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EXPORT OF AGRICULTURAL PRODUCTS AS A DETERMINANT OF CURRENCY SECURITY OF UKRAINIAN ECONOMY

Purpose. *The purpose of this study is the development of the methodological approach for estimation the impact of agri-food exports on the monetary sphere of Ukraine in order to substantiate the prospective directions of the export potential of agricultural products as the factor in ensuring the currency security of Ukraine.*

Methodology / approach. *The following methods were used: literature review in determining the main trends in the export of agricultural products based on the analysis of publications; economic and statistical analysis to assess the impact of key factors on the formation of the export potential of agricultural products and its impact on exchange rate formation; ARDL modelling, Dickey-Fuller, and Engle-Granger tests to estimate the impact of different factors on exchange rate changes.*

Results. *The paper highlights the immediate and delayed influence of selected factors on the dynamics of the exchange rate in Ukraine, showing that the export of food products and raw materials for their production can significantly strengthen the national currency in the long-run. The continuous growth in food exports contributes to a slower appreciation of the exchange rate, which ultimately leads to a stronger national currency. Therefore, the strategy of focusing on increasing food exports can play a vital role in bolstering the Ukrainian currency in the long-run by exerting a positive influence on the exchange rate dynamics and contributing to the overall economic stability.*

Originality / scientific novelty. *The study contributes to the understanding of the complex interplay between war, food security, and economic stability. The novelty implies the ARDL model of the influence of agricultural exports on the currency and exchange rate sphere of the Ukrainian economy. Additionally, the analysis adds new dimension to the discussion on the strategic importance of the agricultural sector for foreign exchange reserves and currency accumulation.*

Practical value / implications. *The practical value is that understanding the relationship between export volumes, global prices, and exchange rate movements can help in predicting and managing currency fluctuations more effectively. By identifying the time frames for the return of exchange rate shocks to their long-term equilibrium and the impact of various factors on currency valuation, the study aims policy-making processes at ensuring currency security for the state.*

Key words: *agricultural exports, currency security, exchange rate, export potential, global food security, export restrictions.*

1. INTRODUCTION

Over the years of its independence, Ukraine has established itself as a state whose development deeply relay on agrarian sector of the economy. This especially applies to the export of agricultural products, at the expense of which the currency channel for replenishing the state's balance of payments is formed. However, russian military

aggression forced adjustments in the formation of the Ukrainian export component from the standpoint of the agricultural sector.

Before the russian-Ukrainian war, the belligerents were the largest producers of agricultural products and food in the world. Before 2022, 55 % of the territory of Ukraine was used for agriculture, but now Ukraine is one of the most food insecure countries in the world (Mottaleb et al., 2022), despite being one of the world's largest exporters of agricultural crops such as corn, barley, and wheat.

Military aggression against Ukraine is aimed at destroying the Ukrainian economy, in particular the agricultural sector, with the purpose of causing panic in the global grain market. Foreign exchange earnings received from the export of grain crops are used by the monetary regulator to support the national currency, finance the technical re-equipment of agricultural producers and improve the socio-economic situation of workers. Thus, the process of ensuring currency security of the national economy takes place.

Today, the importance of increasing the volume of exports of agricultural products is determined by the urgent need to restore agricultural territories and cover the losses from the full-scale invasion of the russian federation. According to estimates of the Kyiv School of Economics (KSE, 2024), as of February 2024, losses and damages in the agricultural sector amounted to USD 80 bln, in particular: the total value of destroyed assets is USD 10.3 bln; losses, including the foregone revenue of producers of agricultural products and an increase in the cost of production – USD 69.8 bln and almost doubled in comparison to 2023. The total needs for Ukrainian economy's reconstruction and restoration during the next 10 years amount to USD 56 bln. Priority needs for 2024 amount to USD 435 mln, most of which is already covered by donor funding.

The main problems that require the transformation of the export mechanism of agricultural products include: restoration of cultivated areas and soil conditions, solving the issue of logistics, commodities share of agricultural export, reducing the industry's imported inputs dependence, and settling the issue of state subsidies for farmers who export products.

Despite the prolongation of the martial law in Ukraine, the export of agricultural products remains a key source of replenishment of the country's foreign exchange reserves. Therefore, the introduction by the state of an effective mechanism of financial support of the agricultural sector aimed at increasing the export of agricultural products is an urgent need from the standpoint of ensuring the currency security of Ukraine.

The purpose of this study is the development of the methodological approach for estimation the impact of agri-food exports on the monetary sphere of Ukraine for the justification of prospective directions of the export potential of agricultural products as the factor in ensuring the currency security of Ukraine. The tasks of this study are as follows: to determine the main trends in the export of agricultural products based on the analysis of publications by Ukrainian and foreign scientists; to assess the impact of key factors on the formation of the export potential of agricultural products and its impact on exchange rate formation using methods of economic and mathematical

modelling; to propose possible directions for increasing the export of agricultural products as a factor in ensuring the currency security of Ukraine.

2. LITERATURE REVIEW

The study of various aspects of the interdependence of exchange rate changes and the export of agricultural products and commodities is a topic of interest to both economists and practitioners. The paper by Kassouri & Altıntaş (2020) studies the impact of terms of trade shocks on the real effective exchange rate using the example of 23 commodity exporting countries in Africa. The results lead to three main conclusions: firstly, the reaction of the exchange rate to the terms of trade shocks is heterogeneous (in the long-run, the exchange rate rises more strongly during positive shocks, in the short-run – during negative shocks); secondly, the asymmetry of the exchange rate response depends on the group of exported goods, and is most pronounced for energy exporters; thirdly, energy and metal exporters are much more prone to exchange rate growth in the long-run than agricultural, food and beverage exporters. The general conclusion is that it is necessary to compensate for the loss of external competitiveness associated with a real increase in the exchange rate by coordinating monetary and fiscal policies to effectively absorb the huge additional foreign exchange reserves and ensure an equilibrium level of the exchange rate, which will bring macroeconomic stability in commodity exporting countries.

In the publication of Iyer (2020), situations with the most acceptable choice of exchange rate regime in agricultural exporting countries are analysed. It has been proven that the advantage of exchange rate flexibility depends on the degree of development of the labor and product markets. It has been established that flexible exchange rates are desirable in developed markets, as they eliminate the transmission mechanism of labor redistribution in the face of commodity price volatility. Considering the low level of development of the labor market and productivity in most countries exporting agricultural products, it is advisable to apply exchange rate targeting in developing agrarian countries.

The study of the impact of real exchange rate shocks on exports of processed agricultural products in Turkey was conducted by Çinar et al. (2015). Using VAR model, the authors proved that there is a significant relationship between real exchange rates and exports of processed agricultural products. This relationship is positive during the first quarter. However, in the future, it becomes negative with the stable trend. On the other hand, real exchange rate shocks can explain only 0.2–0.7 % deviation of the forecast of exports of processed agricultural products.

A significant cohort of researchers pays attention to the effect of export of agricultural products on national economic growth. Thus, in the paper by Bakari & Mabrouki (2018), based on the materials of the countries of South-Eastern Europe for the period 2006–2016, it is investigated the impact of the export of agricultural products on economic growth. The authors used correlation analysis and a static gravity model. Empirical analysis proved that the export of agricultural products has the positive tight correlation with the gross domestic product and the positive effect on

economic growth. These results confirm that the export of agricultural products is a driving force in ensuring economic growth in the countries of South-Eastern Europe. Therefore, the authors emphasise the need to expand investments in the agrarian sector and to consider more carefully issues related to the rise and state support for the development of the agrarian sector in the region, to implement a policy of openness in trade in agricultural products.

Also, Bakari & Tiba (2020), using the example of China, studied the impact of foreign trade in agricultural products on the economic growth of this country for the period 1984–2017. The authors proved that in the long-run, domestic investments and exports of agricultural products have a positive effect on the economic growth. However, the import of agricultural products has a significant negative impact on economic growth. In the short-run, a positive and significant impact of domestic investments, agricultural imports and exports on economic growth was revealed. The positive impact of agricultural exports on economic growth is due to the importance of agriculture in terms of job creation. Thus, a sufficient level of domestic investment in the agricultural sector tends to increase China's economic growth.

The separate scientific work on the issues raised concerns the russian war against Ukraine over food security. Thus, Kozielec et al. (2024) analysed the impact of this conflict on food security in the Middle East and North Africa (MENA) region. Since Ukraine is recognised as one of the world's largest producers and exporters of grain, the conflict is seen as a serious challenge for MENA countries, which are heavily dependent on grain imports. In this context, the importance of global linkages in food supply chains and their impact on regional food security is emphasised. Using data from 2002 to 2021, the study focuses on demographics and food security, analysing how these factors are intertwined with grain export dynamics. The escalation of hostilities disrupted transport routes, damaged infrastructure and complicated logistics, which caused a significant reduction in export volumes. Geopolitical tensions have exacerbated these effects, reducing confidence among grain importers in MENA. The study highlights how these disruptions have affected global supply chains, prices and availability of agricultural products, with a particular focus on MENA region's food security challenges exacerbated by conflict, climate change and import dependence. The study concludes that MENA region's increasing dependence on food imports, combined with climate and political fluctuations, underscores its increasing vulnerability to disruptions in global supply chains and the need for robust strategies to address these challenges.

The paper by Filho et al. (2023) notes that the russian-Ukrainian war has led to severe disruptions in national and global food supplies. Ukraine is a major exporter of wheat, corn and oilseeds, food staples that are currently suffering from supply risks caused by the war. To understand the main areas of research in the literature related to food security in the context of wars, the authors conducted a bibliometric review of the literature based on the term matching method, conducted using 631 peer-reviewed documents retrieved from the Scopus database. In addition to the bibliometric assessment, ten case studies were selected to investigate aspects of food insecurity

caused by the russian-Ukrainian war. The overlap analysis revealed four distinct thematic clusters. At the next stage, for each of the clusters, an assessment of the current situation regarding how the war affects food security was carried out, as well as the causes and possible solutions to food security were identified (Filho et al., 2023).

The issue raised in the scientific publication by Rodinova et al. (2022) is the indisputable scientific development. The authors found that global food security is under threat caused by the war. Due to the fact that the parties to the conflict are the world's largest exporters of grain, there is a risk of deepening the global food crisis. The authors claim that in order to avoid the catastrophic consequences of this crisis for Ukraine and the world, world community needs to take a number of measures, namely: ensure transparency of the agricultural market and global financing of food imports; refrain from introducing export restrictions; to find alternative suppliers for states that depend on Ukrainian and russian agricultural products. In order to stabilise the situation for Ukraine, it is necessary to direct efforts to adapt the logistics system to restore export supplies of agricultural products, support Ukrainian producers of agricultural products and continue cooperation with countries that support its territorial integrity and independence, provide financial and humanitarian assistance. In this context, the study by Herasymchuk (2023) deserves attention, which identified challenges and threats to the agricultural sector in Ukraine: lack of access to land plots, loss of access to water resources, increased production costs, increased risk to food security. In order to neutralise the presented threats, comprehensive measures to ensure economic security and sustainability of agrarian sector are proposed with the help of the development of key directions for investment and credit support of domestic farmers, development of export potential and support of farms. Therefore, the currency security of the state depends on ensuring the economic security of the agricultural sector, in particular, the development of the export potential of this industry.

Also noteworthy is the study by Myskiv et al. (2024), which identified strategic directions for the development of agricultural exports under martial law. The authors emphasise that strategic priorities for the development of agricultural exports should be based on the principles of food security, namely: further development of the food security approaches; systematicity and integration, gradualness and phasing; consideration of various population groups and stakeholders interests in the process of solving food security issues; introduction of innovative technologies in production; sustainability and environmental protection; international cooperation; strategic planning; social responsibility and effective use of natural, financial and human resources.

The critical analysis of the presented studies leads to conclusion that the volume of export of agricultural products has a greater influence on ensuring food security in various territories. Nevertheless, the dilemma of the impact of agricultural exports on exchange rate fluctuations has not been sufficiently investigated. The studies are mainly devoted to the issue of exchange rate changes on the price policy of agricultural export. Therefore, the authors tried to prove the hypothesis of positive affection the export of agricultural products on the stabilisation of the exchange rate as the factor in

ensuring the currency security of Ukraine, which in turn requires a separate study.

3. METHODOLOGY

In order to fulfill the purpose of this study and solve the tasks, both general scientific and special methods of cognition were used, namely: systemic and dialectical approaches in determining the degree of influence of agricultural products export on exchange rate creation; factor analysis when determining the features of the current state of agro-industrial external trade; calculation-analytical and coefficient analysis – in the study of the main economic indicators of agricultural products export, changes in prices and exchange rates; autoregression analysis, Dickey–Fuller and Engle–Granger tests – when estimate the impact of various factors of agricultural export on exchange rate changes; comparative analysis and synthesis – in development of promising directions for improving the mechanism of accumulating the export potential of agricultural products; logical generalisation – when substantiating the conclusions of the paper and formulating proposals; tabular and graphic – for visualisation of obtained results. The informational basis of this research consists of scientific publications of Ukrainian and foreign authors; official materials of the Center for Food and Land Use Research (2024), National Bank of Ukraine (2024), U.N. Food and Agriculture Organization (2024), Federal Reserve Economic Data (2024), Ministry of Foreign Affairs of Ukraine (2022), electronic publications and Internet resources on the issues.

The general concept of the study involves identifying and quantitatively measuring the relationship between the exchange rate dynamics of the national currency and the export of agricultural products and commodities in both the short-term and long-term perspectives (Figure 1). The main hypothesis posits the existence of a positive impact of agricultural exports on the exchange rate.

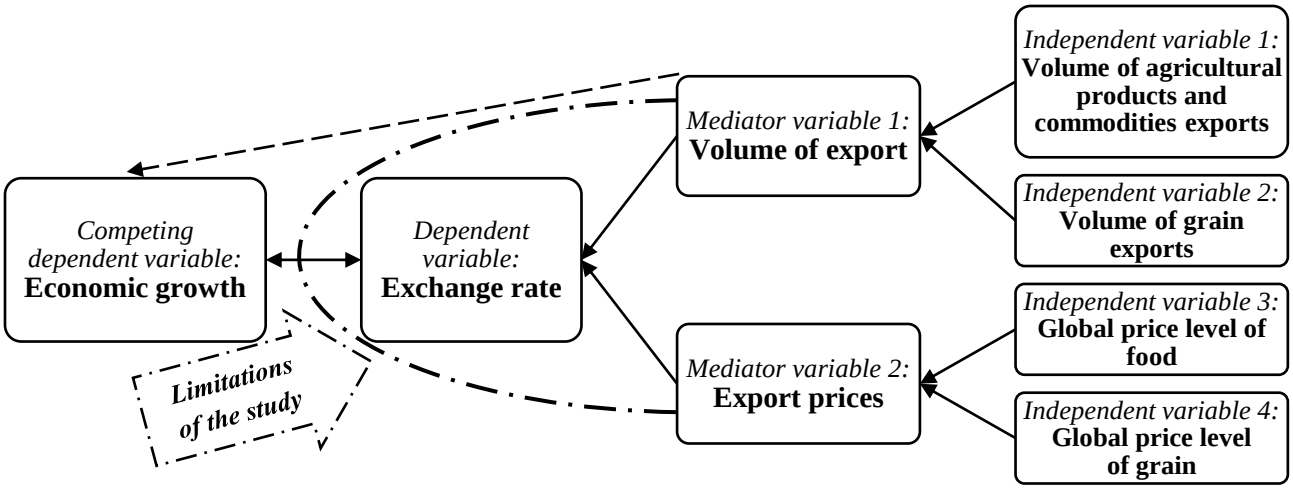

Figure 1. Graphic representation of the study's conceptual framework

Source: developed by the authors.

Before analysing the current state of export of agricultural products as a factor in ensuring currency security of Ukraine, it is reasonable to define the main concepts of

the research topic. According to the Law of Ukraine "On foreign economic activity", the export of goods means the sale of goods by Ukrainian entities engaged in foreign economic activity to foreign economic entities (including for payment in kind) with or without export of these goods across the customs border of Ukraine. In this context, regarding the export of agricultural products, attention should be paid to the research of Segal (2023), who believes that one of the main functions of diplomacy and foreign policy between governments is the facilitating of economic trade and exports and imports for the benefit of all trade parties. Other scholars Myskiv et al. (2024), proved that in order to stimulate the export potential of agricultural products, it is not advisable to apply an isolated approach, but to consider all its characteristics. Since the export potential is a complex system with interconnected elements, it is important to take into account that impacts on individual elements have an impact on the whole structure.

4. RESULTS

4.1. The current state of the export potential of agricultural production in Ukraine. Further research relays on formation the empirical base. First, it is advisable to analyse the dynamics and structure of commodity exports of Ukraine (Table 1).

Table 1

Dynamics and structure of commodity exports of Ukraine in 2021–2023

Commodity export groups	2021		2022		2023	
	Mln USD	Share, %	Mln USD	Share, %	Mln USD	Share, %
Agricultural products	27 687	43.9	23 380	57.2	22 001	63.4
Mineral products	7 874	12.5	4 109	10.0	2 262	6.5
Chemicals	3 173	5.0	1 668	4.1	1 329	3.8
Timber and wood products	2 491	3.9	2 118	5.2	1 719	5.0
Industrial goods	946	1.5	569	1.4	557	1.6
Ferrous and nonferrous metals	15 719	24.9	5 881	14.4	3 888	11.2
Machinery and equipment	3 819	6.1	2 281	5.6	2 150	6.2
Other	1 404	2.2	893	2.2	772	2.2
Total	63 113	100.0	40 899	100.0	34 678	100.0

Source: calculated by the authors based on (NBU, 2024).

As shown in Table 1, despite the two-year period of martial law, the share of agricultural exports in the structure of total exports from Ukraine is constantly growing. Thus, in 2023, the agricultural export made up 63.5 % of the total structure, which is 19.5 % more than in the pre-war year of 2021. Therefore, it can be stated that the agricultural sector of Ukraine has become strategic from the point of view of replenishment of foreign exchange reserves and accumulation of currency funds.

Considering TOP 15 product groups in the export structure of Ukraine, it should be noted that the volume of export of products of the agro-industrial complex is five times greater than the export of goods of the metallurgical sector, although for decades these were quite equal channels of currency earnings to Ukraine. At the same time, the export of cereals makes up the largest share (Figure 2).

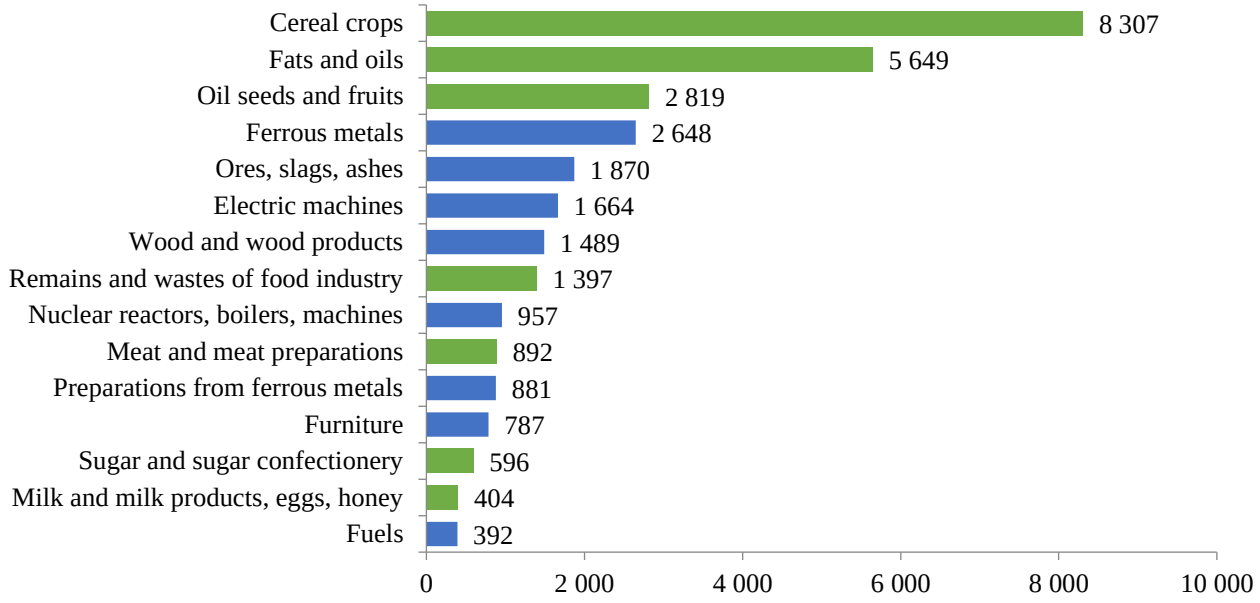

Figure 2. TOP 15 product groups of Ukrainian exports in 2023, mln USD

Source: compiled by the authors based on (SSSU, 2024).

Considering the weight of the export of grains in the total volume of the export of food products justifies its sufficiency in foreign trade (Figure 3).

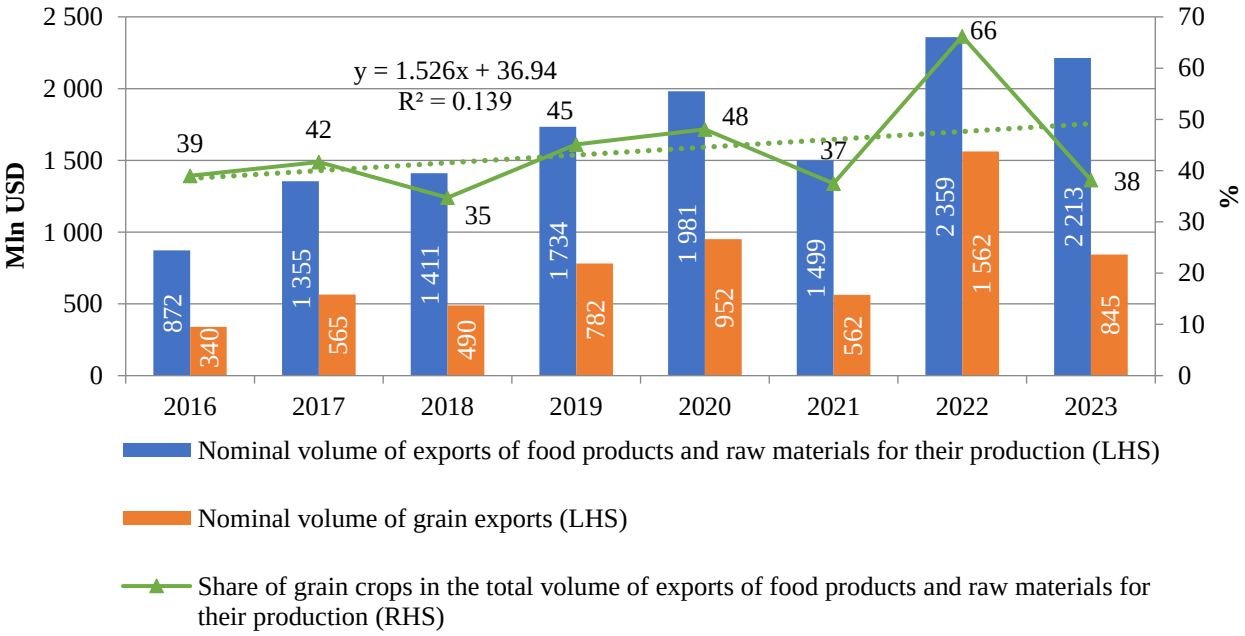

Figure 3. Dynamics of the share of grain crops in the total volume of exports of food products and raw materials for processing in 2016–2023

Source: compiled by the authors based on (FAO, 2024; FRED, 2024).

Thus, in the first year of martial law in Ukraine, the share of grain exports in food exports was 66.21 %. At the current stage, it should be noted that in April 2024, the export of grain and oilseeds increased in absolute means for the seventh month in a row – up to 6.6 mln tons, which is the highest indicator since the beginning of the full-scale invasion. Export growth occurs mainly through the logistics route of the Black Sea ports (Figure 4).

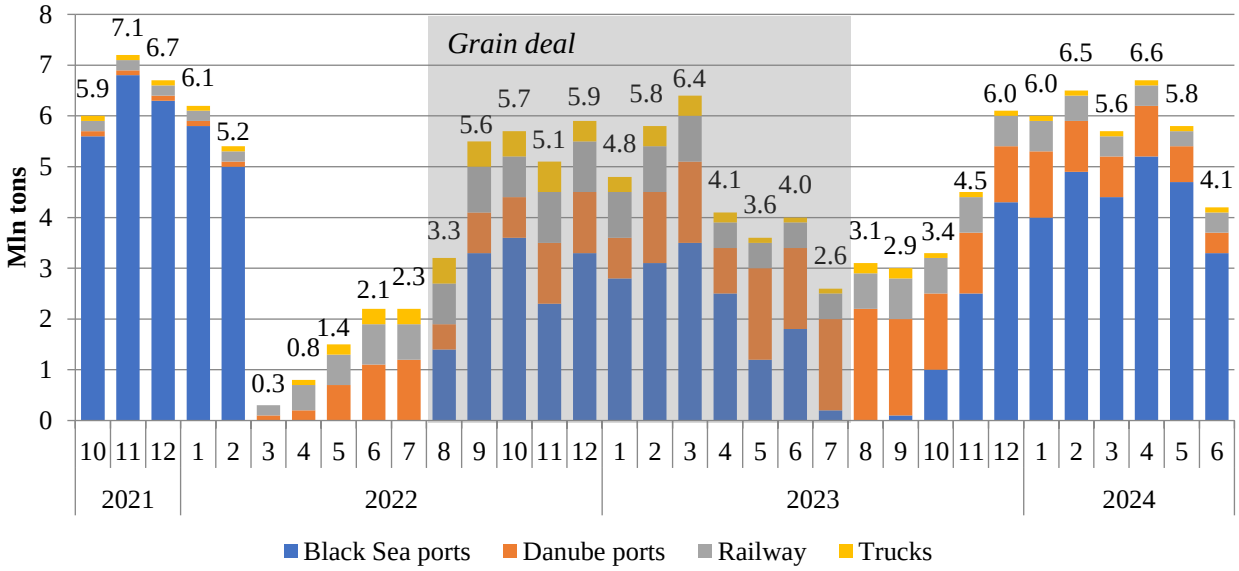

Figure 4. Export of grain and oil crops by types of transport, mln tons

Source: compiled by the authors based on (Centre for Economic Strategies, 2024).

The blockade of land borders with the European Union, especially on the Polish side, remains one of the major problems for Ukraine's economy. The export of agricultural products by trucks is only 1 % of the export of agricultural products (in comparison with summer 2022, when it exceeded 15 %).

In the study of the external trade of agricultural products, the price mechanism for exports takes an important place (Figure 5).

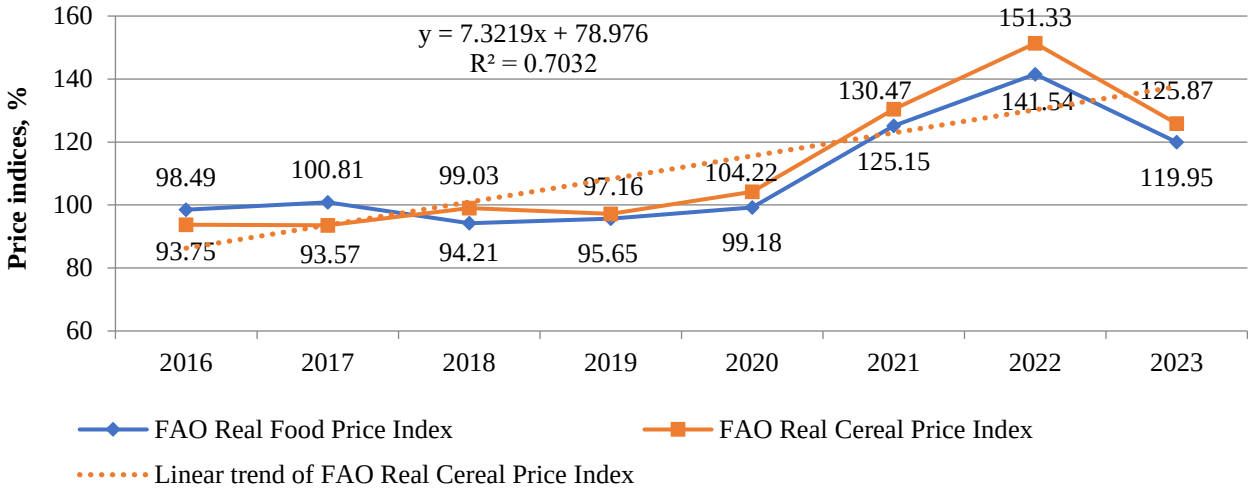

Figure 5. Dynamics of FAO price indices for food products and grains in 2016–2023, %

Source: compiled by the authors based on (FAO, 2024).

The FAO food and grain price indices are indicators of monthly changes in international prices. Performed analysis of changes in these indices determines their weighted average values over the years. According to Figure 4, the largest growth of these indices occurred in 2022, which indicates disruptions in exports from Ukraine and problems with global food security.

Based on the set goal of the research, it is reasonable to conduct an analysis of the

change in the exchange rate. Under the pressure of the complication of export logistics, there was a decrease in the supply of currency for client transactions, which provoked the devaluation of the national currency to the level of UAH 39.28 per 1 USD at the end of 2023 (Figure 6).

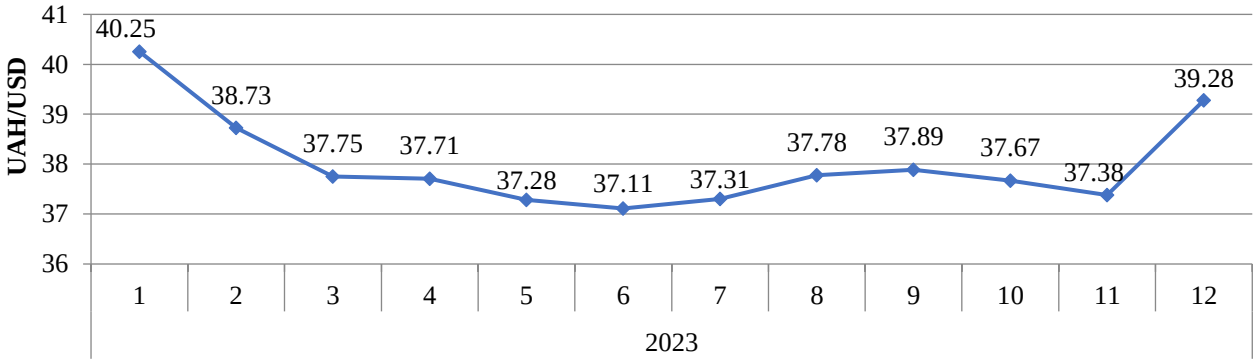

Figure 6. Dynamics of the weighted average exchange rate of hryvnia on the cash market in 2023, UAH/USD

Source: compiled by the authors based on (NBU, 2024).

The prominent difference between the official and cash rates of the national currency against the US dollar was observed during March–June 2022. Also, during this period, the spread increased to the level of 28.5 %. The system of measures of the Regulator made it possible to minimise the difference between the official rate and the rate of the cash and "shade" markets during the first three quarters of 2023. However, the negative information environment, which became a dominant factor in the growth of volatility in the cash segment, manifested itself due to the weakening of the cash rate and the widening of the spread between the official rate and the rate on the "shade" market. In some periods, the spread exceeded 5 %, but remained significantly lower than in fall 2022.

The complex of measures at the beginning of a full-scale invasion, as well as international aid, made it possible to restrain the devaluation of the domestic currency, stabilise the currency market and switch to the "managed flexibility" exchange rate regime in October 2023. Considering the stable situation on the market, NBU continued to loosen foreign exchange restrictions, updating and finalising certain measures.

4.2. Estimation of the impact of the agricultural products exports of Ukraine on exchange rate dynamics. Studying the influence of exports of agricultural products on exchange rate dynamics implies a rational choice of initial time series that can optimally represent the modeled economic phenomena. This study is based on the main findings of previous publications, which also investigated the impact of the main export commodity on the exchange rate – mainly examining price shocks in oil (Garzón & Hierro, 2022; Das, 2021; Alstadheim et al., 2021; Curtis et al., 2023), electricity (Butt et al., 2024), gold (Chen et al., 2022). In most cases, assessments of both short-term and long-term effects were required, including measuring the rate at which exchange rate deviations converge to their long-term equilibrium. Such econometric analysis requires the presence of co-integration of the series of the dependent and explanatory

variables. Since the methods available to the authors are limited to the first order of integration, the following indicators were chosen as the evaluated indicators:

– index of the weighted average exchange rate of the hryvnia on the cash market (RATE), calculated as the ratio of the current exchange rate to the rate of the same month last year;

– index of nominal volumes of export of food products and raw materials for their production, deflated by consumer inflation in the United States (FOOD), calculated as the ratio of the current exchange rate to the exchange rate of the same month last year;

– FAO real food price index (FOODPR), calculated as the ratio of the current exchange rate to the rate of the same month last year;

– index of nominal volumes of grain export, deflated by consumer inflation in the United States (CERL), calculated as the ratio of the current exchange rate to the exchange rate of the same month last year;

– FAO real grain price index (CERLPR), calculated as the ratio of the current exchange rate to the rate of the same month last year.

The sample is presented with monthly data from 2015 to 2023. Descriptive statistics of the time series are presented in Table 2.

Table 2

Descriptive statistics of the time series

Variable	RATE	FOOD	FOODPR	CERL	CERLPR
Mean	1.0742	1.0590	1.0378	1.0935	1.0407
Median	1.0322	1.0485	1.0088	1.0089	1.0281
Maximum	1.5726	2.7880	1.3839	2.8516	1.3504
Minimum	0.8516	0.4155	0.7717	0.2824	0.7323
Std. Dev.	0.1615	0.3083	0.1342	0.4764	0.1380
Skewness	1.5920	1.9394	0.5260	1.3296	0.2101
Kurtosis	5.2287	12.5268	2.9477	5.9080	2.8097
Jarque-Bera	60.4191	423.2195	4.4385	62.1119	0.8510
Probability	0.0000	0.0000	0.1087	0.0000	0.6534

Source: calculated by the authors based on (NBU, 2024; FAO, 2024; FRED, 2024).

The data in Table 2 shows that in the analysed period the exchange rate mainly increased by an average of 7 % monthly. An upward trend was also observed in the export of food in general (by 6 %) and export of grains in particular (by 9 %), although the latter most often remained stable (the median value of the series is close to 1.0). Global real food and grain prices generally grew at almost synchronous rates (3.8 % and 4 %, respectively), although the upward trend in grain prices was more noticeable (2.8 %).

The important step that allows moving on to the identification of long-term relationships between the dependent and explanatory variables is the assessment of the order of integration of the series using Dickey–Fuller test (Table 3).

Interpretation of the Dickey–Fuller test, the results of which are presented in Table 3, suggests the dependent variable and most of the independent ones have the same order of integration (at the level). In order to be able to compare the results of modelling the influence of export volumes with the influence of world price dynamics,

instead of the corresponding variables FOODPR and CERLPR, modified series were introduced, calculated as natural logarithms of the original values (LN_FOODPR and LN_CERLPR), which have the required order of integration.

Table 3

Results of testing variables for the presence of a unit root

Variable	Intercept	Trend	ADF test statistic at		Integration order
			Level	1st Difference	
RATE	+	+	-3.4141***	-5.9664*	I (0)
FOOD	+	–	-5.5524*	-11.8333*	I (0)
FOODPR	+	–	-1.8448	-7.0714*	I (1)
CERL	+	–	-4.4435*	-10.4446*	I (0)
CERLPR	+	–	-1.7331	-8.6537*	I (1)
LN_FOODPR	–	–	-1.7952***	-7.1637*	I (0)
LN_CERLPR	–	–	-1.6821***	-8.6759*	I (0)

Note. *, *** – significant at 1 %, 10 % significant level.
Source: calculated by the authors based on (NBU, 2024; FAO, 2024; FRED, 2024).

The next stage of econometric analysis is to determine the presence of long-term co-integration relationships between the explained and explanatory variables, carried out using Engle-Granger method with automatic specification of lags according to Schwartz criterion (Table 4).

Table 4

Results of testing variables for co-integration (with RATE as the dependent variable)

Variable	Tau-statistic	Z-statistic
FOOD	-4.0443*	-23.1740**
LN_FOODPR	-3.2022***	-26.6751*
CERL	-4.0535*	-23.2941**
LN_CERLPR	-3.1081***	-24.2599**

Note. *, **, *** – significant at 1 %, 5 %, 10 % significant level.
Source: calculated by the authors based on (NBU, 2024; FAO, 2024; FRED, 2024).

The tau- and z-statistic values presented in Table 4, compared with critical values according to MacKinnon. The results of the Engle–Granger test indicate the presence of co-integration between the exchange rate as the dependent variable and all explanatory variables. It is worth to note that the long-term impact of food and grain export volumes from a co-integration point of view is statistically more significant than the impact of world prices for these goods.

To assess the short-term and long-term influence of selected factors on exchange rate dynamics, it is advisable to use an autoregressive distributed lag (ARDL) model, which, in the presence of co-integration of variables, allows obtaining both a short-term form with an error correction coefficient and a long-term form. To determine the maximum number of lags of the dependent and independent variables used in the automatic selection of the best ARDL model, the Lag Order Selection Criteria was implemented. The input number of lags, the final forms of ARDL models and their main characteristics are presented in Table 5.

Table 5

Characteristics of the estimated ARDL models of the influence of export volumes and world prices of food and grains on the hryvnia exchange rate

Independent variable	Lag Order (p=q)	Selected Model (p, q)	R^2	F-statistic	DW	Bounds Test (F-stat.)
FOOD	3	(3, 2)	0.8977	125.8254*	2.1253	6.8172**
LN_FOODPR	8	(8, 8)	0.9483	75.5851*	2.1539	14.2964*
CERL	5	(4, 1)	0.9117	146.3497*	2.2139	7.4221**
LN_CERLPR	4	(3, 2)	0.8918	118.1148*	2.1711	4.9370***

Note. *, **, *** – significant at 1 %, 5 %, 10 % significant level.
Source: calculated by the authors based on (NBU, 2024; FAO, 2024; FRED, 2024).

The characteristics of the obtained models presented in Table 5 indicate their high adequacy (determination coefficients are above 85 %), statistical significance of the coefficients (Fisher test values correspond to the 1 % significance level) and the absence of autocorrelation (Durbin-Watson statistics is close to 2.0). In addition, the results of Pesaran limit testing confirm the presence of long-term co-integration relationships, which makes it possible to construct short-term and long-term forms of these models. The Half Cool-down period, during which the exchange rate is able to approach its long-term equilibrium value by 50 %, is calculated as the ratio of the natural logarithm of ½ to the natural logarithm of ECT index (Table 6).

Table 6

Co-integration forms of estimated ARDL models of the influence of export volumes and world prices of food and grains on the hryvnia exchange rate

Independent variable	Short Run			Long Run		Half Cool-down
	Lag	Coefficient	ECT	Coefficient	Intercept	
FOOD	0	0.0002	-0.1183*	-0.5620**	1.6700*	6 months
	1	0.0423**				
LN_FOODPR	0	-0.1698	-0.2001*	0.8153*	1.0278*	3 months
	1	-0.3162				
	2	0.2911				
	3	-0.3717***				
	4	0.5671**				
	5	-0.1505				
	6	0.3881***				
	7	-0.6054*				
CERL	0	0.0074	-0.1250*	-0.1897***	1.2723*	5 months
LN_CERLPR	0	-0.0175	-0.1001**	0.9442***	1.0331*	7 months
	1	-0.1157				

Note. *, **, *** – significant at 1 %, 5 %, 10 % significant level.
Source: calculated by the authors based on (NBU, 2024; FAO, 2024; FRED, 2024).

The regresses coefficients presented in Table 6 give an idea of the immediate and delayed influence of selected factors on the dynamics of the exchange rate, which in most cases are multidirectional. Thus, the statistically significant direct effect of food export volumes appears a month later and devalues the hryvnia exchange rate by 0.04 % with an increase in foreign trade volumes by 1 %. However, in the long-run, the export of food products and raw materials for their production significantly

strengthens the national currency of Ukraine: each additional percentage of exports slows down the growth of the exchange rate by 0.6 %. With such an impact, six months are enough for the deviation of the exchange rate from the equilibrium value to decrease by half.

As for world food prices, their short-term impact appears after 3–7 months and is quite contradictory. This situation can be explained by the duality of this indicator, which affects not only the cost of Ukrainian exports, but also the price level within the country, which provokes a devaluation effect through the consumer inflation channel. This is clearly confirmed by the direct long-term influence of this factor: for every 1 % increase in world prices, there is 0.8 % of the positive exchange rate dynamics of foreign currencies against the hryvnia. However, the speed of return of short-term exchange rate shocks to their long-term equilibrium is higher: it will take no more than 3 months for a twofold reduction in deviations.

The estimated model with the volume of grain exports did not show statistically significant dynamics over a short time interval. This may indicate an adaptation of the foreign exchange market and the mood of economic entities to the seasonality and rhythm of foreign trade in such goods. However, in the long-run, grain exports have a clear revaluation effect: an increase of 10 % can strengthen the exchange rate of the national currency by 2 %. In order for the deviation of the exchange rate from its equilibrium value to be halved, in a model with the volume of grain exports, it will take up to 5 months.

The influence of global prices for grains in general repeats the similar influence of food prices (since it is their component), but in the long-run it has a much stronger impact on the devaluation of the hryvnia – in fact, for every percent increase in prices there is a percentage depreciation of the national currency. This can be explained by the fact that grains are a component of many processed food and feed products, the import of which increases the domestic price level and significantly accelerates exchange rate dynamics. The rate of return of the exchange rate after short-term shocks to its long-term equilibrium in this model is lower than in the others: it will take at least 7 months for the gap to be halved.

4.3. Prospective directions for increasing the export of agricultural products as a factor in ensuring the currency security of the state. The obtained modelling results justify the crucial role of the effective institutional framework for state stimulation and financing which ensure consistent support for agricultural producers. Since the beginning of the full-scale invasion, the Government has adopted several documents regarding the support and restoration of the agricultural sector. Thus, one of such documents was “Grain from Ukraine” Program, which is a humanitarian food aid initiative launched by the President of Ukraine on November 26, 2022 (Ministry of Foreign Affairs of Ukraine, 2022). According to this program, more than 30 countries and international organisations have been joined and USD 20 mln have been raised.

Along with mentioned, in 2022 the Recovery Plan of Ukraine was launched, which includes five main principles: immediate start and gradual development; increasing wellbeing and ensuring equitable distribution of wealth; integration into EU;

reconstruction based on Build Back Better principle, on a national and regional scale; stimulation of private investments (National Council for the Restoration of Ukraine, 2022). Regarding the agrarian sector, in the section "New agrarian policy", strategic goals for the next 10 years are defined, indicating the economic transformation of the agricultural sector and the development of agrarian infrastructure, promoting the transition of the agri-food sector to "green" growth; development of processing capacities, stimulation and development of processing; return and restoration of agricultural land; development of cooperation and organic production, etc. For 2024, key reforms in the field of agrarian and land policy have been determined, namely: adoption of the Strategy for the Development of Agriculture and Rural Territories for the period until 2030; continuation of reforms in the field of agricultural land circulation; development and adoption of the law on state support of the agricultural sector; reform of the State Agrarian Register; development and adoption of the Irrigation Development Strategy until 2030; Development and adoption of the Mine Action Strategy; European integration in the field of plant protection and food safety (KSE, 2024). Grant support for the agricultural sector has also been determined in Ukraine for 2024. According to the government program "eRobota", grants have been launched for private business, for setting up a greenhouse, for gardening, for processing production, for veterans and their family members. With the support of USAID AGRI-Ukraine (Agriculture Resilience Initiative): a grant program for obtaining services for certification of organic producers, control of export shipments, laboratory testing and issuance of export certificates; grant for the development of facilities for finishing, drying and storage of grain; grants for co-financing for pig breeding development projects in Ukraine; grants for co-financing the modernisation of the reclamation infrastructure of the organisation of water users; an export-oriented program for the processing of grain, oilseeds and leguminous; complex instruments of mixed financing from suppliers of material and technical resources. It is also worth mentioning such grant programs as a grant to support export potential and innovative ideas (EU4Business); program of support for modular granaries, grant support for small agricultural producers and producers of products with geographical indication (FASH and EU); a grant for the SEED educational process, which helps small and medium-sized businesses to scale their business and take business to a new level (UN global agreement, PepsiCo Foundation); grants for the development and implementation of EIT Food technologies within the EU Horizon Europe (EIT Food, EU) (KSE, 2024).

The study of the presented documents makes it possible to formulate strategic vectors for the development of the agrarian sector of the economy from the point of view of accumulating export potential (Figure 7).

The strategic vectors for developing the export potential of agricultural products involve a comprehensive approach that integrates socio-economic and environmental considerations. The formation of the socio-economic potential of the agricultural sector intended to be driven by combining natural and human resources and developing a national model for organising rural areas in alignment with Euro-integration processes to enhance their investment appeal.

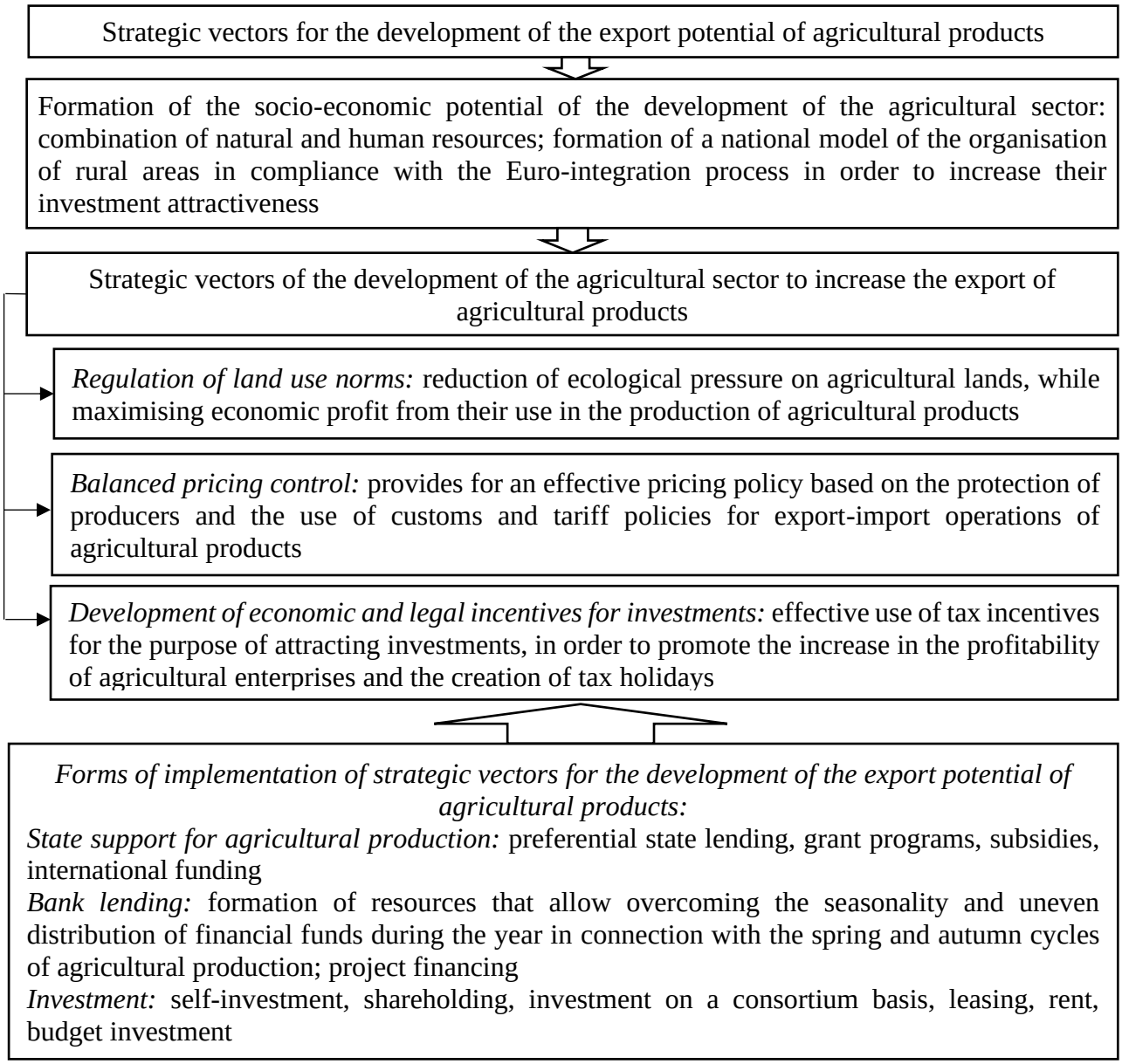

Figure 7. Strategic vectors for the development of the export potential of agricultural products and forms of their implementation

Source: systematised by the authors based on (Myskiv et al., 2024; Kovalenko et al., 2023; Seheda, 2020).

Key strategic vectors for the agricultural sector focus on increasing the export of agricultural products through several means. Firstly, regulating land use norms aims to reduce ecological pressure on agricultural lands while maximising economic profit from their use in production. This ensures sustainable agricultural practices and optimal land management. Secondly, balanced pricing control is essential, involving the creation of effective pricing policies that protect producers and the application of customs and tariff policies for export-import operations. This balance helps stabilise the market and improve the competitiveness of agricultural products internationally.

Moreover, developing economic and legal incentives for investments is crucial. This includes the effective use of tax incentives to attract investments, enhance the profitability of agricultural enterprises, and implement tax holidays to support growth.

Implementing these strategic vectors requires various forms of support. State support through preferential lending, grant programs, subsidies, and international funding plays a pivotal role in reducing financial barriers for producers.

Additionally, bank lending mechanisms are necessary to address the seasonality and uneven financial distribution in agricultural production, providing project financing to help enterprises manage cash flow efficiently. Investment forms such as self-investment, shareholding, consortium-based investment, leasing, renting, and budget investment offer diverse avenues for securing the financial capital needed for modernisation and expansion. Collectively, these measures foster the export capacity of the agricultural sector, contributing to national economic growth and competitiveness in the global market.

Undoubtedly, all these initiatives require an effective mechanism of investment and credit support for the development of the agrarian sector of the national economy. In previous investigation Kovalenko et al. (2023) the authors identified the main components of the system of credit and investment provision of the agricultural sector, which includes subjects and objects of this process and forms of credit and investment provision.

5. DISCUSSION

The authors' findings contribute a new element to the study of the relationship between agricultural exports and economic growth, specifically currency security. Previous research (e.g. Mamba & Ali, 2022) has demonstrated that increasing foreign exchange earnings while simultaneously reducing vulnerability to external shocks is achievable through the strategic promotion of agricultural exports and market diversification. The results of this study highlight the significant role of the monetary component, which enables food-exporting countries not only to enhance their foreign exchange potential but also to self-sustain increasing levels of agricultural financing for the further development of the sector with its external economic orientation.

Additionally, complementing Bakari & Tiba, (2020), a clear revaluation effect of exports on the national currency exchange rate in the long-run was identified, logically aligning with previous findings regarding the direct positive relationship between agricultural exports and economic growth. However, the analysis of short-term trends introduces some contradictions to earlier studies. For instance, according to Çinar et al. (2015), the positive impact of agricultural exports on the effective exchange rate is noted only during the first quarter, whereas the results obtained in this study indicate the opposite: an increase in exports slightly devalues the national currency after just one month. The proposed explanation pertains to differences in the structure of such exports and the overall food security situation in the specific country.

As the authors have already proved, the export of agricultural products affects the strengthening of the national currency and the stabilisation of exchange rate dynamics with a lag of 3 months. Therefore, it can be stated the increase in exports enables monetary regulators to predict the change in the exchange rate with the closest accuracy. But at the same time, it should be noted that in the modern circumstances of

the development of agrarian business, a clear and balanced strategy for accumulating export potential is needed.

Nowadays the logistics of exporting agricultural products remains a problematic issue. The research team of Kuziak et al. (2022) substantiated the main problems of the supply of agricultural products and their consequences during the war, which are: the blocking of Ukrainian ports – the fragility of international stability and security; unpreparedness of the infrastructure for large volumes of transportation – queues at borders, air pollution in this area, losses for transport companies; personnel problems – lack of personnel with the necessary competencies; high prices for energy resources or their shortage – an increase in prices for agricultural products; interruptions in electricity supply – economic losses for the enterprise, delays in production or provision of services.

In such terms, the main program goals of the Association Agreement between Ukraine and EU, which provided for the creation of a free trade zone, should be revised or brought to a logical implementation. This Agreement can play a key role in increasing the export potential of agricultural products and expanding the territorial boundaries of foreign trade in agricultural products. However, attention should be paid to the diversification of domestic agricultural exports, as new problems may arise due to increased competition from European agricultural producers.

Discussing the necessary instruments for state policy in the field of accumulating the export potential of agricultural products, it is worth mentioning the study conducted by Vasyltsiv & Kunytska-Ilyash (2022). They analysed the problems associated with obstacles to the realisation of the export potential, threats to financial security of the agro-industrial complex, and determined the policy of realising the potential, namely: (i) development of the infrastructure of alternative distribution channels for product sales, export insurance, marketing-communication and information-analytical cooperation; (ii) development of cooperation of domestic agricultural producers with foreign processing enterprises, creation of local integrated agro-industrial structures, introduction of alternative forms of financing projects of processing and export of agricultural products; (iii) development of the commercial and intermediary infrastructure for the export of agricultural products, modernisation of the advisory service for agricultural enterprises; (iv) creation of corporate funds for investment and financing of export activities, cooperation and integration for the accumulation of financial and investment resources, formation of platforms for cooperation of exporters of agricultural products and subjects of the financial services market; improvement of the regulatory and methodological base of state supervision of the safety and quality of agricultural products, development of the consulting infrastructure and image support of exporters; (v) improvement of the support system for agro-industrial complex exporting enterprises, promotion of the investment attractiveness of agro-industrial exporting enterprises in foreign markets, improvement of the planning system for realising the export potential of the country's agro-industrial complex.

There is a less optimistic perspective regarding the intensification of policies aimed at expanding exports of agro-industrial and food products. The criticism is

primarily based on concerns over exceeding critically permissible volumes of food exports, which could lead to undesirable consequences for the domestic supply within the exporting country. According to Aragie et al. (2023) export orientation could reduce the availability of food and agricultural products domestically as a large portion of output is diverted to export markets. Additionally, access to food can be restricted by high prices for food and agricultural products, combined with decreases in disposable incomes in urban areas and at the national level, despite rising incomes in rural areas. Based on data analysis from Ethiopia, Kenya, and Uganda, the authors conclude that governments in developing countries should prioritise safeguarding domestic food security, particularly in urban areas, if they persist in pursuing an agro-export orientation as a strategy for growth and foreign exchange earnings (Aragie et al., 2023).

Another aspect of such discussions involves concerns about the global expansion of capacities for processing agricultural raw materials into non-food products. Specifically, Naylor & Higgins (2018) thoroughly analysed the situation in the four largest biodiesel producers (USA, EU, Argentina, and Indonesia) and concluded that food security remains the primary constraint on further development of the biofuel industry. The main adverse effects of the intensification of agricultural product processing are borne by small-scale oilseed producers.

Prospects for further research consist in determining the main directions of implementation of the concept of sustainable development in Ukraine through the development and restoration of the agrarian sphere as a locomotive of currency earnings from the export of agricultural products. According to the authors, it is expedient to take the mechanism of introduction of “green banking”. This issue is partially investigated in the scientific publication of (Lutsiv et al., 2024; Naumenkova & Mishchenko, 2024). These scholars emphasise that “green banking” in practice is a bank management strategy aimed at minimising the negative impact on the environment and efficient use of resources in the course of the bank’s day-to-day operational activities. This strategy also includes the provision of credit resources to support environmental projects, the production of “green” technologies, as well as the creation and sale of ecological goods, products and services. This concept lays down all the prerequisites for its implementation in the agricultural sector of the national economy. Although in Ukraine, it is more focused on energy and heat conservation. The main instruments of the implementation mechanism of “green” banking should include: biobanking, “green” investments, “green” insurance, “green” mortgages, debt securities, securitisation and “green” bonds, partial credit guarantee for the implementation of “green” projects, “green” credit swaps, etc.

Other issues that need to be addressed are the harmonisation of legislation with EU legislation in the field of agriculture and development of rural areas; completion of the development of the national strategy for the development of agriculture and rural areas for 2025–2030; monitoring and accounting of farms in the State Agrarian Register and using it for financial support of agricultural producers. In addition, it is advisable to start preparing for the creation of payment agencies and farm accounting

systems in accordance with EU requirements.

6. CONCLUSIONS

The conducted study advances the understanding of the intricate relationship between war, food security, and economic stability. It introduces an innovative ARDL model that examines the impact of agricultural exports on the currency and exchange rate dynamics of the Ukrainian economy. Furthermore, the analysis offers a new perspective on the strategic significance of the agricultural sector in bolstering foreign exchange reserves and currency accumulation.

The practical implications are substantiated by the fact that by elucidating the relationship between export volumes, global prices, and exchange rate fluctuations, the findings can enhance the prediction and management of currency movements. The study identifies timeframes for the adjustment of exchange rate shocks to their long-term equilibrium and assesses the influence of various factors on currency valuation, thereby informing policy-making processes aimed at maintaining currency security for the state.

The research indicates that the export of agricultural commodities and food products can strengthen the national currency in the long-run by means of several mechanisms. Firstly, this export contributes to a surplus of trade balance, which leads to an increase in foreign exchange reserves, supporting the stability of the national currency. Secondly, agricultural exports can enhance the country's economic stability and growth through generation of incoming revenue, and stimulate agribusiness activity, which in turn can attract foreign investments, further boosting the strength of the national currency. The study explains how export volumes of food and grains execute the impact on the exchange.

Conducted econometric analysis determines long-term co-integration relationships between the explained and explanatory variables related to export volumes and world price dynamics of food and grains on the hryvnia exchange rate. The research found that the long-term impact of food and grain export volumes on the exchange rate is statistically more significant than the impact of world prices for these goods. Estimated ARDL models have proved the short-term and long-term influence of selected factors on exchange rate dynamics, which performs through immediate impact of a 1 % increasing food export volumes on devaluing the hryvnia exchange rate by 0.04 %. Specifically, at the long-term effects, each additional percentage of food exports actually works to slow down the growth of the exchange rate by 0.6 %. These findings are crucial for maintaining a stable economic environment and enhancing the overall currency security of Ukraine.

These findings provide several insights for policymakers. By understanding the relationship between export volumes, global prices, and exchange rate movements, policymakers can develop strategies to mitigate adverse currency fluctuations. This includes the use of foreign exchange reserves and other monetary tools to stabilise the currency during periods of volatility. Policies should balance the needs of export markets with domestic consumption requirements to avoid compromising food

security. Given the interplay between war, food security, and economic stability, the study suggests the need for robust crisis response mechanisms, including contingency strategy for the stable operation of agricultural logistics through the diversification of export routes and their protection with effective economic and, if appropriate, military instruments.

7. LIMITATIONS AND FUTURE RESEARCH

The empirical part of the study was based on data on agricultural exports and exchange rate dynamics in Ukraine in 2015–2023, which covers both the pre-war and war periods. In this regard, some conclusions from the practical part of the study may be clarified in the future, as a sufficient number of statistical observations become available (at least until the end of 2025).

The complexity and interconnectedness of foreign trade mean that numerous variables can influence the outcomes of agricultural exports on currency security. Endogenous factors (such as fiscal policy, internal consumption, business activity) and exogenous ones (global economic fluctuations, natural disasters, sudden changes in international trade policies) can cause significant deviations from expected outcomes, introducing volatility that is difficult to model accurately. Therefore, while the model can provide useful insights, its ability to predict future trends is inherently limited by both internal and external uncertainty.

The additional direction for further research could be cross-country analysis for empirical and political study of the problems of international trade in agricultural products in countries experiencing military conflicts. In particular, the issue of interruptions in grain exports from Ukraine to MENA countries, identified in the literature review and discussion section, despite a number of studies conducted in 2022–2023, needs further consideration in connection with the fundamental and, unfortunately, long-term problems of supply chains reorganisation in the Black Sea region and the eastern Mediterranean.

Regarding political implications from this study, prospects for further research lay in the field of "green banking" as a promising instrument for intensifying the agricultural production with additional lending facilities. Another perspective route for research concerns harmonisation of legislation as a part of Ukraine's integration in EU, mainly regarding compliance in agribusiness and rural development legal bases.

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