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## Assessment of structural changes in exports and price situation on the Ukrainian grain market during the war

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► **Abstract.** The study aimed to assess the main export problems, measure price imbalances in the grain market, and compare the impact of world prices and exchange rate dynamics on domestic selling prices of wheat and corn before and during the war. The following methods were used: comparative analysis, statistical, tabular, graphical, calculation and design, abstract and logical, as well as correlation and regression analysis tools. The study revealed a significant structural transformation of wheat and corn exports during the war, with an almost twofold decrease in the share of Asian countries and an increase in the share of European countries in wheat exports from 1.7% to 48.3% and corn from 32.7% to 56.8%. The negative impact of the logistics transformation of exports on domestic and foreign prices in the grain market was determined. Compared to the pre-war period, domestic wheat and corn prices decreased by 22.7% and 28.2%. An indicative definition of price disproportions showed that before the war, world prices for wheat and corn almost corresponded to domestic prices, while during the war this ratio increased to 2.2 and 1.6 times, respectively. The modelling shows that before the war, a 1 USD/t increase in the global wheat price led to an equivalent increase in the domestic selling price by 0.71 USD/t, while a 1 UAH increase in the dollar increased the price by 3.2 USD/t. The impact of the selected factors has changed dramatically in the war: a corresponding increase in the global wheat price

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by 1 USD/t leads to an increase in the domestic selling price by only 0.19 USD/t, which is almost 4 times less than in peacetime, and a 1 UAH increase in the dollar reduces the domestic selling price of 1 tonne of wheat by 2.26 USD/t. The corresponding impact of the global corn price increase on the domestic price during the war was halved from 0.66 to 0.31 USD/t, and the upward movement of the exchange rate by 1 UAH reduced the selling price of corn by 4.65 USD/t

► **Keywords:** world price; exchange rate; price distortions; price elasticity; impact modelling

## ► Introduction

Despite the war, Ukraine remains a major agricultural producer. Ukrainian producers not only provide a significant share of Ukrainian budget revenues but also create the foundation for Ukraine's food security. The grain market is an important component of the agricultural sector of the economy. In 2021, the share of grain in Ukraine's total exports was 18.1%. During the full-scale war, these relative figures increased significantly. Thus, in 2022, the export share of grain crops increased to 20.6%, and in 2023 to 23%. In the first half of 2024, the export revenue from grain sales exceeded USD 5.3 billion. Its share in total exports was 26.9% (State Statistics Service of Ukraine, n.d.). Despite the war, losses, complicated logistics, and the destruction of infrastructure, as of 2025, farmers continue to work, trying to overcome difficulties and challenges. It is necessary to conduct a comprehensive monitoring of structural changes in the export sector of the Ukrainian grain market during the war, identify price imbalances in the grain market, and model the impact of world prices and exchange rate dynamics on domestic sales prices of wheat and corn, the main export crops.

The issues of organisational, economic and logistical challenges faced by Ukrainian grain exports since the beginning of the full-scale war, the definition of price fluctuations and the assessment of the growing disparity in the relations between grain market participants have been the subject of research by many authors. O. Lotysh (2022) assessed the role of Ukraine in the world grain market and analytically monitored the challenges and threats that had a destructive impact on the country's grain sector. The author assessed the existing potential of the grain market, outlined the fundamental risks caused by the war and focused on the negative impact of price imbalances on the global food market. Analytical monitoring of the priority problems of the grain market in Ukraine in the context of the war was addressed by I. Savenko *et al.* (2022). The authors identified the current state and key factors of supply formation in the grain market, outlined several practical measures to stabilise it, and proposed an effective methodological and practical toolkit for studying the problems of the grain market in wartime.

R. Miroshnyk & I. Bahlai (2022) analysed the main problems of the Ukrainian grain market, highlighting the negative trends in the deterioration of priority market indicators during the war. The authors emphasise the important role of maintaining and adapting the logistics system of grain market producers to the conditions of martial law. As a primary task for the functioning of grain market participants, the authors emphasise the need to ensure the break-even level of their production. According to the authors, active state policy and support from international partners will minimise the impact of negative factors caused by the war on the grain market.

T. Ostashko (2024) studied several relevant issues that arose in the export sector of the grain market with the outbreak of a full-scale war. The author identified the risks and the real scale of the impact of the loss of grain export markets on the Ukrainian economy and assessed the impact of the war on the global grain market and food security in the world. The study focuses on the disparity in the relationship between rural producers and grain traders, the main consequences of which are a significant reduction in grain purchase and export prices. Particularly noteworthy are the results of a study of the impact of the war on grain export prices, followed by a determination of the losses of each participant in the price chain.

M. Zhybak & H. Khrystenko (2024), addressing the crucial role of the grain market in ensuring food security at the national and global levels, outlined several problems of the Ukrainian grain market in wartime. The authors monitored seasonal price fluctuations in the grain market and established the dependence of domestic sales prices of wheat and corn by Ukrainian agricultural enterprises on the dynamics of world prices. O. Bezsmertna & Ye. Musyca (2024) analysed the transformational changes that objectively occurred in grain exports during the war. The authors conducted a thorough analysis of export flows in the grain market, analysed the existing geographical changes in exports, outlined current structural trends and identified the priority consequences of the impact of a full-scale war on the global food crisis.

H. Khrystenko & L. Yarema (2024) conducted a comparative analysis of structural and indicative indicators of grain exports in the pre-war period and during the war. The authors analysed the dramatic changes that have occurred in the foreign trade of the Ukrainian grain market: increased risks, geographical reorientation of export flows, and complicated logistics. A comparative analysis of the geographical structure of grain exports formulated the top 10 countries that imported grain from Ukraine during the war.

E. Prushkivska & R. Kovalenko (2023) analysed the peculiarities of the functioning and structuring of the world grain market in the context of geopolitical instability. The authors conducted a comparative characterisation of the current market trends in the global and national grain markets during the war. The authors emphasise that grain production is a fundamental component of the global economy, and the leading grain-exporting countries can turn their existing agricultural potential into effective levers of their economic policy and strengthen their geopolitical position.

A. Nechyporuk *et al.* (2022) assessed the destructive transformations of grain export logistics caused by the war. The authors identified and compared the capacity of alternative sea routes for grain exports and assessed the urgent

problems of grain supply chain management. Among the main directions of establishing grain logistics and increasing the capacity of the railway infrastructure, the authors highlight the construction of “dry ports”, and organisational and structural reorientation of logistics to the western borders of Ukraine based on foreign project investment.

I. Protsyk & A. Beze (2022) conducted a thorough analysis of global trends in the development of the market components of wheat and corn (production, yields, exports, prices) and indicatively defined the place and role of Ukraine. The authors analysed the retrospective dynamics and variability of prices for grain futures formed on leading international commodity exchanges. The authors identified the main factors that influenced the global price policy for grain crops before the outbreak of a full-scale war with Russia and after 24 February 2022. O. Shandrivka & O. Pyzh (2024) identified the negative impact of the war on the production scale and structure of grain exports using a system of indicators. The authors assessed the transformation of the export potential of Ukraine's grain market during the war and focused on the factor impact on price dynamics and price volatility. The authors proposed a set of effective measures to stabilise and further develop the production and export potential of the grain market in Ukraine.

N. Gafarov *et al.* (2022) conducted a comparative analysis of the availability and patterns of transformation of the production and export potential of grain crops in Ukraine during the war. The authors developed and practically interpreted variational models of grain export flows, incorporating possible scenarios of Ukrainian economic development. Based on regression analysis, the authors determined the impact of the main factors on the export potential of the grain market, namely production volumes, purchase prices, availability and sufficiency of the mineral and organic fertiliser system. To minimise the negative impact of these factors on the decline in the export potential of the grain market, the authors proposed to increase the pace of technological development of grain production, storage and transport logistics.

These studies analysed the negative impact of a full-scale war on grain exports from Ukraine, destructive changes in grain export logistics, and analytical assessment of fluctuations in domestic and world grain prices but lack elements of calculated and constructive determination of price imbalances in the grain market and modelling the impact of world prices and exchange rate dynamics on domestic grain prices. The study aimed to comprehensively assess the priority problems of exports and price distortions that occurred on the grain market and to model the impact of world prices and exchange rate dynamics on domestic selling prices of wheat and corn before and during the war. The achievement of the remaining goal required the consistent solution of the following tasks: to assess transformational changes in the structure of grain exports during the war; to conduct comparative monitoring of price imbalances in the grain market before and during the war; to develop a correlation and regression model of the impact of world prices and the exchange rate on the dynamics of domestic sales prices of wheat and corn by farmers before and during the war with the analytical definition of relevant indicators.

## ► Materials and methods

A range of research methods were used. The method of comparative analysis was used for analytical monitoring of the dynamics of grain exports in Ukraine and indicators of average selling prices of grain crops by agricultural enterprises. The calculation and constructive method were used to determine the transformational changes that occurred in the structure of wheat and corn exports during the war. The statistical method was used to determine the retrospective dynamics of price ratios in the markets of the main export-oriented crops – wheat and corn before and during the war.

The method of correlation and regression analysis alongside the definition and analytical interpretation of the system of coefficients (multiple correlations, determination, Fisher's criterion, Student's t-test) were used to determine the impact of world prices and the exchange rate on the dynamics of domestic sales prices of wheat and corn by domestic farmers before and during the war. Using the tabular method, the study illustrates the identified comparative and effective parameters of the practical application of the correlation and regression modelling tools. The graphical method is used to illustrate the results of modelling the dependence of domestic sales prices of wheat and corn by agricultural enterprises on the dynamics of world prices and exchange rate fluctuations. The abstract and logical method is used to formulate conclusions.

The conceptual feature of the study is a comprehensive assessment of structural transformations of grain exports from Ukraine, analytical monitoring of price imbalances in the grain market and modelling the impact of world prices and exchange rate dynamics on domestic sales prices of wheat and corn. The following logistic coefficients of the price ratio were used as calculation and statistical tools for analysing the retrospective dynamics of price imbalances in the grain market:

$$K_{1i} = \frac{Wp_{w(c)i}}{Sp_{w(c)i}}, \quad (1)$$

where  $K_{1i}$  – logistic coefficient of the correlation with the world price in the  $i$ -th period;  $Wp_{w(c)i}$  – average annual world price of wheat and corn in the  $i$ -th period, USD/t;  $Sp_{w(c)i}$  – average annual cost of sale on domestic wheat and corn market in the  $i$ -th period, USD/t.

$$K_{2i} = \frac{Ep_{w(c)i}}{Sp_{w(c)i}}, \quad (2)$$

where  $K_{2i}$  – logistical coefficient of the correlation with the export price in the  $i$ -th period;  $Ep_{w(c)i}$  – average annual export price of wheat and corn in the  $i$ -th period, USD/t.

Price, as an economic phenomenon, can be objectively determined by a certain set of factors that can both simultaneously and retrospectively change the vectors of their influence. Notably, it is impossible to study all the causal relationships of influence. During the study, the retrospective dynamics of domestic sales prices of wheat and corn by agricultural enterprises was chosen as a random variable  $Y$ . The retrospective sequence of their statistical values is structured into two periods:

►  $y_1, y_2, y_3, y_4, \dots, y_n$ , where  $n$  – number of observations in the sample – 158 (from 1.01.2009 to 1.03.2022);

►  $y_1, y_2, y_3, y_4, \dots, y_n$ , where  $n$  – number of observations in – 28 (from 1.03.2022 to 1.07.2024).

As independent factors of influence, the retrospective of world prices for wheat and corn ( $X_1$ ) and the dynamics of the exchange rate of the national currency of Ukraine against the US dollar ( $X_2$ ) were selected with the appropriate structuring for two periods. The functional dependence of domestic sales prices of wheat and corn by agricultural enterprises on the selected independent factors of influence can be described as follows:

$$Y = F(X_1, X_2). \quad (3)$$

Identification of the objective presence and influence of uncertain random factors that are of a force majeure nature and cannot be measured by specific indicators, notably, the selected random variable  $Y$  (internal sales price) will fluctuate from the functional dependence. In this case, the dependence of domestic selling prices for wheat and corn on their global indicators and exchange rate dynamics will be stochastic rather than functional and will have the following mathematical interpretation:

$$Y = F(X_1, X_2) + \varepsilon, \quad (4)$$

where  $\varepsilon$  – random deviation.

Further practical implementation of the methodological tools of correlation and regression modelling of the dependence of domestic sales prices of wheat and corn by agricultural enterprises on the dynamics of world prices and exchange rate fluctuations is based on the assumption of a linear relationship between  $Y$  and  $X_1, X_2$ :

$$y_{wi} = a_0 + a_1 x_{wi} + a_2 x_{eri} + \varepsilon_i; \quad (5)$$

$$y_{ci} = b_0 + b_1 x_{ci} + b_2 x_{eri} + \varepsilon_i, \quad (6)$$

where  $a_0, a_1, a_2, b_0, b_1, b_2$  – parameters of regression equations;  $y_{wi}$  – monthly dynamics of wheat sales price by agricultural enterprises in the  $i$ -th period, USD/t;  $y_{ci}$  – monthly dynamics of corn sales price by agricultural enterprises in the  $i$ -th period, USD/t;  $x_{wi}$  – monthly dynamics of world wheat prices in the  $i$ -th period, USD/t;  $x_{ci}$  – monthly dynamics of world corn prices in the  $i$ -th period, USD/t;  $x_{eri}$  – monthly dynamics of the USD/UAH exchange in  $i$ -th period, UAH per 1 USD;  $\varepsilon_i$  – random deviation, which interprets the cumulative impact of unaccounted factors and randomness.

The algorithm for determining the relationship between the selected parameters of the correlation and regression model included the following list of logically interrelated tasks: determining and estimating the parameters (coefficients) of the regression equations ( $a_0, a_1, a_2, b_0, b_1, b_2$ ) based on a retrospective of the statistical arrays of the relevant indicators; measuring quantitative parametric signs of the relationship between  $Y$  independent factors  $X_1$  and  $X_2$ ; assessment of the statistical significance of the coefficients of the regression equation; analytical measurement of the degree of influence of the independent variable factors on the parametric value of  $Y$ ; determination and measurement of the elasticity (sensitivity) of the resultant attribute  $Y$  from fluctuations in the factor attributes  $X_1$  and  $X_2$  by 1%.

The list of the above tasks was solved by using the MS Excel software package in practice. The sensitivity of the selling price of wheat and corn to changes in the world price of the respective crops and the exchange rate by 1% was measured using the following formulas:

$$E_{x1} = f'(x_1) \frac{x_1}{y}; \quad (7)$$

$$E_{x2} = f'(x_2) \frac{x_2}{y}. \quad (8)$$

Assuming a linear relationship between  $Y$  and  $X_1, X_2$ , the corresponding formulas are as follows:

$$E_{wx1} = a_1 \frac{x_{wi}}{y_{wi}}; \quad (9)$$

$$E_{wx2} = a_2 \frac{x_{eri}}{y_{wi}}, \quad (10)$$

where  $E_{wx1}$  – coefficient of elasticity (sensitivity) of the wheat sales price by agricultural enterprises depending on the change in the world wheat price by 1%;  $E_{wx2}$  – coefficient of elasticity (sensitivity) of wheat sales price by agricultural enterprises depending on exchange rate fluctuations by 1%;  $a_1, a_2$  – corresponding coefficients of the equations obtained in the course of correlation and regression modelling.

$$E_{cx1} = b_1 \frac{x_{ci}}{y_{ci}}; \quad (11)$$

$$E_{cx2} = b_2 \frac{x_{eri}}{y_{ci}}, \quad (12)$$

where  $E_{cx1}$  – coefficient of elasticity (sensitivity) of the selling price of corn by agricultural enterprises depending on the change in the world price of corn by 1%;  $E_{cx2}$  – coefficient of elasticity (sensitivity) of the selling price of corn by agricultural enterprises depending on exchange rate fluctuations by 1%;  $b_1, b_2$  – corresponding coefficients of the equations obtained in the course of correlation and regression modelling.

The empirical basis of the study is based on Official website of the State Statistics Service of Ukraine (n.d.), statistical data of Index Mundi Open Data Portal (n.d.), informational materials of the Minfin (n.d.) and Ministry of Agrarian Policy and Food of Ukraine (n.d.).

## ► Results and discussion

For a long time, Ukraine has been earning almost 10 billion USD annually from grain exports. Despite the war, these figures for the period 2022-2024 remain almost unchanged. For instance, in the first military year of 2022, export earnings from grain sales totalled 9.1 billion USD, including 2.7 billion USD of wheat, 5.9 billion USD of corn, and 0.45 billion USD of barley. In 2023, the export revenue of grain traders decreased by 8.8% to 8.3 billion USD. In the first half of 2024, grain exports have already reached 5.2 billion USD, including 10.8 million tonnes of wheat exported for 1.8 billion USD, 19.8 million tonnes of corn (3.2 billion USD), and 1.4 million tonnes of barley (0.2 billion USD). However, the volume of grain exports declined during the war, especially in 2022. Thus, compared to 2019, grain exports in the first year of the war decreased by 32.1% or 18.2 million tonnes, including wheat almost halved (from 20 to 11.2 million tonnes), corn by 22.9% (from 32.3 to 24.9 million tonnes), and barley by

48.8% (from 4.1 to 2.1 million tonnes). In 2023, natural export volumes increased relatively to 44.8 million tonnes: 16.2 million tonnes of wheat, 26.4 million tonnes of corn, and 2.2 million tonnes of barley (Table 1).

**Table 1.** Dynamics of grain exports in Ukraine in 2019-2024

Types of crops	2019		2020		2021		2022		2023		2024, the first half of the year	
	million tonnes	million USD	million tonnes	million USD	million tonnes	million USD	million tonnes	million USD	million tonnes	million USD	million tonnes	million USD
Total	56.7	9,633.3	51.3	9,410.7	50.8	12,343.8	38.5	9,108.2	44.8	8,306.7	32.1	5,263.4
Wheat	20.0	3,658.4	18.1	3,595.5	20.1	5,074.8	11.2	2,675.6	16.2	2,941.0	10.8	1,838.7
Barley	4.1	710.1	5.0	877.5	5.7	1,275.4	2.1	446.4	2.2	362.4	1.4	219.7
Corn	32.3	5,218.3	27.9	4,877.1	24.7	5,892.7	24.9	5,934.2	26.4	4,966.4	19.8	3,179.3
Rice	0.006	4.470	0.005	4.011	0.010	6.331	0.001	0.974	0.000	0.140	0.003	4.114
Buckwheat	0.001	0.474	0.000	0.268	0.001	0.760	0.000	0.266	0.001	0.369	0.001	0.483
Other	0.2	41.7	0.3	56.4	0.4	94.0	0.2	50.7	0.1	36.4	0.1	21.0

**Source:** calculated by the authors based on the State Statistics Service of Ukraine (n.d.) and the Ministry of Agrarian Policy and Food of Ukraine (n.d.)

In the first half of 2024, Ukraine has already exported 32.1 million tonnes of grain, which is 71.7% of the previous year's figure. The blocking of the Black and Azov Seas ports, partial resolution of this problem through the grain deal, and several large-scale challenges faced by farmers have forced them to intensify their search for alternative land and river grain sales channels. The enormous logistical challenges caused by the full-scale war had an impact on the volume and structure of grain exports. While in 2019-2021, the structure of wheat exports was steadily

dominated by African countries with an average share of 36.4%, in 2023 this figure dropped to 11.5%. Before the war, more than 55% of wheat was exported to Asian countries. In 2022, this figure dropped to 37.9%, and in 2023 to 35.5%. The logistical transformation of wheat exports has shifted towards European countries. Before the war, the total share of wheat exports to European countries did not exceed 5%, while after the full-scale Russian invasion, it is approaching 50%. A similar trend is also evident in the second dominant export crop, corn (Table 2).

**Table 2.** Transformation of the structure of grain exports during the war, %

	2019		2020		2021		2022		2023		2024, the first half of the year	
	thousand tonnes	%	thousand tonnes	%	thousand tonnes	%	thousand tonnes	%	thousand tonnes	%	thousand tonnes	%
Wheat												
Asia	10,705.1	53.5	10,069.3	55.8	10,944.6	54.5	4,247.8	37.9	5,738.9	35.5	4,458.7	41.3
Africa	7,730.6	38.6	6,079.8	33.7	7,393.1	36.8	2,369.4	21.1	1,855.9	11.5	1,869.5	17.3
Europe	533.4	2.7	695.3	3.8	332.1	1.7	4,250.4	37.9	7,803.8	48.3	4,463.3	41.4
USA	285.5	1.4	32.7	0.2	190.4	0.9	0.34	0.003	0	0	0	0
Corn												
Asia	10,690.7	33.1	11,824.6	42.4	12,545.1	50.8	7,871.6	31.6	7,095.8	26.9	3,204.5	16.2
Africa	5,983.9	18.5	4,695.2	16.8	3,502.9	14.2	2,190.1	8.8	3,624.8	13.7	2,900.1	14.7
Europe	15,092	46.7	6,818.1	24.4	8,068.3	32.7	14,605.9	58.5	14,983	56.8	13,666	69.1
USA	0	0	0	0	0	0	0	0	0	0	0	0

**Source:** calculated by the authors based on the State Statistics Service of Ukraine (n.d.) and the Ministry of Agrarian Policy and Food of Ukraine (n.d.)

During the war, the share of European countries importing corn from Ukraine increased to almost 60%, with an average of 29% coming from Asia and 11.2% from the African continent. At the same time, the loss of the cheapest export channel for grain products through seaports, with a corresponding alternative reorientation to land and river transport, affected domestic and foreign pricing policies on the grain market. Retrospective monitoring shows that in the first year of the war, the

price situation in Ukraine's domestic grain market did not correlate with the catastrophic rise in fuel, fertilisers, other inputs and logistics costs. Compared to the pre-war period, average grain selling prices increased by only 1.8% (from 6,296.1 to 6,406.3 UAH/t). The selling price of wheat generally decreased by 5.1% (from 6,433.6 to 6,104.7 UAH/t), and barley by 4.1% (from 5,862.6 to 5,623.6 UAH/t). Corn for grain experienced a slight increase in price by 5.1% (Table 3).

**Table 3.** Average prices of grain crops sold by enterprises, over time, UAH per tonne, 2019-2024

Product name	2019	2020	2021	2022	2023	2024, the first half of the year	2022 to 2021, %	2023 to 2021, %
Cereals and pulses	3,867.5	4,794.1	6,296.1	6,399.7	5,675.5	7,189.3	101.6	90.1
of them								
wheat	4,077.1	5,017.5	6,433.6	6,097.1	4,970	8,250	94.8	77.3
grain corn	3,684.6	4,668.6	6,245.5	6,555.4	4,702	6,721	105.0	75.3
barley	3,932.5	4,352.7	5,862.6	5,632.7	3,755	6,597	96.1	64.1

**Source:** compiled by the authors based on the State Statistics Service of Ukraine (n.d.)

In 2023, the domestic price situation on the grain market had a steady downward trend, which pushed Ukrainian rural producers beyond the point of profitability. The average price of wheat did not exceed 5,000 UAH/t, which is 18.5% lower than in 2022 and almost a quarter less than the pre-war level. The domestic selling price of corn was 28.3% lower than in 2022, and barley lost another 33.3% in price compared to the pre-war period. The decline in domestic grain prices accelerated in late July 2023 after the grain corridor was closed.

At the beginning of 2024, prices for major crops were even lower compared to the same period in 2023: grade 3 wheat by 10% (5,700 UAH/t), grade 2 wheat by 8.1% (5,953 UAH/t), corn by 9.1% (5,570 UAH/t), barley by 13% (4,383 UAH/t), and spring wheat by 3.5% (6,298 UAH/t). During the same year, from January to mid-July, the purchase prices for wheat began to gradually increase by 47.4% for Grade 2 wheat (from 5,700 to 8,401 UAH/t), and by 37.6% for Grade 3 wheat (from 5,953 to 8,191 UAH/t). Since the beginning of the year, corn has risen in price by almost 21% or 1,151 UAH per tonne from 5,570 to 6,721 UAH/t. The price dynamics

for barley and oats were even more pronounced. Since the beginning of the year, the purchase price of barley has increased by 50.5% from 4,384 to 6,597 UAH/t. Oats increased by 68.6% or 3,500 UAH/t from 5,100 to 8,600 UAH/t.

The result of the retrospective analysis of the dynamic series of price indicators in the markets of priority export crops of wheat and corn was the measurement of the proposed logistic coefficients of the price ratio  $K_1$  and  $K_2$  and their analytical comparison during 2009-2021 and the war. Thus, from 2009-2014, the world wheat price exceeded the domestic selling price, converted at the current exchange rate into the dollar equivalent, by an average of 1.5 times. In the next relevant period, from 2015 to 2021, the price equivalence of the wheat market is confirmed by the average value of the corresponding coefficient  $K_1 = 1.07$ . During the war, this coefficient, as an indicator of wheat market destabilisation, demonstrates that the world price exceeds the domestic purchase price by 2.2 and 2.3 times, respectively. The first half of 2024 preliminarily shows a decrease in this negative trend by 23.7% or from 2.28 to 1.74 points (Table 4).

**Table 4.** Retrospective dynamics of price correlation in the market of export-oriented grain crops

Year	Wheat					Corn				
	Average annual sales price, USD/t	Average annual export price, USD/t	Average annual global price, USD/t	Price-to-earnings ratios		Average annual sales price, USD/t	Average annual export price, USD/t	Average annual global price, USD/t	Price-to-earnings ratios	
				$K_1$	$K_2$				$K_1$	$K_2$
2009	119.8	138.0	223.4	1.87	1.15	126.7	141.1	165.5	1.31	1.11
2010	158.5	186.5	223.7	1.41	1.18	182.1	193.9	186.0	1.02	1.06
2011	213.4	261.2	316.2	1.48	1.22	240.6	254.0	291.8	1.21	1.06
2012	226.2	271.5	313.3	1.39	1.20	223.1	249.1	298.4	1.34	1.12
2013	231.7	243.7	312.2	1.35	1.05	219.9	229.1	259.0	1.18	1.04
2014	194.3	217.3	284.9	1.47	1.12	184.8	190.9	192.9	1.04	1.03
2015	159.5	166.4	204.5	1.28	1.04	163.4	157.6	169.8	1.04	0.96
2016	157.1	151.6	166.6	1.06	0.96	176.2	153.6	159.2	0.90	0.87
2017	176.8	159.4	174.2	0.99	0.90	167.4	154.1	154.5	0.92	0.92
2018	201.4	183.5	209.9	1.04	0.91	178.9	163.5	164.4	0.92	0.91
2019	200.7	182.7	201.7	1.01	0.91	166.1	161.3	170.1	1.02	0.97
2020	221.4	199.1	231.6	1.05	0.90	189.9	174.7	165.5	0.87	0.92
2021	290.8	252.8	315.2	1.08	0.87	239.8	238.8	259.5	1.08	1.00
2022	196.0	238.6	430.0	2.19	1.22	206.1	237.9	318.8	1.55	1.15
2023	149.1	182.1	340.4	2.28	1.22	163.4	188.4	252.7	1.55	1.15
2024 (first half of the year)	151.5	170.4	264.0	1.74	1.12	139.9	160.8	190.9	1.36	1.11

**Source:** calculated by the authors based on State Statistics Service of Ukraine (n.d.), Index Mundi Open Data Portal (n.d.) and Minfin (n.d.)

The logistic coefficient  $K_2$ , which demonstrates the ratio of the domestic purchase price of wheat to the export price, showed the following trend. Thus, in 2009-2014, the export price of grain traders exceeded the purchase price of producers by an average of 1.1 times, and in the following 2015-2021, this ratio decreased to 0.93. During the war, this indicator increased to 1.22. In the first half of 2024, compared to the previous year, 2023, there was an 8.2% decrease in the logistics burden from 1.22 to 1.12 points.

Compared to the wheat market, price distortions in the corn market were less pronounced. For example, the logistic coefficient of the ratio of the world and domestic purchase price during 2009-2014 averaged 1.18, while the  $K_2$  coefficient was only 1.07. During 2015-2021, these indicators decreased to 0.96 and 0.94, respectively, and in 2016-2018 and 2020, the world price of corn was 8-13% lower than its domestic equivalent. A similar trend was established for the indicator of the ratio of domestic purchase and export prices of corn. During the war, the logistic coefficients of the ratio of world and export prices to domestic purchase prices increased by 1.55 and 1.15 points, respectively. The same is true for the wheat market: The first half of 2024 showed a decrease in logistics load factors by 12.3 and 3.5% (to 1.36 and 1.11 points, respectively). It is noted that the stability of the grain market is indirectly determined by the price situation and existing price fluctuations and ratios. The price has a fundamental impact on the category of efficiency of the grain production industry and forms an objective basis for the stability of economic activity and the prospects for the development of its producers.

The application of correlation analysis tools differentiated by types of grain crops and periods has established the following relationships. Thus, the pairwise correlation coefficients in the wheat market before the full-scale invasion are equal to: the dependent variable  $Y$  (domestic wheat price) with independent variables  $X_1$  (world price) and  $X_2$  (exchange rate)  $R_{yx1} = 0.67$  and  $R_{yx2} = 0.18$ ,

respectively, and there is an anticorrelation between the independent factors themselves  $R_{x1x2} = 0.44$ . Similar parameters in the corn market are equal to:  $R_{yx1} = 0.77$ ,  $R_{yx2} = -0.12$ ,  $R_{x1x2} = -0.46$ . Therefore, a significant correlation between the domestic price of wheat and corn and the current dynamics of world prices for these crops is present at 44.9% and 59.2%, respectively. The impact of the exchange rate on the domestic selling price of wheat and corn was much lower at 3.3 and 1.5%, respectively (Table 5).

During the war, when the national economy and its agricultural sector experienced unprecedented global structural, production, logistical, and inflationary challenges, the parameters of the correlation between the factors under study were significantly transformed. Thus, the impact of world prices on domestic selling prices of wheat and corn increased to 54.8% and 73.5%, and the corresponding correlation coefficients increased to 0.74 and 0.86. At the same time, the impact of the devaluation factor (the exchange rate) increased in the wheat market to 47.7%, and in the corn market to 70.4%. There is a significant anticorrelation, or opposite relationship, between  $R_{yx1} = -0.68$  and  $R_{yx2} = -0.84$ . Therefore, the more active the actual disappointing dynamics of the depreciation of Ukrainian national currency, the lower the domestic selling price for grain crops (wheat and corn).

The summarised results of the regression analysis used to study the impact of the dynamics of world prices and the national currency exchange rate on domestic sales prices of the main export-oriented grain crops (wheat and corn) before the full-scale invasion are presented in Table 6. The processing of the relevant dynamic series of actual parameters of domestic selling prices, world prices and the national currency exchange rate for the period from 1 January 2009 to 24 February 2022 determined the following parametric values of the multiple correlation coefficients: 0.86 and 0.81, respectively. Notably, there is a stronger relationship between the domestic selling price of grain and the combined effect of world prices and exchange rate dynamics, compared to the pairwise correlation.

**Table 5.** Comparison of correlation matrices before and during the war

Before the war (1.01.2009-24.02.2022)				During the war (1.03.2022-1.07.2024)			
Wheat				Wheat			
	Y	$X_1$	$X_2$		Y	$X_1$	$X_2$
Y	1			Y	1		
$X_1$	0.669902	1		$X_1$	0.74048	1	
$X_2$	0.18161	-0.44158	1	$X_2$	-0.69073	-0.81372	1
Corn				Corn			
	Y	$X_1$	$X_2$		Y	$X_1$	$X_2$
Y	1			Y	1		
$X_1$	0.7697	1		$X_1$	0.857201	1	
$X_2$	-0.12419	-0.45771	1	$X_2$	-0.83901	-0.74623	1

Source: calculated by the authors

**Table 6.** Resulting parameters of the correlation and regression analysis of the impact of world prices and the exchange rate on domestic sales prices of wheat and corn by farmers in Ukraine for the period 1.01.2009-24.02.2022

Equation	Multiple correlation coefficient R	Determination coefficient R <sup>2</sup>	Fisher's coefficient F-criterion	Student's t-test	Elasticity coefficients
Wheat					
$Y = -35.1583 + 0.7119X_1 + 3.1657X_2$	0.856	0.732	Factual: 211.58 Tabular: 0.31	$tx_1 = 20.10$ $tx_2 = 12.79$	$Ex_1 = 0.89$ $Ex_2 = 0.29$

Table 6, Continued

Equation	Multiple correlation coefficient R	Determination coefficient R <sup>2</sup>	Fisher's coefficient F-criterion	Student's t-test	Elasticity coefficients
Corn					
$Y = 31.9956 + 0.6555X_1 + 1.333X_2$	0.811	0.658	Factual: 149.28 Tabular: 0.42	$tx_1 = 17.08$ $tx_2 = 5.46$	$Ex_1 = 0.70$ $Ex_2 = 0.13$

Source: calculated by the authors

The coefficients of multiple determination indicate that the domestic selling price of wheat before the full-scale invasion depended on world prices and the UAH/USD exchange rate by 73.2%, and corn by 65.8%. 26.8% and 34.2% of the variation in the price parameters of wheat and corn, respectively, were determined by factors that were not covered by the scope of the research. The calculated values of the F-criteria (211.58 and 149.28) exceeded the specified table parameters with a probability of 0.95, which indicates the reliability of the built models. The corresponding test of the significance of the multiple correlation coefficients using the parametric tools of the Student's t-test proved that for both factors in the wheat and corn markets, with a probability of 0.95, there is a significant excess of the threshold parameter  $t_{0.95}(158) = 1.98$ . This confirms the significant significance of the influence of the selected factors. The formalised correlation and regression models of the dependence of domestic selling prices of wheat and corn on world prices and exchange rate dynamics are as follows:

$$Y_{wheat} = -35.1583 + 0.7119X_1 + 3.1657X_2; \quad (13)$$

$$Y_{corn} = 31.9956 + 0.6555X_1 + 1.333X_2, \quad (14)$$

where  $Y$  – theoretical value of the monthly selling price of wheat and corn by agricultural enterprises, USD/t;  $X_1$  – monthly dynamics of world wheat and corn prices, USD/t;  $X_2$  – USD/UAH exchange rate, UAH per USD.

The established correlation and regression dependencies interpreted the nature of changes in domestic sales

prices of grain crops in Ukraine by farmers depending on the current dynamics of the relevant world prices and the exchange rate. For example, the model of wheat price dependence before the full-scale war, according to the calculations, suggests that an increase in the world price by USD 1 per tonne would lead to an increase in the domestic selling price by USD 0.71 per tonne, and an increase in the dollar exchange rate by UAH 1 would increase the price by USD 3.2. Similar calculations of the price dependence of corn show that an increase in the world price by USD 1 per tonne led to a corresponding increase in the realised price by USD 0.66 per tonne, and the growing dynamics of the exchange rate by UAH 1 per tonne increased the price by USD 1.33 per tonne.

A significant advantage (by 27.1%) of the price elasticity of wheat compared to corn was found. Thus, with a 1% increase in the global price of wheat, the domestic selling price increased by 0.89% in the analysed period. In turn, a similar increase in the world price of corn led to an increase in the domestic selling price by only 0.7% relative to the average values in the sample. The elasticity coefficients, which addressed the impact of the second factor (exchange rate), also showed a greater price sensitivity of wheat than corn. Thus, a 1% increase in the dollar led to a 0.29% increase in the selling price of wheat and only a 0.13% increase in the selling price of corn. The relevant results of the correlation and regression analysis used to determine the impact of the dynamics of world prices and the exchange rate on the domestic price situation in the wheat and corn markets during the war are presented in Table 7.

**Table 7.** Resulting parameters of the correlation and regression analysis of the impact of world prices on domestic sales prices of wheat and corn by farmers in Ukraine for the period 24.02.2022-1.07.2024

Equation	Multiple correlation coefficient R	Determination coefficient R <sup>2</sup>	Fisher's coefficient F-criterion	Student's t-test	Elasticity coefficients
Wheat					
$Y = 173.1434 + 0.1944X_1 - 2.2635X_2$	0.756	0.571	Factual: 16.66 Tabular: 0.57	$tx_1 = 2.34$ $tx_2 = -1.16$	$Ex_1 = 0.43$ $Ex_2 = -0.50$
Corn					
$Y = 256.8268 + 0.3099X_1 - 4.6546X_2$	0.908	0.824	Factual: 58.71 Tabular: 0.19	$tx_1 = 4.14$ $tx_2 = -3.57$	$Ex_1 = 0.48$ $Ex_2 = -0.97$

Source: calculated by the authors

The corresponding study of the dynamic series of actual parameters of domestic selling prices, world prices for wheat and corn, and the national currency exchange rate during the war using correlation and regression tools has established that, compared to the pre-war period, the parametric value of the multiple correlation coefficient in the wheat market decreased by 6.2% from 0.86 to 0.76. At the same time, the same indicator of the strength of the factor relationship in the corn market increased by 12.3% from

0.81 to 0.91. In other words, the relationship between the domestic selling price and the combined effect of global prices and exchange rate movements decreased for wheat, while it increased significantly for corn.

In turn, the obtained parametric values of the coefficients of multiple determination during the war demonstrate the following dependence of domestic selling prices for grain crops on world prices and the USD exchange rate: for wheat by 57.1%, and for corn by 82.4%. In other

words, the geopolitical challenges faced by Ukraine's grain market have intensified the factor influence, which is difficult to measure parametrically and to process indicatively using economic and mathematical tools.

However, the influence of the factors selected for modelling remains significant, and the calculated values of the F-criteria (16.66 and 58.71) with a probability of 0.95 again exceed the determined table parameters, which indicates the reliability of the built models. Further verification of the significance of the multiple correlation coefficients using the parametric tools of the Student's t-test proved that the world price factor for both wheat and corn remains significantly above the threshold parameter  $t_{0.95}(28) = 1.98$  with a probability of 0.95. In turn, the factor of exchange rate influence has acquired the opposite anticorrelation effect, with negative values of Student's t-tests: -1.16 and -3.57 respectively. In wartime, the correlation and regression models of the dependence of domestic sales prices of commodity producers on world prices and exchange rate dynamics are as follows:

$$Y_{wheat} = 173.1434 + 0.1944X_1 - 2.2635X_2; \quad (15)$$

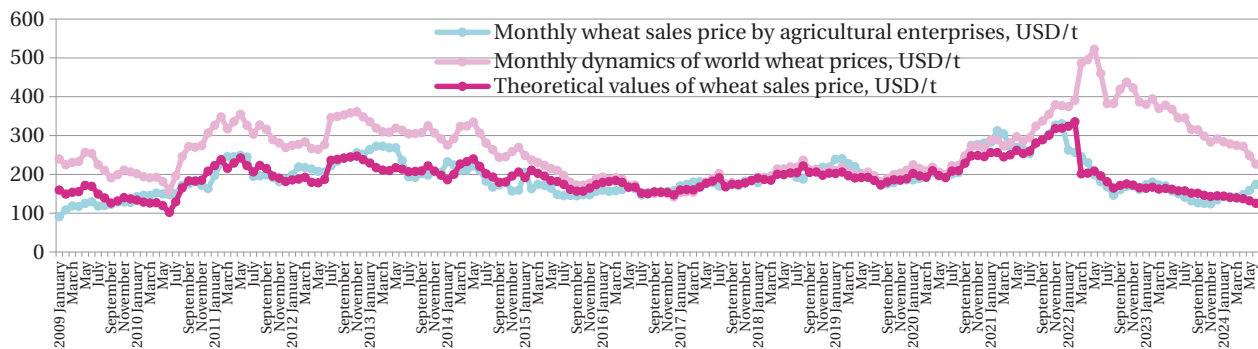
$$Y_{corn} = 256.8268 + 0.3099X_1 - 4.6546X_2. \quad (16)$$

The identified correlation and regression dependencies of wartime suggest the following interpretation of transformational changes in the dependence of domestic grain prices on the actual dynamics of the relevant world prices and exchange rates: an increase in the price by

1 USD/t increased domestic selling price by 0.19 USD/t, which is 3.7 times less than in the pre-war period; a 1 UAH appreciation of the dollar reduces the domestic selling price of wheat by 2.26 USD/t; a 1 USD/t increase in the global corn price increased the sale price by 0.31 USD/t, which is half as much as in the pre-war period; a 1 UAH appreciation of the exchange rate reduces the sale price of corn by 4.65 USD/t.

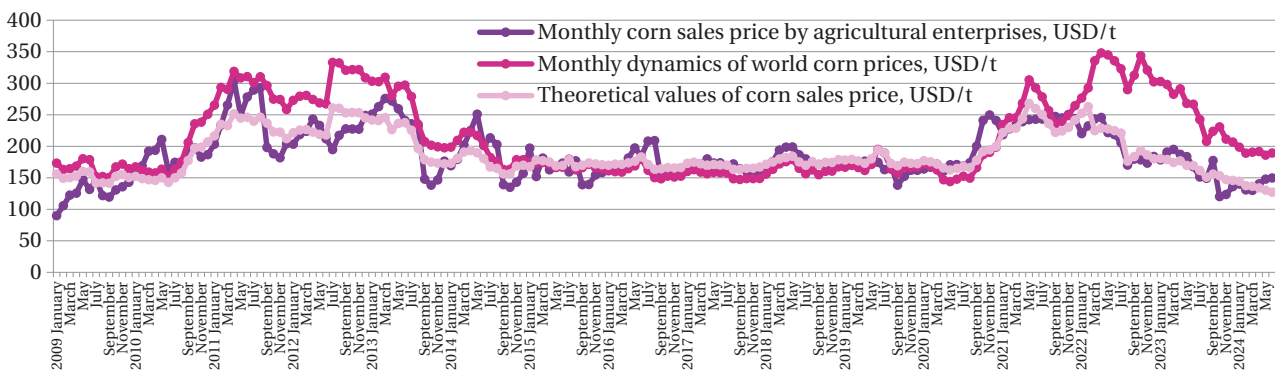
In contrast to the pre-war period, the price elasticities of wheat and corn almost equalised during the war. As such, with a 1% increase in the global wheat price, the domestic selling price increased by 0.43% and 0.48%, respectively, between 24.02.2022 and 1.07.2024. In turn, the elasticity coefficients, which reflect the impact of the rising dollar, became negative. A 1% increase in the dollar during the war led to a 0.50% decrease in the selling price of wheat and a 0.97% decrease in the selling price of corn.

The calculation and analytical study of the developed correlation and regression models of the dependence of domestic sales prices of wheat and corn producers on world prices and exchange rate dynamics formulated theoretical values of the relevant price indicators (Figs. 1, 2). Clear periods of price imbalances in the markets of major export crops were identified. For example, in the wheat market in 2009-2014, there was a significant price disparity between the domestic selling price and the world price. The parameters of domestic wheat sales prices determined in the course of correlation and regression modelling relatively correct the monthly price dynamics.



**Figure 1.** Graphical interpretation of the results of modelling the dependence of domestic wheat sales prices on the dynamics of world prices and the exchange rate

Source: calculated and compiled by the authors



**Figure 2.** Graphical interpretation of the results of modelling the dependence of domestic corn sales prices on the dynamics of world prices and the exchange rate

Source: calculated and compiled by the authors

During 2015-2021, the price situation in the wheat market can be characterised as balanced, with domestic procurement prices practically in line with both global dynamics and certain theoretical parameters. During the war, which caused enormous problems with grain exports from Ukraine, which in turn held strong positions in the world market (Savosh *et al.*, 2020), the price imbalance became more pronounced, with world prices significantly exceeding both actual and theoretical levels of the purchase price of wheat in Ukraine. An identical periodisation of price imbalances was recorded in the corn market. The only difference is the relatively smaller variation in the excess of world prices over domestic sales prices both during 2009-2014 and during the war.

V. Skribans *et al.* (2024) identified and structured several problems faced by Ukrainian and global food markets, in particular wheat and corn producers. The authors demonstrated the need for an adaptive search for new logistics solutions to ensure the functioning of the grain market. It is worth noting that the Black Sea Grain Initiative has contributed to further grain exports from Ukraine and slowed the pace of global food price growth. Furthermore, the proposal to create a transport corridor for Ukrainian agricultural products through the territory of the EU, using the Baltic Sea shipping routes, is considered rational. The results of the study by H.M. Ay & A. Söylemez (2023), which emphasised the importance of Turkey's geopolitical and diplomatic efforts in signing the grain agreement and ensuring the functioning of the Black Sea grain corridor as the main alternative to the export logistics disrupted by the war.

A.M. Martins (2024) analysed the short-term price response of the global grain market in the context of the Russian-Ukrainian war and different periods of the Black Sea Grain Agreement. Following the study, the outbreak of war and periods of non-renewal of the Black Sea Grain Agreement significantly reduced-price indicators in the grain market, with supply constraints leading to a substantial price increase. A. Rose *et al.* (2023) conducted their study using the computable general equilibrium model of the Global Trade Analysis Project (GTAP). The authors analysed the economic consequences of destructive changes in Ukrainian grain exports caused by a full-scale war. Based on the modelling results, disruptions and violations in the export sector negatively affect not only Ukraine and the aggressor country but also cause significant negative economic consequences in other regions of the world. However, there are certain concerns regarding the comparative results of forecasting the losses of real GDP in Ukraine and Russia as a result of deteriorating conditions and opportunities for grain exports.

F. Urak (2023) determined that price volatility in the grain market poses a significant threat to the food security of many countries. The author assessed the degree of risks associated with the pandemic and the Russian-Ukrainian war and their impact on critical agricultural markets in Turkey: wheat, barley, corn, and sunflower oil. The author used the VAR (1)-Asymmetric BEKK-Generalised Autoregressive Conditional Heteroscedasticity (GARCH) (1.1) model. The study established that the combination of short- and long-term uncertainties negatively affects the profitability of participants in critical markets, in particular, grain crops.

R. Ihle *et al.* (2022) quantified how the full-scale war in Ukraine has affected price imbalances in global commodity markets. Using a coherence index, the authors conducted a retrospective analysis of 15 key global indices and identified the impact of logistics disruptions on the growing dynamics of grain, energy and fertiliser prices and the creation of global threats to food and energy security. Following the results of the study, it is necessary to increase the resilience of global food supply chains during economic disasters and wars.

S. Jagtap *et al.* (2022) investigated the nature and extent of the impact of the Russian-Ukrainian war on the efficiency of global food supply chains, including grain. The PRISMA approach (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used to formulate a set of priority tactical and strategic decisions that could minimise the negative impact of the war on the global food supply system. However, the authors' position on the need to find alternative partners for the supply of grain and other food is considered controversial.

The results of a study by A.K. Mottaleb *et al.* (2022) are notable for their methodology of studying price imbalances in the grain market. The authors determined the potential impact of the Russian-Ukrainian war on the dynamics of wheat prices and consumption, both in physical terms and in terms of calories. The authors determined that a 1% decrease in global wheat trade could lead to a 1.1% increase in the producer price. A 1% increase in the producer price, in turn, could reduce per capita wheat consumption by 0.59% per year. Following the authors, a 50% reduction in wheat exports from Ukraine and Russia could lead to a 15% increase in wheat prices and an 8% reduction in wheat consumption.

S. Ishchuk & L. Sozansky (2024) assessed the impact of the war on the dynamics and structure of merchandise exports from Ukraine. The study determined that the commodity orientation of Ukrainian exports (grains, oilseeds) increased significantly during the war. As one of the scenarios for the post-war development of the country's agricultural export potential, the authors propose to partially reorient grain exports to livestock production and increase its exports. Also promising for the post-war recovery of Ukraine's agrarian economy are the results of a study by T. Ostashko *et al.* (2023). The authors emphasised the need to optimise the grain market, aimed at reducing the volume of grain exports as a raw material and increasing the export potential of its processed products.

As a result of the current study is verified methodical calculation and constructive algorithm for studying the price situation on the grain market of Ukraine in the conditions of war, which, as opposed to the existing ones, comprehensively covers a set of indicators for assessing structural transformations and priority problems of grain exports and tools for correlation and regression modelling to determine the impact of the dynamics of world prices and exchange rate fluctuations on the volatility of domestic sales prices of wheat and corn in rural areas. The study of the impact of world prices and the exchange rate in peacetime in the face of logistical and inflationary challenges and the transformations of these factors in the context of the war on pricing in the grain industry is important for government agencies in forecasting grain prices and grain production efficiency.

## ► Conclusions

The study identified price imbalances and an analytical and indicator summary of the results of variable modeling of the factor impact of world prices and exchange rate dynamics on the actual prices of wheat and corn at which rural producers sell their products. The study has established significant structural and logistical transformations that took place in the field of grain exports during the war. Compared to the pre-war period, in 2022, natural exports decreased by 12.3 million tonnes (or 24.2%). In 2023, after the logistical problems were relatively resolved, these figures were 6.0 million tonnes and 11.8%, respectively. During the first year of the war, export revenues from grain sales fell by 3.2 billion USD, or 26.2%, and in 2023, the decrease in cash receipts from grain exports exceeded 4 billion USD compared to 2021.

The study determined that before the war, the main importers of wheat and corn from Ukraine were Asian countries, with an average share of 55 and 42.1%, and African countries with a share of 36.4 and 16.5%, respectively. The risk of Russian shelling of transport vessels in the Black Sea led to a decrease in the share of exports to the Asian region in 2022 to 37.9%, and in 2023 to 35.5%, and corn to 31.6 and 26.9%; to the African region to 21.1 and 11.5%, and to 8.8 and 13.7%, respectively. The reorientation of grain logistics to land and river transport increased the share of European countries in Ukraine's wheat and corn exports in 2023 to 48.3% and 56.8% but negatively affected domestic and international grain market prices. Domestic wheat prices in 2023 dropped by 22.7% and corn prices by 28.2%.

The established price imbalances using the tools of logistic coefficients  $K_1$  and  $K_2$  demonstrate the destabilisation of the grain market: in wartime, world prices exceed domestic selling prices for wheat by 2.2-2.3 times, and for

corn by 1.55 times, while the corresponding indicators for export prices are 1.22 and 1.15. The development of correlation analysis tools for the chosen variable periodisation revealed a significant increase in the factor influence of the dynamics of world prices on domestic selling prices of wheat and corn from 44.9 and 59.2% to 54.8 and 73.5%, respectively, in the context of the war. In turn, the impact of the exchange rate on the domestic selling price of wheat and corn increased dramatically from the pre-war levels of 3.3 and 1.5% to 47.7 and 70.4%, with a proven anti-correlation and negative impact.

The modelling shows that before the full-scale Russian invasion, a 1 USD/t increase in the world wheat price led to a 0.71 USD/t increase in the domestic selling price, a 1 UAH appreciation of the dollar increased the price by 3.2 USD/t, and for corn, these indicators were 0.66 and 1.33 USD/t, respectively. In the context of war, a 1 USD/t increase in the global price leads to a 0.19 and 0.31 USD/t increase in the domestic price of wheat and corn, respectively, while a 1 UAH devaluation reduces the domestic selling price by 2.26 and 4.65 USD/t, respectively. Further research should analyse the forecasting of the pricing process and performance indicators of the internal and external components of the grain market, considering the objective influence of logistics transformations, world prices and the exchange rate.

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## Оцінка структурних змін експорту та цінової ситуації на ринку зерна України в умовах війни

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► **Анотація.** Метою дослідження була оцінка основних проблем експорту, індикативне вимірювання цінових диспропорцій на ринку зерна та порівняльний аналіз впливу світових цін та динаміки валютного курсу на внутрішні ціни реалізації пшениці та кукурудзи до і під час війни. Було використано такі методи: порівняльного аналізу, статистичний, табличний, графічний, розрахунково-конструктивний, абстрактно-логічний, а також інструментарій кореляційно-регресійного аналізу. Встановлено значну структурну трансформацію експорту пшениці та кукурудзи під час війни – майже дворазове зниження частки азійських країн та зростання питомої ваги країн Європи в експорті пшениці від 1,7 до 48,3 %, а кукурудзи – від 32,7 до 56,8 %. Визначено негативний вплив логістичної трансформації експорту на внутрішні і зовнішні ціни на ринку зерна. Порівняно з довоєнним періодом внутрішні ціни на пшеницю та кукурудзу впали на 22,7 та 28,2 %. Індикативне визначення цінових диспропорцій довело, що до війни світові ціни на пшеницю та кукурудзу майже відповідали внутрішнім значенням, а під час війни дане співвідношення збільшилось до 2,2 та 1,6 разів відповідно. Моделюванням встановлено, що до війни збільшення світової ціни пшениці на 1 дол. США/т призводило до еквівалентного зростання внутрішньої реалізаційної ціни на 0,71 дол. США/т, а зростання курсу долара на 1 грн. збільшувало ціну на 3,2 дол. США. В умовах війни вплив обраних факторних ознак кардинально змінився – відповідне збільшення світової ціни пшениці на 1 дол. США/т призводить до зростання внутрішньої реалізаційної ціни всього на 0,19 дол. США/т, що в майже в 4 рази менше, ніж у мирний час, а зростання курсу долара на 1 грн. зменшує внутрішню ціну реалізації 1 т пшениці на 2,26 дол. США. Відповідний вплив зростання світової ціни на кукурудзу на її внутрішній показник під час війни зменшився вдвічі – від 0,66 до 0,31 дол. США/т, а зростаюча динаміка валютного курсу на 1 грн. зменшує ціну реалізації кукурудзи на 4,65 дол. США/т

► **Ключові слова:** світова ціна; валютний курс; цінові диспропорції; цінова еластичність; моделювання впливу