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Contents

V. Tymchak

The impact of global climate change
and Russian aggression in Ukraine on global food security 9

A. Kyrychenko

Modelling of a consumer basket
in food retail trade taking into account nutritional criteria 24

Yu. Nehoda, O. Labenko, O. Zharikova, R. Sabluk

Financial and economic support for the implementation
of resource-saving practices in the agricultural sector 43

M. Ilchuk, I. Konoval, I. Androsovyh, O. Tomashevskya, V. Marchuk

State support for business structures
in the agricultural sector of Ukraine's economy 63

L. Stepasyuk, O. Cherednichenko, N. Volkova, I. Zahrebelna, A. Chukhlib

Scientific approaches to optimal capital structure justification 83

O. Makarchuk

Analytical assessment of trends and prospects
of the sunflower seed market in Ukraine under current challenges 100

T. Balanovska, O. Havrysh, O. Gogulya, K. Dramaretska, V. Voskolupov

Instruments for forming an adaptive
and competitive enterprise management system in the context of digital transformation 111

Ya. Biriukov

Innovative marketing strategies for business development
in the context of digitalisation 131

N. Sulima, N. Mazur, I. Semenets, O. Kushnir, M. Savytskyi

Innovative marketing as a component of the development strategy
for agricultural enterprises 149

Ye. Lanchenko, D. Ursal

The economic mechanism of the functioning
of e-commerce enterprises: Theoretical and practical foundations 169

Зміст

В. Тимчак

Вплив кліматичних змін у світі та російської агресії
в Україні на глобальну продовольчу безпеку 9

А. Кириченко

Моделювання споживчого кошика в роздрібній торгівлі
харчовими товарами з урахуванням нутріціологічних критеріїв 24

Ю. Негода, О. Лабенко, О. Жарікова, Р. Саблук

Фінансово-економічне забезпечення
впровадження ресурсозберігаючих практик в аграрному секторі 43

М. Ільчук, І. Коновал, І. Андросович, О. Томашевська, В. Марчук

Державна підтримка підприємницьких структур
аграрного сектора економіки України 63

Л. Степасюк, О. Чередніченко, Н. Волкова, І. Загребельна, А. Чухліб

Наукові підходи до обґрунтування оптимальної структури капіталу 83

О. Макарчук

Аналітична оцінка тенденцій та перспектив ринку соняшнику
в Україні в умовах сучасних викликів 100

Т. Балановська, О. Гавриш, О. Гоголя, К. Драмарецька, В. Восколупов

Інструменти формування адаптивної конкурентоспроможної
системи менеджменту підприємства в умовах цифрової трансформації 111

Я. Бірюков

Інноваційні маркетингові стратегії розвитку бізнесу в умовах цифровізації 131

Н. Суліма, Н. Мазур, І. Семенець, О. Кушнір, М. Савицький

Інноваційний маркетинг як складова стратегії розвитку аграрних підприємств 149

Є. Ланченко, Д. Урсал

Економічний механізм функціонування підприємств
електронної комерції: теоретичні й практичні засади 169



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The impact of global climate change and Russian aggression in Ukraine on global food security

Abstract. The issue of food security has become particularly relevant in the context of intensifying climate change and geopolitical threats, in particular the war in Ukraine. The aim of the study was to determine the impact of climate change and Russian aggression in Ukraine on the functioning of global agri-food systems. The main focus was on analysing the impact of extreme weather events, water shortages, changes in precipitation patterns and military actions on crop yields, food quality and value, and the functioning of supply chains. The methodological basis of the study was a combination of quantitative analysis of statistical data with qualitative analysis of regional adaptation strategies and socio-economic consequences. The results indicated a high vulnerability of Southern and Central Europe. A decline in wheat, maize and barley yields has been recorded in Southern and Central Europe, while in Northern Europe there has been an increase due to the lengthening of the growing season. In addition, a deterioration in the nutritional value of products has been identified due to a decrease in micronutrient content. The analysis confirmed the effectiveness of climate-resilient technologies, precision farming and community participation in adaptation processes. Special attention was paid to the impact of the full-scale war in Ukraine on food security. It led to a reduction in cultivated areas, loss of production capacity, disruption of logistics and exports of agricultural products, a sharp rise in food prices and social tensions in importing countries. The summary of the results emphasised the need for integrated and regionalised approaches to food security policy in the context of increased climate shocks and other risks. At the same time, the introduction of climate-resilient technologies, diversification of supply and strengthening of international cooperation are critical for the formation of sustainable agri-food systems of the future. The practical significance of the study was to develop scientifically sound approaches to adapting the agricultural sector to climate change and the impact of wars

Keywords: agriculture; adaptation strategies; agricultural sector resilience; post-war recovery; hidden hunger

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INTRODUCTION

Climate change and military factors are the main threats affecting ecosystems, economic stability and human well-being on a global scale. The agricultural sector is the foundation of global food security, which is particularly vulnerable due to its dependence on climatic conditions such as temperature, precipitation and the frequency of extreme weather events. In the European Union (EU), the negative effects of climate change are manifested through regional differences, creating an uneven distribution of risks that requires more in-depth analysis. This study is relevant due to the growing threats to food security, increasing economic instability, and the need to integrate climatic and geopolitical factors into the sustainable development policies of European countries and the world.

H. Fraga *et al.* (2012) argued that Southern Europe (Spain, Italy, Greece) suffers from prolonged droughts, soil degradation and water shortages, while Northern Europe (Sweden, Finland, Denmark) faces excessive humidity, shifts in growing seasons and the spread of new phytopathogens in these areas. An analysis of scientific papers demonstrates active research into the impact of climate change on agricultural production, indicating that this is a fairly large-scale problem. According to a report by the Food and Agriculture Organization of the United Nations (2021), in some regions, changes in climatic factors have caused a 20-25% over the last two decades, from 2000 to 2020, exacerbating the food crisis and intensifying migration processes. In South Asia, water shortages and rising temperatures threaten rice production, which is the staple food for billions of people, creating risks of famine and economic instability. Unlike these regions, Europe has the infrastructure and resources to adapt to climate change and other challenges, but its food systems are also becoming increasingly vulnerable due to market globalisation and dependence on imports of raw materials, particularly cereals and oilseeds. The Organisation for Economic Co-operation and Development (2023) noted that climate shocks in other parts of the world, such as droughts in North America or floods in Australia, can cause price fluctuations in European

markets, thereby worsening access to food for vulnerable populations.

Recent studies by Ukrainian scientists are mainly related to the impact of military operations on the Ukrainian economy, in particular the agricultural sector and logistics chains. P. Martyshev *et al.* (2023) found that military action in Ukraine has a negative impact on agriculture, significantly undermining food security in Ukraine. A. Skrypnyk *et al.* (2021) examined the impact of climate change and military action on Ukraine's agricultural sector. According to estimates by the Intergovernmental Panel on Climate Change (2022), even under a moderate warming scenario (+1.5°C), the yield of major crops in Europe could decline by 10-20% by 2050, posing a threat to both domestic food balances and global markets. In addition, climate change also affects the quality of agricultural products. Research by D.E. Medek *et al.* (2021) and I. Al-Hadeethi *et al.* (2019) showed that negative climate change reduces the content of micronutrients (protein, iron, zinc), which increases the risk of "hidden hunger" – a deficiency of nutrients that has long-term negative consequences for the health and nutrition of the population.

The global scientific community is actively researching the impact of climate change on agricultural production, but most studies focus on global trends or individual regional cases, while a comprehensive analysis of the interrelationships between climatic, agricultural and social factors within the EU remains understudied. Some studies, in particular A. Mirzabaev *et al.* (2023) and the Intergovernmental Panel on Climate Change (2022), highlight global challenges to food security but do not take into account the specificities of European agroecosystems. At the same time, the European Environment Agency (2024) focuses on regional aspects but rarely integrates socio-economic and other factors, such as the war in Ukraine, which has significantly affected European food chains. Such studies require an interdisciplinary approach that combines a range of disciplines (climatology, agronomy, economics and sociology). This approach is necessary to understand the complex dynamics of food security in the EU.

In the context of the implementation of the European Green Deal (European Commission, 2019) and the “Farm to Fork” strategy (European Commission, 2020), research into adaptation solutions is becoming particularly relevant in practical terms. These initiatives aim to create sustainable and environmentally safe food systems, but they also face challenges such as the high cost of transitioning to organic farming, potential temporary productivity losses, and uneven access to financing for small farms. The work of M. Zurek *et al.* (2022) has shown that requirements to reduce pesticide use by 50% by 2030 may complicate the fight against new phytopathogens in Northern Europe, while in Southern Europe, moisture shortages limit the scaling up of irrigation systems. At the same time, these strategies open up opportunities for the introduction of innovative technologies that can increase the resilience of the agricultural sector.

The main challenge facing agricultural specialists is ensuring food security in the context of climate change. It is these changes that affect food security through reduced yields, deteriorating product quality and rising prices. In particular, a report by the Food and Agriculture Organization of the United Nations (2021) showed that rising temperatures and rainfall deficits between 2000 and 2020 reduced rice production in South Asia by 15%, creating risks for food security. In addition, the war in Ukraine has a significant impact on food security. Thus, the aim of this study was to analyse the impact of climatic factors and the war in Ukraine on food security.

MATERIALS AND METHODS

This study covered the period from 2015 to 2024 (within this period, grain exports in 2021 and 2022 were also analysed, and the impact of hostilities on grain exports was analysed) in comparison with the period 2010-2014. This period was chosen because from 2010 to 2014 there was no significant increase in negative climate change that could have caused catastrophic consequences. However, from 2015 to 2024, the climate situation deteriorated under the influence of a number of factors, both natural (droughts, heavy rainfall, dry winds) and

anthropogenic (military operations, etc.). The study used a comprehensive methodological approach that combined analysis of literary sources, statistical modelling, and qualitative analysis of regional characteristics. The methodology was designed to ensure that other scientists could replicate the study using similar materials and methods. The study was conducted in several stages aimed at obtaining reliable scientific results.

Stage 1. Analysis of literary sources. At the first stage, a systematic review of scientific publications on the impact of climate change and other factors on the agricultural sector and food security was conducted. In particular, the work of P. Lamichhane *et al.* (2022), which proposed the concept of adaptive agricultural risk management; the study by the Intergovernmental Panel on Climate Change (2022), which identified key global risks to the food system; and the report by the Organisation for Economic Co-operation and Development (2023), which highlighted the impact of the war in Ukraine on global food chains. Sources were selected based on criteria of relevance, scientific reliability and relevance to the topic. This stage allowed to identify the main climate risks, regional characteristics and gaps in current research.

Stage 2. Sample formation and experimental base. The study covered the most developed countries of the European Union, with an emphasis on regional differences between southern (Spain, Italy, Greece), central (Germany, France, Poland) and northern (Sweden, Finland, Denmark) countries. It also included countries in Asia and Africa, namely Bangladesh and Mozambique, given their vulnerability to climate risks and their role in agri-food chains. These countries were included in the sample for a comparative analysis of the effectiveness of adaptation strategies under different climatic, social and institutional conditions. The sources of information are standardised according to the methodologies of CARE International (2009) and the Intergovernmental Panel on Climate Change (2022), which ensures the comparability of data and the relevance of conclusions. The sample was formed based on the following criteria: 1) the level of dependence of the gross domestic product (GDP) structure on agriculture;

2) vulnerability to climate change (droughts, floods, soil erosion); 3) availability of data on the yield of key crops (wheat, maize, barley) for 2015-2024. The experimental base included statistical data from the Food and Agriculture Organization (2024) and the European Environment Agency (2024).

Stage 3. Research methods. To assess the impact of climate change on food security, methods such as statistical, comparative and qualitative analysis were used. Statistical analysis: regression analysis was used to assess the dependence of crop yields on climate variables (temperature, precipitation, frequency of extreme weather events). Comparative analysis: a comparison of agricultural productivity in different regions of the European Union was carried out to identify regional differences in vulnerability to climate change. Qualitative analysis: content analysis was used to assess the adaptation strategies described in the literature and their effectiveness in the context of EU countries. This included an analysis of reports on the implementation of climate-resilient crop varieties, irrigation systems and digital technologies (International Fund for Agricultural Development, 2023; Balasundram *et al.*, 2023; Ukraine rapid damage and needs assessment..., 2023). The analysis of the impact of the war in Ukraine was carried out using a counterfactual approach to assess losses in cropland, export potential and food inflation.

Stage 4. Assessment of socio-economic consequences. To analyse the impact on food security, the author used a vulnerability assessment method that took into account the availability of products, their quality and price stability. Data on food prices and availability for vulnerable groups were collected from Eurostat (n.d.) and the State Statistics Service of Ukraine (2024).

The choice of methods was dictated by the need for a comprehensive analysis of a multifaceted problem. Statistical and comparative analyses provide a quantitative assessment of the impact of climate change and other factors, while qualitative analysis allows for institutional and social aspects to be taken into account. The use of open data from the FAO (Food and Agriculture Organization, 2024) and the EEA (European Environment Agency, 2024)

guarantees the reliability and reproducibility of the results. A comprehensive approach to sample selection made it possible to cover the diversity of climatic and agricultural conditions in Europe and the world, ensuring the representativeness of this study.

RESULTS AND DISCUSSION

Climate change is one of the key factors affecting global food security, altering the volume and stability of crop production in different regions of the world. Rising average annual temperatures and more frequent extreme weather events, such as droughts and floods, are leading to lower yields in tropical and Mediterranean regions, while at the same time partially increasing productivity in northern latitudes (Intergovernmental Panel on Climate Change, 2022; Food and Agriculture Organization of the United Nations, 2024). Along with changes in quantitative indicators, there is a deterioration in product quality due to a decrease in protein and micronutrient content and an increase in the risk of mycotoxins (Medek *et al.*, 2021). In addition to purely climatic risks, military conflicts also have a negative impact on food security. Such changes put additional pressure on food systems, increase price volatility in global markets and exacerbate inequalities in access to quality food in low-income countries. In this context, it is particularly important to develop and implement adaptation strategies that can minimise the negative impact of climate factors and ensure the stability of agricultural production at both the global and regional levels.

The author's research revealed regional differences in the impact of climate change and the war in Ukraine on food security in Europe. The study was based on an analysis of the impact of military action and climate change on the yield of key crops (wheat, maize, barley), product quality and the effectiveness of adaptation strategies in EU countries for 2015-2024. Approaches developed by scientists (Lobell *et al.*, 2011; Trnka *et al.*, 2019) were used to process the data obtained, in particular regression analysis and scenario modelling based on climate scenarios RCP 4.5 and RCP 8.5. In addition, data was collected on how climate shocks affect the yield of major crops (Table 1).

Table 1. Changes in the yield of key crops in EU regions (2015-2024, % compared to 2010-2014)

Region	Wheat	Maize	Barley
Southern Europe average for 2015-2024 (Spain, Italy, Greece)	-15.3 (± 2.1)	-12.4 (± 1.9)	-10.8 (± 1.7)
Southern Europe (Spain, Italy, Greece) for 2022	-18.5	-15.2	-13.1
Central and Eastern Europe average for 2015-2024 (Germany, France, Poland)	-6.5 (± 1.4)	-8.7 (± 1.8)	-4.2 (± 1.3)
Central and Eastern Europe for 2022 (Germany, France, Poland)	-9.1	-11.3	-6.5
Northern Europe average for 2015-2024 (Sweden, Finland, Denmark)	+3.1 (± 1.2)	+4.8 (± 1.5)	+6.2 (± 1.5)
Northern Europe for 2022 (Sweden, Finland, Denmark)	+2.8	+4.2	+5.5

Source: compiled by the author based on research by the Food and Agriculture Organization of the United Nations (2024), Copernicus Climate Change Service (n.d.)

Analysis of Table 1 showed that in Southern Europe, wheat yields decreased by 18.5% ($\pm 2.1\%$, 95% confidence interval) in 2022 due to droughts and water shortages compared to the average yield for the period 2010-2014. The main reasons for this were intense droughts and water shortages, which limited the availability of soil moisture, as well as high temperatures during the heading and grain filling phases, which caused a decrease in crop weight and quality. In Central and Eastern Europe, maize yields fell by 11.3% ($\pm 1.8\%$) in 2022 due to irregular rainfall and frosts compared to the average yield for the period 2010-2014. This was due to irregular rainfall, which disrupted the water balance during critical stages of

vegetation, as well as spring frosts, which damaged seedlings and reduced plant resistance to subsequent stress conditions. In Northern Europe, the extension of the growing season contributed to a 5.5% ($\pm 1.5\%$) increase in barley yield in 2022 compared to the average yield for the period 2010-2014, as more favourable temperatures and a longer growing season provided favourable conditions for biomass accumulation, while precipitation levels remained sufficient to meet the needs of the crop being grown. In addition to significant quantitative changes, the quality indicators of the yields obtained also changed. The author collected data on the micronutrient content in wheat and presented it in Table 2.

Table 2. Changes in micronutrient content in wheat in EU regions (2015-2024, % compared to 2010-2014)

Region	Protein	Iron	Zinc
Southern Europe (Spain, Italy, Greece)	-7.4 (± 0.9)	-9.1 (± 1.1)	-6.8 (± 0.8)
Central and Eastern Europe (Germany, France, Poland)	-4.8 (± 0.7)	-6.2 (± 0.8)	-5.1 (± 0.6)
Northern Europe (Sweden, Finland, Denmark)	-2.3 (± 0.5)	-3.5 (± 0.6)	-2.9 (± 0.5)

Source: compiled by the author based on research by I. Al-Hadeethi *et al.* (2019) and Eurostat (n.d.)

Analysis of Table 2 shows that the protein content in wheat grown in Southern Europe decreased by 7.4% ($\pm 0.9\%$), and iron content decreased by 9.1% ($\pm 1.1\%$). These changes were caused by increased CO₂ concentrations in the atmosphere and heat stress on crops. In Central Europe, the decrease was 4.8% ($\pm 0.7\%$) for protein and 6.2% ($\pm 0.8\%$) for iron, and in Northern Europe, it was 2.3% ($\pm 0.5\%$) for protein. The change in these indicators poses a particular threat, significantly reducing the quality characteristics of crops. This is reflected in a reduction in protein, iron and zinc content. Such

changes indicate the spread of the phenomenon of “hidden hunger”, which has hidden but serious long-term consequences for public health and the sustainability of global food systems. Thus, climate change in the agricultural sector goes beyond a purely agrotechnical problem and requires consideration of socio-economic and medical factors.

Assessments of the effectiveness of adaptation strategies in agriculture, such as the introduction of climate-resilient crops, the use of precision farming and remote monitoring technologies, have all yielded positive results.

Alongside technological solutions (precision farming, satellite monitoring), approaches that combine institutional adaptation and the involvement of local communities are becoming increasingly important. In Bangladesh, for example, the integration of adaptation systems into advisory services enabled more than 12,000 agricultural advisers to implement localised solutions based on community vulnerability analyses. The implementation of localised adaptation systems through advisory services in Bangladesh had a comprehensive and multi-level effect, namely: firstly, it significantly increased food security, as farmers received recommendations adapted to local conditions, which reduced crop losses during droughts, floods and other extreme weather events; secondly, it improved the economic stability of farmers, as the optimisation of resources (water, fertilisers, seeds) and the introduction of sustainable agricultural technologies reduced production costs and increased yields under stressful conditions (CARE International, 2009).

In addition, the system has helped to improve the adaptive skills of communities: farmers and local advisors have gained knowledge

about climate risks and how to manage them, enabling more effective planning of agricultural work and development strategies at the local level. Thanks to the wide coverage of more than 12,000 agricultural advisors, this approach became scalable and integrated into the local advisory service system, enabling sustainable results to be achieved in many communities simultaneously. Overall, the implementation of localised adaptation systems in Bangladesh has had a systemic effect: increasing food and economic security, strengthening climate change adaptation skills, and developing the capacity of communities to respond effectively to future climate challenges (CARE International, 2009). In Mozambique, on the other hand, farmer field schools have helped to spread agroforestry strategies among the population, conserve moisture and manage crops, thereby reducing climate risks and increasing crop yields (Intergovernmental Panel on Climate Change, 2022). Table 3 provides a comparative analysis of the implementation of adaptation technologies in Mozambique and Bangladesh compared to European countries.

Table 3. Comparative analysis of the economic efficiency of adaptation strategies in Bangladesh, Mozambique and European countries

Country/region	Strategy implemented	Yield increase (%)	Cost reduction (%)	Income growth (%)
Bangladesh	Localised advisory services, sustainable varieties	10-15	5-7	8-12
Mozambique	Farmers' field schools, agroforestry	8-12	3-5	6-10
Central and Eastern Europe (Germany, France, Poland)	Precision farming technologies, automated irrigation	4.1	3-4	4-5
Northern Europe (Sweden, Finland, Denmark)	Satellite monitoring of pests and diseases	3.8	2-3	2,4
Southern Europe (Spain, Italy, Greece)	Drought-resistant wheat varieties	5.6	1-2	3-4

Source: compiled by the author based on research by F. Tubiello *et al.* (2008), CARE International (2009), P. Lamichhane *et al.* (2022), Ukraine rapid damage and needs assessment... (2023), European Environment Agency (2024)

Analysis of Table 3 showed that farmers in Bangladesh and Mozambique have limited access to finance and innovative crop production technologies. The greatest economic impact in these countries was achieved through localised advisory services, field schools and agroforestry, which helped to raise awareness of new

technologies among local farmers. As a result, crop yields in these countries increased by 8-15%, and farmers' incomes grew by 6-12%, demonstrating the high importance of socio-institutional approaches. In test regions in Spain, the introduction of drought-resistant wheat varieties increased yields by 5.6% ($\pm 1.2\%$), which

directly contributed to stabilising the domestic food balance in conditions of water scarcity and reduced the need for external grain imports. This improved the situation in terms of food security (Tubiello *et al.*, 2008; Lamichhane *et al.*, 2022). The introduction of precision farming technologies in Central Europe reduced crop losses due to precipitation by 4.1% ($\pm 0.9\%$), which reduced fluctuations in farmers' incomes, cut the cost of agrotechnical measures, and strengthened the economic sustainability of agricultural production, which is a key factor in ensuring long-term food security. Meanwhile, in Northern Europe, the use of satellite monitoring of pest and disease spread has reduced the negative impact of fungal diseases by 3.8% ($\pm 0.7\%$) and reduce fungicide costs, enabling agricultural producers to increase profitability by an average of 2.4%, which contributed to the economic efficiency of the crop production sector (European Environment Agency, 2024). Although the economic effect in European countries is slightly lower in percentage terms, it is more stable and scalable thanks to technological solutions: precision farming, automated irrigation systems, and satellite monitoring. As emphasised by S.K. Balasundram *et al.* (2023), digital agriculture (precision farming) can not only increase resource efficiency, but also serve as a tool for increasing crop yields and reducing greenhouse gas emissions. A comparative analysis of the results obtained with literature sources confirmed their reliability. In particular, the results of the study are consistent with the conclusions of H. Fraga *et al.* (2012), which indicate the high vulnerability of Southern Europe to droughts. Similarly, the results regarding increased crop yields in Northern Europe coincide with the data of J.E. Olesen *et al.* (2011). The study by D.E. Medek *et al.* (2021) explains the observed decrease in the nutritional value of wheat by the phenomenon of "hidden hunger," which is confirmed by data on the decrease in protein and iron content. In addition to cereals, climate change also affects vegetable and fruit crops. In Southern Europe, tomato yields have fallen by 12% due to heat stress and water shortages, while in Central Europe, apples have suffered from late frosts, reducing yields by 7% in 2023 (Eurostat, n.d.). In Northern Europe, rising temperatures have led to an

expansion of vineyards, but have also increased the risk of fungal diseases (Olesen *et al.*, 2011). These changes make it more difficult to ensure a diverse diet, which is key to food security.

At the same time, the data obtained indicate an uneven distribution of access to adaptation technologies, as highlighted in the work of M. Zurek *et al.* (2022). This factor reduces the overall effectiveness of adaptation to climate change and other challenges. The practical value of the study lies in identifying the need for region-specific adaptation strategies that take into account both agroclimatic conditions and socio-economic factors. It is important to note that building adaptive capacity is impossible without strengthening horizontal communication between farmers and vertical coordination between local and national levels. As the experience of Uganda has shown, the creation of public platforms for the adaptation of the agricultural sector to the negative impact of various factors has contributed to the transfer of practices to the level of state strategy, although limited budgets and weak institutional support remained barriers. India also demonstrates the effectiveness of the transition from local experience to national policy through evidence-based approaches, including vulnerability monitoring and community participation in decision-making (Watershed Organisation Trust, 2014; Global Centre on Adaptation, 2022).

Another significant factor that has had and continues to have a major impact on global food security is the war in Ukraine. Before the full-scale war began in February 2022, Ukraine played a strategic role in the global food market. According to the Food and Agriculture Organization of the United Nations (2022), it was one of the three largest exporters of maize, ranked fourth in terms of wheat exports and first in terms of sunflower oil supplies. Every year, Ukraine exported food to more than 150 countries, accounting for up to 12% of global wheat exports. More than 40% of agricultural products were exported to European Union countries, where Ukrainian grain was used as feed and to stabilise domestic markets (Food and Agriculture Organization of the United Nations, 2022). Until 2022, Ukraine's food security was at an acceptable level: according to Economist

Impact (2022), Ukraine ranked 58th among 113 countries in 2021. Ukraine had a developed infrastructure, which contributed to the development of agricultural exports. In particular, it had Black Sea ports (Odesa, Chornomorsk, Yuzhne), over 20 million tonnes of elevator capacity, and a railway network integrated into European logistics. However, the start of a large-scale invasion (2022) caused a shock to the agri-food system of Ukraine and countries around the world that depend on raw material exports from Ukraine. According to World Bank estimates, more than 30% of Ukraine's agricultural land was either occupied or mined and became inaccessible due to hostilities (Ukraine rapid damage and needs assessment..., 2023). In 2022-2023, the most damage was done to the Kharkiv, Kherson, Zaporizhzhia, Luhansk, and Donetsk regions, which provided over 45% of global wheat and barley exports. The bombings damaged elevators, dryers, tractor stations, grain storage facilities, and logistics centres. In

particular, over 15 million tonnes of grain and production capacity were lost or damaged (KSE Institute, 2023). Another critical problem was the mining of agricultural land. According to the United Nations Mine Action Service (2023), about 174,000 km² of Ukraine's territory (almost a third of the total area) needs to be demined, making large areas of agricultural land (2.5 million hectares) unusable for years to come. The real scale of the war's impact on agricultural production is reflected in official statistics. In 2022, the gross harvest of cereals and legumes in Ukraine fell from 86 million tonnes (2021) to 55.3 million tonnes (2022), i.e. by 36% (State Statistics Service of Ukraine, 2024). Crops such as winter wheat, maize and barley were particularly affected. Due to a lack of fuel and a shortage of plant protection products and agrochemicals (most of which were imported), many farms were unable to carry out spring field work in full. The decline in the cultivation of these crops led to a reduction in exports (Table 4).

Table 4. Ukraine's grain exports in 2021 and 2022

Crop	2021 (million tonnes)	2022 (million tonnes)	Change (million tonnes)	Change (%)
Maize	23	17.7	-5.3	-23
Wheat	20	11.8	-8.2	-41
Total grain exports	44.7	28.8	-15.9	-35.6

Source: compiled by the author based on data from O. Shubravskaya & K. Prokopenko (2022), Ukrainian Club of Agrarian Business (2024), V. Skribans *et al.* (2024)

The changes in exports shown in Table 4 have significantly affected food security in Ukraine and worldwide. The largest decline occurred in the wheat segment (-41%), while maize exports decreased by 23%. The main factors behind this negative trend were military actions that led to the blockade of Black Sea ports and the destruction of logistics infrastructure and storage facilities (Shubravskaya & Prokopenko, 2022). Another factor that significantly affected exports was the reduction in cultivated areas and, consequently, in harvests. Logistical barriers related to the overload of rail and road routes, increased transport costs, and dependence on ports in Romania, Poland, and the Baltic states also had a significant impact.

Thus, the key determinants of the decline in grain exports in 2022 were the combined effects of military action, production and logistical

constraints, which significantly reduced the export potential of Ukraine's agricultural sector. Before the war, approximately 90% of Ukraine's agricultural exports were carried out through Black Sea seaports. However, after the war began, Russia blocked shipping from Ukrainian ports, creating the risk of famine for countries dependent on Ukrainian grain, primarily in North Africa, the Middle East and Asia. The global response to this was the Black Sea Grain Initiative, signed in July 2022 under the auspices of the UN and Turkey, which allowed the export of more than 33 million tonnes of grain during the year of the initiative's operation (United Nations, 2023). In addition, instead of maritime exports, land-based "Solidarity Lanes" were created through Poland, Romania and Slovakia (Skribans *et al.*, 2024). However, these routes have low throughput capacity, are more expensive

and more difficult to coordinate. In addition, they have led to large quantities of Ukrainian grain entering the markets of neighbouring countries, causing conflicts with local farmers and political tensions within the EU (European Commission, 2023).

Ukraine's national food security has also been negatively affected. According to estimates by the Food and Agriculture Organization (2023), the proportion of the Ukrainian population without regular access to safe food increased from 6.5% in 2021 to 22.4% in 2023. The situation is worst in the frontline regions and among internally displaced persons (IDPs), who numbered more than 4.5 million in 2024. Food prices in Ukraine have risen significantly: according to the State Statistics Service of Ukraine (2024), the average annual inflation rate for food products in 2022 was 34.1%. This has had a negative impact on the availability of quality food for low-income groups. It should be noted that Ukraine's agriculture sector has been under the greatest pressure due to the war, and the industry is undergoing significant transformations. Thus, the area under grain crops has decreased by 27.6% compared to the pre-war period, while the decrease in oilseed crops was less significant – 5.6%. Vegetable growing areas have shifted to the central and western regions: the Kyiv region has increased its area by 22.5%, while Vinnytsia, Lviv and Volyn have increased theirs by 7-8%. The structure of cultivated areas has also changed: the share of grain crops decreased by 6.4 percentage points, while oilseeds increased by 4.9 percentage points, due to infrastructure losses and market fluctuations. Despite the overall reduction in cultivated areas, gross production is expected to grow in 2025, in particular due to maize cultivation and the adaptation of crop structures to new challenges. The high share of oilseeds (38% of the value of production) also indicates that they remain an export priority (Lupenko *et al.*, 2025). An analysis of the impact of the war in Ukraine on food security showed that it has become another factor in the food shock. According to data from the Organisation for Economic Co-operation and Development (2023), in March – May 2022, global prices for wheat jumped by 43%, maize by 20%, and vegetable oil by more than 30%.

This put extra pressure on the food systems of countries that import these products, like Egypt, Lebanon, and Pakistan.

For the European Union, the consequences were twofold: firstly, there was a need to compensate for lost imports from Ukraine through domestic production, which prompted some countries to temporarily relax environmental standards, in particular by allowing the cultivation of some protected lands; secondly, the influx of Ukrainian grain into neighbouring countries such as Poland, Slovakia and Hungary caused domestic prices to collapse and a wave of farmer protests, forcing the European Commission in 2023 to allocate compensation packages to the affected countries and temporarily restrict imports of certain goods (Organisation for Economic Co-operation and Development, 2023). The international community responded to these challenges by providing humanitarian, technical and financial support to Ukraine's agricultural sector. In particular, the FAO is implementing programmes aimed at demining agricultural land, providing farmers with seeds and microgrants, and developing logistics in the western regions of the country. As part of the agricultural land demining programme, agricultural land is being cleared of explosive objects, allowing farmers to return to safe land cultivation. In parallel with this, there is a programme to distribute certified seeds and microgrants, which helps small and medium-sized producers to restore the profitability of their farms. In addition, in response to the destruction of logistics routes in the central and southern regions, measures are being taken to develop logistics infrastructure in the western part of the country, including the modernisation of warehouses, support for transport corridors to the EU borders and strengthening the capacity of agricultural cooperatives (Food and Agriculture Organization of the United Nations, 2023). Collectively, these measures aim to reduce the vulnerability of Ukraine's food sector, ensure the continuation of the production cycle and stabilise export flows.

Despite everything, Ukraine has the potential to remain a key player in the food market. Despite all the challenges, it is worth noting the positive dynamics in 11 regions of Ukraine, which have increased their cultivated areas despite

the nationwide decline in the agricultural sector – most notably in Lviv (+5.8%) and Odesa (+4.9%) regions. These regions could become catalysts for the restoration of national food potential in the post-war period (State Statistics Service of Ukraine, 2024). In addition, the war has accelerated the need to transform Europe's agri-food systems towards increasing food reserves, improving the reliability of logistics chains and diversifying imports. This creates an opportunity for Ukraine to become a long-term strategic partner with the EU in the field of food security (Shubravska & Prokopenko, 2022).

The results of the study indicate regional asymmetry in the impact of climate change on crop yields, product quality, and the effectiveness of adaptation strategies in European Union countries. A similar study was conducted by M. Trnka *et al.* (2019), which found that Southern Europe is most vulnerable to climate change due to frequent droughts and moisture deficits. This study is fully consistent with the author's research data, which shows a 15.3% ($\pm 2.1\%$) decrease in wheat yield in Spain. Despite this, a study conducted by J.E. Olesen *et al.* (2011) showed a positive impact of climate change on yields in Northern Europe, particularly for barley, which was also recorded in this study (+6.2% yield in Sweden and Finland). Thus, these results confirm the trends identified in the present analysis. In addition, D.E. Medek *et al.* (2021) investigated the reduction in micronutrient content in cereal crops under the influence of increased CO₂ levels and heat stress. Their conclusions are consistent with the author's findings regarding the reduction in protein, iron and zinc content in wheat, particularly in Southern Europe. Thus, the author's data and the studies cited confirm the threat of widespread hidden hunger in the world.

A study by M. Zurek *et al.* (2022) highlighted the unequal access to adaptation technologies between different regions, a fact confirmed in the author's study. In particular, Central Europe has implemented precision farming technologies that have reduced crop losses, while Southern Europe has remained more vulnerable and less effective in implementing innovative technologies. In addition, H. Fraga *et al.* (2012) pointed out in their research the critical vulnerability

of the agricultural sector in Southern Europe to climate risks, which was confirmed by the author's finding of a more than 10% decrease in yields for major crops. A study by D. Deryng *et al.* (2014) found that heat waves cause a significant reduction in maize and soybean yields, which is consistent with the author's finding of an 8.7% ($\pm 1.8\%$) reduction in maize yields in Central Europe in 2022.

One of the important aspects of ensuring food security in conditions of war and economic instability is the adaptation of national strategies, particularly in Ukraine. As noted by I. Cherven *et al.* (2024), effective food policy must take into account not only external challenges such as war and climate risks, but also internal socio-economic factors that affect the sustainability of the agricultural sector. Research by C. Rosenzweig *et al.* (2020) indicates the need to take into account both agro-ecological and socio-economic conditions when implementing adaptation strategies. The results of the study also reveal the effectiveness of combining technological and institutional solutions, in particular the involvement of local communities. Thus, the results of the study coincide with the research of other scientists. Regarding the impact of the war, a report by the Organisation for Economic Co-operation and Development (2023) recorded an increase in world prices for wheat (by 43%), maize (by 20%) and vegetable oil (by 30%) in March – May 2022. These data fully correspond to the estimates made by the author of the article. Studies by I. Stashkevych (2025), F. Lin *et al.* (2023) and D. Saccone & E. Vallino (2025) showed how changes in grain export routes from Ukraine in 2022–2023 affect global trade in Ukrainian grain and how military actions on the territory of Ukraine have affected global food security. A study by N. Jia *et al.* (2024) analysed in detail how the war in Ukraine has affected global food production and exports, particularly of cereals and oilseeds. It was estimated that as a result of the war, wheat, barley and oat production in Ukraine fell by 20–30% in 2022. This led to a 20% increase in international grain prices during the first three months after the start of the conflict. Low- and middle-income countries were particularly affected, with food

prices rising by 40-50% and more than 13 million people at risk of starvation. In addition, more than 20 countries, including India and Kazakhstan, have imposed restrictions or bans on grain exports, further exacerbating the situation on global food markets.

The results of the author's research are consistent with current scientific literature and official statistics, which increases their reliability. The similarities with the results of other authors confirm the existence of consistent trends, such as declining yields in the South, growth in the North, deteriorating grain quality, and uneven access to innovation. Thus, the results of this study not only confirm pan-European trends, but also refine them using the example of different countries in the context of the war in Ukraine and growing climate challenges.

CONCLUSIONS

The study found that climate change and the war in Ukraine have a systemic, multidimensional and long-term impact on food security. It has been proven that climate change has the strongest impact on the agricultural sector. These changes have led to a decrease in the yield of major crops in 2022 compared to the period from 2010 to 2014 (in particular, wheat in Southern Europe by $15.3\% \pm 2.1\%$, and maize in Central Europe by $8.7\% \pm 1.8\%$), a deterioration in their quality, and increased risks for socially vulnerable groups. Northern Europe, although showing productivity growth due to the lengthening of the growing season (e.g., barley yields in Sweden and Finland by $+6.2\%$), still faces new agronomic challenges, in particular the spread of fungal diseases and phytopathogens. The study confirms the need to implement effective adaptation strategies, primarily such as: the use of climate-resistant varieties, digital technologies for "precision farming" (which reduced crop losses in Central Europe by $4.1\% \pm 0.9\%$), but there is still a need to ensure access to such solutions for

all agricultural market players, including small farmers. The need for institutional support, regionalisation of policies and mechanisms for financing such adaptation measures is a critical condition for an effective response to crises and climate challenges. The study also found that the war in Ukraine has had a significant impact on global and European food chains, significantly destabilising markets and causing a sharp rise in world prices for wheat (+43%), maize (+20%) and vegetable oil (+30%) in March-May 2022. Nevertheless, Ukraine still has the potential to remain a key strategic partner of the EU in the field of food security. Of course, restoring pre-war levels of crop production requires the use of all available resources, in particular the demining of land (2.5 million hectares) that has been taken out of agricultural production. Despite all the challenges, positive dynamics were observed in 11 regions that have increased their sown areas despite the nationwide decline, with the largest increases in Lviv (+5.8%) and Odesa (+4.9%) regions. These regions could become catalysts for the restoration of national food potential in the post-war period. Ensuring food security in the context of climate change and the war in Ukraine requires not only technological solutions, but also profound institutional restructuring, the integration of adaptation policies and the strengthening of cross-border cooperation. Further research should focus on developing interdisciplinary models that take into account biophysical, economic and social aspects in order to formulate effective food security strategies for the 21st century.

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Вплив кліматичних змін у світі та російської агресії в Україні на глобальну продовольчу безпеку

Анотація. Проблема продовольчої безпеки набула особливої актуальності в умовах посилення кліматичних змін та геополітичних загроз, зокрема війни в Україні. Метою дослідження було визначення впливу кліматичних змін та впливу російської агресії в Україні на функціонування глобальних агропродовольчих систем. Основна увага була приділена аналізу впливу екстремальних погодних явищ, дефіциту води, зміни режиму опадів та військових дій на врожайність, харчову якість та цінність сільськогосподарських культур та функціонування ланцюгів постачання. Методологічною основою дослідження було поєднання кількісного аналізу статистичних даних з якісним аналізом регіональних адаптаційних стратегій та соціально-економічних наслідків. Результати свідчать про високу вразливість Південної та Центральної Європи. Зафіксовано зниження врожайності пшениці, кукурудзи та ячменю в Південній і Центральній Європі, тоді як у Північній Європі спостерігалось її зростання внаслідок подовження вегетаційного періоду. Також, виявлено погіршення харчової цінності продукції через зменшення вмісту мікронутрієнтів. Аналіз підтвердив ефективність впровадження кліматостійких технологій, точного землеробства та участі громад в адаптаційних процесах. Окрему увагу приділено впливу повномасштабної війни в Україні на продовольчу безпеку. Вона спричинила скорочення посівних площ, втрати виробничих потужностей, порушення логістики та експорту сільськогосподарської продукції, різке зростання цін на продукти харчування та викликала соціальну напругу в країнах-імпортерах. Узагальнення результатів підкреслює потребу в інтегрованому та регіоналізованому підходах до політики продовольчої безпеки в умовах підвищених кліматичних шоків та інших ризиків. При цьому, впровадження кліматостійких технологій, диверсифікація постачання та посилення міжнародної кооперації є критично важливими для формування стійких агропродовольчих систем майбутнього. Практичне значення дослідження полягало у формуванні науково обґрунтованих підходів адаптації сільськогосподарського сектору до кліматичних змін та впливу війн

Ключові слова: сільське господарство; адаптаційні стратегії; стійкість аграрного сектору; повоєнне відновлення; прихований голод



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Modelling of a consumer basket in food retail trade taking into account nutritional criteria

Abstract. Current global challenges in the field of nutrition, in particular the shortage of nutrient-rich foods and the growth in consumption of ultra-processed foods, pose serious risks to public health and require a review of the structure of the consumer basket. The aim of the article was to model the impact of excise taxation on the structure of food products sold in retail trade, taking into account nutritional criteria. To achieve this goal, methods of economic and mathematical modelling, price elasticity of demand analysis, a systematic approach and comparative analysis of official statistical data from Ukraine and international sources were used. The results of the study showed a significant deviation of the actual consumption structure from the recommended norms: excessive consumption of foods high in sugar, salt and trans fats is combined with insufficient consumption of fresh vegetables, fruits, dairy products and protein sources. In 2024, consumption of foods with high nutritional value in Ukraine was only 36% of the recommended level, with dairy products and fish showing the greatest deficit. Plant-based foods are consumed at one-third below the norm, and fat intake covers only half of the requirement. At the same time, the share of junk food exceeds the acceptable level by more than ten times and continues to grow. The forecast for 2025-2029 shows a gradual recovery in consumption in Ukraine after the shocks of the war, but even in the long term, the indicators will not reach the recommended levels. The economic-mathematical model showed a double effect of excise taxes on unhealthy food products: a decrease in demand for ultra-processed foods and an increase in budget revenues for healthy eating programmes. Modelling has proven that even a moderate price increase stimulates the replacement of such products with healthier alternatives. The proposed approach makes it possible to quantitatively assess the effects of regulation and determine the balance between fiscal interests and health protection. The practical significance of the study lies in the possibility of using the results to justify state policy in the field of food market regulation aimed at forming healthy eating habits among the population

Keywords: consumer food preferences; product format; excise tax; dietary quality of the diet; junk food; economic and mathematical modelling

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INTRODUCTION

In the context of contemporary challenges to the food system and growing threats to public health, particularly due to the spread of unbalanced diets and excessive consumption of unhealthy foods, it is important to study the structure of food consumption in the retail sector. Given the trend towards an increase in the share of ultra-processed foods in the population's diet, particularly in Ukraine, there is an urgent need to develop state regulation tools to correct consumer habits and shape healthy retail offerings.

The problem of forming a healthy consumer basket in the retail food trade is becoming increasingly relevant in the context of global challenges to the food system. The spread of unbalanced diets and the growth in consumption of ultra-processed, or so-called "junk" foods, are leading to increased risks to public health, which requires the introduction of effective state regulation mechanisms. An important area in this field is the study of European experience in healthy eating, which can serve as a basis for adapting Ukrainian practices. A study by N.H. Bosetska *et al.* (2022) offers a comprehensive analysis of healthy eating strategies and practices in European countries. They emphasised the need for a holistic approach that combines educational, social and economic measures to shape rational eating habits. These findings are a valuable foundation for understanding the mechanisms of consumer behaviour change, which directly correlates with the topic of modelling the structure of the consumer basket in retail trade. This line of research was continued by T.V. Brovenko *et al.* (2023), who examined in detail the political strategies, regulatory measures and practical initiatives aimed at promoting healthy eating at the national level. The authors emphasise the role of public policy in shaping healthy trade offerings, which coincides with the goal of modelling the impact of excise taxation in the Ukrainian context.

The importance of a balanced diet as a factor in the prevention of chronic diseases was emphasised by M.P. Gulich & O.D. Petrenko (2023) in their study. They analyse the experience of the WHO and national programmes in Ukraine, which demonstrate the importance

of combining educational measures and regulatory mechanisms to change the eating habits of the population. This approach reflects the idea of the author's research on state intervention in the form of tax instruments to shape healthy demand.

Modern methods of food analysis are necessary for an accurate study of consumer trends. The work of Z.A. Burova *et al.* (2023) systematises the methodology for determining the energy value and nutrient composition of products, which allows for the construction of adequate economic and mathematical models of consumption. This is directly related to the authors' goal of creating a model that takes into account nutritional criteria when analysing the structure of the consumer basket. Attention should also be paid to the study by O.L. Plakida *et al.* (2023), which examines the impact of socio-economic factors on the population's nutrition and its role in maintaining health. Taking these factors into account is important for a comprehensive understanding of consumer behaviour and the effectiveness of regulatory measures, in particular excise taxation. In addition, the issue of food security, which is directly related to the balance of the food basket, is examined in detail in the work of N.I. Trishkina & I.V. Buznitska (2025). The authors emphasised that the availability and quality of products are basic conditions for forming a healthy diet, which serves as the foundation for further analysis of trade offers and consumer patterns.

Thus, the above-mentioned research establishes the understanding that scientifically-backed modelling of the consumer basket is necessary for effective state regulation, taking into account nutritional requirements and behavioural factors. The author's research was aimed at solving this problem by developing an economic-mathematical model of the impact of excise taxation on demand in the segment of harmful products in retail trade, which opens up prospects for improving public health and forming a balanced trade offer in Ukraine. Particular attention is paid to the role of retail trade as a channel for shaping consumer behaviour and implementing tax policy at the end-buyer level.

The introduction of such a tax has the potential not only to reduce the consumption of “junk food”, but also to increase tax revenues, which can be used to support healthy eating and the prevention of chronic diseases.

The aim of the study was to assess the consumer structure in retail trade, taking into account nutritional criteria, and to develop an economic-mathematical model of the impact of excise taxation on the segment of harmful products in Ukraine. In accordance with the set goal, the following tasks were solved: to analyse the structure of food consumption in the retail trade in Ukraine, taking into account nutritional criteria, and to identify the main imbalances between actual consumption and recommended healthy eating standards; to develop an economic and mathematical model of the impact of excise taxation on demand in the unhealthy products segment, taking into account price elasticity and consumer behaviour; to propose recommendations on the use of excise policy as a tool for state regulation of food retail trade with the aim of improving consumption patterns, reducing negative health effects on the population and increasing tax revenues.

MATERIALS AND METHODS

The methodological basis of the study was a combination of a structural-functional approach, economic-mathematical modelling and the concept of nutrition science, adapted to the conditions of food retail trade. The study was conducted in several stages, using the methods described below. The structural-functional approach was used to identify the key elements of the modern consumer basket, as well as to establish relationships between food categories, their nutritional value, frequency of consumption, and retail sales channels. Comparative typological analysis played an important methodological role in the study, which was used to systematise food categories, taking into account both economic and nutritional criteria. Economic criteria included sales volume dynamics. Nutritional criteria included protein, fat and carbohydrate content, as well as the level of food processing (natural and ultra-processed). This combination of criteria made it possible to carry out a more

comprehensive classification of product groups and identify imbalances between actual and recommended diets. At the first stage, products were classified according to their origin (plant or animal), degree of technological processing (natural, processed, ultra-processed products), functional purpose in the diet (main source of proteins, fats, carbohydrates, micronutrients, vitamins) and food density. Comparisons were made between product groups, which made it possible to identify imbalances in consumption and potential risks to nutritional balance. The source of typical nutritional value parameters was the national food standards of the Ministry of Health of Ukraine (Order of the Ministry of Health of Ukraine No. z1206-17, 2017), supplemented by nutrition studies (Burova *et al.*, 2023; Plakida *et al.*, 2023; Trishkina & Buznitska, 2025). The results of the typology formed the basis for further aggregation of products into classification blocks when modelling the consumer basket, and also made it possible to identify groups of goods with the highest potential in terms of ensuring a balanced diet.

The time series analysis was conducted based on statistical data (Food – Ukraine (consumer), n.d.; Food – Worldwide (consumer), n.d.) for 2018-2024, including data from the Statista platform and thematic industry publications. Changes in the consumption structure of the main categories of food products, particularly in the retail sector (online and offline), and their impact on the components of the consumer basket were analysed. Based on the author's typology for assessing structural imbalances between the actual food diet of the world's population and the recommended nutritional guidelines, the study used a method of comparative analysis of the actual consumption of major food groups globally for 2018-2024. The author's study included only products consumed through organised market channels, without taking into account goods of own production or non-market exchange. This approach made it possible to assess the effectiveness of trade supply as a key factor in shaping consumer habits. The regulatory framework was based on the generalised recommendations of international nutrition institutions

(World Health Organization, 2020), on the basis of which a comparative model of the consumer basket was constructed by category: protein, fat and plant products, as well as a group of ultra-processed products, conditionally classified as junk food. The assessment was carried out both statically (as of 2024) and dynamically (2018-2024), with subsequent extrapolation modelling for the period 2025-2029. Comparisons with recommended standards were made in physical units (kg per person per year), which made it possible to identify deviations from the actual diet and the degree of deficiency or excess consumption in each category. The method identified persistent structural trends, in particular a deficit in the consumption of nutritionally valuable products and a parallel increase in the consumption of ultra-processed foods, indicating a global shift towards a low-nutrient but high-calorie diet. The results obtained formed the basis for further national analysis and comparative conclusions on the effectiveness of trade policy in the context of creating a healthy food environment.

In the context of the study, the use of economic and mathematical modelling as an instrumental method aimed at quantitatively reflecting the impact of excise taxation on the structure of demand in the segment of food products with low nutritional value played a special role. The modelling methodology was based on the use of parameters of goods pre-classified by degree of harmfulness (confectionery, semi-finished products, spreads and sweeteners), the determination of price elasticity of demand, and the assessment of changes in consumption depending on price changes due to the introduction of excise tax. The model took into account baseline consumption volumes, population size, average retail prices, the amount of excise tax, as well as the potential effect on tax revenues and the indexed change in consumer health. The calculations were based on statistical data from Statista (Food – Ukraine (consumer), n.d.; Food – Worldwide (consumer), n.d.) and the authors' calculations for 2024, which allows for a relevant forecast assessment. The developed approach involves the use of classical functional demand equations, taking into account negative elasticity, as well as

assessing the effect of fiscal intervention under different tax scenarios. Below are methodological approaches to modelling a consumer basket of food products, taking into account nutritional criteria. The purpose of the modelling was to compare actual food consumption (based on retail data) with recommended consumption standards based on nutritional principles. This approach made it possible to assess the balance of the consumer basket, identify shortages or surpluses of individual product groups, and determine areas for correction in trade supply and consumer preferences.

Actual consumption (in kg/year per person) was determined based on statistical data from Statista (Food – Ukraine (consumer), n.d.; Food – Worldwide (consumer), n.d.) on the volume of food sales in retail trade divided by the population. Recommended consumption levels were calculated in accordance with: recommendations World Health Organization (2020); national food standards of Ukraine (Order of the Ministry of Health of Ukraine No. z1206-17, 2017); average daily norms for a hypothetical adult population with moderate physical activity (based on the combination of data from the above sources – national and international – for the purpose of standardisation (e.g. in kilograms per person per year). Methodological assumptions: average standards are applied to the entire population without distinction by age, gender or lifestyle; calculations are made in kilograms per person per year – this ensures comparability with retail trade data; food products are grouped according to their nutritional value.

Key variables of the model of excise tax impact on consumption of harmful products and fiscal revenues in the context of retail trade in Ukraine:

Q_0 – basic consumption of unhealthy food (in kg/person/year);

P_0 – current price per unit of goods;

t – excise tax rate (UAH/kg or % of cost);

$P_1 = P_0 + t$ – new price including excise tax;

ε – price elasticity of demand (negative value);

Q_1 – new consumption volume after the introduction of excise tax;

N – number of consumers (population of Ukraine);

R – state tax revenues from excise tax.

Basic equations of the model of the impact of excise tax on the consumption of harmful products and fiscal revenues in the retail trade in Ukraine:

1. Assessment of changes in consumption:

$$Q_1 = Q_0 * (1 + \varepsilon \frac{t}{P_0}). \quad (1)$$

If elasticity $\varepsilon = -0.8$ (price elasticity of demand -0.8 is an empirically based benchmark widely used to model the impact of excise taxes on harmful products) and the price increases by 20%, consumption will fall by approximately 16%.

2. Calculation of total consumption:

$$S_1 = Q_1 * N. \quad (2)$$

3. Calculation of tax revenue:

$$R = t * S_1 = t * Q_1 * N. \quad (3)$$

4. Assessment of changes in health (optional, using indices):

$$\Delta Z = \alpha * (Q_0 - Q_1), \quad (4)$$

where α – the coefficient of influence of 1 kg of unhealthy food on the spread of non-communicable diseases or the increase in treatment costs.

This approach facilitates the transition from the diagnostic to the intervention stage of the study, ensuring the validity of management conclusions regarding the feasibility of introducing product excise taxes as an element of public policy aimed at correcting consumer behaviour and reducing social costs for the treatment of non-communicable diseases associated with excessive consumption of unhealthy products. The study included an analysis of the relationship between the transformation of consumer demand and the development of entrepreneurship in the food and agricultural sectors. Methodologically, this was achieved by extrapolating changes in the structure of the consumer basket to the business models of retailers and agricultural producers. In particular, the impact of excise policy on the range, logistics and margins of retail chains was assessed, and the risks and opportunities for companies producing both low-quality and healthy products were identified. Particular attention was

paid to the impact of changes in the structure of demand on agricultural production – the growing demand for vegetables, cereals, protein crops and the corresponding prospects for the agricultural business.

The bibliographic method made it possible to generalise and systematise existing approaches to the formation of the consumer basket from the perspective of nutrition, as well as state regulation, in particular in the field of excise taxation of harmful food products. The experience of EU countries (Slovakia, Hungary, Poland) and other countries (South Africa, Great Britain, Mexico, UAE, Saudi Arabia) in establishing minimum healthy diets, introducing fiscal instruments to limit the consumption of products of low nutritional value, and organising retail trade offerings. This comprehensive analysis created a theoretical basis for the development of original models for assessing the impact of tax mechanisms on consumption patterns and the formation of a balanced retail offering. The method of logical generalisation was applied at the final stage to formulate conclusions regarding the possibilities of integrating a nutrition-based approach into state policy on the formation of the consumer basket, as well as the potential for using the research results in the practice of food retailers.

RESULTS AND DISCUSSION

Food retail in Ukraine has undergone significant transformations in three key periods: pre-COVID (2018-2019), COVID (2020-2022) and the period of full-scale Russian invasion (since 2022). The Ukrainian market is showing higher recovery rates compared to global indicators, which is due to post-crisis economic recovery, increased demand and growth in per capita retail trade revenues. The main factors driving the sector's development are the significant share of household spending on food, growth in consumption of local products, especially in the meat, fish, fruit and vegetable segments, as well as changes in consumer preferences. The projected further growth in per capita retail food trade revenues indicates a strengthening of Ukrainians' purchasing power, despite the difficult demographic situation (Ilchuk *et al.*, 2023). At the same time, there is a structural restructuring

of forms of product promotion: the share of e-commerce in food products is growing, especially in large cities, and wholesale trade chains are being restored, which play an important role in ensuring the physical availability of products in frontline and rural areas (Ilchuk *et al.*, 2025). Thus, an analysis of the dynamics of food retail trade in Ukraine shows its high sensitivity to socio-economic shocks and, at the same time, its ability to recover quickly. Against the backdrop of growing per capita trade revenues and changing consumer preferences, the qualitative composition of the consumer basket is becoming particularly important. In this context, there is a need for a more in-depth analysis not only from an economic point of view, but also from a nutritional point of view, i.e. taking into account the impact of consumed products on the health of the population.

Below is the author's classification of food products from a nutritional point of view, based on their functional role in the human diet. The main principle of grouping is not culinary or commercial purpose, but nutritional value and nutrient content: the presence of complete protein, fibre, essential fatty acids, vitamins and minerals, or, conversely, an excess of simple sugars, trans fats and additives. Four main categories have been identified: foods with high nutritional value – primarily sources of complete protein (of animal origin) and micronutrients necessary for the body to function; plant-based foods – the basis of the diet – vegetables, fruits, nuts, and grains, which should make up the largest share of daily consumption; sources of fats – mainly of plant origin, which are important for metabolism but require control over quantity and quality; junk food (unsuitable for regular consumption) – products with low nutritional value, excessive calorie content, high sugar, salt, artificial additives or trans fats, which are not recommended for regular consumption.

The first three categories of food products cover the main components of a balanced diet. Foods with high nutritional value are primarily meat, fish, eggs and dairy products, which provide the body with complete protein, essential amino acids, B vitamins, iron, calcium and other vital micronutrients. Plant-based foods – vegetables, fruits, nuts, grains and legumes – form

the basis of a healthy diet, are the main source of fibre, natural antioxidants, vitamins and complex carbohydrates, and should predominate in the daily diet. Sources of fat, mainly of plant origin, are important for energy balance, absorption of fat-soluble vitamins and normal functioning of the hormonal system, but require moderate consumption and attention to their quality, in particular to the content of saturated fats and trans fats.

The last group was identified based on an analysis of scientific sources on nutrition. The study by S. Pettigrew *et al.* (2017) compares the terms “junk food”, “discretionary” and “snack food”. The authors conclude that “junk food” is the most understandable and meaningful term for consumers, as it clearly signals low nutritional value and potential health risks. In turn, M. Hadjikakou & P. Baker (2017) point out that “junk food” is more of a slang or journalistic term, but acknowledge its widespread use and ease of understanding compared to more technical concepts such as EDNP (energy-dense, nutrient-poor) or discretionary foods. This highlights the practical advantage of “junk food” in communicating with the public. Researchers C. Finardi & G. Tognon (2014) note that despite the lack of a single scientific definition of junk food, the term is widely used in research, as well as in political and educational strategies aimed at reducing the consumption of unhealthy foods. Finally, C.A. Monteiro *et al.* (2019) propose the concept of ultra-processed foods (UPFs), which largely overlaps with the meaning of “junk food” and has a clear scientific rationale for health risks, including obesity, cardiovascular disease and metabolic disorders. Thus, despite some terminological ambiguity in scientific discourse, it is “junk food” that is the most appropriate term in the author's analysis – due to its clarity for a wide audience, its established use in the public sphere and its consistency with current ideas about the harmfulness of food. Table 1 provides a brief description of each group, the food products included in each of them, and the recommended consumption rate, which is consistent with data from the World Health Organization (2021) and current scientific publications in the field of nutrition (Burova *et al.*, 2023; Plakida *et al.*, 2023; Trishkina & Buznitska, 2025).

Table 1. Grouping of food products in the consumer basket, taking into account nutritional criteria and recommended frequency of consumption

Food group	Products included in the group	Nutritional value	Approximate norm, kg/person/year
Foods with high nutritional value	Meat	Sources of complete protein, calcium, vitamin B12, omega-3, iron	60
	Fish and seafood		15
	Dairy products and eggs		200 (dairy products) + 20 (eggs) = 220
	Total for the group		295
Plant-based foods – the basis of the diet	Vegetables	Sources of fibre, vitamins, antioxidants, folic acid, potassium	115
	Fruits and nuts		50 (fruit) + 5 (nuts) = 55
	Bread and cereal products		140
	Total for the group		310
Sources of fat	Oils and fats	Sources of unsaturated fatty acids, vitamin E, energy	13
Junk food (not suitable for regular consumption)	Confectionery and snacks	High calorie content, excess sugar, salt, trans fats, colourings; low biological value	It is better to avoid completely
	Spreads and sweeteners		
	Semi-finished products		

Source: author's own development

This approach allows grouping to be used as a basis for modelling a healthy consumer basket. An assessment of the consumption structure of food products sold worldwide in 2018-2024 reveals key imbalances between the actual diet of the population and the recommended norms based on nutrition science. The author's research analyses the consumption of goods sold in retail trade, excluding products that may be consumed from own cultivation or non-market sources. This approach makes it possible to assess the effectiveness of supply

in the organised trade system, which forms the basis of the affordable range for most consumers. 2024 is the last year for which complete actual statistics are available, while data from 2025 onwards are forecasts. At the same time, the dynamics of previous years make it possible to trace consistent trends in changing food practices that are critical to the formation of a healthy trade offer. The calculation of the consumption of food products sold by author groups in comparison with the indicative norms in the world is shown in Figure 1.

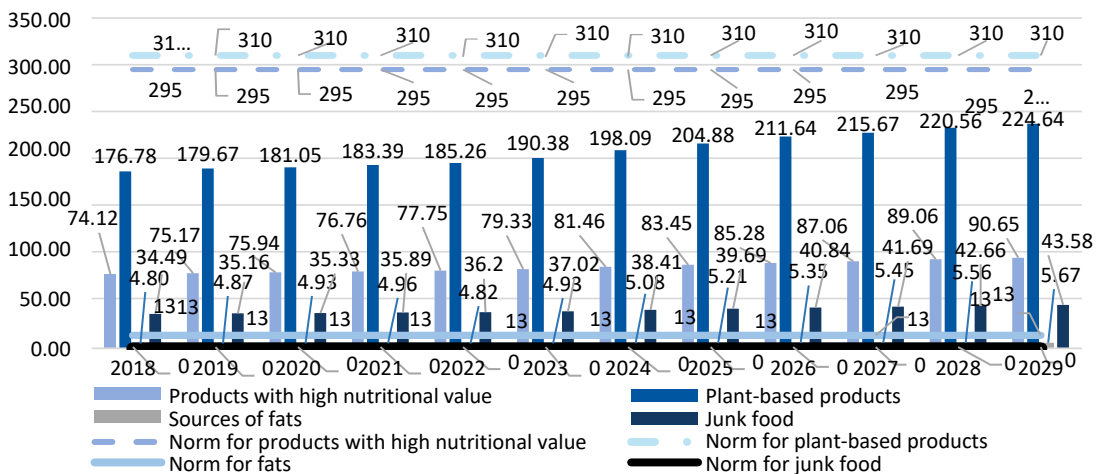


Figure 1. Calculation of the consumption of retail food products by author's groups in comparison with indicative norms in the world, kg per person

Note: 2025-2029 forecast data

Source: developed and constructed by the author using materials from Food – Worldwide (consumer) (n.d.)

Figure 1 shows that actual consumption of the main groups of nutritionally valuable products (protein, plant, fat) in 2024 significantly deviates from the recommended norms, ranging from -32% to -75% depending on the category. The largest gap is observed in the consumption of dairy products, fish and meat. At the same time, the consumption of junk food, which includes confectionery, semi-finished products and sweeteners, exceeds the recommended norm (0 kg) by more than 38 kg per person per year, indicating an undesirable trend of replacing a balanced diet with high-calorie but low-nutritional products.

The dynamics for 2018-2024 show a gradual increase in consumption in all categories: meat consumption increased from 19.08 to 20.65 kg (+8.2%), vegetables from 64.12 to 72.35 kg (+12.8%), but dairy products only from 50.94 to 56.21 kg (+10.3%), i.e. there is still a significant lag. On the other hand, junk food increased from 34.49 to 38.41 kg (+11.4%) (Food – Worldwide (consumer), n.d.). Despite the positive dynamics, the growth rate of consumption of healthy products sold is significantly lower than the growth rate of consumption of ultra-processed products. This poses risks to global public health, in particular the spread of chronic non-communicable diseases. An analysis of the structure of the global consumer basket for 2024 and a dynamic analysis for 2018-2024 reveal a systematic failure to comply with nutritional standards. The recorded deficit in the consumption of foods with high nutritional value is accompanied by excessive and growing consumption of junk food. These results confirm the need to review the retail trade offer and strengthen communication on the formation of healthy eating habits.

According to Statista's forecast data (Food – Worldwide (consumer), n.d.), a gradual increase in consumption is expected in almost all product groups in 2025-2029. The fastest growth rates are predicted for plant-based products and junk food, while the growth rates for nutrient-rich products (especially meat and fish) remain moderate. The forecast indicates positive dynamics in all categories: meat will grow from 20.65 (2024) to 22.82 kg (+10.5%), vegetables – from 72.35 to 82.56 kg (+14.1%), and fruit from 37.22 to 41.89 kg (+12.5%). However, even in 2029, the figures will

still be significantly below normal, with a deficit of over 200 kg in the high nutritional value group, over 85 kg in the basic plant group, and over 7 kg in the fat group. The largest growth in the forecast is for junk food: from 38.41 kg in 2024 to 43.58 kg in 2029 (+13.5%), which is more than the expected growth in the meat, fish or milk categories. The structure of the diet remains unbalanced, even despite improvements in absolute terms. The continued dominance of junk food poses serious risks to future public health.

In 2025-2029, a gradual increase in the consumption of food products in all product groups is expected. The most intensive growth will be in the consumption of plant products (in particular vegetables and cereals), but even with optimistic growth rates, actual consumption in 2029 will not reach the recommended nutritional standards. The projected shortfall in the category of foods with high nutritional value will be over 69%, in sources of fat – over 56%, and in the plant group – over 27%. At the same time, the level of junk food consumption not only remains consistently high, but continues to grow. This confirms the global trend of replacing a balanced diet with high-calorie but low-nutrient foods, which is a challenge for the development of nutrition-oriented retail trade.

In the context of these global trends, the analysis of the structure of food products sold in Ukraine is particularly relevant. As in the rest of the world, the domestic market shows certain imbalances between actual consumption and nutritionally sound standards. However, the specific consumer behaviour of Ukrainian households, economic constraints, the peculiarities of the retail offer, and the impact of martial law form unique national characteristics for analysis (Fig. 2).

Analysis of the data in Figure 2 shows that actual consumption lags significantly behind the recommended norms for all key groups. In particular, products with high nutritional value in 2018-2029 cover on average only 35-45% of the norm (295 kg per person per year). The lowest values were recorded in 2022 (92.91 kg), which is associated with the consequences of the war, logistical disruptions and a decline in household incomes. A similar situation can be observed with regard to plant products: actual

volumes are on average half the norm (310 kg). In the crisis year of 2022, their sales amounted to only 168.18 kg, or about 54% of the norm, after which a gradual upward trend began. The consumption of fat sources in the calculation period ranges from 4.0 to 5.7 kg, while the norm is 13 kg. This means that Ukrainian consumers receive less high-quality fats, compensating for the deficit with cheaper products rich in trans fats and oils of questionable quality. On the other hand, junk food consumption remains consistently high, ranging from 33.7 to 45.6 kg per person per year. In the absence of established normative

requirements, this signals negative changes in the structure of nutrition: excessive consumption of low-quality calories coupled with a shortage of healthy products. Thus, the Ukrainian food basket is characterised by significant imbalances between actual and rationally recommended consumption: an excessive proportion of “empty” calories and a significant deficit of nutrients. This creates risks of deterioration in the health of the population in the medium and long term and highlights the need for government policy aimed at increasing the availability and attractiveness of foods with high nutritional value.

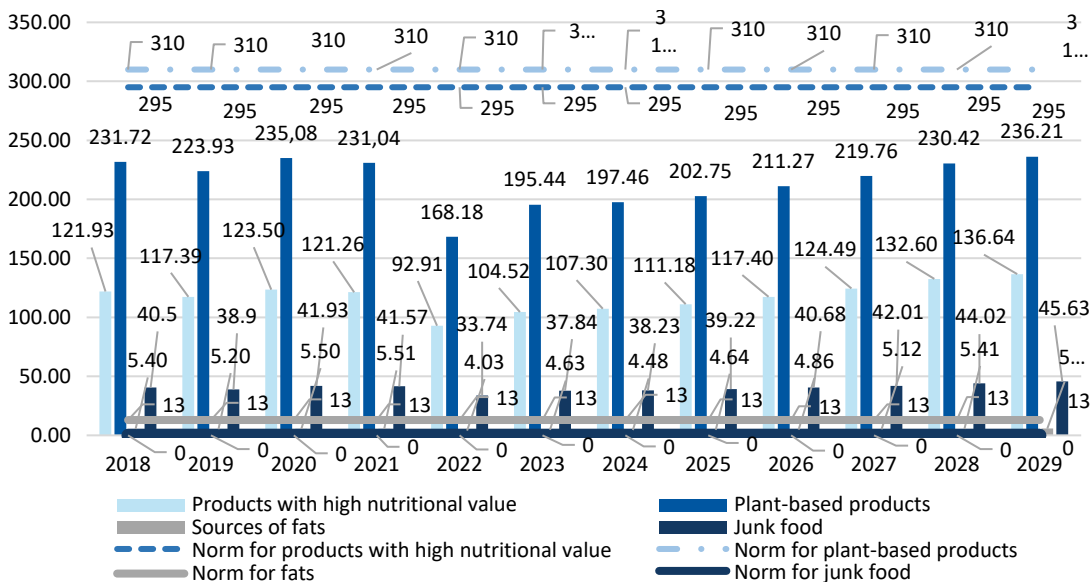


Figure 1. Calculation of the consumption of retail food products by author’s groups in comparison with indicative norms in Ukraine, kg per person

Note: 2025-2029 forecast data

Source: developed and constructed by the author using materials from Food – Ukraine (consumer) (n.d.)

Assessment of the dynamics of food sales in Ukraine for 2018-2024. (Food – Ukraine (consumer), n.d.). allows to identify both common features with global trends and differences that require separate consideration from the perspective of national food security, public health and retail trade efficiency. An assessment of the structure of food consumption in Ukraine for 2018-2024 reveals persistent imbalances between the actual diet of the population and recommended nutritional guidelines, similar to global trends but with their own specific

characteristics. In 2024, the consumption of foods with high nutritional value (meat, fish, dairy products and eggs) will be only 107.3 kg per person, compared to the recommended norm of 295 kg, i.e. the deficit will reach 187.7 kg or -63.6%. The largest gap is in the category of dairy products and eggs (62.5 kg against the norm of 220 kg, -71.6%), as well as in the consumption of fish and seafood – only 4.48 kg against the required 15 kg (-70.1%). The actual consumption of plant products, which form the basis of the diet, in 2024 is 197.5 kg, which is 112.5 kg less than the

norm of 310 kg (-36.3%). The largest decline is observed in the consumption of bread and cereals, which remains at 72 kg against the recommended norm of 140 kg. Fats (oils and fats) are consumed at a level of 4.48 kg against the norm of 13 kg, which means a deficit of more than 65%. At the same time, the consumption of junk food, which is not recommended for regular consumption, will be 38.23 kg per person in 2024. This is less than in 2018 (40.50 kg), but after a decline in 2022 (33.74 kg), growth is observed again. The junk food structure is dominated by confectionery and snacks (17.93 kg) and semi-finished products (15.29 kg).

The dynamics for 2018-2024 showed that after a decline in consumption in 2022 due to the full-scale war, a gradual recovery in consumption volumes has been observed in all categories since 2023: meat consumption increased from 33.74 kg in 2022 to 40.34 kg in 2024 (+19.5% in two years), and vegetable consumption from 74.02 to 85.42 kg (+15.4%); at the same time, the level of consumption of nutrient-rich products is still significantly lower than the recommended levels, which poses risks to public health. According to Statista's forecast (Food – Ukraine (consumer), n.d.), by 2029, consumption is expected to grow gradually in almost all groups: products with high nutritional value will increase to 136.64 kg (+27% by 2024), but this is still only 46% of the recommended norm; plant-based products will increase to 236.21 kg (+19.6% by 2024), but the gap between consumption and the recommended norm will remain at over 23%; consumption of junk food is also projected to increase to 45.63 kg in 2029, which exceeds the recommended limit of 0 kg per person per year by more than 10 times.

Ukraine reflects the global problem of an unbalanced diet but faces additional risks caused by war, economic instability, and a limited retail supply. Despite a certain recovery in consumption volumes after 2022, the consumption structure remains unhealthy, with low levels of nutritionally valuable products and excessive consumption of junk food. The forecast for 2025-2029 shows positive dynamics in absolute terms, but even in the most optimistic scenarios, there will still be a significant lag behind the norms. The situation requires a review

of trade policy, the activation of healthy eating programmes and increased availability of quality food in Ukrainian retail. Thus, the modelling of the consumer basket in the retail food trade, taking into account nutritional criteria, made it possible to identify critical deviations of the actual diet of the population, both globally and in Ukraine, from the recommended standards. The imbalance in food supply, the dominance of ultra-processed products, and the shortage of nutrient-rich food groups create long-term risks to public health.

The results obtained indicate the need to: adapt trade policy to sustainable nutrition goals; develop a retail product range focused on nutritional adequacy; strengthen communication and educational campaigns on healthy eating; monitor structural shifts in consumption based on regular modelling of the consumer basket. A model approach based on comparing actual consumption with the normative nutritional structure can serve as an effective tool for assessing the quality of trade offerings and as a benchmark for reforming retail trade in the interests of public health. A summary of the results of modelling the consumer basket in food retail, taking into account nutritional criteria in the global and Ukrainian context, revealed profound imbalances between actual consumption and recommended healthy eating standards. A significant lag in sales of products with high nutritional value against the backdrop of consistently high and growing consumption of ultra-processed goods classified as "junk food" indicates a negative structural trend in consumer practices. This trend poses a serious threat to public health, as it contributes to the spread of chronic non-communicable diseases and increases the economic burden on the healthcare system.

In this context, it is becoming relevant to move from the diagnostic stage of research to the stage of instrumental intervention by developing an economic-mathematical model of the impact of excise taxation on demand in the segment of harmful products in the retail trade structure. Such a model allows not only to quantitatively assess the potential effect of the introduction of excise duty (reduction in consumption, change in price elasticity, growth in tax revenues), but also to formulate scientifically

sound recommendations for state policy in the field of rationalising food consumption. Thus, the logic of the study moves from an actual assessment of the consumption structure to modelling scenarios of its change under the influence of fiscal instruments, in particular, targeted excise taxation of certain categories of food products. This opens up the prospect of forming a nutrition-oriented trade offer through

mechanisms of state regulation, economic incentives for healthy food choices, and restrictions on the availability of harmful products through taxation. The analysis of international experience made it possible to compile Table 2, which presents countries that have already introduced such a tax and obtained results available for analysis, as well as those that have only recently implemented it.

Table 2. Effect of introducing excise taxes on junk food in countries around the world

Country	Type of tax	Results
South Africa	Tax on sweetened beverages since April 2018 (rate is 2.1 South African cents per gram of sugar exceeding 4 grams per 100 millilitres of beverage)	29% reduction in sweetened beverage purchases, 51% reduction in beverage calorie content, incentives for manufacturers to reduce sugar content
Slovakia	Tax on sweetened beverages since 2025 (0.15 euros per litre of beverage)	Expected revenue of €80 million in 2025, then €110 million/year
United Kingdom	Special tax on sweetened beverages, known as the 'sugar tax' from 2018 (two differentiated rates: 8 g/100 ml or more – 24 pence per litre; from 5 to 7.9 g/100 ml – 18 pence per litre. Less than 5 g/100 ml – not taxed)	A nearly twofold reduction in sugar consumption among children, and approximately 11 grams per day among adults
Mexico	Tax on sugary drinks since 2014 (1 Mexican peso per litre of sugary drinks (approximately 10% of the price))	Reducing demand by 6% in the first year, up to 12% by the end of the year
Hungary	Tax on unhealthy products, covering sweet and salty products, including beverages since 2011 (sweet beverages – 0.02 euros per litre; sweets, candies, chocolate – €0.40 per kilogram; salty snacks – separate rate based on salt content; energy drinks – higher rate due to caffeine and sugar)	Reduction in consumption of sweetened beverages by 19-22% and processed foods by 3-4% after the tax was introduced
United Arab Emirates	Consumer (excise) tax on sweet drinks and energy drinks since 2020 (50% on sweet drinks, 100% on energy drinks)	Reduction in consumption of sweetened and energy drinks by 20-40% after the excise tax was introduced
Saudi Arabia	Tax on sweet drinks since 2017 (50% on sweet drinks)	30-35% reduction in consumption of sugary drinks after the tax was introduced
Poland	Tax on sweet drinks from 2021 (0.50 zloty per litre basic tax; 0.05 zloty for each gram of sugar above 5 g/100 ml; additionally: 0.10 zloty/l for drinks containing caffeine or taurine)	Sales of such drinks fell by 10-20%, especially among young people

Source: grouped by the author according to A. Bíró (2015), M.A. Colchero *et al.* (2016), N. Stacey *et al.* (2019), P. Scarborough *et al.* (2020), Z. Berezhvai *et al.* (2024), A. Al Jawaldeh *et al.* (2024), Reuters (2024), M. Sajdakowska *et al.* (2024)

An analysis of Table 2 shows that the introduction of excise taxation has had lasting positive effects in most countries: a 6-20% reduction in the consumption of ultra-processed foods and sugary drinks, a reduction in the sugar content

of recipes, and a significant increase in budget revenues. At the same time, in structural terms, there is a redistribution of demand in favour of healthier alternatives, confirming the effectiveness of fiscal instruments in transforming food

practices. These empirical results provide a basis for moving towards the construction of an economic-mathematical model of the impact of excise tax on “junk food” in Ukraine, which will allow: assessing projected changes in demand depending on the level of tax burden; model fiscal policy options taking into account the price elasticity of demand; determine the expected effect in terms of reducing the consumption of products with low nutritional value; assess the potential of tax revenues and the possibilities for their reinvestment in preventive health programmes. The application of such a model creates a scientifically sound basis for making management decisions in the field of state reg-

ulation of retail food circulation with the aim of improving the consumer structure and reducing social costs of combating the consequences of an unbalanced diet. Table 3 shows a fragment of the calculation of the consumption of food products sold in Ukraine according to the author’s classification, limited to only one group – junk food. The choice of this particular group is due to its high socio-economic significance: products in this category (confectionery, snacks, spreads, sweeteners, semi-finished products) are high in calories, low in nutritional value and are a key factor in the excessive consumption of sugar, salt and fats, which affects both public health and nutrition policy.

Table 3. Fragment of the calculation of consumption of food products sold in the author’s group of junk food in Ukraine, kg per person

Indicator	Year						
	2018	2019	2020	2021	2022	2023	2024
Junk food in total of them:	40.50	38.90	41.93	41.57	33.74	37.84	38.23
confectionery and snacks	17.55	16.96	18.79	18.83	15.61	17.97	17.93
spreads and sweeteners	7.20	6.79	7.10	6.89	4.53	4.90	5.01
semi-finished products	15.75	15.15	16.04	15.85	13.60	14.97	15.29

Source: author’s calculations based on materials by Food – Ukraine (consumer) (n.d.)

Trends in total junk food consumption: after growing to 41.93-41.57 kg per person in 2020-2021, there was a sharp decline to 33.74 kg in 2022, which may have been due to economic factors related to the full-scale invasion. In 2023-2024, the indicator recovered slightly to 37.84-38.23 kg. Confectionery and snacks show a similar trend: a decline in 2022 to 15.61 kg and a partial recovery in subsequent years. Spreads and sweeteners have the lowest consumption among the subgroups, with a minimum in 2022 (4.53 kg) and a gradual increase in 2023-2024. Semi-finished products consistently account for a significant share of junk food consumption, but there will be a decline in 2022 (13.60 kg), followed by a recovery to 15.29 kg in 2024. The junk food group shows cyclical fluctuations in consumption related to economic, social and political factors. The sharp decline in 2022 indicates the sensitivity of consumer patterns to external influences, while the partial

recovery in 2023-2024 indicates a return of demand for these products.

Based on the 2024 data presented in the calculation fragment in Table 3, a model was applied. The prices given in the model are the average retail prices per 1 kg of the corresponding product in Ukraine as of 2024. They are selected to realistically reflect the weighted average retail cost across the country, not to distort the effect of the tax: prices that are too low or too high could overestimate or underestimate the impact of the excise tax; to be suitable for calculation at both the macro and household levels. Taking into account the calculations of consumption of food products sold by the author’s group of junk food in Ukraine and the author’s model, calculations were made using formulas 1-4 of changes in demand for food products with low nutritional value and an assessment of tax revenues under the influence of excise tax (Table 4).

Table 4. Model calculations of changes in demand for low-nutritional-value foods and assessment of tax revenues under the influence of excise taxation

Category	Model indicators							
	Q ₀ , kg	P ₀ UAH	t, UAH	ε	P ₁ , UAH	Q ₁ kg	S ₁	R, billion UAH
Confectionery products	18	120	24	-0.8	144	15.1	0.54	13.06
Semi-finished products	15	95	19	-0.7	114	12.9	0.46	8.82
Spreads and sweeteners	5	60	12	-0.6	72	4.4	0.16	1.90
Total	-	-	-	-	-	-	-	23.78

Note: Q₀ – base consumption of unhealthy food (in kg/person/year); P₀ – current price per unit of goods; t – xcise tax rate (UAH/kg or % of cost); P₁ = P₀ + t – new price including excise tax; ε - price elasticity of demand (negative value); Q₁ – new consumption volume after the introduction of excise tax; R – state tax revenues from excise tax

Source: author’s calculations based on data Food – Ukraine (consumer) (n.d)

Model calculations show that the introduction of excise duty on junk food will lead to a decrease in the consumption of confectionery products by ≈16%, semi-finished products by ≈14%, spreads and sweeteners by ≈12%. The largest tax revenues are expected from confectionery products (≈UAH 13 billion), with total revenues amounting to ≈UAH 23.8 billion per year. The results demonstrate the effectiveness of excise regulation in simultaneously reducing the consumption of products with low nutritional value and filling the budget.

The funds obtained can be used to subsidise healthy foods (vegetables, fish, milk), educational programmes on nutrition, and medical infrastructure. The final modelling indicators in Table 4 reflect the expected reduction in demand and the amount of fiscal revenue as a result of the introduction of excise duties on certain categories of harmful products. At the same time, for a better understanding of the comparative effectiveness of the tax in different product groups, it is advisable to present the results in graphical form (Fig. 3).

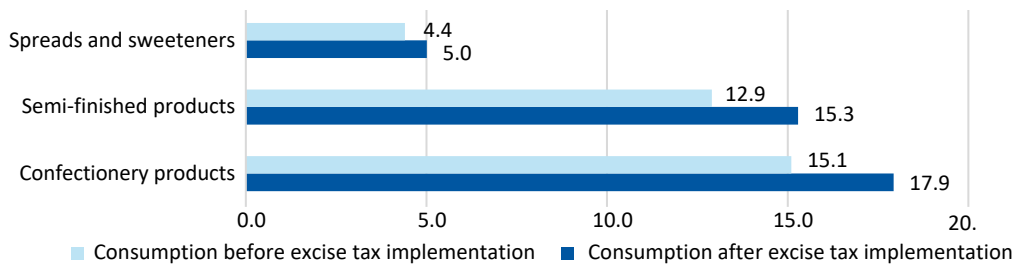


Figure 3. Modelling changes in junk food consumption following the introduction of excise duty in Ukraine, kg per person per year

Source: calculated and constructed by the author based on the results of own research

Figure 3 shows the decrease in individual consumption of unhealthy foods (in kilograms per person per year) in the three product categories studied – confectionery, semi-finished products and spreads/sweeteners – under the influence of the proposed excise tax. This graphical interpretation allows to visually assess the scale of expected changes in consumer behaviour and compare the sensitivity of demand in different market

segments to fiscal intervention. In particular, it can be seen that the largest reduction in consumption in absolute terms is expected in the confectionery category, which is consistent with both the level of initial consumption and the elasticity of demand. Thus, Figure 3 complements Table 4 by providing a structured visual assessment of the effectiveness of excise regulation in terms of its impact on the volume of harmful food consumption.

It can be concluded that the introduction of food excise taxes on “junk food” is a well-founded and tested approach that could become a powerful tool of public policy in Ukraine. It combines changing consumer habits, improving public health, and filling the budget during the difficult times of war. In this context, the construction of an economic-mathematical model of the impact of excise taxation on demand in

the unhealthy food segment made it possible not only to assess the potential fiscal and social effects (decrease in sales, increase in budget revenues, change in price elasticity), but also to develop a number of practical recommendations. These recommendations are aimed at both shaping public policy in the food sector and transforming the business strategies of retail and agro-processing enterprises (Table 5).

Table 5. Recommendations based on the results of modelling the impact of excise taxation

Direction	Recommendations
State policy	Use part of excise revenues to subsidise the production of foods with high nutritional value (vegetables, fruits, protein products). Launch information campaigns on healthy eating. Provide tax breaks and credit support to producers of healthy foods.
Business strategies of enterprises	Adjust the product range by reducing the share of unhealthy products and expanding functional and healthy alternatives. Develop new product lines based on local agricultural raw materials. Use nutrition trends as a marketing advantage.

Source: author's own development

Thus, the modelling results showed that excise taxation can serve not only as a tool for regulating consumer practices, but also as a multiplier for the development of entrepreneurship and the agricultural sector. For retailers, this means rethinking their product range policy; for producers, it means adapting to the growing demand for nutrient-rich products; and for the state, it means creating conditions that combine fiscal interests with public health priorities. Within the analysis of the consumer basket and its transformations, the development of functional products that can be an alternative to ultra-processed goods is of particular importance. In particular, L. Kaprelyants *et al.* (2019) explore the potential of functional products in the context of the Ukrainian market. The authors show that expanding the production of functional food products (enriched with nutrients and bioactive components) is advisable given the existing dietary imbalances and consumption trends. They justify the need for technological and regulatory conditions for the development of this segment and emphasise that functional products can be an effective response to the challenges of an unbalanced diet. This is consistent with the approach of this study: excise policy can create an incentive for businesses to switch to the production of functionally enriched products. Thus, tax

regulation can serve as a comprehensive tool, not only reducing the consumption of harmful products, but also promoting the development of healthy alternatives with high nutritional value.

Changes in the structure of the food basket, caused by both regulatory measures (excise policy) and public nutrition trends, have direct consequences for entrepreneurship in the food trade sector. For retailers, the key consequences include: a reduction in the range of ultra-processed goods subject to excise duties; the need to review logistics and contractual relationships with suppliers; and a shift in margins towards products with higher nutritional value (fresh vegetables, dairy and protein products). For food industry enterprises, there are mixed effects. Junk food manufacturers face the risk of declining demand, falling profitability and the need to adapt their product range. At the same time, new market niches are opening up for manufacturers of healthy products: the development of functional products, local fermented products and organic products. The article by P. Hrynko *et al.* (2021) proves that innovative business models in trade are focused not only on technology but also on consumer values, in particular health and food quality. This correlates with consumer basket modelling, as such models are able to take into account the shortage of healthy products

and the excessive consumption of ultra-processed foods. Therefore, the consumer basket should be considered as part of an innovative trade strategy that combines financial interests with the formation of healthy eating habits.

The agricultural sector responds directly to structural changes in demand. Demand for vegetables, legumes, cereals and protein crops is expected to grow, which may encourage agribusinesses to expand the range of crops they grow, revising pricing policies, investing in the production of functional and healthy products based on traditional agricultural enterprises, and integrating nutritional approaches into the processing of agricultural raw materials. Thus, the transformation of the consumer basket has a multiplier effect – from retail chains to primary production, forming a new business ecosystem in the food and agricultural economy.

The results of the study also correlate with the conclusions of Z. Berezvai *et al.* (2024), who analysed the long-term impact of the tax on harmful products in Hungary. The authors concluded that the initial effect of the tax on reducing consumption is offset over time by rising incomes and insufficient awareness of the consequences of excessive consumption. The conclusions of the Hungarian researchers confirm the importance of modelling both short-term and long-term effects in the context of socio-economic transformations, which is also one of the key analytical lines of the author's research. A comparison of the results of the study with the approaches outlined by T. Csákvári *et al.* (2023) demonstrates a common understanding that the effectiveness of tax regulation in the food sector directly depends on the flexibility of pricing policy and the willingness of consumers to change their eating habits. The Hungarian authors argue that a sustained decline in consumption is observed only in the sweet drinks category, while other market segments show partial or temporary adaptation. Both studies emphasise the need to support tax measures with additional instruments of influence, such as supply-side reform and public awareness campaigns.

A similar idea regarding the relationship between tax incentives and producer behaviour can be found in the work of P. Scarborough *et al.* (2020), which analyses the impact of the tax

on sweetened beverages in the United Kingdom. The authors found that under pressure from fiscal constraints, most companies chose to reformulate their products, reducing sugar content to avoid additional burdens. This confirms the importance of including manufacturers as active players in the regulatory model system, which is one of the conceptual foundations of the authors' approach. A broader view of the cultural adaptation of fiscal interventions is provided by the analysis of A. Al Jawaldeh *et al.* (2024), which focuses on the experience of Saudi Arabia and the UAE. The study proves that with the right communication strategy, taxes on harmful products find broad public support, especially if they are accompanied by the targeted use of the collected funds for public health needs. This approach can be adapted to Ukrainian conditions as part of a long-term strategy to reduce social costs for the treatment of food-related diseases.

At the same time, the results obtained in the study by C.M. Dahl *et al.* (2023), which analysed the short-term effect of the tax on saturated fats in Denmark, caution against an overly narrow approach to tax decisions. The researchers found undesirable consequences – a shift in demand to other fatty products or purchases abroad. This confirms the importance of developing a systematic, balanced set of tools that includes monitoring consumer behaviour, demand elasticity and marginal substitution effects. Recent studies show that the effectiveness of tax measures on unhealthy foods largely depends on the broader context of their implementation, including socio-economic conditions, public awareness, and the quality of accompanying policies. A.M. Thow *et al.* (2022), in a comprehensive review of European experience with sweetened beverage taxation, emphasise that the success of such measures is determined not only by the taxation mechanism itself, but also by the transparency of tax revenue use, sustained political support, and effective information campaigns. The authors note that tax interventions integrated into public health financing strategies have a more lasting impact on consumer behaviour and contribute to reducing the consumption of harmful products.

The role of socio-economic and ethnic factors in shaping food behaviour is particularly

emphasised in a systematic review by K. Backholer *et al.* (2020), who investigated the impact of unhealthy food advertising on children. It was found that children of different social status and ethnic origin are exposed to uneven influence of marketing campaigns, which shapes different consumption patterns and risks of obesity. The authors emphasise that it is important for tax and regulatory measures to take these inequalities into account in order to avoid exacerbating them and to ensure fair access to healthy food, especially for vulnerable groups of the population. A significant document summarising the factors for implementing tax policy in the field of healthy eating is the review World Health Organization (2021). It emphasises that the success of fiscal measures depends on adaptation to the local context, the inclusion of budgetary support instruments and regular monitoring of results. It is important to integrate tax measures into comprehensive public health strategies that combine educational campaigns, advertising regulation and support for the production of healthy products. Such a systematic approach ensures maximum positive impact on the eating habits of the population and contributes to a sustainable reduction in social costs associated with diseases caused by poor nutrition. Thus, the results of the study are confirmed by numerous international studies that reveal the multifaceted nature of the impact of fiscal regulation on the food market. This gives grounds to assert the relevance of the proposed models and the advisability of their further testing in Ukrainian conditions, with the possibility of localising the best international practices.

CONCLUSIONS

The study provides grounds for asserting that, under current conditions, the retail trade in food products in Ukraine exhibits significant structural imbalances, characterised by an increase in the consumption of products of low nutritional value, so-called junk food, against the backdrop of a shortage of nutritionally valuable goods. An assessment of the structure of food consumption worldwide (2018-2024) reveals critical imbalances between actual diets and recommended norms, with particular attention to the growth in junk food consumption,

which exceeds the norm by more than 38 kg per person per year. Ukraine also has a significant shortage of nutrient-rich products – in 2024, consumption of products with high nutritional value will be only 1073 kg per person, compared to the norm of 295 kg, while junk food consumption remains consistently high and is growing. These data highlight the need to adapt the commercial offer and shape healthy eating habits among consumers. The results of the study demonstrated systemic deviations from nutritionally sound norms both globally and in Ukraine, with junk food dominating and a shortage of foods with high nutritional value. This determines the priorities for health policy and retail development.

According to the study, the developed economic-mathematical model of the impact of excise taxation on the consumption of low-nutritional-value foods demonstrates the ability to predict a decrease in demand for junk food within the range of 12-16%, depending on the product category and price elasticity of demand. The model allows for the assessment of both changes in consumption volumes and potential additional tax revenues, which on average could amount to approximately 23.8 billion hryvnia per year. The results obtained demonstrate the effectiveness of excise regulation as a public policy tool that can simultaneously contribute to reducing harmful food consumption, improving public health and filling the budget. At the same time, the proposed model provides flexibility for adjusting tax rates to take into account social goals and market characteristics, which is important in the context of forming a balanced and sustainable trade offer in Ukraine.

An analysis of other countries' experiences shows the effectiveness of excise taxes in combating excessive consumption of ultra-processed foods and sugary drinks, confirming the feasibility of introducing similar fiscal instruments in Ukraine. The proposed model approach allows not only to assess quantitative changes in demand, but also to form scientifically based recommendations for state policy aimed at transforming the trade offer towards improving the quality of nutrition of the population. The results of the study show that changing the structure of consumer demand is of strategic

importance not only for public health, but also for the development of entrepreneurship. For retailers and food companies, this means the need to adapt their assortment policy and logistics solutions, and for junk food producers, it means the risk of losing market share. On the other hand, agricultural enterprises gain new opportunities related to the growing demand for vegetables, grains, protein crops, and products with high nutritional value. This determines the need to integrate nutritional guidelines into the development strategies of agricultural and food businesses. Further research prospects include assessing e-commerce in food products in Ukraine and worldwide, which opens up new opportunities for introducing healthy

eating practices and influencing consumption patterns through digital sales channels. It is also advisable to develop a model that takes into account the socio-demographic differentiation of consumers, regional characteristics, and a comprehensive combination of fiscal and non-fiscal instruments to promote healthy eating.

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Моделювання споживчого кошика в роздрібній торгівлі харчовими товарами з урахуванням нутріціологічних критеріїв

Анотація. Сучасні глобальні виклики у сфері харчування, зокрема дефіцит нутрієнтно цінних продуктів і зростання споживання ультрапереробленої їжі, формують серйозні ризики для здоров'я населення та потребують перегляду структури споживчого кошика. Метою статті було моделювання впливу акцизного оподаткування на структуру реалізованих у роздрібній торгівлі харчових товарів з урахуванням нутріціологічних критеріїв. Для досягнення поставленої мети використано методи економіко-математичного моделювання, аналізу еластичності попиту за ціною, системного підходу та порівняльного аналізу офіційних статистичних даних України й міжнародних джерел. Результати дослідження засвідчили істотне відхилення фактичної структури споживання від рекомендованих норм: надмірне споживання продуктів з високим вмістом цукру, солі та трансжирів поєднується з недостатнім споживанням свіжих овочів, фруктів, молочної продукції та білкових джерел. У 2024 р. в Україні споживання продуктів з високою харчовою цінністю становило лише 36 % від рекомендованого рівня, тоді як молочні продукти й риба виявили найбільший дефіцит. Рослині продукти споживаються на третину менше норми, а обсяги жирів покривають лише половину потреби. Водночас частка сміттєвої їжі перевищує допустимий рівень більш ніж у десять разів і продовжує зростати. Прогноз на 2025-2029 рр. демонструє поступове відновлення обсягів споживання в Україні після шоків війни, однак навіть у довгостроковій перспективі показники не досягнуть рекомендованих рівнів. Економіко-математична модель показала подвійний ефект акцизів на шкідливі харчові товари: зменшення попиту на ультраперероблену їжу та зростання бюджетних надходжень для програм здорового харчування. Моделювання довело, що навіть помірне підвищення цін стимулює заміну таких продуктів кориснішими альтернативами. Запропонований підхід дає змогу кількісно оцінити ефекти регулювання й визначити баланс між фіскальними інтересами та охороною здоров'я. Практичне значення дослідження полягає у можливості використання результатів для обґрунтування державної політики у сфері регулювання ринку харчових товарів, спрямованої на формування здорових харчових звичок населення

Ключові слова: харчові уподобання споживачів; формат реалізації продуктів; акцизний податок; дієтологічна якість раціону; сміттєва їжа; економіко-математичне моделювання



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Financial and economic support for the implementation of resource-saving practices in the agricultural sector

Abstract. The purpose of this study was to identify effective financial and economic instruments for the implementation of resource-saving technologies in Ukrainian agriculture in the context of rising energy costs, climate change, and military challenges. The study analysed the regulatory framework, state, and international support instruments, as well as the dynamics of investment flows and the implementation of environmental practices in the agricultural sector. The study found that despite a decline in investment in 2024 to UAH 42.89 billion, the agricultural sector's profitability increased to a record UAH 327 billion and its profitability to 35%. With state support exceeding UAH 7 billion in 2025, over 8,750 agricultural enterprises received soft loans worth UAH 46.9 billion, and about 2,000 received compensation for purchased machinery worth UAH 486 million. Significant emphasis was placed on expanding the area of organic farming (up

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to 550,000 hectares) and digitalising agricultural production. The effectiveness of public-private partnerships was determined, particularly through the attraction of USD 480 million in joint projects of the International Development Finance Corporation, the European Bank for Reconstruction and Development, and the role of the Digital Restoration Ecosystem for Accountable Management digital platform for accountable management, in the implementation of over 8,600 projects worth more than UAH 572 million. There is a growing interest in biogas complexes, precision agriculture, and digital platforms, including those involving Myronivskiy Khliboprodukt, Astarta, and Kernel. The study suggested ways to improve support through tax and credit incentives, public-private partnerships, and digital solutions. The practical significance of this study lies in the possibility of using its findings to develop targeted support programmes for the agricultural sector

Keywords: lending; investment; climate; agriculture; precision agriculture

INTRODUCTION

The need to transform agricultural production in the face of limited resources, high costs, and climate change requires the introduction of innovative technologies with a strong level of resource efficiency. At the same time, the spread of such practices is constrained by insufficient funding, limited access to investment, and imperfect incentive mechanisms. In these circumstances, it is of particular relevance to develop effective financial and economic approaches that can ensure sustainable modernisation of the agricultural sector, improve its environmental and food sustainability, increase private capital participation, strengthen institutional support, and account for the needs of different categories of producers. Insufficiently effective financial incentives for the adoption of environmentally friendly technologies in agriculture continue to be a key barrier to greening production. V. Holian *et al.* (2024) covered this subject, finding that accelerating the implementation of resource-saving practices is possible only if an effective financial and economic toolkit is developed that focuses on investment support for environmental infrastructure and innovative agricultural technologies.

The lack of economic levers that encourage agricultural producers to use natural resources sustainably complicates the implementation of resource-saving approaches in agriculture. This aspect was studied by V. Halanets & A. Kolodiy (2025), who determined that the effective implementation of environmentally oriented agricultural policy depends on the ability of the state to create a favourable financial and institutional environment, including investment

support, subsidy mechanisms, and incentives for the transition to organic production. Their conclusions emphasise the significance of adapting European practices to the national context and the role of local governments in implementing such initiatives. The insufficient level of economic efficiency of resource use in rural production necessitates the search for innovative approaches to optimising financial support. This area was studied by V. Kovalenko *et al.* (2023), who emphasised the significance of adapting investment strategies to the needs of agricultural production, particularly through improved financial planning and state support mechanisms. The researchers proved that effective resource provision is possible if innovative financial instruments are combined with a strategic management system at enterprises.

The complexity of providing agricultural producers with financial resources hinders the renewal of production processes and the introduction of resource-saving solutions. This issue was investigated by N. Hryshchuk (2021), who focused on the impact of state support, bank lending, and investment policy on the development of agricultural production. The researcher identified the need to create favourable conditions for attracting external and internal sources of financing, emphasising the value of affordable credit and guarantee mechanisms. The limited impact of existing financial instruments on the intensification of resource-saving practices in rural production indicates the need to rethink approaches to supporting the agricultural sector. H. Kryshchal *et al.* (2025) analysed the current state of financial support for

agricultural enterprises and emphasised the significance of focusing investment policy on innovative environmental technologies, as well as the need to develop effective interaction between government agencies, banking institutions, and agricultural producers. The researchers focused on the need to improve state regulation and institutional support.

The instability of the economic environment and external challenges limit the access of agricultural businesses to financial resources, which reduces investment activity in the implementation of resource-saving technologies. S. Moshenskyi *et al.* (2023) explored ways to improve the efficiency of agricultural financing under martial law, emphasising the significance of adapting credit and investment policy to new risks and conditions. The researchers substantiated the role of government support programmes, institutional stability, and tax incentives in ensuring the sustainability of the agricultural sector. Restrictions in financial access and inefficient management of investment flows in agriculture reduce the possibility of modernisation and transition to resource efficiency. P. Nesenenko *et al.* (2024) analysed the key factors influencing the development of agricultural production in an unstable economy, focusing on the need to revise state support mechanisms and intensify local investment. The researchers substantiated the expediency of using integrated financial models and adaptive cost management, which can ensure the economic sustainability of enterprises.

Insufficient efficiency in managing financial resources aimed at increasing the sustainability of agriculture hinders the widespread introduction of resource-saving innovations. R. Dimitrov *et al.* (2024) examined approaches to implementing green transformation in agriculture, focusing on the value of a systematic approach to investment support, the introduction of digital technologies, and strengthening the institutional capacity of farms. The researchers showed that the combination of environmental and financial instruments allows creating a new rural economy. At the same time, the existing studies do not sufficiently cover the issue of integrating resource-saving practices with

mechanisms of public financing, tax incentives, and institutional and financial support, do not reveal the specifics of adapting such solutions to the conditions of micro and small enterprises, limited budgets, risky environment and post-crisis challenges, and do not sufficiently analyse the effectiveness of combining financial instruments with motivational mechanisms and opportunities to attract private capital, which requires further research.

The purpose of this study was to substantiate approaches to improving the efficiency of financial and institutional mechanisms that promote the introduction of energy and resource-saving technologies in rural production in the context of economic instability. For this, the following objectives were set: to analyse the current state of financing of agricultural enterprises in terms of introducing innovative eco-technologies; to explore the potential of public-private partnerships and tax instruments in stimulating resource conservation.

MATERIALS AND METHODS

The study was practical in nature and covered the period from 2021 to March 2025. The study analysed the economic nature and classification of resource-saving technologies in agriculture by energy sources, level of application, and types of innovations – mechanical, digital, and bioenergy. To assess the investment activity of the agricultural sector, the level of capital investment for 2021 – early 2025 was analysed (AgroPortal, 2025b). The study also investigated which actions in Ukraine were considered violations of environmental legislation and analysed the possible consequences of such violations (Kurkul, 2025). The study included an analysis of the dynamics of certified organic land areas in 2021-2024, which helped to track changes in the implementation of environmentally friendly farming.

The study defined the basis for regulatory support for the implementation of resource-saving practices. Specifically, the Constitution of Ukraine (1996), the Law of Ukraine No. 1264-XII (1991), the Law of Ukraine No. 962-IV (2003), the Law of Ukraine No. 2496-VIII (2018), as well as the Strategy for the Development of Agriculture and Rural Areas for 2025-2027 (Order of the

Cabinet of Ministers of Ukraine No. 1163-2024-p, 2024) were analysed. This was done to define the legal framework that would regulate the implementation of resource-saving practices in agriculture, ensure their compliance with environmental standards, and create institutional conditions for the effective use of financial and economic support instruments. The levels of state support in 2024 were determined (Gontagro, 2025), particularly based on data from the State Agrarian Register (n.d.). The analysis covered such programmes as “Financial Support for the Development of Farms” (Resolution of the Cabinet of Ministers of Ukraine No. 384-2021-p, 2021), “Provision of Partial Compensation for the Cost of Agricultural Machinery and Equipment” (Ministry of Economy, Environment and Agriculture of Ukraine, 2024), “Support for Organic Producers” (SSUFSCP, 2022), and the Unified State Register of Entities Receiving State Support (State Tax Service of Ukraine, 2023).

In the context of international cooperation, the study analysed how the state cooperated with the World Bank (Ukraine Plan 2024-2027, n.d.), the Food and Agriculture Organisation of the United Nations (n.d.), the United Nations Environment Programme (n.d.), and the United States Agency for International Development (n.d.). The empirical part of the study analysed the sources of funding for resource-saving solutions, including investments by leading Ukrainian agricultural holdings – MHP (n.d.), Kernel (n.d.), Astarta-Kyiv (n.d.), Agro-Region (n.d.), Agroprosperis (n.d.) – in the implementation of biogas plants, digital platforms, and energy-efficient equipment. This data was collected and systematised based on open sources and industry analytical reports (AgroPortal, 2024a; Latifundist Media, 2024; Shevchenko, 2025). Regional differences in the structure and specifics of small and medium-sized agricultural producers were also identified (Strategy for the development of agriculture..., 2024), which helped to identify the specific features of financial support for agricultural production in different parts of the country. Statistical data for 2021-2025 were analysed, which provided a basis for substantiating financial and economic processes in the agricultural sector of Ukraine. The sources of information were the official data of the Ministry of Finance

of Ukraine (2025), as well as sectoral analytical reviews, including reports on state support and tax revenues (Skilky-skilky, 2023; AgroPortal, 2025c). The following evaluation criteria were employed in the study: total investment (UAH billion), level of state support (UAH billion), tax revenues (UAH billion), net profit of enterprises (UAH billion), and profitability (%). This helped to quantify the dynamics of key financial indicators and compare the effectiveness of various forms of support and investment in the agricultural sector. At the final stage of the study, the study outlined areas for strengthening financial and economic instruments for the implementation of resource-saving practices, as well as prospects for the development of public-private partnerships (SuperAgronom, 2025), which were examined considering the practices of the Digital Restoration Ecosystem for Accountable Management (DREAM, n.d.).

RESULTS AND DISCUSSION

Theoretical and methodological foundations of financial and economic incentives for resource conservation in agricultural production

In the context of transformation processes in the agricultural sector of Ukraine, the key factor in ensuring the sustainability of production is the introduction of resource-saving technologies. Their economic essence is to reduce production costs through more efficient use of natural, energy, financial, and labour resources, which contributes to the productivity and competitiveness of agricultural enterprises. The key categories of such technologies include energy-saving (use of bioenergy solutions, solar panels), water-saving (drip irrigation, water-retaining soil treatments), precision farming technologies (Global Positioning System (GPS) navigation, sensor systems, remote monitoring), as well as models of minimal or zero tillage (No-till, Strip-till) (Dejanovic *et al.*, 2023).

The relevance of introducing such technologies is confirmed by capital investment statistics. In 2021, about UAH 68 billion was invested in Ukraine's agricultural sector, which amounted to approximately USD 2.5 billion – the most successful year before the war. In 2022, due to economic instability and military risks, the volume of capital investments decreased to

UAH 49.6 billion, which is 27% less than in 2021. However, over 82% of these funds were used to upgrade the technical base and implement resource-saving solutions. In 2023, the investment rate partially recovered, reaching UAH 63.8 billion (AgroPortal, 2025b). In 2024, the overall level of investment was at around USD 100 per hectare of agricultural land, which is still one of the lowest in Europe (AgroPortal, 2025a). Specifically, investments in agricultural machinery are reduced by 39%, the need for tractor capacity is reduced by 75%, labour costs by 80%, and fuel consumption by 84%. No-till technology can save up to 60 litres of diesel per hectare by reducing the number of mechanised operations, including sowing (5-6 L/ha), spraying (4 L/ha), and fertilising (2 L/ha) (WEAGRO, 2024).

Precision agriculture plays a special role, enabling an increase in yields by 15-30%, saving up to 30% of fertilisers and plant protection products, and up to 20% of seeds. For example, the HarvEast agricultural holding (n.d.) managed to increase the yield of moisture-sensitive crops by 15-25% in the southern regions of the country, while the Continental Farmers Group (n.d.) reduced production costs by 15% through the introduction of GPS navigation and differentiated input application (WEAGRO, 2024). Since 2019, precision farming elements have been applied on 20-30% of the cultivated area in Ukraine (approximately 8 million hectares), while in large agricultural holdings – up to 50%. Digital resource accounting tools are widely used: GPS monitoring, sensors, Business Automation Software (BAS), Agro Accounting, and Enterprise Resource Planning (ERP) solutions that automate management processes (SuperAgronom, 2019).

In Ukraine, violations of environmental legislation in agriculture are subject to various forms of liability, ranging from administrative fines to criminal prosecution, depending on the nature and severity of the violations. One of the most widespread environmental offences in the agricultural sector is the burning of dry vegetation. Such actions are subject to fines: for individuals – UAH 3,060-6,120, for legal entities – UAH 15,300-21,420. If the arson caused the death of people or animals, or led to significant environmental consequences, criminal liability is stipulated – up to 10 years in prison. Un-

der martial law, such actions may be classified as sabotage (Kurkul, 2025). Furthermore, fines are imposed for late or intentional non-payment of environmental tax. In case of a delay of up to 30 days, a fine of 5% of the amount owed is imposed, over 30 days – 10%, and in case of proven intent – up to 25% of the unpaid amount (Onyshchenko, 2025). There are fines for violations of water protection legislation, including for illegal discharges of pollutants into water bodies: individuals can pay up to 100-200 tax-free minimums, and officials – up to 200 minimums (Government Portal, 2025c). Additionally, unauthorised collection of birch sap in rural areas is subject to fines ranging from UAH 850 to UAH 1,700 (Teryukhanova, 2025). The combination of environmental violations typical of the agricultural sector – excessive use of chemicals, soil degradation, water pollution, and uncontrolled burning – creates critical risks to the environment, public health, and biodiversity. In this regard, there is a tendency to strengthen government control and increase the amount of fines.

Against this backdrop, Ukraine continues to gradually expand the environmental segment of agricultural production. In 2023-2024, the area of certified organic land amounted to 470-550 thousand hectares, which is about 1.5-2% of all agricultural land (approximately 30 million hectares). For comparison, the average share of certified organic land in the European Union (EU) was 9-10% of the total area of their agricultural land (Organic, 2025). Despite the war, Ukraine's organic sector is showing a gradual recovery, especially in the cultivation of grains, soybeans, oilseeds, berries, and vegetables. The government is actively promoting the transition of the agricultural sector to sustainable production. As of the beginning of 2025, the total amount of budget support for agriculture exceeded UAH 5 billion (11% more than in 2024). A significant part of these funds is allocated for environmental modernisation: the introduction of resource-saving technologies, support for organic farming, digitalisation of production, and development of alternative energy sources.

Separately, the state compensates up to 25% of the cost of energy-efficient equipment (UAH 800 million in 2025) and provides grants of up to UAH 1 million for digital technologies

(drones, precision farming systems, software) – over 300 farms have already received such support in 2024 (Gontagro, 2025). International donors, including the World Bank, have provided USD 500 million to restore the agricultural sector, part of which is also directed to environmental projects (Ukraine Plan 2024-2027, n.d.). The State Agrarian Register (SAR) plays a significant role in the financial support of agroecologisation, providing subsidies of UAH 3,100 per hectare in 2024-2025 for farmers with land up to 120 hectares (maximum UAH 372,000 per farm) (State Agrarian Register, n.d.). Thus, increased environmental control, expanded penalties, a growing number of organic producers, and increased financial support form a systemic environment for the environmental modernisation of Ukraine's agricultural sector.

The mechanisms of state regulation of sustainable agricultural production in Ukraine are formed based on a combination of legal, economic, institutional, and financial instruments aimed at ensuring environmentally safe and resource-efficient agricultural development. The basis of the regulatory framework for resource-saving agricultural production in Ukraine is the Constitution of Ukraine (1996), which mandates the right of citizens to a safe environment. The Law of Ukraine No. 1264-XII (1991) defines the general principles of state environmental policy, resource protection, and environmental safety. The Law of Ukraine No. 962-IV (2003) sets out requirements for soil conservation, prevention of soil degradation and erosion, which is critical in the context of climate change. The Law of Ukraine No. 2496-VIII (2018) creates a legal framework for the development of the organic sector, which is a component of the ecological transformation of the agricultural sector. The state strategy in this area is set out in the Order of the Cabinet of Ministers of Ukraine No. 1163-2024-p (2024), which identifies key priorities, such as soil protection, adaptation to climate change, development of small farms, and support for organic farming. Financial and economic support mechanisms are implemented through a series of government programmes. The programme "Financial support for the development of farms" (Resolution of the Cabinet of

Ministers of Ukraine No. 384-2021-p, 2021) provides subsidies and soft loans: farmers receive a subsidy per ha of cultivated land (especially newly established farms – up to UAH 60 per ha) and a special subsidy for keeping cows (up to UAH 100 per head), as well as access to compensation for cheap loans (the total budget of the programme is over UAH 200 million) (Review of state support in the agribusiness..., 2021). The programme "Provision of partial compensation for the cost of agricultural machinery and equipment" (Ministry of Economy, Environment and Agriculture of Ukraine, 2024) is aimed at updating the farmers' production park: 15% of the cost of Ukrainian machinery and equipment is compensated, with localisation of over 60%, which helps to support Ukrainian producers and energy efficiency. There is a separate programme called Support for Organic Producers (SSUFSCP, 2022), which provides partial reimbursement of the costs of certification and implementation of organic practices, with compensation reaching 80-100% of the cost of certification for farms that meet the organic criteria.

At the international level, Ukraine actively cooperates with leading organisations in the field of agriculture and the environment. Specifically, the Food and Agriculture Organisation of the United Nations (n.d.) is implementing the Emergency and Early Recovery Response Plan for 2025-2026 with a budget of USD 150 million, which provides support to more than 500,000 residents of rural communities through the provision of agricultural inputs, aid in land rehabilitation, and the development of market infrastructure. Additionally, under the EU-supported investment grant programme, USD 2.8 million has been allocated for 237 farms in the Carpathian region since 2023 for energy-saving solutions, equipment, and training (Food and Agriculture Organisation of the United Nations, 2024). The United Nations Environment Programme (n.d.) provides advisory and methodological support for the implementation of ecological farming practices and the reduction of harmful emissions in agricultural production. Since 2022, the United States Agency for International Development (n.d.) has over USD 350 million to provide farmers with seeds, fertilisers, storage services, and financing, of which about USD 49.8 million

has been allocated as so-called bridge financing. In 2023, in cooperation with Bayer, an additional USD 15.5 million was raised for digital agricultural solutions and educational programmes (Bayer United States, 2023). Another valuable partner is the European Bank for Reconstruction and Development (Ministry of Finance of Ukraine, n.d.), which in 2023, together with the Clean Technology Fund, provided USD 30 million to Astarta-Kyiv Holding (n.d.) for projects in the field of energy efficiency, implementation of Environmental, Social and Governance (ESG) solutions, and modernisation of agricultural production (Astarta-Kyiv, 2023). Overall, such cooperation allows combining state support instruments with financial resources from international donors and private investors, ensuring the sustainable development of Ukrainian agriculture even under martial law. A special place is occupied by Ukraine's participation in the European Green Deal, which is focused on deep decarbonisation, reducing the environmental impact of the agricultural sector, and supporting sustainable production practices. Together, these documents and programmes form a comprehensive regulatory and institutional framework for the implementation of resource-saving technologies in Ukrainian agriculture.

M. Sanyaolu & A. Sadowski (2024) considered precision agriculture as a tool for cost optimisation and efficiency improvement, with a focus on economic feasibility for large farms. The Net Present Value (NPV) calculations showed that the technology is only profitable at revenues above EUR 100,000. The present study focused on supporting the adoption of resource-saving solutions through government programmes, tax incentives, and environmental regulations. While M. Sanyaolu & A. Sadowski used a predominantly financial and analytical approach, the present study also covered institutional and legal aspects. The approach proposed by G. Timpanaro & V.T. Foti (2024) was based on the concept of agroecology and the participation of local communities in building sustainable rural areas. The focus was on small farmers, cooperatives, and the circular economy. This was different from the structure of this study, where the drivers of change were public investment and external partners. Thus, the Italian study proposed

a bottom-up socio-ecological approach, while the present study proposed a top-down macro-economic model of support. G. Betti *et al.* (2025) discussed the consequences of the war in Ukraine for the EU agricultural market. The Agricultural Member State Modelling (AGMEMOD) model helped to estimate the dynamics of production, prices, and trade as a result of external influences. At the same time, the present study considered concrete tools for responding to the crisis within the country, such as financing, modernisation, and legislative support. As a result, the studies do not duplicate each other but expand the understanding of the impact of military events on the agricultural sector: one through an international model, the other through an example of national recovery.

This approach contrasts significantly with the Ukrainian context, where the focus has been on large-scale government stimulus and modernisation of large enterprises. Although the goal of strengthening resilience was common to all the studies, the ways to achieve it demonstrated opposite models: decentralised social versus centralised institutional. Overall, in the context of the transformation of Ukraine's agricultural sector, the present study showed that resource-saving technologies play a crucial role in strengthening its sustainability and competitiveness. Despite the challenges posed by the war and economic instability, the government has consistently implemented financial, legislative, and organisational mechanisms to support environmental modernisation.

Assessment of financial capabilities and investment activity in the agricultural sector of Ukraine

In 2025, over UAH 6 billion was allocated from the state budget for the agricultural sector, including UAH 1 billion for the development of livestock and agro-processing; UAH 4.726 billion for subsidies per hectare and livestock; UAH 200 million for land reclamation; UAH 1.37 billion for grants for gardens and greenhouses; and UAH 1 billion for the demining of agricultural land (Government Portal, 2024b). The programme to support small and medium-sized farms under the Emergency Project for Inclusive Assistance for the Recovery of

Ukraine's Agricultural Sector (ARISE) (ARISE project, n.d.) provided compensation per hectare of land, with 4,139 farmers receiving subsidies worth UAH 316.9 million in 2025. Another 1,421 recipients received UAH 44.8 million for cattle (Stepanenko, 2025). Within the framework of the programme to compensate 25% of the cost of machinery in 2023-2025, thousands of agricultural producers purchased over 8,000 units of Ukrainian machinery. In 2025 alone, as of April, more than 2,000 farmers received compensation worth almost UAH 486 million (Debet-Kredyt, 2025). At the same time, the programme "Affordable Loans 5-7-9%" (PrivatBank, n.d.) was active, with more than 17,000 loans worth UAH 58.3 billion issued

in 2023-2025, of which more than 12,000 were to agricultural enterprises. In 2024, 8,750 farms took advantage of the loans, and in 2025, 3,965 farms did so (Government Portal, 2025a). At the same time, a special place in the financing structure is occupied by enterprises' own funds, which are often used to implement large-scale infrastructure and energy efficiency projects. The largest agricultural holdings such as Myronivsky Hliboproduct (MHP, n.d.), Kernel (n.d.), Astarta-Kyiv (n.d.), Agro-Region (n.d.), Agroprosperis (n.d.) are actively investing in biogas complexes, cogeneration plants, solar power plants, and digital precision farming systems. Table 1 presents the estimated amounts of investments and key areas of innovation in these companies.

Table 1. Investments of Ukraine's leading agricultural holdings in resource-saving and energy-efficient solutions in 2023-2025

Agricultural holding	Amount of investments	Key energy efficiency and innovation projects
MHP	USD 20 million + additional investments	12 MW biogas complex, 20 MW cogeneration plant
Kernel	USD 150 million (loans + investments from FMO)	20 MW cogeneration plant, DigitalAgriBusiness
Agro-Region	USD 12 million per year	Energy independence, expansion of machinery fleet, wagons
Agroprosperis	Not specified	800 MW solar power plant, drones for plant protection products
Astarta	~ USD 80 million	Deep soybean processing plant, electricity, and gas supply systems

Source: compiled by the authors of this study based on AgroPortal (2024a), Latifundist Media (2024), A. Shevchenko (2025)

These examples demonstrate the prominent level of private capital involvement in the development of energy efficient agricultural production in Ukraine. Specifically, MHP agricultural holding invested over USD 20 million in the 12 MW Biogas Ladyzhyn biogas complex (The world's largest biogas complex was..., 2019), which processes more than 300 tonnes of chicken manure per day, provides up to 40% of the company's energy consumption and reduces CO₂ emissions by 100 thousand tonnes annually (MHP. The example of Ukrainian..., n.d.). Kernel has implemented a 20 MW biomass cogeneration project that allows it to simultaneously generate heat and electricity for its own production. Agro-Region annually invests about USD 12 million in expanding its machinery fleet,

upgrading its logistics facilities, and taking steps to ensure energy independence. Agroprosperis is building an 800 MW solar power plant and introducing agrodrones for plant protection products, which reduces resource consumption and increases the accuracy of agricultural operations. Astarta has invested about USD 80 million in a deep soybean processing plant and energy infrastructure upgrades, as well as introduced the AgriChain digital platform and certified its energy management according to the International Organisation for Standardisation (ISO) 50001 standard (Liga Zakon, 2025a). Taken together, these initiatives demonstrate the reorientation of large agricultural enterprises towards a sustainable production model with a focus on renewable energy, digital

solutions, and reducing environmental impact. Most investments are aimed not only at reducing resource consumption but also at ensuring energy independence of farms, introducing precision farming, digitalising management, and expanding processing capacity. Combined with government support and international technical assistance, these sources form a multi-component financial model for implementing resource-saving solutions in agriculture.

Regional differences in the structure and specifics of small and medium-sized agricultural producers in Ukraine continue to be a key factor in the development of effective state support for the agricultural sector. In 2024-2025, about 94% of enterprises in the agricultural sector are small, 5.8% are medium-sized, and less than 1% are large enterprises. The number of medium-sized agricultural enterprises is estimated at around 2,900, while the number of large enterprises is only 27. The geographical structure of agribusiness shows a clear concentration of large and medium-sized producers in strong agricultural regions such as Poltava, Dnipro, Odesa, Vinnytsia, and Lviv regions. In less agriculturally oriented regions, small farms predominate, due to natural and climatic features, resource constraints, and the level of infrastructure development (Strategy for the development of agriculture..., 2024). In terms of cultivated land, most small enterprises operate on plots of 20-50 hectares, while medium-sized enterprises cultivate between 50 and 250 hectares. In the western and mountainous regions, the share of small farms with small areas is dominant, while in the steppe regions there is a greater concentration of medium-sized farms. Large agroholdings operate on areas of more than 1,000 hectares, but they make up a small proportion of the total number of farms. In terms of production figures, according to some estimates, as of 2015, small and medium-sized farms accounted for about 83% of total marketable agricultural output, of which medium-sized farms accounted for 51% and small farms for 32.3%. Large enterprises accounted for only 16.7%. In 2023, the growth in production of grains and oilseeds was partly driven by small and medium-sized farms. Specifically, regions with active production of vegetables, fruits, and berries – Vinnytsia,

Chernivtsi, Khmelnytskyi, Dnipro, Lviv, and Poltava regions – demonstrate a strong level of participation of small producers (The agricultural sector of Ukraine in 2023..., 2024).

The specifics of financing also have regional differences. In 2025, the Ukrainian government has allocated more than UAH 4.7 billion in subsidies per hectare, primarily targeting small and medium-sized enterprises. Specifically, farms cultivating between 1 and 120 hectares are eligible for UAH 4 thousand per hectare. The most active applications were recorded in Vinnytsia, Poltava, Odesa, Dnipro, and Lviv regions. For example, in Vinnytsia region, over UAH 475 million has already been received in 2025 to support cultivated land, which indicates that hundreds of farms are actively involved in aid programmes (AgroPortal, 2024b). At the same time, regions directly affected by the hostilities, such as Donetsk, Kharkiv, Zaporizhzhia, and Kherson regions, have lost a considerable number of small and medium-sized agricultural enterprises. The total number of lost agricultural enterprises as of 2024 is estimated at 1,261. In these regions, a sizeable number of farmers have suspended operations or been forced to relocate. In 2025, the state budget allocates UAH 1 billion for the demining of agricultural land, which allows resuming activities in the de-occupied territories (SuperAgronom, 2025).

In terms of exports, small and medium-sized farmers play a significant role, particularly in the context of global food security. Although there is no precise data on the share of exports by region, activity is observed in the central, southern, and western regions. Cooperation between farmers helps to improve export chains, which is a key factor in accessing foreign markets. Of particular note is the development of organic production in the western regions, which are leaders in terms of the number of organic farms, although official sales volumes are not yet detailed (Liga Zakon, 2025b). Overall, the regional structure of the agricultural sector in Ukraine clearly demonstrates the predominance of small and medium-sized producers, which not only form the basis of national production but also ensure the flexibility and adaptability of the agricultural system in challenging socio-economic conditions.

In 2021-2025, investment activity, tax burden, state support, and profitability of agricultural enterprises in Ukraine underwent substantial changes, reflecting the transformation of the financial and economic environment in the wake of war and recovery. In 2021, agriculture, forestry, and fisheries received UAH 51.44 billion in capital investments (12.6% of the total economy), of which over UAH 49.6 billion was in agriculture, hunting, and related services. This was the basis for record profitability: the net profit of agricultural enterprises reached UAH 238.8 billion, with a profitability of 36.4%, and the most profitable areas were the cultivation of grains, pulses, and oilseeds (44%), and livestock (12.7%). In 2022, investments stayed at the level of the previous year, but real investment activity decreased by 26.1% due to military risks. The agricultural sector's net profit decreased to UAH 87.1 billion, and the share of loss-making enterprises increased to 21.6%. Despite this, the sector remained profitable, with operating margins exceeding 20%, indicating that its internal potential was maintained (Skilky-skilky, 2023).

The year 2023 was marked by a recovery: investment increased to UAH 63.8 billion (USD 1.7 billion), and profits rose to UAH 65.8 billion. At the same time, the tax burden on farmers included income tax (18%), unified social contribution (USC) (22%), military duty (5%), and land tax. The establishment of limits for individual entrepreneurs affected the taxation structure of small agribusinesses. In 2024, investments decreased to UAH 42.89 billion (8% of total capital investments), due to increased security risks and tighter budget discipline. Still, the agricultural sector's profits rose sharply to UAH 327 billion, five times greater than in 2023. The sector's revenues reached UAH 2.4 trillion,

driven by a shift in exports, high grain prices, and the development of processing. The agricultural sector became the largest excise taxpayer: UAH 85.9 billion (81.7% of the total). This confirmed its leading role in filling the budget (AgroPortal, 2025c).

In 2025 (as of May), the trend of high fiscal activity continued: in the first four months of the year alone, the budget received UAH 1.266 trillion, of which UAH 105 billion was income tax, UAH 146.5 billion was personal income tax (PIT) and military duty, and UAH 35.9 billion was excise tax. The Ministry of Agrarian Policy estimates that the agricultural sector will pay an additional UAH 5.2 billion to the budget due to an increase in the military tax rate to 5% and changes in the criteria for critical enterprises. The total amount of state support in 2025 will exceed UAH 7 billion. The financial forecast for 2025 envisages a 3% increase in production and a further recovery in profitability, while maintaining a lower level of gross product than in 2021. The financial analysis also revealed a substantial difference between the types of agricultural enterprises. In 2022, large agricultural companies had revenues that were 15 times greater than those of medium-sized companies and 345 times higher than those of small ones. However, it was small and medium-sized enterprises that demonstrated the best growth dynamics in 2010-2022: +17 and +10 times, respectively (against a three-fold increase in large enterprises). This demonstrates their flexibility and adaptability in a crisis. The greatest profitability rates in all years were observed in grain producers and livestock producers, particularly in dairy farming (27.9%) and pig farming (8.6%) (Ministry of Finance of Ukraine, 2025). Table 2 summarises key economic indicators for 2021-2025.

Table 2. Dynamics of investments, tax revenues, state support, and profitability of agricultural enterprises in Ukraine in 2021-2025

Year	Investments, billion UAH	State support, billion UAH	Taxes (main), billion UAH	Net profit, billion UAH	Profitability, %, UAH
2021	51.44	~6.0	~60.0	238.8	36.4
2022	48.8	~4.5	~53.0	87.1	20.3
2023	63.8	~5.5	~65.0	65.8	~18.0
2024	42.89	~6.5	85.9 (excise tax)	327	~35.0
2025 (o.)	–	>7.0	>105 (profit) + other	projected ↑	projected ↑

Source: compiled by the authors of this study based on Skilky-skilky (2023), Ministry of Finance of Ukraine (2025), AgroPortal (2025c)

A comparative analysis of investment activity shows that the largest investment volumes were in 2021 and 2023, but in 2024, despite the decline in investment, there was a sharp increase in profitability. This confirms that not only the size but also the quality of investment, particularly in precision agriculture, bioenergy, and digitalisation, is crucial. Despite a substantial decline in investment in 2024, agricultural enterprises demonstrated record profitability, reflecting more efficient use of resources and increased productivity. At the same time, the level of state support tended to increase gradually, reaching over UAH 7 billion in 2025, which, together with tax revenues exceeding UAH 105 billion, confirms the stable fiscal role of the sector. Profitability, although fluctuating, almost reached the level of 2021 in 2024, demonstrating the high recovery potential of the agricultural sector even under martial law.

F.J. Castillo-Díaz *et al.* (2025) focused on the relationship between land use and sustainable development in Spain, while the present study analysed the financial and institutional instruments for implementing resource conservation in Ukraine. Despite the different geography and subject matter, both approaches focused on the introduction of innovations such as digitalisation and the bioeconomy, although the barriers were identified differently: environmental in the Spanish case and financial in the Ukrainian. One focused on the analysis of the efficiency of economic systems, while the other focused on the strategy of state support and investment. E.M. García-Granero *et al.* (2025) covered the interaction of EU policies and circular economy principles in the development of sustainable agri-food systems. In comparison, the present study focused on the practical implementation of resource conservation through financial incentives and support programmes. In both cases, the environmental transformation of the agricultural sector was discussed, but while one tended to focus on strategic concepts, the other was more focused on applied tools.

The approach of the Chinese researchers M. Du *et al.* (2025) was aimed at building a comprehensive model for assessing the sustainability of agricultural production based on quantitative analysis and multi-criteria assessment. This study relied on empirical data, financial

mechanisms, and regulatory analysis. The unifying element was the idea of combining economic and environmental factors to achieve sustainable development. While S. Erfanian *et al.* (2024) covered the global context of climate challenges and the impact on food security, this study looked at a narrower one – the national level of support for resource conservation. Both approaches were aimed at increasing the adaptability of the agricultural sector but differed in their methods: S. Erfanian *et al.* used climate modelling, while the present study focused on financing policies. In 2023–2025, a multi-component system of financing resource-saving technologies in the agricultural sector was formed in Ukraine, combining state support, international aid, banking programmes, and private investment. Leading agricultural holdings are actively implementing innovative and energy-efficient solutions, demonstrating a strong interest in increasing energy autonomy and technological development. Government programmes are focused mainly on small and medium-sized farms, which form the backbone of the country's agricultural system and play a vital role in ensuring food security. Thus, the combination of state support and business activity contributes to the sustainable development of the agricultural sector even in the face of crisis challenges.

Areas for strengthening financial and economic instruments for implementing resource-saving practices

Expansion of financial and economic instruments for implementing resource-saving practices in Ukrainian agriculture is a critical element of the state policy of sustainable development. In the context of climate change, rising energy costs, and military challenges, the agricultural sector faces the challenge of efficient resource management, which requires both innovative technologies and flexible financial mechanisms for their implementation. In 2023–2025, the government is introducing mechanisms for concessional lending, grant support, attracting investment through public-private partnerships, and creating digital platforms to coordinate investment flows.

One of the key support instruments was concessional lending to farmers under the government programme “Affordable Loans 5-7-9%”.

The programme allows farmers to receive loans at a reduced interest rate, depending on the purpose and size of the enterprise. In 2023, 10,300 agricultural enterprises received 33 billion in soft loans under this programme (Yur-gazeta, 2023). In 2024, 8,750 enterprises received a total of UAH 46.9 billion, and in

the first half of 2025, 3,965 enterprises attracted UAH 24.4 billion (PrivatBank, n.d.). This data is presented in Table 3, which demonstrates an increase not only in the volume of financing but also in the average loan size per enterprise, which indicates that businesses are focused on modernising their production facilities.

Table 3. Dynamics of the use of concessional loans by agricultural enterprises (5-7-9% programme) in 2023-2025

Year	Number of enterprises	Volume of loans, billion UAH	Average loan amount, million UAH
2023	10,300	33	3.8
2024	8,750	46.9	5.4
2025 (April)	3,965	24.4	6.2

Source: compiled by the authors of this study based on Yur-gazeta (2023), Government Portal (2025b)

As Table 3 demonstrates, there is a clear trend towards a decrease in the number of entities receiving credit support, while the amount of funding and the average size of one loan are growing significantly. This indicates a concentration of resources on supporting capital-intensive projects, particularly those related to the purchase of innovative equipment, modernisation of irrigation infrastructure, and installation of biogas plants. The state programme of partial compensation for the cost of Ukrainian-made agricultural machinery is of particular significance: over 11,900 units from 144 enterprises are included in the register, and the level of compensation is up to 25%. This mechanism supports the localisation of production, reduces farmers' costs, and stimulates the renewal of the technical park (Government Portal, 2024a).

A grant support system operates in parallel with credit instruments. For example, the eRobota programme (eRobota, n.d.) provided more than 1,156 grants totalling more than UAH 5.8 billion in 2022-2024. In 2024, 375 grants worth UAH 1.79 billion were awarded. The grants cover the modernisation of production facilities, purchase of precision farming equipment, development of greenhouse complexes, and installation of energy-saving systems. This helps to encourage small and medium-sized producers to transform their farms environmentally (Financial Club, 2025). A prominent component was the creation of a favourable institutional environment. In 2023, the Ukraine Facility dig-

ital tool (Ukraine Facility in..., n.d.) was launched, a platform that enables transparent tracking of investment and grant flows and evaluation of the effectiveness of implemented projects. This ensures not only control and transparency but also increases the level of trust of international partners in Ukrainian aid recipients. An analysis of the dynamics of investment in agriculture shows that the share of projects related to resource conservation has increased from 8% in 2021 to more than 17% in 2024, reflecting a shift in funding towards greening agricultural production (Ukraine Plan, n.d.).

In the context of the financial and economic transformation of agricultural production in Ukraine, the development of public-private partnerships (PPPs) deserves special attention, as it is increasingly demonstrating its effectiveness as a tool for mobilising investment, reducing financial risks and introducing innovations. In practice, PPPs are implemented by combining government initiatives and resources with private capital and the expertise of international partners. Successful examples of this approach include projects involving the World Bank, the International Finance Corporation (IFC), the United States Agency for International Development (USAID), and the European Bank for Reconstruction and Development (EBRD), which act not only as donors but also as guarantors of the financial stability of investments in the face of macroeconomic instability. In 2023, IFC, in partnership with the EBRD and DFC, provided a

USD 480 million financing package to MHP: specifically, USD 130 million from IFC, USD 100 million from the EBRD and USD 250 million from the U.S. International Development Finance Corporation (DFC), to support production continuity, energy efficiency, and carbon footprint reduction (IFC, EBRD, DFC help bolster Ukrainian..., 2023). Within the framework of the Trade Facilitation Programme, the EBRD is implementing a trade finance mechanism to support the import of agricultural machinery – specifically, in 2024-2025, the bank provided guarantees worth EUR 5 million for the import of tractors and equipment for Ukrainian farmers (Ministry of Finance of Ukraine, n.d.). Such projects demonstrate the effectiveness of attracting international capital to modernise agricultural production, reduce environmental impact, and increase the sector's resilience in wartime. The DREAM digital platform (n.d.) is a tool for transparent management of restoration projects that provides public access to all information about their financing, implementation, and results. It covers more than 8,600 projects with a total budget of over UAH 572 billion and integrates with state registries, the Prozorro system, and Geographic Information System (GIS) solutions, which allows attracting investors through open data and standardised monitoring. The platform is actively used by communities, authorities, and international donors to assess the effectiveness of infrastructure, energy, and agriculture projects. The platform coordinates hundreds of agricultural projects with a focus on energy efficiency, renewable energy sources, and greening of production processes. Specifically, the platform is implementing initiatives to introduce energy-efficient grain dryers, solar photovoltaic systems, and smart irrigation systems, each of which is accompanied by government guarantees or co-funding. This allows attracting foreign private capital, reducing investment risks, and providing flexibility in project financing even in wartime or political uncertainty (The DREAM project management..., 2025).

In the bioenergy sector, the development of partnership models is particularly evident in the implementation of biomethane projects, where state support is combined with private investment in agricultural waste disposal technologies.

The potential of biomethane production in Ukraine is estimated at 21.8 billion m³ per year, and ten new biomethane plants are planned to be launched in 2025 with a total investment of over USD 50 million. This will simultaneously reduce energy dependence on imported gas, reduce greenhouse gas emissions, and promote the circular use of biomass (Investors plan to build..., 2024). An equally significant area is the modernisation of irrigation systems, which is being carried out under the PPP with the involvement of FAO, USAID, and EBRD. Pilot projects are being implemented in the southern regions of Ukraine – specifically, in Dnipro, Mykolaiv, and Odesa regions – to restore irrigation infrastructure, introduce energy-saving pumping stations, and digital water consumption monitoring and management systems. The integration of private technology solutions and international funding has resulted in water savings of up to 25-30% and an increase in crop yields of 15-20% (SuperAgronom, 2025). Thus, public-private partnerships in Ukraine's agricultural sector are gradually turning into a systemic tool for modernisation, adaptation to climate challenges, and expanding access to innovation. Its further development requires institutional strengthening, including the creation of regional grant platforms, guarantee mechanisms for small producers, simplification of procedures for attracting investors, and digitalisation of performance monitoring processes. In the long term, this will contribute to achieving not only economic efficiency, but also environmental sustainability of agricultural production based on green growth.

S. Zhu *et al.* (2024) focused on the impact of green lending on the sustainable development of farms in China. The researchers employed econometric modelling to identify the relationship between the volume of lending and environmental performance. In contrast, the present study focused on the broader system of resource conservation financing in Ukraine, which included both government support and investments by agricultural holdings. X. Zhong & J. Wang (2024) offered a different vision, analysing the institutional conditions for green efficiency in the Chinese agricultural sector. Their approach was quantitative and based on

efficiency calculations, while the present study relied on examples of practical implementation of government programmes and investment models. Thus, both studies emphasised that environmental modernisation cannot be achieved without a regional approach and innovative content. Z. Zhang *et al.* (2025) examined the impact of institutional quality on the effectiveness of green finance in the agricultural sector. The researchers emphasised the role of the regulatory environment and institutional barriers. The present study provided an applied analysis of state support, investments, and programmes for small agricultural enterprises. Despite the differences in methods, both studies demonstrated the need to combine environmental and economic efficiency. Integrative approaches to assessing green progress, such as in D. Li *et al.* (2022), provide a multidimensional picture of the greening of the agricultural sector, covering economic, social, and natural aspects. The current model, on the other hand, was based on an empirical analysis of national programmes that ensured the adaptation of financial instruments to the concrete needs of the sector. This approach proved effective in assessing the applicability of innovations in practice.

K. Sekine (2024) analysed the Japanese practices of structural transformation, particularly in land management and support for farming communities. Against this background, the Ukrainian approach appears more technocratic, with a predominance of financial incentives, institutional partnerships, and support for innovation, while the Japanese model is more focused on long-term social change. T.K. Nath *et al.* (2024) presented a study on the bioeconomy in the Global South. It concerned not so much the financial instruments as the social practices, transdisciplinary approaches, and local community participation. The present study had different optics, focusing on institutional support, tax incentives, and digital tools. Still, there is a significant point of overlap between the studies: both considered environmental modernisation as a comprehensive, multifactorial strategy. The expansion of financial and economic mechanisms to support resource-saving practices in Ukrainian agriculture indicates the development of a systemic approach to the

greening of agricultural production. There is a positive trend in the increase in financing, the average loan size, and the intensification of grant programmes, accompanied by the digitalisation of investment coordination processes. This integrated approach is viewed as a key factor in ensuring the sustainability and competitiveness of the agricultural sector in the face of external challenges.

CONCLUSIONS

In 2023-2025, Ukraine has formed a comprehensive financial and economic model for supporting resource-saving technologies in agriculture, which combines government programmes, international aid, banking instruments, and agricultural enterprises' own investments. Specifically, capital investments in the agricultural sector amounted to UAH 49.6 billion in 2022, UAH 63.8 billion in 2023, and in 2024, investments were kept at around 100 USD/ha, which continues to be one of the lowest in Europe. Over 17,000 loans worth UAH 58.3 billion were disbursed under the government's 5-7-9% programme in 2023-2025, of which over 12,000 loans were to agricultural enterprises. The average loan amount was UAH 3.8 million in 2023, UAH 5.4 million in 2024, and UAH 6.2 million in the first half of 2025. This indicates a re-orientation of funding towards larger, more technically complex projects, such as the introduction of biogas plants, GPS navigation, drones, digital platforms, etc.

The programme to compensate 25% of the cost of agricultural machinery in 2023-2025 covered more than 8,000 units of Ukrainian-made machinery, including more than 2,000 farmers in 2025, worth almost UAH 486 million. At the same time, over 1,156 grants under the eRobota programme totalling UAH 5.8 billion were implemented to modernise farms. In 2025, the state allocated over UAH 6 billion to the agricultural sector, including UAH 4.726 billion in per-hectare subsidies, UAH 1 billion for mine clearance, and UAH 1.37 billion for grants for gardens and greenhouses. The share of resource-saving projects in all investments is increasing – from 8% in 2021 to over 17% in 2024. Private agricultural holdings such as Kernel, MHP, Astarta, Agro-Region, and Agroprosperis have invested hundreds

of millions of dollars in bioenergy, precision farming, and digital solutions. There has also been a gradual increase in organic farming areas – 470-550 thousand hectares, or 1.5-2% of all agricultural land. At the same time, the increase in fines for environmental violations, including up to 25% of the unpaid tax or up to 10 years in prison for intentional arson, demonstrates the consistency of government policy towards environmental responsibility. All this suggests that despite the war and economic instability, Ukraine is systematically creating conditions for the environmental transformation of the agricultural sector: through increased financial support, institutional modernisation, and stimulation of investment activity, especially in the areas of precision agriculture, energy efficiency, and digitalisation of production. A limitation of the present study was that it mainly

covered macroeconomic indicators and the activities of large agricultural enterprises, which complicates the holistic assessment of the effectiveness of financial mechanisms for micro and small farms. Prospects for further research include assessing the impact of financial instruments at the level of individual regions and types of farms, particularly by analysing the effectiveness of support for micro-producers in the combat zone and in the de-occupied territories.

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Фінансово-економічне забезпечення впровадження ресурсозберігаючих практик в аграрному секторі

Анотація. Метою даного дослідження було виявлення ефективних фінансово-економічних інструментів для впровадження ресурсозберігаючих технологій у сільському господарстві України в умовах зростання енергетичних витрат, кліматичних змін та воєнних викликів. У межах дослідження проаналізовано нормативно-правову базу, інструменти державної й міжнародної підтримки, а також динаміку інвестиційних потоків і впровадження екологічних практик в агросекторі. У результаті встановлено, що попри скорочення інвестицій у 2024 році до 42,89 млрд грн, прибутковість агросектору зросла до рекордних 327 млрд грн, а рентабельність – до 35 %. За державної підтримки, яка перевищила 7 млрд грн у 2025 році, понад 8 750 агропідприємств отримали пільгові кредити на суму 46,9 млрд грн, а близько 2 000 отримали компенсацію за придбання техніку на 486 млн грн. Значний акцент було зроблено на розширенні площ органічного землеробства (до 550 тис. га) та цифровізації агропромисловості. Визначено ефективність публічно-приватного партнерства, зокрема через залучення 480 млн доларів США у межах спільних проєктів International Development Finance Corporation, Європейського банку реконструкції та розвитку і International Finance Corporation, а також роль цифрової платформи Digital Restoration Ecosystem for Accountable Management для підзвітного управління, у реалізації понад 8 600 проєктів на суму понад 572 млрд грн. Зафіксовано зростання інтересу до біогазових комплексів, точного землеробства та цифрових платформ – зокрема, за участі Миронівського хлібопродукту, Астарті та Kernel. Запропоновано напрями вдосконалення підтримки через податкові й кредитні стимули, публічно-приватне партнерство та цифрові рішення. Практичне значення дослідження полягає у можливості використання його результатів для розробки цільових програм підтримки аграрного сектору

Ключові слова: кредитування; інвестиції; клімат; сільське господарство; точне землеробство



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State support for business structures in the agricultural sector of Ukraine's economy

Abstract. The relevance of the study is primarily conditioned by the greater uncertainty of business in agriculture compared to other sectors and its leading place in the economic development of Ukraine, the need to strengthen food security, rural development, and environmental protection. The purpose of the study was a comparative assessment of the levels and trends of state support for agricultural entities of Ukraine and EU member states in general, determining the economic

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consequences of implementing the “Farm to Fork” and “Biodiversity” strategies in agricultural production of Ukraine and improving the decision-making tool for state support for business structures of the agricultural sector of Ukraine in 2026-2030. In the course of the research, methods of analysis and synthesis, mathematical modelling, normative, and computational and constructive methods were used. As a result of the study, the tools and areas of state support for business structures of the agricultural sector of Ukraine under martial law were analysed, and a comparative assessment of state support for agriculture of Ukraine and EU member states in 2019-2023 was presented. It was established that the implementation of the “Farm to Fork” and “Biodiversity” strategies can reduce in the short term in agricultural enterprises the volume of grain production by 9.2%, oilseeds by 21.0%, and the amount of profit by USD 1.02 billion or approximately USD 57.6 per 1 ha of agricultural land. A mathematical model was proposed for evaluating decision-making on the choice of priority areas of state support for agricultural production. The practical significance of the results obtained in the course of the study lies in the possibility of their use by central and regional executive authorities conducting agricultural policy when making decisions on the development of agriculture in Ukraine

Keywords: entrepreneurship; sustainable development; agricultural policy; agri-food trade; financing; European integration

INTRODUCTION

As a result of the military actions of the Russian Federation against Ukraine, agricultural producers suffered significant losses due to the destruction and damage of agricultural machinery, granaries, livestock premises, perennial plantings, theft of factors of production and manufactured products. A significant part of Ukraine’s arable land was occupied, mined, or chemically contaminated. The number of business entities, and the number of employees employed in the agricultural sector, has significantly decreased. Instability in agricultural markets, export restrictions imposed by some countries, slowing global agricultural productivity growth, and climate change make it necessary to reform or reorient support for agriculture. Therefore, Ukraine, as a candidate for EU membership, should use the long-term experience of the Common Agricultural Policy (CAP) to reform the system of state support for business entities in the agricultural sector.

Various aspects of the Common Agricultural Policy (CAP) have been studied by many foreign and Ukrainian researchers. E. O’Rourke & J.A. Finn (2020) proved that payments to farmers, unlike the action-oriented approaches under CAP 2014-2022, should be result-oriented and related to achieving specific environmental results. M. Díaz *et al.* (2021) pointed to increased coherence in the use of CAP tools and noted

that in order to improve the adoption of mandatory requirements and maximise the implementation of effective voluntary measures to preserve diversity, EU member states should provide farmers with knowledge dissemination and training services, improve support for local initiative groups through the European Innovation Partnership in agriculture (EIP-AGRI) and the LEADER Programme. The European Commission (2020b), based on the materials of more than 300 experts, identified the directions of CAP reform for 2023-2027 to improve its effectiveness in preserving biodiversity and landscapes, and to achieve the goal of a green agreement to stop and return to the previous state of biodiversity loss of agricultural land.

Kh.A. Hryhorieva (2024) investigated the problems of legal support of state support for agriculture in Ukraine and in the European Union. J. Barreiro-Hurle *et al.* (2021) presented the results of a study of the impact of selected “Farm to Fork” and “Biodiversity” strategies within the 2030 climate targets and CAP post-2020 on EU agriculture using the CAPRI model. Along with that, G. Pe’er *et al.* (2025) noted the important role of science in the public debate on environmental policy, as CAP is not immune to misconceptions and misinformation. P. Jeanneret *et al.* (2021) also noted that scientists can support policy development after evaluating its results

and identify innovative business models that align food production and consumption, conservation, and economic and social goals.

The issue of state support for the development of agriculture in Ukraine was widely covered in the works of Ukrainian researchers and scientists. T.O. Zinchuk & N.M. Kutsmus (2023) examined the tools and forms of state support in the EU CAP and substantiated the need to consider its achievements in Ukrainian agricultural policy. D. Shelenko *et al.* (2023) proved that the state support mechanism should provide the necessary volumes of agricultural production, their structure and changes in the business strategy. Yu. Lupenko *et al.* (2023) and M. Malik *et al.* (2023) in their papers established that the mechanism of state support should provide business entities with access to production material resources and financial resources for the restoration and diversification of business activities in the post-war period.

All the above-mentioned studies proved the need to improve the system of state support for business entities in the agricultural sector of Ukraine, which should have a stimulating character. However, there are no studies that would address this issue in a comprehensive manner. They should be based on investigating the experience of regulating the activities of business entities in the agricultural sector of Ukraine, analysing the best practices of Ukrainian science, the Common Agricultural Policy of the EU and the system of state support for agriculture in other countries of the world. The purpose of this study was to investigate the economic consequences of implementing the strategies “Farm to Fork” and “Biodiversity” in the agricultural production of Ukraine and the need to improve the decision-making mechanism for state support of business structures of the agricultural sector of Ukraine in the post-war period, which would encourage agricultural producers to organise effective and sustainable agricultural systems, preserve and restore biodiversity, ensure food security and healthy nutrition.

MATERIALS AND METHODS

The study analysed data for the period from 2019 to 2023, as data for 2024 was not yet available at the time of writing. The research methodology

was based on a systematic approach, which consisted in considering agriculture as a complex ecological, social, and economic subsystem that is a component of the national economy. This allowed considering agriculture as a system that effectively carries out its activities only with the coordinated functioning of its elements and parts, and identifying the impact of individual instruments of state support for business structures of the agricultural sector on its development. When determining the levels and areas of state support for agriculture in Ukraine and the EU countries, the methodological approach used by the Organisation for Economic Cooperation and Development (OECD, 2021) was used. On its basis, a comparative assessment of the levels and trends of state support for agricultural entities of Ukraine and EU member states as a whole was carried out.

To assess the impact of the decision to implement the strategies of the European Green Deal “Farm to Fork” and “Biodiversity” in agricultural production in Ukraine, the basic linear programming model was used to optimise the production structure of the enterprise (Zaburanna *et al.*, 2014). It allowed determining the optimal production structure of agricultural enterprises at the national level based on the criterion of “maximum profit”. The inclusion in the basic model of restrictions for agriculture, which are provided for by the strategies “Farm to Fork” (European commission, 2020a) and “Biodiversity” (European commission, 2020b) and the addition of the model with the conditions for providing state support to agricultural enterprises, helped to determine the volume and areas of this support.

The basic model for optimising the production structure of the enterprise was supplemented with restrictions that reflected the conditions for providing state support to agricultural enterprises:

1. Restrictions on the use of funds for the current activities of agricultural producers.

$$X_{gv} - X_{kk} - U_{kp} - U_{kv} \leq P_p, \quad (1)$$

where: X_{gv} – the required total amount of funds for the current activities of agricultural producers; X_{kk} – the required amount of short-term

loan needed by agricultural producers for their current activities; Ukp – the required amount of state support funds, which will be used for partial compensation of working capital formation costs; Ukv – the required amount of state support funds that will be used to partially compensate for interest on short-term loans. Values Ukp , Ukv can be controlled variables, i.e., they can be used as parameters, if they change, the results of solving the problem will also change, which allows determining their quantitative impact on the development of agricultural production. Pp – the amount of own funds of agricultural producers that they can use to carry out current activities.

2. Restrictions on the amount of obtaining a short-term loan.

$$Xkk \leq Kk, \quad (2)$$

where: Kk – the maximum possible amount of obtaining a short-term loan by commodity producers.

3. Condition for the ratio of the amount of short-term loan received by commodity producers and the amount of state support funds that will be used for partial compensation of interest on loans.

$$Uk \leq \delta Xkk, \quad (3)$$

where: δ – the share of state support funds that will be used to partially compensate for interest on loans.

4. Restrictions on the amount of state support funds that will be directed to the current activities of agricultural producers.

$$Ukp + Ukv \leq Kkp, \quad (4)$$

where: Kkp – the maximum possible amount of state support funds, which will be directed to the current activities of rural producers

5. Restrictions on the use of funds for investment activities of agricultural producers.

$$Xok - Xdk - Ukd - Udv \leq Pi, \quad (5)$$

where: Xok – the required total amount of funds for investment activities of agricultural producers; Xdk – the required amount of long-term loan necessary for agricultural producers to carry out investment activities; Ukd – the

desired amount of state support funds, which will be used for partial reimbursement of expenses for the formation of fixed capital to agricultural producers; Udv – the required amount of state support funds, which will be used to partially compensate for interest on long-term loans.

Values Ukd , Udv when implementing models can be used as parameters for determining the quantitative impact on the development of agricultural production. Pi – the amount of own funds of agricultural producers that they can use to carry out investment activities.

6. Limit on the amount of obtaining a long-term loan.

$$Xdk \leq Kd, \quad (6)$$

where: Kd – the maximum possible amount of obtaining a long-term loan by commodity producers.

7. Condition for the ratio of the amount of long-term loan received by commodity producers and the amount of state support funds that will be used for partial compensation of interest on long-term loans.

$$Udp \leq \varepsilon Xdk, \quad (7)$$

where: ε – the share of state support funds that will be used to partially compensate for interest on long-term loans.

8. Restrictions on the amount of state support funds that will be directed to investment activities of agricultural producers.

$$Ukd + Udv \leq Kk, \quad (8)$$

where: Kk – the maximum possible amount of state support funds, which will be directed to the investment activities of rural producers;

The main sources of information for the study were materials from the State Statistics Service of Ukraine (2024), the OECD database (2021; 2022; 2023; 2024), European Commission (2024), materials of Ministry of Agrarian Policy and Food of Ukraine (2021; 2022; 2025a; 2025b), Agribusiness of Ukraine handbook 2023/24 (2024), law of Ukraine No. 2629-VIII (2018), Law of Ukraine No. 2710-IX (2022), Law of Ukraine No. 3460-IX (2023) the order of the Cabinet of Ministers of Ukraine No. 495-r (2024). The model included activities of agricultural enterprises that provided about 90% of

their gross agricultural output in 2023: growing wheat, rye, barley, corn, millet, buckwheat, oats, legumes, sunflower, soy, rapeseed, flax, sugar beet, potatoes, vegetables, fodder crops (fodder root crops, corn for silage and green fodder, annual grasses for hay, haylage and green fodder, perennial grasses for hay, haylage, green fodder and seeds), vineyards, fruit and vegetable plantations, care of hayfields and pastures, breeding dairy cows, young cattle, pigs, sheep, and poultry. The model included 63 variables and 78 constraints. The study on the impact of the decision on the implementation of the strategies of the European Green Deal “Farm to Fork” and “Biodiversity” in agricultural production in Ukraine was conducted according to two scenarios (European Commission, 2019). The first scenario provided for calculating the profitability of agricultural enterprises under the existing production structure in 2023 with state support in the amount of UAH 4.0 billion (pre-war value) and in the absence of restrictions on the “Farm to Fork” and “Biodiversity” strategies. At this stage of calculations, the adequacy of the developed model was also checked by comparing the actual indicators for 2023 with the calculated indicators. The calculations were performed using the Excel add-in “Solver”. At this stage, the model removed the restrictions on variables for activities and included restrictions for agriculture, which are provided for in the “Farm to Fork” and

“Biodiversity” strategies. Under the second scenario, the production structure of agricultural enterprises was optimised according to the “maximum profit” criterion, provided that state support of UAH 4.0 billion was provided.

RESULTS AND DISCUSSION

State support for business entities in the agricultural sector of Ukraine is provided through direct budget support, preferential taxation, and state regulation of product prices. Every year, the state budget of Ukraine allocates a certain amount of expenditures (direct budget support) to finance a certain budget programme to support agricultural producers. Until 2020, the state budget of Ukraine allocated several programmes to support agricultural producers (Law of Ukraine No. 2629-VIII, 2018). In 2020-2023, these programmes were combined (except for the programme “Provision of loans to farms (UDF)” in one budget programme “Financial support for agricultural producers” (Law of Ukraine No. 2710-IX, 2022). After 2022, under martial law in Ukraine, with limited funds, the system of support for agricultural producers was somewhat disrupted and funds from the state budget were allocated mainly only for urgent needs. Therefore, the analysis of the amount of funds paid for the implementation of state programmes to support agricultural producers is presented for 2019-2021 (Table 1).

Table 1. Volumes of funds paid for the implementation of state programmes to support agricultural producers of Ukraine in 2019-2021

Year	State programme of support for agricultural producers	Amount of funds received, thous. UAH	Number of recipients*
2019	State support for animal husbandry	2,433,576.12	1,179
	State support for the development of hop growing, establishment and supervision of young orchards, vineyards, and berry fields	397,878.90	210
	Provision of loans to farms (USF)	225,083.00	595
	Financial support for activities in the agro-industrial complex by reducing the cost of loans	449,872.34	966
	Financial support for farm development	420,446.65	5,944
	Financial support for agricultural producers	640,793.81	4,315
	Total	4,567,650.82	9,927
2020	Provision of loans to farms (USF)	65,566.90	176
	Financial support for agricultural producers	3,965,818.47	11,538
	Total	4,031,385.37	11,614

Table 1, Continued

Year	State programme of support for agricultural producers	Amount of funds received, thous. UAH	Number of recipients*
2021	Provision of loans to farms (USF)	50,000.00	127
	Financial support for agricultural producers	4,662,394.88	11,198
	Total	4,712,394.88	11,257

Note: the number of recipients is not the sum of the programmes, because some subjects participated in several programmes simultaneously

Source: Ministry of Agrarian Policy and Food of Ukraine (2021)

The data in Table 1 show that in 2019-2021, agricultural businesses received slightly more than UAH 4 billion in state support annually. It was received mainly by large agricultural enterprises, the share of which in the total number of business entities did not exceed 18%. In the structure of funds paid from the state budget in 2019-2021,

from 95 to 99% of the total amount of support was allocated for the programme “Financial support for agricultural producers”. In 2021, the budget programme “Financial support for agricultural producers” was implemented under the following main subprogrammes: (Ministry of Agrarian Policy and Food of Ukraine, 2021) (Table 2).

Table 2. Components of the budget programme “Financial support for agricultural producers” of Ukraine in 2021

State subprogramme of financial support for agricultural producers	Amount of funds received, thous. UAH	Number of recipients
Compensation of losses from damage to agricultural crops as a result of anthropogenic and natural emergencies	107,910.49	527
State support for potato production	53,214.59	2
State support for the development of animal husbandry and processing of agricultural products	1,609,572.93	707
State support for agricultural producers by allocating budget subsidies per unit of cultivated land	50,000.00	653
State support for agricultural producers using reclaimed land	16,745.87	7
Provision of additional financial support to family farms through the mechanism of additional payment in favour of insured persons –S members/chairman of the family farm of a single contribution to mandatory state social insurance	603.60	1
State support for measures in the agro-industrial complex by reducing the cost of loans	1,200,000.00	4,434
Financial support for the development of horticulture, viticulture and hop growing	512,228.00	292
Total	4,712,394.88	11,257

Note: the number of recipients is not the sum of the programmes, since some subjects participated in several programmes simultaneously

Source: Ministry of Agrarian Policy and Food of Ukraine (2021)

The data in Table 2 show that by 2022, Ukraine had already established a stable system of financial support for agricultural producers, consisting of separate subprogrammes, which in turn were divided into separate areas of support. In 2021, for the implementation of the subprogramme “State support for the development of animal husbandry and processing of agricultural products” was allocated the most funds – 34.1% of the total amount of

support. The implementation of this subprogramme allowed partially reimbursing agricultural producers for the cost of building or reconstructing livestock farms, purchased breeding animals, milking parlours, agricultural processing enterprises, etc. With minor changes, this subroutine is also being implemented in 2025 (Resolution of the Cabinet of Ministers of Ukraine No. 950-2025-p, 2025). The implementation of the subprogramme

“State support for activities in the agro-industrial complex by reducing the cost of loans” provided an opportunity for business entities to receive compensation for using loans to replenish working capital and purchase fixed assets of production (Resolution of the Cabinet of Ministers of Ukraine No. 300, 2015).

To register agricultural producers who want to receive state support and transparently distribute all types of support among them, the State Agrarian Register (2025) was created in Ukraine in 2021. As of September 18, 2024, 176 thousand agricultural producers were already registered in the State Agrarian Register and more than 50 support programmes were implemented through it (Liga Zakon, 2025). After 2022 the situation with direct state support programmes remained very difficult. In 2022, 1.5 times less funds were allocated for the implementation of state programmes to support agricultural producers in Ukraine compared to 2021 (NISS, 2023). Since 2023, state support for businesses in the agricultural sector has been provided by three ministries: the Ministry of Agrarian Policy, the Ministry of Economy, and the Ministry of Finance of Ukraine. Of the total amount of expenditures of the Ministry of Agrarian Policy in the amount of UAH 7.6 billion (Law of Ukraine No. 3460-IX, 2023), UAH 926.7 million was allocated for financial support of the agro-industrial complex, of which UAH 199.0 million was allocated for the support of business entities that use reclaimed land, UAH 725.6 million was allocated to establish the authorised capital of the fund providing partial loan guarantees for the agricultural sector, while UAH 2.0 million was directed to support family farms by offering additional payments toward the single social insurance contribution for insured members or heads of such farms.

Ministry of Economy of Ukraine, according to Resolution of the Cabinet of Ministers of Ukraine No. 738-2022-p (2022) provides irrevocable state aid to business entities in the agricultural sector in the form of grants for the implementation of projects for the development of horticulture, berry growing, viticulture, and greenhouses. For the development of horticulture, the business entity is granted a grant in the amount of 70% of the project cost, but not more

than UAH 10.0 million per 1 ha of plantings and subject to co-financing of the project cost in the amount of at least 30% by the grant recipient. For the implementation of greenhouse projects, the business entity is granted a grant in the amount of up to 70% of the project cost, but not more than UAH 7 million, and subject to co-financing by the grant recipient of at least 30% of the cost of building a modular greenhouse. Grants are provided subject to the creation of jobs: from 5 to 10 permanent and 125–425 seasonal employees per 1 hectare, depending on the name of garden plantings, and at least 4 permanent and 10 seasonal greenhouses per 1 hectare.

In 2022, grant funds were paid for the development of horticulture, berry growing and viticulture in the amount of UAH 34.29 million, and for greenhouses – UAH 14.02 million. In 2023, grant funds in the amount of UAH 502.86 million were paid for the implementation of projects for the development of horticulture, berry growing, and viticulture, and UAH 153.83 million was paid for greenhouses (Ministry of Agrarian Policy and Food of Ukraine, 2025a; 2025b). Due to the deterioration of the financial condition of farmers and other producers and the lack of financial resources for their production activities under martial law, the government extended the programme “Affordable Loans 5-7-9%” (2021). Under this programme, business entities can receive loans for the purchase of fixed and working capital in the amount of up to UAH 90 million at 5-9% per annum.

In 2024, 12,729 agricultural enterprises in Ukraine received bank development loans worth about UAH 100 billion, including UAH 44.8 billion provided to 8,511 farms under the state programme “Affordable Loans 5-7-9%”. Since December 2024, Ukrainian banks have provided loans to agricultural companies under the “5-7-9%” concessional lending programme only if they comply with environmental and social standards (Agribusiness of Ukraine 2023/24, 2024). Since March 2024, in connection with the changes introduced by Resolution of the Cabinet of Ministers of Ukraine No. 275-2024-p (2024), the Programme for partial compensation of the cost of Ukrainian-made agricultural machinery and equipment has come into effect, providing for partial compensation

in the amount of 25% of the cost of purchased machinery and equipment. The amount of state support per agricultural producer is limited to the amount of no more than 10 thousand minimum wages established on January 1 of the corresponding year.

A separate type of support for business entities in the agricultural sector is the implementation of joint projects with international partners. Within the framework of the grant agreement of the Ukraine Relief, Recovery, Reconstruction and Reform Trust Fund (emergency project for providing inclusive support for the restoration of Agriculture in Ukraine (ARISE) between Ukraine and the International Bank for Reconstruction and Development and the International Development Association (Order of the Cabinet of Ministers of Ukraine No. 495-r, 2024) the programme "Affordable Loans 5-7-9%" was financed in the amount of USD 500.0 million, grant support was provided to farms that have between 1 and 120 hectares in use and/or keep between 3 and 100 cows in the amount of USD 49.2 million, and USD 0.8 million was allocated for coordination and monitoring of the programme (Agribusiness of Ukraine 2023/24, 2024).

The USAID AGRO programme supported micro, small, and medium-sized agricultural enterprises in the face of a full-scale invasion to preserve their economic activity, restore logistics chains and ensure food security of the population (USAID Project, 2025). The USAID AGRO programme raised USD 0.35 billion in 2022; in 2023 – USD 0.5 billion; in 2024 – more than USD 2.26 billion (Agribusiness of Ukraine 2023/24, 2024). Within the framework of the FAO programme, projects were implemented in Ukraine: "Mine clearance and restoration, grain storage assistance" (Canada) in the amount of USD 45.7 million, "Supply chain strengthening" (EU) – USD 25.6 million, "Food security" (France) – USD 8.0 million, "Emergency seed support for food security" (Norway) – USD 6.8 million, "Animal health promotion" (Germany) – USD 5.1 million, "Grain storage assistance" (Multidisciplinary fund) – USD 3.0 million, "Mine clearance and recovery" (World Food Programme) – USD 2.7 million, "Restoration of Sumy region" (Joint UN programme) – USD 2.3 million, "Assistance in the affected regions" (Japan,

Belgium) – USD 1.9 million (Agribusiness of Ukraine 2023/24, 2024).

In December 2024, the State Agrarian Register (SAR) started accepting applications from agricultural producers to receive funds under the grant programme, which was funded by the European Union and FAO and was aimed at increasing the competitiveness of the agricultural sector of Ukraine. Grants will be paid to small business entities in the amount of up to UAH 416 thousand 500 (USD 10 thousand), micro and small enterprises, agricultural cooperatives and associations of producers of products with geographical indications in the amount of up to UAH 1 million 41 thousand 250 (USD 25 thousand) (Agravery, 2025). The status of Ukraine as a candidate country for EU membership has made it necessary to address the issue of bringing Ukrainian legislation in the agricultural sector to European standards. At the end of 2024, since 2014, the level of implementation of the association agreement between Ukraine and the European Union of Ukraine and the harmonisation of the regulatory framework has reached 81%, in particular, in the field of entrepreneurship – 91%, in agriculture – 74% (Government portal, 2024). The further process of Ukraine's integration into the EU requires the introduction and effective application of CAP tools and standards of the EU member states, which ensures the social, economic, and environmental development of agriculture. As in the agricultural policy of Ukraine, in most cases, the priority remains to further increase production volumes without considering environmental and social requirements.

To develop proposals for improving the system of state support for farmers in Ukraine, which would comply with the principles of CAP, it is necessary to conduct a comparative analysis of the levels of support for agriculture in Ukraine and the EU countries. OECD calculates support values by recipient: producer support estimate (PSE), consumer support estimate (CSE), general service support estimate (GSSE), nominal protection coefficient (NPC), total support estimate (TSE) (OECD, 2024). The support provided to agricultural producers in Ukraine, as reflected by the PSE indicator, remains significantly lower than in European Union

countries. From 2019 to 2023, Ukraine's PSE averaged 0.88% of the gross revenue of agricultural enterprises, whereas in the EU it reached

17.34%. On a per-hectare basis, Ukraine received an average of USD 7.12, compared with USD 601.88 in EU member states (Table 3).

Table 3. Comparative analysis of agricultural support levels in Ukraine and EU countries in 2019-2023, USD million

Indicators		Ukraine					EU				
		2019	2020	2021	2022	2023	2019	2020	2021	2022	2023
Total production cost (at farm gate)	total	34,265	34,579	50,143	34,546	32,333	452,697	454,748	483,603	513,859	522,235
	1 ha of agricultural land	827.5	835.1	1213.8	836.2	782.7	2,779.0	2,807.8	2,985.9	3,172.8	3,224.5
Total cost of consumption (at farm gate)		25,594	24,112	30,786	21,590	21,344	435,556	445,464	457,245	517,389	512,229
Producer support estimate (PSE)	total	1,025	490	57	-874	777	104,698	104,538	90,064	88,137	100,571
	1 ha of agricultural land	24.75	11.83	1.38	-21.16	18.81	642.71	645.46	556.09	544.19	620.96
■ Commodity production support		690	178	-271	-1,167	457	20,160	16,900	12,076	15,410	26,678
■ market price support		690	178	-271	-1,167	457	19,864	16,601	11,804	15,158	26,422
■ payments based on output		0	0	0	0	0	296	299	272	252	256
■ Subsidies, partial reimbursement of the cost of fixed assets, etc.		120	135	150	110	222	14,780	15,821	15,704	15,252	15,816
■ Payments for the area of crops and animal husbandry, benefits from preferential taxation, support for small and medium-sized producers, etc.		214	172	178	183	98	27,053	29,115	21,765	21,426	27,167
Percentage of PSE (%)		3.00	1.41	0.11	-2.51	2.38	19.5	19.3	16.03	15.02	16.86
Manufacturer's rated protection coefficient (NPC)		1.01	1.01	0.99	0.97	1.01	1.05	1.04	1.03	1.03	1.05
Nominal manufacturer assistance coefficient (NAC)		1.02	1.01	1.00	0.98	1.02	1.24	1.24	1.19	1.16	1.2
General services support estimate (GSSE)	total	222	224	268	262	241	12,002	12,416	14,375	12,931	14,293
	1 ha of agricultural land	5.36	5.41	6.49	6.34	5.83	73.68	76.66	88.76	79.84	88.25
■ System of agricultural knowledge and innovation		68	71	75	88	78	6,623	6,568	7,803	7,008	7,850
■ Inspection and control		138	141	177	160	153	1,170	1,180	1,246	1,192	1,293
■ Infrastructure development and maintenance		6	2	5	2	2	1,577	1,684	2,216	1,781	2007
■ Marketing and promotion		0	0	0	0	0	2597	2,919	3,066	2,894	3,090
Percentage of GSSE (% of TSE)		17.8	31.32	82.4	...	23.71	10.2	10.6	13.71	12.75	12.4
Consumer support estimate (CSE)		-700	-192	279	1,089	-411	-18,411	-14,668	-11,127	-14,811	-25,493
■ Transfers to producers from consumers		-638	-174	291	1,104	-384	-19,172	-15,036	-10,995	-14,478	-25,407
■ Other transfers from consumers		-56	-17	-8	-16	-6	-265	-128	-578	-632	-904
CSE percentage (%)		-2.8	-0.8	0.91	5.05	-1.93	-2.86	-4.98	-2.44	-2.86	-4.98
Total support estimate (TSE)	total	1,246	714	325	-612	1,018	117,101	117,450	104,886	101,386	115,301
	1 ha of agricultural land	30.09	17.24	7.87	-14.81	24.64	718.85	725.18	647.60	625.99	711.91
Percentage TSE (% of GDP)		0.8	0.46	0.16	0.38	0.62	0.6	0.7	0.61	0.61	0.65
Total budget support estimate (TBSE)	total	556	530	596	554	562	97,237	100,849	93,082	86,228	88,879
	1 ha of agricultural land	13.43	12.80	14.43	13.41	13.60	596.91	622.68	574.72	532.40	548.77
Percentage TBSE (% of GDP)		0.4	0.34	0.3	0.35	0.34	0.6	0.7	0.54	0.52	0.5

Note: EU28 for 2019, EU27 plus UK for 2020, and EU27 for 2021-2023

Source: calculated by the authors based on OECD data (2021; 2022; 2023; 2024)

According to Table 3, in 2019-2023, support for farmers in Ukraine was characterised by instability, which was mainly due to changes in market price support. In 2021-2022, it acquired negative values, because the average producer prices for most goods were inferior to the world ones. Domestic prices for meat products and sugar exceeded global market levels, whereas prices for most grains, industrial crops, and milk were typically below international benchmarks. In 2019-2020 and again in 2023, the value of positive support outweighed the negative price support. Sugar and pork producers received the highest support, while oats, rye, milk and sunflower seeds were implicitly taxed. The single tax regime, to which Ukrainian agricultural producers are entitled, generates implicit tax benefits, which are estimated at approximately USD 102.4 million annually. The volume of budget support for Ukrainian producers during

2019-2023 was insignificant and did not exceed 3% of gross revenues of agricultural enterprises. In the EU countries, this figure exceeded 15%.

General support service expenditure (GSSE) in Ukraine remains low compared to other countries, averaging 0.65% of agricultural production value in 2019-2023, compared to 2.7% in EU countries. During 2019-2023, total support estimate for agriculture in percentage terms (TSE) in Ukraine averaged 0.48% of GDP compared to 0.63% in the EU countries, and per 1 ha of agricultural land, this indicator in monetary terms averaged USD 13.0 in Ukraine, and USD 685.9 in the EU countries (OECD, 2024). To illustrate changes in the application of tools and forms of support to farmers in connection with internal processes in the EU and with environmental requirements, the dynamics of composite costs for EU CAP during 2000-2024 is presented (Fig. 1).

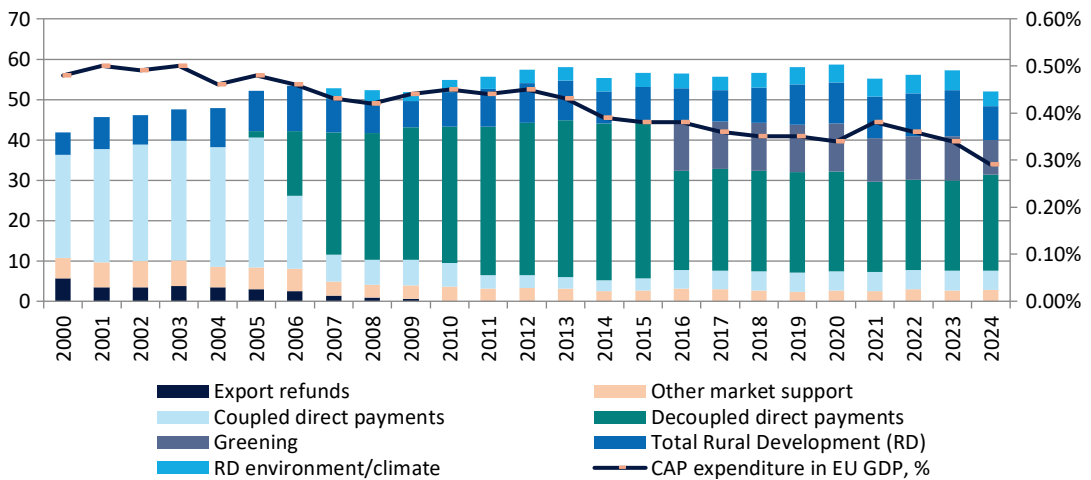


Figure 1. Components of spending on the EU's Common Agricultural Policy, billion EUR
Source: developed by the authors based on the European Commission (2024)

The data in Figure 1 show that non-production payments account for a significant part of the structure of farm support costs in EU countries. The CAP programme also provides compensation for the provision of public goods, for compliance with agricultural practices that are useful for climate, for spatial and landscape planning, the viability of the rural economy, public health, product quality, etc. Ukraine needs to take the new CAP policy 2023-2027 as a tie-in

and not repeat the mistakes that took place in the CAP of previous years: the lack of motivation of agricultural producers to increase labour productivity, undermining fiscal stability, the implementation of mandatory measures by farmers without achieving the necessary results, trade conflicts in the international arena. In 2024, in order to prepare the agricultural sector for Ukraine's accession to the EU and harmonise the state agrarian policy to the requirements of

the EU, the Strategy for the development of Agriculture and rural areas in Ukraine for the period up to 2030 (Resolution of the Cabinet of Ministers of Ukraine No. 1163-2024-p, 2024).

In 2020, the European Commission, as the basis of the European Green Deal, published the strategies “Farm to Fork” (European commission, 2020a), and “Biodiversity” (European commission, 2020b), which impose restrictions on agriculture by targeted reduction of 10% of the use of agricultural land under landscape features of high diversity and 50% of pesticides, reduction of nutrient losses by at least 50% in the absence of deterioration of soil fertility, increase to 25% of the area of agricultural land in the European Union under organic farming (OECD, 2023). Before implementing individual tools and forms of support for farmers, European scientists often assess their impact on agriculture using economic and mathematical models. To assess EU policy at the macro or meso level as noted by A. Gonzalez-Martinez, *et al.* (2021), large-scale models are used: MAGNET, AGMEMOD, BATModel. L.C. Smith *et al.* (2018) evaluated the impact of the transition on organic agricultural production in England and Wales using a large-scale linear programming model. In their report, J. Barreiro-Hurle *et al.* (2021) proved that the goals set out in the “Farm to Fork” and “Biodiversity” strategies can be included in CAP analysis using existing tools, in particular the CAPRI model. If the prices of agricultural products in the study can be accepted as exogenous variables, then linear programming models can be used. If product prices are endogenous variables and need to be determined during the implementation of the model, it is advisable to use partial equilibrium models of the AGMEMOD type.

To investigate the impact of implementing the “Farm to Fork” and “Biodiversity” strategies

in agricultural production in Ukraine, a linear programming model was used to optimise the production structure of production, which was supplemented by the conditions for providing state support to agricultural enterprises (equations 1-8). Based on the aggregated data of agricultural enterprises of Ukraine in 2023, a model for optimising their production structure was formed. The adequacy of the developed model was checked by comparing the actual indicators for 2023 with the calculated indicators for the model. After the development of an adequate model, the results of calculations on it became the basis (and scenario) for comparing the results of calculations on the model, which included restrictions on Agriculture provided for by the strategies “Farm to Fork” and “Biodiversity” (scenario 2).

When modelling goals to reduce the use of pesticides and fertilisers, additional changes in other costs and yields were assumed. The goals of reducing the use of pesticides and fertilisers, and increasing the area under organic production were considered by introducing variables that reflect individual crop cultivation technologies into the model. Unlike econometric models (Barreiro-Hurle *et al.*, 2021) linear programming models have this capability. E. Anastasiou *et al.* (2023) proved the need to use precision farming technologies, as this contributes to increasing crop yields and animal productivity, reducing costs, and optimising the use of technological resources. The difference in crop acreage, production and sales volumes, livestock and poultry, and financial results calculated according to the two scenarios showed a significant impact of the political decision on the future implementation of the “Farm to Fork” and “Biodiversity” strategies on agricultural production in Ukraine (Table 4).

Table 4. Production and sale of crop production in agricultural enterprises of Ukraine (according to 2023 data)

Culture	Sown area, thous. ha			Gross production, thous. tonnes			Sales of products, thous. tonnes		
	Scenario 1*	Scenario 2**	Scenario 1 in % to Scenario 2	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2
Cereals and legumes	7,889.4	7,548.1	95.7	47,894.6	43,503.7	90.8	38,796.0	34,276.8	88.4
Industrial oilseeds	7,622.4	6,240.6	81.9	19,986.9	15,779.8	79.0	17,538.5	14,366.7	81.9
Sugar beet	238.1	273.4	114.8	12,690.0	14,280.8	112.5	12,690.0	14,280.8	112.5

Table 4, Continued

Culture	Sown area, thous. ha			Gross production, thous. tonnes			Sales of products, thous. tonnes		
	Scenario 1*	Scenario 2**	Scenario 1 in % to Scenario 2	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2
Potatoes	14.8	14.8	100.3	423.8	403.8	95.3	291.0	270.6	93.0
Vegetables	26.3	27.8	105.9	954.3	959.7	100.6	668.0	671.8	100.6
Grapes	15.1	16.04	106.2	224.9	239.0	106.3	213.7	227.0	106.2
Garden	36.46	37.8	103.7	557.9	578.3	103.7	530.0	549.4	103.7

Note: * Scenario 1 (existing production structure 2023); ** Scenario 2 (optimal production structure with limitations of the “Farm to Fork” and “Biodiversity” strategies)

Source: developed by the authors based on the State Statistics Service of Ukraine (2024) and the results of calculations using the model

The data in Table 4 show that due to the need to comply with restrictions on the use of resources when implementing European Green Deal strategies, the area of arable land in agricultural enterprises will decrease by 1,577.3 thous. ha. The acreage under grain and leguminous crops decreases mainly due to a decrease in the area under wheat, but their share in the structure of acreage increases from 48.7% to 51.6%. Due to the need to comply with scientifically based crop rotations, the area under sunflower will decrease by 1,569.5 thous. ha, while the area under soybeans will increase to 1,755.5 thous. ha. Increasing the area under perennial plantings

will help to reduce greenhouse gas emissions. Restrictions on the use of mineral fertilisers and pesticides in the second scenario will lead to a decrease in crop yields and, together with a decrease in acreage, will lead to a decrease in grain production by 9.2%, oilseeds by 21.0%. Accordingly, the volume of sales of these products will also decrease. An increase in organic crop production leads to an increase in the number of animals by about 10% (scenario 1 – the existing production structure in 2023; scenario 2 – the optimal production structure with restrictions on the “Farm to Fork” and “Biodiversity” strategies) (Table 5).

Table 5. Production and sale of livestock products in agricultural enterprises of Ukraine (according to 2023 data)

	Livestock, thous. units			Gross production, thous. tonnes			Sales of products, thous. tonnes		
	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2
Cows	382.2	420.4	110.0	2,892.5	3,181.7	110.0	2,805.7	3,086.3	110.0
Young bovine cattle	542.7	597.0	110.0	135.1	148.7	110.0	86.8	95.5	110.0
Pigs, thous. units	3,347.9	3,703.8	110.6	582.5	644.5	110.6	405.1	448.2	110.6
Sheep, thous. units	129.7	143.0	110.3	1.7	1.9	109.4	1.3	1.4	106.7
Poultry, million units	101.8	107.2	105.3	1,487.3*	1,546.7	104.0	1,189.8	1,237.4	104.0
				5,644.4**	6,011.3	106.5	5,080.0	5,410.2	106.5

Note: *poultry meat, ** eggs, million units

Source: developed by the authors based on the State Statistics Service of Ukraine (2024) and the results of calculations using the model

The volume of milk production and sales under the second scenario will increase by 10.0% compared to the first scenario. However,

the volume of meat production and sales will increase by an average of 6.1%, eggs – by 6.5%. Modelling of decision-making on the

implementation of the “Farm to Fork” and “Biodiversity” strategies in agricultural production in Ukraine showed their negative economic impact (Table 6).

Table 6. Results of calculation of financial results of modelling decision-making on the implementation of the “Farm to Fork” and “Biodiversity” strategies in agricultural production in Ukraine (according to 2023 data)

Indicator	Scenario 1	Scenario 2	Scenario 1 in % to Scenario 2
Gross output, billion UAH	939.1	837.7	89.2
Revenue, billion UAH	769.9	682.9	88.7
Cost of products sold, billion UAH	580.1	545.7	94.1
Profit, billion UAH	139.1	96.5	69.4
Level of profitability, %	24.0	17.7	-6.3

Source: developed by the authors based on the State Statistics Service of Ukraine (2024) and the results of calculations using the model

When implementing the “Farm to Fork” and “Biodiversity” strategies in agricultural production of Ukraine, the value of gross output of agricultural enterprises may decrease by 10.8%, the amount of cash receipts from sales of products – by 11.7%, and the amount of profit – by UAH 42.5 billion (USD 1.02 billion per 1 ha of agricultural land that is in use by agricultural enterprises will amount to about UAH 2,387.5 (USD 57.6). This suggests that raising environmental standards for agriculture and food can increase the cost of producing individual products in the short term and negatively affect the competitiveness of products. Therefore, as compensation for additional expenses incurred and lost income incurred in connection

with the obligations taken by agricultural enterprises to introduce climate and environmentally friendly methods of farming or for stimulating the provision of public goods in the system of state support for economic entities in the agricultural sector of Ukraine, it is necessary to include payments under “eco-schemes” by analogy with EU member states. As a result of the implementation of the economic and mathematical model based on equations (1-8), the areas of distribution of UAH 4.0 billion (the average amount of funds allocated in the state budget in 2019–2021 directly to support the production of agricultural products) of state support funds for rural producers were also established (Table 7).

Table 7. Grouping of food products in the consumer basket, taking into account

Areas of state support for rural producers	Amount of state support funds, UAH billion
Partial compensation of interest on short-term loans	0.6
Partial compensation for the cost of Ukrainian-made agricultural machinery	1.32
Financial support for the development of animal husbandry	0.82
Financial support for development, horticulture, viticulture, and hop growing	0.49
Partial reimbursement of premises for storage and processing of agricultural products	0.77

Source: developed by the authors based on the results of calculations using the model

The data in Table 7 indicate that the main areas of distribution of state support funds for rural producers should be:

- partial compensation of interest on short-term loans to agricultural producers who suffered significant losses during the Russian occupation or as a result of military operations to restore agricultural production;

- partial compensation of the cost of Ukrainian-made agricultural machinery for the introduction of climatic and environmentally friendly agricultural methods by agricultural producers;

- financial support for the development of animal husbandry to stimulate an increase in production to provide the population of Ukraine

with food products of its own production (milk, beef, pork), to improve the conditions of keeping animals and preserve jobs in rural areas;

- financial support for development, horticulture, viticulture, and hop production to encourage increased production, save jobs in rural areas and reduce greenhouse gas emissions.

- partial reimbursement of premises for storage and processing of agricultural products will contribute to the creation of new enterprises that will operate in Ukraine and focus on export. Such projects will help to solve the problem of surplus products, produce products with higher positive costs, create new jobs, and provide jobs for related industries.

The results obtained in the course of research based on the assumptions and limitations of the model are somewhat conditional and should not be perceived as an accurate quantitative impact that will be realised if the green course goals are achieved. However, they can be useful for preliminary analysis of the impact of implementing the European Green Deal goals. The adequacy of the results obtained using economic modelling is evidenced by the results of other researchers. Results of the study by F. Baquedano *et al.* (2022) showed that policies that restrict the use of agricultural resources under the EU's "Farm to Fork" strategy reduce production volumes, farmers' incomes, and raise food prices, which could eventually lead to increased food security, which ranges from 30 million (EU only) to 171 million (global) by 2030.

Results of the study by L.C. Smith *et al.* (2018) based on economic simulations of the productive impact of the large-scale transition to organic farming in England, evidence of a 36% decline in food production in terms of metabolic energy from conventional agriculture. J. Barreiro-Hurle *et al.* (2021) noted that agro-economic models cannot reproduce reality in all its complexity and therefore have certain disadvantages and limitations that should be considered and that affect the results of studies based on such models. The experience of using CAP in EU member states showed that improving the productivity of the agricultural sector and its environmental sustainability can be compatible with increasing the share of spending on innovation, information, training, and advice.

Achieving the ambitious goals of the European Green Deal will require the introduction of new tools for the system of state support for business structures in the agricultural sector, rethinking the role and significance of individual payments, innovations and information support, and the adoption of new approaches to the provision of environmental services. All these tools of the system of state support for business structures, firstly, cannot be reflected in a mathematical model, and secondly, there is a lack of information about the impact of these tools on the economic, social, and environmental parameters of agricultural development. The performance of the state support system for agricultural enterprises is shaped by additional factors that must also be taken into account when forecasting the sector's future development.

In their study, M. Beck *et al.* (2021) noted the positive impact of the political instruments and measures of the Common Agricultural Policy (CAP) on knowledge sharing, advisory services and innovation, which will make a significant contribution to improving the productivity and sustainability of the EU's agricultural and food sectors. R. Vos *et al.* (2022), in the report on agricultural support policy reform, noted that better results could be achieved if even a small portion of agricultural subsidies were reconfigured to investment in research and development that focuses on productivity-enhancing and emission-reducing technologies. T. Sumrada *et al.* (2021) noted that environmental monitoring and reporting under CAP are insufficient, especially for biodiversity. Therefore, this area of activity requires increased investment in equipment, human resources, training, etc. A. Gulati *et al.* (2021) pointed to the need for coherence in the use of tools and proved that the most expensive and controversial agricultural policies in India were led precisely by the inconsistency of government measures to improve national food security, maintain low food prices for large numbers of low-income people and improve the well-being of farmers.

E.D. Concepción *et al.* (2020) highlighted the need to set clear priorities for biodiversity conservation and restoration, which must be consistent with the Green Deal, "Farm to Fork", and "Biodiversity" strategies. The chosen

instruments of agricultural policy and the size of the budget should ensure effective and timely achievement of ambitious goals. The priority area of the state support system in the post-war period in Ukraine will be the restoration of the productive potential of the agricultural sector. According to A. Dibrova *et al.* (2023), to restore the activities of an agricultural enterprise in de-occupied territories specialising in grain production and oilseed cultivation, the fixed capital requirement per hectare of crops is approximately USD 1,370-1,500, and the working capital requirement is USD 1,340-1,400.

G. Pe'er *et al.* (2022) noted in their paper that CAP 2023-2027 has opportunities to solve the problem of preserving biodiversity and neutralising climate crises. However, its implementation does not guarantee success, as changes in the new CAP are insignificant compared to the challenges of preserving biodiversity and combating climate change. In addition, many EU member states do not have the capacity to achieve the Sustainable Development Goals because they do not have systems for developing strategic plans, monitoring and reporting. Therefore, in the Strategy for the development of agriculture and rural areas in Ukraine for the period up to 2030, a prominent place is given to highlighting the organisational basis for implementing state support in the agricultural sector (Resolution of the Cabinet of Ministers of Ukraine No. 1163-2024-P, 2024). However, J. Barreiro-Hurle *et al.* (2021) still proved that mathematical models remain a powerful tool for assessing the impact of policies on agricultural development, provided that they are designed to cover as much as possible all aspects related to economic, social and environmental parameters.

The process of Ukraine's integration into the EU requires a reorientation of agricultural policy to European values: ensuring stable food supplies; promoting the competitiveness of agricultural entities; promoting fair trade; protecting the environment and sustainable resource management, combating climate change; restoring lost biodiversity. To achieve this, Ukraine must design state support tools and mechanisms for agricultural producers that promote socially, economically, and environmentally sustainable

development of the sector. In modernizing its system of public assistance for agricultural businesses, Ukraine can benefit from drawing on the extensive experience of the European Union's Common Agricultural Policy.

CONCLUSIONS

In Ukraine, there is still no clear system of measures of state support for business entities in the agricultural sector, a system of principles and criteria for providing state support. In 2019-2021, the share of business entities in the agricultural sector that received state support in their total number did not exceed 18%. Unlike the support system in Ukraine, in the new CAP 2023-2027 of the EU member states, each measure of state support for farmers is part of the overall system of state support, is consistent with other measures and has a clear legislative basis. The process of implementation and effective application of the tools and standards of the CAP of the EU member states, which ensures the social, economic, and environmental development of agriculture, poses a serious challenge to the government of Ukraine in the face of incompleteness of agricultural regulations and legislative acts, incompleteness of the system of organisation and infrastructure of support for agriculture with limited financial resources during the war period. Between 2019 and 2023, government support for agricultural producers in Ukraine, measured using the OECD approach, amounted to an average of only 0.88% of gross farm revenues, compared to 17.34% in EU member states. On a per-hectare basis, Ukraine received an average of USD 7.12, whereas agricultural producers in the EU received about USD 601.88 per hectare.

The process of harmonising the state agrarian policy of Ukraine to the requirements of the EU and achieving the goals of the European Green Deal and sustainable development will lead to changes in the production structure of agriculture and a decrease in its profitability. Therefore, in the system of state support for economic entities in the agricultural sector of Ukraine, it is necessary to include, by analogy with the EU member states, payments under "eco-schemes" as compensation for all or part of the additional costs and revenues

incurred, lost in connection with the obligations taken by agricultural enterprises to introduce climate and environmentally friendly methods of farming or for incentives and remuneration for the provision of public goods through agricultural practices that are useful for the environment and climate. To determine the impact of using certain levers of state support for agricultural production on the development of agriculture and to optimise the distribution of state support funds, it is advisable to use economic and mathematical methods and models. They can become an effective tool for making decisions on choosing priority

areas of state support for agricultural production. Further research should focus on improving agricultural sustainability management standards and tools and ensuring their compatibility with the EU CAP.

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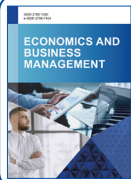
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Державна підтримка підприємницьких структур аграрного сектора економіки України

Анотація. Актуальність дослідження зумовлена перш за все більшою невизначеністю бізнесу у сільському господарстві порівняно з іншими секторами та його провідним місцем в економічному розвитку України, необхідністю зміцнення продовольчої безпеки, розвитку сільських територій та охорони навколишнього середовища. Метою дослідження була порівняльна оцінка рівнів і тенденцій державної підтримки суб'єктів господарювання сільського господарства України та країн-членів ЄС загалом, визначення економічних наслідків впровадження стратегій «Farm to Fork» та «Біорізноманіття» в сільськогосподарське

виробництво України та удосконалення інструменту прийняття рішень щодо державної підтримки підприємницьких структур аграрного сектора України у 2026-2030 роки. У процесі дослідження застосовувалися методи аналізу та синтезу, метод математичного моделювання, нормативний та розрахунково-конструктивний методи. У результаті дослідження було проаналізовано інструменти та напрями державної підтримки підприємницьких структур аграрного сектору України в умовах воєнного стану, подана порівняльна оцінка державної підтримки сільського господарства України та країн-членів ЄС в 2019-2023 рр. Встановлено, що впровадження стратегій «Farm to Fork» та «Біорізноманіття» може зменшити в короткостроковій перспективі в сільськогосподарських підприємствах обсяги виробництва зерна на 9,2 %, насіння олійних культур на 21,0 %, а величину прибутку на 1,02 млрд. дол. США або біля 57,6 дол. США у розрахунку на 1га сільськогосподарських угідь. Запропоновано математична модель для оцінки прийняття рішень щодо вибору пріоритетних напрямів державної підтримки сільськогосподарського виробництва. Практична цінність отриманих у процесі дослідження результатів полягає в можливості їх використанні центральними та регіональними органами виконавчої влади, які проводять аграрну політику, при прийнятті рішень щодо розвитку сільського господарства України

Ключові слова: підприємництво; сталий розвиток; аграрна політика; агропродовольча торгівля; фінансування; євроінтеграція



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Scientific approaches to optimal capital structure justification

Abstract. Maintenance of proportions between equity and debt capital ensures the necessary level of financial independence of enterprises and increases their efficiency. The study aimed to generalise and systematise scientific approaches to determination of the optimal capital structure of an enterprise, analyse their practical significance in modern business conditions, and substantiate the criteria for optimisation of the capital structure to ensure effective financial

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activity. The study used methods of theoretical generalisation, a systematic approach, economic and statistical, comparative, and regression analysis to substantiate the optimal capital structure of an enterprise. The study assessed and analysed the overall capital structure of agricultural enterprises and several specific cases. The density of the relationship between the net profit of an enterprise, the financial leverage ratio, and the share of equity, was determined using the regression analysis method, noting that an increase in the share of debt capital has a negative impact on the net profit of agricultural enterprises, which is determined by an increase in interest payments on loans and an increase in financial risks. The study determined the most rational ratio between equity and borrowed capital based on the example of specific enterprises, as it is impossible to determine a single optimal structure for the industry. The authors' vision of the problem of equity and borrowed capital ratio optimisation was proposed based on the following criteria: profitability of equity and the effect of financial leverage, which characterise the efficiency of capital use under different options for its structure. The practical significance of the study is determined by the applicability of the results in agricultural enterprises, providing effective tools for economic monitoring in the formation of a rational capital structure

Keywords: enterprise; net profit; return on equity; debt capital; financial leverage effect

INTRODUCTION

A crucial aspect of the development of an enterprise, protection of the interests of owners in modern economic conditions is capital. The structure and model significantly affect the financial condition of business entities, including liquidity, solvency and creditworthiness, profitability and profit. Therefore, the determining factor for the successful functioning of enterprises is the presence of a sufficient amount of capital and its optimal structure. In conditions of changing market conditions and high interest rates on bank loans, it is quite difficult for enterprises to form an effective capital structure, but to obtain a positive financial result and ensure the reputation of a "strong player" in the market, the choice of the optimal ratio of equity and borrowed funds in the capital structure is critical.

Economists predominantly address optimisation of the ratio of equity and borrowed capital to ensure the most effective proportionality between profitability and financial stability of enterprises. One of the directions of such research is a dynamic approach to determination of the optimal capital structure. H. DeAngelo *et al.* (2022) noted that this approach incorporates the decision on the optimal ratio between borrowed and equity capital as a dynamic decision that is a response to changes in the value of the company.

Empirical studies conducted in some companies and various industries are notable, as they can be used to verify the proposed theses.

T.S. Msomi (2024) noted that many theoretical and empirical studies on this issue address the effect of capital structure of financial stability of enterprises. The study analysed key performance indicators of the company, comparing them with the volume of equity and debt capital. I. Filimonova *et al.* (2021) highlighted the relevance of the specific conditions of the industry that affect the activities of enterprises. Modern scientists have presented a large number of empirical studies on the influence not only of capital structure, but also of other related factors. In particular, E. Alghifari *et al.* (2022), A. Akhmadi *et al.* (2022) analysed the debt-to-equity, short-term debt to total assets, and the financial leverage ratios. W. Anwar *et al.* (2022), N. Rusnaeni *et al.* (2023) analysed how capital structure affects such indicators of company performance as ROE and ROA. P. Gratton (2025) noted that companies that form their assets using a greater share of equity have a low leverage ratio and a conservative capital structure. Firms that rely predominantly on debt to fund their assets and day-to-day activities exhibit high financial leverage and follow an aggressive capital structure strategy. While elevated leverage and an aggressive financing approach may support faster growth, a more conservative capital structure can produce the opposite outcome. Empirical evidence from companies listed on the Vietnamese stock market provides valuable insights

into this relationship. Drawing on their analysis of the link between capital structure and firm value, T. Bui *et al.* (2023) proposed a set of recommendations for corporate managers, investors, and policymakers regarding the selection of an optimal financing structure.

The Ukrainian economy is in a state of crisis, therefore the priority for Ukrainian enterprises is optimisation of the structure of the capital used, as efficiency planning is initiated by determination of sources of financing. During enterprise operations and asset formation, each enterprise uses not only internal, but also borrowed capital. Therefore, for business entities, the significance of improvement of the capital structure is increasing, since the optimal structure ensures complete utilisation of production capabilities of the enterprise. Structuring the capital of agricultural enterprises can be used for the qualitative and quantitative assessment and determination of the efficiency of use. Yu. Makarenko & D. Klymenko (2022) noted, in optimisation of the capital structure, Ukrainian enterprises should incorporate the following features: many of them have an unsatisfactory financial condition; when forecasting the results of their activities, models are used that do not provide an accurate forecast of the dynamics of financial leverage; significant depreciation of fixed assets requires investments to replace them; existing methods of making investment and financial decisions do not incorporate the interests of the state and enterprise owners.

Determining an appropriate balance between equity and debt financing, developing a mechanism for identifying this balance, and responding promptly and effectively to changes in external conditions are essential for the efficient operation of enterprises and for maintaining stable financial and economic performance. The study aimed to analyse theoretical approaches to determination and improvement of the capital structure of an enterprise and to substantiate the criteria for its optimisation.

LITERATURE REVIEW

The issue of determination of the optimal capital structure of enterprises was substantially covered by a range of studies. In general, the definition of the concept of “capital structure” is

ambiguous and debatable. All economists-scientists define it as the ratio of equity and debt capital. Along with this, the scientific literature mentions many theoretical and methodological approaches to the formation and determination of the optimal capital structure, which is determined by dynamic changes in the market situation and business conditions, as well as the attitude of investors to various types of risks.

Final, balanced answer to the optimal capital structure of enterprises has not been determined. However, since capital is the main source of funds for the functioning and development of any enterprise, the formation of its optimal structure is crucial. In this case, the structural proportions of the equity and debt components are substantial as determinative conditions for the efficient functioning of the enterprise. Optimal ratio between these components provides the required level of profitability and stable financial balance in the process of development.

The modern economic environment is characterised by significant changes and instability, which encourages enterprises to constantly adapt to new conditions, ensuring financial benefits or even basic survival. One of the main possible tools that reduce risks and ensure the stability of the enterprise is the optimisation of the capital structure. A wide range of scientific approaches to determination of capital structure can justify decisions regarding its formation. F. Modigliani & M. Miller (1958) were the first to address this issue. However, for more than half a century it remains as complex as in 1958 (Ezeani *et al.*, 2021).

I. Blank (2012) considered the optimal capital structure as “such a ratio of the use of equity and debt funds, under which an effective proportionality between the coefficients of financial profitability and stability of the company would be ensured, that is, its market value would be maximised”. A similar opinion was expressed by V. Podolska & O. Yarish (2007), defining the optimisation of capital structure as “the ratio between equity and debt capital, which ensures the most effective proportionality between the profitability and financial stability of the company”. Thus, determining the optimal capital structure of an enterprise is an important element of its strategic analysis, which contributes to achieving maximum efficiency of its activities.

Numerous studies created many theories on the optimisation of the capital structure and its impact on the value of the enterprise. E. Konuś *et al.* (2022) believed that the optimal capital structure should be addressed in the context of the value of capital and the enterprise as a whole. Therefore, the study proposed an innovative model for optimisation of the capital structure, using an assessment of its effective value and determining the share of new capital and long-term debt, which maximises the value of capital and minimises its total cost. Z. Palmowski *et al.* (2020) investigated the possibilities of improving the Leland-Toft capital structure optimisation model. Developing an improved model, the authors also proposed to optimise the capital structure covering its value and the value of the enterprise, and also provide certain recommendations on the optimal long-term debt and equity level.

The optimal capital structure that maximises enterprise value reflects a balanced compromise between lower capital costs and higher operating efficiency. T. Minh (2021) determined the cause of consistently low levels of debt among many enterprises and selection of different capital structures within similar fundamentals. Z.A. Khan & I. Hussanie (2018) highlighted establishment of a balance between debt and equity capital as critical and determined its optimal structure to ensure the effective functioning of business entities. L. Cathcart *et al.* (2020) and W. Mbanyele (2021) noted that raising funds contributes to tax savings, but increases the risk of enterprise default, while equity contributes to an increase in the rate of return and, accordingly, a decrease in the value of the enterprise.

R. Bilgin & Y. Dinc (2019) argued that every enterprise possesses a distinct optimal capital structure at which its value is maximised. Accordingly, the optimal capital structure represents a trade-off between the tax advantages of debt financing and the anticipated costs of financial distress. This relationship can be expressed through the leverage ratio, as the extent of debt usage directly influences variations in the return on equity. In most cases, the optimal value of financial leverage is individual for each enterprise. T. Nguyen *et al.* (2021) also noted that when financial leverage deviates

from the optimal capital structure, the value of the company may decrease. However, this correlation theory does not consider situations in which borrowed capital is not used, although the case is rare (Miglo, 2020).

J. Gajdka & M. Szymański (2019) highlighted the fact that determination of the optimal capital structure in the long term is impossible, the reason for which is the influence on its formation of many factors of economic and social content. The influence of industry characteristics, profitability of activity, life cycle of the enterprise, macroeconomic cycles, etc. is also noted. Therefore, enterprises are forced to constantly adapt to changing environmental conditions, for example, along with increasing profitability, reduce financing at the expense of attracted resources.

Analysis of scientific sources and world publications concluded that a significant number of studies did not sufficiently form the optimal capital structure. The main problem of the considered theories and models of capital structure is the impossibility of their application for recommendations on the formation of the optimal capital structure for a particular enterprise. Accordingly, the problems considered in this article are only a certain attempt at further research in the conditions of instability of the Ukrainian economy.

MATERIALS AND METHODS

The study covered the time frame from 2017 to 2023 and was conducted based on data from the official website of the State Statistics Service of Ukraine (n.d.) on the financial and economic activities of agricultural enterprises in Ukraine, Balance Sheet (Financial Statement, Form 1-2) of PJSC “Ternopil’ska Poultry Farm” (Reporting, n.d.), PJSC “Vasylkiv’ska Poultry Farm” (Annual reports, n.d.), PJSC “Poltava Poultry Farm” (Reporting data and audit, n.d.), LLC “Orlovets’ka Poultry Farm” (Small business financial reporting, 2023). The study addressed the activities of agricultural enterprises in Ukraine, namely poultry farms. The selected sample consists of enterprises located in different regions of Ukraine, which unified the results of research for the industry and covers the period 2021-2023. The enterprises were selected because they represent different regions, scales, and

organisational forms of the Ukrainian poultry industry and provide accessible, reliable financial data for comparative analysis. A detailed study of the capital structure was conducted using the example of PrJSC "Ternopil'ska Poultry Farm", which was used for an in-depth analysis of the features of the formation and optimisation of the capital structure.

The study was conducted in accordance with several key principles, including the selection of research directions based on scientific approaches to identifying an optimal capital structure, the formulation of objectives aimed at substantiating ways to optimise enterprise capital structure, and the accumulation of empirical evidence through the collection, processing, and systematisation of statistical data presented in tabular and graphical form. Theoretical generalisation involved a review and analysis of relevant studies and publications covering the period from 2017 to 2023. To accomplish the stated objective, a range of research methods was applied. The monographic method was used to provide a comprehensive analysis of the capital of agricultural enterprises in Ukraine and to examine trends in equity and debt capital. The system-structural analysis method was employed to identify relationships among the key components of capital structure and to substantiate their influence on the financial performance of agricultural enterprises. The calculation and constructive method was applied to financial and economic computations, including the assessment of financial leverage and profitability indicators. The effectiveness of financial leverage is determined using formula 1:

$$EFL = (1 - Spp) \times (KVRa - SVK) \times \frac{ZK}{VK}, \quad (1)$$

where *EFL* – effect of financial leverage, which consists in the increase in the return on equity ratio (increase in return on equity using borrowed capital), %; *Spp* – income tax rate; *KVRa* – gross asset return ratio, which is determined by the ratio of gross profit to the average cost of assets; *SVK* – average interest rate on the loan paid by the enterprise for the use of borrowed capital; *ZK* – average amount of borrowed (borrowed) capital used by the enterprise; *VK* – average amount of the enterprise's equity.

The regression analysis method was also applied, with the help of which the density of the relationship between the net profit of agricultural enterprises, the financial leverage ratio and the share of the enterprise's equity capital was established. For calculation, Formula 2 was used, for a linear model – Formula 3:

$$E = f(x) \cdot \frac{\bar{x}}{\bar{y}}, \quad (2)$$

$$E = a_1 \cdot \frac{\bar{x}}{\bar{y}}. \quad (3)$$

The method of logical generalisation was used for the formation of conclusions and proposals. Microsoft Excel software was used for statistical processing of the research results. These methods in combination provide scientific validity, practical orientation and depth of analysis in the formation of the optimal capital structure at the enterprise.

RESULTS AND DISCUSSION

The desire of enterprises for economic independence requires priority on capital source management. It is undeniable that the capital structure is central in the development of modern Ukrainian enterprises, but there is no universal method for its optimisation as of 2025. Incorporating the opinion of economists and the practical experience of the studied agricultural enterprises, it is possible to consider the most optimal ratio between the elements of capital, which is determined on the basis of influencing factors, economic risks, practical experience, which can bring the target capital structure as close as possible to its optimal value.

Regulation of the capital structure of an enterprise is usually conducted in two directions: by substantiating the optimal proportions between equity and debt capital; attracting the necessary volumes of equity and debt capital to achieve the target structure (Wang, 2024). Hence, the process of regulating the capital structure involves the process of optimisation. The optimal capital structure depends on the asset financing policy chosen by the enterprise, which includes (Ma & Xu, 2020; Ndruru & Ananda, 2025):

a) a conservative approach, which assumes that the financing of non-current assets, the

constant part of current assets and half of the variable part of current assets is conducted at the expense of internal and long-term borrowed capital, and the financing of the second half of the variable part of current assets should be conducted at the expense of short-term borrowed resources. This financing model ensures a high level of financial stability of enterprises in the process of their development;

b) the moderate (or compromise) approach presumes that non-current assets and the permanent portion of current assets are financed through internal funds and long-term borrowings, while the variable component of current assets is covered by short-term debt. This financing model ensures a satisfactory level of financial stability for enterprises;

c) the aggressive approach stipulates that non-current assets are financed exclusively by internal resources and long-term borrowed capital, whereas current assets are financed through short-term borrowings. Although this model reduces the reliance on equity capital, it may create challenges related to maintaining enterprise solvency and financial stability.

Therefore, the effectiveness of capital management significantly depends on the selected methods and methodological approaches to optimising the capital structure. Factor analysis determined the components of the impact on the performance indicator, in particular to identify reserves for increasing the profitability of enterprise assets. When forming the optimal capital structure, enterprises must incorporate the existing financial market

conditions and be able to respond promptly to their changes (Aleskerova *et al.*, 2020; Davydenko *et al.*, 2021). This is relevant in times of crisis and instability, such as full-scale military operations in Ukraine, which radically affected the change in the conditions of such a market (Didukh & Fedorova, 2023).

Agricultural enterprises of Ukraine are no exception in this situation. Thus, after economic growth in 2021, military operations from 2022 affected the capital structure of agricultural enterprises. Due to reduced financing and disruption of logistics chains, a significant number of enterprises were forced to revise their investment strategies. In particular, a significant part of the assets was redirected to production safety, and part of the working capital was allocated to restoration of damaged property of enterprises and infrastructure.

Under martial law, the role of state programmes to support and lend to agricultural enterprises increased, which affected changes in the ratio of internal and borrowed capital. To preserve jobs and production capacities, individual farms attracted additional sources of financing, in particular grants and international assistance. In general, military actions necessitated the adaptation of the capital of agricultural enterprises to new realities, including increased attention to diversifying its sources. As shown by the analysis of the dynamics of the equity capital of agricultural enterprises in Ukraine (Fig. 1), significant changes occurred in 2017-2023 due to economic, political, and in recent years, as noted earlier, also due to military factors.

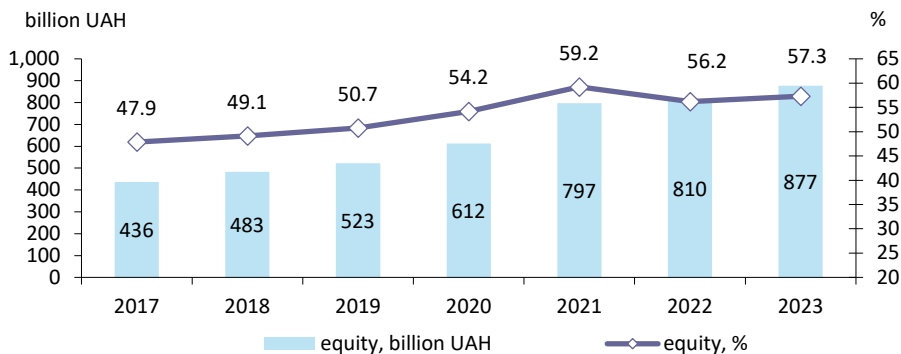


Figure 1. Dynamics of equity of agricultural enterprises of Ukraine

Source: data from the State Statistics Service of Ukraine (n.d.)

From 2017 to 2021, there has been a gradual increase in the share of equity from UAH 436 billion to UAH 877 billion, which indicates a favorable trend in the financial stability of enterprises. Equity grew on average by ~ UAH 70-80 billion annually, with the exception of 2019, when the growth rate was relatively lower. From 2021, on the contrary, the pandemic and global economic difficulties led to a slight decrease in it (Fig. 1). It is worth noting that 2021 was one of the most successful, which ensured survival of farmers of 2022 and, despite military operations, provide profits. In 2017, the share of equity in the financing structure was 47.9%, in 2021 it reached its highest value – 59.2%, and in 2023 – 57.3%, which indicates a gradual increase in the independence of enterprises from attracted sources of financing. Thus, the analysis of the dynamics of equity capital of agricultural enterprises in Ukraine shows that even when the national economy was

experiencing significant challenges (COVID-19 pandemic, war), it continued to grow, which demonstrates the high adaptability of the agricultural sector. The positive dynamics of capitalisation even in conditions of economic shocks reflects the stability and investment attractiveness of agricultural enterprises.

The overall dynamics of the capital of agricultural enterprises indicates a significant increase in current liabilities and collateral by almost 68% from UAH 912 billion in 2017 to UAH 1,531 billion in 2023. Along with this, long-term liabilities and collateral have not undergone significant changes during this period. The seasonal nature of production requires farmers to make significant financial investments, therefore, as a rule, they more often use short-term loans for the purchase of fertilisers, plant protection products, and fuel for the sowing and harvesting company (Fig. 2).

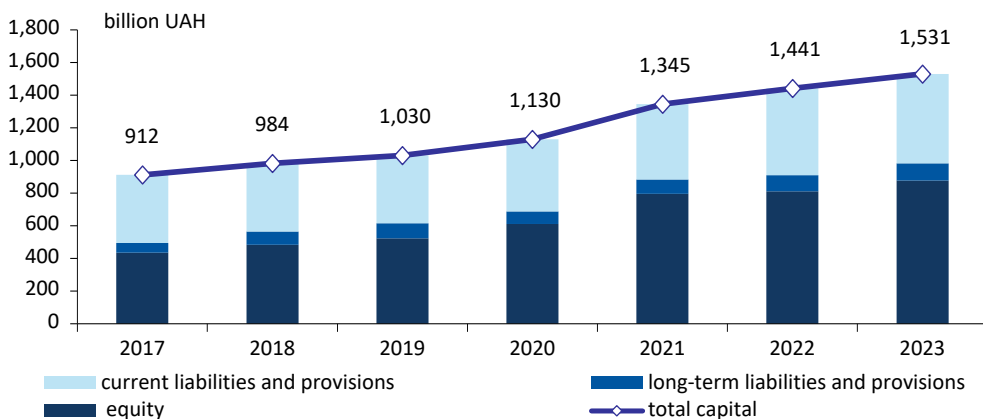


Figure 2. Dynamics of internal and borrowed capital of agricultural enterprises of Ukraine

Source: data from the State Statistics Service of Ukraine (n.d.)

The trend of stable growth in equity indicates the strengthening of the financial independence of enterprises. Current liabilities and collateral account for the largest share of the attracted resources. The insignificant share of long-term liabilities in the capital structure may indicate the limited use of long-term credit instruments in financing the agricultural sector. Thus, changes in the capital structure indicate a strengthening of the role of enterprise funds while maintaining a relatively

stable level of current and long-term liabilities. Such dynamics indicate an increase in the financial stability of the agricultural sector. Given that the capital of enterprises is used for the purpose of making a profit, a regression analysis was conducted and the density of the relationship between the net profit of agricultural enterprises, the financial leverage ratio and the share of the enterprise's equity was established (Table 1). Formulas 1, 2 and 3 were used for the calculations.

Table 1. Parameters of the regression equation and their estimation

Factors	Equation parameters		Correlation coefficient (R)	Coefficient of determination (R ²)	F-test	Elasticity coefficient (R ²)
	a ₀	a ₁				
X1 – financial leverage ratio	380.74	-303.95	0.726	0.527	6.449	-2.57
X2 – share of equity capital, %	-486.33	11.21	0.756	0.571	7.334	5.56

Source: calculated by the authors

The level of density of the relationship between the effective characteristic and the specified factors was indicated by the correlation coefficient. The values for X1 (financial leverage coefficient) $R = 0.53$ and for X2 (share of equity capital) $R = 0.57$ indicate a moderate density of the relationship between these factors (Table 1). According to the Fisher criterion, the dependence equations are statistically significant when the calculated values of the F-criterion for X1 (6.449) and X2 (7.334) exceed the tabulated $F_{gr} = 5.99$ with a probability of 95%. The elasticity coefficient shows the percentage change of the effective characteristic (Y) on average when the factor characteristic (X) changes by 1%. The regression analysis indicates that an increase in the financial leverage ratio by 1% leads to a decrease in the performance indicator (net profit) by 2.57%, an increase in the share of equity by 1 percentage point causes an increase in net profit by 5.56% relative to the average values in the sample. The results of the analysis indicate the influence of financial leverage and capital structure on the net profit of the enterprise. Thus, the value of financial leverage (-2.57) indicates that an increase in the share of borrowed capital negatively affects net profit, which is associated with an increase in interest on loans and financial risks in conditions of military operations. The positive effect of equity (+5.56) indicates that enterprises with a higher share of equity demonstrate better financial results. In this case, it is appropriate to recall the classical financial principle: increasing the share of attracted capital contributes to increased profitability under normal production conditions, but excessive dependence on it leads to increased financial risks and a decrease in net profit.

Enterprises that maintain an optimal capital structure are better positioned to enhance their financial development potential and to increase the return on equity through the application of financial leverage. Financial leverage reflects the extent to which borrowed funds are employed and directly influences changes in equity profitability. A higher degree of leverage indicates a larger proportion of debt financing and, consequently, greater interest obligations. Assessing the effect of financial leverage therefore enables an evaluation of the effectiveness of using borrowed capital to improve returns on equity. However, it is necessary to establish a boundary between the benefit from using borrowed funds and the risk of reducing the financial stability of the enterprise (Polishchuk & Zabolotna, 2023). The strength of the action of financial leverage is determined by the increase in the profitability of equity capital as a result of attracting borrowed funds. This method of calculation is quite widely used in continental European countries.

The research on capital structure optimisation focused on agricultural enterprises in Ukraine representing diverse forms of ownership and management. Nevertheless, given the substantial differences in financial and economic conditions, scale of operations, organisational and legal structures, and access to financial resources, the authors conclude that the development of a single universal model of optimal capital structure for such enterprises is not feasible. Therefore, a detailed study of the capital structure was conducted on the example of a specific enterprise – PJSC “Ternopil’ska Poultry Farm” for 2021-2023, which provided an in-depth analysis of the features of the formation and optimisation of the capital structure in modern conditions of economic activity (Table 2).

Table 2. Dynamics of capital cost assessment indicators of PJSC “Ternopil’ska Poultry Farm”

Indicators	2021	2022	2023
Amount of capital used (assets), million UAH	644.0	691	862

Table 2, Continued

Indicators	2021	2022	2023
Equity, million UAH	459.1	499	697
Share of equity, %	71.3	72.2	80.8
Debt capital, million UAH	184.9	193	166
Gross profit (excluding interest on loan), million UAH	51.4	106	461
Amount of interest paid for the use of debt capital, million UAH	24.8	35.8	23.5
Interest on loan, %	13.4	18.6	14.2
Gross return on assets, %	8.0	15.4	53.5
Financial result before tax, million UAH	26.6	70.6	437.3
Profit tax rate, decimal fraction	0.18	0.18	0.18
Net profit, million UAH	21.7	57.9	358.0
Return on equity, %	4.7	11.6	51.4
Financial leverage ratio	0.403	0.386	0.238
Increase in return on equity with the use of debt capital, %	-1.8	-1.0	7.6

Source: calculated by the authors based on Reporting (n.d.)

The results of the calculations show (Table 2) that during the period under study, the company's assets increased by 33.9%, and a fairly significant increase in equity by 51.8% was also observed. The share of equity increased from 71.3% to 80.8%, which indicates an improvement in the financial stability of the company. As for borrowed capital, in 2023, compared to 2021, it decreased by UAH 18.8 million, and compared to 2022 – by UAH 27 million. Accordingly, the financial leverage ratio decreased during the analysed period, which in 2023 was 0.238, compared to 0.403 in 2021, which is a positive phenomenon. It is worth noting a significant increase in gross profit – 9 times, financial result before tax – 16 times, net profit in 2023 amounted to UAH 358 million compared to UAH 21.7 million in 2021. The increase

in these indicators is usually a positive phenomenon, but it is worth noting that the price factor has a significant impact on this situation, since the growth of income is mainly due to an increase in product prices, which indicates the dependence of the company's financial results on external market conditions. As a result, the return on equity increased from 4.7% to 51.4%, and the gross return on assets – from 8% to 53.4%. Thus, in 2023, the financial results of the studied enterprise significantly improved due to a decrease in borrowed capital, which contributed to a reduction in financial risks, increased profitability and efficiency of asset use. To substantiate the optimal capital structure of PJSC "Ternopil'ska Poultry Farm", an analysis of various options for the ratio of equity and debt capital was conducted (Table 3).

Table 3. Options for optimisation of the capital structure of PJSC "Ternopil'ska Poultry Farm"

Indicators	Options						
	1	2	3	4	5	6	7
Amount of capital used (assets), UAH million	862	862	862	862	862	862	862
Share of equity, %	100	90	80	70	60	50	40
Equity, UAH million	862	776	690	604	517	431	345
Debt capital, UAH million	0	86	172	259	345	431	517
Gross profit (excluding interest on the loan), UAH million	461	461	461	461	461	461	461
Interest on the loan, %	-	14.2	14.2	14.2	14.2	14.2	14.2
Gross return on assets, %	53.5	53.5	53.5	53.5	53.5	53.5	53.5
Amount paid for the use of borrowed capital, UAH million	0	12.2	24.4	36.8	49.0	61.2	73.4
Amount of gross profit including interest on the loan, UAH million	461.0	448.8	436.6	424.2	412.0	399.8	387.6

Table 3, Continued

Indicators	Options						
	1	2	3	4	5	6	7
Profit tax rate, decimal fraction	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Net profit, UAH million	378.0	368.0	358.0	347.8	337.8	327.8	317.8
Return on equity, %	43.9	47.4	51.9	57.6	65.3	76.1	92.1
Financial leverage ratio	0.00	0.11	0.25	0.43	0.67	1.00	1.50
Increase in return on equity with the use of borrowed capital, %	0.0	3.6	8.0	13.8	21.5	32.2	48.3

Source: calculated by the authors based on Reporting (n.d.)

From the theoretical point of view, the optimal capital structure of an enterprise should form such conditions under which this enterprise will be able to receive maximum profit at the lowest costs for its formation. However, analysis of the options for optimisation of the capital structure of PJSC “Ternopil’ska Poultry Farm” determined that the highest net profit (UAH 378.0 million) the enterprise will be able to receive in the event of a complete absence of borrowed capital. However, in the conditions of modern challenges this is an unrealistic scenario, because for its development the enterprise needs significant investments that can help conduct a successful business. Moreover, the results of the study show that a gradual decrease in the share of equity capital leads to a decrease in the enterprise’s profit, with an increase in the share of borrowed capital, the return on equity will decrease. According to the calculation results, it is worth noting that the optimal capital structure, other things being equal, should balance between net profit and financial risks. In market conditions, the attention of enterprises is focused on making a profit. As shown in Table 3, with an increase in the share of borrowed capital in the asset structure,

net profit decreases, and the financial leverage ratio increases. This eliminates the possibility of determining the optimal ratio of equity and borrowed capital.

The results of the regression analysis determined that an increase in the share of borrowed capital has a negative impact on the net profit of the enterprise, which is associated with an increase in loan payments. Enterprises prioritise a source of higher hierarchy during selection of financing, implying lowest costs and risks. Accordingly, external sources of financing are used after the full involvement of internal ones. Although the largest amount of net profit is provided in the absence of borrowed capital in the studied enterprise, this option is not possible for agricultural enterprises in the current conditions, given the economic and political situation in the country. In addition, when using combined sources for capital formation, the efficiency of the enterprise’s activities increases. Therefore, further research is focused on analysing the performance of enterprises in one industry: PJSC “Vasylkiv’ska Poultry Farm”, PJSC “Poltava Poultry Farm”, LLC “Orlovetska Poultry Farm” and the previously considered PJSC “Ternopil’ska Poultry Farm” (Table 4).

Table 4. Indicators of capital cost assessment, 2023

Indicators	PJSC “Vasylkiv’ska Poultry Farm”	PJSC “Poltava Poultry Farm”	LLC “Orlovetska Poultry Farm”	PJSC “Ternopil’ska Poultry Farm”
Amount of capital used (assets), thousand UAH	32,333	1,046,732	28,555	862,000
Share of equity, %	32.9	91.7	45.3	80.8
Equity, thousand UAH	10,628	960,017	12,946	697,000
Debt capital, thousand UAH	21,705	86,715	15,609	166,000
Gross profit (excluding interest on the loan), thousand UAH	2,969	94,580	11,430	461,000
Interest on the loan, %	13.4	16.1	14.3	14.2
Gross return on assets, %	9.2	9.0	40.0	53.4

Table 4, Continued

Indicators	PJSC "Vasylkivska Poultry Farm"	PJSC "Poltava Poultry Farm"	LLC "Orlovetska Poultry Farm"	PJSC "Ternopilka Poultry Farm"
Amount paid for the use of borrowed capital, thousand UAH	2,908.5	13,961.0	2,232.1	23,500
Amount of gross profit including interest on the loan, thousand UAH	60.6	80,619	9,198.0	437,300
Amount of income tax, thousand UAH	10.9	14,527.0	1,655.6	79,300
Income tax rate, %	0.18	0.18	0.18	0.18
Net profit, thousand UAH	49.7	66,092	7,542.6	358,000
Return on equity, %	0.5	6.9	58.3	51.4
Financial leverage ratio	2.042	0.090	1.206	0.238
Increase in return on equity with the use of borrowed capital, %	-7.1	-0.5	25.4	7.6

Source: calculated by the authors based on Reporting (n.d.), Annual reports (n.d.), Reporting data and audit (n.d.), Small business financial reporting (2023)

The highest return on equity (58.3%) and financial leverage (25.4%) is achieved by LLC "Orlovetska Poultry Farm", where the share of equity is 45.3%. Moreover, a high level of return on equity and financial leverage, 51.4% and 7.6%, respectively, was achieved by PJSC "Ternopilka Poultry Farm" with an equity share of 80.8%. PJSC "Poltava Poultry Farm" and PJSC "Vasylkivska Poultry Farm" have low profitability of equity and are unable to ensure its growth, as evidenced by the negative value of the financial leverage effect. Notably, PJSC "Ternopilka Poultry Farm" and PJSC "Poltava Poultry Farm" have the most similar capital structure among the considered enterprises, but radically different financial indicators. A similar example is the results of LLC "Orlovetska Poultry Farm" and PJSC "Vasylkivska Poultry Farm", in which a similar trend is observed. Therefore, even with a low share of equity, high profitability can be achieved by utilising high efficiency, while reasonable use of borrowed capital provides a positive effect of financial leverage.

X. Li (2024) addressed capital-intensive enterprises with unique characteristics in terms of capital structure, which is a combination of debt and equity capital financed by operating activities. This study also considered capital-intensive enterprises that require significant investment in land, fixed assets, etc. The results obtained indicate that a high level of debt increases financial risks. Accordingly, such enterprises have high operating leverage, and a

balanced capital structure can help mitigate such risks. Q. Shi (2023) conducted an in-depth study of the capital structure of listed companies. Research identified a non-linear relationship between corporate performance indicators and the leverage ratio within the capital-intensive real estate sector. The present study does not address this dimension, as it concentrates on analysing the capital structure of agricultural enterprises. Although capital-intensive industries share certain structural characteristics, the optimal balance between debt and equity is inherently industry-specific and therefore varies across sectors.

A. Bueno-Ferrer & J. de Pablo Valenciano (2025) emphasised that the variables ROA and business size have no effect on capital structure. The study also emphasised the activities of enterprises of different sizes and its results coincide with those indicated. J.N.J. En & N.I.A. Malek (2021) and N.A. Ramli *et al.* (2022) proved a significant relationship between capital structure and its efficiency. The study also noted that business entities should consider various options for optimising capital structure, which ensure high efficiency of their activities. The study by J. Mazanec (2023) compares models from different industries, including agriculture, that describe how capital structure affects business performance. The study, similarly to aforementioned, emphasises the need for equity to prevail over external liabilities, which contributes to increased performance.

C.D. García-Gómez *et al.* (2021) emphasised that the existing theoretical and empirical research on capital structure is incomplete. And the effect of excessive leverage negatively affects business efficiency. This study also assumes that in practice it is impossible to determine the optimal capital structure of the enterprise, and an increase in the financial leverage ratio leads to a decrease in net profit. Therefore, both studies reflect current trends and have common conclusions. H. Kryshchal *et al.* (2025) demonstrated that the war has negatively affected agricultural enterprises' access to financing and increased credit risks. This study determines that a higher share of borrowed capital reduces profitability and requires an individually balanced capital structure. Both studies emphasise that, in war-time conditions, the significance of an optimal capital structure and cautious use of debt becomes especially critical. According to L. Zhi Wei & B. Naysary (2021) the choice of capital structure is vital for the survival, stability and resilience of the enterprise. E. Hernawati *et al.* (2023) emphasise the significance of such decisions for its future development. The present study also examined an optimal capital structure aimed at achieving a balance between internal and external sources of financing. Nevertheless, the effect of such a structure on maximising enterprise value was not assessed and may therefore constitute a direction for future research.

According to the calculations, when determining a rational capital structure, it is worth analysing the profitability of equity and the effect of financial leverage, which reflect the efficiency of capital use under different structural configurations. The analysis shows that an excessive increase in borrowed capital reduces net profit due to higher financial costs and risks, while an adequately balanced share of equity strengthens financial stability and improves performance. Therefore, achieving an optimal capital structure requires finding a balance between the benefits of using debt and the potential threats it poses to the enterprise's financial sustainability.

CONCLUSIONS

The study revealed that the optimal capital structure depends on the asset financing policy

of the enterprise, which includes various methodological approaches, in particular conservative, moderate, aggressive. However, there is no universal formula for determining the optimal capital structure for a company. Firms may pursue varying objectives, which in turn shape their financing decisions. In addition, the same company may face different market conditions, opportunities, and challenges that require adjustments to its capital structure.

Each business entity should consider options for optimisation of the capital structure, which ensure high efficiency of activity. However, the capital optimisation process must incorporate not only the ratio between internal and borrowed resources, but also the influence of factors on the choice of capital structure, which will minimise risks and increase the efficiency of management decisions aimed at ensuring the financial stability and profitability of the enterprise. Factor analysis can be used to determine the components of the impact on the performance indicator. The findings of the correlation and regression analysis show that a 1% increase in the financial leverage ratio results in a 2.57% decline in the performance measure, namely net profit, while a one percentage point rise in the share of equity leads to a 5.56% increase in net profit relative to the sample mean. In line with the study's objectives, an evaluation of the capital structure of agricultural enterprises in Ukraine was subsequently undertaken. The study determined that determination of the optimal structure is impossible in general, therefore further research was specified on enterprises in the poultry industry.

Analysis of the dynamics of the capital cost assessment indicators of PJSC "Ternopil'ska Poultry Farm" shows that over the past three years the share of equity in the total value of assets has been increasing. At the same time, both the return on equity and the effect of financial leverage show an upward trend. An evaluation of alternative approaches to optimising the enterprise's capital structure indicates that a reduction in the proportion of equity results in lower profitability, while an increase in the share of borrowed capital leads to a decline in return on equity. As a result, identifying an optimal balance between equity and debt capital is not feasible.

Therefore, the next step in determination of the optimal capital structure was the analysis of the results of the activities of poultry enterprises with different capital structures. The analysis established that in determination of a rational structure, it is worth emphasising the profitability of equity and the effect of financial leverage, which characterise the efficiency of capital use under different options for its structure. Attraction of additional debt capital is advisable provided that net profit provides a sufficient level of financial stability of the enterprise, because excessive debt burden can lead to a decrease in liquidity and dependence on creditors.

Therefore, in the context of the dynamism of the external environment, in practice it is impossible to determine the optimal capital structure, so this ratio should be based on a deep

analysis of the financial indicators of the enterprise. Prospects for further research include the development of adaptive models for optimisation of capital structure, incorporating industry characteristics and changes in the macroeconomic environment, as well as in studying the impact of capital structure on the financial stability of enterprises in conditions of economic instability.

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Наукові підходи до обґрунтування оптимальної структури капіталу

Анотація. За умови дотримання певних пропорцій між власним і позиковим капіталом забезпечується необхідний рівень фінансової незалежності підприємств та підвищується ефективність їхньої діяльності. Метою статті було узагальнення та систематизація наукових підходів до визначення оптимальної структури капіталу підприємства, аналіз їхньої практичної значущості в сучасних умовах господарювання та обґрунтування критеріїв оптимізації структури капіталу для забезпечення ефективної фінансової діяльності. В дослідженні були використані методи теоретичного узагальнення, системного підходу, економіко-статистичного, порівняльного та регресійного аналізу для обґрунтування оптимальної структури капіталу підприємства. В межах дослідження було здійснено оцінку та аналіз структури капіталу в цілому в сільськогосподарських підприємствах і в конкретних підприємствах зокрема. Визначена за допомогою методу регресійного аналізу щільність зв'язку між чистим прибутком підприємства, коефіцієнтом фінансового левериджу та часткою власного капіталу свідчить, що збільшення частки позикового капіталу має негативний вплив на чистий прибуток аграрних підприємств, що зумовлюється збільшенням сплати відсотків по кредитах і посиленням фінансових ризиків. Автори здійснили спробу визначити найбільш раціональне співвідношення між власним і залученим капіталом на прикладі конкретних підприємств, оскільки єдину оптимальну структуру по галузі визначити неможливо. Запропоновано авторське бачення проблеми оптимізації співвідношення власного та позикового капіталу на основі наступних критеріїв: рентабельність власного капіталу та ефект фінансового левериджу, які характеризують ефективність використання капіталу за різних варіантів його

структури. Практичне значення дослідження полягає в тому, що його результати можуть бути використані сільськогосподарськими підприємствами для розробки ефективних інструментів економічного моніторингу при формуванні раціональної структури капіталу

Ключові слова: підприємство; чистий прибуток; рентабельність власного капіталу; позиковий капітал; ефект фінансового левериджу



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Analytical assessment of trends and prospects of the sunflower seed market in Ukraine under current challenges

Abstract. The sunflower market is a strategic segment of Ukraine's agrarian economy and has undergone sharp transformations under contemporary challenges, especially during the war. The purpose of the study was to conduct an analytical assessment of the trends and prospects of the sunflower seed market in Ukraine. Market indices were used to evaluate pre-war and wartime dynamics, while linear regression revealed price linkages between sunflower seed and sunflower oil. Obtained results showed that since 2022, sunflower seed exports increased due to several factors: disruption of processing facilities, blocked ports, urgent need for revenue, supply shortages, and changes in export policy. During this period, both sunflower seed and sunflower oil prices rose significantly. The Black Sea Grain Initiative (July 2022) restored agricultural trade flows, leading to a price decrease. Simultaneously, the EU Autonomous Trade Measures (ATMs) temporarily removed import duties and quotas on Ukrainian products, supporting exports. However, ATMs termination in June 2025 may reintroduce tariffs and quotas, potentially reshaping trade conditions. Despite risks, sunflower seed production remains highly profitable, with profitability ranging from 35-50% in recent years, motivating enterprises to expand cultivation. Regression analysis confirmed strong price interdependence: a 1 UAH/t increase in seed prices raises oil prices by 1.47 UAH/t. Overall, Ukraine retains strong potential to expand its sunflower seed market, especially through greater domestic processing into sunflower oil for export. The practical significance of the study lies in the fact that its results can be used: by producers – to gain a better understanding of the trends and current situation in the sunflower seed market; by government institutions – for the development of effective agricultural policy, particularly in the area of infrastructural investments; by the academic community and students – to deepen their knowledge of agricultural markets and methods of their analysis

Keywords: export; sunflower seed production; analysis; prices; regression model

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INTRODUCTION

Sunflower seed is one of the leading oilseed crops in the agricultural sector of Ukraine, playing a key role in both domestic agriculture and export-oriented trade. Ukraine traditionally holds leading positions in the world in terms of production and export of sunflower oil, which determines high attention to the state and dynamics of this market. In conditions of wartime, changes in logistics routes, fluctuations in raw material prices and global transformations in food chains, analysis of the sunflower market acquires particular importance. Research on the sunflower seed market is essential from both an economic and social standpoint. This crop provides a significant share of foreign exchange earnings to the state budget and is a source of employment for agricultural enterprises, processing enterprises, and logistics companies. In addition, the stability and competitiveness of the sunflower seed market affect food security both domestically and internationally, especially in the context of sunflower oil exports. Ukraine producing approximately 42% of all sunflower seeds in the world, and export of processed sunflower oil accounted to 45% of the world's sunflower oil (Ukroilprom, 2025). This highlights Ukraine's unique role in international food chains, and explains why changes in logistics, prices, or acreage have far-reaching global consequences.

V. Petrenko *et al.* (2024) concluded that at present, sunflower seed and sunflower oil remain the most profitable segment of Ukraine's agricultural sector, consistently attracting strong global demand. However, sunflower cultivation and processing have been the most heavily affected by the consequences of the war, as sunflower seed account for an average of 62% of the total oilseed cultivation area in the country. The need for further research in competitiveness on the global oilseed market to enhance understanding and optimise competitiveness in the dynamic oilseed industry was highlighted in their research by E. Kastakova *et al.* (2023). Based on the competitiveness index, they concluded that Paraguay, Brazil, Argentina, and Ukraine achieved the greatest competitiveness in the studied period 2010-2020. W. Wilson *et al.* (2025) substantiated that shifts in agricultural practices and policy frameworks, changes influencing

economies of scale, and the dynamic nature of the global market environment have all contributed to reshaping the industry.

An ex-post evaluation of the effects of the Russia's invasion of Ukraine on global grain and oilseed trade was conducted by S. Ahn *et al.* (2023). Applying a commodity-level empirical approach, they estimated counterfactual trade flows and analysed the regional patterns of global trade reallocation. The findings indicated that the war led to significant trade diversion, with North American and European countries emerging as the main beneficiaries. In turn, J.W. Glauber & D. Laborde Debucquet (2023) stated that as long as the war continues, Ukraine's agriculture will continue to operate at a limited level. Shortfall in exports will need to be compensated by other suppliers; otherwise food prices are likely to stay elevated. O. Makarchuk & T. Kuts (2022) evaluated factors that influence on Ukrainian sunflower oil prices. They conducted price analysis based on domestic sunflower seed prices and European sunflower oil prices. The obtained results showed that European sunflower oil prices Granger-causes Ukrainian sunflower oil price. M. Hamulczuk *et al.* (2023) evaluated the market integration using the ARDL-ECM approach. The obtained results confirmed the existence of a long-run equilibrium relationship between the Ukrainian sunflower oil prices and the European prices. In the long-run, a 1% increase in European sunflower oil prices influence the growth of the Ukrainian sunflower oil prices varying from 0.91% to 1.00%.

The purpose of the study was to analyse trends and prospects of the sunflower market in Ukraine in the frame of current challenges that have appeared due to the war and volatility on global markets. To achieve the goal of the research, the following objectives were set: (1) data collection and analysis of main indicators of sunflower market in Ukraine; (2) analysis of sunflowerseed prices and comparative characteristics of oilseeds profitability in dynamics before the war and during the war; (3) application of regression model to find the linkage among Ukrainian oilseeds prices and Ukrainian sunflower oil prices within the further generalisation of getting results to highlight prospects

of the sunflower seed market in Ukraine in the frame of war time. This integrated approach enabled a deeper understanding of price transmission mechanisms and offered data-driven insights into the market's short- and medium-term prospects.

MATERIALS AND METHODS

The methodological framework of the study combined statistical, econometric, and analytical approaches to ensure a comprehensive assessment of the sunflower seed market in Ukraine under current challenges. Statistical methods were applied to collect, structure, and analyse official data from national and international sources (State Statistic Service of Ukraine, n.d.; APK-inform, n.d.; USDA-FAS, n.d.) regarding production volumes, export dynamics, and price trends for sunflower seed and sunflower oil. Comparative analysis was used to identify differences and similarities in the behaviour of key indicators to analyse the market across the pre-war and wartime periods (2020-2025), which enabled the evaluation of structural transformations in Ukrainian sunflower seed market. To analyse the profitability of oilseeds in Ukraine, the period from 2019 to 2025 was considered.

Since the successful functioning of agricultural enterprises in the market depends on high product prices and profitability, the dynamics of sunflower seed and sunflower oil prices were analysed. Connection detection among these products prices provided an opportunity to apply regression model, which, in turn, showed how strong one price influenced to another. Thus, econometric modelling, specifically linear regression analysis, was implemented to quantify the relationship between sunflower seed and sunflower oil prices and to reveal the degree of their interdependence. Monthly data of variables were presented from 2022 until July 2025, where source of information was the APK-inform (n.d.). There was linear regression model applied:

$$Y = \beta_0 + \beta_1 X + \varepsilon, \quad (1)$$

where Y – sunflower oil prices, X – sunflower seed prices, β_0 – value of Y when $X = 0$, β_1 – value that shows how much Y changes for a unit change in X , ε – residuals. When P-value for

parameter β_1 is lower than the critical value of 0.05, it will confirm that the model is significant. In the model the value of R-squared indicates how reliable the model's predictions fit the actual data. R-squared value that is close to 1 suggests a better fit and means the model's values accuracy.

In addition, forecast analysis was applied to assess potential market prospects under the scenario of termination of the EU Autonomous Trade Measures, focusing on possible tariff and quota implications for Ukrainian exporters. Ultimately, the abstract logical method was used to generalise the obtained results, interpret causal relationships, and formulate conclusions and recommendations for the further development of the sunflower market in Ukraine. Comparative analysis was used to assess the dynamics of market indicators in the pre-war and wartime periods. Elements of economic forecasting were used to estimate market prospects considering the potential termination of the EU Autonomous Trade Measures. Therefore, the use of various scientific tools provided the possibility to conduct study on dynamics and prospects of the sunflower seed market in Ukraine.

RESULTS AND DISCUSSION

Sunflower seed production is of strategic importance for the agrarian economy of Ukraine. It is one of the most profitable crops, traditionally providing high gross yields and occupying a leading position in the structure of sown areas. Ukraine is a world leader in the production and export of sunflower oil, which forms a significant part of the country's foreign trade agricultural balance. In addition, the development of this segment stimulates related industries, in particular, the processing industry, transport and logistics infrastructure, and export-oriented trade. According to the USDA forecast, global sunflower seed production is expected to reach 56.3 mln t in 2025/2026 marketing year (MY), that is 3.9 mln t higher than in 2024/2025 MY (Fig. 1). This forecast was driven by higher yields compared to previous year, where weather conditions in the main Black Sea growing region declined sunflower seed production (USDA report, 2025). The harvested area was forecast to increase slightly in the 2025/2026 MY compared with the previous year.

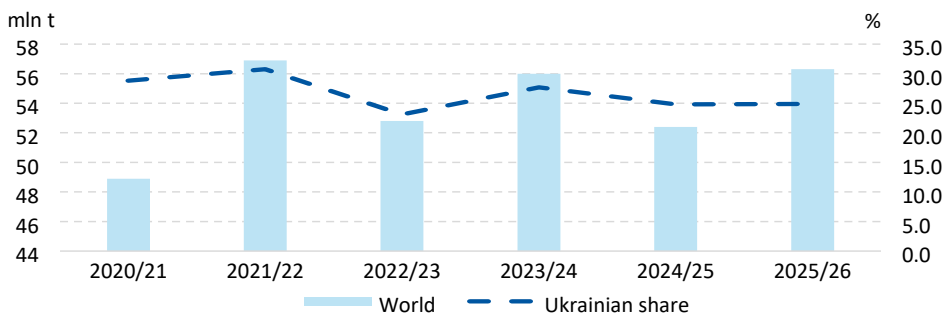


Figure 1. Trends in global sunflower seed production and Ukrainian share

Source: author's presentation based on USDA-FAS (n.d.)

Since the beginning of the war in Ukraine in 2022, various factors affected sunflower seed product exports, which include disruptions to logistics and varying government policies regarding trade restriction and promotion (Nechyporuk *et al.*, 2023). In turn, these factors have affected global prices. Following the sharp increase in prices in 2022, driven by limited access to Ukrainian grain, the implementation of the Black Sea Grain Initiative and the operation of the export corridor facilitated a revival of trade, which, in turn, led to a significant decrease in prices in the period from 2023 to 2024.

After the termination of the preferential trade policy (ATMs) with the EU on June 5, 2025, the following changes were expected (European Commission, 2025): (1) return of tariffs and quotas products, including sunflower seed, sunflower oil, corn, sugar, honey, poultry, etc; the quota limit for key products to be reduced, i.e., corn from 4.7 mln t to approximately 0.65 mln t per year; (2) implementation of new tariff-quota mechanisms. New multi-year quota system is being agreed upon within the framework of the DCFTA (Deep and Comprehensive Free Trade Area with the EU). It will be set between the pre-war DCFTA levels and the higher volumes allowed under the ATMs, however still lower than the volumes of period 2022–2025. A quota allocation model of 7/12 of the annual volume was applied for 2025, which meant reducing the yearly quota to cover only 7 months out of 12 (Svitlychna, 2025); (3) economic losses for Ukraine. The loss of the tariff-quota regime may lead to a reduction in export revenues up to EUR 3.5 billion annually (Reuters, 2025); (4) enhance

domestic processing. Oilseed processing plants are currently operating at around 65% of their capacity. In this regard, there are plans to maximise the use of domestic processing potential (UkrAgroConsult, 2025); (5) seed certification. The EU Council has granted equivalence to the seed certification standards of sunflower seed (and other oilseed crops) in Ukraine and Moldova, removing the need for additional checks, which facilitates access to the EU market for certified seeds (UBN, 2025).

Sunflower seed production in Ukraine was significantly decreased in 2022/2023 MY due to the war, logistic constraints, lack of resources, and adverse weather conditions (Sydiakina & Podriezov, 2023). The drought was recorded in key regions (e.g. Dnipropetrovsk region), which significantly reduced yields in average to 2 t/ha. For the subsequent years, there is observed increase in sunflower seed production and in 2025/2026 MY it could account to 14,000 thousand t. Sunflower seed yields vary by years. In 2022/2023 MY, the war and drought lead to sharp decline. However, in 2023/2024, the yield was approximately 2.42 t/ha; for 2024/2025 MY was forecasted at the level of 2.41 t/ha. Notably, oilseed yields in Ukraine remain stable even under challenging conditions (Panfilova *et al.*, 2025). Regarding the sunflower seed area, before the full-scale invasion in 2022, the average area under sunflower seed was approximately 6.9 mln ha. In 2022–2026 it declined around by 20–22% compared to pre-war level (Fig. 2). The reduction in sunflower seed areas is not only a consequence of the physical loss of fields (i.e., significant part of agricultural lands was occupied, some fields

were mined, making them unusable), but also a strategic decision by agricultural enterprises

in response to the risks of war, unstable prices, logistical constraints, and economic losses.

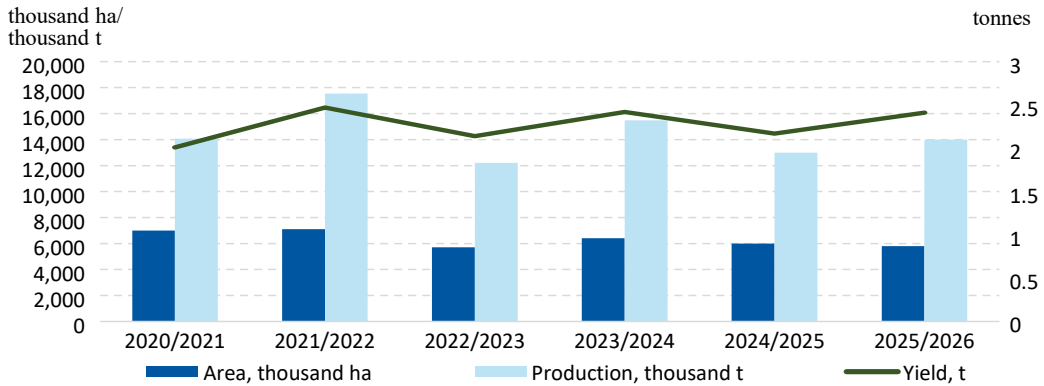


Figure 2. Dynamics of sunflower seed production, area, and yield in Ukraine

Source: author’s presentation based on the State Statistic Service of Ukraine (n.d.), USDA-FAS (n.d.)

Table 1 presents sunflower seed balance in Ukraine, which shows that approximately 98% is processed domestically for sunflower oil. Export of sunflower seed sharply increased in 2021/2022 MY due to the blockade of Black Sea ports. Therefore, Ukraine was unable to export a significant share of sunflower oil, which previously accounted for up to 90% of oilseed exports. Indeed, producers began to export raw sunflower seed as a crisis-response measure to recover at least part of the lost income. In 2022/2023 MY, exports of sunflower seed continued. After the launch of the “Grain Corridor”, many traders continued to focus on exporting raw seeds, especially to EU markets. In this period, the

processing industry had not yet fully recovered operations, and logistics remained difficult. Stabilisation of volumes was observed in 2023/2024 MY, when government began restricting raw seed exports to support domestic processing and exports of value-added products like sunflower oil. Most processing plants resumed or expanded operations, thus more seeds were processed domestically. Nevertheless, seed exports for next years declined to more typical levels, though still slightly higher than pre-war volumes. In 2025/2026 MY, self-sufficiency ration was equal to 1.02. In turn, it means that production of sunflower seed covers domestic needs for processing enterprises.

Table 1. Balance dynamic of sunflower seed in Ukraine, thousand t

Indices	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	2025/2026
Beginning Stocks	43	96	4,645	845	176	151
Production	14,100	17,500	12,200	15,500	13,000	14,000
Imports	24	21	31	20	30	30
Total Supply	14,167	17,617	16,876	16,365	13,206	14,181
Exports	191	1,622	1,856	314	230	250
Crush	13,750	10,800	14,000	15,700	12,300	13,600
Food Use Dom. Cons.	50	50	50	50	50	50
Feed Waste Dom. Cons.	80	500	125	125	475	125
Domestic Consumption	13,880	11,350	14,175	15,875	12,825	13,775
Ending Stocks	96	4645	845	176	151	156
Total Distribution	14,167	17,617	16,876	16,365	13,206	14,181
Self-Sufficiency Ratio	1.02	1.54	0.86	0.98	1.01	1.02

Source: author’s calculations based on USDA-FAS (n.d.)

One of the main factors that enhance interests of agricultural enterprises to produce oilseeds is high profitability compared to other crops due to stable demand and export prices. In the analysed period from 2019 to 2025, the average profitability of oilseeds production in Ukraine has shown significant fluctuations due to market volatility, war-related disruptions, and changing logistics and trade conditions (Table 2). In the period of 2019-2021, profitability remained relatively stable, driven by strong global demand and favourable prices, especially for sunflower seed. In 2022, a sharp decline in processing and export infrastructure occurred due to the war

that, in turn, led to logistical challenges. However, high global prices partially offset the impact, keeping average profitability from collapsing. In 2023 year, despite the gradual recovery of oilseed processing and export capacities (i.e., supported by the “Grain Corridor” and reoriented trade to EU countries) (Hamulczuk *et al.*, 2023), profitability remained uneven across regions of Ukraine. With stabilisation of logistics and increased domestic processing capacity utilisation in the period of 2024-2025, average profitability started recovering. Nonetheless, the loss of EU trade preferences in July 2025 was expected to put downward pressure on margins, especially for raw seed exports.

Table 2. Oilseeds profitability in Ukraine, %

Oilseeds	2019	2020	2021	2022	2023	2024	2025*
Sunflower seed	30-35	40-50	35-45	20-30	30-40	35-50	35-50
Soybeans	15-20	20-30	20-30	10-20	15-25	20-30	20-30
Rapeseed	20-25	25-35	25-35	15-25	20-30	25-35	25-35
Flaxseed	5-10	10-15	10-15	5-10	5-10	5-10	5-10

Note: * – forecasted value

Source: UkrAgroConsult (2025), Ministry of Agrarian Policy and Food of Ukraine (2025)

The interest to increase sunflowerseed production in Ukraine mainly depends on market conditions that have developed in both internal and external markets. The main factor on mentioned markets remain favourable price to enhance production of sunflower seed (Shpychak *et*

al., 2024). Therefore, it is crucially important to analyse sunflower seed prices dynamics. As mentioned above, approximately 98% of sunflower seed goes for domestic processing for sunflower oil. Thus, Figure 3 shows that sunflower seed prices follow sunflower oil prices.

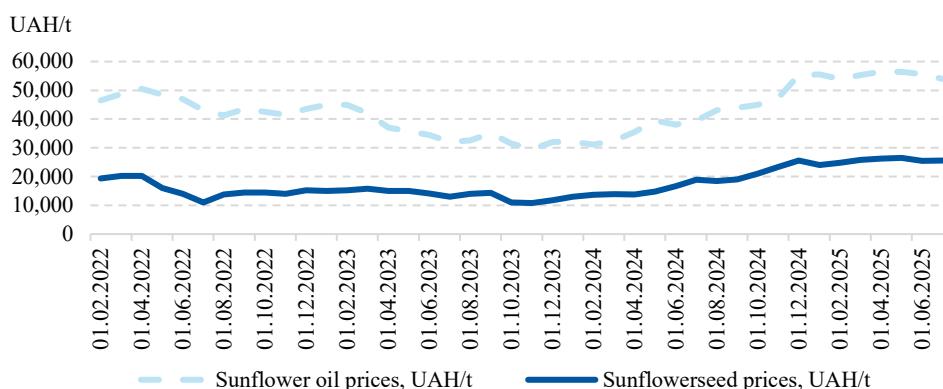


Figure 3. Dynamics of Ukrainian sunflower seed and sunflower oil prices, UAH/t

Source: based on the APK-inform (n.d.)

Between analysed periods from 2022 to June 2025, the Ukrainian sunflower market experienced notable price fluctuations influenced

by internal and external factors. Indeed, price competitiveness plays a crucial role in enabling Ukraine to sustain and expand its position in

the global oilseed market (Husby *et al.*, 2024; Premović, 2024). The figure confirmed a strong interdependence between sunflower oil and sunflower seed prices, indicating a high level of market integration and producer sensitivity to trends in the processing sector. In such

circumstances, based on equation 1, the regression model between domestic sunflower seed prices ($P_{\text{sunflower seed prices}}$) and sunflower oil prices ($P_{\text{sunflower oil prices}}$) was created. The obtained results of the regression analysis are presented in Table 3.

Table 3. Regression model between Ukrainian sunflower seed and sunflower oil prices

Specification of the model	Regression equation: $P_{\text{sunflower oil prices}} = 17,279.5 + 1.47 * P_{\text{sunflower seed prices}}$
R	0.87
R ²	0.75
P-value for parameter a_0	0.0000
P-value for parameter a_1	0.0000

Source: author's calculations

The results showed the tightness among domestic sunflower oil prices and sunflower seed prices. An increase in sunflower seed prices by 1 UAH/t leads to an increase in sunflower oil prices by 1.47 UAH/t. In turn, the regression analysis indicates a strong linkage between factors, which were taken into account, i.e., the coefficient of multiple correlation $R = 0.87$ that means a close relationship. The P-value for parameter a_1 is lower than the critical value of 0.05 and it confirms that the model is significant.

Thus, analysing the sunflower seed market in Ukraine, there is both resilience and vulnerability in the face of modern challenges, including war-related disruptions, changes in trade policy, and climate instability. The transition towards higher value-added processing and the reorientation of trade flows are shaping new strategic priorities for producers. In this context, strengthening domestic processing capacity, diversifying export destinations, and promoting innovation and sustainability in cultivation and processing practices are becoming decisive factors for maintaining the long-term competitiveness of Ukraine's sunflower seed industry.

Further development in the oilseed sector largely depends on the coordinated efforts of the government, agribusinesses, and industry associations aimed at creating favourable investment conditions, improving logistics infrastructure, and ensuring access to advanced technologies. Adaptive policy measures and flexible responses to geopolitical challenges and changing market

conditions will be essential for sustaining growth. The observed trends and market dynamics confirm that Ukraine continues to play a crucial role in the global oilseed market. However, its future success will depend on structural modernisation, deeper integration into international value chains, and consistent support for sustainable and innovative production practices.

Given the current macroeconomic instability and changes in global agricultural markets, the results of this study raise important questions about the sustainability and adaptability of the sunflower seed market in Ukraine. The following discussion aims to interpret these results and highlight key problem areas and opportunities. Unlike other scientific and analytical papers, this study analyses the sunflower seed market in the pre-war period and during the war. The indices of sunflower seed production, its yield, area, prices, and profitability were compared. The presented balance indicators in the time-frame period 2020/2021 MY to 2025/2026 MY indicated a decrease in the level of self-sufficiency of sunflower seeds at the beginning of the war, in particular, its level was 0.86 in the 2022/2023 MY, and in the 2024/2025 MY this indicator was 1.01, which, in turn, characterised the return of the ability to meet domestic needs with production.

N. Grunwald *et al.* (2021) in their paper identified trends and outlined development prospects for the seed industry of Ukraine. The key challenges in seed production development were highlighted, along with proposed measures

to encourage selection activities in Ukraine. The paper also outlined prospects for the future of Ukrainian seed production, in particular sunflower seed. According to O.E. Shandrivska *et al.* (2024), a comprehensive assessment of the world and Ukrainian sunflower oil markets was conducted. The study aimed to identify core trends, major determinants, and the outlook for this strategic branch of agriculture. In contrast, the author of the current study focused on examining as the main trends on the sunflower seed market and considering the profitability of sunflower seed to find the correlation among sunflower seed prices and sunflower oil prices.

O.A. Kozak *et al.* (2023) in their monograph addressed the fundamental aspects of Ukraine's European integration and the development of agri-food trade with EU member states. Their analysis covered the dynamics of oilseed exports from Ukraine to the EU up to 2021, the export structure, and the identification of leading EU countries in terms of import volumes of major oilseeds. In contrast, the current research examined the mechanisms introduced in 2023 to facilitate trade under the framework of ATMs and assessed the implications of their termination. The paper used materials on EU agricultural trade and its implications for Ukraine in connection with a revision of trade preferences, as highlighted by the European Commission (2025). In the paper by L. Savosh *et al.* (2020) and in the present study, the emphasis was placed on the strategic role of the agricultural sector and the influence of external factors on market development. L. Savosh *et al.* analysed Ukraine's position in the global grain market, whereas the current study applied a similar approach to the sunflower market, considering wartime shocks and changes in trade policy. Both studies used market indicators to assess trends and highlight the importance of exports for the stability of the agricultural economy. Using scientific methods, T. Premović *et al.* (2023) analysed international market trends and prices of sunflower seeds for industrial processing from April 2022 to March 2023 amid the ongoing war in Ukraine.

The study by T.B. Hassen & H. El Bilali (2022) demonstrated that the Russia-Ukraine war has caused significant disruptions to global agri-food supply chains, sharp price fluctuations,

and shifts in the structure of international trade. These conclusions are consistent with the findings of the present study, in which wartime shocks are likewise identified as one of the key factors driving the increase in sunflower seed exports and the intensification of price volatility on the domestic market. L.N. Sari *et al.* (2023) focused on the analysis of price integration across major vegetable oil markets and confirmed the presence of strong interdependencies between the prices of different types of oils. This provided an essential theoretical and empirical basis for the application of the regression model in this study, particularly in demonstrating the dependence between sunflower seed prices and sunflower oil prices. Thus, this study extended existing research by providing a comprehensive analysis of the sunflower market both prior to and during the ongoing war in Ukraine, while also considering changes in EU agricultural trade policies and price dynamics. The findings underscored that the topic holds not only theoretical significance but also considerable practical implications for the development of agribusiness strategies and the formulation of evidence-based public policies.

CONCLUSIONS

The global sunflower seed market continues to play a crucial role in the production of vegetable oils, with sunflower oil remaining one of the most sought-after edible oils due to its health benefits and versatile applications. In recent years, market dynamics have been significantly influenced by climatic conditions, geopolitical tensions, and shifts in global trade flows. The sunflower market in Ukraine is characterised by dynamic development, primarily due to the high demand for sunflower seed and its processed products both in the domestic and global markets. Approximately 98% of sunflower seed is consumed domestically by oil-processing enterprises. However, following the outbreak of war in Ukraine in 2022, sunflower seed processing within the country declined due to the closure of processing plants and limitations in production capacity. This, in turn, led to an 8.5-fold increase in sunflower seed exports during the 2021/2022 MY compared to 2020/2021 MY. Starting from the 2023/2024 MY, domestic

sunflower seed processing began to stabilise, supported by the restoration of logistics routes and the implementation of the EU ATMs, which temporarily removed import duties and quotas on Ukrainian products. However, the expiration of the ATMs on June 5, 2025, may have the following consequences, i.e., the reinstatement of tariffs and product quotas, and the introduction of new tariff-quota mechanisms.

Demand for sunflower oil continues to rise, driven by both population growth and the increasing preference for plant-based, healthy food options. However, price fluctuations remain a concern, influenced by both supply chain uncertainties and input cost increases such as fertilisers and fuel. However, sunflower seed profitability remain high, i.e., 35-50%. This, in turn, attracts agricultural enterprises to enhance their capacities for sunflower seed production. The study found strong a link between domestic sunflower seed prices and sunflower oil prices. The regression model indicates that a 1UAH/t increase in sunflower seed prices results in a 1.47 UAH/t increase in sunflower oil prices. The multiple correlation coefficient ($R = 0.87$) confirms a strong relationship between the

dependent and independent variables. Moreover, the P-value for parameter a_1 verifies the statistical significance of the model.

In the long term, the sunflower market is expected to grow steadily, supported by technological advancements in crop cultivation, the development of drought-resistant hybrids, and the growing global emphasis on sustainable agriculture. Strategic investments and international cooperation will be a key to ensuring market stability and food security. Further research into the sunflower seed market in Ukraine will focus on forecasting prices for sunflower seeds and sunflower oil using advanced econometric models (ARIMA, VAR), with particular attention to the impact of trade policies, international demand fluctuations, and logistical constraints.

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CONFLICT OF INTEREST

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Аналітична оцінка тенденцій та перспектив ринку соняшнику в Україні в умовах сучасних викликів

Анотація. Ринок соняшнику є стратегічним сегментом аграрної економіки України та зазнав різких трансформацій під впливом сучасних викликів, особливо в умовах війни. Метою статті було здійснити аналітичну оцінку тенденцій і перспектив ринку насіння соняшнику в Україні. Проаналізовано ринок насіння соняшнику в Україні із застосуванням показників ринку, зокрема у довоєнний та воєнний період; використано лінійну регресійну модель для виявлення взаємозв'язку між цінами на насіння соняшнику та соняшникову олію. Отримані результати показали, що з 2022 р. експорт насіння соняшнику зріс через наступні чинники: руйнування переробних потужностей, блокування портів, нагальна потреба в доходах, дефіцит пропозиції на світових ринках та зміна в експортній політиці. У цей період ціни як на насіння соняшнику, так і на соняшникову олію суттєво зросли. Запровадження Чорноморської зернової ініціативи у липні 2022 р. сприяло відновленню торгівлі аграрною продукцією, що призвело до зниження цін. Водночас автономні торговельні заходи (ATMs) ЄС тимчасово скасували імпорتنі мита та квоти на українську продукцію, таким чином підтримавши експорт. Однак, припинення дії ATMs у червні 2025 р. може знову сприяти запровадженню тарифів та квот, змінюючи умови торгівлі. Попри ризики, виробництво соняшнику залишається високоприбутковим, зокрема упродовж останніх років рентабельність становила 35-50 %, що у свою чергу стимулює підприємства до розширення посівів. На основі регресійного аналізу здійснено висновки про тісну залежність між цінами: підвищення ціни на насіння соняшнику на 1 грн/т спричиняє зростання ціни на соняшникову олію на 1,47 грн/т. Загалом, Україна має значний потенціал для розширення ринку соняшнику, зокрема шляхом поглиблення внутрішньої переробки на соняшникову олію для подальшого експорту. Практичне значення дослідження полягає в тому, що його результати можуть бути використані: виробниками – для кращого розуміння тенденцій і поточної ситуації на ринку соняшнику; державними установами – з метою формування ефективної аграрної політики, зокрема в аспекті інфраструктурних інвестицій; науковою спільнотою та студентами – для поглиблення знань про функціонування аграрних ринків та методи їх аналізу

Ключові слова: експорт; виробництво соняшнику; аналіз; ціни; регресійна модель



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Instruments for forming an adaptive and competitive enterprise management system in the context of digital transformation

Abstract. The purpose of this study was to identify priority directions for improving the enterprise management system, taking into account the challenges of the digital environment and the need to ensure a sustainable competitive position in the market. Within the scope of the research, a comparative analysis of digital maturity assessment methodologies was conducted,

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and the dynamics of the implementation of enterprise resource planning systems, customer relationship management systems, and business intelligence solutions in the corporate sector of Ukraine during 2020-2024 were examined. Particular attention was paid to the analysis of internal organisational changes, including the adaptation of management models to the level of digital maturity, the development of employees' digital competencies, and the formation of a digital management culture. The results of the study indicated that in 2024, 15.2% of enterprises already used ERP systems, while 5.2% applied artificial intelligence, and more than 83% employed customer relationship management systems. It was found that the implementation of digital solutions made it possible to increase profitability by 1.3-1.6 times and to reduce customer churn by half. From a regional perspective, the highest level of digital activity was observed in Lviv, Dnipropetrovsk, and Odesa regions, where the digital maturity of enterprises reached 0.8 on the scale. It was also established that digital culture and flexible management models (Scrum, Agile, Lean) were being actively implemented: 66% of companies applied Scrum, while the productivity of Agile teams increased by 25%. Within the Chief Digital Transformation Officer Campus programme, 440 digital transformation leaders were trained in 2024 alone. The practical significance of the study lies in the fact that its results could be used by enterprises to develop an adaptive management system aligned with their level of digital maturity, enhance the effectiveness of decision-making, and ensure long-term competitiveness in the digital economy

Keywords: innovation; competitiveness; management; managerial processes; digitalisation; digital competencies

INTRODUCTION

The rapid development of digital technologies is significantly transforming the operating environment of enterprises, presenting new requirements for management systems. The conditions of globalisation, intensified competition, and increasing dependence on digital infrastructure are changing traditional approaches to business process organisation. Enterprises striving for sustainable development are compelled to implement innovative solutions that ensure adaptability, prompt decision-making, and improved management efficiency. The transition to digital management models, based on the use of information systems, data analytics, process automation, and the development of employees' digital competencies, is becoming of particular importance.

The need to adapt management systems to the conditions of the digital economy necessitates a rethinking of the functions, roles, and tools of modern management. This issue is highlighted in the work of A. Zaverbnyj *et al.* (2024), which analyses the impact of digital technologies on the transformation of organisational processes. The study concluded that the use of information systems contributes to enhancing the efficiency of management decisions and increasing

the adaptability of companies. The integration of digital technologies into business activities has generated growing interest among researchers due to the necessity for enterprises to adapt to the conditions of an unstable economic environment and rapid technological changes. The digital transformation of management processes, the use of cloud solutions, automation, big data analytics, and the creation of new business models were the subjects of study by I.V. Perevozova *et al.* (2024), who demonstrated that the implementation of digital solutions significantly increases productivity, promotes cost optimisation, and improves management decision-making.

The insufficient effectiveness of traditional management models in the face of rapid changes and globalisation pressures has led to the adoption of modern approaches. This issue is addressed in the work of V. Zelic *et al.* (2023), where it is substantiated that the application of data analytics, artificial intelligence, blockchain technologies, robotic automation, and cloud solutions contributes to the optimisation of business processes, increased transparency of management, and enhanced decision-making efficiency. The authors demonstrated that digitalisation creates new opportunities for

enterprise development, particularly through the personalisation of communications and the flexibility of business models. The growing role of digital technologies in management necessitates a reconsideration of approaches to business process organisation, the formation of new competencies, and the transformation of the market interaction model. This issue is explored in the work of O.V. Alekseeva *et al.* (2024), which analyses the impact of digitalisation on enterprise operations and identifies the key factors for the successful implementation of digital solutions. The authors concluded that the use of cloud services, automated management systems, artificial intelligence tools, and digital platforms enables companies to enhance flexibility, adaptability, and competitive positioning.

The low effectiveness of traditional approaches to management organisation in the context of digital transformation necessitates a revision of the methods used by enterprises to maintain competitive advantages. The work of V. Varga (2020) examined the peculiarities of digitalising management processes and proposed a conceptual model for implementing digital tools within the strategic management system. The author demonstrated that digital technologies enable increased labour productivity, improved information processing, and greater flexibility in decision-making. Particular attention was given to the role of digital competencies among managers and the formation of a new organisational culture. The need to enhance management effectiveness in the context of digital transformation requires a deeper understanding of the role of information technologies in supporting the strategic goals of enterprises. This issue is addressed in the study by G.M. Chepurda & E.S. Adamenko (2025), which analysed the main areas of digitalisation, including the implementation of automated management systems, digital platforms, and business analytics. The authors concluded that the use of such tools contributes to improved coordination of internal processes, increased accuracy of management decisions, and the formation of a digital culture within companies. The work emphasises that digitalisation is not merely a technical process but requires a comprehensive revision of organisational structure and management approaches.

The complexity of adapting enterprises to changes associated with digitalisation calls for a reassessment of management functions in the new environment. In the work of O.V. Taranych (2020), the possibilities of implementing digital technologies to improve management efficiency, particularly in decision-making, planning, and control, were explored. The author substantiated the importance of digital transformation as a tool for increasing organisational flexibility and highlighted the advantages of integrating intelligent systems into management processes. It was shown that digitalisation fosters the development of new leadership models, increases the role of digital competency among staff, and promotes the development of adaptive strategies. The insufficient effectiveness of traditional management systems in the context of digital transformation requires the implementation of new approaches to the organisation of enterprise activities. The study by T. Hrinka (2023) analysed the impact of digitalisation on increasing competitiveness, particularly through improving organisational structure, the use of cloud technologies, digital document flow, Customer Relationship Management (CRM) systems, and automated solutions. The author demonstrated that the application of digital tools contributes to increased productivity, ensures the promptness of management decisions, and creates conditions for the development of an innovative culture. Special attention was given to the specifics of digital transformation in small businesses, which requires an individualised approach to technology selection.

At the same time, the issues of quantitative assessment of the effectiveness of digital transformation, the impact of digital changes on strategic management, the adaptation of small businesses, the formation of digital culture and flexible management models, as well as the integration of digital technologies into long-term planning, considering the level of digital maturity of enterprises, remain insufficiently explored. The aim of this study was to justify the necessity of adopting new approaches to enhancing the enterprise management system, one that can flexibly adapt to market changes throughout the digital transformation process and foster long-term competitive advantages. To accomplish

this objective, the following tasks were outlined: to analyse the impact of digital tools on the organisational structure, functions, and management efficiency within an enterprise; and to provide a rationale for the development of an adaptive management model that ensures both flexibility and technological integration in contemporary conditions.

MATERIALS AND METHODS

The conducted research was of a theoretical and practical nature, with its temporal boundaries covering the period from 2020 to 2024. The study aimed to define the essence and evolution of management approaches in the context of digital transformation in enterprises. A review of scientific literature on the digital transformation of management was carried out. For this purpose, the works M. Shehadeh *et al.* (2023), A.A. Vărzaru & C.G. Bocean (2024), J. Chukwunweike & O. Aro (2024) were selected, which are distinguished by an interdisciplinary approach, a focus on digital strategies, and a deep analysis of the transformations of management processes in various sectors. These sources enabled the formulation of an approach to defining the key elements of a competitive management system, such as the presence of a digital strategy, a flexible organisational structure, integrated Customer Relationship Management (CRM), Enterprise Resource Planning (ERP), and Business Intelligence (BI) solutions, the development of digital competencies, and the formation of a digital culture.

To assess the level of digital maturity of enterprises, a number of leading international methodological approaches were applied, allowing for a comprehensive comparison across various industries. In particular, the Deloitte (n.d.) digital maturity model, the BCG (n.d.) (Boston Consulting Group) index, and the Capgemini (n.d.) model were used. Additionally, the models of PwC (n.d.) (PricewaterhouseCoopers) and the ISO-oriented model (Certiget, n.d.) were also employed. The study focused on key indicators such as the degree of automation of business processes, the level of integration of digital solutions (ERP, CRM, BI), the development of digital culture, the presence of IT infrastructure, staff competencies in digital technologies, and the innovative capacity of enterprises. These indicators

enabled the analysis of the level of digital integration in management processes and the identification of priority areas for adaptation to new digital challenges. Particular attention was given to the dynamics of digital investments in the corporate sector of Ukraine between 2020 and 2024. Statistical and analytical sources on digital transformations in the corporate sector of Ukraine were reviewed. Specifically, data from the NISS (2024a; 2024b) report and statistical materials from the Government portal (2025) were used to analyse the dynamics of digital investments, the cloud security market, and the pace of business analytics implementation. Within the descriptive method, the functional capabilities of BAS ERP (n.d.) (Business Automation Software Enterprise Resource Planning) and SAP ERP (n.d.) (Systems, Applications and Products in Data Processing) systems were analysed, including examples of their practical use.

In particular, BAS ERP was examined in the context of its implementation in companies such as Joint Stock Company (JSC) Motor Sich (n.d.), Private Joint Stock Company (PJSC) "Pharmaceutical firm 'Darnytsia'" (n.d.), and PJSC MHP (n.d.). By contrast, SAP ERP has been implemented in PJSC DTEK Kyiv grids (n.d.), JSC Ukrainian railways (n.d.), and JSC "National Joint Stock Company 'Naftogaz of Ukraine'" (n.d.). Special attention was given to the Ukrainian-produced ERP system IT-Enterprise (n.d.), which demonstrated effectiveness in large-scale manufacturing, particularly in the agricultural sector. The criteria for selecting these companies were: industry coverage (manufacturing, energy, transportation, pharmaceuticals, and agriculture), the scale of transformation, and the availability of analytical data. At the final stage of the study, scenario forecasting methods were applied based on the collected statistical data. The level of digital maturity of enterprises was taken into account, allowing for the modelling of potential scenarios of digital transformation up to 2030.

RESULTS AND DISCUSSION

The theoretical and methodological foundations of modern management system formation in the context of digital transformations

Enterprise management in the digital age is undergoing a fundamental transformation that

encompasses not only the tools of management but also the principles of management system design, leadership style, and decision-making logic. Traditional management models, developed during the industrial era, were based on hierarchy, rigid division of functions, and centralisation of power. As the complexity of the external environment increased and digital technologies were introduced, these models began to lose their effectiveness, leading to the emergence of new management approaches focused on adaptability, speed, flexibility, and customer centricity. The essence of modern management lies in the ability of an organisation to quickly respond to changes, create added value through innovation, operate in conditions of constant uncertainty, and make data-driven decisions. Digitalisation radically changes management principles, as digital technologies become both the subject and the tool of managerial influence. At the core of the new management paradigm are digital platforms, cloud services, artificial intelligence, big data analytics, automated management systems, and remote team management. The evolution of management approaches has gained qualitatively new content with the advent of digital management concepts, which focus on the transformation of processes, structures, and corporate culture within enterprises. Initially, digital tools were predominantly used in operational activities: automation of accounting, production processes, logistics, etc. Gradually, information and communication technologies (ICT) began to be implemented in strategic planning, performance analysis, human resource management, and customer interaction, which provided grounds to speak about the transition to data-driven management (Vărzaru & Bocean, 2024).

Modern management theories, such as agile management, design thinking, lean approach, and platform management, actively integrate digital technologies into their practices. In the context of digitalisation, categories such as flexibility, decision-making speed, decentralisation, self-organisation of teams, openness to experimentation, and innovation management become increasingly significant. Real-time communication, digital transparency, and the personalisation of employee influence create a new

form of interaction between management and staff, distinct from classical administrative models. The digital transformation of management involves not only technological renewal but also a rethinking of the manager's role. Whereas the primary functions of a manager were once control and planning, today they act as facilitators of change, strategists, and analysts. A digital leader must possess a high level of digital literacy, be able to work with digital platforms, manage multifunctional teams that can work asynchronously, and assess the risks associated with digital innovations (Chukwunweike & Aro, 2024).

A competitive management system in the context of digital transformation is the result of integrating modern technologies, strategic thinking, analytical tools, and effective interaction among all levels of the enterprise. Its effectiveness is determined by the ability to respond swiftly to changes in the market environment, ensure sustainable development dynamics, and maintain competitive advantages in the long term. The formation of such a system requires an understanding of its key elements, which must function synchronously and complement each other. The first and one of the defining elements is strategic management, based on the principles of digital adaptability. This involves having a clear mission, vision, and a flexible strategy that considers digital trends, consumer needs, new business model formats, and technological potential. Such a strategy must be adaptable to rapid changes, include built-in mechanisms for updating, and anticipate scenario planning, allowing for effective action in conditions of uncertainty. The second important element is the institutional management structure, which must be decentralised, adaptive, and open to change. This means delegating authority, creating flexible management teams, applying project management principles, and using digital communication platforms. A modern management system must eliminate excessive bureaucracy, ensure decision-making speed, and create conditions for internal entrepreneurship. The next element is the knowledge management system and analytical decision support. Collecting, storing, processing, and utilising internal and external information in digital format enables informed decision-making

based on data. Big Data analytics, Business Intelligence (BI), Key Performance Indicators (KPI) monitoring systems, and forecasting become the foundation for decisions that enhance management effectiveness and ensure competitiveness. Another key element is the digital culture and human resource management system. Human capital remains the leading driving force of transformations, but to implement digital strategies, it is necessary to create an environment that fosters openness to innovation, learning, and experimentation. Human resource management should be based on the principles of digital literacy, the development of new competencies, particularly in analytics, working with platforms, project management, and cybersecurity (Shehadeh *et al.*, 2023).

Equally important components are the processes of interaction with clients and external partners. A competitive management system must ensure the establishment of sustainable relationships with target groups, the implementation of CRM systems, omnichannel communication strategies, service automation, and service personalisation. This increases consumer satisfaction, fosters loyalty, and creates added value in supply chains. The infrastructural component of the management system includes ERP systems, document management systems, cybersecurity services, cloud platforms, digital storage, and process automation technologies.

A high level of integration of digital solutions enables cost optimisation, reduces time spent on operations, enhances transparency in management, and ensures the scalability of the business model. Thus, a competitive management system for an enterprise in the digital age is a comprehensive architecture that encompasses strategic planning, analytics, an adaptive organisational structure, innovative personnel, digital infrastructure, and effective interaction with the external environment. Its main task is to ensure a sustainable competitive advantage in a dynamic environment and the digital economy (Darvidou, 2024).

In the process of transforming modern enterprises, digital maturity has become a key indicator that reflects the organisation's ability to adapt to technological changes, integrate digital solutions at all levels of management, and enhance the effectiveness of its operations. To determine the actual level of digital maturity, methodologically grounded approaches need to be applied, taking into account a comprehensive set of characteristics: from organisational structure to technological readiness and the culture of innovation. In practice, there are several recognised models that offer systematic methods for evaluating the digital transformation of enterprises. Table 1 presents the main methodological approaches used to assess digital maturity.

Table 1. Methodological approaches to assessing the digital maturity of enterprises

Methodological approach	Key assessment components	Type of assessment
Deloitte digital maturity model	Strategy, technologies, processes, culture, structure, leadership	Qualitative and quantitative
BCG digital transformation index	Digital strategy, leadership, innovation, customer interaction	Quantitative (scoring system)
Capgemini digital maturity model	IT infrastructure, organisational culture, business models, customer experience	Combined (survey + data)
PwC digital maturity assessment	Technologies, operations, people, structure, leadership	Questionnaire + analytics
Integrated ISO-standards model	Processes, resources, digital competencies, compliance with criteria	Quantitative based on compliance indicators

Source: compiled by the authors based on Deloitte (n.d.), BCG (n.d.), J. Bravo-Jaico *et al.* (2025)

As shown in Table 1, the key approaches share common components – strategy, technologies, culture, and structure – yet differ in terms of methodology and depth of analysis. For example, the Deloitte (n.d.) model combines both quantitative and qualitative methods, allowing for a balanced view of the current state of digital transformation. The BCG (n.d.) index is primarily used for quick assessments of changes and the development of digital transformation roadmaps. Capgemini (n.d.) focuses on the integration of digital tools into business models and the management of customer experience. The PwC (n.d.) model, based on in-depth surveys and subsequent analysis, helps identify specific barriers and drivers of change. The ISO-oriented model (Certiget, n.d.) is the most regulated, enabling enterprises to assess the alignment of their internal processes with international standards for digital maturity. In summary, it can be noted that the effectiveness of using any given methodology depends on the research objectives, the scale of the company, and the industry specifics. None of the models is universal; however, their combination can provide a comprehensive understanding of the maturity level and assist in developing a well-founded digital development strategy. Therefore, applying a structured approach to diagnosing digital maturity is an essential condition for building a competitive management system in the digital economy.

The study by R. Rostamzadeh *et al.* (2024) and the present research shared a common idea – the recognition of digital transformation as a key driver of change in management; however, they differed in focus. In R. Rostamzadeh *et al.*, the emphasis was placed on social customer relationship management (SCRM), while this study focused on the comprehensive modernisation of the enterprise management system. Both approaches highlighted the importance of data analytics, cloud technologies, and the significance of decentralisation, adaptability, and the digital competencies of staff. At the same time, R. Rostamzadeh *et al.* explored in greater depth the impact of social media, customer emotions, and brand crisis management, whereas these aspects were only outlined in the present study. In the work of A. Shen *et al.* (2024), digital transformation was interpreted as a strategic tool

for the development of the digital economy, but within the context of government policy and the formation of a competitive environment in the field of cloud computing. The main focus was on institutional support for digital innovations, the effectiveness of policies, and the assessment of market outcomes. In contrast, this study examined the internal organisational changes related to the digitalisation of the enterprise management system. A common feature of both works is the emphasis on a strategic approach, the importance of investment in digital infrastructure, and digital maturity; however, the difference lies in the scale of the analysis: the macro level in A. Shen *et al.* contrasts with the micro level in the present work.

The results presented in the study by R. Ouyang *et al.* (2024) also address the impact of digital technologies on management processes, albeit in a narrower context – the formation of China's digital economy. The authors primarily examined digitalisation through the lens of Industry 4.0, automation of production chains, and the development of smart platforms. Accordingly, the main focus of the analysis was on industry ecosystems, digital infrastructures, and technological modernisation of production. In contrast, this study focused on the managerial tools of digitalisation, as well as organisational restructuring. A commonality is the emphasis on technological innovations as a source of competitive advantage; however, the conceptual approaches differed – from the sectoral industrial model to the cross-functional transformation of business processes. Meanwhile, the study by T. Luque-Martínez *et al.* (2024) was aimed at exploring digital transformation in Spain's educational sector. The emphasis was placed on the formation of digital identities for universities, the shift in consumer models in education, and the rethinking of branding strategies in the digital economy. Special attention was given to digital platforms, personalised experiences, visual storytelling, and emotional interaction analytics. In contrast, this research examined the structural transformation of management in commercial enterprises, covering automation, integration of digital management systems, and changes in organisational culture. The common conclusions emphasised the importance

of digital competency, strategic vision, and an innovative environment as key prerequisites for successful digitalisation. In the work of F. Xue *et al.* (2024), the interaction between innovation strategy, digital transformation, and the competitiveness of manufacturing enterprises in China was analysed. The authors studied the impact of the external institutional environment, political incentives, and market conditions on enterprises' activities in digital innovations. These approaches contrast with the present study, where the analysis of digital transformation was predominantly internally focused – through changes in management structure, the digitalisation of business processes, and the formation of a digital culture at the enterprise level. Both works equally recognised the importance of strategic flexibility, investment in digital tools, and the need to develop human capital, yet they differed in the scale and direction of analysis.

In the study by I. Benedetti *et al.* (2025), digital transformation was primarily viewed not only as an internal process of improvement but also as part of a broader innovation ecosystem. The authors paid particular attention to open innovations, digital entrepreneurship, and the significance of inter-organisational interactions. In contrast, within this study, the focus shifted to the internal restructuring of management processes – specifically, the automation of functions, adaptation of structures, and development of digital competencies among staff. Thus, while both approaches unanimously emphasised the importance of strategic vision, digital culture, and professional expertise, I. Benedetti *et al.* focused more on the external relations of the enterprise, whereas this study focused on internal organisational transformations. Similarly, in the work of E.M. Martinelli & A. Tunisini (2024), digital transformation was analysed through the lens of changes in inter-organisational interactions, particularly in the realm of business-to-business (B2B) communications. The researchers emphasised the concept of relational strategising as an adaptive mechanism to the new conditions of the digital environment. In contrast, this study primarily examined internal management aspects: organisational structure transformation, digital integration, and adaptive leadership. Both approaches

utilised the analytical framework of strategic management, but applied it in different contexts: E.M. Martinelli & A. Tunisini in the inter-organisational context, while this study at the level of internal processes.

Equally notable was the study by P. Datta *et al.* (2020), in which digital transformation was presented as a driving force for the rethinking of organisational business models. The authors emphasised the creation of new consumer value, which, in turn, required the transformation of service chains and innovations in customer interactions. On the other hand, this study focused more on internal changes that ensured management flexibility, process alignment, and increased efficiency. It is worth noting that both approaches acknowledged the importance of technological infrastructure and data; however, in P. Datta *et al.*, the conceptual dimension prevailed, while this study was dominated by the applied analysis of organisational practices. As for the study by T. Nakamura (2024), it undoubtedly demonstrated a profound understanding of digital transformation at the corporate strategy level within the context of the Japanese economy. The author focused on the role of digital innovations, flexible structures, and organisational learning, thus forming a macroeconomic view of the transformations. In comparison, this study had a distinctly micro-applicative character and focused on the internal adaptation mechanisms: digitalisation of management, changes in communication approaches, and modernisation of the functional structure. Despite the difference in scale, both studies converged on the thesis regarding the need to rethink the role of leadership and update management paradigms in the digital age.

In the work of X. Han *et al.* (2024), digital transformation was viewed through the lens of the resource-based approach, with a clear focus on logistics and e-commerce. The authors argued that the integration of digital resources into supply chains, as well as the role of organisational culture, were key factors in enhancing efficiency. Meanwhile, this study focused primarily on the transformation of management structures within enterprises. Both approaches undoubtedly shared the idea of the necessity of combining technological innovations with

organisational adaptation. However, while in X. Han *et al.* the focus shifted towards the external environment in which enterprises operate, in this case, the key analytical object was the internal management system. Between 2020 and 2024, the digital transformation of Ukraine's corporate sector acquired a systemic nature and demonstrated high dynamics, even in the face of deep socio-economic challenges.

In the study by N. Durão *et al.* (2024), digital transformation was viewed as a phased process, with a focus on strategic management, data integration, and interdepartmental interaction. Similarly, in this study, digitalisation was interpreted as a gradual internal adaptation, but with an emphasis on implementing specific solutions (ERP, cloud services, analytics). Both approaches recognised the importance of digital culture, leadership, and human capital, although N. Durão *et al.* emphasised external competitiveness, while this study focused on the internal transformation of processes. Meanwhile, in the study by D. Ellström *et al.* (2021), digital transformation was examined through the lens of changes in manufacturing companies in Northern Europe, with a focus on organisational flexibility, the development of digital skills, and employee training. Similar emphasis was placed in this study, where the role of adaptive management and internal digital modernisation was also highlighted. However, D. Ellström *et al.* primarily focused on industrial enterprises and the cultural barriers to transformation, while this study covered a broader inter-industry context, analysing the economic effects of implementing digital solutions. Therefore, both approaches recognised the significance of digitalisation, but differed in the scale of analysis and applied focus.

The approaches of Ö. Larsson & P. Wallin (2020) recognised the special importance of digital transformation for enhancing business flexibility, as well as the role of strategic approach, knowledge management, and digital competencies of staff. At the same time, Ö. Larsson & P. Wallin focused on the concept of open strategising – involving a wide range of participants in the formation of digital strategy in industrial companies in Sweden. In contrast, the Ukrainian study focused on internal management changes, the implementation of digital

systems, and the adaptation of business processes. The study by E. Boffa & A. Maffei (2024) and the analysed research shared the common recognition of the key role of digital transformation in strengthening the competitiveness of manufacturing enterprises. In both works, digitalisation was viewed as a driving force for changing management approaches, modernising processes, and strategic renewal. However, the focus of E. Boffa & A. Maffei study was on evaluating the maturity of digital initiatives in Italian industrial companies, particularly in the context of Industry 4.0, using a structured analytical approach to determine the level of digital integration. They emphasised the importance of technological infrastructure, leadership support, and organisational readiness for change.

Digital transformation radically changes approaches to managing enterprises, placing flexibility, analytical thinking, innovation, and the integration of digital technologies into all levels of the organisational system at the forefront. The transition from a hierarchical model to decentralised management requires a new type of leadership, based on data, adaptability, and digital literacy. Building a competitive management system today is only possible with strategic thinking, a high level of digital maturity, and the ability to continuously update. These characteristics are becoming the key to sustainable business development in the digital economy.

Analysis of the impact of digitalisation on enterprise performance

Between 2020 and 2024, digital transformation in Ukraine's corporate sector demonstrated steady growth, despite significant challenges posed by the pandemic and full-scale war. Enterprises have increasingly implemented digital solutions to automate business processes, improve operational efficiency, and strengthen their market position. Investments in digitalisation varied across sectors: in most companies, they accounted for 1-5% of annual revenue, while in technology-intensive industries, they exceeded 20% (Nesenyuk, 2024). The greatest interest was generated by ERP systems, CRM solutions, cloud services, data analytics, and cybersecurity. A key catalyst for digital change has been electronic communication operators, including

PJSC Kyivstar (n.d.), PJSC VF Ukraine (n.d.), and Datagroup-Volia (n.d.), which, according to preliminary estimates, plan to invest about \$6 billion in digital infrastructure from 2025 to 2030, equating to approximately \$850 million annually just within the telecom sector. This creates conditions for accelerating the digitalisation of the entire corporate environment through the development of Fifth Generation networks, expanding access to high-speed internet, and improving information technology (IT) infrastructure (NISS, 2024a). Companies are also placing significant focus on cybersecurity – in 2024, the cloud security market in Ukraine grew to \$1.7 million, three times higher than pre-war levels. The use of resource and customer relationship management systems has significantly increased: according to 2024 data, 53% of domestic companies used CRM solutions, while another 33% employed international systems. This has enabled enterprises to enhance flexibility, adaptability, and management efficiency in a turbulent environment (NISS, 2024b).

At the same time, the business analytics segment was also developing: about 15.2% of companies used tools for big data processing and forecasting, which enabled them to respond more accurately to market changes and consumer trends. Regionally, the highest levels of digital activity were recorded in Dnipropetrovsk, Lviv, and Odesa regions (up to 0.8 on the digital maturity scale) (Government portal, 2025). Overall, more than 85% of enterprises had stable internet access, although in some regions, this figure remained unstable due to damaged infrastructure. Thus, the dynamics of digital investments and the implementation of ICT in Ukraine's corporate sector indicate a clear trend towards digital maturity. In 2021, 89% of companies declared the presence of digital transformation goals in their strategic plans, and 44% rated their digital preparedness as high or very high. Investments by telecommunications operators, the active implementation of ERP and CRM systems, and the growing demand for cybersecurity and analytics – all of these confirm the irreversibility of digital transformation in Ukrainian business (EBA, 2021).

Between 2020 and 2024, the Ukrainian corporate sector demonstrated active digital

transformation, implementing innovative tools to enhance business efficiency and resilience. ERP systems play a key role in the digital transformation of Ukrainian businesses, particularly in large and medium-sized enterprises. They provide centralised management of various aspects of company operations – from finance and logistics to customer and employee interactions – which significantly improves transparency, control, and the efficiency of business processes. The most widely used solution in the Ukrainian environment is BAS ERP (n.d.). This system was specifically adapted to Ukrainian legislation, accounting practices, and tax reporting, making it popular among enterprises seeking to automate daily operations with minimal localisation costs. In JSC Motor Sich (n.d.), BAS ERP is integrated into the management of production processes, which has reduced the production cycle time and introduced end-to-end material flow planning. As a result, the enterprise has improved the efficiency of material and inventory accounting and reduced defects. Private Joint Stock Company “Pharmaceutical firm ‘Darnytsia’” (n.d.) uses BAS ERP for managing prescription calculations, ensuring compliance with GMP requirements, tracking product batches, as well as quality control and supply chain management. This has allowed the company to integrate all functional blocks into a unified digital system, which is critical for an industry with high regulatory demands (BAS ERP, n.d.). Another widely implemented solution is SAP ERP (n.d.). This system is designed for large corporations with complex structures, providing comprehensive management of the enterprise, including production processes, financial reporting, procurement, analytics, and Human Resources (HR). PJSC DTEK Kyiv grids (n.d.) uses SAP ERP to integrate financial accounting, logistics, equipment maintenance management, and energy balance management, enabling the company to promptly analyse costs and plan production resources at the holding level. JSC Ukrainian railways (n.d.) uses SAP ERP for automating procurement processes, asset accounting, personnel management, and finance: the system covers over 60,000 users across Ukraine and ensures centralised control over strategic processes. In JSC “National Joint Stock Company

‘Naftogaz of Ukraine’” (n.d.), SAP ERP is used for managing the resources of subsidiary companies, including in energy, gas transportation, and financial flow accounting, which allows the consolidation of data from different divisions and enhances management transparency (Naftogaz of Ukraine, 2019).

Another powerful solution is Oracle E-Business Suite (n.d.), which provides comprehensive integration of various functions: accounting, project management, supply chains, and human resources. Successful examples of this system’s implementation include PJSC Kyivstar, JSC Ukrtelecom (n.d.), and JSC Oschadbank (n.d.), where the system serves as a tool for improving operational efficiency and automating complex business processes. For instance, after implementing Oracle E-Business Suite and related solutions such as Oracle Exadata Database Machine, PJSC Kyivstar reduced operational costs by approximately 15% through the unification of IT systems and business processes, while the performance of financial and analytical systems increased by 3-5 times, significantly speeding up data processing for billing and reporting. For medium and large businesses, the Microsoft Dynamics 365 (n.d.) solution, which combines ERP and CRM functions, is also attractive. This platform is used by leaders in the Ukrainian retail and logistics markets, including Limited Liability Company (LLC) Epicenter (n.d.), LLC Rozetka (n.d.), and LLC New Post (n.d.), enabling them to provide a high level of service personalisation, inventory control, logistics, and marketing campaigns in a unified environment (Rubryka, 2024). In particular, at LLC New Post, Microsoft Dynamics AX 2012 R3 currently serves over 600 employees in Kyiv and Poltava. The implementation of this ERP system has automated nearly two dozen financial processes, integrated logistics and accounting workflows, and ensured the generation of comprehensive reporting in accordance with international standards, thus enhancing the transparency of the company’s operations and management control (OntargIT, n.d.).

Equally important for Ukrainian businesses is the national ERP system IT-Enterprise (n.d.), which covers the full cycle of resource and production management. It has been implemented

in leading Ukrainian companies such as PJSC MHP (n.d.) – the largest agricultural holding in Ukraine, and JSC Motor Sich (n.d.) – a key player in the machine engineering industry. In addition to IT-Enterprise, MHP has implemented the SAP S/4HANA system along with associated products (CRM, Ariba, MDG (Master Data Governance), SuccessFactors, vZoo), which cover all key areas – from agricultural production to finance and HR. Tools for Big Data are systematically used, particularly in the vZoo project for poultry farming management based on artificial intelligence and analytics using Azure DWH (Azure Data Warehouse). In crop production, a geoinformation platform has been developed, which digitised over 130,000 land plots and 3,000 fields, ensuring control over fertiliser application, yield forecasting, and monitoring of diseases and pests. Thanks to digital solutions, PJSC MHP was able to recover up to 30% of technical losses in agricultural production, which demonstrates a significant improvement in management efficiency (UNN, 2021).

In the pharmaceutical sector, an example of digital leadership is PJSC “Pharmaceutical firm ‘Darnytsia’” (n.d.), which, in 2024, entered the top 30 most digitised companies in Ukraine. The company uses ERP solutions, big data, and artificial intelligence to elevate its business processes, particularly in logistics, quality control, and the transition from a manufacturing to a marketing, and later a patient-oriented, model. These tools not only enable optimisation of supply chains but also reduce the time to market, ensuring competitiveness in challenging economic conditions (Mind, 2025).

CRM systems responsible for managing customer experience have been implemented in more than 80% of enterprises. In 2023, 83.7% of companies used CRM, and the share of Ukrainian solutions increased eightfold since 2021. The integration of CRM and ERP allows the consolidation of information about customers, finances, and inventory into a single system, facilitating more accurate supply chain and order management (Business. Diia, 2023). Cloud services are also being actively implemented. Solutions such as LBS Cloud (n.d.) or SAP Business ByDesign (n.d.) enable enterprises to avoid high costs for IT infrastructure. The popularity of

cloud services among small and medium-sized businesses is linked to their accessibility and the SaaS model, which does not require significant investments. The automation of business processes through RPA (Robotic Process Automation) helps minimise human errors, reduce costs, and compensate for staff shortages (Chernikov, n.d.). A positive correlation between the level of digitalisation and profitability is confirmed: digital solutions contribute to cost reduction, increased productivity, and improved customer interaction. This underscores the importance of continuing digital transformation across all sectors of the Ukrainian economy (Fintechinsider, 2025).

Overall, between 2020 and 2024, the digital transformation of Ukraine's corporate sector reached a qualitatively new level, gradually encompassing key functional and management processes within enterprises. The implementation of ERP and CRM systems, the development of cloud services, big data analytics, and RPA solutions became the foundation for enhancing business efficiency, transparency, and adaptability in the face of crisis challenges. Successful cases from companies such as PJSC MHP, PJSC DTEK Kyiv grids, PJSC "Pharmaceutical firm 'Darnytsia'", and LLC Rozetka confirm the practical potential of digital solutions across various sectors.

Tools for enhancing the competitiveness of management systems in a digital environment

In the context of the dynamic development of the digital economy, the implementation of modern digital management tools has become a key condition for enhancing the competitiveness of enterprises. This primarily involves the use of CRM, ERP, and BI systems, the development of a digital culture in management, the formation of digital competencies, and the adaptation of management models to the level of the enterprise's digital maturity. By the end of 2024, approximately 15.2% of Ukrainian enterprises were already using ERP systems, and only 5.2% were applying artificial intelligence in business (Nesenyuk & Melnyk, 2024). The demand for cloud, mobile, and intelligent solutions, including those with artificial intelligence (AI) integration, is increasing. It is expected that by 2030, approximately 60-70% of Ukrainian companies will switch to

cloud-based ERP and CRM systems. This is facilitated by the policies of leading software providers such as Microsoft, which offers discounts of up to 80% on licences for Ukrainian companies. SaaS models are gaining preference due to their rapid updates, accessibility, flexibility, and high profitability (Kyivstar Business Hub, 2025).

The implementation of CRM and ERP systems allows companies to manage customer databases, orders, inventory, and finances more efficiently. Research shows that investments in CRM yield an average of \$8.7 in revenue for every dollar invested, with a payback period of about one year. CRM solutions reduce customer retention costs by 15-20%, cut customer churn by half, and increase the efficiency of new product launches by 30%. Meanwhile, ERP systems contribute to reducing operational costs, optimising inventory, improving the accuracy of accounting, and enhancing the quality of management decisions. The expected average profit increase for companies that have implemented ERP/CRM systems is 1.3-1.6 times higher compared to those that do not use them (Wezom, 2021). The use of BI solutions in Ukraine is still not widespread. Only 7.5% of companies use BI systems with elements of artificial intelligence. However, among market leaders, the share of such companies reaches 60-70%. Generative AI, particularly ChatGPT, is actively integrated into business analytics: 21.3% of enterprises use it (Kyivstar Business Hub, 2025).

In this context, the digital culture of management takes on particular significance. In 2024, as part of the Chief Digital Transformation Officer (CDTO) Campus programme (CDTO, n.d.), 440 digital transformation leaders were already trained in Ukraine (CDTO Campus annual..., 2024). Initiatives by Diia. Education (n.d.) reach thousands of managers annually. This reflects a systematic increase in digital competencies within both the public and private sectors. The average budget for developing digital competencies is typically 1-2% of the company's annual revenue. The level of digital maturity among Ukrainian companies varies significantly across industries. The average digitalisation index is 56 out of 100 (KPMG, 2025). Digital maturity assessments in specific industries are presented in Table 2.

Table 2. Digital maturity assessment of enterprises by industry (2024)

Industry	Digital maturity (0-100)	Characteristics
IT	70-80	High level of innovation, full integration of AI, cloud, and analytics
Energy	50-60	ERP, BI implementation, but slow progress due to complex infrastructure
Machine engineering	40-50	Moderate digitalisation, limitations due to resources and regulation
Pharmaceuticals	45-55	Active implementation of quality control and analytics
Agriculture	30-40	Early stage: agricultural drones, analytics, isolated examples of digitalisation

Source: compiled by the authors based on KPMG (2025), Y. Polikovska (2025a), K. Mykhaylova (2025)

Overall, digital transformation in Ukraine is actively progressing. In the IT sector, it has reached a high level of integration, while in the agricultural sector and traditional industries, particularly in light, food, and mining industries, digitalisation is still in its early stages. The average digital maturity index for communities and regions is around 30 out of 100. The change in management models is directly linked to digital transformation. According to international and national studies, around 60-70% of companies undergoing digitalisation are transitioning to agile management models – Scrum, Agile, and Lean. Scrum is the most common: over 66% of companies implementing Agile approaches use it. Agile teams are 25% more productive, and 98% of companies report a positive impact on decision-making speed and process flexibility. Lean approaches are widely applied in manufacturing: they reduce order completion time, decrease waste, and increase efficiency (Schaefer, 2023). Thus, flexible management has already become an integral component of adaptive management in the digital age. This enables companies to adapt more quickly to market changes, implement innovations, and maintain competitiveness in an unstable environment.

It is expected that by 2030, the digital transformation of corporate governance in Ukraine will become systemic and will cover most medium and large enterprises. According to forecasts, more than 60% of such companies will actively use resource and customer relationship management systems – ERP and CRM – on a cloud-based platform. This will significantly reduce IT infrastructure costs, enhance the flexibility of business processes, and provide real-time data access. More than half of the

companies plan to implement business intelligence (BI) systems with elements of artificial intelligence, which will facilitate deeper analysis of market trends, personalisation of customer experience, and more accurate financial forecasting (Polikovska, 2025b).

Management models are also undergoing changes: at least 70% of companies will transition to agile management methods (Agile, Scrum, Lean), which will ensure rapid adaptation to changes in the external environment, increase team productivity, and shorten decision-making cycles. In the context of these changes, the average level of digital maturity of Ukrainian businesses will rise to 75 out of 100 possible points, and the share of companies with a developed digital culture will exceed 60%. This not only signifies technical modernisation but also a shift in mental models, management approaches, and educational priorities in favour of innovation and continuous development. Digital tools in Ukraine are no longer just operational support – they are becoming the foundation of strategic competitiveness for companies. In the face of wartime and economic challenges, it is the comprehensive approach – from technical implementation to the transformation of mindset – that will ensure the resilience, adaptability, and leadership positions of Ukrainian enterprises in the digital economy (KPMG, 2024).

In conclusion, the implementation of digital management tools has become a defining factor in the transformation of Ukrainian enterprises towards greater flexibility, efficiency, and resilience. Data confirms the gradual growth of digital maturity, particularly in the IT sector, while other sectors demonstrate slower adaptation rates. Thus, in the context of the formation of

the digital economy, Ukrainian enterprises are increasingly integrating digital solutions at all levels of management. The implementation of ERP, CRM, and BI systems, the development of digital culture, and the transition to agile management models ensure a significant increase in business efficiency, adaptability, and competitiveness. However, the persistence of intersectoral disparities and low digital maturity in traditional sectors indicates the need for further systemic transformations. The transition to a comprehensive digital management model, which includes not only technical renewal but also a rethinking of leadership and organisational culture, is a key factor for success in the current economic environment.

CONCLUSIONS

Digital transformation has become a key factor in enhancing the competitiveness of Ukrainian enterprises in the context of an unstable economic environment. Between 2020 and 2024, businesses actively implemented ERP and CRM systems, cloud services, and business analytics, which significantly optimised business processes, reduced costs, increased management flexibility, and improved decision-making speed. For example, CRM solutions, used by over 83% of companies in 2023, helped reduce customer churn by half and increase profitability by 1.3-1.6 times. ERP systems, with BAS ERP playing a particularly important role, ensured the integration of finance, logistics, human resources, and production management, which was especially effective in companies such as PJSC MHP, JSC Motor Sich, PJSC "Pharmaceutical firm 'Darnytsia'", PJSC DTEK Kyiv grids, and others. Statistical data indicate a growth in digital maturity: the average digitalisation index of companies reached 56 out of 100, while in leading regions (Lviv, Dnipropetrovsk, Odesa regions), this figure reached 0.8 on the digital maturity scale. The demand for cloud technologies is increasing – by 2030, it is expected that 60-70% of companies will transition to cloud-based ERP and CRM systems, which will reduce IT infrastructure costs and provide greater mobility and accessibility. However, in 2024, only 5.2% of companies used artificial intelligence in business practices, although among technological leaders, this figure reaches

60-70%. Additionally, only 7.5% of enterprises have implemented BI solutions with AI elements, but this segment holds significant growth potential, particularly in the context of personalising customer experience and forecasting financial indicators. Flexible methodologies – Scrum, Agile, and Lean – play a critical role in shaping the new management model, already applied by 60-70% of companies undergoing digital transformation. This results in a 25% increase in team productivity and accelerates the decision-making cycle. The role of the manager is transforming from a function of control to a facilitator of innovative change, requiring new digital competencies and strategic thinking. In 2024, within the framework of the CDTO Campus programme, 440 digital transformation leaders were trained, and thousands of managers undergo training annually as part of the Diia. Education initiative.

Digital management culture is gradually becoming the norm – the budget for developing digital skills reaches 1-2% of a company's annual revenue. The shift in management paradigms from centralised to decentralised management, supported by the use of KPI, BI, Big Data, and cloud services, creates the foundation for a more resilient and competitive business model. It is estimated that by 2030, the average digital maturity index of Ukrainian companies may rise to 75 out of 100, and more than 60% of enterprises will have fully developed a digital culture. Thus, digital transformation in Ukraine not only modernises technical processes but also fundamentally changes the logic of management, leadership style, and market interaction, which becomes the basis for long-term competitiveness in the global digital economy. A limitation of this study was its focus primarily on the internal aspects of digital transformation within enterprises, without covering empirical data from small businesses and intersectoral comparisons. Future research prospects include a deeper analysis of the impact of digital strategies on business performance, the development of adaptation models for enterprises with low digital maturity, and the exploration of synergies between digital transformation and sustainable development.

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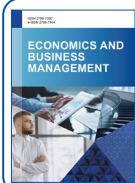
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Інструменти формування адаптивної конкурентоспроможної системи менеджменту підприємства в умовах цифрової трансформації

Анотація. Метою даного дослідження було виявлення пріоритетних напрямів удосконалення системи менеджменту підприємства з урахуванням викликів цифрового середовища та потреби забезпечення стійкої конкурентної позиції на ринку. У межах дослідження було проведено порівняльний аналіз методик оцінки цифрової зрілості, а також вивчено динаміку впровадження систем управління ресурсами підприємства, систем для управління взаємовідносинами з клієнтами та рішень для бізнес-аналітики у корпоративному секторі України у 2020-2024 роках. Основну увагу було приділено аналізу внутрішніх організаційних змін, зокрема адаптації управлінських моделей до рівня цифрової зрілості, розвитку цифрових компетенцій персоналу та формуванню цифрової культури управління. За результатами дослідження було встановлено, що у 2024 році 15,2 % підприємств уже використовують ERP-системи, тоді як 5,2 % – штучний інтелект, а понад 83 % – системи для управління взаємовідносинами з клієнтами. Було виявлено, що впровадження цифрових рішень дає змогу підвищити прибутковість у 1,3-1,6 рази, а також удвічі скоротити відтік клієнтів. У регіональному розрізі найвищий рівень цифрової активності фіксується у Львівській, Дніпропетровській та Одеській областях, де цифрова зрілість підприємств сягає 0,8 за шкалою. Також було встановлено, що цифрова культура та гнучкі управлінські моделі (Scrum, Agile, Lean) активно впроваджуються: 66 % компаній застосовують Scrum, а продуктивність

команд Agile при цьому зростає на 25 %. У межах програми Chief Digital Transformation Officer Caprus лише за 2024 рік було підготовлено 440 лідерів цифрової трансформації. Практичне значення дослідження полягає в тому, що його результати можуть бути використані підприємствами для побудови адаптивної системи управління, яка відповідає рівню їх цифрової зрілості, підвищує ефективність прийняття рішень та забезпечує довгострокову конкурентоспроможність в умовах цифрової економіки

Ключові слова: інновації; конкурентоспроможність; менеджмент; управлінські процеси; цифровізація; цифрові компетентності



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Innovative marketing strategies for business development in the context of digitalisation

Abstract. The aim of this study was to identify the patterns in the formation and effectiveness of innovative marketing strategies in the digital environment, considering the specific features of the activities of small and medium-sized enterprises (SMEs). The methodological basis was a systems-comparative, content and structural-logical analysis, which made it possible to consider comprehensively the theoretical approaches, digital communication tools and practical examples of the application in national business practice. In the course of the study, the evolution of marketing strategies, trends in the use of customer relationship management systems, in particular HubSpot, Zoho and Bitrix24, was analysed, and the influence of the social networks Facebook, Instagram, TikTok, and LinkedIn on the formation of consumer loyalty was examined. Particular attention was paid to the analysis of the analytical platforms Meta Business Suite, Google Analytics and Hootsuite, which provide the measurement of the effectiveness of marketing campaigns. It was established that in the first half of 2025 about 72% of advertising expenditure fell on the platforms Facebook, Google and Instagram, while the volume of paid search reached UAH 11.36 billion and display advertising – UAH 8.5 billion. The results of the strategic analysis using the “strengths – weaknesses – opportunities – threats” model showed that the implementation of innovative marketing strategies ensured an increase in the effectiveness of communications and a reduction in promotion costs. The main weaknesses remained limited financial resources and a low level of digital skills among staff. Opportunities included the expansion of e-commerce and programmes to support digitalisation, while threats comprised cyber risks and intensifying online competition. Practical examples of the activities of Ukrainian companies Prom.ua, Beauty Service Ukraine, Ecosoft and Rozetka confirmed the effectiveness of targeted advertising and the introduction of innovative marketing approaches in increasing brand visibility and customer engagement. The practical significance of the study lies in the possibility of using its results by enterprise managers, marketers, digital communication consultants and analysts for the development of effective marketing strategies, increasing profitability, brand awareness and consumer engagement

Keywords: transformations; automation; e-commerce; personalisation; competitiveness; interaction

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INTRODUCTION

The changes taking place in the global business environment under the influence of digital technologies are fundamentally transforming approaches to the interaction of companies with consumers and partners. The digital economy forms new conditions of competition in which traditional methods of promotion give way to flexible and technologically oriented tools. Enterprises are increasingly integrating automated management systems, Big Data, consumer behaviour analytics, social media and artificial intelligence tools to increase the accuracy of marketing decisions.

The field of marketing is undergoing rapid changes due to the impact of digital technologies, which leads to a decrease in the effectiveness of traditional promotion tools and requires the renewal of approaches to business management. In the work of T. Ustik & N. Kolodnenko (2025), the theoretical and methodological foundations of innovative strategies for the digitalisation of enterprises are analysed, the advantages of digital marketing compared with traditional marketing are determined, and methods for assessing the effectiveness of its tools are considered. The authors emphasised that small and medium-sized businesses face difficulties in the systematic use of digital technologies, which reduces the level of competitiveness and slows down management processes. In the process of transforming economic systems, enterprises encounter difficulties in the transition from traditional approaches to modern digital marketing tools. In the study by P.I. Korenyuk & M.V. Dmytrochenkov (2024), the essence of innovative approaches to the formation of marketing strategies in the digital environment based on the integration of big data, artificial intelligence, cloud technologies and blockchain is revealed. The authors underlined the importance of enterprises moving from traditional models to Internet marketing with an organic combination of online and offline tools in order to increase competitiveness and ensure sustainable development.

In the process of marketing development, enterprises face the need for a profound transformation of strategies under the influence of digital technologies and changing consumer expectations. In the work of N. Karpenko *et*

al. (2025), the conceptual foundations of innovative approaches to the formation of marketing strategies focused on the integration of digital tools, in particular big data analytics, automated Customer Relationship Management (CRM) systems, artificial intelligence and e-commerce platforms, are considered. The authors determined that business effectiveness largely depends on the ability of enterprises to combine technological solutions with creative communication strategies and the personalisation of the customer experience. Enterprises need to update the approaches to marketing management in connection with growing competition, rapid changes in consumer preferences and the development of the digital environment. In the work of O. Cherniavska & V. Kaznodii (2023), transformational changes in the functioning of marketing systems under the influence of digital technologies were examined. The authors stressed that the key challenge for enterprises was the need to adapt marketing strategies to the conditions of digitalisation, which included the automation of analytical processes, the use of online platforms and the personalisation of communications with consumers. The results of the study showed that digital tools significantly increased the effectiveness of promotion and interaction with target audiences while reducing expenditure on traditional advertising channels.

Enterprises face the need for the constant improvement of the approaches to product promotion in conditions of high competition and digital transformation. In the study of V. Dalik *et al.* (2023), the features of the formation of digital marketing strategies aimed at ensuring flexibility, adaptability and business innovativeness in the conditions of digitalisation are considered. The authors emphasised the importance of analytical tools for studying the competitive environment, the use of the latest technologies, artificial intelligence and process automation to increase the effectiveness of marketing activities. V. Holub (2024) carried out a theoretical analysis of the impact of digitalisation on the development of marketing strategies in entrepreneurial activity and determined the role of digital technologies in increasing the

efficiency of management processes and business competitiveness. The author underlined that digital marketing tools, in particular social networks, online shops, mobile applications and analytical platforms, create new opportunities for building customer-oriented business models and provide flexibility in responding to market changes.

Enterprises face the need to rethink the approaches to the development of marketing strategies due to the rapid development of digital technologies and increasing competition. In the study of T. Knyazeva & O. Kazanska (2022), the concepts of electronic marketing are systematised, the processes of its implementation are analysed and the conditions for effective functioning in the digital environment are determined. The authors emphasised that the success of marketing activities depends on the ability of the organisation to ensure the integration of Internet technologies, strategic planning and managerial flexibility. At the same time, Yu.I. Olyfirenko *et al.* (2024) noted that traditional approaches to marketing are gradually losing effectiveness due to the influence of digital technologies, in particular artificial intelligence, machine learning, virtual and augmented reality. The study systematised digital trends, including content marketing, Search Engine Optimisation (SEO), influencer marketing, personalisation, gamification, tokenisation, the metaverse, and emphasised the need for omnichannel interaction with clients.

Issues of the strategic integration of digital technologies and innovations into long-term models of marketing and business management remain insufficiently researched, in particular the quantitative assessment of the effectiveness of digital tools, the determination of the impact on the resilience and stability of enterprises, as well as the construction of a universal adaptive model of digital marketing that would take into account the level of digital maturity of companies, market specifics and socio-economic effects. The aim of this study was to establish the features of the development and effectiveness of innovative marketing strategies in the digital space, taking into account the specific features of the functioning of small and medium-sized enterprises (SMEs). To achieve this aim, the

following main tasks were set: to analyse scientific approaches to the formation of innovative marketing strategies in the context of the digital transformation of the economy; to assess the impact of digital technologies on the effectiveness of marketing processes and to determine directions for improving business development strategies under conditions of digitalisation.

MATERIALS AND METHODS

The study had a theoretical character and covered the period from 2022 to the first half of 2025. In the course of the work, the systems-comparative method was applied to examine the evolution of the concept of marketing strategies in the context of digital transformation. The analysis focused on the study of the specifics of the marketing activities of small and medium-sized enterprises in the digital environment. This made it possible to form an understanding of the conditions under which SMEs build the own marketing strategies, using limited resources but a high level of flexibility. The next analytical direction was the study of the technological component of marketing activities. For this purpose, by means of comparative analysis, the CRM systems HubSpot CRM, Zoho CRM and Bitrix24 were examined, which made it possible to determine common principles for the automation of communications, processing of client data and personalisation of interaction. The application of this method ensured the identification of the key functions of CRM as tools for increasing the effectiveness of marketing processes. The method of theoretical generalisation made it possible to outline the role of marketing innovations as a means of increasing the flexibility of enterprises and as a basis for the formation of competitive advantages.

To study the impact of digital communication channels on product promotion, a structural-functional analysis was applied, which covered the leading social networks – Facebook, Instagram, and TikTok. The professional network LinkedIn was examined separately, and its results were compared with the data of the analytical report IT rating UA (2025) in order to assess the effectiveness of different platforms in the marketing activities of enterprises. To confirm the results, the case method was used,

on the basis of which examples of the activities of the Ukrainian company Prom.ua were considered, using the source D. Stadzhi (2020). The case of the Indonesian enterprise Pemppek Sulthan and Pindang Agan Palembang, described in the study by C.M. Wulandari *et al.* (2025), was analysed separately. This example was used to compare the results of international experience in the use of social media, which made it possible to assess the impact of TikTok and Instagram on increasing brand awareness, audience reach and the dynamics of subscriber growth in the small-business segment. The case of the company Beauty Service Ukraine was also considered, which made it possible to analyse practical approaches to targeted advertising. Additionally, content analysis was applied to the analytical platforms Meta Business Suite, Google Analytics and Hootsuite to study the system of indicators for assessing marketing effectiveness. The case of the company Apricotton, which used the Hootsuite tool to increase awareness and the number of views, was also considered (Hootsuite, n.d.). The market dynamics of digital advertising for 2022 – the first half of 2025 were determined by analysing statistical data presented in the report by S. Stark (2025) in order to identify trends in changes in the structure of advertising expenditure, investment levels and the directions of digital-sector development in the context of the formation of innovative marketing strategies.

To study the features of the implementation of innovative marketing strategies, SWOT analysis was used. This method made it possible to systematise the strengths, weaknesses, opportunities, and risks of using digital tools in the activities of SMEs. To confirm the results of theoretical generalisation, the case method was applied, whereby examples of the practical use of innovative marketing solutions at the enterprise Ecosoft were examined, reflecting the particularities of the application of digital strategies in the field of e-commerce and the impact on the effectiveness of marketing processes. The use of this method made it possible to establish the correspondence between theoretical approaches and real business processes, and to outline the conditions under which innovative strategies demonstrate the highest effectiveness.

RESULTS

Principles for the formation of innovative marketing strategies in the conditions of the digital economy

The evolution of the concept of marketing strategies in the context of digital transformation reflects profound changes in the ways enterprises interact with consumers, in the structure of market communications and in approaches to forming competitive advantages. Traditional marketing models based on the four classic components – product, price, place, and promotion (the 4P model – Product, Price, Place, Promotion) – have gradually lost the effectiveness in the new conditions of the global digital economy. Data, technologies and real-time communications are becoming the main resources for business development. Digitalisation has created a new type of environment in which information, the speed of its processing and the personalisation of interaction with the consumer determine the level of success of the enterprise. The first stages of the transformation of marketing strategies are associated with the emergence of e-commerce, when the Internet became a tool for promotion and sales. This enabled enterprises to go beyond local markets and expand the client base without significant financial expenditure. Later, with the development of search engines and social networks, new channels of interaction appeared, providing two-way communication between the brand and the consumer. Thus, the strategic role of marketing shifted from one-way informing to the formation of communities around the brand, involving clients in content creation and developing loyalty (Diadyk *et al.*, 2024).

Digital analytics is gradually becoming a key element of marketing strategy, as it provides a deep understanding of consumer behaviour, the effectiveness of advertising campaigns and the results of business decisions. Companies actively use Big Data to track consumer behaviour, analyse demand trends and forecast changes in the market. This makes it possible to form more accurate audience segments and develop personalised offers. Classical marketing campaigns are being replaced by dynamic strategies built on the principles of adaptability, rapid testing of hypotheses and automated management

of interaction with the client. Such approaches reduce uncertainty and allow enterprises to make decisions based on real data rather than intuition or the experience of previous years (Islam, 2024).

Particular importance in the transformation of strategies is attached to the development of artificial intelligence and machine learning technologies. These technologies make it possible to forecast purchasing behaviour, optimise advertising budgets, determine effective communication channels and create content that meets the expectations of a specific consumer. For example, the integration of recommendation algorithms into CRM systems provides enterprises with the opportunity to personalise interaction with clients in real time (Nwabeke & Abdul-Azeez, 2024). Marketing strategies are increasingly integrated with the concept of sustainable development, where digitalisation is used not only as an instrument of profitability but also as a means of forming long-term values. Companies focus on transparency, ethics, social responsibility and consumer trust, which requires new formats of communication and control over reputation in the digital space. This approach contributes to the formation of brands that do not merely sell products, but create socially significant value, which is an important component of innovative business development strategies. The marketing activity of SMEs in the digital environment acquires particular significance, since it is digitalisation that has opened up new opportunities for this sector to enter the market, form competitive advantages and increase the effectiveness of communication with consumers. For SMEs, marketing in the digital economy has ceased to be only a tool of promotion – it has been transformed into a strategic mechanism for managing enterprise development, which ensures flexibility, adaptability and interactive interaction with clients. The main difference between the marketing activities of SMEs and large corporations lies in limited resources but, at the same time, in greater speed of decision-making, creativity, and the ability to respond quickly to changes in consumer demand (Newase & Sangan, 2025).

The digital environment has provided SMEs with access to tools that previously required

significant investment, in particular analytical systems, CRM platforms, social networks and e-commerce services. Thanks to this, SMEs can organise marketing processes effectively even with a limited budget. The use of social media such as Facebook, Instagram, and TikTok makes it possible to create personalised communication channels with consumers and increase audience engagement. In addition, the use of LinkedIn helps form the professional image of the brand and expand partnership contacts in the business environment. For small companies, social networks have become not only an advertising but also an analytical tool that makes it possible to study consumer behaviour, test new products and assess the effectiveness of marketing decisions in real time (Sharabati *et al.*, 2024). Small businesses in Indonesia – producers of local dishes Pempek Sulthan and Pindang Agan Palembang – effectively used Instagram and TikTok to promote the brand and attract clients. According to the results of the analysis, TikTok generates on average 833 views per day and 86% new subscribers, while Instagram – 499 views per day and 53% new subscribers. Although the level of user engagement remained below 1%, Instagram exceeded TikTok in terms of likes, comments and views, which indicates higher quality interaction with the content. This example shows that even small enterprises, using different social platforms for personalised communication, can significantly increase brand awareness, expand the client base and strengthen audience loyalty (Wulandari *et al.*, 2025).

An important element of digital marketing for SMEs is the implementation of CRM systems, which help structure data about clients, automate communication processes and build long-term relationships with consumers. CRM is a customer relationship management system that allows enterprises to store contacts, record the history of interactions, forecast sales and improve the quality of service. For SMEs, the use of such platforms is not just a technological update, but a key condition for increasing the effectiveness of marketing activities and forming a personalised approach to each client. One of the most convenient for SMEs is HubSpot CRM, which combines ease of use with powerful functionality. It provides centralised storage

of contacts and makes it possible to track client activity on social networks, in email and on the company's website. HubSpot also supports the automation of marketing campaigns, which helps small companies save resources while increasing sales performance. Its free basic version makes the platform attractive for businesses with a limited budget.

Another popular solution among SMEs is Zoho CRM, which is characterised by flexible settings and a modular structure. It makes it possible to manage sales processes, communication with clients and analysis of results within a single system. Enterprises can connect only those tools the enterprises need – from email marketing automation to integration with financial or analytical modules. Zoho CRM also supports multichannel interaction, which allows effective combination of online communications, telephony, and work with chats. Among the solutions actively used by Ukrainian companies, Bitrix24 should be highlighted. It combines a CRM, task management system, corporate portal and tools for internal communications, which makes it a comprehensive business management instrument. Bitrix24 allows the creation of sales funnels, the automation of client request processing and the control of the effectiveness of marketing campaigns in real time. Thanks to wide integration possibilities, the platform supports remote work of teams, which is relevant for small businesses.

Digital platforms also contribute to increasing the transparency of business processes and forming reputational capital through review systems, ratings, and recommendations. For SMEs, this is a chance to increase consumer trust even in the absence of a substantial branding budget. At the same time, the integration of payment systems, automation of orders and the use of artificial intelligence technologies to forecast demand improve the efficiency of operational activities. Despite wide opportunities, digitalisation also creates certain risks for SMEs. The main challenges remain cyber-security, lack of qualified personnel, limited experience in the use of complex digital tools and dependence on the algorithms of large platforms. There is also a need for a strategic approach to digital marketing: small enterprises often use tools fragmentarily, without an integrated strategy, which reduces the effectiveness of digital initiatives. However, with proper staff training, the involvement of external consultants and the implementation of basic principles of digital security, these risks can be significantly reduced (Startseva *et al.*, 2021). In the conditions of the digital economy, marketing innovations have become not only an instrument for attracting consumers, but also a key factor in the strategic development of the enterprise. For a better understanding of the significance, the main types of innovations in marketing, the characteristics, and the impact on business management have been systematised (Table 1).

Table 1. Types of marketing innovations and the strategic significance for enterprise management

Type of innovation	Essence and examples	Strategic significance for enterprise management
Technological innovations	Use of digital technologies – Big Data, artificial intelligence, CRM systems, automation of marketing campaigns, e-commerce platforms	Ensure management decision-making based on data, improve demand forecasting, personalise offers and increase the efficiency of business processes
Organisational innovations	Formation of cross-functional marketing teams, digitalisation of internal processes, integration of marketing, analytics and information technology departments	Increase the speed of response to changes, improve coordination of actions, promote adaptability and strategic consistency of management decisions
Communication innovations	Use of social media, influencer marketing, personalised advertising, interactive content, Augmented Reality/Virtual Reality technologies	Promote the formation of an emotional connection with consumers, increase customer loyalty, strengthen the brand and expand market presence
Conceptual innovations	Reorientation from sales to creating value for the client; formation of a customer-oriented and socially responsible marketing strategy	Strengthen the enterprise's competitiveness in the long term, form reputational capital and ensure sustainable business development

Source: compiled by the author on the basis of A.B. Vărzaru & C.G. Bocean (2025), S. Deep & P. Zanke (2025)

From Table 1, it can be seen that innovations in marketing are not limited to technological solutions – these innovations encompass organisational changes, new communication approaches and the transformation of managerial thinking. The implementation of innovative tools allows enterprises not only to meet customer needs more effectively, but also to form a new strategic management paradigm based on flexibility, an analytical approach and orientation towards long-term value. Thus, innovations in marketing act as a powerful strategic resource of the enterprise, ensuring its resilience, adaptability, and ability to outpace competitors in the dynamic digital environment.

Tools of innovative marketing:

Social networks, CRM systems and e-commerce

Social networks have become an integral component of the digital transformation of business, opening up new opportunities for SMEs in terms of development, promotion, and building relationships with clients. These networks allow companies with limited resources to compete effectively with large brands, increasing recognition and creating stable links with consumers. The most effective platforms for promoting SMEs in the digital environment in 2025 remain Facebook, Instagram and TikTok, each of which has its strengths depending on the type of business and audience. Facebook is universal and suitable for a wide range of businesses, especially those willing to invest in targeted advertising. The platform supports various content formats – from posts to videos and communities – which contributes to forming trust in the brand and building loyalty (Nagorny, 2024). Instagram remains the main platform for visually oriented content, popular among users under 34 years of age, and makes it possible to retain audience attention through Stories, Reels and interactive formats. TikTok is oriented towards short creative videos that quickly engage young users, and is therefore effective for brands with a visual or entertainment product. LinkedIn, in turn, performs a strategic function in B2B communications, allowing SMEs to build partnerships, enhance the professional image and attract clients with high purchasing power (IT rating UA, 2025).

The effectiveness of marketing in social networks is based on the integration of several tools. The most common among Ukrainian SMEs are targeted advertising, storytelling, influencer marketing, content marketing and video content. Targeted advertising makes it possible to reach the target audience according to sociodemographic and behavioural criteria, optimising the budget and reducing customer acquisition costs. Storytelling forms an emotional connection with the consumer through authentic narratives about the brand or product, which increases trust and recognition. Influencer marketing expands reach through cooperation with opinion leaders who share the company's values. Content marketing builds the brand's expertise by creating useful posts and advice, while video content – reels, live streams or short videos on TikTok – holds attention and stimulates interaction (AG.Marketing, 2025).

Successful examples of Ukrainian enterprises demonstrate the practical value of these tools. Prom.ua implemented a large-scale advertising campaign in 2020 that combined television content, social media and bloggers, achieving coverage of 80% of TV viewers and attracting more than 73% of the audience to the website. Within the digital campaign, coverage amounted to about 16.1 million users, which is approximately 56% of the entire Internet audience of Ukraine. After interacting with the advertising content, 73.4% of the covered users went to the Prom.ua platform, which indicates a high effectiveness of communication. In addition, eight bloggers on Instagram and YouTube were involved in the project, providing more than 6 million contacts with the target audience in social networks (Stadzhi, 2020). Beauty Service Ukraine, thanks to targeted advertising on Facebook and Instagram, increased the number of applications 3.5 times within three months while reducing the cost per lead by more than half. The producer of natural products Bionerica, using Facebook advertising, attracted 134 wholesale clients, spending about USD 1.35 per client (Wezom, 2022). Such cases confirm that the strategic integration of social networks into the SME business model can have a direct economic effect, especially under conditions of proper segmentation and personalisation of content.

Social networks play a decisive role in forming the brand, trust, and consumer loyalty. These networks make it possible to increase brand visibility, create a unique image of the company through personalised messages and reduce the information distance between business and clients. Active interaction with the audience through comments, responses to questions and the demonstration of the internal life of the company strengthens brand authenticity. Customer reviews, stories of successful product use and cooperation with micro-influencers form a reputation for reliability. Loyalty is maintained through regular value-based content, promotions, special offers and the creation of communities around the brand, which contributes to repeat purchases (Akanji, 2025).

Analytical tools, in particular Meta Business Suite, Google Analytics and Hootsuite, play a key role in the collection, systematisation and interpretation of marketing data in enterprises. Meta Business Suite provides integrated management of Facebook and Instagram pages, allowing the tracking of publication effectiveness, analysis of user interactions, click-through rate and conversions, and the formation of reports on the results of advertising campaigns in real time. Google Analytics focuses on in-depth analysis of web traffic, user behaviour and conversion paths, making it possible to assess the effectiveness of different promotion channels and make data-driven decisions. Hootsuite functions as a centralised platform for monitoring social networks, allowing the planning of posts, measurement of audience engagement, tracking of brand mentions and analysis of the dynamics of the content strategy. The combination of these tools provides a comprehensive approach to managing digital communications, contributing to more accurate

targeting, more efficient use of advertising budgets and increased overall effectiveness of marketing activities. These tools make it possible to track audience behaviour, determine the most effective types of content and optimal publication times, as well as identify trends. Automated reporting and visualisation of results through interactive dashboards simplify decision-making. In addition, cross-platform integration makes it possible to combine data from multiple channels, creating a holistic picture of marketing activities. This helps small businesses distribute budgets more effectively, increase the accuracy of forecasts and ensure stable growth. For example, the Canadian brand Apricotton, using the Hootsuite platform for social media analytics, managed to increase impressions to 66,000 in just two weeks, saving about 8 hours per week on content management and increasing sales by 108%. This approach demonstrates how the integration of analytical tools into marketing activities allows small enterprises to increase the effectiveness of digital communications without a substantial increase in expenditure (Hootsuite, n.d.).

For effective management of activity in social networks, SMEs use a system of key performance indicators that reflect both marketing and business results. The main ones include: number of followers, reach, engagement, number of website visits, conversions, customer acquisition cost, return on marketing investment, click-through rate and number of leads (Outsourcing Team, 2024). The choice of specific key performance indicators depends on the goals of the campaign – increasing awareness, attracting new clients or increasing sales. These indicators are basic benchmarks for assessing the effectiveness of enterprise activities in social media, as shown in Table 2.

Table 2. Key indicators for assessing the effectiveness of SMEs' marketing activities in social networks

Indicator	Essence	Value for business
Reach	Number of unique users who saw the content	Determines the scale of campaign coverage
Engagement rate	Percentage of interactions with content (likes, comments, reposts)	Reflects the level of audience interest
Conversions	Number of users who performed the target action	Measures the real effectiveness of the campaign
Customer acquisition cost	Cost of acquiring one customer	Makes it possible to assess the efficiency of expenditure

Table 2, Continued

Indicator	Essence	Value for business
Return on marketing investment	Ratio of profit to marketing expenditure	Determines the profitability of investment
Click-through rate	Share of users who clicked on a link or advert	Shows the quality and relevance of the content
Leads	Number of potential clients who left the contact details	Reflects the campaign's ability to generate interest

Source: compiled by the author on the basis of Outsourcing Team (2024)

The main difficulties for Ukrainian SMEs lie in the absence of clearly defined objectives, the complexity of tracking multichannel conversions, limited budgets and frequent changes in social media algorithms. Added to this is the difficulty of quantifying “soft” metrics – such as trust, recognition or emotional attachment. That is why enterprises are increasingly integrating social networks with CRM systems and e-commerce platforms in order to obtain a holistic analytical picture and link marketing actions to financial results. Thus, the combination of social media, CRM systems and e-commerce forms a new paradigm of innovative marketing. It is based on analytics, automation and personalisation, which enables SMEs to increase competitiveness, expand markets and ensure sustainable development in the digital economy.

Current market dynamics indicate that the digital segment is a key factor in the growth of communication activity and sales volumes in the SME sector. According to the results of the first half of 2025, the volume of paid search in Ukraine amounted to UAH 11.36 billion (approximately UAH 11.4 billion), with a forecast growth of 40% by the end of the year, which may exceed UAH 28.4 billion. Display advertising indicators for January-June 2025 reached UAH 8.5 billion, and the forecast increase by the end of the year is 20% (more than UAH 21.7 billion). These trends reflect the priority of channels with a high level of measurability of effectiveness and the gradual recovery of brand investment.

The structure of advertising budgets is dominated by global digital ecosystems, in particular Facebook, Google and Instagram, which account for about 72% of total expenditure. In the video advertising segment the share reaches 78%, while in display advertising format it is approximately two thirds. For SMEs, such a

market structure makes it advisable to use an omnichannel approach to promotion, with an emphasis on leading platforms and clearly defined performance indicators. Significant structural shifts are observed in advertising formats: after fluctuations between video and display advertising in previous years, in the first half of 2025 an advantage of video content has been recorded, whose share is 52% compared with 48% for display. At the same time, the importance of the Connected TV segment is growing; it combines television coverage with digital measurability, gradually increasing its share in total video budgets. Mobile devices remain the main channel for consuming advertising, accounting for about 75% of all digital expenditure (for Facebook, this figure reaches approximately 90%). Large screens continue to play a leading role for the YouTube platform, which determines the need to orient video strategies towards a mobile-first format, taking into account the integration of multi-platform screens. Among additional channels, search engine optimisation and social media marketing show the most dynamic growth. After a reduction in investment in social media advertising in 2022, caused by military actions and economic instability, the market began to recover – total business expenditure on SMM advertising reached UAH 824 million in 2024 and is forecast at UAH 1.236 billion by the end of 2025, exceeding pre-war figures. Influencer marketing also maintains positive dynamics, with a forecast of UAH 856 million in 2025. The highest growth rates are demonstrated by search engine optimisation: from UAH 1.876 billion in 2024 to an expected UAH 2.251 billion in 2025, which underlines its strategic importance for the long-term organic growth of brand visibility. Thus, for SMEs it is advisable

to combine performance-oriented channels (search, retargeting) with systematic investment in search engine optimisation and video marketing in social media (Stark, 2025).

Consequently, social networks have become a central element of innovative marketing for SMEs, combining opportunities for promotion, analytics, and the building of long-term relationships with clients. These networks provide access to a wide audience at minimal cost and make it possible to form consumer trust and loyalty through personalised communication. Practical cases of Ukrainian SMEs demonstrate that targeted advertising, video content and storytelling can directly influence the growth of sales and brand recognition. The use of key performance indicators and analytical platforms helps increase the effectiveness of marketing strategies. Overall, social media are forming a new ecosystem for the development of SMEs, ensuring the resilience and competitiveness in the digital economy.

Risks and prospects of implementing innovative marketing strategies in the activities of SMEs

Innovative marketing strategies are becoming an integral factor in the development of SMEs in the digital economy. These strategies enable businesses to interact effectively with clients, expand sales markets, increase competitiveness and ensure stable growth even with limited resources. At the same time, the implementation of such strategies is accompanied by a number of challenges that encompass financial, organisational, technological and human-resource risks. SMEs in Ukraine, which are increasingly introducing digital marketing tools – social media, CRM systems, e-commerce, analytical platforms – face problems of insufficient staff qualifications, the complexity of assessing campaign effectiveness and the instability of the market environment. Table 3 reflects the results of the SWOT analysis of the implementation of innovative marketing strategies in the activities of SMEs.

Table 3. SWOT analysis of the implementation of innovative marketing strategies in the activities of SMEs

Strengths	Weaknesses
Flexibility in decision-making and rapid adaptation to digital trends. High level of customer orientation. Possibility of rapidly testing new formats (SMM, SEO, CRM). Personalisation of communications and closeness to the consumer.	Limited budgets for marketing and technologies. Insufficient staff qualifications in the field of digital marketing. Absence of clear key performance indicators and a systematic analytical approach. Dependence on the algorithms of global platforms (Meta, Google, TikTok).
Opportunities	Threats
Development of the digital market in Ukraine and growth of the online audience. Attraction of foreign investment into the digital sector. Integration of CRM and artificial intelligence (AI) for automation of analytics. Participation in digital transformation programmes and grant projects.	Changes in social platform algorithms and rising advertising costs. Cyber risks, data leaks and confidentiality issues. Inflationary pressure and instability of purchasing power. Competition with large corporations that have large-scale budgets.

Source: compiled by the author on the basis of Y.K. Dwivedi *et al.* (2021), T. Chebakova (2025)

On the basis of the SWOT analysis carried out, several groups of risks characteristic of the implementation of innovative marketing strategies in SMEs can be identified (Table 3). Financial risks consist in the high cost of technological solutions, dependence on paid services (CRM, targeted advertising, analytical tools), as well as the instability of exchange rates, which affects the price of imported IT solutions. Organisational risks include

the absence of systematic planning, clear key performance indicators and the difficulty of measuring results in the case of multichannel campaigns. Technological risks are associated with the high dynamics of changes in social platform algorithms, which can sharply reduce audience reach even with high-quality content. Human-resource risks lie in the shortage of specialists capable of combining analytical and creative skills,

as well as in the outflow of talent to large international companies.

Information security risk also remains a significant challenge for SMEs. The use of e-commerce, CRM and analytical platforms involves processing large volumes of personal data, so failure to comply with cyber-security standards or violation of confidentiality rules may lead to loss of reputation and financial losses. Small enterprises are particularly vulnerable, as these enterprises do not have sufficient resources to develop systems of internal control of data security. In addition, dependence on global technology giants (Meta, Google, TikTok) creates strategic vulnerability – changes in policies or restrictions on access to services can significantly affect marketing results. Despite these threats, the development potential of innovative marketing for SMEs is extremely significant. One of the key prospects is the expansion of sales markets through e-commerce. Online trade enables enterprises to go beyond local consumers, integrate into global supply chains and interact with clients in real time. The use of Big Data tools and analytics helps to forecast consumer behaviour, optimise the offer and personalise marketing campaigns. For example, analytics of social networks and CRM platforms makes it possible to segment the audience accurately, determine the optimal moment for purchase and increase the conversion rate (Chebakova, 2025).

The growing role of social media opens up new directions for the integration of innovative strategies. For SMEs this is an opportunity to implement SMM with lower costs but higher effectiveness thanks to personalised messages, storytelling, and cooperation with micro-influencers. Many Ukrainian companies already demonstrate that even a limited budget can provide significant results if the strategy is based on value-driven communication and systematic analytics. A revealing example is the case of the company Ecosoft, which, with the help of a PPC strategy and adapted communication, successfully entered the markets of the United Kingdom and the EU. The company did not increase its advertising budget; instead, it optimised advertising settings, audience segmentation and campaign analytics, which made it possible to achieve business objectives at the initial

stage – increasing brand awareness and attracting new B2B partners (Inweb, 2025). Thanks to comprehensive optimisation of advertising campaigns and the introduction of innovative approaches, Ecosoft demonstrated a significant improvement in key performance indicators in the period August-December 2024 compared with the same period in 2023. In particular, the number of purchases increased by 30.6%, revenues grew by 43.8%, while the advertising budget increased by only 2.5%, which indicates effective allocation of expenditure. At the same time, a 28.7% reduction in the share of advertising expenditure, a 10% increase in the average ticket and a 40.2% increase in advertising profitability were recorded. The results obtained confirm that competent optimisation of PPC campaigns without a substantial increase in budget can ensure sustainable brand development in international markets and significantly increase the economic return on marketing investment (Trofimchuk, 2025).

Another promising area is the implementation of CRM systems, which provide the integration of marketing, analytical and financial data in a single environment. This allows small businesses to manage customer relationships effectively, forecast sales, increase the level of customer retention and automate repeated communications. Integration of CRM with social media makes it possible to synchronise data on user behaviour, assess emotional response and respond more quickly to changes in demand. In addition, e-commerce is becoming not only a sales channel but also a platform for testing innovative solutions. Ukrainian SMEs are actively integrating platforms such as Shopify, Prom.ua, Rozetka and Etsy, which makes it possible to reduce expenditure on physical infrastructure and at the same time expand the geography of clients. The use of AI algorithms for personalised recommendations, chatbots for customer service and analytical dashboards for demand forecasting makes this area strategic in the context of increasing competitive pressure. Rozetka has introduced personalisation algorithms that analyse user behaviour from the first clicks on the site. This enables the dynamic adaptation of product blocks, the selection of personalised promotions and recommendations taking into

account the region, search history, type of device and other parameters, as the system selects more relevant offers for each user. In addition, Rozetka actively uses chatbots to automate customer service, which significantly reduces response time and improves the quality of support while simultaneously reducing the workload on operators, since chatbots can automatically process up to 40% of standard requests and store the full history of dialogues in the Business Advisory Services CRM system (Klyuyev, 2025).

Among promising trends, it is also worth noting the development of omnichannel strategies that combine social media, CRM and e-commerce into a single digital ecosystem. This makes it possible to increase the consistency of communications, avoid duplication of efforts and form a more holistic user experience. For Ukrainian enterprises, such an approach is particularly relevant, as it allows more effective operation in a saturated market where consumers expect personalised service and rapid responses to requests. Another important prospect is state and international support for the digital transformation of SMEs. The programmes of the United States Agency for International Development (USAID) and EU4Business, as well as the national initiatives Diia.Business and Diia.Digital, create a comprehensive environment for the development of innovative entrepreneurship. The USAID programme is aimed at the digital transformation of Ukraine's economy through increasing digital literacy, developing electronic services and supporting technological startups. Thanks to this, enterprises gain access to online business tools, mentoring programmes, consultations on digital marketing and opportunities for financing the development of innovative products. The EU4Business initiative is implemented by the EU jointly with the European Bank for Reconstruction and Development and Deutsche Gesellschaft für Internationale Zusammenarbeit and provides grants, loans, and training programmes for Ukrainian SMEs, in particular in the areas of digitalisation, automation, and implementation of CRM systems. It stimulates business innovation by providing access to financial resources for the modernisation of production and marketing infrastructure. The national platforms Diia.Business and Diia.Digital

serve as an ecosystem for supporting entrepreneurship – these platforms provide free online courses, consultations on digital management, tools for starting a business, as well as information on grant programmes and state services in digital format. Taken together, these initiatives encourage the introduction of innovation in business through three key mechanisms: simplifying access to technologies, increasing entrepreneurs' competences and reducing financial risks during digital modernisation.

In conclusion, it can be stated that the effective implementation of innovative marketing strategies in the activities of SMEs in Ukraine is a strategic priority for increasing the competitiveness. Despite existing risks, innovative tools – social media, CRM, e-commerce, analytics – are forming a new business paradigm based on data, automation and flexible management. Future success will depend on the ability of enterprises to combine creativity and technological capability, invest in the digital competences of staff and ensure data security. As a result, innovative marketing can become not only an instrument of adaptation to the digital economy but also a key factor in the long-term resilience and economic growth of SMEs.

DISCUSSION

Marketing is undergoing a profound transformation under the influence of digitalisation, which encompasses all aspects of interaction between business and the consumer. The integration of Big Data technologies, artificial intelligence, CRM systems, blockchain, as well as virtual and augmented reality tools has created the conditions for a shift from traditional models to customer-oriented and analytically driven strategies. This process has been accompanied by the growing role of social media, personalisation and sustainable marketing, which is gradually turning marketing activity into a systemic tool of strategic enterprise development. The present study developed a general concept shared with the work of S. Zhang (2025) – the idea that the digital economy has become the driving force behind the evolution of marketing. Both approaches recognised that traditional management models had lost the effectiveness due to the spread of Big Data, artificial

intelligence and social media. At the centre of both works was the pursuit of personalisation and the building of analytically driven relationships with the consumer. At the same time, S. Zhang focused on the impact of China's state digital policy and the formation of macroeconomic conditions, whereas the present study examined the practical mechanisms of digitalisation of small business – the use of CRM systems, key performance indicators and analytical platforms to strengthen the resilience of enterprises. In addition, sustainable marketing in S. Zhang is interpreted as a tool of global corporate responsibility, while in the present study it is seen as a means of increasing brand trust in the digital environment. The ideas expressed in the work of S. Mirdasse (2024) organically continued this vision, emphasising the role of technologies as the basis for the formation of a new model of marketing activity. Both studies focused on the importance of Big Data, artificial intelligence, CRM systems and social networks in building customer-oriented strategies. However, whereas S. Mirdasse viewed the digital economy as a global system of market and process integration, the present study detailed the practical aspects – how SMEs adapt these technologies to the own resource capacities, ensuring resilience and consumer loyalty.

A similar approach was taken in the study by M. Sohaib *et al.* (2022), which also emphasised the leading role of digitalisation in marketing management. In both cases, the discussion concerned the use of Big Data, AI and automated systems for more accurate decision-making and personalisation of communications. However, M. Sohaib *et al.* considered digital marketing in a global corporate dimension, whereas the present study focused on the effectiveness of implementing digital tools by Ukrainian SMEs, demonstrating specific results such as increased return on investment through CRM and SMM campaigns. The views of S. Gao (2025) also resonated with the conclusions of the present study: both confirmed that digital tools are a key factor in improving the effectiveness of strategies. However, S. Gao analysed these processes at the level of corporate ecosystems and interactions between digital platforms, whereas the present study revealed the practical side – how

SMEs used these tools to strengthen competitiveness and customer loyalty.

The study by E. Boom-Cárcomo *et al.* (2024) had a similar focus, but it broadened the context of digitalisation to the social dimension, considering innovation as a factor of sustainable development and corporate responsibility. In contrast, the present study concentrated on the economic effect of implementing digital tools by small enterprises, demonstrating the potential to enhance managerial efficiency and enable rapid adaptation to market changes. In the study by T. Nadeak *et al.* (2024), digitalisation was viewed as a factor in the global transformation of marketing, combining interactive communication, personalisation and analytical support. Both approaches recognised the key role of Big Data and social media in creating new formats of interaction; however, while T. Nadeak *et al.* systematised global trends, the present study revealed specific examples of the implementation of these tools by Ukrainian enterprises, demonstrating the applied significance.

Comparison with the work of Z. Pu (2022) showed a common understanding of digitalisation as the driving force behind marketing strategies, but the difference lay in scale. Z. Pu analysed the Chinese market in the context of the “Internet+” policy and the development of 5G, VR and AR technologies, whereas the present study focused on the adaptation of similar technologies to the realities of SMEs. Both approaches recognised that analytics and personalisation had become the basic principles of marketing activity. The study by M.T. Khanom (2023) summarised the strategic principles of digital business transformation on a global scale, defining it as the driving force of innovative development. In this context, it logically echoed the present study, which examined the practical implementation of these principles in the activities of SMEs. While M.T. Khanom analysed digital transformation as a strategic process, the present study demonstrated its operational application – through CRM, Big Data and innovative models of customer orientation.

The relationship between innovation, competitive strategy and business performance was a central theme both in the present study and in the work of M. Rubio-Andrés *et al.* (2024). Both

approaches proceeded from the understanding that in the era of the digital economy, it is precisely innovativeness that determines the ability of enterprises to remain competitive. In M. Rubio-Andrés *et al.*, this proposition was empirically confirmed through a quantitative analysis of the interdependence between strategic orientations, the level of innovation and market outcomes of SMEs. In the present study, the issue was revealed in practical terms: digital tools such as Big Data, CRM systems and artificial intelligence were considered not only as technological resources but also as the foundation for building adaptive marketing models that ensure rapid responses to market changes. Thus, both approaches combined strategic vision with pragmatic mechanisms for implementing innovation, although these approaches differed in the level of generalisation – from the statistically confirmed relationship in M. Rubio-Andrés *et al.* to the practical case analysis in the present work.

The issue of strategic renewal of marketing through digital technologies was also the focus of C. Albrecht (2024). Similar to the conclusions of the present study, the author emphasised that digital transformation had not only changed communication tools but had also shaped a new logic of strategic thinking. In C. Albrecht's work this phenomenon was analysed using the example of German companies, where digitalisation was combined with a high level of automation, strict ethical standards and corporate responsibility. The present study approached the problem from another angle – it demonstrated how SMEs adapt global trends to the own scale, using digital tools to optimise processes, personalise the customer experience and form flexible marketing strategies. Such a contrast between the macro-level of the European model and the practical reality of SMEs highlighted the universality of the impact of digital transformation regardless of context.

A specific continuation of this discussion was offered by O. Urefe *et al.* (2024), who examined how innovative marketing strategies help small businesses overcome digitalisation barriers in developing countries. The conclusions resonated with the results of the present study, since in both cases, digital technologies were viewed as a catalyst for entrepreneurship

and competitive resilience. O. Urefe *et al.* emphasised that the integration of Big Data, CRM and AI contributes to building consumer trust and loyalty even in environments with limited technological infrastructure. At the same time, the authors described in detail the barriers – a shortage of specialists, cyber risks, low digital readiness of companies – that hinder the effective implementation of innovations. The present study continued this line, but focused on Ukrainian realities, showing how digital solutions can serve not only as a communication tool but also as a strategic mechanism for enhancing resilience and forming a customer-oriented culture.

Summarising the results of the comparison, it can be noted that digital transformation has become not just a technological trend but a profound factor in the evolution of marketing management. All the approaches considered demonstrated a gradual shift from intuitive and traditional marketing to systemic, analytically grounded management based on data, automation, and customer orientation. Digital tools – from CRM and Big Data to social media, AI, VR and AR – have shaped a new logic of interaction between business and the consumer, where flexibility and personalisation determine the success of market strategies.

CONCLUSIONS

The study conducted has proved that innovative marketing strategies are a key factor in improving business performance in the digital economy. The application ensures the integration of technological, organisational and communication solutions aimed at strengthening the competitive position of enterprises. The analysis showed that marketing has lost the boundaries between the online and offline space, turning into a flexible system that combines Big Data, CRM systems, analytical platforms, social networks and e-commerce. Such a combination creates a new management logic, where the speed of information processing, customer behaviour analytics and personalisation become decisive for achieving business objectives. Statistical indicators have confirmed that digital communications remain the main driver of growth for Ukrainian business. In the first half of 2025, the volume of paid search amounted

to UAH 11.36 billion, and display advertising to UAH 8.5 billion, which demonstrates a significant recovery of the market after previous crisis periods. About 72% of advertising expenditure falls on the global platforms Facebook, Google and Instagram, which necessitates the strategic use in communication campaigns. At the same time, video formats are gradually dominating over banners, mobile devices account for more than 75% of digital expenditure, and the growing role of SEO and SMM indicates a reorientation of business towards long-term, analytically measurable tools.

Practical cases have confirmed that the effectiveness of marketing is determined not by the size of the budget but by the quality of the strategy. The company Prom.ua achieved a reach of 80% of TV viewers and 73% of the internet audience, while Beauty Service Ukraine increased the number of enquiries by 3.5 times while reducing the cost per lead by more than half. The SWOT analysis showed that flexibility, customer orientation and rapid adaptation are the strengths of SMEs, whereas the main risks are associated with financial constraints, staff shortages and dependence on the algorithms of global platforms. In summary, it can be stated that innovative marketing strategies provide

Ukrainian enterprises with the opportunity not only to survive but also to develop in a dynamic digital environment. The implementation forms a new management paradigm based on data, automation, flexibility, and consumer trust. In the context of global competition, this is the basis for strengthening financial stability, increasing the effectiveness of communications and creating sustainable business growth. A limitation of the present study is that it was based mainly on secondary sources and did not include a quantitative assessment of the effectiveness of implemented digital strategies in the real business sector. Prospects for further research lie in conducting an empirical analysis of the performance of innovative marketing tools in various sectors of the economy and in developing models for the adaptation for small and medium-sized enterprises.

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Інноваційні маркетингові стратегії розвитку бізнесу в умовах цифровізації

Анотація. Метою даного дослідження було визначити закономірності формування та ефективності інноваційних маркетингових стратегій у цифровому середовищі з урахуванням особливостей діяльності малих і середніх підприємств (МСП). Методологічною основою став системно-порівняльний, контент- та структурно-логічний аналіз, що дозволив комплексно розглянути теоретичні підходи, інструменти цифрової комунікації та практичні приклади їх застосування у національній бізнес-практиці. У ході дослідження було проаналізовано еволюцію маркетингових стратегій, тенденції використання систем управління взаємовідносинами з клієнтами, зокрема HubSpot, Zoho та Bitrix24, а також вивчено вплив соціальних мереж Facebook, Instagram, TikTok і LinkedIn на формування споживчої лояльності. Окрему увагу приділено аналізу аналітичних платформ Meta Business Suite, Google Analytics і Hootsuite, які забезпечують вимірювання результативності маркетингових кампаній. Встановлено, що у першому півріччі 2025 року близько 72 % рекламних витрат припадало на платформи Facebook, Google та Instagram, тоді як обсяг платного пошуку сягнув 11,36 мільярда гривень, а медійної реклами – 8,5 мільярда гривень. Результати стратегічного аналізу за моделлю «сильні сторони – слабкі сторони – можливості – загрози» показали, що впровадження інноваційних маркетингових стратегій забезпечувало підвищення ефективності комунікацій і зниження витрат на просування. Основними слабкими сторонами залишалися обмежені фінансові ресурси та низький рівень цифрових навичок персоналу. До можливостей віднесено розширення e-commerce і програм підтримки цифровізації, а до загроз – кіберризиків та посилення онлайн-конкуренції. Практичні приклади діяльності українських компаній Prom.ua, Beauty Service Ukraine, Ecosoft і Rozetka підтвердили результативність таргетованої реклами та впровадження інноваційних маркетингових підходів у підвищенні видимості бренду й залученості клієнтів. Практичне значення дослідження полягає у можливості використання його результатів керівниками підприємств, маркетологами, консультантами з цифрових комунікацій та аналітиками для розроблення ефективних маркетингових стратегій, підвищення рентабельності, впізнаваності бренду та залученості споживачів

Ключові слова: трансформації; автоматизація; електронна комерція; персоналізація; конкурентоспроможність; взаємодія



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Innovative marketing as a component of the development strategy for agricultural enterprises

Abstract. The aim of this study was to substantiate the impact of digital technologies and marketing solutions on improving the performance, competitiveness, and adaptability of agricultural enterprises in Ukraine amidst the transformation of the economy, using two leading companies – Myronivsky Hliboproduct and Kernel – as examples. The methodology was based on a combination of quantitative analysis of financial and production indicators and qualitative analysis of the

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digital marketing tools employed by these enterprises, to identify the relationship between the level of digitalisation and business performance. In the case of Myronivsky Hliboproduct, revenue increased from USD 1.41 billion to USD 2.26 billion, while net profit grew from USD 302 million to USD 437 million. The average selling price of products rose by 50%, from USD 1.34 to USD 2.01 per kilogram, while the share of digital tools in the marketing budget increased from 25% to over 65%. Kernel showed a similar positive trend: revenue rose to USD 4.12 billion (+15%), net profit reached USD 466 million (+22%), and the margin strengthened to 11.3%. Additionally, the company increased social investments by 21% and reduced carbon emissions by 32%. The results obtained demonstrated that digitalisation of marketing, business process automation, and the development of online communication channels have become key factors in enhancing the profitability, financial stability, and international competitiveness of Ukrainian agricultural companies. The practical significance of the study lies in the fact that its findings can be used by agricultural enterprise managers, marketing consultants, and government institutions when developing strategies for digital transformation, optimising marketing processes, and boosting the export potential of Ukraine's agricultural sector

Keywords: digital transformation; management; competitiveness; brand; content; promotion

INTRODUCTION

In the context of global competition and an unstable economic environment, a key factor for increasing the efficiency of agricultural enterprises is the introduction of new approaches to market activity management. Traditional methods of product promotion no longer ensure sufficient interaction with target consumers, especially considering the digitalisation of the agricultural sector, changes in consumer behaviour models, and the growing role of sustainable development. In this context, innovative approaches to organising marketing processes, combining digital tools, analytical technologies, brand strategy, and corporate social responsibility, become of particular importance.

Within the context of marketing process development in agriculture, the main challenge remains the low level of adaptation of enterprises to rapid market changes, which is caused by economic instability, military risks, and limited investment opportunities. Research D. Zmievets & L. Pronko (2024) showed that the lack of effective mechanisms for implementing innovations in marketing activities significantly complicates the improvement of enterprise competitiveness and hinders their integration into the digital economy. The researchers systematised approaches to the use of information and communication technologies, identified the role of digital promotion channels in strengthening the positions of producers, and substantiated the need to update communication

strategies with consumers. In the conditions of dynamic market processes, the issue of the effective combination of innovative approaches and marketing strategies to enhance the performance of agricultural sector enterprises is particularly relevant. The patterns of forming innovative development strategies, aimed at improving production efficiency and balancing the interests of different market participants, were revealed in the study by V.G. Margasova & N.M. Vdovenko (2022), who proved that the foundation of successful enterprise operation lies in a consumer-oriented approach, demand elasticity analysis, rational pricing, and the use of innovations in communication policy.

The insufficient effectiveness of marketing tools in the activities of agricultural enterprises has led to the need to search for new approaches to enhancing the effectiveness of innovative development. The importance of implementing information and communication technologies and digital marketing tools to strengthen the competitive positions of agricultural enterprises was substantiated in the study by T.V. Ilchenko (2020). The author identified the main directions for activating innovative activities: improving innovation stimulation mechanisms, developing support infrastructure, forming marketing support systems, and using digital promotion channels. The lack of a systematic approach in constructing marketing strategies for agricultural enterprises

complicates achieving stable growth and effective entry into external markets. I. Dmytriiev *et al.* (2022) demonstrated that the effectiveness of enterprises' activities is determined by the ability to combine innovative approaches to marketing with a focus on sustainable development. Using the example of the company Myronivsky Hliboproduct, the authors proved that the implementation of a vertically integrated business model, supported by technological innovations and principles of environmental responsibility, contributes to strengthening competitive positions in the international market.

The lack of a systematic approach to the use of digital tools in the marketing activities of enterprises complicates their integration into the international economic space. A key factor in increasing competitiveness, as noted by L. Kvasova *et al.* (2023), is the development of digital promotion strategies, the use of social media, Search Engine Optimization (SEO), data analytics, and e-commerce platforms. The authors emphasised that the effective combination of digital technologies with customer-oriented management models contributes to the growth of product exports and the formation of a positive brand for enterprises. The low effectiveness of implementing innovations in the marketing activities of agricultural enterprises necessitates the improvement of approaches to strategic development. In the study by O. Krasnorutskyy *et al.* (2023), it was noted that a key factor in enhancing competitiveness is the application of digital technologies, analytical platforms, and customer-oriented business models. The authors stressed that innovative marketing fosters the development of sustainable strategies, optimisation of supply chains, and more efficient resource use.

The activities of agricultural enterprises are characterised by a low level of innovation implementation, which limits their ability to adapt to the dynamic changes in the market environment. The need to enhance the innovation component of management was substantiated in the study by O.P. Lucii & T.A. Korniychuk (2022), where the principles for forming an innovation development strategy were identified, including systematised approaches, flexibility, adaptability, and a focus on minimising risks, which

ensure the effective implementation of strategic objectives. At the same time, V. Mamchur *et al.* (2024) established that the main factor in improving performance is the digitalisation of management processes, automation of analytics, and the formation of customer-oriented interaction systems. The authors proved that the introduction of advanced marketing technologies, particularly analytical platforms and e-commerce, contributes to improved sales efficiency, resource optimisation, and the expansion of enterprises' market presence. The study emphasised the need to integrate marketing strategies into the overall system of innovative management, which ensures business stability and flexibility.

Despite significant scientific progress in the study of innovative marketing, further research is required on the issues of quantitatively assessing the effectiveness of digital strategies, developing adaptive management models for innovation processes, determining the impact of digitalisation on the economic sustainability and investment attractiveness of agricultural enterprises, as well as improving mechanisms for measuring innovation potential and enhancing the digital competence of managers. The aim of this study was to substantiate the role of implementing innovative approaches into the marketing management system to increase the competitiveness and sustainability of agricultural enterprises in the context of the digital transformation of the economy, based on the analysis of the practices of two leading companies – Myronivsky Hliboproduct and Kernel. To achieve this aim, the following tasks were set: to assess the impact of digital technologies and innovative marketing tools on the effectiveness of strategic development in agricultural business; to identify potential directions for the innovative development of the agricultural sector in Ukraine based on national and international digitalisation support programmes.

MATERIALS AND METHODS

The research was empirical in nature and covered the period from 2020 to the first half of 2025. The marketing activities of the company Myronivsky Hliboproduct (MHP, n.d.) were analysed using the method of systemic-comparative

analysis to determine the features of building the company's digital communication model (MHP4U, n.d.). The choice of this company was due to its leading position in the market, high level of digitalisation of business processes, developed export system, and active integration of digital tools into its marketing strategy. The implementation of the Systems, Applications, and Products in Data Processing – Customer Relationship Management (SAP CRM) system (SAP, n.d.) was evaluated using a functional-analytical approach to identify the effectiveness of customer relationship management and improve the accuracy of marketing decision-making. The use of social media platforms Facebook (n.d.), Instagram (n.d.), and TikTok (n.d.) was examined using content analysis, which allowed for the determination of the brand's digital activity level, audience engagement, and the effectiveness of the communication policy. Based on the analysis, the key promotion tools and directions for digital interaction with customers were identified (RAU, 2024).

The dynamics of the key financial and production indicators of MHP from 2020 to the first half of 2025 were assessed using the method of economic-statistical analysis with the aim of identifying trends in the changes in operational effectiveness. The analysed indicators included production volumes, sales and export of poultry (thousand tonnes), the share of exports in revenue (%), average sales price (USD/kg), revenue (billion USD), Earnings Before Interest, Taxes, Depreciation, and Amortisation (EBITDA) (million USD), net result (million USD), key export markets, and the share of digital tools in the marketing budget (%). The use of official financial reports, Financial results for the third quarter and nine months... (2020; 2021; 2022), allowed for the identification of structural changes in production and sales activities. Further analysis, conducted based on the reports Financial results for the third quarter and nine months... (2023; 2024) and Financial results for the second quarter and six months... (2025), was carried out using the method of comparative analysis to determine the dynamics of the enterprise's financial stability.

The marketing strategies of the company Kernel (n.d.a) were examined using the method

of systemic analysis to identify the relationships between management decisions, digital technologies, and the structure of marketing management (Kernel, n.d.b). The choice of Kernel was justified by its significant impact on Ukraine's export potential, the comprehensive integration of digital tools into marketing, and the presence of a developed corporate information technology (IT) infrastructure. The effectiveness of implementing the Enterprise Resource Planning (ERP) solution Microsoft Dynamics Navision (NAV) (Dynamics NAV, n.d.) and the electronic goods transport waybill system eTTN (Latifundist Media, 2024) was analysed using a functional analysis method to assess the level of automation of business processes. The activities of the IT company Kernel Digital (n.d.) and the use of the DigitalAgriBusiness system (Latifundist Media, n.d.) were evaluated using the method of comparative analysis to determine the effectiveness of digital solutions in monitoring supply chains and sales analytics.

The key financial and production indicators of the company Kernel for 2020 to the first half of 2025 were analysed using the method of economic-statistical analysis with the aim of identifying development trends, financial stability, and investment activity effectiveness. The analysis covered indicators such as revenue (billion USD), EBITDA (million USD), EBITDA margin (%), net profit (million USD), net margin (%), export volumes of grains and oilseeds (million tonnes), the share of exports in revenue (%), investments (million USD), net debt (million USD), net debt/EBITDA, social investments (million USD), and CO₂ emissions (thousand tonnes). All indicators were obtained from the official financial reports of Kernel Holding S.A. annual report for the year... (2020; 2021; 2022). Additional data from the reports Kernel Holding S.A. annual report for the year... (2023; 2024; 2025) were used to ensure the completeness of the time series and to track the dynamics of the company's key performance indicators. The application of the method of dynamic series allowed for tracking changes in profitability structure and determining the stability of the company's financial results.

The prospects for the innovative development of Ukraine's agricultural sector were

assessed using the method of comparative analysis. For this purpose, state support programmes were considered, including “Affordable Loans 5-7-9%” (Privatbank, n.d.), as well as the eRobota (n.d.) grant initiative and the United States Agency for International Development (USAID) Agriculture Growing Rural Opportunities (AGRO) project (Organic knowledge platform, n.d.), which aim to improve enterprises’ access to financial resources. Additionally, the FAO Ukraine Resilience Programme (FAO emergencies and resilience, n.d.) and international initiatives such as Horizon Europe (European Commission, n.d.c) and The European Green Deal (European Commission, n.d.a) were analysed, as these form the foundation for technological modernisation and the transition of the agricultural sector to more sustainable production models. Special attention was given to the Digital Europe Programme (European Commission, n.d.b), which promotes the expansion of digital capabilities for agricultural enterprises. The activities of international financial institutions – the European Bank for Reconstruction and Development (EBRD, n.d.), World Bank in Ukraine (n.d.), and the International Finance Corporation (IFC in Ukraine, n.d.) – were also considered, as they provide investment resources for the digitalisation and innovative development of enterprises. The application of the comparative analysis method enabled the systematisation of support programmes and the identification of their contribution to creating a favourable environment for the digital transformation of marketing and technological renewal of agricultural enterprises in Ukraine.

RESULTS AND DISCUSSION

Marketing system and innovative transformation of MHP

The marketing activities of agricultural enterprises in the context of the digital economy have become of strategic importance, determining growth rates, market adaptability, and the resilience of business models. For the company Myronivsky Hliboproduct (MHP, n.d.), innovative marketing is a key factor in ensuring competitive advantages, as it combines technological modernisation with the creation of long-term consumer loyalty. Market development trends

require enterprises to deeply integrate digital tools into the marketing system – from customer relationship management to the automation of analytics, targeting, and communication personalisation. For MHP, the marketing department structure encompasses several functional units responsible for various areas of work. Overall leadership is provided by the director of the marketing department. Within the department, teams function for market analysis, development of marketing strategies, social media management and content creation, brand management, trade marketing, and corporate communications. The organisational model is based on a functional principle with a clear distribution of roles – brand managers, trade marketers, social media marketing (SMM) specialists, analysts, and communications managers coordinate the full cycle from consumer research to brand support in the market (MHP4U, n.d.).

MHP actively implements digital technologies in its marketing activities. SAP CRM (SAP, n.d.) is used as the main system for managing customer relationships, enabling the collection, analysis, and personalisation of data to improve service efficiency. In the area of SEO, the company applies the optimisation of corporate websites and content, ensuring stable visibility in search engines. Advanced content marketing is supported by the use of artificial intelligence tools to automate material creation and increase team productivity. In the field of SMM, MHP actively maintains pages on Facebook (n.d.), Instagram (n.d.), and TikTok (n.d.), using analytics to measure reach, engagement, and the effectiveness of targeted advertising (Latifundist Media, 2021).

An important component is e-commerce and trade marketing, within which the company uses digital Point of Sale (POS) materials, Quick Response (QR) codes, and “digital consumer corners” that combine offline and online experiences. Data analytics is implemented through SAP systems, Big Data, and Artificial Intelligence (AI), which help forecast demand, plan production, and optimise communication campaigns. Interaction between marketing, sales, and production is organised based on centralised planning – the CRM system ensures the transfer of customer data, allowing production

volumes to be adapted in accordance with demand (RAU, 2024; Lopokha, 2025) MHP's marketing strategy is based on multichannel communication, where digital tools dominate over traditional ones. The main channels for promoting the brands "Nasha Ryaba", "Bashchynskyi", and "Lehko!" are social media, YouTube, outdoor advertising, and Public Relations (PR) communications, aimed at strengthening trust and emotional connections with customers. Between 2020 and 2024, the company implemented a comprehensive digital transformation of marketing: it introduced SAP CRM, Big Data analytics, AI solutions for automating routine processes, and created digital touchpoints with consumers in retail (RAU, 2024).

In the context of the war, MHP adapted its marketing policy – transforming the brand "Nasha Ryaba" into the "Yizha Svischa" format, expanding the franchise network "Miasomarket", intensifying communications in digital channels, and launching patriotic content campaigns. The company focuses on transparency and partnership with the creative industry, maintaining marketing effectiveness even in crisis conditions. Overall, MHP's strategy is aimed at synergy

between production, sales, and marketing, the use of analytics for accurate market forecasting, and the dominance of digital platforms in the structure of marketing investments, ensuring the company's sustainable leadership in the Ukrainian agricultural market (Forbes, 2022).

From 2020 to the first half of 2025, MHP's activities were characterised by significant variability in results, driven by both global crisis phenomena and internal socio-economic challenges. Despite the considerable pressure from external factors – pandemic restrictions, rising costs of feed, energy resources, and military risks – the company retained its position as a key producer and exporter of poultry in Ukraine. During this period, the company's marketing strategy transformed from focusing on stabilising production and sales processes to implementing innovative digital tools that enhanced communication and sales management effectiveness. The dynamics of MHP's key production, sales, and financial indicators for 2020 to the first half of 2025 are presented in Table 1, demonstrating a trend of gradual recovery and the strengthening of the company's digital marketing presence in both domestic and international markets.

Table 1. Dynamics of key indicators of MHP for 2020 – first half of 2025

Indicator	2020	2021	2022	2023	2024	2025 (6 months)
Poultry production in Ukraine, thousand tonnes	541.6	551.7	515.5	546.4	533.7	341.9
Poultry sales, thousand tonnes	523.8	521.5	477.1	512.0	501.0	–
Poultry export, thousand tonnes	279.0	300.3	257.3	312.0	276.3	185.6
Share of export in revenue, %	54	51	59	60	56	–
Average sales price, USD/kg	1.34	1.64	1.97	1.94	2.01	2.29
Revenue (in billion USD)	1.41	1.65	1.88	2.29	2.26	1.64
EBITDA, million USD	302	519	275	329	437	236
Net result, million USD	-109	+377	-269	+122	+141	75
Key export markets	MENA, EU, Africa	EU, MENA	EU, MENA, Africa	EU, MENA	EU, MENA	EU, MENA
Share of digital tools in marketing budget, %	25	35	55	60	65	–

Source: compiled by the authors based on Financial results for the third quarter and nine months... (2020; 2021; 2022; 2023; 2024), Financial results for the second quarter and six months... (2025)

From Table 1, it is evident that in 2020, against the backdrop of global economic turbulence, MHP managed to maintain production at the level of 541.6 thousand tonnes, with the share of exports in revenue standing at 54%. In 2021, thanks to the recovery of the European Union (EU) and Middle Eastern (MENA) markets, export volumes increased to 300.3 thousand tonnes, and net profit exceeded USD 370 million. The war in 2022 significantly affected logistics and production – production output decreased to 515.5 thousand tonnes, and the company incurred a loss of USD 269 million. However, by 2023, MHP showed recovery dynamics, increasing export volumes to 312 thousand tonnes and returning to profitable operations. In 2024, despite the ongoing war risks, the company stabilised production, improved operational efficiency, and achieved an EBITDA growth of USD 437 million. By the end of the first half of 2025, the company maintained a positive trend: production amounted to 341.9 thousand tonnes, exports were 185.6 thousand tonnes, and revenue reached USD 1.64 billion, with EBITDA at USD 236 million and net profit at USD 75 million. The data shows that from 2020 to the first half of 2025, the company demonstrated a high capacity for adaptation in the face of macroeconomic instability and war risks. The reduction in production and sales in 2022 did not result in a loss of financial stability due to the increase in the average sales price, cost optimisation, and the expansion of presence in European markets. Following the 2022 crisis, the company resumed positive dynamics, as evidenced by the increase in export volumes in 2023-2024 and the stabilisation of key financial indicators. By the end of the first half of 2025, MHP maintained a positive trend, ensuring revenue of USD 1.64 billion, EBITDA of USD 236 million, and net profit of USD 75 million, indicating effective management even under challenging external conditions. The gradual increase in the share of digital tools in the marketing budget – from 25% in 2020 to over 65% in 2024 – demonstrates the shift to a deeply digitalised communication model with consumers. Therefore, MHP demonstrated a high level of strategic resilience, combining deep digital transformation with flexible production and sales management. The integration of data analytics, CRM systems, SMM

communications, and innovative content formats allowed the company to maintain its position in the domestic market and retain its status as one of Europe's leading exporters. The overall positive dynamics of key indicators reflect the effectiveness of the marketing model focused on long-term competitiveness and brand capitalisation development.

This study aligns with the work of Y. Zhang (2024), which focuses on the transformation of agricultural product sales in China and the impact of online marketing strategies in the post-pandemic period. In Y. Zhang research, it was demonstrated that the effectiveness of online marketing is shaped by a complex of interacting factors – government support, visual effects, e-commerce broadcasts, customer relations, and multi-platform presence. The author employed fuzzy-set Qualitative Comparative Analysis (fsQCA) and Necessary Condition Analysis (NCA), concluding that no single factor ensures high performance without the synergy of digital strategy elements. Compared to Y. Zhang study, this work not only emphasised digital promotion channels but also the integration of innovations into the strategic management of agricultural enterprises. While Y. Zhang analysed small businesses within the framework of government support, this study focused on the corporate level, demonstrating how large companies implement CRM systems, Big Data, SEO, SMM, and analytical platforms to enhance competitiveness.

The study by H. Tang *et al.* (2024) primarily focused on the relationship between digital transformation, sustainable development, and social responsibility. This idea resonated with the findings of the current study, where digitalisation was also viewed as a means of improving efficiency, but through the lens of corporate adaptation in crisis conditions. While H. Tang *et al.* described macro-level patterns in environmental policy, this study demonstrated the actual business mechanisms for implementing innovations within a single enterprise. A similarly focused study was conducted by J. Wang & L. Zhang (2024), which explored the impact of digital technologies and branding on the competitiveness of agricultural enterprises. In both works, marketing was defined as a key factor in building trust in the brand and business stability.

However, while J. Wang & L. Zhang concentrated on the theoretical aspects of building brand value, this study illustrated how a digital strategy can be implemented in practice – through the systematic work of the company's marketing department and the combination of innovative tools.

This study partially aligns with the work of L. Li *et al.* (2024), which analysed the impact of innovations on the sustainable development of agricultural enterprises. The authors demonstrated that independent innovations contributed to growth; however, excessive investment reduced the effectiveness. This work also emphasised the key role of innovations and digital technologies in strengthening the competitive positions of enterprises, though the focus was not on the intensity of investments, but on the effectiveness of using digital tools to enhance sales and profitability. A common assertion was that digitalisation strengthens the innovative potential of agricultural businesses, but the study by L. Li *et al.* had a macro-level focus and was based on quantitative analysis, while the current study had a practical focus, demonstrating the practical implementation of digital strategies at the enterprise level.

The marketing of agricultural enterprises in the digital economy has become a key factor for business growth and sustainability. The example of MHP confirmed that the combination of digital technologies with analytical systems, CRM, SMM, and Big Data tools enhances communication and sales effectiveness. The consistent digital transformation enabled the company to strengthen its positions in both domestic and foreign markets, maintain profitability even under wartime challenges, and increase brand recognition. The integration of innovative approaches into the marketing policy demonstrated that the strategic use of digital tools forms long-term competitiveness and increases the adaptability of agricultural businesses to changes in the market environment.

Analysis of the innovative marketing strategies of Kernel

The marketing management structure at Kernel (n.d.a) is based on a centralised model, which ensures a unified strategic vision, coherence in communication decisions, and control over the

implementation of corporate brand standards. All key decisions are made at the central level, allowing marketing campaigns to be aligned with the overall business strategy, avoiding the duplication of functions, and improving communication effectiveness between departments. This management model fosters synergy between business directions, enables the scaling of successful marketing practices, and creates a unified system of interaction between marketing, sales, trading, and export (Kernel, n.d.b).

Kernel actively implements digital technologies at all levels of marketing management. The core of the information system is the ERP solution NAV (Dynamics NAV, n.d.), which integrates financial, logistics, and sales processes, ensuring the automation of document flow, including through the electronic goods transport waybill system (eTTN) (Latifundist Media, 2024). This has significantly reduced the time taken for information exchange in supply chains and increased transparency in logistics. For analytics, the company employs AI algorithms, machine learning, and forecasting techniques, which improve the accuracy of market trend assessments, demand forecasting, and the effectiveness of sales strategies. One of the key solutions is the mobile app Scouting (AgroTimes, 2021), which is used for field monitoring of crop conditions with georeferencing and is integrated into the digital agro-logistics system, enabling prompt adjustments to production planning.

Kernel's own Information Technology (IT) company, Kernel Digital (n.d.), creates and maintains internal digital products, including the DigitalAgribusiness system (Latifundist Media, n.d.), which ensures the management of analytics, production, and sales within a unified environment. This is an integrated digital platform that combines analytical modules, production management tools, and logistics operations within a single information environment. The system provides a full cycle of agro-production management – from planning planting areas and monitoring field conditions to controlling the execution of technological operations, resource management, yield analysis, and optimising sales decisions. DigitalAgribusiness accumulates data from drones, field sensors, mobile applications used by agricultural teams, satellite

monitoring systems, and internal logistics platforms. The use of Big Data, Business Intelligence (BI) dashboards, and deep neural networks (Deep Neural Networks) allows the company to analyse large datasets coming from drones, field sensors, mobile applications, and logistics platforms. These technologies provide accurate yield forecasts, raw material quality control, and the optimisation of marketing decisions based on market conditions. An important element of Kernel's corporate communication is its digital branding strategy and corporate PR, aimed at shaping a positive brand image and increasing the loyalty of target audiences. The company maintains an active presence on social media platforms such as Facebook (n.d.) and Instagram (n.d.). It also actively uses Viber (n.d.) and Telegram (n.d.), applying analytics for targeting and optimising advertising campaigns. High visual quality of content, interactive activities, competitions, and informational campaigns support sustained brand recognition. A key role is played by the Public Relations (PR) department, which coordinates external communications and collaborates with international agencies, including Saatchi & Saatchi Ukraine (n.d.) (Forbes, 2024).

The integration of marketing processes with export and trading divisions is based on centralised planning. Export teams provide marketing with analytics on external markets, which allows the adaptation of advertising campaigns to the consumer preferences of EU countries, the Middle East, Africa, and Asia. At the same time, the marketing department supports trading by forming digital campaigns aimed at increasing the brand recognition of Ukrainian agricultural products abroad. The use of analytical systems allows the synchronisation of sales plans with

demand forecasts, optimising logistical flows and minimising delays in supply. By the end of 2025, Kernel's strategic goals include further development of omnichannel marketing, which integrates online and offline consumer interaction channels into a unified communication system. Priority areas include the use of targeted advertising with detailed Key Performance Indicators (KPI) monitoring, expansion of content marketing, enhancing the role of analytics in decision-making, and applying a data-driven approach to marketing management. Through the combination of AI, machine learning, BI, and Big Data technologies, the company aims to achieve maximum personalisation of communications, automation of advertising campaigns, and precise forecasting of consumer behaviour (Landlord, 2025). Thus, Kernel is consistently implementing digital tools across all stages of marketing activity, combining centralised management with the flexibility of analytical solutions. This allows the company to strengthen its position in international markets, enhance communication effectiveness, adapt sales strategies to market fluctuations, and form long-term competitive advantages through an innovative marketing management model.

From 2020 to the first half of 2025, Kernel demonstrated gradual recovery of financial stability, increased operational efficiency, and active expansion of its presence in external markets. The company increased its export volumes of oilseeds and cereals, implemented digital solutions in trading, logistics, and marketing management. The dynamics of key indicators are presented in Table 2, which reflects trends in revenue growth, improved profitability, and strengthened brand activity for Kernel.

Table 2. Dynamics of key performance indicators of Kernel from 2020 to the first half of 2025

Indicator	2020	2021	2022	2023	2024	2025 (6 months)
Revenue (billion USD)	3.50	5.65	5.33	3.91	3.58	4.12
EBITDA (million USD)	443	929	806	544	381	466
EBITDA margin, %	12.7	16.4	15.1	13.9	10.6	11.3
Net profit (million USD)	118	506	513	299	168	238
Net margin, %	3.4	9.0	9.6	7.6	4.7	5.8

Table 2, Continued

Indicator	2020	2021	2022	2023	2024	2025 (6 months)
Export volume of grains and oilseeds (million tonnes)	7.9	8.8	8.0	7.3	8.1	8.3
Share of export in revenue (%)	85	88	90	87	89	90
Investments (million USD)	141	161	169	144	113	184
Net debt (million USD)	980	780	565	372	281	143
Net debt / EBITDA	2.2x	0.8x	0.7x	0.7x	0.7x	0.3x
Social investments (CSR) (million USD)	18.6	22.7	23.9	24.8	25.1	30.4
CO ₂ emissions (thousand tonnes)	3,891	3,574	3,411	3,203	3,022	2,044

Source: compiled by the authors based on Kernel Holding S.A. annual report for the year... (2020; 2021; 2022; 2023; 2024; 2025)

As shown in Table 2, following the turbulent period of 2022-2023, Kernel demonstrated a clear recovery in its financial performance. Revenue increased from USD 3.58 billion in 2024 to USD 4.12 billion in 2025 (+15%), reflecting stable recovery in the export of grains and oilseed processing products. The increase in EBITDA to USD 466 million (+22%) was accompanied by a strengthening of the margin to 11.3%, reflecting effective cost management and the gradual normalisation of logistics chains. At the same time, the company's net profit rose by 42% to USD 238 million, with net profitability improving by 1.1 percentage points. Despite a noticeable reduction in operating cash flow due to fluctuations in working capital, Kernel maintained positive liquidity dynamics, reducing net debt to USD 143 million (-49%) and achieving a Net debt / EBITDA ratio of only 0.3x in the first half of 2025. This indicates the company's high financial stability and flexibility in the face of external risks. In the non-financial aspect, Kernel demonstrated enhanced corporate social responsibility – social investments grew by 21%, while total CO₂ emissions decreased by 32%. These results confirm the company's focus on integrating sustainable practices (ESG) and the integration of digital technologies to improve production, trading, and marketing efficiency. Therefore, from 2020 to 2025, Kernel ensured a balanced combination of financial performance, digital transformation,

and ecological modernisation, positioning its marketing model as one of the most effective among Ukrainian agricultural corporations targeting the international market.

This study aligns with the work of M. Zastempowski & S. Cyfert (2022), which examined the role of innovative competencies in strengthening the competitive advantages of agricultural sector enterprises. In the research by M. Zastempowski & S. Cyfert, it was proven that the effectiveness of organisational development is determined by the ability of companies to form dynamic resources – a combination of management skills, knowledge, and technological innovations that ensure rapid adaptation to changes in the environment. Similarly to their findings, this study confirmed that the digital transformation of marketing creates a foundation for increasing the flexibility, analyticity, and innovativeness of business processes. However, the approaches differed in the level of detail: M. Zastempowski & S. Cyfert focused on a theoretical-methodological analysis of models of innovation competencies, while this research had a practical focus, demonstrating the practical implementation of digital tools within a single agricultural enterprise. While the Polish authors' work focused on generalising the strategic principles of innovation development in European companies, this study showed how digital solutions – CRM, Big Data, SMM, and AI – transformed

into specific mechanisms for increasing profitability and consumer loyalty.

The conclusions of E.N. Sadjadi & R. Fernández (2023) were closely related to the ideas discussed, as they investigated how intellectual technologies shape new models of efficiency in the agricultural sector of Spain. The authors emphasised that the success of digitalisation depends on the integration of technologies into the management strategy. In this study, these propositions were empirically confirmed using the example of the Kernel company, which applied analytical systems to optimise logistics, sales, and production planning. However, while E.N. Sadjadi & R. Fernández generalised the trends for the entire sector, this study analysed the internal mechanisms of digital transformation at the corporate level. The research by E. Abad-Segura *et al.* (2024) revealed the role of digitalisation and sustainable management in ensuring the competitiveness of agricultural businesses. As in this study, the authors emphasised the importance of the synergy between technological innovations, government support, and human capital. However, while E. Abad-Segura *et al.* studied systemic processes at the level of EU countries, this research focused on the internal integration of Kernel's digital tools into marketing and management activities. A similar approach was adopted by A. Martos-Pedrero *et al.* (2025), who analysed the relationship between internationalisation, innovation, and financial stability in Spanish cooperatives. In their model, entering external markets served as a catalyst for digital changes. In contrast, this study observed the opposite – it was digitalisation that became the driving force behind increasing the efficiency and flexibility of the company. Thus, both approaches led to similar outcomes, but through different paths: in A. Martos-Pedrero *et al.*, the market acted as the driver, whereas in this study, it was technological transformation.

This research partially aligns with the work of E.E. Eliseu *et al.* (2024), which was dedicated to the implementation of sustainable agricultural practices (GAPs) in developing countries, using Angola as a case study. The authors demonstrated that ecological innovations – irrigation, agroforestry, and composting – increase the

efficiency and resilience of the agricultural sector. Similarly, in this study, efficiency was achieved through innovations; however, the focus was on the digital transformation of marketing and management rather than natural resources. Both studies shared the conclusion that innovations ensure the sustainable development of agricultural business, but differed in approach: E.E. Eliseu *et al.* analysed the ecological component at the macro level, whereas this study revealed the corporate digital mechanisms that enhance efficiency.

Prospects for the innovative development of agricultural enterprises in Ukraine

The innovative development of agricultural enterprises in Ukraine today is a determining factor in their competitiveness and ability to integrate into the global market. Dynamic changes in the economic environment, the growing role of digital technologies, and the need to enhance food security in the context of wartime challenges are shaping a new model of agribusiness, where technological solutions become the key resource for growth. The prospects for the innovative development of the agricultural sector depend on the combination of three main directions: the digital transformation of management, the integration of ESG into production processes, and the increasing role of analytics in strategic decision-making. One of the priority areas is the development of the digital agro-economy, which involves the transition of enterprises from traditional production methods to data-driven management. The use of ERP, CRM, AI, Big Data, and machine learning systems ensures the full automation of accounting, logistics, sales, and marketing processes. Successful examples from companies such as MHP and Kernel prove the effectiveness of this approach: the former uses SAP CRM to manage the customer base and communications, while the latter employs Microsoft Dynamics NAV and BI panels to control operational efficiency. In the future, such systems will enable medium and small agricultural enterprises in Ukraine to scale their business and enter international markets without significant infrastructure costs.

An important trend is the integration of artificial intelligence (AI) technologies and analytics into demand forecasting, crop yield prediction,

and market trends. Agricultural companies are implementing AI platforms for the automated analysis of large data sets, machine learning models to forecast consumer demand, deep neural networks to identify patterns in production and sales dynamics, as well as satellite monitoring systems with analytical modules. AI technologies already used in agro-holdings help reduce production risks, enhance the accuracy of management decisions, and optimise marketing strategies. Thanks to Agrohub Innovations Lab (n.d.), which unites over 50 agritech startups, modules for automatic plant disease detection, fertiliser norm calculations, and crop rotation efficiency forecasting are being implemented. In the future, these technologies will transform the approach to risk management, enabling the creation of flexible business models capable of responding to price fluctuations, changing climatic conditions, and consumer behaviour in real-time.

Another promising direction is the development of digital marketing and analytical platforms to support brands. Ukrainian agricultural companies are increasingly transitioning from traditional advertising to the comprehensive use of social media, SMM, content marketing, and e-commerce. Digital communications are becoming not only a tool for promotion but also a channel for building trust between the producer and the consumer. In 2026-2027, the active implementation of omnichannel marketing technologies is expected, where data from both online and offline sources will be combined to create a unified customer history. This will enhance the effectiveness of communications, allow for the creation of personalised offers, and strengthen brand loyalty (Koberniuk, 2023). A significant potential is concentrated in the field of sustainable development innovations and ESG approaches. Enterprises that combine environmental efficiency with technological innovations will have an advantage in EU markets, where strict environmental standards are in place. The implementation of energy-efficient technologies, bioenergy, CO₂ emission monitoring systems, and digital reporting platforms will help Ukrainian companies not only reduce costs but also comply with European certification requirements, opening access to funding

programmes and green investments. For instance, Kernel is already implementing carbon footprint reduction programmes under the Jumbo Impact Fund initiative, which may serve as a model for other enterprises (AgroElita, 2024).

The prospects for innovative development are also closely linked to the development of human capital. The training of specialists in digital marketing, data analytics, innovation management, and agritech is critically important for shaping a new generation of managers. Enterprises are increasingly establishing corporate academies, as MHP has done through its Culinary School and educational initiatives for employees. In the future, such programmes may be expanded into industry-specific educational platforms that integrate business and science. No less important is deepening cooperation with the state and international partners within the framework of agricultural digital transformation programmes. At the level of public policy, the key role in shaping the conditions for innovative development is played by financial and advisory support instruments. One of the most important is the "Affordable Loans 5-7-9%" programme (Privatbank, n.d.), which provides enterprises with access to cheap financial resources. Thanks to preferential lending, agricultural companies are able to invest in modernising production facilities, acquiring digital management systems, renewing equipment, implementing ERP/CRM platforms, and automated logistics solutions, which are critical elements of their digital transformation. The eRobota (n.d.) grant initiative is aimed at the development of processing enterprises, horticulture, and greenhouse farming. The programme supports projects that involve the implementation of modern irrigation technologies, energy-saving equipment, electronic document management, precision farming systems, and innovative post-harvest processing methods. With the help of grants, enterprises can modernise production and increase its automation, reducing technological losses and improving the quality of finished products. The USAID AGRO programme (Organic knowledge platform, n.d.) plays a significant role in the development of the innovative infrastructure of the Ukrainian agricultural sector. It supports the digitalisation of small and medium-sized

farms by helping to implement monitoring information systems, modern logistics solutions, precision farming technologies, agricultural analytics tools, and food safety management systems. Special attention is given to the development of innovation clusters, training personnel in digital skills, and disseminating technological practices that enhance the efficiency of production processes. The FAO Ukraine Resilience Programme (FAO emergencies and resilience, n.d.) aims to strengthen the resilience of agricultural enterprises by implementing modern agritech, restoring production capacities, and supporting the transition to more efficient and environmentally friendly management models. The programme fosters the introduction of innovations in risk management, soil fertility conservation systems, digital monitoring tools, and the modernisation of post-harvest processing and logistics technology. Additionally, the EU4Business (n.d.) project: competitiveness and international cooperation for small and medium-sized enterprises ensures financing for digital solutions and training for entrepreneurs in agrimarketing. International programmes such as Horizon Europe (European Commission, n.d.c), The European Green Deal (European Commission, n.d.a), and the Digital Europe Programme (European Commission, n.d.b) open access for Ukrainian companies to grants for research and development in agritech, energy efficiency, digital management, and carbon footprint reduction. Participation in these initiatives not only provides financial support but also facilitates integration into European technological partnership networks. Cooperation with international financial institutions – specifically, the EBRD (n.d.), World Bank in Ukraine (n.d.), and IFC in Ukraine (n.d.) – creates additional opportunities for implementing digitalisation projects, modernising production facilities, and introducing environmentally safe technologies. The EBRD supports the implementation of energy-efficient solutions, environmental monitoring systems, and digital operation management platforms. The World Bank promotes the development of data infrastructure, digital services, and modern technologies in supply chains, increasing transparency and productivity in enterprises. The IFC provides financial instruments

for upgrading technical infrastructure, automating processes, and implementing innovative agritech solutions. Taken together, this support enables enterprises to accelerate digital transformation, reduce technological risks, and adapt production to international standards.

A crucial role in the future development will be played by the integration of agribusiness into the digital ecosystem of the national economy. The development of open data systems, electronic document management, and online platforms for trading and export will contribute to increasing transparency and reducing transaction costs. Currently, Ukraine already has such tools in place as the State Agrarian Register (n.d.), which consolidates information about farmers and provides access to state support programmes; the eTTN system, which optimises logistics and ensures the monitoring of cargo movements; and the DREAM (n.d.) platform for managing infrastructure investments in communities, including agricultural projects. In the trading and export sectors, the Prozorro (n.d.) platform is particularly promising. The use of this system allows agricultural enterprises to expand sales channels, participate in large public and commercial procurements, enter into contracts with minimal transaction costs, and increase trust with counterparties due to data transparency. This makes Prozorro an effective tool for scaling exports and integrating enterprises into a competitive trade space.

This study partially aligns with the work of V. Graskemper *et al.* (2021), which examined the types of strategic choices made by farmers in Germany. The authors demonstrated that innovation, education, and willingness to take risks determined entrepreneurs' inclination towards expansion or diversification of their activities, while conservative farmers opted for stabilisation strategies. These findings resonated with the results of this study, which also emphasised the importance of innovative thinking and strategic adaptation for the growth of agricultural companies. However, unlike the individual-oriented approach of V. Graskemper *et al.*, which analysed the behaviour of farmers, this research had a corporate dimension and demonstrated how digital transformation strengthened the efficiency and competitiveness of large enterprises.

Thus, both studies converge in their assessment of innovation as a driver of agribusiness development, but differ in the level of analysis: V. Graskemper *et al.* focused on the individual, while this study focused on the corporate and technological aspects.

The work of G. Cascone *et al.* (2024) highlighted the relationship between technological innovations and sustainable practices in production, whereas this study demonstrated how similar principles were applied in digital marketing. While G. Cascone *et al.* focused on macro-level environmental and production aspects, this study examined corporate management mechanisms that ensure the adaptability and market resilience of companies, specifically MHP and Kernel. In the work of A. Bonfiglio (2024), the emphasis was on territorial clusters and institutional interaction among participants in the agrarian economy. This resonated with the idea in the present study regarding the significance of innovation for development, but the difference lay in the focus: A. Bonfiglio analysed regional connections, while this study revealed the internal digital modernisation of business models.

The research by L. Altamore *et al.* (2024) focused on the impact of the Internet of Things (IoT), sensor systems, and big data on the ecological efficiency of agriculture. In this study, technological innovation also defined success, but through demand analytics, CRM systems, and digital communications. While L. Altamore *et al.* described innovations in production, in this study, they were viewed as tools for brand management and marketing processes. The work of A. Giorgio *et al.* (2024) further explored the topic, showing how digitalisation changed production systems in Italy. Its findings aligned with the conclusions of this research: in both studies, technologies were considered fundamental to business adaptability, but A. Giorgio *et al.* analysed industry policy, whereas this study focused on the practical corporate strategies of the company Kernel.

This study partially aligns with the work of M.J. Mihanović *et al.* (2025), which analysed the impact of digital innovations on the sustainability of business models in the transport sector of Croatia. Both studies emphasised that

digitalisation is a key factor in the efficiency, adaptability, and competitiveness of enterprises, yet they differed in their subject matter and context of analysis. M.J. Mihanović *et al.* focused on the digital modernisation of transport systems, which contributed to improving logistical efficiency and ecological safety, while this study demonstrated the impact of digital technologies on agribusiness, specifically through marketing tools, CRM, Big Data, and demand analytics. Both approaches converge in the conclusion that the integration of digital systems into strategic management ensures flexibility and business resilience in the context of global turbulence. However, in M.J. Mihanović *et al.*, attention was paid to the institutional and regulatory barriers to digitalisation, whereas this study reveals the practical mechanisms of corporate digital transformation in the case of agricultural enterprises. Both works complement each other, showcasing different sectoral aspects of the impact of innovations on sustainable economic development.

Thus, the prospects for the innovative development of agricultural enterprises in Ukraine are determined by the combination of digital transformation, sustainable development, and intellectual analytics. MHP and Kernel act as catalysts for these changes, providing examples of innovation integration into production, logistics, and marketing. The further expansion of digital practices, automation of business processes, the implementation of AI-based forecasting systems, and the creation of partnership ecosystems between business, science, and government lay the foundation for the transition of the Ukrainian agricultural sector to a qualitatively new stage of development – a stage characterised by a technologically-oriented, competitive, and sustainable agribusiness, capable of ensuring not only economic growth but also food stability on both regional and global scales.

CONCLUSIONS

The results of the conducted study confirmed that innovative marketing is a decisive factor in the competitiveness of Ukrainian agricultural enterprises in the context of the digital economy. A comparative analysis of the activities of MHP and Kernel demonstrated the effectiveness of digital transformation as a tool

for adapting businesses to wartime challenges, global competition, and changes in consumer trends. During the period from 2020 to 2024, MHP demonstrated stability in financial performance: revenue increased from USD 1.41 billion to USD 2.26 billion, while EBITDA grew from USD 302 million to USD 437 million. At the same time, the average product selling price increased by 50%, from USD 1.34 to USD 2.01 per kilogram, which indicates an effective marketing policy and flexibility in responding to market fluctuations. The growth in the share of digital tools in the marketing budget from 25% to over 65% confirmed the company's transition to a deeply digitised model of communication with consumers. These changes ensured a stable level of exports, which in 2023-2024 exceeded 300,000 tonnes, allowing the company to maintain its status as one of the largest chicken exporters in Europe. The figures for the first half of 2025 confirm the continuation of this trend: revenue reached USD 1.64 billion, EBITDA stood at USD 236 million, the average selling price increased to USD 2.29 per kilogram, and exports amounted to 185.6 thousand tonnes, indicating the continued high growth dynamics and competitive position of the company in international markets. Kernel, in turn, demonstrated a strong growth dynamic in financial indicators. The company's revenue in 2025 reached USD 4.12 billion, which is 15% higher than in 2024, while EBITDA increased by 22% to USD 466 million. The net debt level decreased nearly sevenfold, from USD 980 million in 2020 to USD 143 million in 2025, and the Net debt/EBITDA ratio dropped to 0.3×, indicating

high financial stability and resource management efficiency. The company also increased social investments by 21% and reduced CO₂ emissions by 32%, highlighting the integration of ESG principles into its corporate strategy.

Based on these indicators, it can be concluded that innovative marketing not only increases the profitability of agribusinesses but also creates the foundation for their resilience in the face of wartime risks and global economic instability. The digital transformation of MHP and Kernel proves that it is the synergy of technology, analytics, and strategic marketing management that forms the basis for long-term growth and international competitiveness of Ukrainian agricultural enterprises. The limitation of this study lies in the focus primarily on the corporate level of digital transformation in agricultural marketing, which requires further expansion of observations to other segments of the industry. Future research prospects involve a deeper evaluation of the impact of digital technologies on the effectiveness of marketing strategies of agricultural enterprises and the development of universal models for their integration into sustainable development strategies.

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Інноваційний маркетинг як складова стратегії розвитку аграрних підприємств

Анотація. Метою даного дослідження було обґрунтувати вплив цифрових технологій і маркетингових рішень на підвищення результативності, конкурентоспроможності та адаптивності аграрних підприємств України в умовах трансформації економіки на прикладі двох провідних компаній – Миронівський хлібопродукт та Kernel. Методологія ґрунтувалася на поєднанні кількісного аналізу фінансово-виробничих показників і якісного аналізу цифрових інструментів маркетингу, що застосовуються цими підприємствами, для виявлення взаємозв'язку між рівнем цифровізації та результативністю бізнесу. У Миронівського хлібопродукту виручка зросла з 1,41 до 2,26 мільярда доларів США, а чистий прибуток – із 302 до 437 мільйонів доларів США. Середня ціна реалізації продукції збільшилася на 50 % – із 1,34 до 2,01 долара США за кілограм, тоді як частка цифрових інструментів у маркетинговому бюджеті зросла з 25 % до понад 65 %. Компанія Kernel продемонструвала аналогічну позитивну динаміку: виручка підвищилася до 4,12 мільярда доларів США (+15 %), чистий прибуток – до 466 мільйонів доларів (+22 %), а зміцнення маржі до 11,3 %. Додатково компанія збільшила соціальні інвестиції на 21 % і скоротила викиди вуглецю на 32 %. Отримані результати засвідчили, що цифровізація маркетингу, автоматизація бізнес-процесів і розвиток онлайн-комунікацій стали ключовими чинниками підвищення прибутковості, фінансової стійкості та міжнародної конкурентоспроможності українських аграрних компаній. Практичне значення дослідження полягає в тому, що його результати можуть бути використані керівниками аграрних підприємств, консультантами з маркетингу та державними

інституціями під час розроблення стратегій цифрової трансформації, оптимізації маркетингових процесів і підвищення експортного потенціалу аграрного сектору України

Ключові слова: цифрова трансформація; управління; конкурентоспроможність; бренд; контент; просування



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The economic mechanism of the functioning of e-commerce enterprises: Theoretical and practical foundations

Abstract. The study was aimed at analysing the theoretical and methodological foundations and practical approaches to the formation and improvement of the economic mechanism of e-commerce enterprises' activities. The methodological basis comprised systemic-structural and comparative approaches to examining the economic mechanism of the functioning of e-commerce enterprises in the context of the digital economy. The economic mechanism was considered as a set of interrelated elements – resources, costs, profit, and managerial decisions – that form an integrated digital ecosystem of the enterprise. In 2024, the share of online sales in the structure of Ukraine's retail turnover increased to 3.1% (UAH 48.1 billion) compared with 2.1% (UAH 18.3 billion) in 2020, which confirms the consistent digitalisation of the consumer market even under crisis conditions. An analysis of key e-commerce players revealed different development trajectories. During 2020-2024, Rozetka increased its revenue from UAH 17.6 billion to UAH 29.7 billion, however, net profit remained volatile (from UAH 111 million in 2020 to UAH 16.3 million in 2024), which is explained by active investments in logistics and digital infrastructure. Prom demonstrated stable growth: revenue increased from UAH 924.5 million to UAH 2,052.2 million, and profit in 2024 reached UAH 269.2 million, indicating effective cost optimisation and the implementation of innovative solutions. The example of Amazon illustrated the global scale of digital technology integration: the company's revenue grew from USD 386.1 billion in 2020 to USD 638 billion in 2024, and net profit, after temporary losses in 2022 (-USD 2.7 billion), recovered to USD 59.2 billion. It was determined that enterprises should more actively implement data analytics and machine-learning algorithms for demand forecasting and offer personalisation, automate business processes and logistics, as well as maintain a balanced financial structure and invest in digital infrastructure in order to enhance

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the effectiveness of managerial decision-making and ensure resilience and competitiveness. The practical significance of the study lies in the fact that the obtained results may be used by e-commerce enterprises to improve the economic mechanism through the integration of digital technologies, cost optimisation, and the enhancement of competitiveness in a dynamic market

Keywords: digital technologies; managerial decisions; logistics; resource management; profitability; innovations

INTRODUCTION

The development of the global economy is characterised by the rapid spread of digital technologies, which leads to qualitative changes in business organisation and the interaction between market participants. One of the most dynamic sectors is electronic commerce, which has become a key tool for ensuring the competitiveness of enterprises. Its development contributes to the increased accessibility of goods and services, the expansion of markets, the formation of new business models, and the improvement of the efficiency of economic activities. The operation of electronic commerce enterprises is accompanied by a number of challenges. In particular, the question of forming an effective economic mechanism, which takes into account the peculiarities of the digital environment, the rapid pace of technological change, consumer needs, and increasing competition, is of particular relevance. The insufficient adaptation of traditional management tools to the conditions of the digital economy necessitates the search for new approaches to business process organisation, resource management, financial flows, and interaction with market counterparts. Thus, the study of the theoretical and practical foundations of the economic mechanism for the functioning of electronic commerce enterprises is gaining importance. It provides an opportunity not only to better understand the specifics of the development of this field but also to develop effective tools to enhance the performance and resilience of businesses in the context of the digital transformation of the economy.

The issue of economic support for the functioning of electronic commerce enterprises has attracted the attention of many researchers, who have focused on various aspects of this issue. D. Mandlik *et al.* (2025) emphasised that the foundation of the success of electronic business was the construction of adaptive business

models, which changed according to market conditions and technological innovations. The authors argued that enterprises that timely implemented flexible organisational forms gained stable advantages in the face of digital competition. Continuing this thought, V. Svatošová (2021) highlighted the financial instruments supporting electronic commerce. The author's research showed that the speed and transparency of financial transactions, the use of electronic payment systems and digital currencies, were crucial for increasing consumer trust and ensuring the stability of cash flows.

While the financial component played a crucial role, M. Dielini *et al.* (2025) drew attention to the issues of risk management. The researchers argued that cyber threats, related to personal data breaches and hacker attacks, constituted one of the greatest threats to the sustainable development of electronic enterprises. The study proposed the creation of a multi-layered protection system that would combine both technological and organisational measures. An important addition to this approach was the work of M. Dykha *et al.* (2021), who analysed marketing tools in the field of electronic commerce. The scholars demonstrated that the key condition for establishing long-term relationships with consumers was the personalisation of offers and the use of recommendation system algorithms. This approach enabled enterprises to retain customers and build sustainable competitive advantages.

At the institutional level, the contribution of G. Gupta & I. Bose (2022) was significant, as they emphasised that the absence of a clear regulatory framework often limited the development opportunities of electronic enterprises. Their research showed that the establishment of transparency in the market would contribute both to attracting investments and increasing

consumer trust. A different dimension of the problem was examined by B.M. Mohsen (2023), who focused on logistics processes. The author argued that without digital platforms for supply chain management, enterprises could not ensure fast and high-quality customer service. The integration of electronic systems into logistics infrastructure allowed for cost reduction, minimisation of delay risks, and an improvement in service levels.

A.A. Alsmadi *et al.* (2023) highlighted the importance of big data analytics in the field of electronic commerce. The researchers argued that the use of consumer behaviour prediction algorithms enabled enterprises to better adapt their product assortments and develop effective marketing campaigns. A more global approach was demonstrated by Y. Wang *et al.* (2020), who examined the integration of electronic commerce into international value chains. They emphasised that digital platforms allowed small and medium-sized enterprises to access global markets, integrate into international networks of collaboration, and attract new resources for development. No less important was the position of O. Pomaz *et al.* (2025), who explored the role of organisational culture in fostering innovation within enterprises. The authors argued that only those organisations that cultivated openness to change, a willingness to experiment, and the swift implementation of innovations were able to successfully compete in the digital environment. A. Urbinati *et al.* (2020) combined a strategic management approach with the use of digital technologies. The study showed that the long-term sustainability of electronic enterprises depended on the ability of management to formulate a coherent development strategy focused on the digitalisation of business processes and enhancing the flexibility of organisational structure.

In general, the issue of electronic commerce has been studied from various perspectives – ranging from the formation of business models and financial provision to risk management, logistics, marketing, and organisational structures. Despite the existing scientific developments, there remain issues that require further in-depth analysis. In particular, the comprehensive integration of financial, organisational, and

institutional instruments into a unified economic mechanism for the functioning of electronic commerce enterprises remains insufficiently explored. The impact of digital transformation on the optimisation of business processes and the integration of modern technologies, such as big data analytics, artificial intelligence, and automated logistics systems, into the practical activities of enterprises also remains under-researched. The aim of the study was to substantiate the theoretical foundations and develop practical approaches to the formation and improvement of the economic mechanism for the functioning of electronic commerce enterprises in the context of the digital transformation of the economy. The objectives of the study were to analyse contemporary approaches to the organisation of the economic mechanism of electronic commerce enterprises; identify the key factors influencing the effectiveness of business processes and financial activities of electronic commerce enterprises; and formulate recommendations for integrating organisational, financial, and institutional instruments into a cohesive management system to enhance the competitiveness and sustainability of electronic commerce enterprises.

MATERIALS AND METHODS

The study of the economic mechanism for the functioning of electronic commerce enterprises was conducted using an integrated approach, combining both systematic and structural-functional analysis with quantitative and qualitative research methods. This methodological combination allowed for the integration of various groups of sources and ensured a comprehensive study of the subject. The systematic approach involved viewing the economic mechanism as a unified whole, within which all its components – resources, costs, profits, management decisions, and digital tools – form a coordinated outcome. This enabled the analysis of economic processes not in isolation, but in their interconnections, tracing how the transformation of a particular element impacts the functioning of the entire mechanism. The structural-functional approach complemented the analysis by allowing for a detailed examination of each element of the mechanism, identifying its functional purpose,

and assessing its contribution to ensuring the resilience and adaptability of enterprises.

The materials for the study included both statistical data and the financial and non-financial reports of companies. To characterise the state of electronic commerce in Ukraine, official data from the State Statistics Service of Ukraine (n.d.) on the dynamics of trade turnover from the sale of goods via the internet in 2020-2024 were used. Based on these, a dynamic analysis was conducted, which allowed for the identification of general trends in the development of digitalisation in the retail sector and the determination of the place of online commerce within the structure of the national market. This provided a foundation for comparing macro-level processes with the results of the analysis of specific companies.

To assess the features of the economic mechanism at the enterprise level, a quantitative analysis of key financial indicators was conducted for leading market participants – Rozetka (n.d.a), Prom (n.d.a), and Amazon (n.d.). The selection of these companies was based on their representativeness: Rozetka is the leader in Ukrainian online retail, Prom is the leading Ukrainian platform for small and medium-sized businesses, and Amazon is a global player that demonstrates a high level of digitalisation and scalability of business processes. For each company, the following indicators were analysed: revenue, net profit, operating expenses, asset volume, capital, liabilities, and employee numbers. The methodology for processing the data was based on comparing the indicators over time for the years 2020-2024, which allowed for tracking their dynamics and determining the nature of the changes. The application of this approach enabled the identification of both positive and negative fluctuations in the economic indicators, influenced by external crisis factors, technological innovations, and managerial decisions.

A qualitative analysis was conducted based on the study of public data from the companies Rozetka (n.d.b), Prom (n.d.b), and Amazon (n.d.) regarding the implementation of digital tools – big data analytics, machine learning algorithms, logistics automation systems, cloud services, and personalised customer solutions. This approach allowed for the assessment of how digital

technologies are integrated into the economic mechanism and how they transform the interaction between its core elements – resources, costs, profits, and management decisions. To evaluate contemporary approaches in the digital economy, the activities of Walmart (n.d.), LockN-Lube (n.d.), Temu (n.d.), and Horoz Lojistik (n.d.) were analysed, particularly their practices in data analytics, business process automation, and logistics. Additionally, a comparative analysis was employed, which facilitated the comparison of the economic mechanisms of Ukrainian companies (Rozetka and Prom) with the practices of the global leader, Amazon. This enabled the identification of specific features in the development of domestic electronic commerce and outlined potential directions for improving management mechanisms in the context of digital transformation. Thus, the integration of statistical data, financial and non-financial company reports, and the use of a combination of quantitative and qualitative research methods ensured the validity of the results and the comprehensiveness of the conclusions. This approach not only allowed for the description of the current state of the economic mechanism for the functioning of electronic commerce enterprises but also created a foundation for formulating practical recommendations for its improvement.

RESULTS

The economic mechanism in the current context of market transformation is acquiring new characteristics that significantly distinguish it from classical models. Traditionally, it was viewed as a set of tools for resource organisation, cost control, and profitability achievement, its structure is formed in the digital environment, where key roles are played by information technologies, analytics algorithms, and automated systems (Adam, 1995). Digitalisation ensures the constant adaptability of the economic mechanism, as it transforms into a multi-level system capable of integrating financial, material, informational, and human components into a unified ecosystem (Johnson *et al.*, 2021). Thus, the modern economic mechanism is not merely a tool for planning and control but serves as the foundation for dynamic enterprise management, capable of simultaneously responding to

market challenges and creating its own competitive advantages.

The first and fundamental element in the structure of the economic mechanism is resources. Their role has significantly changed: whereas previously financial and material assets held central importance, today, informational and technological resources take precedence, providing the analytical and innovative foundation for business processes. These resources include large data sets, software solutions for data processing, analytical platforms, and cloud technologies that enable flexible scaling of operations (Miao, 2021). The effectiveness of resource use depends on their integration into a single system, where data is transformed into management insights, and technologies become tools for enhancing productivity. This allows enterprises to accelerate business processes, reduce transaction costs, and develop new customer service models (He & Zhang, 2023). It is also important to note that it is these informational and technological resources that provide the resilience of enterprises to external shocks and create the foundation for long-term competitiveness.

The second element is costs, which directly determine the effectiveness of resource use. In the digital economy, cost management acquires new characteristics: it goes beyond simple control or reduction of expenditures and transforms into a systematic process of optimisation and rationalisation of financial flows (Attaran, 2020). The use of digital technologies allows for a detailed breakdown of the cost structure, the forecasting of changes, and the timely identification of inefficient processes. As a result, enterprises can reallocate resources towards innovative areas, maintaining a balance between short-term savings and long-term development. At the same time, digitalisation ensures more transparent cost control, which is particularly important for maintaining trust from partners and consumers. Thus, costs become not only an indicator of the burden on the enterprise but also a strategic management tool that identifies opportunities for innovation and development.

Profit is the important component in the studied mechanism, traditionally regarded as the end result of activity, but in the digital

economy its significance is much broader. Profit is generated not only through sales volumes but also by optimising operational processes, improving service quality, personalising offerings, and actively utilising digital tools (Hada & Mihalcea, 2020). Analytical systems enable enterprises to more accurately forecast the profitability of individual segments, identify key drivers of financial performance, and quickly adjust business strategies (Zhang & Lucey, 2022). In this paradigm, profit serves two functions: on the one hand, it is an indicator of the effectiveness of the economic mechanism, and on the other, it acts as a signal for managerial decision-making. This duality highlights the new role of profit as an active element of the studied mechanism, influencing its further development.

The central link of this mechanism is managerial decisions, which integrate all other elements and define the strategy for the functioning of the mechanism. In contemporary conditions, the decision-making process has undergone significant transformation due to the use of digital technologies: from routine analysis to complex support systems based on artificial intelligence algorithms (Yang *et al.*, 2023). This ensures the speed and accuracy of forecasts, minimises risks, and allows enterprises to adapt to market changes in real-time. Managerial decisions form a closed system where resources are optimally utilised, costs are kept under control, and profit becomes the foundation for further development. In the digital economy, managerial decisions extend beyond internal processes and shape the ability of enterprises to interact with the market environment as an integrated, constantly changing ecosystem (Gomes *et al.*, 2023).

Overall, the interaction of resources, costs, profit, and managerial decisions in the digital environment forms a cohesive model of the economic mechanism's functioning. Digital technologies serve as the integrating link that connects all the elements into a unified system, ensuring flexibility, transparency, and the ability to self-regulate (Nathalie *et al.*, 2024). As a result, electronic commerce enterprises not only maintain resilience in fluctuating conditions but also actively form their own competitive advantages, combining economic efficiency

with innovation and strategic adaptability. Thus, schematically, the economic mechanism for the

functioning of electronic commerce enterprises can be presented as follows (Fig. 1).

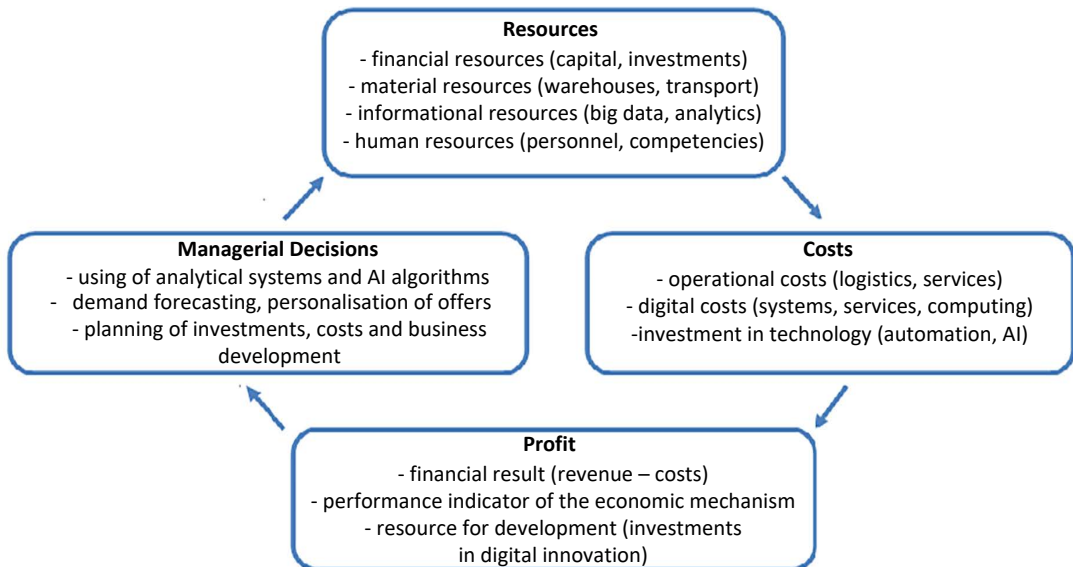


Figure 1. Diagram of the economic mechanism for the functioning of electronic commerce enterprises

Source: developed by the authors

The diagram illustrates the interconnection of key elements – resources, costs, profit, and managerial decisions – within the unified digital ecosystem of the enterprise. Resources (financial, material, informational, and human) form the foundation of the enterprise’s operations, being transformed through the cost management system into economic results. Cost optimisation determines the level of profitability, and the resulting profit becomes the basis for further investments and development. Managerial decisions, supported by analytical platforms, artificial intelligence algorithms, and forecasting technologies, ensure the enterprise’s adaptation to market changes and the closed-loop interaction of elements. All blocks of the diagram are connected by digital technologies, which serve as the integrating link, ensuring the flexibility, transparency, and dynamism of the examined economic mechanism.

In contemporary electronic commerce, big data analytics and machine learning have become key tools for making effective managerial decisions. Amazon has actively utilised these

technologies for demand forecasting, inventory optimisation, and personalising customer offerings from 2020 to 2024. By using machine learning algorithms, Amazon analyses vast amounts of data regarding user behaviour on its platform and mobile applications, enabling it to predict consumer needs, adjust product assortments and prices, and adapt marketing strategies in real-time. For example, in 2024, precise demand forecasting allowed Amazon to reduce the number of inactive or low-selling product items (ASINs) in its catalogue from approximately 74 billion to fewer than 50 billion by the end of 2024, thereby reducing infrastructure maintenance costs (Liu *et al.*, 2024). Another example is Walmart (n.d.), which implemented the Polaris analytics platform to enhance the efficiency of its internal operations. The use of semantic search and data analysis enabled the company to increase the relevance of search results by 4.8% and boost online purchase conversion by 10% between 2023 and 2024, directly impacting its financial performance (Gomes, 2024). Through such approaches, enterprises not only optimise

internal processes but also create a personalised experience for each user, which is critically important in the competitive landscape of electronic commerce.

Cost optimisation is a critically important aspect of ensuring competitiveness. The implementation of digital technologies allows for the reduction of operational costs and improves the efficiency of resource use. In 2021-2023, LockN-Lube (n.d.) integrated over 20 different supply chain management systems, which resulted in a 15-20% reduction in inventory management costs and improved operational efficiency (ElevatIQ, n.d.). The integration of digital technologies into business processes and logistics is a necessary condition for achieving high efficiency. For example, in 2023, Temu (n.d.) formed a strategic partnership with the Turkish logistics company Horoz Lojistik (n.d.) to ensure fast and secure delivery of goods in Turkey. This partnership allowed for the optimisation of delivery routes for heavy and bulky items, reducing the average last-mile delivery time by 25% (Reuters, 2025).

The development of electronic commerce in Ukraine has demonstrated a dynamic process of adaptation to changing conditions, particularly during the COVID-19 pandemic (since 2020) and Russia's full-scale aggression (since 2022). These factors have influenced the structure and functioning of the market, fostering

both new opportunities and the emergence of several challenges. One of the main trends is the growth of mobile commerce. According to the EVO group of companies, which includes Prom, Shafa, and Kabanchik, Ukrainians spent UAH 239 billion on online purchases in 2024, an increase of 25% compared to 2023. This indicates the sustained growth of the e-commerce market in Ukraine despite challenging economic conditions. The number of online shoppers also increased, reaching approximately 11 million in 2024, which is 1 million more than in 2023. The average spend per purchase was UAH 1,300, and each shopper made an average of 17 purchases during the year. These figures demonstrate growing consumer trust in online shopping and its integration into daily life. Among the most popular items purchased online by Ukrainians in 2024 were phone cases, dietary supplements, sneakers, pet food and treats, and perfumes. A particularly noticeable increase in demand was observed for climate-related equipment, including generators and charging stations, as a result of power outages during the summer months (Kuzmenko, 2024). The highest activity is observed in the central and western regions of Ukraine, particularly in Kyiv, where 15% of all online purchases are made (Dimura, 2025). Figure 2 presents the turnover of retail enterprises from the sale of goods via the internet.

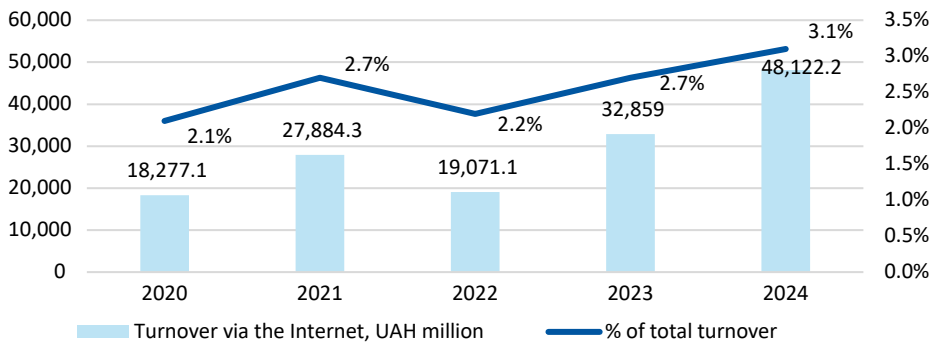


Figure 2. Turnover of retail enterprises from the sale of goods via the internet in Ukraine for 2020-2024

Source: developed by the authors based on data from the State Statistics Service of Ukraine, n.d.

The dynamics of retail enterprises' turnover from the sale of goods via the internet indicate a steady growth in the importance of

electronic commerce within the national economy. In 2020, the volume of online sales amounted to only UAH 18.3 billion, which accounted for

2.1% of total turnover. By 2024, this figure had nearly tripled, reaching UAH 48.1 billion (31%). At the same time, some unevenness in the dynamics can be observed: in 2022, under the influence of war and crisis phenomena, online sales decreased to UAH 19.1 billion, 31.6% less than in 2021. However, in 2023-2024, the market demonstrated a rapid recovery, surpassing pre-crisis levels. This indicates the high adaptability of electronic commerce to external challenges, its potential as a sales channel under offline trade restrictions, and the gradual formation of a sustainable trend towards the digitalisation of consumer markets in Ukraine.

Despite the positive trends, challenges remain. One of the main issues is logistics, particularly in wartime conditions. Infrastructure destruction, including roads and warehouses, complicates the delivery of goods, especially in frontline and remote regions. Furthermore, currency instability and inflation affect the purchasing power of the population, which could lead to a decrease in online sales volumes. Another challenge is cybersecurity. The growing number of online transactions increases the risk of cyber threats, necessitating

enhanced security measures. The implementation of modern data protection systems and staff training on cybersecurity issues has become essential for ensuring the safe operation of electronic commerce. In response to these challenges, Ukrainian enterprises are actively implementing innovative technologies, including big data analytics, machine learning, and business process automation. This not only optimises operations but also creates a personalised experience for each customer, which is a key factor in the competitive landscape of electronic commerce.

Rozetka is the leader in the Ukrainian electronic commerce market, characterised by its scale of operations and a high level of integration of digital technologies across all components of the enterprise's economic mechanism. The company's product range includes over 60 million items in more than 7,000 product categories, ensuring broad coverage of consumer needs and creating a foundation for effective strategic planning. Its resource potential ensures the formation of an optimal product policy and inventory management. Table 1 presents the key indicators of the company (Rozetka, n.d.a).

Table 1. Key indicators of Rozetka for 2020-2024, UAH million

Indicator	2020	2021	2022	2023	2024
Revenue	17,629.6	21,172.6	18,388.1	25,463.9	29,742.6
Net profit	111	34	119.1	12	16.3
Operating expenses	2,213	3,231.9	3,244.1	4,616.7	5,204.4
Assets	2,734.9	4,232.7	3,642.3	4,858.2	5,202.8
Capital	179.8	213.8	332.8	344.8	286.1
Liabilities	2,556.5	3,988.5	3,282.3	4,452	4,886.1
Number of employees	230	417	923	800	940

Source: developed by the authors based on Rozetka (n.d.a)

The analysis of the financial indicators for Rozetka from 2020 to 2024 demonstrates a stable growth in revenue and assets, indicating the effectiveness of the economic mechanism and the adaptability of the business to changing market conditions: revenue increased from UAH 17,629.6 million in 2020 to UAH 29,742.6 million in 2024, although it temporarily decreased to UAH 18,388.1 million in 2022 due to external challenges; operating expenses grew from UAH 2,213 million to UAH 5,204.4 million, reflecting investments in infrastructure, logistics,

and digital technologies; net profit fluctuated from UAH 111 million in 2020 to UAH 16.3 million in 2024, showing the impact of external factors and investment activity; assets increased from UAH 2,734.9 million to UAH 5,202.8 million, capital grew from UAH 179.8 million to UAH 286.1 million, and liabilities rose from UAH 2,556.5 million to UAH 4,886.1 million, reflecting the strengthening of the financial base and an active financial policy; the number of employees increased from 230 to 940, demonstrating the scaling of business processes and the

development of digital platforms. Overall, such dynamics indicate the comprehensive interaction of resources, costs, profit, and managerial decisions, ensuring the effective functioning of Rozetka's economic mechanism in the digital economy and supporting its competitiveness in the Ukrainian electronic commerce market.

The implementation of digital technologies, such as warehouse automation, mobile applications, and customer support systems based on chatbots, allows for the optimisation of operational processes, reduction of costs, and improvement of resource efficiency. Investments in infrastructure development and technological solutions are aimed at accelerating order processing, increasing delivery speed, and enhancing service quality, which positively impacts the company's financial results. Rozetka's gross turnover in 2024 exceeded UAH 48 billion, reflecting stable growth and the effectiveness of the economic mechanism's

functioning (Rozetka, n.d.a). The company's managerial decisions are based on big data analytics, which ensures accurate demand forecasting, optimisation of product assortments and pricing, as well as timely adaptation to changes in market conditions. The comprehensive integration of resources, costs, profits, and managerial decisions forms a cohesive economic mechanism that ensures a high level of adaptability, competitiveness, and resilience in the digital economy.

Prom is the leading Ukrainian marketplace for small and medium-sized businesses, facilitating effective interaction between a large number of sellers and consumers through a digital platform. The platform unites over 700,000 sellers and offers more than 100 million products, creating significant resource potential for forming a broad product range and meeting the diverse needs of customers. Table 2 presents the key indicators of the company (Prom, n.d.a).

Table 2. Key indicators of Prom for 2020-2024, UAH million

Indicator	2020	2021	2022	2023	2024
Revenue	924.5	1,271.2	1,247.2	1756,1	2,052.2
Net profit	14,4	56.1	225.2	351,3	269.2
Operating expenses	937.4	1,242.2	996.7	814,3	1,019.9
Assets	466	481.3	840	1,030	1,191
Capital	35.9	90.6	315.8	671,5	752.5
Liabilities	430.1	390.7	524.1	338,5	435.3
Number of employees	560	582	549	670	725

Source: developed by the authors based on Prom (n.d.a)

The analysis of Prom's financial indicators for 2020-2024 demonstrates a stable growth in revenue and capital, reflecting the effectiveness of the economic mechanism and the company's ability to adapt to the dynamic conditions of the e-commerce market: revenue increased from UAH 924.5 million in 2020 to UAH 2,052.2 million in 2024, while net profit showed significant growth, reaching UAH 351.3 million in 2023, indicating an effective policy of cost optimisation and resource management; operating expenses fluctuated from UAH 937.4 million in 2020 to UAH 1,019.9 million in 2024, with a decrease in 2023 reflecting the implementation of innovative approaches to business process automation and the digitalisation of operational processes; the company's assets grew from

UAH 466 million to UAH 1,191 million, capital increased from UAH 35.9 million to UAH 752.5 million, and liabilities changed from UAH 430.1 million to UAH 435.3 million over the period, demonstrating a flexible financial policy and rational engagement of borrowed resources; the number of employees increased from 560 to 725, which indicates the scaling of business processes and the strengthening of the company's resource potential. Overall, this dynamic confirms the comprehensive interaction of resources, costs, profit, and managerial decisions, ensuring the effective functioning of Prom's economic mechanism in the digital environment and supporting its competitiveness in the Ukrainian e-commerce market.

The use of digital technologies in Prom's operations includes the implementation of

artificial intelligence for personalisation of recommendations, an automated fraud detection system, and mobile applications for user convenience. This allows for the optimisation of operational processes, reduction of risks, and improvement of resource efficiency. The company's financial results are derived from commissions on sales, advertising services, and additional services for sellers, ensuring stable income and contributing to the platform's sustainable development. Analytical tools based on big data enable accurate demand forecasting, optimisation of product assortments and pricing, while managerial decisions allow for the timely adaptation of operations to changing market conditions. The

comprehensive integration of resources, costs, profit, and managerial decisions forms a cohesive economic mechanism, ensuring the efficiency, flexibility, and competitiveness of Prom in the context of the Ukrainian e-commerce market (Prom, n.d.).

Amazon is a global leader in e-commerce, demonstrating a high level of integration of digital technologies into the functioning of all components of its economic mechanism. The company sells products through its website and mobile platforms, serving customers in various regions of the world, which provides significant resource potential and the ability to scale business processes (Amazon, n.d.). Table 3 presents the key indicators of the company.

Table 3. Key indicators of Amazon for 2020-2024, USD billion

Indicator	2020	2021	2022	2023	2024
Revenue	386.1	469.8	514	574.8	638
Net profit	21.3	33.4	-2.7	30.4	59.2
Operating expenses	363.7	444.5	462.7	527.9	569.4
Assets	321.2	420.5	452	514	624.9
Capital	93.4	138.2	146	201.9	286
Liabilities	126.4	142.2	155.4	164.9	179.4
Number of employees	1,298,000	1,468,000	1,540,000	1,610,000	1,700,000

Source: developed by the authors based on Amazon (n.d.)

The analysis of Amazon's financial indicators for 2020-2024 shows steady growth in revenue and assets, which reflects the effectiveness of the economic mechanism and the company's ability to scale business processes on a global level: revenue increased from USD 386.1 billion in 2020 to USD 638 billion in 2024, demonstrating market expansion and diversification of profit sources through Amazon Web Services and online retail; net profit fluctuated, with a loss of USD 2.7 billion in 2022, but it recovered to USD 59.2 billion in 2024, reflecting the adaptation of the mechanism to crisis conditions; operating expenses grew from USD 363.7 billion to USD 569.4 billion, reflecting investments in logistics, technological infrastructure, and automation; assets increased from USD 321.2 billion to USD 624.9 billion, capital rose from USD 93.4 billion to USD 286 billion, liabilities grew from USD 126.4 billion to USD 179.4 billion, and the number of employees increased from 1,298,000 to 1,700,000, indicating the scaling

of the resource potential; overall, this dynamic confirms the effective interaction of resources, costs, profit, and managerial decisions, ensuring the stable functioning of Amazon's economic mechanism in the digital environment and supporting its leading position in the global e-commerce market.

Amazon's investments cover logistics, technological infrastructure, cloud services (Amazon Web Services), and innovative solutions, including augmented reality to improve the shopping experience and automation of warehouse processes. These initiatives allow the company to optimise costs, increase operational efficiency, and reduce order processing times. In 2024, Amazon's online sales exceeded USD 400 billion, confirming the high efficiency of its economic mechanism and the significant profitability of the enterprise (Amazon, n.d.). Managerial decisions are based on big data analytics, machine learning algorithms, and intelligent decision-support systems, which ensure accurate

demand forecasting, optimisation of assortments, pricing, and personalisation of offers. The comprehensive interaction of resources, costs, profit, and managerial decisions forms a cohesive and adaptive economic mechanism, enabling Amazon to maintain its leadership position in the global e-commerce market and ensure a high level of innovation and competitiveness.

Based on the analysis of the financial and operational indicators of Rozetka, Prom, and Amazon, a set of recommendations has been developed to improve the economic mechanisms of e-commerce enterprises, combining digital innovations and organisational approaches. One of the key directions is strengthening the integration of big data analytics and machine learning algorithms for demand forecasting, inventory management, and offer personalisation. For instance, even with an increase in revenue for Rozetka to UAH 29,742.6 million and Prom to UAH 2,052.2 million in 2024, net profit remained relatively unstable (UAH 16.3 million for Rozetka and UAH 269.2 million for Prom), which indicates the need for more accurate forecasting and resource optimisation to improve profitability (Rozetka, n.d.a; Prom, n.d.a). The use of digital tools allows for predicting changes in demand, adjusting procurement and distribution strategies in a timely manner, which helps reduce operational losses and improve the efficiency of business processes. The experience of global companies such as Amazon (n.d.) demonstrates that the systematic use of big data analytics and machine learning contributes to the flexibility of the economic mechanism and the rapid adaptation to unstable market conditions.

A second direction is the optimisation of costs and resource provision through the automation of business processes, the implementation of cloud services, and digital management platforms. This enables the reduction of capital and operational expenses, accelerates order processing, improves the efficiency of managerial decisions, and shortens delivery times. For example, Amazon invests in technological infrastructure and logistics systems, ensuring business scalability and stable profit (USD 59.2 billion in 2024) even during market fluctuations, while Ukrainian companies can apply automated warehouses and inventory management

systems to reduce operational costs and increase competitiveness. The use of digital technologies also facilitates the integration of various types of resources – financial, material, human, and informational – into a unified system, which enhances the effectiveness of managerial decisions and ensures a quick adaptation to market changes (Amazon, n.d.).

The third direction concerns financial stability and optimal management of capital and liabilities. The analysis of the indicators for Rozetka and Prom highlights the need to maintain liquidity and a balanced ratio of equity to borrowed resources in order to implement innovative projects and ensure stable development. Changes in the structure of liabilities and capital demonstrate that rational financing allows companies not only to sustain operational activities but also to invest in digital solutions and technological modernisation, which in the long term enhances the effectiveness of the economic mechanism and the enterprise's resilience.

The fourth direction is the integration of organisational and digital mechanisms into logistics, marketing, and customer service. The use of robotic warehouses, automated delivery systems, consumer behaviour analytics, and AI-based recommendation services enables a reduction in order processing times, lowers logistics costs, and increases customer satisfaction (Rozetka, n.d.b; Prom, n.d.b). For example, strategic partnerships such as that of Temu with Horoz Lojistik demonstrate the effectiveness of integrating digital technologies and external logistics resources for business scaling and ensuring timely delivery (Reuters, 2025). In combination with the management of costs, resources, and profits, this forms a cohesive, adaptive, and innovative economic mechanism capable of sustaining stable growth, efficiency, and resilience for enterprises in the dynamic e-commerce market.

DISCUSSION

The results of the study confirm that the economic mechanism of modern enterprises in the context of the digital economy has ceased to be linear and limited by traditional management approaches. This mechanism in electronic commerce encompasses financial, material,

informational, and human resources, among others, which interact within an integrated digital platform. Such a transformation not only ensures control and planning but also dynamic adaptation to changes in the market environment, enabling the enterprise to respond quickly to external challenges, including technological innovations, demand fluctuations, and competitive influences. This emphasises that the modern economic mechanism of the studied business operates through the interconnection of its elements, which determine the effectiveness of its activities. I. Yoo & C.G. Yi (2022) examined the transformation of economic mechanisms under the influence of digitalisation, but their conclusions primarily focused on a centralised approach, where the key attention was given to financial and material resources as the basic elements of management. T. Zhang *et al.* (2022), on the other hand, believed that digital tools could only play the role of an auxiliary factor, enhancing the effectiveness of traditional planning and control mechanisms. This position was based on the notion of the economic mechanism as a system where technologies are unable to radically change management principles, but merely optimise the speed of information processing or communication processes. In contrast, the current study showed that digital integration is not just an additional element but a key condition for the effective functioning of the mechanism. Digital technologies not only ensure the fast exchange of information but also create a flexible structure for managerial decisions, enabling the enterprise to effectively adapt to changes in the external environment.

Resources remain a central element of the economic mechanism, but their use and management are changing under the influence of digitalisation. Attention was given to informational and technological resources, which ensure the timely decision-making process, enhance business process efficiency, and create new competitive advantages. The study demonstrated that the effective combination of various types of resources contributes to a synergistic effect, allowing for optimal distribution of costs and enhancing the enterprise's adaptability to a rapidly changing environment. A. Pieloch-Babiarz *et al.* (2021) emphasised the importance of

material and financial resources, considering them as the foundation of an enterprise's stability. However, informational and technological resources in their work were considered secondary. The current results showed that it is, in fact, digital resources, including databases, analytical platforms, and technological tools, that form the basis of competitiveness and allow the integration of different types of resources into a unified mechanism for the functioning of e-commerce enterprises. At the same time, the coherence between material, financial, and technological resources creates a synergistic effect, enhancing the overall productivity and resilience of the mechanism.

Costs in the digital economic mechanism serve not only as a tool for financial control but also as an instrument of strategic management. Cost optimisation involves not only their reduction but also the rational redistribution of resources to support innovative initiatives and technological solutions. The research indicates that the integration of digital technologies enables more detailed control over costs, identification of inefficient processes, and the making of managerial decisions that enhance productivity and reduce resource losses. O.J. Oteri *et al.* (2023) proposed approaches to cost optimisation, focusing on the reduction of administrative and production costs; however, they did not account for the importance of reallocating resources to support innovation processes. The results of this study highlight that cost optimisation is a comprehensive process that includes analysing the cost structure, automating business processes, and rationally redistributing financial flows to implement strategic innovations. The distinction lies in the current approach, which combines financial discipline with the support of innovation, whereas the authors focused solely on cost reduction.

Profit in the digital economy has ceased to be merely an end financial indicator; it now plays the role of a signal for managerial decision-making and an assessment of the effectiveness of the interaction between resources and costs. The research showed that the use of analytics and forecasting tools allows for more accurate evaluation of financial results, optimisation of development strategies, and quick adaptation to

changing market conditions, thereby enhancing the effectiveness of the economic mechanism. M.B. Tudose *et al.* (2022) viewed profit as a static indicator reflecting past performance. In contrast, the results of this study showed that profit in the digital economic mechanism serves as an active management tool, signalling the effectiveness of the interaction between resources and costs in real time. This aspect allows the enterprise to make prompt managerial decisions, adjust strategies, and adapt the mechanism to rapid market changes, significantly surpassing the role of profit in traditional approaches, as discussed by the authors.

Decision-making in the digital environment is complicated by the large volume of data and the rapid changes in market conditions. The research demonstrates that the integration of decision support systems, big data analytics, and machine learning algorithms increases the speed and accuracy of managerial actions. This approach ensures the optimal distribution of resources, timely correction of costs, and effective implementation of the enterprise's strategic objectives. L. Li *et al.* (2022) explored the application of big data analytics in decision-making, but their study was limited to traditional forecasting methods and did not include automated decision support systems. The current results showed that digital platforms and machine learning algorithms not only allow for forecasting but also enable the prompt adaptation of management strategies. In other words, the integration of technologies not only improves the accuracy of forecasts but also ensures the dynamic interaction of all elements of the mechanism, surpassing the capabilities of the authors' approach.

The implementation of innovative solutions, including machine learning, logistics automation, personalised services for customers, and cloud platforms, creates the foundation for the high-efficiency functioning of the economic mechanism. The research shows that the integration of these tools allows for accelerating order processing, optimising resources, forecasting demand, and adapting business processes to changes in consumer behaviour, which enhances the overall competitiveness of the enterprise. A. Sorescu & M. Schreier (2021) considered digi-

tal innovations primarily in the narrow context of marketing and customer communication, interpreting them as tools for improving market access, personalisation of offers, and enhancing customer loyalty. The approach of S.C. Ho & Y.P. Hsu (2022), in turn, focused on the development of product promotion channels, the creation of mobile applications, and the use of digital services to improve the quality of the customer experience. However, such an interpretation effectively limited the role of digital technologies to front-office functions, neglecting the potential of logistics automation, inventory management, financial processes, or internal resource integration. The results of this study showed that the comprehensive use of innovative tools across all business processes is essential for improving the efficiency of the mechanism. The integration of automated logistics platforms, personalised services, and analytical tools allows for cost optimisation, accelerates order processing, and creates competitive advantages.

The final aspect is the adaptability and resilience of the economic mechanism. The results of the study showed that the interaction of all elements of the mechanism allows the enterprise to quickly respond to external challenges, technological innovations, and market fluctuations. The systemic approach ensures the flexibility of business processes, the preservation of competitive advantages, and sustainable long-term functioning even in conditions of uncertainty and change. P.K. Ozili & P.T. Iorember (2024) equated the resilience of an enterprise with its financial stability and the level of asset diversification. Their approach was based on quantitative parameters that ensure long-term stability. In contemporary conditions, such an approach is incomplete, as financial indicators, although important, do not guarantee sufficient adaptability to technological changes and market fluctuations. The current results indicate that resilience is formed through the integration of all elements of the mechanism – resources, costs, profits, and managerial decisions – in the digital environment. Such an economic mechanism enables the enterprise to quickly respond to technological changes, market fluctuations, and innovations, which significantly surpasses the role of financial indicators in the classical

sense. Thus, the economic mechanism of electronic commerce enterprises is now integrated, adaptive, and innovative, where digital technologies, managerial decisions, cost optimisation, and the effective use of resources interact to ensure high efficiency, resilience, and competitiveness of the studied business.

CONCLUSIONS

The economic mechanism, in its traditional understanding, is a set of interconnected elements: tools, methods, and principles that ensure the effective functioning of an enterprise. However, in the context of the digital economy, it acquires new characteristics, as classical approaches to resource and financial flow management undergo significant transformations under the influence of information technologies. The analysis showed that e-commerce enterprises form a multi-level order of interaction, where financial, material, informational, and human resources are integrated into a single digital ecosystem. In 2024, turnover from online sales in Ukraine reached UAH 48.1 billion, accounting for 3.1% of total retail turnover, compared to just 2.1% in 2020, indicating gradual but steady digitalisation of the consumer market.

The results of the study of leading market participants confirmed the key role of resources in the functioning of the mechanism. Specifically, Rozetka's revenue from 2020 to 2024 increased from UAH 17.6 billion to UAH 29.7 billion, but net profit remained unstable (ranging from UAH 111 million in 2020 to UAH 16.3 million in 2024), which can be attributed to investments in logistics and digital platforms. This demonstrates that in modern conditions, resources not only ensure business stability but also act as a factor in forming strategic advantages, even at the cost of short-term profitability. The second important element is costs, the optimisation of which determines the efficiency of functioning. The study of Prom showed that a rational policy of reducing operating expenses from 2020 to 2024 enabled not only maintaining stability but also ensuring growth in net profit from UAH 14.4 million to UAH 269.2 million. This confirms that cost optimisation is not merely a mechanism for savings, but a tool for innovative

development and increasing the flexibility of enterprises. Profit, as an integral indicator of efficiency, was found to be dependent on the cost structure and the level of digitalisation of business processes. For Amazon, a decline was observed in 2022 to USD -2.7 billion due to large-scale investments, but by 2024, profit rose to USD 59.2 billion, demonstrating the ability of a digitally integrated mechanism to quickly adapt to crisis conditions. Managerial decisions proved to be a central element in ensuring the interaction of resources, costs, and profits. In the case of Ukrainian companies, decisions are increasingly based on big data analytics and automated forecasting systems, which improve management accuracy. Amazon, in turn, is characterised by the full integration of machine learning algorithms, which ensure the personalisation of offerings and accurate demand forecasting, creating competitive advantages.

Thus, the study showed that the effectiveness of the economic mechanism in e-commerce enterprises is determined by the integration of digital innovations in the interaction of resources, costs, profits, and managerial decisions. It is recommended to more actively utilise data analytics, machine learning, and automated platforms for demand forecasting, inventory optimisation, and offer personalisation, as well as to maintain a balanced financial structure and invest in technological infrastructure to improve business processes, logistics, and customer service, which will ensure the resilience and competitiveness of enterprises. A limitation of the study is its focus solely on specific companies and generalised statistical data, whereas further research should be directed towards an in-depth industry and comparative analysis of different e-commerce models in the context of digital transformation.

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Економічний механізм функціонування підприємств електронної комерції: теоретичні й практичні засади

Анотація. Дослідження було направлене на аналіз теоретико-методологічних основ та практичних підходів до формування й удосконалення економічного механізму діяльності підприємств електронної комерції. Методологічною основою був системно-структурний та порівняльний підходи для дослідження економічного механізму функціонування підприємств електронної комерції в умовах цифрової економіки. Економічний механізм розглядався як комплекс взаємопов'язаних елементів – ресурсів, витрат, прибутку та управлінських рішень, які формують цілісну цифрову екосистему підприємства. У 2024 р. частка онлайн-продажів у структурі роздрібногo товарообігу України зросла до 3,1 % (48,1 млрд грн) проти 2,1 % (18,3 млрд грн) у 2020 р., що підтверджує послідовну цифровізацію споживчого ринку навіть за умов кризи. Аналіз ключових гравців електронної комерції показав різні траєкторії розвитку. Rozetka у 2020-2024 рр. збільшила дохід з 17,6 до 29,7 млрд грн, однак чистий прибуток залишався коливальним (від 111 млн грн у 2020 р. до 16,3 млн грн у 2024 р.), що пояснюється активними інвестиціями у логістику та цифрову інфраструктуру. Prom продемонстрував стабільне зростання: дохід зріс з 924,5 млн грн до 2052,2 млн грн, а прибуток у 2024 р. досяг 269,2 млн грн, що свідчить про ефективну оптимізацію витрат і впровадження інноваційних рішень. Приклад Amazon ілюстрував глобальний масштаб інтеграції цифрових технологій: дохід компанії виріс з 386,1 млрд дол. у 2020 р. до 638 млрд дол. у 2024 р., а чистий прибуток, після тимчасових збитків у 2022 р. (-2,7 млрд дол.), відновився до 59,2 млрд дол. Визначено, що підприємствам доцільно активніше впроваджувати аналітику даних і алгоритми машинного навчання для прогнозування попиту та персоналізації пропозицій, автоматизувати бізнес-процеси та логістику, а також підтримувати збалансовану фінансову структуру й інвестувати в цифрову інфраструктуру для підвищення ефективності управлінських рішень та забезпечення стійкості й конкурентоспроможності. Практичне значення роботи полягає в тому, що отримані результати можуть бути використані підприємствами електронної комерції для удосконалення економічного механізму шляхом інтеграції цифрових технологій, оптимізації витрат та підвищення конкурентоспроможності на динамічному ринку

Ключові слова: цифрові технології; управлінські рішення; логістика; управління ресурсами; прибутковість; інновації

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