi Rih and Voznesensk by private suppliers, which further complicated the supply of production (A well-known cheese factory plans to resume..., 2024; ALC "Bashtanskyi cheese factory", n.d.).

In 2023-2024, the enterprise was unable to restore pre-war production volumes: revenues remained at UAH 236 thousand in 2023 and fell to UAH 220 thousand in 2024, the workforce decreased to 300 employees, and financial results fluctuated between profit and loss (ALC "Bashtanskyi cheese factory", n.d.). Thus, Bashtanskiy cheese factory demonstrated that regional producers are much more vulnerable to disruptions in logistics chains than large integrated holdings. Dependence on local raw materials, limited transport routes and a lack of resources to diversify markets predetermine the critical instability of the business models in crisis conditions.

Another example is Haisyn Dairy (Haisyn Dairy, n.d.), a medium-sized food industry enterprise specialising in the processing of cow's milk and the production of cheese, butter, dried dairy products and other dairy goods. During 2020-2024, the enterprise showed an increase in activity volumes, yet its financial results remained unstable. In 2020, the plant's revenue amounted to UAH 231.9 million and net profit to UAH 4.1 million. In 2021, revenue rose to UAH 280.9 million, but the enterprise recorded a loss of UAH 9.6 million. From 2022, the plant returned to profitability: with revenue of UAH 411.1 million, net profit was UAH 25.1 million. In 2023, the indicators again increased – revenue reached UAH 556.3 million and net profit amounted to UAH 14.5 million. In 2024, the enterprise reached a new maximum: revenue amounted to UAH 697.2 million and net profit to UAH 16.4 million. From a logistics perspective, the plant is a typical example of a regional producer dependent on the local raw material base. Raw materials are supplied by external providers – farms and local producers. To ensure stable quality, the enterprise has created a modern raw milk reception facility, where milk undergoes bactofugation, separation and pasteurisation, which allows the parameters of purchased milk to be equalised and guarantees compliance with technological requirements. The plant's own logistics infrastructure is particularly important: a fleet of isothermal trucks and refrigerated lorries ensures cooling of milk during transportation, preserving its quality. The presence of refrigerated storage enables the required storage regime for finished products to be maintained. This approach minimises risks associated with supply disruptions or rising logistics costs and provides the enterprise with greater resilience in crisis conditions (LLC "Gaisinsky Dairy Plant", n.d.).

Additionally, it is worth emphasising that the impact of logistics disruptions reveals differences between regional and large food industry companies. For regional producers, dependence on local raw materials and a narrow network of transport routes is critical: if roads are destroyed or the number of suppliers decreases, the production process is immediately blocked. A lack of own storage capacity and a limited vehicle fleet make it impossible to respond quickly to supply interruptions. As a result, even short-term disruptions lead to increased cost of production, loss of output and reduced profitability, as evidenced by the examples of regional plants. Large integrated holdings, by contrast, possess a much wider range of adaptation tools. Thanks to access to diversified supply channels, the own transport companies and international markets, large integrated holdings are able to partially offset higher costs due to the scale of operations. Moreover, the use of digital technologies (GPS monitoring, RFID systems, WMS platforms) and investments in infrastructure development increase the flexibility and help avoid critical disruptions in production and distribution chains. This explains why, under crisis conditions, many regional enterprises were forced to suspend or minimise production, while large companies demonstrated an ability to maintain financial stability and even increase export performance. Thus, enterprise size and the degree of integration into international logistics networks became key factors differentiating the impact of crisis phenomena on food industry business models. In the context of addressing logistics challenges and the need to adapt to new economic conditions, the role of digital transformation in logistics is crucial. As emphasised by G. Saktaganova *et al.* (2025), digital technologies offer significant opportunities for enhancing

global integration in the transport and logistics sectors. The study stresses the importance of implementing digital solutions to improve efficiency, manage disruptions in supply chains and ensure seamless integration into the global market. This is consistent with the findings of the present study, in which it is discussed how the introduction of modern digital tools such as RFID systems and WMS is critical for strengthening the resilience of logistics operations under current disruptions.

The present study and the work of M. Drljača *et al*. (2025) share a common position on the decisive role of logistics disruptions in shaping the financial resilience of enterprises. Both highlight that rising costs required diversification of suppliers and active implementation of digital solutions. At the same time, the approach of M. Drljača *et al*. was broader: the authors went beyond the corporate level and proposed a multi-level resilience model encompassing enterprises, national economies and the global system, using macroeconomic risk indicators to forecast future crises. A similar logic can be traced in the study by S. Jagtap *et al*. (2024), which confirmed the multifactor nature of logistics disruptions and the impact on profitability. Both works emphasised the need for process digitalisation and management flexibility; however, the difference lay in the scale of analysis: the present study examined the problems of Ukrainian producers in wartime conditions, whereas S. Jagtap *et al*. focused on the European context, identifying the role of Brexit, the pandemic and other systemic challenges. Common features were also observed between this study and the work of J. Pyeman (2025). Both highlighted the transformation of food chains under the influence of the pandemic and crisis phenomena, which led to rising costs and declining profitability. Both regarded liquidity management, diversification and digital technologies as critically important. At the same time, J. Pyeman concentrated on Malaysian retail, where financial models and machine learning were applied to forecast profitability, whereas the present study raised the issue of war risks and restricted access to external markets.

In the work of Y. Zhu & G.T. Tsoulfas (2024) and in this study, a shared idea emerges: long supply chains are extremely vulnerable to shocks, and the shortening, coupled with digital tools, can reduce risks. The difference, however, lies in the context: in Ukraine, the key problems were war, port blockades and inflation, whereas Y. Zhu & G.T. Tsoulfas examined the case of the Netherlands, where challenges were driven by small production scales and high logistics costs. A similar parallel can be drawn between this study and the work of I. Ali *et al.* (2024). Both emphasised the vulnerability of chains to crises and the need for technological modernisation. Yet while the present research describes war-economic risks for Ukrainian producers, I. Ali *et al.* considered global challenges caused by the pandemic, placing emphasis on transparency, traceability, and coordination in international networks. A related line can also be seen in comparison with the study of S. Tian & Y. Mei (2023). In both works – the present study and that of S. Tian & Y. Mei – the importance of innovative strategies, digitalisation and diversification of supply channels is recognised. However, S. Tian & Y. Mei focused on Chinese companies and the impact of geopolitical threats, whereas this study underscores wartime challenges in Ukraine – infrastructure destruction, port blockades and sharp inflationary fluctuations. Similar emphases are observed when comparing this work with the study of O. Olabode *et al*. (2025). Both studies note the multifactor nature of disruptions and the role of innovative solutions in ensuring resilience. At the same time, O. Olabode *et al*. analysed global structural challenges related to climate change and resource constraints, whereas the present study shows local war-related consequences for the Ukrainian economy. In the work of M.C.-P. Poo *et al*. (2024), too, there is a common focus on the multifactor character of logistics disruptions and the need for digitalisation. However, that paper examined global risk management strategies, integrating principles of the circular economy and green logistics, whereas the present study is more applied and localised within the Ukrainian wartime reality. When compared with the research of Z.F. Ardekani *et al*. (2023), there is a shared understanding of the critical role of digital solutions, diversification and sustainable practices. The difference lies in the context: Ukraine's wartime reality versus Brazil's experience of the COVID-19 pandemic, where the main attention was devoted to environmental aspects and the transition to more sustainable agri-food chains.

Summarising the results of the analysis, it can be noted that MHP and Kernel demonstrated different levels of profit elasticity in response to rising logistics costs. For MHP, the most critical year was 2022, when port blockades and higher "Ukrzaliznytsia" tariffs led to a more than twofold decline in operating profit. However, thanks to the introduction of digital technologies, in 2023-2024 the company managed to reduce the sensitivity of financial results to external shocks and restore profitability. Kernel, by contrast, maintained strong financial indicators in 2020-2021, but under wartime conditions and export reorientation to more expensive routes in 2022-2024 its profitability fell sharply. Both companies confirmed the ability to adapt to crisis conditions by diversifying markets and developing alternative logistics, yet the extent to which logistics costs impacted final financial results proved to be the decisive factor in the resilience.

Conclusions

Summarising the results of the study, it can be concluded that in 2020-2024, logistics disruptions became the key factor transforming the business models of regional food producers in Ukraine. The combination of war-related risks, inflationary pressure and rising energy prices significantly increased enterprise costs. Diesel prices rose from UAH 24.54 per litre in 2020 to UAH 52.66 per litre in 2024, while petrol A-95 increased from UAH 25.18 to UAH 58.49 per litre. Inflation peaked in 2022 (126.6%), which, together with infrastructure destruction, led to declining profitability and higher production costs.

External trade also changed. In 2020, exports of agri-food products amounted to about USD 20 billion, whereas in 2022 the exports fell to USD 44.15 billion in total exports owing to port blockades. Exports of processed food products decreased by one third – to USD 2.5 billion – while imports amounted to USD 2.65 billion. In 2023-2024, there was partial recovery: exports of processed products grew to USD 3.27 billion in 2023 and continued to increase in 2024, providing about USD 41 billion of exports, with sunflower oil (over USD 5 billion) and poultry meat (USD 945 million) remaining the main items.

The analysis of leading companies showed different levels of resilience. At MHP, revenue rose from USD 1,414 million in 2020 to USD 2,262 million in 2024, whereas in 2022 the company incurred a loss (-USD 269 million) due to logistics constraints and higher fuel prices. By 2024, profitability had been restored to USD 141 million, and the operating margin increased to 15%. Kernel recorded a record net profit of USD 513 million in 2021, but in 2022 moved into loss – USD 41 million – because of higher transport costs. In 2023, the company partially recovered its performance (USD 299 million net profit), yet in 2024 profit fell to USD 168 million, underlining dependence on port logistics and international market conditions.

The key factors undermining financial resilience were higher transport tariffs, rising fuel prices, Black Sea port blockades and the need to reorient routes through the Danube and the EU. Logistics costs within the cost structure reached 25% and directly affected profitability. At the same time, investments in digitalisation – GPS tracking, RFID, WMS systems – reduced profit elasticity in response to rising costs, enhancing the efficiency of resource management. Unlike large holdings, regional producers showed greater dependence on logistics: Bashtanskiy cheese factory displayed critical vulnerability due to loss of raw materials and transport, whereas Haisyn Dairy, thanks to its own infrastructure, maintained resilience and increased revenue from UAH 231.9 million in 2020 to UAH 697.2 million in 2024. A limitation of this study is that it focused mainly on the Ukrainian context and the 2020-2024 time frame, without considering the long-term implications for global supply chains. A promising avenue for future research is an in-depth examination of the effectiveness of digital technologies and alternative logistics routes in ensuring the resilience of the food industry in the post-war period.

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Вплив логістичних збоїв на бізнес-моделі регіональних виробників харчової продукції

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Анотація. Метою дослідження було визначити особливості адаптації виробничо-збутових стратегій підприємств харчової промисловості України до викликів, спричинених кризовими явищами у логістичних ланцюгах. Методологія ґрунтувалася на емпіричному підході з аналізом вартості пального, рівня інфляції, зовнішньої торгівлі та фінансових результатів провідних компаній. Використано економіко-статистичні, порівняльні й фінансово-аналітичні методи для дослідження середніх цін на дизель і бензин, що зросли з 24,54 та 25,18 грн/л у 2020 році до 52,66 та 58,49 грн/л у 2024 році. Індекс споживчих цін у 2022 році досяг 126,6 %, що разом із подорожчанням енергоносіїв різко збільшило витрати підприємств. Зовнішня торгівля у 2022 році скоротилася, експорт готових харчових продуктів зменшився до 2,5 млрд дол., тоді як у 2023-2024 роках відбулося відновлення: експорт зріс до 3,27 млрд дол. у 2023 році та близько 41 млрд дол. у 2024 році. Фінансовий аналіз показав, що дохід Миронівського хлібопродукту зріс із 1 414 млн дол. у 2020 році до 2 262 млн дол. у 2024 році, при цьому чистий прибуток у 2022 році був від'ємним (-269 млн дол.), але у 2024 році відновився до 141 млн дол. Kernel у 2021 році зафіксувала рекордний прибуток у 513 млн дол., проте у 2022 році отримала збиток – 41 млн дол., частково відновивши показники до 168 млн дол. у 2024 році. Додатково розглянуто регіональні приклади – Баштанський сирзавод і Гайсинський молокозавод, які продемонстрували різну стійкість до логістичних викликів, що дозволило оцінити вразливість локальних виробників порівняно з холдингами. Практичне значення полягає у можливості використання результатів для розробки стратегій мінімізації логістичних ризиків та підвищення фінансової стійкості підприємств

Ключові слова: постачання; витрати; експорт; рентабельність; конкурентоспроможність; дохід