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Контактна адреса:
Університет Григорія Сковороди в Переяславі
08400, вул. Сухомлинського, 30, м. Переяслав, Україна
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Address for contacts:
Hryhorii Skovoroda University in Pereiaslav
08400, 30 Sukhomlynsky Str., Pereiaslav, Ukraine
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Adaptive natural resource management as a driver of sustainable economic development in Ukraine: Challenges and opportunities

Ludmila Kozak*
PhD in Economics, Professor
National Transport University
01010, 1 M. Omelianovych-Pavlenko Str., Kyiv, Ukraine
https://orcid.org/0000-0003-3995-172X

Mariia Danchuk
PhD in Economics, Associated Professor
National Transport University
01010, 1 M. Omelianovych-Pavlenko Str., Kyiv, Ukraine
https://orcid.org/0009-0007-3033-3227

Abstract. The study aimed to analyse the impact of adaptive natural resource management on the sustainable economic development of Ukraine. Specifically, it focused on the challenges the country faces in adapting to changing environmental conditions and the strategies needed to overcome these barriers to ensure efficient resource utilisation. The research explored the role of adaptive management in addressing critical issues such as natural resource depletion, environmental degradation, and climate change, all of which significantly influence Ukraine's economic stability. Key challenges examined included water pollution, soil degradation, atmospheric pollutant emissions, and the environmental consequences of war. The analysis highlighted the potential of adaptive management to enhance the country's economic competitiveness, improve resource efficiency, and foster investment in the "green" economy. The study identified significant barriers to the effective implementation of adaptive strategies, including insufficient data for environmental monitoring, an outdated regulatory framework, and limited involvement of communities and businesses in management processes. Statistical data on water pollution, pollutant emissions, degraded land, and the environmental impact of war provided a basis for assessing the current situation. The findings also revealed opportunities to address these issues through innovative technologies, legislative improvements, and the development of financial mechanisms, such as "green" bonds and grants. The conclusions emphasised that achieving sustainable economic development in Ukraine requires institutional reforms, enhanced monitoring systems, and increased investment in environmental projects. Furthermore, international cooperation and the promotion of educational initiatives were identified as essential components for advancing sustainable development goals

Keywords: ecological sustainability; environmental policy; national security; management strategies; ecosystem services

INTRODUCTIONS

Adaptive management of natural resources is a critical component of sustainable economic development in Ukraine, particularly in the context of climate change, environmental crises, and high levels of natural resource exploitation. The challenge of ensuring the rational use of natural resources has become increasingly urgent in light of global phenomena such as resource depletion, ecosystem degradation, biodiversity loss, and environmental pollution. For Ukraine, this issue holds special significance due to the country's abundant natural resources, which, despite their potential, are subject to inefficient use, leading to severe environmental and economic challenges. Adaptive management, characterised by flexible and dynam ic approaches to planning and resource utilisation, offers a promising solution to address these pressing issues.

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*Corresponding author

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A substantial body of research exists on adaptive management of natural resources, predominantly focusing on the theoretical principles and general aspects of this approach. For instance, J. Fransen *et al.* (2024) explored the application of adaptive management in the Mathare district of Nairobi during the COVID-19 pandemic. Their study analysed how local organisations enhanced community resilience through initiatives targeting the most vulnerable populations during crises. The authors highlighted the pivotal role of citizen engagement and collective action in mitigating the adverse impacts of global disasters. In a related context, W. Wang *et al.* (2024) examined the interplay between green policies and financial development in the G7 countries. Their research assessed how environmental regulations can drive economic growth by fostering green development. Particular attention was given to how environmental initiatives attract investments and strengthen financial stability, aspects crucial for economies striving toward sustainability.

The relationship between renewable energy and natural resource conservation in developing countries was analysed by H. Zhang *et al.* (2024), who emphasised the critical role of renewable energy sources in promoting sustainable development and conserving natural resources. Their study demonstrated that the efficient utilisation of renewable resources is essential for improving environmental conditions, particularly in nations with limited natural resource availability. M. Islam & D. Chadee (2024) investigated the adaptive management of global supply chains and its influence on the resilience of suppliers in developing countries during external shocks, such as economic crises and natural disasters. Their research proposed an adaptive management model designed to maintain supplier efficiency under challenging conditions, thereby enhancing the overall resilience of global supply chains.

The efficiency of natural resource utilisation and the advancement of green economies in BRICS countries were studied by L. Fan & D. Wang (2024). Their research focused on recent innovations in clean energy and globalisation, highlighting their contributions to economic growth and the reduction of greenhouse gas emissions. The study underscored the importance of international collaboration and technological advancements in ensuring the sustainable use of natural resources. Further, Z. Gatgash & S. Sadeghi (2024) analysed the effects of various management strategies on soil quality, water resources, and the overall ecological status of watersheds. Their results demonstrated that adaptive management approaches, characterised by flexibility and responsiveness to ecosystem changes, offered significant advantages over traditional management practices. Specifically, adaptive management was associated with improvements in water quality, reductions in soil erosion, and increases in biodiversity in the areas studied.

T. Demianenko (2023) investigated mechanisms to promote the sustainable development of industrial enterprises in Ukraine, proposing models that integrate environmental and economic dimensions for achieving sustainable industrial growth. The study underscores the critical importance of synergy between economic and environmental initiatives to drive sustainable industrial development. C. Işık *et al.* (2024) explored the influence of Environmental, Social, and Corporate Governance (ESG) factors on economic growth in East and South Asia. Their research highlights how ESG considerations can support sustainable development in regions where rapid economic growth is often accompanied by significant environmental and social challenges.

An important gap in existing research is the lack of comprehensive studies that address the local characteristics of Ukraine. This includes the impact of war on ecosystems and natural resources, the urgent need for infrastructure restoration, the adaptation of legislation, and the active involvement of communities in management processes. These factors present unique and evolving challenges that have not yet been sufficiently studied.

Thus, the aim of this study was to evaluate how adaptive natural resource management can contribute to sustainable economic development in Ukraine. It provided a comprehensive analysis of current challenges and barriers to the effective utilisation of natural resources, while exploring prospects for implementing adaptive management approaches. The study emphasised the importance of strengthening institutional and financial systems, fostering the integration of local communities and businesses, and leveraging innovative technologies to enhance resource efficiency and sustainability in Ukraine.

MATERIALS AND METHODS

The study focused on analysing the adaptive management of natural resources in Ukraine and evaluating its economic efficiency. The methodological approach employed a comprehensive analysis that integrated the examination of international experience with an assessment of the current situation in Ukraine. The research was grounded in the analysis of statistical data and the comparison of international practices. Official data from the State Statistics Service of Ukraine (2023) served as the primary source of information. A review of scientific literature enabled the identification of key principles and characteristics of adaptive management. These include flexibility, the capacity to respond promptly to changes, and the incorporation of innovative technologies.

Systematic and problem analysis was conducted to outline the key challenges associated with implementing adaptive approaches in natural resource management. The underlying causes of these challenges were identified, and their potential ecological and economic consequences for the state were predicted. Factor risk analysis was employed to evaluate the risks and barriers to implementing adaptive management. This method facilitated the identification of critical issues, including latent factors influencing data variables, and allowed for an assessment of both external and internal factors impacting the effectiveness of adaptive management.

A multifactor analysis was used to examine the impact of adaptive management on economic development. This

analysis assessed the relationship between the adoption of adaptive strategies and improvements in the economic productivity of various regions. It enabled the identification of influencing factors and provided a basis for predicting management outcomes to support social and economic growth and sustainable development. Examples of adaptive management implementation in different countries, including Ukraine, Sweden, Norway, and Canada, were analysed. The findings highlighted numerous benefits of adaptive management, particularly its role in the efficient utilisation and preservation of natural resources.

The study examined the impact of innovative technologies on the effectiveness of adaptive management of natural resources. The potential applications of satellite monitoring, geographic information systems (GIS), the Internet of Things (IoT), and Big Data for collecting and processing information on the state of natural resources were explored. Their role in monitoring changes in soils, water resources, and forests was analysed, alongside the potential for predicting risks and developing optimal management solutions using artificial intelligence. Predictive methods were employed to determine the prospects and primary directions for implementing adaptive management of natural resources in Ukraine.

Data systematisation and processing were conducted using SPSS and Excel software tools, enabling the analysis of key trends, identification of correlations among various indicators, and assessment of the impact of adaptive management on natural resource sustainability. The analysis incorporated both quantitative and qualitative aspects, ensuring a comprehensive approach to the study.

RESULTS

Theoretical foundations of adaptive natural resource management

Adaptive management of natural resources is a concept centred on a flexible and dynamic approach to decision-making within the inherent uncertainty of natural ecosystems. This approach involves continuous monitoring of resource conditions and the timely adjustment of management strategies in response to new data and external changes. In scientific literature, adaptive management is often described as a "learning-by-doing process" aimed at mitigating environmental degradation risks while ensuring sustainable resource use. Its defining feature is the integration of scientific knowledge, management practices, and feedback to enable continuous improvement of decisions (Fernandes *et al.*, 2021).

A key principle of adaptive management is flexibility, which allows for rapid responses to changes in ecosystem and resource conditions – an essential capability in the face of global uncertainties, such as those posed by climate change. Integrativeness refers to the coordinated interaction among various sectors – economic, social, and environmental – and across governance levels: national, regional, and local. A focus on the long-term perspective ensures that the needs of future generations are considered in alignment with sustainable development goals. The involvement of stakeholders, including communities, businesses, scientists, and government entities, is another critical element, enhancing the effectiveness of management measures. Finally, continuous monitoring of resource conditions and a robust feedback loop enable the refinement of strategies in response to emerging challenges and the outcomes of prior actions.

Adaptive management plays a crucial role in advancing the global Sustainable Development Goals (SDGs). Under SDG 13 (Climate Action), adaptive management enables rapid responses to changing climate conditions, mitigating negative impacts on ecosystems and human communities. Key strategies include implementing sustainable natural resource management practices, developing innovative technologies to reduce greenhouse gas emissions, and improving energy efficiency. In the context of SDG 15 (Life on Land), adaptive management supports the restoration and conservation of biodiversity, protects land from degradation, and maintains healthy ecosystems. These efforts are foundational for ensuring food security and enhancing the resilience of local communities. Adaptive management relies on continuous ecosystem monitoring, using collected data to refine management policies and practices. This dynamic approach helps safeguard natural resources for future generations (Intergovernmental Panel on…, 2014; Food and Agriculture…, 2019).

Community engagement and the incorporation of traditional knowledge are integral to promoting social justice and reducing inequalities in resource access. Adaptive management fosters equitable resource distribution, reducing social disparities and contributing to sustainable development. Integrating traditional knowledge into modern natural resource management techniques not only supports ecological balance but also strengthens the sustainability of local livelihoods, reducing vulnerability to environmental and social crises.

Modern challenges in natural resource management

Modern challenges in natural resource management arise from a combination of global and local factors that significantly impact ecosystems and the natural environment. These factors generate new threats to sustainable development and underscore the need for integrated approaches to addressing environmental issues. Table 1 presents an overview of the key challenges in natural resource management along with their environmental and economic consequences.

Table 1. Key challenges in natural resource management

Challenges	Reasons	Consequences	Impact on the economy of the country
Resource depletion	Over-extraction, demand growth	Raw material shortage, rising costs, threat to economic stability	GDP decline resulting from increased energy import costs, rising energy prices, and job losses in the extractive industries

Table 1. Continued

Challenges	Reasons	Consequences	Impact on the economy of the country
Environmental degradation	Pollution, overexploitation of land and water systems	Productiveness deterioration, ecosystem destruction, threat to biodiversity	Decreasing agricultural yields, increased costs of ecosystem restoration, and diminished export potential in the agricultural sector
Climate change	Greenhouse gases, reduction of natural CO_2 absorption capacity	Temperature increase, frequent extreme weather events, reduced yields, economic losses	Rising costs for agrochemical treatments, declining agricultural yields, financial losses from natural disasters (floods and droughts), and infrastructure deterioration
Population growth	Population outbreak, urbanisation growth	Increasing pressure on natural resources, demand growth for energy, food and water	Rising infrastructure costs, increasing resource scarcity, economic instability
Environmental pollution	Industrialisation, lack of proper waste processing	Ecosystems destruction, pollution of water, air and soil	Increased costs for environmental clean-up and restoration, rising healthcare costs
Inefficient resource management	Insufficient planning, corruption, lack of transparent mechanisms	Uneven resource distribution, natural areas degradation	Investment attractiveness decrease, increased risks of economic losses, irrational use of the budget
Military actions	Armed conflicts, political instability	Infrastructure destruction, pollution, inability to use natural resources	Significant economic losses, rising recovery costs, reduced access to strategic resources

Notes: GDP – gross domestic product
Source: developed by the authors

One of the primary challenges in natural resource management is the growing demand for resources driven by demographic pressure. The rapid increase in the global population has led to heightened demand for food, water, and energy, placing additional stress on natural resources, particularly in countries with high levels of urbanisation and intensive industrial production. This has resulted in the depletion of natural resources, especially non-renewable ones such as minerals, oil, and natural gas. In Ukraine, this issue is particularly acute regarding the depletion of energy resource deposits, such as coal, necessitating an urgent transition to alternative energy sources. These processes pose significant economic risks for countries reliant on the export or import of such resources. The shortage of raw materials leads to increased extraction and processing costs.

An equally critical environmental challenge is pollution, which manifests in several major forms: waste disposal and recycling, particularly of plastics; transport and industrial emissions into the atmosphere; and chemical pollution of soils and water bodies. These factors not only threaten ecosystem health but also result in considerable economic losses. Reduced agricultural productivity, rising healthcare costs, and expenses for cleaning polluted water resources are direct consequences of environmental degradation. Man-made disasters, along with air and water pollution, can lead to economic losses by reducing the quality of life and labour productivity, as well as increasing expenditures on treating diseases caused by pollution.

Environmental degradation resulting from the depletion of natural resources significantly exacerbates challenges in Ukraine. One of the most pressing issues is the destruction of fertile soils due to erosion, intensive agricultural practices, and the improper use of fertilisers. According to the Ministry of Agrarian Policy and Food of Ukraine (State Statistics Service…, 2023), approximately 40% of the country's agricultural land is affected by erosion, making it a primary factor in declining land productivity. Currently, over 10 million hectares of arable land are classified as degraded. This directly impacts national food security by reducing both the quantity and quality of agricultural products. The Food and Agriculture Organisation (Bélanger & Pilling, 2019) reported that soil erosion in Ukraine results in the loss of 5-7 million tons of fertile soil annually, which diminishes crop yields and heightens dependence on chemical fertilisers. The intensive and uncontrolled use of fertilisers and pesticides further contributes to soil pollution, exacerbating the problem. Soil contamination by chemicals is one of the most severe environmental issues in Europe, and the costs associated with land remediation and restoration are substantial. Experts estimate that Ukraine loses up to 3% of its GDP annually due to land degradation, representing a significant economic burden for the country.

Water resource pollution in Ukraine is another critical issue, with far-reaching implications for water quality, access to clean water, and economic stability. Approximately 20% of water resources are at risk of contamination, primarily due to agricultural activities, including the runoff of pesticides and chemical fertilisers. This not only degrades conditions for irrigation but also increases the costs of water purification. Industrial waste, agro-industrial runoff, and urban drainage further contribute to the pollution of rivers and lakes in many regions. Water scarcity, driven by inefficient use, adds to the problem. Per capita, Ukraine has only about 1,300 cubic meters of water available annually – significantly below the European standard and the global average of approximately 2,500 cubic meters. Furthermore, 60% of Ukraine's water resources are polluted, adversely affecting public health and increasing water treatment costs (State Statistics Service…, 2023).

The consequences of soil degradation and environmental pollution have significant social implications. In Ukraine, the risk of food crises is rising due to the deterioration of

soil and water quality, leading to a decline in stability within rural areas. Since agriculture serves as the primary source of income for many rural families, land degradation exacerbates poverty and intensifies social tensions in these communities. Over time, the depletion of arable land and limited opportunities for sustainable agriculture may drive migration from rural areas to urban centres, further aggravating issues of urbanisation and overpopulation in cities.

Ukraine also faces critical challenges concerning its forest resources. Uncontrolled deforestation and a shortage of forest resources diminish the ecosystem's capacity to regulate the climate, purify air, and sustain biodiversity. Illegal logging is a persistent problem; according to the State Agency of Forest Resources of Ukraine (2024a), this activity results in the annual loss of over 10 million cubic meters of forest. Data from the Food and Agriculture Organisation (Bélanger & Pilling, 2019) indicate that forest cover in Ukraine is declining at an approximate rate of 1% per year. If this trend continues, it will lead to substantial biodiversity loss and diminished ecological resilience. The degradation of forest ecosystems has a compounding effect, reducing their ability to recover and sustainably support climate regulation and biodiversity preservation. The lack of effective measures to control deforestation and promote forest restoration threatens to increase greenhouse gas emissions while diminishing forests' capacity to sequester carbon. This, in turn, accelerates the progression of climate change.

Climate change is intensifying existing environmental and economic challenges in Ukraine while introducing new threats. Rising average annual temperatures, shifting precipitation patterns, and the increased frequency of droughts and floods are significantly impacting agricultural productivity, limiting access to water resources, and heightening risks to infrastructure. According to the UK's National Meteorological Service, average annual temperatures in Ukraine could rise by 1.4-3.1°C by 2050, surpassing the global average rate of climate change (Wilson *et al*., 2021). This warming trend will heavily affect agriculture, a cornerstone of Ukraine's economy, particularly by reducing crop yields.

The National Institute for Strategic Studies reports that climate change is already decreasing the yields of staple crops such as wheat, corn, and barley. For example, a severe drought in southern Ukraine during 2020 led to a 30-40% reduction in corn yields, resulting in economic losses of approximately USD 3.5 billion (Gusarova, 2020). Additionally, climate change is increasing the frequency and intensity of floods in western Ukraine, leading to significant economic repercussions. The 2020 floods in this region caused damage to infrastructure and agriculture valued at over UAH 2 billion (State Statistics Service…, 2023).

Climate change also facilitates the spread of pests and plant diseases, further reducing agricultural yields and increasing crop protection costs. According to the Ministry of Agrarian Policy and Food of Ukraine, the cost of agrochemical treatments could rise by 15-20% by 2030 due to these factors. This imposes additional economic burdens on farmers, particularly in regions where agriculture constitutes the primary source of income. The contrasting effects of droughts in the south and floods in the west of Ukraine exacerbate economic losses and deepen regional disparities, leading to greater economic and social imbalances. Given that agriculture contributes approximately 10% of Ukraine's GDP, the ongoing impacts of climate change pose a substantial threat to the country's economic stability (State Statistics Service…, 2023).

The war in Ukraine has led to profound social and economic consequences that directly impact natural resource management and the country's sustainable development. According to the Kyiv School of Economics (2022), Ukraine's economic losses from the war in 2022 exceeded USD 600 billion. Estimates indicate that the country's GDP in 2023 decreased by 35-40% compared to 2021, significantly affecting all sectors, particularly agriculture, which traditionally contributed around 10% of GDP. This loss of economic stability hinders the implementation of adaptive natural resource management strategies, as insufficient financial resources make it challenging to pursue environmental initiatives and ensure sustainable development.

Hostilities and occupation in eastern and southern Ukraine have resulted in the loss of approximately 25% of agricultural land. This has significantly disrupted food production; for instance, grain output in 2022 fell by 37%, according to the Ukrainian Agribusiness Club (2023). Rising domestic food prices have further limited access to basic food products, underscoring the urgency of developing adaptive natural resource management strategies to address shifts in production and consumption patterns. Furthermore, environmental damage caused by the war is estimated to exceed USD 10 billion, including water pollution from explosions and infrastructure destruction.

More than 1,200 cases of environmental pollution resulting from military actions have been documented, significantly degrading the quality of water and soils. Restoring ecosystems affected by the war will require the adoption of new environmental standards and management strategies to ensure sustainable post-war development. The war has also triggered substantial population displacement. According to the United Nations High Commissioner for Refugees, more than 8 million people have been internally displaced, and approximately 7.8 million Ukrainians have left the country (About 1.5% on…, 2024). This large-scale movement poses additional challenges for natural resource management in host regions. Local communities must address increased demand for resources and services, requiring the adaptation of existing management models. Effective adaptive approaches must account for these changes, providing support for displaced populations and host communities alike.

Post-war reconstruction in Ukraine will require substantial investment, with estimates suggesting that approximately USD 38 billion will be needed to restore infrastructure and ecosystems in the coming years (Ukraine rapid assessment…, 2023). The integration of innovative

technologies into the agricultural sector, alongside the implementation of environmental regulations, will be essential to minimising the negative impact on natural resources. Adaptive natural resource management should serve as a cornerstone of recovery efforts, ensuring the alignment of economic, social, and environmental priorities.

However, ineffective policy and resource management pose significant challenges. The absence of robust mechanisms for regulating resource use, coupled with corruption in environmental governance and conflicts of interest among public, private, and governmental sectors, undermines efforts toward sustainable resource management. These issues exacerbate environmental degradation, result in inefficient resource utilisation, and lead to economic losses that are ultimately borne by state and local budgets. Ukraine's natural resource management system faces multiple challenges, including climate change, environmental degradation, and economic instability. Addressing these requires the development and implementation of comprehensive and adaptive strategies that promote sustainable development. Effective management practices must prioritise ecosystem preservation and resilience, while simultaneously bolstering economic stability.

Economic impact of adaptive natural resource management

Adaptive management of natural resources has a substantial economic impact, optimising resource utilisation, enhancing economic competitiveness, and attracting investments in the "green" economy. One of the primary benefits of adaptive management is the efficient use of resources, which not only reduces costs but also ensures the preservation of resources for future generations. In Ukraine, where water scarcity is a pressing issue, adaptive management can facilitate a more equitable distribution of water across regions and economic sectors. This approach helps prevent crisis situations during dry periods and droughts, mitigating economic losses caused by natural disasters and improving water availability for agriculture and industrial enterprises.

A key component of adaptive management is the integration of innovative technologies to boost productivity in agriculture and industry. For instance, implementing precision agriculture systems in Ukraine, such as soil moisture monitoring and automated irrigation technologies, can significantly reduce water and fertiliser use. Experts estimate that adopting these technologies could lower irrigation costs by 20-30% and improve crop yields by 15-20% (Kononenko *et al*., 2024). This not only reduces production costs for agricultural producers but also enhances their competitiveness in both domestic and international markets. Adaptive management also fosters cost reductions in industry. For example, modernising thermal power plants with energy-efficient technologies has resulted in a 10-15% reduction in energy consumption, positively affecting overall production costs (Kononenko *et al*., 2024).

Adaptive management plays a critical role in attracting investments in the "green" economy. Ukraine is experiencing significant growth in energy projects focused on renewable energy sources. International assistance programs, such as Horizon Europe (2020), provide financial support for initiatives in renewable energy and energy efficiency. As a result, Ukraine is implementing projects that reduce reliance on fossil fuels and lower greenhouse gas emissions. For instance, in 2021, over 300 MW of renewable energy capacity was brought online, contributing to reduced energy costs and improved environmental conditions (Konechenkov, 2022). Such investments not only cut energy expenses but also generate new jobs, positively influencing the economic conditions of various regions.

Adaptive management also helps mitigate economic risks associated with the inefficient use of natural resources. In Ukraine, one of the primary threats is water resource scarcity in southern regions, which poses significant risks to agricultural productivity and economic stability. Implementing adaptive water resource management strategies enables the optimisation of water usage, minimises losses, and prevents shortages during critical periods. A key element of adaptive management is continuous monitoring and control of resource utilisation. This allows for timely responses to fluctuations in supply and demand, significantly reducing economic losses caused by the inefficient use of water, land, and energy. Moreover, it helps avoid excessive environmental pollution.

Through adaptive management, Ukraine can further integrate its economy into the international environmental and economic framework. The implementation of international environmental agreements, such as the Paris Agreement on Climate Change, necessitates the adoption of effective mechanisms for managing natural resources. These include deploying energy-efficient technologies, expanding the use of renewable energy sources, and reducing greenhouse gas emissions. Participation in global initiatives, such as the Horizon Europe program and "Green Bonds", enables Ukraine to secure financing for the development of sustainable technologies. These investments not only mitigate economic risks but also enhance the country's environmental performance. The adoption of such initiatives promotes the modernisation of production facilities, improves energy efficiency, and reduces dependence on imported energy sources, thereby strengthening Ukraine's economic stability. Table 2 summarises the economic impacts of adaptive natural resource management.

Table 2. Economic impact of adaptive natural resource management

Category	Economic impact	Management result
Efficient use of resources	Reducing costs for water use, land use, energy consumption; increasing productivity	Optimisation of water supply in agriculture, reduction of energy costs through energy-efficient technologies

Table 2. Continued

Category	Economic impac	Management result
Increasing competitiveness	Reducing production costs, improving innovation, increasing exports	Modernisation of enterprises, introduction of "green" technologies into production
Investment promotion	Attracting financing for sustainable development, increasing investment in renewable energy and environmentally friendly projects	Using green bonds to finance renewable energy
Prevention of natural and man-made disasters	Reducing economic losses due to natural and man-made disasters, reducing infrastructure restoration costs	Implementation of early warning systems, modernisation of infrastructure to increase disaster resilience
Reducing dependence on imported resources	Reducing costs for importing energy resources and raw materials, increasing the country's energy and resource security	Development of domestic energy sources, use of renewable energy sources, efficient water use
Social and economic sector	Increasing social stability through the creation of new jobs and reducing social costs	Creating "green" work places, financing projects in agriculture, investing in education and science
Sustainable economic development	Increasing economic stability through sustainable resource use, preserving ecosystems and improving the environmental situation	Investments in sustainable development, use of renewable resources, long-term sustainable development policy

Source: developed by the authors

Adaptive management of natural resources is a vital tool for a country's economic development, promoting the rational use of resources and mitigating environmental risks. It relies on continuous monitoring of ecosystem conditions, analysis of the collected data, and rapid adjustments to management decisions. This approach enables real-time consideration of changes in ecosystems, optimising the costs associated with their preservation and restoration. The efficiency of natural resource utilisation improves with the integration of innovative technologies and flexible management practices, which helps reduce resource depletion. Additionally, adaptive management minimises the expenses linked to the impacts of natural disasters and environmental degradation. The economic benefits are evident in increased profitability in resource-dependent sectors such as agriculture and forestry. Adaptive management also facilitates investment in the "green" economy and fosters the development of sustainable business models. By reducing reliance on resource imports, it strengthens the country's economic and energy security. In summary, adaptive management of natural resources has a profound economic impact, ensuring the rational use of resources and reducing environmental risks.

Examples of adaptive natural resource management

Adaptive natural resource management in Ukraine is still in its early stages, but pilot projects already implemented demonstrate the effectiveness of this approach. One notable example is the "Integrated Water Resources Management in Dnipro River Basin" project, supported by the United Nations Development Program (UNDP). This initiative applied integrated strategies for water resources management, including water quality monitoring, community involvement, and the use of innovative treatment technologies. The results showed substantial improvements in water resource management, particularly in reducing water pollution levels. Through the implementation of water quality monitoring and wastewater treatment systems, the concentrations of heavy metals, such as lead and mercury, in the Dnipro River decreased by 18-22% compared to initial levels. Additionally, the project achieved a 15-20% reduction in organic pollutants, as measured by biological oxygen demand (UNDP, 2024).

Another significant achievement was the improved access to high-quality drinking water. Modernisation of water treatment systems and the construction of new treatment plants provided over 500,000 residents in various regions of the Dnipro basin with access to cleaner and safer water. The introduction of advanced purification technologies significantly reduced concentrations of harmful bacteria, such as coliphages, ensuring drinking water met high safety standards. These efforts not only improved public health but also positively impacted the ecological stability of the region. By reducing water pollution and enhancing the quality of water resources, the project significantly improved the ecosystem health of the river and its surrounding water bodies. This contributed to the restoration of biodiversity in the Dnipro basin, reinforcing the ecological sustainability of the region (State Agency of Water Resources of Ukraine, 2017).

Another example of adaptive resource management can be seen in forestry efforts, particularly in the Carpathian region of Ukraine. Programs aimed at reducing illegal deforestation and implementing advanced monitoring systems using satellite technologies have been actively developed and implemented. Several key initiatives to combat illegal logging and restore forest plantations have yielded significant results in this region. One notable example is "Forests for the Future" program, launched with the support of international organisations, including the United Nations Development Program and "Ecology and People" International Fund. This program leverages satellite technologies to monitor forest conditions and detect illegal logging activities. The Earth Observation for Sustainable Development system enables real-time forest monitoring, allowing for rapid responses to unauthorised activities. Since the introduction of these technologies, Ukraine has

recorded a reduction of over 30% in illegal deforestation compared to the period prior to the program's implementation. As of October 2024, reforestation efforts in the Carpathians had been carried out over an area of 2,900 hectares, with over 3,300 hectares expected to be completed by the end of the year. In 2024, it was planned to plant 14 million seedlings (State Agency of Forest Resources of Ukraine, 2024b). This approach represents an essential step toward sustainable development and the preservation of the Carpathians' natural resources.

Adaptive management of natural resources has demonstrated substantial economic benefits in several countries, including Sweden, Norway, and Canada. Its effectiveness lies in reducing economic risks, enhancing the resilience of natural resources, and ensuring sustainable economic flows across various sectors. This analysis examines the economic benefits of adaptive management in each of these countries and identifies additional areas where it has been successfully implemented.

Sweden has emerged as a leader in adaptive forest management. By employing an integrated approach that considers environmental, social, and economic dimensions, Sweden has significantly improved the balance between biodiversity conservation and the economic benefits derived from its forest industry. These well-established forest management practices ensure forest health while maintaining sustainable productivity. Such measures minimise losses from illegal logging and the depletion of forest resources, thereby enhancing long-term economic gains. In addition to forestry, adaptive management in Sweden extends to the energy and agricultural sectors. In agriculture, adaptive practices enable effective responses to climate change, increasing resilience to droughts, improving crop yields, and reducing economic risks. In the energy sector, Sweden's investments in renewable energy sources are supported by adaptive management strategies that optimise energy production and consumption, reduce costs, and improve overall system efficiency. The economic benefits of adaptive management in Sweden are evident in enhanced forestry productivity and the sustainable use of natural resources. These practices contribute to the country's strong competitiveness in the global markets for wood products and clean energy (Swedish Forest Agency, 2024).

In Norway, adaptive management plays a pivotal role in fisheries, where continuous monitoring of fish populations and the regulation of catch quotas form the foundation for the sustainable development of the fishing industry. This approach helps maintain stable fish population levels, prevents resource depletion, and ensures consistent incomes for fishermen and fish processing enterprises (ICES, 2024). Over the long term, it enables the country to avoid economic losses associated with overfishing while ensuring stable revenue from the export of fish products. Adaptive management is also applied in Norway's energy sector, particularly in hydroelectric power, which is a cornerstone of the country's economy. Advanced technologies for monitoring water resources are used to optimise the operation of hydropower plants, reducing energy production costs and improving the efficiency of water use. Additionally, adaptive management has been implemented in forestry and tourism. Monitoring systems in these sectors help balance environmental preservation requirements with the economic benefits derived from tourism and forest resources.

Canada serves as a prime example of adaptive management in water resources. In the Fraser River Basin, water level monitoring and climate risk forecasting systems have been implemented to enable timely responses to changes in water levels and the adaptation of water use strategies. These measures mitigate the risks of flooding and drought, delivering significant economic benefits to agriculture and other water-dependent sectors such as energy and industry. Adaptive management is also widely applied in Canada's forestry sector, particularly in combating forest fires. Utilising satellite technologies and forest monitoring systems, the country can respond rapidly to fire threats, reducing suppression costs and ensuring the economic stability of the forest industry. In agriculture, adaptive management is used for land management and climate change adaptation, helping to mitigate economic risks associated with droughts and other natural disasters (Government of Canada, n.d.). This approach enhances agricultural resilience, ensuring more stable crop yields even under changing environmental conditions. The economic effectiveness of adaptive management in Canada is evident in reduced costs for disaster mitigation, increased crop productivity, and the sustainable development of water and forest resources enabling the country to maintain high productivity in these industries.

A comparison of Ukraine's approach to adaptive management with international models reveals significant differences. The primary challenges facing Ukraine include the lack of a systemic approach, insufficient funding, and a weak legislative framework. In contrast, countries like Sweden and Canada actively utilise innovative technologies and ensure the involvement of all stakeholders in their adaptive management strategies. Ukrainian programs, however, often remain limited to the pilot project stage, without transitioning to widespread implementation. Another key difference lies in the scale of funding. International models benefit from substantial investment, often supported by international grants and institutional mechanisms.

Although Ukraine has made some progress in adaptive management, the experiences of other countries highlight areas for improvement in national strategies. Adopting international best practices, such as integrating innovative technologies, strengthening resource monitoring and control, and fostering active community involvement, could significantly enhance the situation in Ukraine.

Challenges in implementing adaptive management

Adaptive natural resource management in Ukraine faces several significant challenges that hinder its effective implementation and development. One of the most pressing issues is the lack of comprehensive data and monitoring systems. Ukraine's limited network of natural resource

observation points makes it difficult to make informed decisions and respond promptly to environmental changes. The absence of accurate and up-to-date information on ecosystem conditions, pollution levels, water resource distribution, and other critical indicators results in the inefficient use of natural resources and complicates the planning of sustainable development strategies.

Another significant challenge is the underutilisation of modern technologies, particularly Geographic Information Systems (GIS) and automated monitoring systems. GIS is a powerful tool for collecting, analysing, and visualising data on natural resources, yet its application in Ukraine remains limited. The absence of integrated, national-level natural resource monitoring systems further complicates the adaptation of management strategies to dynamic environmental conditions. Modern technologies, including GIS and automated systems, have the potential to enable prompt responses to environmental changes and provide predictions of their consequences. However, widespread implementation is hampered by underfunding and a lack of adequately trained personnel. management in Ukraine (Vasenko, 2023).

The environmental consequences of the war present another critical challenge, significantly worsening the state of the environment in Ukraine. Military actions have caused severe damage to ecosystems, including water pollution, forest destruction, soil contamination with toxic substances, and disruptions to natural processes. Restoring these ecosystems requires substantial efforts, with adaptive natural resource management serving as a crucial element of the rehabilitation process. However, the unstable situation in the country and limited access to affected areas make the implementation of such initiatives particularly difficult (Pylypovych & Petrovska, 2023). Another significant issue is the low level of involvement from communities and businesses, which hinders the effectiveness of adaptive management. Local communities and businesses should actively participate in decision-making regarding natural resource use, but they often lack sufficient environmental awareness or interest in sustainable development. Many communities do not have the necessary knowledge for effective resource management, while businesses frequently prioritise short-term economic gains over the adoption of sustainable practices (Shevchenko, 2012).

An outdated regulatory framework further impedes the implementation of adaptive management. Ukraine's legislative system often fails to meet modern requirements for environmental prot ection and the sustainable use of natural resources. Existing laws rarely incorporate innovative technologies or strategies designed to adapt to climate change. This lack of clear and contemporary regulations results in legal uncertainty, complicating the execution of long-term environmental projects.

Financial constraints are another major barrier. Effective adaptive management requires significant investments in areas such as technology implementation, monitoring systems, ecosystem restoration, and infrastructure development. However, Ukraine has limited access to financing for these projects, which significantly slows their progress. Many environmental initiatives depend on government funding or support from international organisations, but economic difficulties and political instability often render these resources unavailable. Table 3 provides a summary of the most common challenges encountered when implementing adaptive natural resource management in Ukraine.

Table 3. Challenges in implementing adaptive natural resource management

Challenge	Challenge description	Economic impact of implementing adaptive management
Lack of qualified personnel	Insufficient level of training of specialists in the field of ecology and new technologies	The shortage of qualified personnel hinders the implementation of innovative technologies and adaptive management, leading to delays in natural resource management projects and reducing their efficiency. This, in turn, has a negative economic impact.
Low effectiveness of state policy	Public policy often lacks sufficient clarity and effectiveness in addressing sustainable development and adaptive management	Ineffective policies obstruct the implementation of adaptive strategies and innovations, resulting in slower economic development and worsening environmental conditions. This, in turn, leads to additional costs for resource restoration and further losses to the national economy.
Incoordination between central and local authorities	Lack of effective coordination between different levels of government (central and local authorities) in matters of natural resource management	The lack of coordination between management bodies impedes the implementation of effective decisions and delays the response to changes in ecosystems, resulting in economic losses across various sectors.
Low level of environmental awareness	Many citizens and businesses lack sufficient awareness of the importance of environmental issues and sustainable development	Insufficient environmental awareness among citizens and businesses undermines the effectiveness of environmental practices, encouraging irresponsible use of natural resources. This leads to high restoration costs and diminishes the effectiveness of environmental policies.
Low cooperation between business and science	Lack of effective cooperation between businesses and scientific institutions in the development and implementation of sustainable technologies	The lack of integration between scientific developments and business practices slows innovative progress, reduces the effectiveness of natural resource management technologies, and results in missed economic opportunities.

Table 3. Continued

Challenge	Challenge description	Economic impact of implementing adaptive management
Corruption and poor governance	Problems with corruption and inefficiency in natural resource management	Corruption and inefficient management result in the misallocation of budget funds to untargeted projects and delays in implementing adaptive strategies. This leads to long-term economic consequences, including high resource restoration costs and inefficient use of natural resources.
Resistance of enterprises	Traditional industries (energy, industry, agriculture) often resist the introduction of new, more sustainable practices due to the high costs of modernisation	The resistance of enterprises in traditional industries to innovative approaches reduces the economic efficiency of implementing adaptive natural resource management. This results in greater environmental harm and missed opportunities for economic growth in sustainable development sectors.
Lack of integrated natural resource monitoring systems	Ukraine lacks modern integrated natural resource monitoring systems that would ensure timely and accurate data collection	The absence of such systems complicates natural resource management, leading to errors in planning and decision-making. This negatively impacts economic outcomes and can result in financial losses.
Outdated regulatory framework	The regulatory framework governing natural resource management is outdated and does not meet modern challenges	Outdated regulations hinder the adoption of new technologies and adaptive management, resulting in economic losses due to inefficient resource use and slowing innovation development.
Insufficient funding	Lack of sufficient funding for the implementation of projects in the field of natural resource management	Insufficient funding limits the ability to implement adaptive management and develop new technologies, which in turn reduces economic competitiveness and increases the costs of restoring natural resources.
Environmental consequences of war	The war has inflicted significant damage on ecosystems and natural resources, complicating their recovery	The consequences of war generate additional economic costs for ecosystem and resource restoration, while also causing losses in agriculture and other sectors, negatively impacting the country's overall economic development.

Source: created by the authors

Adaptive natural resource management in Ukraine faces numerous challenges, including insufficient monitoring and data, ineffective use of new technologies, low efficiency in state policies, and an unstable legal framework. Many of these issues stem from a shortage of qualified personnel, a lack of coordination between government agencies, low environmental awareness among citizens and businesses, and the risk of corruption. These factors have a significant economic impact, delaying the implementation of adaptive strategies and leading to substantial economic losses. To achieve sustainable development, it is essential to address these challenges in a comprehensive manner by enhancing the effectiveness of policies, modernising infrastructure, and ensuring adequate personnel training.

Prospects for implementing adaptive management in Ukraine

The prospects for adaptive natural resource management in Ukraine include several key areas that can optimise resource use and support the country's sustainable development. The first step involves developing a natural resource monitoring system using innovative technologies. The integration of GIS, satellite monitoring, and digital models will enable real-time data collection and processing regarding the state of ecosystems. The use of these technologies will facilitate the prompt detection of environmental changes, prediction of trends, and timely responses to emerging risks. Economically, this will result in reduced costs for ecosystem restoration and minimised economic losses caused by the irrational use of resources. Furthermore, the implementation of such technologies will enhance the transparency of management processes and attract additional investments, as international partners prioritise accurate and transparent data when funding environmental initiatives.

The second important area is the adoption of digital technologies, specifically Big Data, the Internet of Things (IoT), and artificial intelligence (AI), for natural resource monitoring. IoT technologies can create integrated systems that gather data from various sources, such as soil moisture sensors, river water levels, or forest temperature. This will lead to more precise data and forecasts, which will improve long-term resource planning. Additionally, the implementation of AI will automate data analysis and decision-making processes, enhancing efficiency. The economic impact of these technologies includes optimised resource use, reduced energy costs, and improved efficiency in agriculture, energy, and other industries.

To ensure the effective implementation of adaptive management, it is crucial to undertake institutional reforms aimed at strengthening control over natural resource use and ensuring their sustainable management. The creation of a unified database on natural resources, the improvement of the regulatory framework, and the integration of adaptive approaches at all levels of government will significantly reduce corruption risks and minimise administrative costs. The economic benefits of such reforms include increased efficiency in natural resource use, the creation of favourable conditions for investment and the development of a "green" economy, as well as more stable long-term economic growth.

An important area of focus is the development of financial mechanisms to support adaptive management,

such as the use of "green" bonds, grants, and concessional loans for financing environmental projects. Attracting international investments and leveraging environmental funds will facilitate the financing of infrastructure projects aimed at implementing sustainable technologies across various sectors, including energy, agriculture, and water management. This will generate additional employment opportunities and stimulate the development of new, innovative technologies within the country.

In conclusion, the successful implementation of adaptive natural resource management in Ukraine requires a focus on integrating new technologies, instituting institutional reforms, and developing financial mechanisms. These efforts will significantly enhance the efficiency of natural resource use, reduce economic risks, and ensure the sustainable development of the country over the long term.

DISCUSSION

The results of the study confirmed that adaptive management of natural resources can significantly enhance the environmental and economic sustainability of a country. For example, the study found that the key issues related to water management and land degradation were consistent with the findings of P. Mperejekumana *et al.* (2024), who highlighted the importance of integrating climate change adaptation into the water-energy-food nexus to ensure sustainable development in the East African Community. Similar to that study, the authors emphasised that without active adaptation to environmental challenges, countries may face significant risks to economic development. Additionally, the results underscored the importance of employing innovative technologies to improve natural resource management. This aligns with the findings of M. Anas *et al.* (2024), who noted that the adoption of "green" financial technologies and innovations could play a key role in conserving natural resources and promoting environmental sustainability. They noted that such approaches are vital for enhancing environmental quality in the context of diminishing natural resources.

However, the study also revealed some differences. For instance, S. Saud *et al.* (2024) emphasised the importance of an integrated approach to natural resource use and economic complexity as a driver for "green" growth in the European Union. In contrast, the study highlighted significant barriers to implementing similar strategies in Ukraine, particularly insufficient infrastructure and an inadequate legislative framework, which hindered the adaptation of these concepts to the local context.

The study results revealed that the primary challenges related to water management and land degradation were consistent with the findings of T. Li *et al.* (2024), who emphasised the need to address multiple stressors to ensure sustainable livelihoods in dryland ecosystems. This highlights the importance of an integrated approach to resource management, which is particularly crucial for Ukraine, where environmental challenges demand comprehensive solutions. Additionally, the study results confirmed the significance of utilising renewable energy sources and fostering innovation in agriculture. These findings coincide with those of G. Aziz *et al.* (2024), who emphasised the critical role of renewable energy and the agricultural sector in promoting sustainable economic growth and a green environment. Both studies stress that without a transition to sustainable energy, countries may struggle to achieve long-term sustainable development.

The findings regarding the negative impact of climate change on agriculture in Ukraine are consistent with the study by H. Jie *et al.* (2023), which examined the relationship between sustainable energy policies, social and economic development, and ecological footprint. The authors noted that insufficient renewable energy policies can exacerbate environmental problems, supporting the results of this study, which highlight the need for reform in the energy sector. Additionally, the study by E. Ali *et al.* (2021) found that implementing a green economy can be an effective pathway to sustainable development in various countries, including Ghana. The findings also suggest that Ukraine needs to adopt elements of a green economy to address its existing environmental challenges. Furthermore, the study by K. Uralovich *et al.* (2023) emphasised that environmental education is a key factor in achieving sustainable development and environmental sustainability. This aligns with this research, which underscored the importance of raising environmental awareness among the population to ensure the successful implementation of adaptive natural resource management.

The study by F. Ahmed *et al.* (2022) also emphasised the role of institutional quality and financial development in ensuring sustainable economic growth. Their research found that insufficient government support and an imperfect legal framework hinder the implementation of adaptive strategies, a finding that aligns with the results of the authors mentioned earlier. Further analysis of the study results suggests that adaptive management of natural resources can support financial development, as highlighted by A. Raihan (2024). The author noted that economic progress, natural resources, and capitalisation are essential for financial development, which confirms the findings of our study that underscore the need to leverage natural resources to improve the country's financial stability. The study by M. Basheer *et al.* (2023) also highlighted the importance of cooperative adaptive management in the face of climatic and social and economic uncertainties. This research concurs with this, stressing that for effective natural resource management, Ukraine must implement mechanisms that consider the specificities of local ecosystems and engage communities in the decision-making process.

In summary, our research confirms the importance of adaptive natural resource management for sustainable economic development in Ukraine. These findings are consistent with international studies but also reveal unique challenges specific to the country. This underscores the need to develop adaptive management strategies that take into account the particularities of the Ukrainian context.

CONCLUSIONS

The study on the impact of adaptive natural resource management on the sustainable economic development of Ukraine identified key problems, barriers, and prospects for implementing this approach in national practice. The analysis revealed that adaptive management is an effective tool for optimising natural resource use, enhancing environmental sustainability, and ensuring long-term economic development. Specifically, it was found that the main barriers to the implementation of adaptive management in Ukraine include the lack of up-to-date data on the state of natural resources, insufficient use of modern monitoring technologies, low environmental awareness among communities and businesses, and an outdated regulatory framework. These factors hinder the implementation of sustainable management strategies, reduce resource efficiency, and increase environmental risks. However, the study also highlighted the potential to overcome these barriers through the adoption of innovative technologies, such as GIS, satellite monitoring, and climate change forecasting models.

The results indicated that the implementation of adaptive management could lead to reduced water and energy costs, improved agricultural productivity, and enhanced competitiveness for the Ukrainian economy. For example, the use of precision agriculture technologies could reduce fertiliser and water costs by 20-30%, while the modernisation of water treatment systems could decrease pollution levels by 15-20%. Developing integrated natural resource monitoring systems using modern technologies would improve the accuracy and timeliness of management decisions. Involving communities and businesses in the implementation of adaptive management, through educational initiatives and financial incentives, will help raise environmental awareness and foster responsibility in resource use. Furthermore, improving the regulatory framework to emphasise adaptive approaches and innovations is essential for creating favourable conditions for sustainable development. Overall, adaptive management facilitates a balance between economic growth and environmental conservation, which is critical in the context of current climate change challenges.

An important area for future research is examining the environmental consequences of war on natural resources and developing adaptive mechanisms for ecosystem restoration after conflicts. To improve outcomes, it is essential to enhance the use of modern technologies, such as GIS and automated management systems, and to promote effective financial instruments that ensure sustainable development.

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CONFLICT OF INTEREST

None.

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Адаптивне управління природними ресурсами як чинник сталого економічного розвитку України: проблеми та перспективи

Людмила Козак
Кандидат економічних наук, професор
Національний транспортний університет
01010, вул. М. Омеляновича-Павленка, 1, м. Київ, Україна
https://orcid.org/0000-0003-3995-172X
Марія Данчук
Кандидат економічних наук, доцент
Національний транспортний університет
01010, вул. М. Омеляновича-Павленка, 1, м. Київ, Україна
https://orcid.org/0009-0007-3033-3227

Анотація. Повномасштабне вторгнення російських військ в Україну 24 лютого 2022 року призвело до суттєвих змін на українському ринку праці, що потребують детального аналізу та розуміння їх подальшої динаміки. Мета цієї роботи – з'ясувати, як вплинули зміни демографічної структури національного ринку праці на макроекономічні показники України. Завдяки таким методам, як статистичний аналіз, порівняння, синтез та прогнозування, було проведене дослідження актуальних демографічних та економічних показників. У результаті дослідження була отримана та проаналізована статистика вимушеного переміщення біженців як усередині України, так і за її кордон з урахуванням віку, статі, освіти та інших демографічних показників – всього було релоковано, мінімум, 12 мільйонів українських громадян, 75 % з яких є працездатними, а більше половини мають високу професійну кваліфікацію. Окремо було вивчено інформацію щодо молоді та студентства, які продовжують або починають навчання за кордоном, та сформовано висновки щодо їх асиміляції у новому суспільстві та вірогідності їх повернення в Україну. У процесі аналізу умов зростання показників безробіття, була порахована кількість підприємств, що припинили свою діяльність через бойові дії чи тимчасову окупацію – як у географічному розрізі, по областях, так і за формою власності підприємств. Виявилось, що на сході України кількість закритих суб'єктів підприємницької діяльності сягає 80 % та, в тому числі, майже третина фізичних осіб-підприємців припинили свою діяльність. Також було спрогнозовано умови повоєнної відбудови України з урахуванням долі біженців, які повернуться, та перспектив вступу країни до Європейського Союзу. Практична значимість цього дослідження полягає в оцінці впливу змін структури ринку праці на економіку України. Результати роботи можуть бути корисні державним структурам, що вже зараз формують стратегію повоєнного відновлення України

Ключові слова: макроекономічні показники України; валовий внутрішній продукт; індекс відновлення ділової активності України; ринок праці; демографія

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Analysis of the structure of export-import activity of Ukraine

Larisa Norik*
PhD in Economics, Associate Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9a Nauky Ave., Kharkiv, Ukraine
V.N. Karazin Kharkiv National University
61022, 4 Svobody Sq., Kharkiv, Ukraine
https://orcid.org/0000-0002-7077-1260

Tetiana Skliar
Postgraduate Student
Simon Kuznets Kharkiv National University of Economics
61166, 9a Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0009-0004-6109-1396

Abstract. Foreign trade is a major factor in a country's economic development since it facilitates the integration of the national economy into the global system by granting access to foreign resources, technologies, and markets. In the context of globalisation, economic processes are constantly changing, requiring continuous monitoring and analysis of international economic relations. For Ukraine, which has undergone considerable economic and political changes in recent years, the study of foreign trade dynamics, particularly the structure of imports and exports, is particularly relevant. The purpose of this study was to comprehensively investigate changes in Ukraine's foreign trade from 2017 to 2024, specifically to identify key trends in trade balance dynamics, structural shifts in exports and imports, and to determine prospective development vectors of export-import activities. To fulfil this purpose, the study analysed trade balance dynamics, examined the dynamics of the commodity structure of Ukraine's foreign trade through the analysis of the shares of product groups in total trade turnover, assessed the geographic structure of imports and exports considering changes in international trade partnerships, and analysed changes in the structure of service exports and imports. The analysis of Ukraine's foreign trade for 2017–2024 revealed key trends and issues. In the trade in goods, a persistent negative balance was observed due to reliance on energy imports and the raw material orientation of exports. In contrast, the services sector showed a positive trade balance, driven by the growth of the IT sector. Changes in the geographical structure of trade highlighted a shift towards European markets and increased reliance on imports from China, affecting the commodity structure of Ukraine's export-import activities, with substantial implications for the country's economic strategy. The findings obtained can be used to shape economic and trade policies aimed at optimising foreign economic relations and reducing risks associated with dependence on specific suppliers and countries

Keywords: foreign trade; geographic diversification; trade balance; export services; energy imports

INTRODUCTIONS

Export and import activities are a key tool for ensuring economic growth and development of countries in the context of globalisation. In the modern world, foreign trade is becoming a mechanism for integrating any country into the international economy, increasing the competitiveness of national production, and adapting to the challenges of global economic and political changes. Ukraine, as a country with a strategic geographical location and extensive resources, plays a significant role in ensuring stability in global commodity markets, specifically for agricultural products, metallurgy, and the chemical industry. L. Malu-arets *et al.* (2024a) examined the specific features of the development of Ukraine's export and import activities in the context of globalisation, specifically identifying factors that affect the structure of foreign trade and developed recommendations for its optimisation. O. Pelekh's (2021) study

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*Corresponding author

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of structural changes in Ukraine's exports and imports of goods in 2002-2018 showed that in early 2002, the basis of merchandise exports comprised such groups of goods as metals and products from them, machinery, equipment and transport, food and agricultural products, while in 2018 Ukrainian exported mainly raw and semi-raw materials. Since 2018, Ukraine has experienced considerable changes in the structure of its export and import operations, driven by both internal reforms and external factors.

Recent research highlights a wide range of issues related to transformations in the structure of Ukraine's foreign trade. The analysis of I. Havrylyuk (2024), based on data for the first half of 2023, showed that exports to the EU fell by 10% due to a drop in exports of a considerable number of product categories due to problems with the transit of agricultural products and import bans on grains and imposed by some EU member states. At the same time, the continued growth of imports combined with a moderate decline in exports led to a deterioration in Ukraine's trade balance, which grew to a negative balance of over USD 11 billion. S. Bondarenko *et al.* (2024) analysed the transformation of logistics chains, the structure and dynamics of Ukraine's agricultural exports in the context of Russian military aggression and assessed the economic and global implications of these changes for the national economy and global food security.

Researchers pay considerable attention to the analysis of structural changes in foreign trade in the context of globalisation processes. T. Ostashko & V. Venger (2023) focused on the vectors of Ukraine's trade policy in the context of multipolar globalisation, which involves the concentration of development and trade centres among both developed and developing economies. I. Jacyna-Gołda *et al.* (2024) examined the state of foreign trade and the trade balance of Ukraine and Poland, identified trends in sustainable development and prospects for trade relations between the two countries, considering the existing commodity structure, and emphasised that Ukraine's post-war recovery will require intensification of logistics flows with the EU.

There are also notable studies that explore the specifics of export-import operations in the services sector and emphasise their positive effects on economic growth and production development (Maluarets *et al.*, 2024b). Specifically, I. Privarnikova (2024) focused on trade in services, the growth of which is a crucial factor influencing various economic indicators of the country.

Despite a sizeable number of studies analysing Ukraine's export and import activities, the need to update such analyses is critical. Previous studies covering the structure of foreign trade mostly focused on periods of economic stability or conventional trade relations, while the current environment caused by global challenges and internal transformations has greatly changed the dynamics of foreign trade. Previous studies often drew conclusions based on statistical data that have lost their relevance today due to rapid changes in trade relations caused by the escalation of the war, the growing role of sanctions and economic support from Ukraine's partners. The impact of the war, the reorientation of trade to European markets, new logistics routes, and growing dependence on imports of strategic resources pose unique challenges that have not yet been fully reflected in scientific research. While some studies have already covered the effects of the hostilities on foreign trade, most of them focused on the immediate effects, such as the destruction of infrastructure, blocked ports, or reduced exports to certain regions. However, Ukraine has switched to new logistics routes, intensified trade with European countries under the Association Agreement with the EU and expanded the geography of exports to other regions of the world. All this creates new trends that could not be fully reflected in previous studies. The war also continues to affect the structure of imports: dependence on critical goods such as fuel, technology, and raw materials is growing, while in previous years these aspects were analysed in less detail, meaning that the current state of Ukraine's export and import activities, which is constantly under the effects of new geopolitical, economic, and logistical realities, requires additional analysis.

Furthermore, many studies are of an overview nature or focus on specific aspects of foreign trade, such as agricultural exports (Tul *et al.*, 2023) or energy security (Labenko *et al.*, 2022; Sytnik & Stopochkin, 2023). In other words, most studies are related to the analysis of general trends in foreign trade or specific aspects. There is no comprehensive analysis of the current structure of Ukraine's export and import activities that would factor in the effects of geopolitical changes, global economic instability, and internal economic transformations. The rapid dynamics of changes in Ukraine's foreign economic environment underlines the need to update existing data and interpretations. The modern realities require a systematic approach that will identify new patterns, assess changes in trade flows, and identify potential growth points. Therefore, even with a considerable number of scientific studies available, the need for a modern study of the structure of Ukraine's export and import activities is evident.

Thus, the purpose of this study was to investigate changes in Ukraine's foreign trade, specifically, to identify the key trends in the dynamics of the trade balance, to identify structural changes in exports and imports, and to determine the prospective vectors of development of export and import activities.

MATERIALS AND METHODS

The study employed a quantitative method that focuses on objective measurements and analysis of statistical data. The study period covered 2017-2024. Since this time can be characterised by various economic, political, and social changes, for a more detailed analysis, the study period was divided into separate periods, namely:

1. 2017-2019 – the beginning of stabilisation after the consequences of Russia's military aggression in 2014, the annexation of Crimea and hostilities in the east of Ukraine, recovery of key economic indicators, improvement of the

foreign economic situation due to the growth of exports, specifically of agricultural and metallurgical products, and the start of structural reforms, active cooperation with international financial organisations (International Monetary Fund, World Bank).

2. 2020-2021 – the COVID-19 pandemic and recovery from the pandemic, initially a drop in economic activity due to quarantine restrictions and lower demand in foreign markets, extensive government spending to support businesses and the population, crisis measures by the government, followed by a gradual economic recovery, growth in foreign trade, recovery in production in some sectors, Ukraine's active integration into international economic processes, and continued reforms in many sectors of the economy;

3. 2022-2024 – the war, economic losses, and adaptation to new reality, destruction of infrastructure, reduced production capacity and considerable losses in foreign trade, support from international partners becomes an essential important factor in adapting Ukraine's economy to new conditions.

This study was based on the available literature on the subject, statistical data from the website of the State Statistics Service of Ukraine and the website of the United Nations Development Programme. At the time of drafting this paper, the available data included complete data up to the third quarter 2024. Different analyses used different ranges of years depending on the content of each concrete study, in some cases the latest available data was only 2023.

The study was conducted in four stages. Each stage was aimed at investigating distinct aspects of export and import activities and comparing data for different years of the study period (2017-2024). The first stage involved analysing the dynamics of Ukraine's trade balance (2017-2024). For this, descriptive and graphical methods were employed to reflect general trends in the balance, as well as to compare the effects of individual factors on the overall balance of foreign trade.

At the second stage, the dynamics of the commodity structure of exports and imports was investigated, using percentage shares to estimate it. This helped to separate structural changes in foreign trade from fluctuations in total trade volumes, as well as to establish how various commodity groups change their specific weight. Importantly, the shares helped to identify trends that may not be visible when analysing absolute values. Descriptive and tabular methods were employed for the analysis.

At the third stage, the study analysed the geographical structure of exports and imports of goods. The analysis of the geographical structure of Ukraine's exports and imports was based on data only for 2022-2024, as the war in Ukraine has dramatically altered the economic situation, the structure of foreign trade, and the geography of partners. Many conventional trade routes and partnerships have either become limited or ceased to exist, while new countries have become key partners. Since 2022, there has been an active reorientation of exports and imports caused by changes in logistics, sanctions, blockades, and international relations. This has affected the geographical structure of Ukraine's foreign trade. Therefore, considering these changes in the foreign economic environment, the 2022-2024 period was chosen to analyse the geographical structure of exports and imports of Ukrainian goods. Both descriptive and graphical methods were employed to visualise changes in the geographical distribution of foreign trade. To assess the dynamics of the geographical structure of exports and imports of goods, the study uses percentage shares. The shares reflect the role that each country plays in the overall structure of exports or imports, regardless of changes in the total volume.

At the fourth stage, the study analysed changes in the structure of exports and imports of services. For this, the same methods were employed as for commodity exports and imports: descriptive, tabular, and graphical methods, which helped to examine changes in the composition of exported and imported services, as well as their relationship with other macroeconomic indicators.

RESULTS

Dynamics of the trade balance of export and import operations

The analysis of the dynamics of Ukraine's trade balance in 2017-2024 helped to assess key trends in the country's foreign economic activity and identify the principal challenges faced by the economy during this period. The trade balance is a significant indicator of economic stability, reflecting the relationship between exports and imports of goods and services. The years covered by the study included periods of economic growth, crisis caused by the COVID-19 pandemic, and the impact of the war and its aftermath on foreign economic processes.

In 2017-2024, there were changes in the volume of merchandise exports caused by fluctuations in Ukraine's position on international markets. At the same time, imports were also influenced by the growing demand for high-tech equipment and energy resources. Figure 1 presents the trends in exports and imports, as well as the size of Ukraine's trade deficit over the specified period.

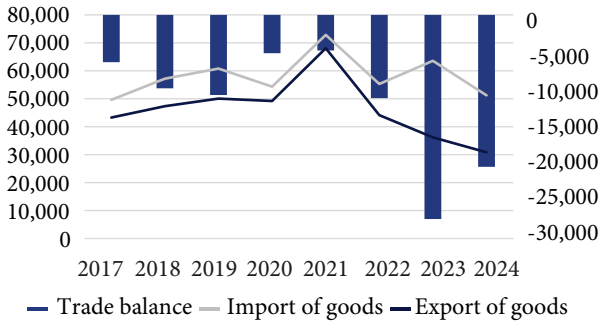

Figure 1. Dynamics of Ukraine's exports, imports and trade balance in 2017-2024, million USD

Notes: data for 2024 are presented as of the end of September 2024 (9 months)

Source: developed by the authors using data from the State Statistics Service of Ukraine (n.d.)

In 2017-2019, the trade tended to gradually increase. This trend was driven by faster growth in imports than exports. Imports exceeded exports in every year of this period, suggesting an increased dependence on foreign goods. The period of 2020-2021 was characterised by a substantial reduction in the trade deficit, accompanied by a simultaneous increase in imports (from about USD 54 billion to USD 73 billion) and exports (from USD 49 billion to USD 68 billion). The start of the recovery from the COVID-19 pandemic contributed to a substantial increase in both foreign trade and demand on international markets. Furthermore, at that time, a considerable portion of trade was reoriented to the internal market. The period of 2022-2024 was the most challenging for Ukraine's economy. In 2022, the war, disruption of logistics chains, and a decline in exports caused by restrictions on access to international markets led to a sharp and substantial increase in the trade balance deficit, which reached a record level of USD 27,384 million in 2023. In the first 9 months of 2024, the deficit growth rate slowed down, suggesting that the economy is gradually adapting to wartime conditions. This deepening of the deficit points to the need for active measures to stimulate exports, replace imports with domestic goods, and support internal production.

The discovery of Ukraine's trade deficit underscores the relevance of analysing the structure of its export and import activities and finding ways to improve the situation. In this context, a comparison with the EU is expedient, as it has a long track record of maintaining a positive balance and demonstrates how economies with a strong level of integration and export diversification can successfully balance imports and exports, thus ensuring stable economic development (Fig. 2).

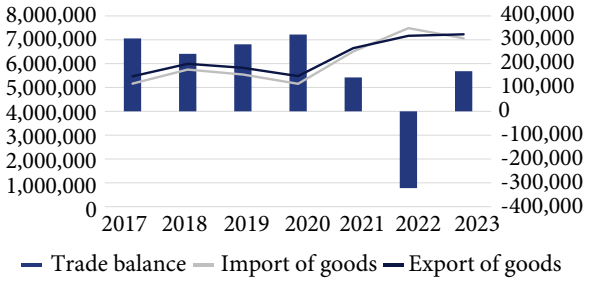

Figure 2. Dynamics of EU exports, imports and trade balance in 2017-2023, million USD

Source: developed by the authors using data from the UN Trade and Development (n.d.)

Figure 2 shows that EU exports were stable 2017-2020, with only minor fluctuations. Therewith, the EU pursued an export and import policy during the study period that allowed exports to be slightly higher than imports, which ensured a positive trade balance. In 2020, exports and imports declined markedly while maintaining a balance, due to the recession caused by the COVID-19 pandemic. A substantial increase in foreign trade began in 2021 as economies began to recover and demand for goods and services increased. Therewith, a substantial increase was observed in imports of goods, which peaked 2022, exceeding exports for the first time, resulting in a negative EU trade balance. This was caused by the outbreak of a full-scale war in Ukraine, which led to a growing deficit and a sharp rise in the price of energy and certain goods. However, the EU managed to turn this situation around in a year and achieve a surplus in 2023 thanks to a decrease in imports and a continued prominent level of exports.

Thus, Ukraine's negative balance reflects its dependence on imports and insufficient export diversification, which limits opportunities for sustainable economic growth. In contrast, the EU's surplus is the result of its integration policy, broad access to international markets, and prominent levels of product competitiveness. These differences underline the need to adapt Ukraine's economic policy to reduce the trade balance deficit. Furthermore, the comparison pointed to the significance of Ukraine's participation in international economic agreements that would help reduce trade barriers and ensure the stability of economic relations. For Ukraine, this could become a key tool for integration into the global economy and improving the efficiency of national resource use.

Changes in the commodity structure of export and import activities

Changes in the commodity structure of exports and imports are a prominent aspect of analysing the dynamics of Ukraine's trade balance. The study helped to identify the categories of goods responsible for the growth or decline in exports and imports in different periods. Such an analysis enabled the identification of key industries that shaped the country's export potential, as well as revealed the economy's dependence on imports of critical goods. Table 1 presents the changes in the share of merchandise exports in total merchandise exports 2017-2024.

Table 1. Dynamics of the commodity structure of exports in 2017-2024 (% of total exports of goods)

Code and name of goods according to UCGFEA	Years							
	2017	2018	2019	2020	2021	2022	2023	2024
I. Live animals; products of animal origin	2.57	2.57	2.56	2.42	1.98	3.34	3.78	3.91
II. Products of plant origin	21.38	20.96	25.91	24.2	22.9	30.54	32.47	32.19
III. Fats and oils of animal or vegetable origin	10.68	9.53	9.49	11.7	10.37	13.48	15.66	13.56
IV. Ready-made food products	6.56	6.4	6.46	6.85	5.58	5.66	9.07	8.7
V. Mineral products	9.16	9.2	9.76	10.86	12.4	9.8	6.69	8.57

Table 1. Continued

Code and name of goods according to UCGFEA	Years							
	2017	2018	2019	2020	2021	2022	2023	2024
VI. Products of chemical and related industries	3.85	3.97	3.87	4.11	4.15	2.92	2.46	2.38
VII. Polymeric materials, plastics, and products from them	1.3	1.47	1.45	1.39	1.63	1.07	0.9	0.87
VIII. Raw hides, tanned leather	0.35	0.35	0.3	0.27	0.24	0.24	0.22	0.26
IX. Timber and wood products	2.8	3.17	2.81	2.87	2.96	4.27	4.14	3.61
X. Mass from timber or other fibrous cellulosic materials	1.2	1.16	0.88	0.82	0.79	0.63	0.64	0.58
XI. Textile materials and textile products	1.76	1.79	1.7	1.58	1.27	1.52	0.98	1.52
XII. Footwear, headwear, umbrellas	0.42	0.44	0.38	0.34	0.28	0.4	0.19	0.37
XIII. Products made of stone, gypsum, cement	0.84	0.85	0.83	0.9	0.84	0.68	0.82	0.8
XIV. Natural or cultured pearls, precious or semiprecious stones	0.24	0.13	0.18	0.23	0.19	0.09	0.04	0.12
XV. Precious metals and products from them	23.49	24.66	20.57	18.39	23.57	13.61	10.85	11.19
XVI. Machinery, equipment, and mechanisms; electrical equipment	9.92	9.87	8.96	9.14	7.75	8.46	7.26	7.51
XVII. Means of land transport, aircraft, floating craft	1.45	1.42	1.77	1.54	1	0.82	0.95	1.01
XVIII. Optical and photographic devices and equipment	0.35	0.32	0.36	0.33	0.25	0.27	0.29	0.23
XIX. Weapons, ammunition; their parts and accessories	0	0	0	0	0	0	0.01	0
XX. Miscellaneous industrial products	1.67	1.75	1.75	2.04	1.84	2.2	2.59	2.58
XXI. Works of art	0	0	0	0	0	0	0	0.04

Notes: data for 2024 are presented as of the end of September 2024 (9 months)
Source: developed by the authors using data from the State Statistics Service of Ukraine (n.d.)

An analysis of the dynamics of the commodity structure of Ukraine's exports helped to identify certain trends and changes in exports in certain years of the study period. In 2017-2019, the commodity structure of Ukraine's exports showed stable growth trends in the exports of agricultural products and metals. Agricultural products accounted for a quarter of all exports in 2019, which can be explained by the high demand for Ukrainian grain on global markets. At the same time, there was a slight decline in the share of goods in the category "Fats and oils of animal or vegetable origin", which was caused by competition in international markets and fluctuations in raw material prices. Although trade in metals showed some fluctuations, it stayed a significant component of exports with a share of over 20%. A slight decline was also observed in the machinery, equipment, and machinery group, suggesting a low level of investment in this sector and a decrease in its competitiveness.

The period of 2020-2021 was characterised by major changes caused by the global COVID-19 pandemic and related economic consequences. Specifically, in 2021, the share of grain exports slightly decreased due to logistical problems and a temporary drop in demand. At the same time, fats and oils demonstrated their stable role in the export structure, showing a slight increase in 2020. Mineral products are particularly noteworthy, with their share gradually increasing over the period, reaching 12.4% in 2021. This is explained by soaring prices for raw materials on the international market. At the same time, a decline in production and lower demand from major importers led to a decrease in the share of base metals.

The 2022-2024 period was marked by considerable changes caused by geopolitical events that substantially influenced Ukraine's export opportunities. During this period, a sharp increase was observed in the share of products, which reached 32.47% in 2023 and almost the same value in 9 months of 2024, which is associated with diversification of markets and stable demand for grain. Exports of fats and oils stayed stable, despite increased competition and restrictions on EU markets. The growth in the share of exports of prepared food products was also a positive trend. The situation was more challenging for exports of metals and metal products, which almost halved since the start of the full-scale invasion. This is caused by a reduction in production capacity due to the hostilities and lower demand for steel products from key partners. At the same time, investments in the restoration of steelmaking facilities in the areas close to war zone stay unaffordable due to the destruction of infrastructure, damage to key steel mills, and a shortage of resources. Logistical challenges and energy constraints also hamper the industry's operations. Despite the challenges, operating steelmakers are gradually refocusing on the internal market and continue to look for new opportunities for development, which has resulted in a slight increase in steel exports in 9 months of 2024. This is explained by the adaptation of Ukrainian producers to the war and the development of new markets.

Thus, the analysis of the dynamics of Ukraine's commodity export structure in 2017-2024 revealed a considerable dependence on external factors, such as changes in demand on international markets, the geopolitical situation, and internal economic conditions. Based on the analysis, several sectors with potential for further development can be identified, as well as areas where government support is needed to ensure sustainable growth. The greatest potential for growth was demonstrated by vegetable products (change in share from 21.38% to 32.47% depending on the year) and ready-made food products, whose share is growing, while the share of conventional sectors such as non-precious metals is gradually declining. To ensure export stability, it is necessary to invest in diversifying markets, supporting industrial production, and increasing the competitiveness of high value-added goods.

While exports reflect external demand for a country's products, imports show what goods and resources are needed to meet internal demand and support national production. The data in Table 2 helped to assess the key trends in imports of goods, which are driven by economic and social factors, as well as geopolitical factors and their consequences for the global and national economies.

Table 2. Dynamics of the commodity structure of imports in 2017-2024 (% of total imports of goods)

Code and name of goods according to UCGFEA	Years							
	2017	2018	2019	2020	2021	2022	2023	2024
I. Live animals; products of animal origin	1.5	1.6	1.8	2.3	2.2	2.2	2.3	2.2
II. Products of plant origin	2.8	2.7	3	3.7	2.9	3.6	3.6	3.4
III. Fats and oils of animal or vegetable origin	0.5	0.5	0.4	0.5	0.6	0.6	0.4	0.4
IV. Ready-made food products	3.9	4.1	4.3	5.5	4.9	5	5.5	5.5
V. Mineral products	25.3	25.1	21.5	16	20.6	24.8	18.1	14.8
VI. Products of chemical and related industries	13.3	12.5	12.4	13.5	13.4	11.7	12.7	12.7
VII. Polymeric materials, plastics, and products from them	6.6	6.3	5.9	6.3	6.6	6.1	6.4	6.2
VIII. Raw hides, tanned leather	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.4
IX. Timber and wood products	0.5	0.5	0.5	0.6	0.6	0.4	0.4	0.4
X. Mass from timber or other fibrous cellulosic materials	1.9	1.9	1.7	2	1.5	1.4	1.4	1.4
XI. Textile materials and textile products	3.5	3.6	3.9	4.2	3.7	4.7	4.1	3.8
XII. Footwear, headwear, umbrellas	0.5	0.6	0.8	0.8	0.8	1.1	0.8	0.8
XIII. Products made of stone, gypsum, cement	1.3	1.4	1.3	1.4	1.3	1.2	1.2	1.2
XIV. Natural or cultured pearls, precious or semiprecious stones	0.1	0.1	0.2	0.3	0.3	0.1	0.2	0.1
XV. Precious metals and products from them	6.1	6.3	6.1	5.8	6	4.9	5.7	6.2
XVI. Machinery, equipment, and mechanisms; electrical equipment	20.1	21.1	22.1	21.3	19.6	17.3	19.2	22.1
XVII. Means of land transport, aircraft, floating craft	8.5	8	10.2	10.6	10.4	10.7	13.4	14.1
XVIII. Optical and photographic devices and equipment	1.6	1.7	1.8	2.4	2.1	2.2	2.5	2.7
XIX. Weapons, ammunition; their parts and accessories	0	0	0	0	0	0	0.1	0.1
XX. Miscellaneous industrial products	1.5	1.5	1.7	2.3	1.9	1.3	1.6	1.6
XXI. Works of art	0	0	0	0	0	0	0	0.1

Notes: data for 2024 are presented as of the end of September 2024 (9 months)
Source: developed by the authors of this study using data from the State Statistics Service of Ukraine (n.d.)

The analysis of Table 2 suggested that in 2017-2019, Ukraine's imports of goods maintained a generally stable trend with minor fluctuations. At the beginning of 2017, mineral products, chemicals, as well as machinery and equipment accounted for a significant share of imports. These groups of goods continued to be the key imports in all three years, reflecting the continuous need for energy and raw materials, and the active development of technological infrastructure in Ukraine, which required imports of modern machinery and equipment for production needs, specifically for the development of heavy industry and machine building. The share of imports grew in the "Vegetable products" category. The increase in demand for these goods was driven by both internal economic changes and external demand for agricultural products. In contrast, the share of mineral products, although staying high, showed a slight decline. This suggests a decline in energy imports and a shift in focus to other groups of goods due to price fluctuations on international markets.

In 2020-2021, there was an adjustment in the share of imports caused by the impact of the COVID-19 pandemic, which led to economic stagnation and lower demand for certain categories of goods. The share of mineral products decreased significantly in 2020, as energy demand declined amid the global economic recession. The "Machinery, equipment, and mechanisms" category saw a decline in its share of imports, as a result of a slowdown in investment in industry and lower demand for new equipment amid

economic uncertainty. Despite crisis, some product groups showed an increase in their share in imports. The share of chemicals and related products continued to grow in 2021, reflecting the stable demand for chemicals needed to supply the medical and pharmaceutical industries in the context of the pandemic. There was also an increase in demand for food products during this period, caused by economic instability and changes in consumer preferences during the pandemic. In 2021, economic activity began to partially recover. Specifically, the share of imports of polymeric materials and products increased significantly. This suggests a stabilisation in demand for materials for industrial production.

The period of 2022-2024 is characterised by considerable changes in the structure of imports to Ukraine, driven by both external and internal factors. One of the key factors affecting imports was the ongoing war, which caused both an economic crisis and the need to rebuild infrastructure and adapt to new economic realities. This led to major changes in demand for certain categories of goods. One of the most notable changes in the import structure was an increase in the share of goods in the category of vehicles and aircraft, machinery and electrical equipment, optical and photographic instruments, and the introduction of the category of "Arms, ammunition; their parts and accessories". This growth was driven by purchases of military equipment and supplies to restore the country's energy and transport infrastructure damaged due to military action. These changes in imports reflect the strategic need to meet military needs and restore critical sectors of the economy, which are the basis for stability and gradual recovery of the national economy.

Thus, imports of goods in 2017-2024 demonstrated a shift in emphasis due to economic challenges. The decline in the share of "Mineral products" and the growth in demand for technical equipment, vehicles, and construction materials indicate strategic priorities in the recovery of the national economy and infrastructure. Specifically, this suggests an adaptation to the new conditions created by the war and the economic crisis. These trends underline the value of strategic investments in modernising transport, production, and energy infrastructure. The shift from energy imports to increased imports of technological goods, vehicles, and energy equipment is a crucial step in ensuring economic stability and post-crisis recovery. Furthermore, the growing demand for energy equipment and the need for means to wage war and restore damaged energy infrastructure pose further challenges that require a comprehensive approach. Considering these changes, Ukraine can create a foundation for sustainable economic development in the medium term.

The analysis of the commodity structure of imports suggests that the priority sectors for investment include production equipment, transport infrastructure, chemicals and agro-processing, as they are of strategic significance for economic stability and recovery, as well as contribute to the development of innovative technologies and reduce dependence on imports in an unstable environment.

Dynamics of the geographical structure of exports and imports of goods in 2022-2024

The geographical structure of Ukraine's foreign trade is a significant element of economic stability and development of the country in the context of global economic changes. The development of new trade routes and partnerships helps to reduce dependence on conventional markets and create conditions for the diversification of economic relations in the future. In 2022-2024, Ukraine's foreign trade activity underwent major changes in the geographical structure of exports and imports of goods, with logistics, trade routes, and the main markets for Ukrainian goods changing significantly. Figure 3 shows a bar chart illustrating the dynamics of the shares of Ukraine's exports to ten key trading partners in 2022-2024.

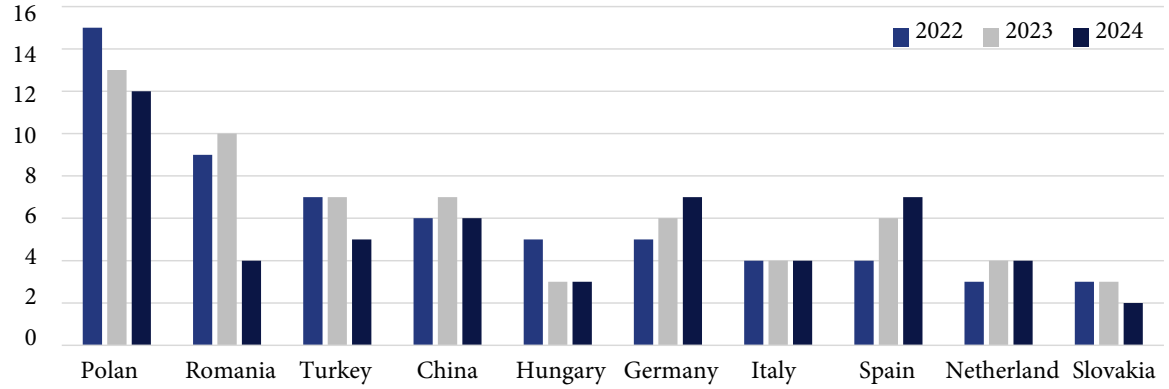

Figure 3. Change in the share of Ukraine's exports to the 10 largest importing countries in 2022-2024, % of total exports
Notes: data for 2024 are presented as of the end of September 2024 (9 months)
Source: developed by the authors using data from the State Statistics Service of Ukraine (n.d.)

In 2022, despite the military hostilities, Ukraine managed to maintain some of its export positions, although the structure of foreign trade was markedly shifted in favour of new markets. Ukraine adapted its customs policy and changed its priorities in foreign trade, specifically to accommodate new trade agreements such as the

Association Agreement with the EU, changes in export and import restrictions, and new customs procedures that became important after 2022. The blockade of the Black Sea and the problem of transporting goods through conventional ports forced Ukraine to adapt new export routes, for instance, through the western borders and European countries.

The principal destinations of Ukrainian exports were still the EU countries, but with an increasing share of Central and Eastern European countries, specifically Poland, Romania, and other neighbours, which have become major transit points for Ukrainian products. Ukraine's agricultural exports, particularly grain, stayed the primary commodity on these markets. In 2023, there was a sharp shift in focus to new markets, as conventional supply channels, specifically to Russia, became impossible due to economic sanctions and military action. As a result, the EU strengthened its position as the main importer of Ukrainian goods. At the same time, Ukraine began to focus more actively on the markets of the Middle East, Asia, and North Africa, particularly Turkey and the Gulf countries, which accounted for a considerable portion of its exports. China also showed an increase in demand for Ukrainian products, which created new opportunities for Ukrainian exporters. In the first 9 months of 2024, Ukraine's exports continued to focus on the EU, specifically on new markets in Italy and Spain, as well as on Asia and Africa.

Thus, the analysis of the geographical structure of Ukraine's exports in 2022-2024 revealed a substantial reorientation of trade flows conditioned by the impact of military operations and geopolitical changes. The primary destination of Ukraine's exports was the EU, which accounted for more than 60% of total supplies, indicating Ukraine's integration into the European market. An increase in the share of exports to countries such as Spain, the Netherlands, and Germany indicates that regional cooperation is strengthening in the context of restructuring logistics chains. This analysis provides information to inform the development of effective foreign economic policy strategies, orienting the country towards new markets, export diversification, and reducing dependence on individual trading partners.

Imports of goods to Ukraine in 2022-2024 also went through a series of substantial changes. In 2022, a considerable decline in imports was observed, driven by disruptions in logistics chains and a drop in internal demand caused by a decline in economic activity and consumer opportunities. However, over time, new supplies of goods were established, specifically from Poland, Romania, Germany, and other EU countries, as well as from Turkey and China. Figure 4 shows a bar chart illustrating the dynamics of the shares of imports to Ukraine ten key trading partners in 2022-2024.

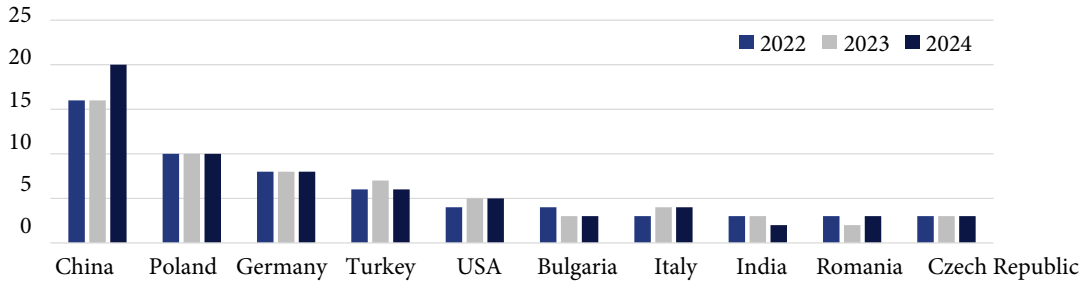

Figure 4. Change in the share of imports to Ukraine from 10 exporting countries in 2022-2024, % of total imports
Notes: data for 2024 are presented as of the end of September 2024 (9 months)
Source: developed by the authors using data from the State Statistics Service of Ukraine (n.d.)

Changes in the shares of Ukraine's key importing countries reflect both general trends in the country's foreign trade and specific fluctuations in trade relations with individual countries. An analysis of the data in Figure 4 shows different levels of stability and dynamics in cooperation with the principal import suppliers, indicating significant economic and geopolitical factors that influence Ukraine's foreign trade. China, Poland, and Germany are the leading suppliers of goods to Ukraine. The most striking is the growth of China's share among suppliers of goods. The country's share increased from 16% in 2022 to 20% in 9 months of 2024, suggesting a steady increase in the significance of China as a trading partner of Ukraine. This dynamic also reflects global trends, where China is one of the principal suppliers of products for many countries, including Ukraine. The share of imports from Poland stayed stable at 10% throughout the period, reflecting the significance of this country for the Ukrainian economy. Poland is one of Ukraine's closest trading partners due to its geographical proximity and well-established economic relations, and it has the most even trade turnover with Ukraine, which suggests mutual integration of the economies. Trade with Germany also remained stable, with the share of imports from this country staying at 8%. The share of imports from the Czech Republic also stayed unchanged at 3%, suggesting stability in the volume of goods supplied. Slight fluctuations occurred in the shares of imports from Turkey, the United States, Bulgaria, and other countries. These changes demonstrate the value of continuous monitoring and analysis of foreign trade relations to ensure effective economic policy and optimisation of Ukraine's trade flows in the international arena.

Analysing the dynamics of the geographical structure of imports to Ukraine is a valuable tool for assessing

changes in foreign trade and identifying major trends in mutual economic relations. It helps to identify key trading partners, assess the stability, and diversification of sources of supply of goods, and identify potential risks associated with dependence on certain countries or regions. Such analysis can help forecast changes in trade flows and adjust trade policy. Furthermore, it informs the development of a strategy for diversifying economic relations and reducing the country's vulnerability to external economic or political factors, which is vital to ensure national economic security.

Dynamics of the structure of exports and imports of services

Ukraine's foreign trade in services is characterised by fluctuations caused by economic and political factors, including changes in international relations, crises, and challenges to the internal economy (Fig. 5). In 2017-2019, exports and imports of services showed steady growth (the increase in exports of services in 2019 compared to 2017 was 45%, and imports were 24%). The balance reached a record level in 2019, suggesting the continued dominance of exports over imports during this period.

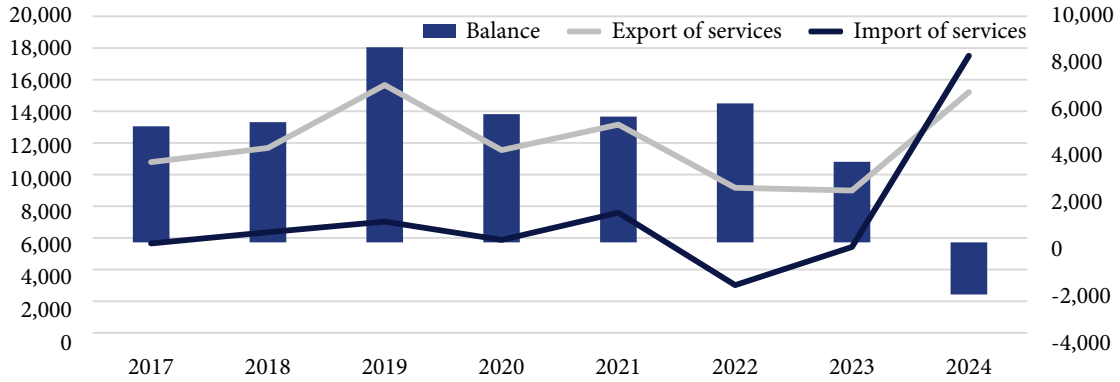

Figure 5. Dynamics of Ukraine's exports and imports of services in 2017-2024, USD million

Notes: data for 2024 are presented as of the end of March 2024 (Q1)

Source: developed by the authors using data from the State Statistics Service of Ukraine (n.d.), UN Trade and Development (n.d.b)

The key driving forces behind this growth were the expansion of international cooperation in the services sector due to integration into European and global markets, the growing competitiveness of Ukrainian services, the overall improvement in the economic environment, which contributed to an increase in both demand for Ukrainian services and the availability of imported services. In 2017-2020, the main categories of exports included transport (over 50% of total) due to an increase in air traffic, material processing services (over 10%), and telecommunications (over 15%), which ensured Ukraine's leading positions in the EU and US markets (Table 3).

Table 3. Dynamics of the structure of service exports in 2017-2023 (% of total service exports)

Name of the service according to the CFES	Years						
	2017	2018	2019	2020	2021	2022	2023
Services for the processing of material resources	13.2	14.5	10.5	11.7	11.6	10.1	8.9
Repair and maintenance services not elsewhere classified	2.3	2.1	1.7	2	2.3	1.4	1.3
Transport services	54.3	50.1	58.2	43.2	40.4	32.3	35.4
Travel-related services	2.2	2.6	2.1	2.3	2.6	1.6	1.3
Construction services	0.9	1.3	0.8	0.7	0.4	0.3	0.6
Insurance services	0.4	0.4	0.5	0.5	0.9	0.2	0.4
Services related to financial activities	1.4	1.3	1.1	1.1	0.7	1.8	2.8
Royalties and other services related to the use of intellectual property	0.3	0.4	0.4	0.8	0.5	0.3	0.3
Telecommunications, computer, and information services	16.3	18.1	16.4	26.4	29.3	40.5	37.6
Business services	8.5	9.1	8.2	10.9	10.9	11.2	11.2
Services to individuals, cultural and recreational services	0.1	0.2	0.1	0.3	0.4	0.2	0.3
Public and government services	0	0	0	0.1	0.1	0	0

Source: developed by the authors using data from the State Statistics Service of Ukraine (n.d.)

The growth in imports of services in 2017-2019 was driven by increased demand for services in transport (over 20%), logistics and tourism services (about 15%), as Ukraine attracted more international companies and tourism. In addition, this period also saw an expansion of cooperation in financial and information and communication services, which became a prominent factor in supporting economic growth. A detailed analysis of the key trends in imports of services is provided in Table 4, which allows assessing structural changes in this sector.

Table 4. Dynamics of the structure of imports of services in 2017-2023 (% of total imports of services)

Name of the service according to the CFES	Years						
	2017	2018	2019	2020	2021	2022	2023
Services for the processing of material resources	0	0	0	0.1	0.1	0.1	0.2
Repair and maintenance services not elsewhere classified	1.3	1.3	1.2	1	1	1.6	1.2
Transport services	21.5	23	22.2	18.1	22.8	34.5	18.4
Travel-related services	14.1	15.6	18.5	12	20.8	6.2	5.3
Construction services	1.9	0.9	0.6	0.7	0.7	0.6	0.4
Insurance services	2.3	1.2	1.3	2.2	1.7	2.3	2.1
Services related to financial activities	10.6	8.3	8.3	10.8	6.7	12.2	9.9
Royalties and other services related to the use of intellectual property	7.2	7.8	8	9.2	8	9.7	6.4
Telecommunications, computer, and information services	7.5	7.4	7.6	9.6	8.7	13.7	9.8
Business services	14.7	21.8	19.3	16.9	14.7	17.8	11.3
Services to individuals, cultural and recreational services	0.4	0.2	0.2	0.2	0.3	0.6	0.2
Public and government services	18.7	12.4	13	19.4	14.5	0.7	34.9

Source: developed by the authors

In 2017-2019, the need for specialised services in sectors such as finance (about 10%), legal services, and consulting emerged, which became a vital component of business development in Ukraine. The lack of internal capabilities for some high-tech services, such as IT consulting, software development, and other services, also required the import of foreign expertise and technology. With the outbreak of the COVID-19 pandemic in 2020, the situation on global markets changed, leading to negative consequences: border closures, reduced international traffic, and the suspension of activities in certain sectors of the economy became considerable challenges for Ukraine's foreign trade in services. In 2020, the COVID-19 pandemic led to a 26% drop in exports and a 16% drop in imports. In 2021, due to the resumption of international contracts, exports partially stabilised (up 14% compared to 2020), and imports increased by 29%. In the structure of services exports, a decline in demand for transport services was observed, which was the result of restrictions on international transport and border closures. At the same time, there was an increase in demand for information and remote work services, as many companies switched to remote work. The intensive development of digital technologies and outsourcing of services enabled Ukrainian companies to continue cooperation with international partners even in challenging conditions. In 2020-2021, as a result of restrictions on international travel and changes in the global economy, imports of some services decreased markedly, but at the same time, the need for other services, such as IT services and consultancy, increased.

In 2022, Ukraine's economy faced significant challenges, but amid these challenges, new opportunities for the development of certain service export sectors emerged. In 2022, exports decreased by 30% and imports by 60%. At the same time, the IT sector continued to develop and became the primary driver of service exports, particularly in outsourcing and development. The integration of Ukrainian companies into the markets of Europe and the United States deepened, specifically through the provision of cybersecurity, digital technologies, software, and e-commerce services. The hostilities, the destruction of infrastructure, and the decline in demand for conventional services also changed the structure of imports. However, some sectors, such as financial services, IT consulting, and legal services, continued to grow due to the need to adapt to the new economic environment. In 2023, exports stayed stable, while imports recovered by 80%. In Q1 2024, a record growth in imports of services was recorded, driven by the attraction of international technical aid and increased demand for infrastructure, financial, and engineering services. Exports of services also increased due to the intensification of IT services and consulting projects.

Thus, the dynamics of the structure of Ukraine's exports and imports of services in 2017-2024 is complex and interconnected with global and internal economic factors. Despite numerous difficulties, the Ukrainian economy continues to actively integrate into international services markets, specifically due to the development of high-tech sectors. Considering the global economic trends and the

need for digitalisation, further development of this sector of the Ukrainian economy can be expected.

DISCUSSION

The analysis of the structure of Ukraine's export-import activity has led to conclusions that are consistent with the findings of a series of scientific studies, but at the same time complement and develop them in the context of a new economic reality that arose as a result of hostilities and changes in the country's foreign economic policy. Specifically, the studies of O. Pelekh (2021) and N. Trusova *et al.* (2021), which analysed Ukraine's foreign trade up to 2022, often focused on stable trade relations and the dominance of conventional markets. However, after the outbreak of the war and the imposition of international sanctions, these markets became less relevant, and Ukraine was forced to quickly reorient its foreign trade activities to new regions, including the EU and other countries, as evidenced by the data presented for 2022-2024.

The analysis of the structure of exports and imports confirmed the consistency with the findings of O. Don & N. Yariz (2024), who found an increase in the share of agricultural products and food in Ukraine's exports 2019 and 2023. This growth partially offset the decline in other sectors and reflects the ability of Ukraine's foreign trade to adapt to new challenges. Specifically, the findings of S. Ishchuk & L. Sozanskyy (2024) also confirmed the key findings on Ukraine's adaptation to challenging economic conditions. It was noted that, despite a decline in exports in 19 of 20 product groups 2022, the structure of exports stayed relatively stable, with the largest shares being accounted for by vegetable products, fats and oils, and ferrous metals.

The presented analysis of the structure of international trade is consistent with the arguments put forward by A. Mishrif & A. Khan (2024), who emphasised the value of free trade agreements for attracting foreign direct investment. According to the researchers, such agreements not only remove barriers to trade but also create favourable conditions for business. The data of the present study not only confirmed the existing theoretical approaches but also provided new empirical data that offer a deeper understanding of the mechanism of influence of free trade agreements on the development of foreign economic activity and attraction of foreign direct investment.

According to A. Janáková Sujová *et al.* (2023), net export growth positively influences the sector's economy, but only when the increase in imports is smaller than the increase in exports. The analysis of the dynamics of the trade balance between Ukraine and the EU confirmed this conclusion, but it is vital to emphasise the significance of favourable conditions for diversifying export markets, which will help reduce dependence on imports and ease the economic situation in the sector. For Ukraine, this means the value of supporting exports through more favourable tariffs, subsidies for transport costs, and incentives for small and medium-sized businesses to enter international markets.

The study by D. D'Ingiullo *et al.* (2024), which emphasised the role of related activities and institutions that support complex and innovative activities, also correlated with the findings of the present study, as an analysis of Ukraine's foreign trade structure in recent years showed that the country was forced to look for new opportunities to export complex goods and services through the expansion of economic relations with other countries. This contributed to the development of innovation, which would not have been possible without strengthening institutional support and developing new forms of economic interaction.

The present study also developed the ideas of Z. Zhang (2024), who discussed the changes in the structure of international trade caused by the development of globalisation and the weakening of the monopolistic policies of major powers, which is directly relevant to the situation in Ukraine in the 2022-2024, when the country was forced to reorient its foreign trade due to changes in the global economy and against the backdrop of war. Entering new markets, particularly through diversification of exports and production, can stimulate the development of economic sectors, which is in line with the approaches presented by K. Leshchenko & S. Leshchenko (2023), who investigated Ukraine's priority areas of development in the post-war period, specifically by ensuring sustainable economic growth, modernising infrastructure, and developing trade relations with the EU.

Notably, the findings of the presented study complement those of L. Ambroziak *et al.* (2024), who analysed the competitive position of Polish and Ukrainian producers in the EU market, particularly in the context of the war in Ukraine and its influence on world markets of agricultural goods. An analysis of the geographical diversification of Ukraine's exports after 2022 in the context of shifting trade flows and market reorientation towards the EU further supported the conclusions on the changing competitive situation.

The conducted analysis of the structure of exports and imports of services in Ukraine is a development of the approaches of A. Yeerken & F. Deng (2023), who determined the impact of trade in digital services on the share of labour income. An analysis of the structure of Ukrainian services exports revealed that the export of digital services has become a major factor in the existence of many Ukrainian companies, especially in times of war. The ideas expressed by H. Luo & X. Qu (2023) regarding the need to formulate a more targeted foreign trade policy were also developed in the present study. The findings obtained pointed to the significance of developing a foreign trade strategy that focuses on market diversification, intensifying exports of digital services and high-tech products, which can positively influence the overall level of economic development of Ukraine.

J. Liang & C. Qiao (2024) noted that digital trade helps accelerate the modernisation of the industrial structure. The present study supported this conclusion by pointing out that the development of digital technologies in trade can stimulate the introduction of more environmentally friendly and resource-saving technologies in enterprises.

Admittedly, in Ukraine, where a considerable number of industrial enterprises still use outdated technologies, the development of digital trade and the integration of modern Internet platforms can become the basis for the transition to green innovations in production, specifically in such sectors as energy, machine building, and agriculture.

CONCLUSIONS

The analysis of the structure of Ukraine's export and import activities in 2017-2024 revealed key trends and issues that affect the country's export and import potential. The study included an assessment of the balance of foreign trade in goods and services, an analysis of the dynamics of the international trade structure and changes in the geographical structure of exports and imports. During the period under study, foreign trade in goods was consistently negative, which was determined by a series of factors. Ukraine stays dependent on imports of energy resources, machinery, and equipment, which substantially affects the trade balance. At the same time, the structure of exports was not sufficiently diversified, with a sizeable share of commodities such as grain, ferrous metals, and agricultural products. Still, in 2023-2024, a partial recovery in exports was observed, driven by growing demand for Ukrainian agricultural products.

The situation in trade in services was more favourable. In 2017-2023, Ukraine demonstrated a stable positive balance, driven by the active development of the IT services and transport industry. The decline in imports of services during the pandemic and the hostilities also helped to maintain the positive balance. However, at the beginning of 2024, a negative balance was recorded in the services sector due to an increase in imports, specifically of technical and advisory services needed to rebuild the economy. The dynamics of the structure of international trade in goods and services revealed a low level of export diversification. Commodity exports were dominated by raw materials, while imports were mainly focused on energy and industrial goods. The services sector saw a growing role for the IT sector, which became one of the key factors behind the surplus. An analysis of the geographical structure of trade showed considerable changes in Ukraine's priorities. The role of the EU countries as the primary trading partner grew, especially in the period after 2022, when trade with Russia was almost completely cut off. The increase in trade with Poland, Germany, the Netherlands, and other European countries demonstrates Ukraine's active integration into European markets. At the same time, dependence on imports from China increased due to the need for industrial goods and machinery.

Overall, the analysis revealed that Ukraine's foreign trade is still vulnerable to external and internal crises. However, there are significant opportunities to improve the situation, specifically through diversification of the export structure, development of high-tech industries, and expansion of the geographical base of partners. These steps will strengthen Ukraine's economic potential and ensure sustainable economic growth in the future.

Further research could be aimed at an in-depth study of the impact of structural changes in foreign trade on economic stability and the development of industries that make the largest contribution to the trade balance. Relevant areas include analysing the long-term effects of diversifying merchandise exports, reducing dependence on imports of strategic resources, and developing recommendations for optimising the geographical structure of foreign trade. Particular attention should be paid to assessing the economic effect of integration into the European market and the possibilities of expanding exports of services, considering the rapid growth of Ukraine's IT sector.

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CONFLICT OF INTEREST

None.

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Аналіз структури експортно-імпортної діяльності України

Лариса Норік
Кандидат економічних наук, доцент
Харківський національний економічний університет імені Семена Кузнеця
61166, пр-т Науки, 9а, м. Харків, Україна
Харківський національний університет імені В.Н. Каразіна
61022, майдан Свободи, 4, м. Харків, Україна
https://orcid.org/0000-0002-7077-1260
Тетяна Скляр
Аспірант
Харківський національний економічний університет імені Семена Кузнеця
61166, пр-т Науки, 9а, м. Харків, Україна
https://orcid.org/0009-0004-6109-1396

Анотація. Зовнішня торгівля є важливим фактором економічного розвитку країни, оскільки вона забезпечує інтеграцію національної економіки у світову систему, сприяє доступу до іноземних ресурсів, технологій і ринків збуту. В умовах глобалізації економічні процеси постійно змінюються, що потребує постійного моніторингу та аналізу зовнішньоекономічних відносин. Для України, яка в останні роки зазнає значних економічних і політичних змін, важливість дослідження динаміки зовнішньої торгівлі, зокрема структури імпорту та експорту, є особливо актуальною. Метою статті було комплексне дослідження змін у зовнішній торгівлі України протягом 2017-2024 років, зокрема визначення основних тенденцій у динаміці торгового балансу, ідентифікація структурних змін експорту та імпорту, а також визначення перспективних напрямів розвитку експортно-імпортної діяльності. Для досягнення поставленої мети в дослідженні виконано аналіз динаміки сальдо торгового балансу, вивчено динаміку товарної структури зовнішньої торгівлі України через аналіз часток товарних груп у загальному товарообігу, виконаний аналіз географічної структури імпорту та експорту з урахуванням змін у міжнародному торговельному партнерстві та аналіз змін у структурі експорту та імпорту послуг. Аналіз зовнішньої торгівлі України за 2017-2024 роки показав ключові тенденції та проблеми. У торгівлі товарами спостерігалося стійке від'ємне сальдо через залежність від імпорту енергоносіїв та сировинну орієнтацію експорту. У сфері послуг, навпаки, переважало позитивне сальдо завдяки зростанню IT-сектору. Зміна географічної структури торгівлі підтвердила переорієнтацію на європейські ринки та зростання залежності від імпорту з Китаю, а також істотно вплинула на товарну структуру експортно-імпортної діяльності України, що мало важливі наслідки для економічної стратегії держави. Отримані результати можуть бути використані для формування економічної та торгової політики, спрямованої на оптимізацію зовнішньоекономічних відносин, а також зменшення ризиків залежності від окремих постачальників та країн

Ключові слова: зовнішня торгівля; географічна диверсифікація; торговий баланс; експортні послуги; імпорт енергоносіїв

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Managing the loan portfolio of banks in the context of military conflicts: Comparison of world experience and the experience of Ukraine

Denys Osipenko*
Researcher
University of Edinburgh Business School
EH8 9JS, 29 Buccleuch Sq., Edinburgh, Great Britain
https://orcid.org/0000-0002-5984-1168

Abstract. The study examined optimal strategies for managing banks' loan portfolios during military conflicts, with an emphasis on comparing global practices with the Ukrainian experience. The paper analysed the specific risks faced by the banking sector during periods of war, particularly a substantial increase in the share of non-performing loans (NPLs), and evaluated approaches to their minimisation and management. The methodology was based on a comparative analysis of data from the Ukrainian banking system for 2013-2024 and the experiences of countries that have faced military conflicts, such as Syria, Iraq, Yugoslavia, and Yemen. Statistical data on the dynamics of NPLs, lending activities, and the impact of war on borrowers' solvency were considered, and measures implemented by banks to reduce credit risks and ensure resilience have been analysed. The results of the study show that during the war in Ukraine, the share of NPLs reached 40%, substantially threatening the financial stability of the banking system. The comparative analysis confirms the importance of debt restructuring, tightening credit policies, effective risk management, and attracting international support to maintain banks' liquidity during the crisis period. Moreover, Ukrainian banks have demonstrated their ability to adapt by implementing modern technologies for assessing creditworthiness, risk forecasting, and managing liquidity. The findings highlight the importance of government intervention in ensuring financial stability and using innovative solutions to effectively manage credit risks. Further research is recommended to focus on analysing the role of technological solutions and international support, and regulatory measures in restoring Ukraine's financial system after the conflict ends

Keywords: capital; financial stability; risk assessment; economic consequences; bank loans

INTRODUCTIONS

In the context of substantial economic and financial risks associated with crisis phenomena, the management of banks' loan portfolios becomes particularly important. Since the outbreak of hostilities in Ukraine in 2014, and especially in connection with the escalation to a full-scale war in 2022, the banking sector of Ukraine has experienced substantial shocks, which has led to an increase in systemic risks. One of the key problems was the rapid increase in the share of non-performing loans (NPLs), a decrease in the solvency of borrowers, and an increase in credit risk. These factors require banks to strengthen measures to ensure financial stability, including improving credit risk management systems, revising approaches to assessing creditworthiness, and creating reserves. In addition, banks face difficulties in maintaining liquidity and exchange rate stability due to limited access to international financial markets and capital, which exacerbates financial instability in the sector.

Global experience in managing loan portfolios during military conflicts is an important source for analysing and improving the Ukrainian banking system. In many countries that have experienced military crises, such as Iraq, Syria, or Afghanistan, governments and central banks have taken a number of measures to minimise risks and stabilise the financial sector. In particular, programmes to restructure loans, introduce state guarantees to support banking institutions, and stimulate the economy through the banking sector were successful. However, each region has its own unique circumstances, so it is important to develop

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*Corresponding author

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an individual approach, considering the realities and specific features of the Ukrainian economy.

The impact of conflict and political instability on the banking sector in developing countries was investigated by A. Compaoré *et al.* (2020). The authors analysed indicators of banks' liquidity, access to capital, lending, and asset quality, developing econometric models to assess changes in banking systems during and after conflicts. As a result of their analysis, it was determined that conflicts substantially increase the likelihood of banking crises, negatively affecting financial stability, reducing confidence in banks, and slowing economic recovery. However, this study did not take into account regional and national factors that could have substantially affected the nature of the conflict and the structure of the financial system in individual countries.

The problem of assessing the quality of banks' loan portfolio remains relevant. N. Volkova & T. Shpuniarska (2023) analysed the portfolio structure of Oschadbank Joint Stock Company (JSC) and suggested ways to improve it. The researchers noted a decrease in NPL due to careful verification of borrowers, but the impact of external economic factors during the war remains poorly understood. During the war, the banking sector of Ukraine faced the problem of stability. R. Kirchner *et al.* (2022) examined the main challenges, in particular, the loss of assets in the occupied territories, reduced lending and reduced bank liquidity. They note that the National Bank of Ukraine's anti-crisis measures have strengthened confidence in the hryvnia and prevented the outflow of deposits. However, challenges such as moving to a floating course and managing NPL remain. Although researchers have provided recommendations for a swift response to these challenges, a deeper analysis of strategic long-term measures for the recovery of the banking system after the war is required.

In turn, S. Arzhevitin *et al.* (2023) noted that despite the losses, the Ukrainian banking sector continues to operate, although lending has slowed down due to high risks. The support of the National Bank and state programmes contributed to stability, but the issues of reducing currency and credit risks require further study. Economic uncertainty and geopolitical risks have a negative impact on the growth of bank lending, particularly consumer and mortgage lending. E. Demir & G. Ozturk Danisman (2021) showed that economic uncertainty substantially reduces the growth of the corporate loan portfolio. The impact of these factors on the capitalisation and stability of banks, as well as the behaviour of banks in different countries, requires further analysis.

The problem of bank lending in conditions of uncertainty is urgent since the growth of NPL creates substantial risks for the financial stability of banks. M.O. Vdovychenko (2024) considered ways to improve the credit performance of banks, in particular, by optimising the structure of the loan portfolio and managing credit risks. An important aspect is the use of world experience to solve NPL problems. However, there is still a need to adapt foreign practices to the Ukrainian market, especially in the field of asset securitisation. I. Shalyhina (2024) noted the growth of credit risks and the deterioration of the quality of loan portfolios in Ukraine during the war and focused on methods of minimising banking risks and managing NPLs. However, the issues of adapting international practices and creating new tools for managing risks in war conditions remain the subject of further research.

I. Dotsenko (2024) explored the dynamics of NPL in the banking sector of Ukraine and suggested areas for improving credit risk management, including risk management policies, strengthening control over lending operations for risky regions, and developing a risk monitoring system. However, the subject of new challenges associated with the impact of a full-scale war requires further review. The analysis of the work of scientists showed that insufficient research had been conducted on methods of securitisation of distressed assets and their use to reduce bank losses. This issue requires careful analysis and further research to use the best methods of managing loan portfolios during the war.

An important aspect during a military conflict is also the development of adaptive strategies and analysis of business challenges. A study by D. Varakin *et al.* (2024) provides important insights for managing credit risk in wartime environments. The authors highlight the substantial socio-economic and operational disruptions that Ukrainian businesses face, including the destruction of logistics chains, infrastructure, and financial instability. The need for adaptive risk management strategies that include asset diversification, implementing backup plans, and strengthening cybersecurity to ensure business continuity is highlighted. In addition, the paper stresses the importance of regulatory support, such as tax breaks and labour law adjustments, which are crucial for mitigating economic losses. These results demonstrated the crucial role of resilience and flexibility in overcoming the uncertainties of military conflicts and their impact on credit risk modelling in war-affected economies.

The purpose of this study was to analyse approaches to effective management of credit risks of banking institutions in an unstable environment caused by military conflicts, with the definition of the most effective mechanisms for reducing the negative impact of such factors on the financial system. It was necessary to investigate how the war in Ukraine contributes to the growth of the share of NPL and what factors influence this process, compare credit risk management practices in Ukraine with the experience of other countries that have experienced military conflicts, and identify effective strategies for implementation in the Ukrainian context to achieve this goal.

MATERIALS AND METHODS

The examination of bank loan portfolio management in the context of military conflicts was conducted in Ukraine in the period from 2013 to 2024, covering a critical stage for the country. Attention was also paid to countries affected by military conflicts, such as Iraq, Syria, Yugoslavia, and Yemen. These countries were selected because of their experience in implementing various credit management

strategies in the face of instability, which allows for a comparative analysis and examination of which of the methods were most effective in such critical situations.

In the first stage, the National Bank of Ukraine (2024a) data for the period from 2013 to 2024 was analysed to identify changes in the banks' loan portfolio and the level of NPL. This analysis included studying statistical indicators such as total lending, the share of NPLs in the loan portfolio, and the dynamics of changes in interest rates. The collected data helped to assess the impact of the military conflict on the banking system and identify the main trends in lending. They also revealed exactly how the situation at the front and economic realities affected banks' decisions on issuing new loans and their risk management strategies.

The second stage included a detailed investigation of the basic principles of monetary policy of the National Bank of Ukraine (2022a). In particular, the inflation reports for 2015 and 2024 were analysed, which revealed how changes in the policy of the National Bank of Ukraine (2015; 2024b) affected the banking sector during the war. This stage also covered the study of decisions taken by the National Bank of Ukraine in response to the economic challenges associated with the conflict. Decisions on changing the discount rate, measures to support banks' liquidity and other regulatory initiatives were analysed (Minfin, 2024a). This allowed for a better understanding of how monetary policy has affected the availability of credit for businesses and individuals.

The third stage included an analysis of international experience in managing the loan portfolio in countries that have survived military conflicts. Methods used in Iraq, Syria, Yugoslavia, and Yemen to identify the most effective credit management practices in wartime were considered. This phase included an analysis of available research, reports from international organisations, and publications describing various approaches to credit risk management (Hinrichsen, 2019; Alyousef, 2022). Using the comparative method, common features and differences in credit risk management strategies and the most successful measures in conditions of instability were identified.

During the final stage, a comparative table was formed summarising the experience of managing the loan portfolio in Ukraine and other countries that have experienced military conflicts. The table contains the main aspects of credit management, such as the structure of debt obligations, risk management policies, debt restructuring, interaction with international organisations, the use of new technologies, and restoring confidence in banks. This table has become an important tool for analysing and comparing strategies used in Ukraine and international practice, which allowed drawing conclusions about possible ways to improve the management of the loan portfolio in war conditions.

RESULTS AND DISCUSSION

The impact of the war on the structure of bank loan portfolios and the growth of NPLs in Ukraine

The Russian aggression, which has been ongoing since 2014, has had a substantial negative impact on the banking system of Ukraine. This prolonged conflict has disrupted social stability and continues to deteriorate the state of the country's economy, particularly in the financial sector. The increase in the number of NPLs is one of the most substantial consequences of the war. Many borrowers, both individuals and legal entities, faced financial difficulties due to the fighting and economic instability, which made it difficult for them to meet their obligations to banks. As a result, the rapid growth of NPLs negatively affected the liquidity of banks and their loan portfolios.

According to the National Bank of Ukraine, the level of lending decreased, and NPL indicators reached record values in 2024. Banks are experiencing a decline in lending due to concerns about financial stability, which forces them to introduce stricter credit conditions and raise interest rates, which in turn restricts access to financing for individuals and businesses. In addition, the change in economic conditions due to the war has led to instability in the foreign exchange market. This has created additional problems for banks that were trying to maintain the stability of assets and liabilities. Many banks were forced to create reserves under NPL, which further complicated their ability to lend and finance new projects. An analysis of the impact of the Russian-Ukrainian war on the loan portfolio of Ukrainian banks showed that the conflict had a substantial negative impact on the country's financial system. For a long time, since 2014, and especially in the period from 2022, the banking sector of Ukraine has undergone major changes, which led to an increase in the number of NPLs and fluctuations in lending volumes (Fig. 1).

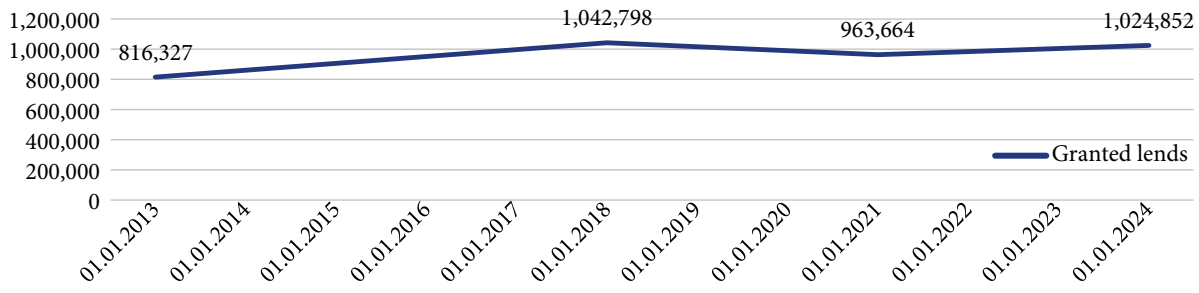

Figure 1. Lending volumes in 2013-2024, million UAH

Source: compiled by the author on the basis of S. Raga *et al.* (2020), Minfin (2024b)

These changes required banking institutions to develop new risk management strategies to adapt to ever-changing conditions and ensure the stability of the financial system. Based on the data of the National Bank of Ukraine, Table 1 shows the volume of NPL in Ukrainian banks as of January 1, 2013, 2018, 2021, and as of September 1, 2024. Table 1 shows how the situation with NPLs in banks has changed over the years. According to the National Bank, at the beginning of 2023, the share of NPL in Ukraine was 38%.

According to the data shown in Table 1, in 2024, the volume of NPLs in Ukrainian banks increased substantially compared to 2013. For example, JSC CB "PrivatBank", which is one of the largest banks in the country, experienced the largest increase in NPL – from UAH 29.633 million to UAH 178.803 million. This shows that the bank, which plays a critical role in the financial system of Ukraine, has faced serious challenges that threaten its financial stability. In addition, NPL growth was also observed in other major banks, such as JSC "Oschadbank" and JSC "Ukreximbank".

Table 1. Volumes of NPL in banks, million UAH

Bank name	01.01.2013	01.01.2018	01.01.2021	01.09.2024	2013-2024 difference
JSC CB "PrivatBank"	29.633	236.211	181.196	178.803	149.170
JSC "Ukreximbank"	11.601	70.191	64.227	49.886	38.285
JSC "Raiffeisen Bank"	10.808	8.435	1.700	10.324	-484
JSC "TASKOMBANK"	135	1.748	1.597	3.656	3.521
JSC "Oschadbank"	4.624	80.717	56.900	66.106	61.482
JSC "FUIB"	5.194	8.613	4.618	7.684	2.490
JSC "UKRSIBBANK"	3.479	7.225	1.867	2.174	-1.305
JSC "PINbank"	74	11	77	9	-65

Notes: CB – Commercial Bank

Source: compiled by the author on the basis of National Bank of Ukraine (2024a)

These changes point to an aggravation of the problem of credit risks throughout the banking system, as borrowers, especially in frontline regions, face difficulties in repaying loans. A high level of NPL entails the need to form reserves, which, in turn, reduces the liquidity of banks and their ability to make new loan transactions. Thereby, some banks, such as JSC "Raiffeisen Bank" and JSC "Ukrsibbank", demonstrated the ability to reduce NPL volumes. This may indicate the successful implementation of risk management strategies and a cautious approach to lending, which can reduce the impact of military operations on their financial condition. This is especially important because the stability of these banks can have a positive impact on the entire banking system in a crisis.

As a result of the war, the stability of Ukraine's banking sector has deteriorated, and banking institutions must adapt to the new circumstances. It is important to use effective credit risk management methods, such as debt restructuring, improving lending standards, and introducing new technologies to preserve the banking system. On April 15, 2022, the National Bank of Ukraine (2022a) changed the basic principles of monetary policy for the period of martial law to support the stability of the banking sector and the country's economy. Its main tasks are to ensure the reliable functioning of the banking system, support the country's defence capability and stability of finances in war conditions. The National Bank of Ukraine recognises that traditional market instruments are ineffective during military operations. Thus, to ensure prompt response to financial risks, the National Bank of Ukraine temporarily abandoned inflation targeting using a floating exchange rate.

The National Bank of Ukraine (2024a) has implemented a number of flexible monetary policy changes to ensure sufficient liquidity of the banking system during the war. One of the key steps was the introduction of administrative restrictions on the foreign exchange market, which was necessary to maintain price stability in conditions of extreme economic uncertainty. Although such measures pose risks, in particular, increase the threat of inflation and may weaken confidence in monetary policy, they have allowed the National Bank of Ukraine to temporarily control currency fluctuations. In addition, the National Bank of Ukraine (2022b) was granted the right to buy government securities on the primary market to finance the budget, which was an important step to support government spending in times of crisis. The National Bank of Ukraine actively cooperates with the government and international organisations to attract additional external financing necessary to meet humanitarian needs and restore infrastructure. The monetary policy also includes the introduction of additional financial sanctions to increase economic pressure on the aggressor country.

As the economy and financial system stabilise, the National Bank of Ukraine plans to return to the traditional monetary policy regime. This will provide for the resumption of a floating rate of inflation targeting, which will become possible when the predictability of economic processes improves. In addition, administrative restrictions on currency transactions will be lifted if necessary. Thus, the basic principles of the monetary policy of the National Bank of Ukraine in the context of war demonstrate how flexibly the regulator responds to the challenges facing the financial system of Ukraine. Appropriate actions are aimed at supporting economic processes and ensuring stability, which is very important in a conflict situation. Effective measures and further integration into the international

financial system will be necessary to restore Ukraine's economy after the war.

An analysis of the National Bank of Ukraine's inflation reports (2015; 2024b) shows substantial changes in the economic context and monetary policy caused by the ongoing military conflict and global economic challenges. In 2015, Russian aggression in eastern Ukraine led to a sharp economic downturn, accompanied by ultra-high inflation rates, which reached 42% (Fig. 2). As a result of the war, gross domestic product (GDP) substantially decreased, which prompted the National Bank of Ukraine to introduce a tight monetary policy. Unlike in 2015, in 2024, Ukraine's economy, despite the fact that it was still suffering from war, began to recover. International financial support and structural reforms have allowed the National Bank of Ukraine to move to a softer monetary policy. Forecasts for economic growth have become more optimistic and promised GDP growth of 3.7% in 2024.

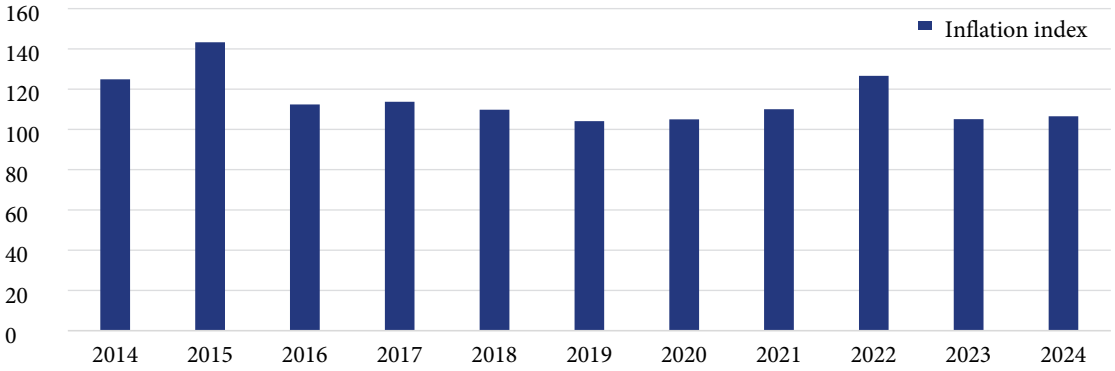

Figure 2. Dynamics of inflation in 2014-2024, %

Source: compiled by the author based on Minfin (2024c)

The National Bank of Ukraine raised the discount rate to 30% in 2015 to curb inflation and stabilise the hryvnia. Reducing currency risks and controlling inflation expectations were the main goals of the measures, including banning lending in foreign currency. In contrast, in 2024, the National Bank kept the discount rate at 13%, focusing on trends in inflation and the foreign exchange market. The accounting policy of the National Bank of Ukraine for the period 2015-2024 was aimed at controlling inflation and maintaining macroeconomic stability in the face of serious economic and political challenges. In 2015, the rate peaked to stop inflation from rising due to the crisis. In the future, in the context of economic stabilisation and recovery, the National Bank of Ukraine reduced the discount rate, reaching 6% in 2020. However, due to military operations and economic challenges in 2022, the rate increased to 25%. In 2023-2024, the National Bank of Ukraine again began to reduce it to support the economic recovery and stimulate lending (Fig. 3).

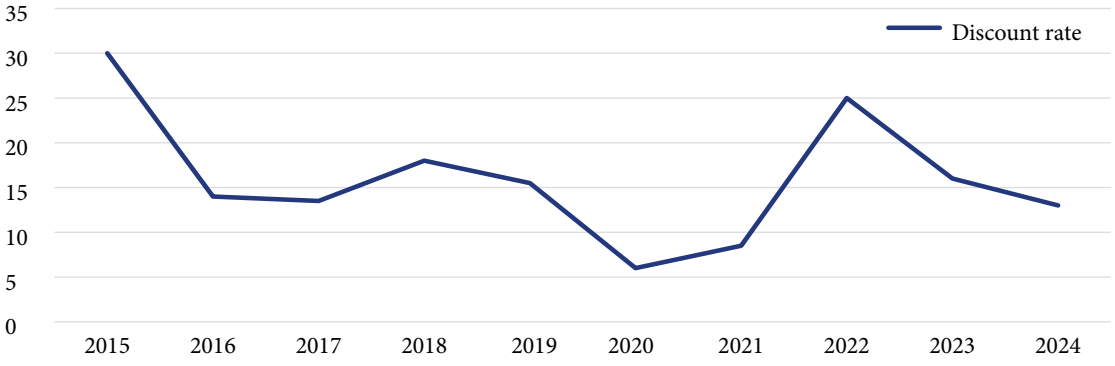

Figure 3. Discount rate level for 2015-2024, %

Source: compiled by the author based on Minfin (2024a)

Inflation forecasts for the end of 2015 were pessimistic; it was expected that the devaluation of the hryvnia and the increase in tariffs would lead to its growth of up to 30%. The overall economic climate and consumer demand were substantially affected by infrastructure destruction and high unemployment. According to the forecast, inflation is expected to fall to 8.5% in 2024, compared to 13% at the beginning of the year. However, when the economy stabilises and the state in the energy sector improves, the National Bank of Ukraine hopes for a gradual reduction in inflation to 5% by 2026.

A comparison of inflation reports from 2015 and 2024 showed changes in the monetary policy of the National Bank of Ukraine in light of changes in military and

economic circumstances in Ukraine. In 2015, the National Bank of Ukraine was forced to act during a deep crisis, applying tough measures to control inflation, such as a substantial increase in the discount rate and currency exchange rate control, to stabilise the financial system. However, in 2024, the National Bank of Ukraine's policy is aimed at a more balanced approach, with an emphasis on economic growth, reducing inflation to 5% in the medium term, and easing monetary conditions. This analysis showed that monetary policy must adapt to new circumstances and requires more research on credit risk management during military conflicts.

International experience in managing a loan portfolio in the context of military conflicts

The experience of managing the loan portfolio of banks gained in Syria during the long war can be useful for Ukraine in its attempts to stabilise the banking sector. Syria's economy was severely disrupted by the war, which led to higher unemployment, lower incomes, and a substantial drop in living standards. Although it faced many challenges, the private banking sector was able to survive. According to a study by O. Alyousef (2023), none of the private banks went bankrupt even during the war, which indicates a certain strength of the system. Credit and asset management policies were one of the main elements that affected banks' profitability. In particular, due to the high level of NPL, banks had to reduce their lending volumes. According to the study, the share of NPLs in banks' portfolios has increased to 40%. This has led to the need to form reserves and limit new loan agreements. During the war in Syria, the banking system was under substantial pressure due to the growing share of NPL and the threat of liquidity. O. Alyousef analysed the determinants of private bank liquidity in Syria during crises, which emphasised the importance of managing liquidity in conflict situations. The results of the study showed that conflicts negatively affect the banking sector and the growth of NPL is one of the main causes of financial instability.

A study by F. Suliman *et al.* (2023) also emphasised the need to adapt credit policy in Syria, in particular, the importance of debt restructuring to preserve the liquidity of the banking system. Researchers noted that such measures can help banks reduce losses from NPL and maintain stability during the crisis period. This is consistent with the Ukrainian experience, where banks are also implementing restructuring programmes to overcome economic challenges. In such circumstances, the effectiveness of Syrian banks depended on many factors. First, high-cap banks were able to maintain profitability because their higher capital was positively correlated with profitability indicators. Second, banks maintained their liquidity by maintaining substantial deposits, which contributed to their stability. Operational efficiency was crucial for banks' profitability. Profitability was affected by the high cost of managing and servicing loans. Therewith, the debt restructuring measures that were introduced to support borrowers have proven useful, as they have reduced risks and improved the credit quality of portfolios. In addition, it is important to keep records of assets that do not generate profit, such as profit from the revaluation of currency positions. Since these returns do not reflect returns on banks' core business, their inclusion in financial statements can mislead investors and creditors. It is necessary to introduce risk management methods, implement loan restructuring programmes, and ensure liquidity by attracting deposits to maintain the stability of the banking system during the crisis. A study by F. Suliman *et al.* (2023) also highlights how important it is for financial statements to be transparent; this can increase confidence in the banking sector.

Iraq, as a country that has experienced many military conflicts, has useful experience in managing the loan portfolio of banks in an unstable environment. The war, which began in 2003, caused serious social and economic problems that affected the banking system. Iraq had the largest debt in the world, reaching about USD 130 billion. Prolonged military action, political isolation, and economic sanctions have led to an increase in debt. Banks faced high levels of NPL in conflict situations, which increased risks to their liquidity and lending capabilities. Banks have increased their lending requirements and raised interest rates to reduce risk. The introduction of debt restructuring programmes to support borrowers who find themselves in difficult financial conditions was one of the key measures (World Bank, 2018). Table 2 shows the main indicators of the debt situation in Iraq from 2003 to 2006, illustrating the impact of military conflicts on the banking and lending sectors.

Table 2. Iraq's debt situation (2003-2006)

Year	Total debt, USD million	Major creditors	Terms of restructuring
2003	130,000	Paris Club, USA	Debt reduction by 80%
2004	120,000	Foreign banks	Restructuring through an agreement
2006	80,000	International organisations	Political support

Source: S. Hinrichsen (2019)

From 2003 to 2006, the debt situation in Iraq changed substantially, as shown in Table 2. In 2003, the country faced huge debt obligations. However, in 2004, an agreement was reached to reduce the debt by 80% through restructuring. International political support has allowed reaching this agreement, emphasising the importance of external cooperation in the context of the economic crisis. Thus, Iraq's experience in managing its banking portfolio during military conflicts shows how important it is to change risk management strategies and actively approach debt restructuring.

Ukraine, which also faces serious problems in the banking sector during the war, must consider these lessons to ensure financial stability and support economic recovery. Effective management of the loan portfolio is very important for economic recovery and stability of the financial system.

The war in Yugoslavia (1991-2001) had serious economic, social, and political consequences for the country. The banking sector has been substantially affected by conflicts since the breakup of Yugoslavia, in particular, by the management of loan portfolios of financial institutions. During this period, there were high levels of NPL, unstable exchange rates and a drop in confidence in banks. During the war, banks faced many challenges, such as massive corporate bankruptcies, which led to a sharp increase in NPL. As a result, banking institutions were forced to introduce strict lending standards. Higher interest rates and stricter requirements for borrowers to reduce risks and protect assets were part of this. Many banks chose to be conservative and limited the number of new loans (Tung, 2000). This affected the overall level of lending in the country. In addition, due to the instability in the political and economic environment of the region, many banks have begun to actively use debt restructuring methods. These measures have helped borrowers in difficult financial conditions. For example, during the war, some banks began implementing loan restructuring programmes to prevent massive defaults on borrowers. As a result, this preserved the banks' liquidity and prevented bankruptcies at critical moments.

The collapse of Yugoslavia and military conflicts in the 1990s led to a substantial deterioration in the country's banking system. The World Bank's report (World Bank, 2001) described Yugoslavia's transition to a decentralised economy, which includes reforming the banking system and introducing market mechanisms for stabilisation. In particular, the author emphasises the importance of radical economic reforms to restore confidence in banks and stabilise credit markets after the crisis. Compared to Ukraine, Yugoslavia had similar challenges in the banking system, where banking sector reforms were also needed to recover from the crisis. The study confirms that conflicts in both countries are forcing the banking system to adapt to new realities by implementing stricter risk management standards and reforms to maintain liquidity.

The management of the loan portfolio during the military conflict in Yugoslavia involved constant monitoring of credit risks. At that time, banks were actively implementing risk management systems to reduce the negative financial consequences. This included assessing borrowers' solvency, analysing their financial condition, and monitoring compliance with credit conditions. Despite all efforts, the Yugoslav banking sector suffered substantial losses. It is estimated that the share of NPL in some banks reached between 30 and 50%, which substantially undermined the financial stability of the system (Cvikl & Mrak, 1996). In addition, this led to a loss of trust on the part of clients who were forced to look for alternative sources of financing, such as foreign investment and informal lending. After the end of the war, the countries of the former Yugoslavia were forced to rebuild the banking sector. This required not only the reorganisation of the debt but also the introduction of new regulatory rules that met the current conditions. In particular, countries such as Croatia and Slovenia have successfully implemented reforms that have helped stabilise the banking system and restore lending. Thus, the experience of Yugoslavia shows that effective management of the loan portfolio during a military conflict requires a comprehensive approach that involves a strict credit policy, Debt Restructuring, active risk tracking and adaptation to changing economic conditions. This experience can be useful for countries that face similar challenges.

The war in Yemen, which began in 2015, was one of the longest and most destructive wars in recent history. This conflict had severe humanitarian consequences and substantial economic problems, which also affected the financial system. As banks face a variety of challenges, such as rising NPLs, falling borrower confidence, and instability in financial markets, managing banks' loan portfolios has become challenging. M. al-Shaibani (2020) confirmed that military conflicts substantially affect financial systems, increasing the share of NPLs and increasing overall risks for banks. In addition, the author emphasised the need to support borrowers through debt restructuring, which is also confirmed by the Ukrainian experience. The importance of international support for stabilising the financial system during and after the military conflict is also stressed. International aid programmes can provide the banking system with resources to continue operations, reduce NPL levels, and maintain liquidity.

The war in Yemen led to an economic collapse, when the country's GDP shrank by more than 50%, and infrastructure was completely destroyed. In 2020, 80% of the population needed humanitarian assistance, which made lending even more difficult. Many companies closed or reduced their operations during the war, which led to higher unemployment rates and a decrease in the solvency of borrowers. The rise in NPL levels has been one of the most serious challenges facing Yemeni banks. It is estimated that in 2021, several banks had a 40% NPL. This jeopardised their liquidity and they were forced to restrict new loan agreements and create reserves under the NPL (Hanna *et al.*, 2021).

The banking sector of Yemen has introduced a number of measures to manage credit risks to cope with the problems. Firstly, banks have increased their requirements for borrowers. This included a more detailed credit check, which reduced the number of new loans granted to high-risk individuals and companies. However, these actions also limited the possibility of obtaining credit for companies that could potentially play an important role in the economic recovery. Secondly, to help borrowers who find themselves in difficult financial conditions, banks have started implementing debt restructuring programmes. This became especially important because many businesses were unable to repay loans due to declining sales and rising costs. The restructuring allowed borrowers to continue operating and banks to reduce losses.

In addition, managing the loan portfolio during the war in Yemen required close cooperation with international financial organisations. For example, the World Bank (2019) and the International Monetary Fund provided financial assistance to support banks' liquidity and economic recovery. This support allowed banks to adapt to the new conditions through lending programmes and technical assistance. Therewith, financial donors had to consider the difficult political and social situation in Yemen. For example, international organisations have tried to work with various parties to the conflict to guarantee unhindered access to recovery money.

The war in Yemen has shown the role that new technologies play in managing the loan portfolio. Many banks have started using digital platforms to track credit risks and process loan applications. This has helped reduce management costs and improve process efficiency. Even during the fighting, the introduction of e-banking was an important step in maintaining customer trust and ensuring access to financial services (World Bank, 2023).

In times of military conflict, managing a bank portfolio requires flexibility, adaptability, and a proactive approach to risk management. Yemen's experience shows how important it is to implement strict credit policies, restructure its debt, and cooperate with international organisations. This not only ensures the stability of the banking system but also contributes to the economic recovery after the war. Ukraine, which is also suffering from military conflict, should consider this experience to strengthen its banking sector and ensure financial stability. Successful loan portfolio management can be crucial for economic recovery and financial system stability.

Credit risk management strategies during military conflicts

Managing banks' loan portfolios is critical to ensuring financial stability and supporting economic recovery. The experience of countries that have experienced or are in military conflict, such as Ukraine, Iraq, Yemen, Yugoslavia, and Syria, provides valuable lessons on effective risk management strategies, debt restructuring, new technologies, and restoring confidence in the banking system. Table 3 compares various aspects of loan portfolio management in these countries, providing a better understanding of how to adapt banking strategies in times of instability and crisis. Table 3 summarises the main strategies and challenges that countries have faced in different periods of conflict.

Table 3. Comparative table of experience in managing the loan portfolio of banks in different countries in the context of military conflict

Loan portfolio management aspect	Experience of Ukraine	Experience of Iraq	Experience of Yemen	Experience of Yugoslavia	Experience of Syria
Structure of debt obligations	High level of NPL (up to 40%) in war conditions	The share of NPL reached 40% after conflicts	The share of NPL in some banks reached 40%	The share of NPL reached 50% during the conflict	The share of NPL reached 50% due to the economic collapse
Risk management policy	Tougher requirements for borrowers, strict lending conditions	Higher interest rates and strict conditions	Introduction of strict credit policies	Increased collateral requirements for borrowers	Strengthening security requirements, taking measures to reduce risks
Debt restructuring	Restructuring programmes to support borrowers	Debt restructuring to maintain liquidity	Debt restructuring programmes to support businesses	Implementation of restructuring programmes	Restructuring to support businesses
Interaction with international organisations	Cooperation with the IMF and the World Bank	Receiving international assistance	Cooperation with international financial institutions	Cooperation with international organisations	Support from international organisations
Using new technologies	Introduction of digital credit processing platforms	Using new technologies for risk management	Introduction of technologies for monitoring credit risks	Limited use of new technologies	Introduction of new technologies to improve processes
Restoring confidence in banks	The problem of trust through military action, the need for transparency	Difficulties with public trust	Loss of confidence in banks due to instability	Loss of confidence in the banking system	Instability has led to a loss of confidence

Source: compiled by the author

The experience of managing the loan portfolio of banks in the context of military conflicts is complex and multifaceted. Comparing Ukraine with other countries that have experienced similar challenges highlights the importance of adapting banking strategies to the specific conditions that arise during conflicts. Each country faced unique challenges, such as high NPL levels, the need for stricter risk management policies, and a loss of public confidence. In Ukraine, for example, banks introduced new requirements for borrowers to reduce risks, while in Iraq and Yemen,

banks have also introduced strict credit policies, but with an emphasis on debt restructuring. In Yugoslavia, unlike in other countries, the emphasis was placed on innovative approaches to lending, although there were also problems with liquidity. The Syrian experience highlighted the importance of technological innovation to improve management processes as banks try to adapt to new conditions and maintain liquidity in crisis situations. In terms of international support, all countries have tried to interact with international financial organisations to obtain the necessary resources and expertise.

A comparison of the experience of Ukraine, Syria, and Yugoslavia in managing bank loan portfolios in conflict situations showed similar trends. In all cases, there was a substantial increase in the share of NPL, which required the adaptation of credit policies and the introduction of debt restructuring programmes. In addition, all the countries examined faced problems with the liquidity of the banking system, which forced banks to turn to international assistance.

A paper of M.M. Diwani (2022) confirmed that the growth of NPLs during military conflicts is a critical factor negatively affecting the stability of the banking system, and emphasised the need to adapt credit policies to better manage risks. A. Kreimer *et al.* (1998) emphasised the need for international assistance to restore financial systems after conflicts, which is also reflected in the Ukrainian experience. A World Bank's (1979) study highlighted the importance of long-term reforms for rebuilding the banking system after war and the current study focuses on risk management during active conflict. The impact of conflicts on banking systems has common features: a substantial increase in NPLs, reduced liquidity, and the need for international support to restore stability. I. Zaichko *et al.* (2023) highlighted the importance of reducing NPL volumes to increase bank profitability, which is one of the crucial measures to overcome the financial crisis. The study also focused on concessional lending and opportunities to increase banks' revenue through changes in credit policies.

A study by S. Shpak *et al.* (2023) highlighted that war has a substantial impact on economic activity due to lower collateral costs and an increased likelihood of default. This affects the ability of firms to get loans, which is a key issue during a conflict. In addition, S. Ahmed *et al.* (2022) emphasised that geopolitical conflicts, such as the Russian-Ukrainian crisis, have a serious impact on financial markets, in particular, European stock markets. G. Nagarajan (1997) emphasised the importance of developing financial institutions in countries emerging from conflict, as this is crucial for economic recovery. Microfinance services play an important role in this process, which can help small businesses resume their operations.

In light of the growing global geopolitical tensions, the study by M.S. Qureshi & T. Tsuruga (2023) highlighted the risks of financial fragmentation at the global level. This can have a substantial impact on international payment systems and the distribution of capital across borders, which is of particular importance for developing economies. Thus, the results of this study are consistent with international experience, which indicates the need to adapt credit policies, restructure debts, and attract international support to maintain the stability of the banking system during and after conflicts.

CONCLUSIONS

During the study, several key aspects of managing the loan portfolio of banks in the context of military conflicts were identified based on a comparison of world experience and the experience of Ukraine. Armed conflicts substantially increase the level of credit risks, which is manifested in an increase in the share of NPLs. In Ukraine, this share reaches 40% in 2023-2024, which is a substantial challenge to the financial stability of the banking system. A similar situation was observed during wars in other countries, such as Syria and Iraq, which also had a substantial increase in NPL.

International experience shows that in response to the growth of NPL, banks in such countries actively apply debt restructuring. In particular, in Syria, restructuring has become a critical mechanism for supporting the banking system. Ukrainian banks also resorted to this tool, which slightly improved the liquidity of tanks and reduced financial pressure on borrowers. This confirms that restructuring is an important tool for maintaining the stability of banks during the crisis period.

Another necessary step in managing credit in the context of military conflicts is to apply a strict credit policy. In international practice, in particular, in Arab countries, this was reflected in the introduction of stricter requirements for borrowers, which helped reduce the risks of non-repayment of loans. Ukrainian banks were also forced to reconsider their approaches to assessing the creditworthiness of customers, using the latest technologies for risk management. The use of strict credit policies during the war reduced the risks of non-repayment of loans since only customers with high creditworthiness received access to loans. This helped reduce the volume of NPLs. The use of the latest technologies for risk assessment allowed banks to quickly identify problems and prevent losses, which helped stabilise the banking sector in times of crisis.

Government support programmes and international financial assistance play an important role in stabilising the banking sector. World experience shows that banks that received support from the state or international financial organisations were able to respond faster to changes in economic conditions and maintain liquidity. This confirms that the active participation of the state and international partners in regulating the financial sector during the crisis is a key factor in maintaining stability. Ukraine, like other countries that have faced conflicts, has received substantial support from international financial organisations, which has reduced the pressure on the banking sector and the economy in general.

Prospects for further research may include an analysis of the introduction of innovative technologies for

managing credit risks and maintaining liquidity in crisis situations. An important area is the automation of creditworthiness assessment processes, which will allow banks to respond more quickly to changes in economic conditions related to military conflicts.

ACKNOWLEDGEMENTS

None.

CONFLICT OF INTEREST

None.

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Управління кредитним портфелем банків в умовах збройних конфліктів: порівняння світового досвіду та досвіду України

Денис Осіпенко
Науковий співробітник
Університет Единбурзької бізнес-школи
EH8 9JS, пл. Бакклю, 29, м. Единбург, Велика Британія
https://orcid.org/0000-0002-5984-1168

Анотація. У статті було досліджено оптимальні стратегії управління кредитними портфелями банків під час воєнних конфліктів із акцентом на порівняння світових практик з українським досвідом. Проаналізовано специфічні ризики, з якими стикається банківський сектор у період війни, зокрема значне зростання частки непрацюючих кредитів (NPL), оцінено підходи до їх мінімізації та управління. Методологія базувалася на порівняльному аналізі даних банківської системи України за 2013-2024 роки та досвіду країн, таких як Сирія, Ірак, Югославія і Ємен, що пережили воєнні конфлікти. Розглянуто статистичні дані щодо динаміки NPL, кредитування та впливу війни на платоспроможність позичальників, а також проаналізовано заходи, які застосовували банки для зниження кредитних ризиків та забезпечення стійкості . Результати дослідження продемонстрували, що під час війни в Україні частка NPL досягла 40%, що суттєво загрожує фінансовій стабільності банківської системи. Порівняльний аналіз підтвердив важливість реструктуризації боргів, посилення кредитної політики, ефективного управління ризиками та залучення міжнародної підтримки для збереження ліквідності банків у кризовий період. Водночас українські банки продемонстрували здатність до адаптації, впроваджуючи сучасні технології для оцінки кредитоспроможності, прогнозування ризиків та управління ліквідністю. Отримані результати підкреслили важливість державного втручання для забезпечення фінансової стабільності та використання інноваційних рішень для ефективного управління кредитними ризиками. Подальші дослідження рекомендується зосередити на аналізі ролі технологічних рішень, міжнародної підтримки та регуляторних заходів у відновленні фінансової системи України після завершення конфлікту

Ключові слова: капітал; фінансова стійкість; оцінка ризиків; економічні наслідки; банківські кредити

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Sustainable development marketing in education: Implementation of SMART technologies in the educational process

Oksana Nemyrovska*
PhD in Economics Sciences, Associate Professor
State Tax University
08200, 31 Universytetska Str., Irpin, Ukraine
https://orcid.org/0000-0003-1955-6132

Abstract. The relevance of this study stems from the exploration of potential approaches to the management of higher education institutions in the context of the ongoing digitalisation and informatisation trends shaping contemporary society. The study aimed to develop an approach for structuring the educational process in an institution through the application of SMART technologies (Specific, Measurable, Assignable, Realistic, Time-Related) to enhance the quality of education. The study employed a methodology combining distinct mathematical models from the theory of digital automata. This approach enabled the implementation of a tailored algorithm for surveying devices within the monitoring zone. It also incorporated methods of synthesis, economic analysis, logical generalisation, as well as graphical and bibliographic techniques for the visualisation of results. The scope of the study included educational institution network infrastructure (such as cameras and environmental monitoring sensors) and individual electronic devices used by participants in the educational process, including smartphones, tablets, and smartwatches. An environment of a "smart educational institution" was established, enabling decision-making support based on data from SMART devices and ensuring feedback aligned with students' needs. The feature of distributed data processing was implemented using an additional managed switch, with its control modified based on automata theory. The proposed approach was tested at the State Tax University (Irpin) through the voluntary participation of second- to fourth-year bachelor's degree students in March-April 2024. The results obtained were compared to those achieved without the use of SMART devices and demonstrated a 1.2% improvement in the quality of educational services. This enhancement was attributed to improved attendance rates and increased engagement of higher education students in the knowledge acquisition process. The practical significance of this study lies in the potential application of the proposed solution to enhance the quality of educational services in higher education institutions, contributing to increased consumer satisfaction

Keywords: digitalisation of education, monitoring of educational service delivery, distributed data processing, management information exchange, transition matrix, input signal

INTRODUCTIONS

The accessibility of modern information technologies has significantly expanded the possibilities for collaboration, remote work, learning, and skill development within a specific institution or under the guidance of a particular specialist anywhere in the world. The digitalisation of society has created the conditions for changing the processes of managing the production of goods and services, minimising subjective influence on managerial decisions. Based on the research of S. Hunt *et al.* (2022), the trajectory of an educational institution can be defined as a line of movement in the plane of service development during the coordination of work, aimed at identifying and meeting the needs of the consumer.

Research by N. Fedchyshyn *et al.* (2024) highlighted that Ukrainian higher education institutions have yet to fully grasp the potential of framing education as a service, requiring appropriate management approaches and a market- and consumer-oriented focus to enhance

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*Corresponding author

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quality. Instead, a fragmented, localised approach to institutional management has been prevalent, as emphasised by O. Hurenko *et al.* (2024), without sufficient consideration of the trajectory component. However, as demonstrated by S. Stephens & C. McLaughlin (2020), the application of management approaches in education, alongside information technologies – particularly those that are SMART – can radically transform motivation, behaviour, the content of educational programs, and the formation of individual learning trajectories. According to Qu. Brown (2021), SMART technology in education can be understood as a specific approach to self-monitoring, analysis, and reporting using computer systems and microprocessors to perform daily tasks involving real-time information exchange. These technologies encompass networks of devices designed to animate static physical objects, smart connected devices (e.g., security cameras, smartphones, tablets), and smart devices capable of limited automation without requiring Internet connectivity (e.g., appliances programmed to operate at specific times). Various management strategies have been incorporated into projects for implementing "smart classrooms and laboratories", which have begun to be partially introduced in Ukraine, as noted in the studies of J. Yershova & L. Bazhan (2020), D. Bugayko *et al.* (2024).

Several European countries have been successfully using SMART technologies to manage the trajectory of educational institutions for quite some time. This has enabled the adaptation of learning systems to the practices of Swiss firms, as evidenced by the research of G. di Maio *et al.* (2020). Educators in Sweden were initially concerned about the pace of internationalisation in education but later shifted the trajectory of educational service management towards a competitive approach using modern information and communication technologies, as analysed by I. Hammar & H. Östh Gustafsson (2022). In Norway, the trajectory of modern education management is based on gender equality, promotional opportunities, ambition, and professionalism, as stated by I. Drake & S. Svenkerud (2024). The latter factor specifically includes the ability for self-control and the desire to master the potential functions of modern information technologies, which aligns with the SMART concept. While the studies reviewed presented general concepts, they did not provide specific algorithms or proven practical approaches to managing educational services using SMART technologies. This has hindered implementation and led to the formal reproduction of individual processes, thus slowing down institutional development.

Therefore, this study aimed to develop an approach for constructing the trajectory of an educational institution using SMART technologies to improve the quality of the educational process. To achieve this goal, the following objectives were set: to develop an algorithm for managing institutional development through trajectory construction, self-monitoring, analysis, and reporting to improve the quality of educational services; to present an implementation tool for a complex task with several constraints and a mathematical apparatus for practical implementation.

MATERIALS AND METHODS

The approach to structuring the trajectory of an educational institution using SMART technologies was based on the application of specific mathematical models from the theory of digital automata. These models were employed to algorithmise the process of polling additional managed switches within the institution's network, recording the results, and supporting managerial decision-making. This facilitated feedback provision tailored to students' needs and addressed challenges arising during the delivery of educational services, ensuring their alignment with efficiency criteria. Specifically, a finite logic model was utilised to cycle through states under specified constraints and conditions, alongside transition models of abstract automata, such as the Moore machine (Hopcroft *et al.*, 2001). To evaluate encoding, a coding efficiency coefficient was introduced: $K_{eff} = W/P$, where P is the total number of automaton transitions, and W is a weight function:

$$W = \sum t_{ij}, \quad (1)$$

where t_{ij} is the Hamming distance (Guth, 2020) between the state codes a_i and a_j, indicating the number of memory elements that change state during a given transition.

In determining the weight function, summation was performed across all transitions of the automaton. The efficiency coefficient facilitated the evaluation of the complexity of the automaton's combinational circuit. The lower the coefficient value, the less complex the circuit, with the optimal value being $K_{eff} = 1$. A heuristic state encoding algorithm was employed to minimise the total number of memory element changes across all transitions. The algorithm followed these steps:

1. A matrix M was constructed, consisting of all pairs of transition numbers (a_r, b_r) of the automaton.

2. The rows of the matrix were rearranged such that each subsequent row contained at least one element from the previous rows.

3. States from the first row of matrix M were encoded as follows: $Ka_1 = 00...00$, $Kb_1 = 00...01$, where Ka, Kb are the code of the respective row in the matrix, denoted by lowercase letters.

4. The first row of matrix M, containing the encoded states, was removed, resulting in a new matrix M'.

5. Due to step 3, one element was encoded in the initial row of matrix M'. An unencoded element was selected from the first row of matrix M' and denoted as γ.

6. Matrix $M\gamma$ was constructed by selecting from matrix M' the rows containing γ. It is assumed that $M\gamma = \{\gamma_1, \gamma_2, \ldots, \gamma_f, \ldots, \gamma_F\}$ is the set of elements from matrix $M\gamma$ that have already been encoded. Their codes are denoted by $K\gamma_1, K\gamma_2, \ldots K\gamma_f$, respectively.

7. For each $K\gamma_f (f = 1, 2, \ldots, F)$, a set of codes $C^1_{\gamma f}$ was identified. This set consists of codes at a Hamming distance of 1 from $K\gamma_f$, which have not yet been used for encoding the states of the automaton. Based on this, the set D was constructed:

$$D_{\gamma}^{1} = \bigcup_{f=1}^{F} \cdot C_{\gamma f}^{1}, \quad (2)$$

where f is the indices of the codes for each element K in the matrix set; γ is an element of the matrix; $C_{\gamma f}^{1}$ is the set of codes whose code distance from the code $K_{\gamma f}$ is equal to 1.

If $D_{\gamma}^{1} = 0$, then a new set is constructed, which is analogous to the previous one:

$$D_{\gamma}^{2} = \bigcup_{f=1}^{F} \cdot C_{\gamma f}^{2}, \quad (3)$$

where $C_{\gamma f}^{2}$ is the set of codes whose code distance from the code $K_{\gamma f}$ is equal to 2.

If $D_{\gamma}^{2} = 0$, it is constructed D_{γ}^{2} until $D_{\gamma}^{2} \neq 0$ is found.

8. It is assumed that $D_{\gamma}^{2} = \{K_{\gamma 1}, \ldots, K_{\gamma g}, \ldots, K_{\gamma G}\}$.

9. For each $K_{\gamma g}$ calculate $w_{gf} = |K_{\gamma g} - K_{\gamma f}|^2$, which is the Hamming distance between $K_{\gamma g}$ and all used codes $K_{\gamma f}$ $(f = 1, 2, \ldots, F)$. Here w is the Hamming distance, $K_{\gamma g}$ are the codes of the elements of matrix $M\gamma$ for $D_{\gamma}^{2} \neq 0$; $K_{\gamma f}$ are the codes of the elements of the matrix $M\gamma$ for constructing the initial set D.

10. It is calculated $w_g = \sum_{f-1}^{F} \cdot w_g$, $(g = 1, \ldots, G)$.

11. From D_{γ}^{2} is selected K_{γ} for which is true $w_g = w_{gmin}$. Element γ is encoded with code K_{γ}.

12. From the matrix M' the rows in which both elements are encoded are deleted, resulting in a new matrix, also denoted as M'. If there is no row left in matrix M' proceed to step 12, otherwise, proceed to step 5.

13. Using equation (1), the function $w = \Sigma t_{ms}$, where $t_{ms}|K_m - K_s|^2$. Where w is the Hamming distance, t is the Hamming distance between the codes of states a_i and a_j, which is equal to the number of memory elements changing their state during the studied transitions, and K is the code mark on the corresponding transition.

14. End.

The approach to managing the trajectory of an educational institution using SMART technologies was tested by integrating devices, sensors, and surveillance cameras (manufactured by various brands, including Samsung, TP-LINK, Hikvision, and others of Chinese and South Korean origin) into a unified network. This integration was achieved via additional managed switches (MikroTik CRS328-24P-4S+RM, Latvia, running RouterOS), with modifications enabling query mirroring to other network devices without interfering with users' private information. The testing was conducted at the State Tax University in Irpin, involving second- to fourth-year bachelor's degree students during in-person attendance in classrooms equipped with SMART devices connected to the system.

A total of 160 students participated in the pilot study. During the testing, proprietary software developed specifically to implement the proposed method was utilised for managing transitions between devices, alongside SMART Remote Management for overseeing the institution's SMART devices and Internet Security Systems scanners to ensure network device security. Students' personal SMART devices were connected voluntarily; however, most participants supported the experiment and actively tested the technology. The testing was conducted in March-April 2024, comparing the outcomes of one month of operation with connected SMART devices against a month in standard mode. The experiment adhered to ethical principles for research involving human participants, in compliance with the norms and regulations of the Declaration of Helsinki (1964).

Analysing the modern educational institution, it was found that devices and systems (such as sensors monitoring critical parameters, Wi-Fi networks, access to digital libraries, knowledge control and assessment systems, and online learning platforms) could be integrated to perform management functions and support development tasks. Considering the requirements of governmental, educational, social, and socio-psychological directions for the development of territorial communities, as outlined in the Order of the Ministry of Development of Communities and Territories of Ukraine No. 172 "On the Approval of the Procedure for the Formation of the Concept of Integrated Development of the Territory of the Territorial Community" (2022), such management approaches should be implemented across all areas of state activity, including education. This would enable the delivery of educational services to be structured according to the criterion of efficiency.

The implementation of the "smart" technology was examined through several technical innovations. All staff members of the educational institution were assigned an ID number embedded in a SMART card containing a data chip. This card served simultaneously as an employee identification card and an electronic access key to offices and laboratories. Students were assigned their ID numbers based on the identifiers of their SMART devices, such as smartphones, tablets, or smartwatches, which they carried with them at all times. Each individual was assigned a unique ID, which was recorded in the institution's information system database. Additional managed switches were integrated into the institution's existing network and programmed to register students' SMART devices without accessing the personal data stored on those devices. Upon entering the institution, a student's SMART device automatically connected to the Wi-Fi network and was logged into the institution's information system. Data collected from the SMART devices were mapped to the institution's floor plan, identifying the location of users in specific classrooms or laboratories during sessions. This information was cross-referenced with the class schedule to track attendance.

In the final stage, specific events were recorded for subsequent processing and decisionmaking to adjust the institution's trajectory. Surveillance cameras were connected to the educational institution's network via additional managed switches, which operated on the principle of a digital automaton. These switches transmitted signals and received mirrored responses, functioning based on a protocol of random instantaneous recordings of specific areas where registered IDs were detected. This protocol was founded on the algorithms of digital automaton theory within Industry 4.0 technologies (de Oliveira *et al.*, 2024), incorporating

machine learning (Tancredi *et al.* 2022). It facilitated the controlled recording of photos, videos, and audio during educational activities.

RESULTS AND DISCUSSION

It was found that the collected information is assigned to a specific employee/classroom and can be reviewed by the responsible person (staff member or lecturer) at the end of the session by logging in with their ID to the folder where the materials are stored. Once the materials have been analysed, the responsible person can delete them or archive them. Thus, in the course of the study, the main goals of the developed SMART technology were established for different groups of educational service consumers (Table 1).

Table 1. Goals of the SMART technology

Consumer groups	Monitoring attendance of staff and students without interfering in the educational process or infringing on personal freedoms	Implementing selective monitoring of educational quality	Supporting feedback within the institution's communication system
Learners	-	+	+
Lecturers	-	+	+
Institution managers	+	+	+
Stakeholders	-	+	-

Source: created by the author

It was established that the aforementioned outcomes are achieved by connecting additional managed switches to the network, creating mirroring bridges. The implemented technical measures were found to enable several functions. If less than 50% of the students are present in a classroom, a long-duration video recording of the session begins. For instance, the lecturer receives a notification on their SMART device about the recording, while students receive a reminder on their SMART devices from the electronic information system about the need to complete a survey regarding the quality of teaching and course materials where low attendance was recorded. This reminder will disappear only after the student completes the online survey, which is recorded in the institution's system using the student's ID.

It was found that the recorded class sessions and student survey responses are accessible to authorised personnel in the quality assurance department for analysis and discussion. Surveillance cameras in non-working areas (corridors, stairwells, library, cafeteria, etc.) are activated by motion sensors and transmit event recordings to the institution's database through switches in case of increased noise levels or fire alarms. In other situations, cameras are activated periodically according to a schedule set in a digital state machine to monitor areas with high occupancy, while electronic fire safety devices, water supply monitoring systems, and air temperature sensors operate continuously and transmit relevant information to the central system without switches, implementing the concept of a "smart" institution analogous to a "smart home" (Setz *et al.*, 2021).

It was argued that by recording staff and students in the institution's information system, it becomes possible to facilitate feedback through a dedicated page on the institution's internal portal accessible via SMART devices. Here, users can ask questions of administrative staff, contact lecturers or other university staff, request books from the library, obtain references from accounting or HR departments, adjust their own educational trajectories, or submit absence requests. In response, users receive a notification on their SMART device indicating the date and time when the requested document will be ready or the reference number of the recorded request. This approach has enabled the systematisation of information by discipline, lecturer, and student, which in turn has provided the basis for developing additional measures or changes to the content and list of educational components, thus shaping the institution's development trajectory in response to market demands. The distributed information processing was based on the use of an additional managed switch within the system, whose control was modified based on automata theory. This involved partitioning all states of the initial abstract automaton into classes of equivalent states that do not intersect pairwise and replacing each equivalence class with a single state (a class representative). As a result, a minimal automaton was obtained with the number of states equal to the number of equivalence classes of the input state partition.

The essence of this approach was as follows: transitions and outputs between individual devices and network sensors were defined in tabular form. Surveillance cameras and user SMART device identifiers were considered, divided into input signals from SMART devices and formed into sets based on student groups (alphabetical units). A transition and output table was then constructed, which determined when to activate the surveillance camera in a particular classroom or laboratory and transition to another set with the same or fewer alphabetical units. An implementation example was developed and presented for a complex scenario involving four classrooms, three corridor cameras, and several registered "smart" devices analysed by the system (Fig. 1).

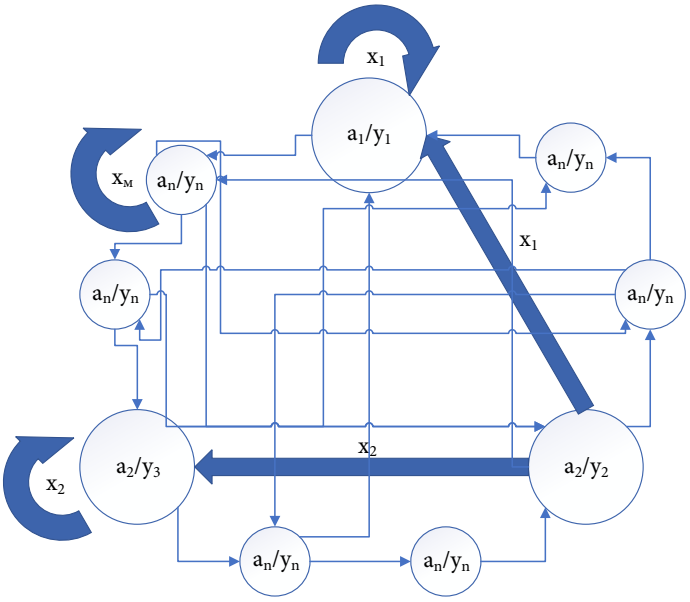

Figure 1. Generalised transition graph of the abstract automaton for implementing the approach to constructing the trajectory of managing an educational institution using SMART technologies

Source: created by the author

The camera transition graph is designed to ensure that all classrooms and student groups receive equal monitoring throughout the day, regardless of the order in which student groups move between classrooms. The automaton inputs (input signals from SMART devices), shown in Figure 1, form sets denoted as $a_{1}..a_{n}$; SMART devices, along with users, move between classrooms denoted as $y_{1}..y_{n}$; camera transitions are denoted as $x_{1}..x_{3}$ in the diagram. For simplicity, it is assumed that there are three cameras: $x_{1}..x_{3}$.

It was found that the number of classrooms, groups, and devices can vary. To algorithmically solve the problem presented in Figure 1, a transition from an abstract automaton to a structural one is used, followed by the interpretation of the logical scheme through the encoding of input, output signals, and internal states of the automaton using sets of variables. To encode input signals, the set of input signals $X = \{x_{1}, x_{2},... x_{M}\}$ is written, which is encoded by vectors $K_{in} = int(log_{2}M)$, where *int* is rounding to the nearest larger integer, and M is the cardinality (number of symbols) of the input alphabet. The encoding of input signals is arbitrary.

The output signals of the automaton $Y = \{y_{1}, y_{2}, ... y_{S}\}$ are encoded by a vector of length $K_{out} = int(log_{2}S)$, where S is the cardinality of the output alphabet. The encoding of output signals can be implemented using the following algorithm:

1) Each output signal y_{i} is associated with an integer $P^{i}i$, equal to the number of occurrences of the signal y_{i} in the automaton's output table.

2) The numbers P_{i} are ordered in descending order.

3) The output signal y_{i} with the highest weight ($P_{i}max$) is encoded with a code containing all zeros (00...00).

4) The next L output signals (where L is the number of bits in the binary vector of the output signal), in descending order of weight according to step 2, are encoded with codes containing one unit (00...01, 00...10,... , 10...00).

5) To encode the following output signals in descending order, all codes containing two units are used, then three units, and so on, until all output signals are encoded.

As a result, an encoding is obtained where the more often an output signal occurs in the output table, the fewer units are contained in its code. This approach is necessary to simplify the algorithmisation of the processes of software implementation of the approach to building the trajectory of an educational institution using SMART technologies. Directly, the state of the automaton $A = \{a_{1}a_{2}...a_{R}\}$ is encoded by a vector of length $K_{state.} = int(log_{2}R)$, where R is the cardinality of the state alphabet. It should be noted that the length of the state code vector also determines the number of memory elements (triggers) of this automaton.

Consequently, encoding internal states with binary symbols significantly influenced the cost of the combinational part of the automaton circuit. Optimal encoding yielded minimal costs when connecting all SMART devices to the network. Under this criterion, the complexity of the circuits implementing disjunctions at the inputs of memory elements decreased, i.e., the combinational circuit of the automaton was minimised. Students of higher education participating in the experiment noted that the ability to quickly resolve several issues significantly facilitated the educational process, modernised it, and made it more engaging. Moreover, the presence of attendance monitoring significantly stimulated responsibility and improved attendance quality.

It was asserted that a "smart" educational institution is an element of a smart city. As M. Murroni *et al.* (2023) point out, that smart cities and 6G technologies have the

potential to transform lifestyle and work patterns in the coming years, thereby increasing attention to the concept of managing educational services using SMART technologies. This claim is supported by the authors based on market research and a reassessment of the entire wireless communications sector. From a technical perspective, this requires addressing several issues, such as compatibility, data privacy, security, the digital divide, and implementation challenges. The development of this field will require specialists who are already working in such environments (Murroni *et al.*, 2023).

While the latest research may seem somewhat futuristic, given the lifecycle of any service in an intensely competitive and innovative environment, the trends outlined can be substantiated (Zhang *et al.*, 2020; Mancini *et al.*, 2021; Oliva *et al.*, 2022). Furthermore, T. Zhang *et al.* (2020) indirectly pointed to the potential of SMART technologies to ensure educational sustainability, a notion corroborated by the research of E. Nica *et al.* (2021) on the use of information technology in education in the context of the COVID -19 pandemic. Their study analysed the resilience of online learning methods by examining students' attitudes towards academic disciplines. The authors emphasised that, regardless of changes in the world or society, sustainable development in education is crucial. Their findings illustrate that while online learning can be successfully implemented in universities in the short term, a long-term perspective demands the development of a hybrid system based on blended learning, utilising modern technologies that can swiftly adapt to the changes of a dynamic environment and ensure educational sustainability. Other researchers, such as M. Caeiro-Rodriguez *et al.* (2021), have highlighted the need for continued intensive technological development in shaping higher education services, with a focus on information exchange, which they define as a European perspective.

A similar approach to managing not only individual educational institutions but the entire education sector, as described in this study, has been elaborated upon by researchers N. Vinogradova *et al.* (2020). Specifically, these researchers drew a parallel between the formation of a knowledge economy and the creation of an information and communication technology environment. In this context, SMART technologies serve as a trajectory for building the future educational model of higher education, as they enable flexible changes in the learning process, allowing for adaptability, personalisation, continuity, multidimensionality, and systematic approaches.

The concept of constructing trajectories for educational institutions has been extensively researched in publications by Chinese scholars, as evidenced by the articles of F. Yang *et al.* (2022) and Y. Can & A. Hou (2021). In the research of Y. Can & A. Hou (2021), it was noted that since 2014, the Chinese government has been actively developing policies to promote the development of the Internet and encourage the participation of students from remote areas of the country in education, as well as international student mobility. The existing policy comprehensively utilises supply-oriented, environment-oriented, and demand-oriented instruments. The latter two instruments are used more frequently and effectively, as noted in the study of F. Yang *et al.* (2022), due to the increasing use of modern communication tools by the population. The findings support the argument made by scientists that the analysis of an institution's development trajectory is fully correlated with access to modern information and communication technologies. The Internet and the tools oriented towards supply, environment, and demand allow for the rapid modification of educational service delivery paths and encourage students to engage with the SMART technologies available within the institution. It is difficult to agree that the pressure for liberalisation in education compels countries to adapt their educational systems, but it is easier to agree that the use of modern technologies in education is influenced by market demands (Can & Hou, 2021). In this context, it is also hard to dismiss the multilayered approach that facilitates the creation of short paths through the use of SMART technologies, while simultaneously expanding the sphere of collaboration with employers. Therefore, it is possible to agree with and significantly extend the research by N. Vinogradova *et al.* (2020) concerning the formation of a knowledge economy through SMART technologies.

The identified prospects of interaction and mutual influence of SMART technologies, which have found implementation and mathematical grounding in the proposed approach, can be used to construct new higher education models. This is not only due to the "convenience" and attractiveness of technological innovations, as defined by researchers N. Vinogradova *et al.* (2020), but, further building on this, it enables the formation of professionals capable of addressing issues swiftly and efficiently, utilising the latest developments and an understanding of the historical connections. This, in turn, supports the assertions made by T. Zhang *et al.* (2020) regarding the competition of innovations, with an emphasis on innovations in education that shape educational services, responding promptly to changes in their lifecycle.

When comparing the present research with the studies of T. Zhang *et al.* (2020) and M. Caeiro-Rodriguez *et al.* (2021), it cannot be agreed that the use of new technologies to build the trajectory of an educational institution and the application of SMART technologies for this purpose is solely a European perspective. M. Caeiro-Rodriguez *et al.* (2021) provided an example of higher education institutions in Greece, Estonia, Denmark, Portugal, and Spain, where, in addition to the best practices of using SMART technologies in managing educational services, challenges related to student communication were noted. However, T. Zhang *et al.* (2020) highlighted the potential for ensuring the sustainability of education, which also involves the development of communication skills, as confirmed by the study described in this research. As a result, students who participated in the experiment significantly increased their communication with lecturers and administrative staff, as they gained the opportunity to receive answers to questions, prompt

feedback, and enhanced communication among participants in the educational process. This was corroborated by the increased attendance at consultations and the number of new registrations for additional consultations and electives.

CONCLUSIONS

During the course of the research, an algorithm for managing the development of an educational institution through the construction of a management trajectory was developed. The information required to create this trajectory was gathered using SMART devices from the participants in the educational process. The mathematical framework allowed this approach to be adopted as a foundation for creating similar systems in other higher education institutions across Ukraine. Effective feedback within the educational institution not only facilitated the clear construction of the institution's trajectory but also contributed to the improvement of the educational service itself by increasing engagement and enabling participants in the educational process to access information in real-time. Moreover, the feedback between students and lecturers or the institution's administration enables management according to effectiveness criteria, as the information used for decision-making is not only timely but also systematised, thereby minimising the time spent on information processing.

Comparing the aforementioned approach with the experience of countries considered in the analysed academic sources, it is possible to highlight the undeniable advantages of the proposed approach: realism and optimality, which, when combined with real-time operation, demonstrate the effectiveness of SMART technologies, as they align with the SMART criteria outlined in the concept. A limitation of the studies reviewed is the relatively small number of transitions for operating SMART devices, which may result in the loss of some data packets and delays in processing the received information. This can be minimised by expanding the network of SMART devices and transmitting all data for processing in cloud services. These conclusions have allowed for the identification of promising research directions on this topic, namely: determining the development of soft skills when applying SMART technologies in managing the educational process, and developing adjustments to "services by design" using SMART technologies for monitoring the professional development of graduates, as the latter involves gathering information about practical experience, which depends on the evaluation of students' expectations. On this basis, it is possible not only to improve specific educational components but also to introduce new courses aligned with the demands of the time.

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CONFLICT OF INTEREST

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Маркетинг сталого розвитку у сфері освіти: імплементація SMART-технологій у навчальний процес

Оксана Немировська
Кандидат економічних наук, доцент
Державний податковий університет
08200, вул. Університетська, 31, м. Ірпінь, Україна
https://orcid.org/0000-0003-1955-6132

Анотація. Актуальність роботи була зумовлена дослідженням можливих підходів до управління закладами вищої освіти в контексті тенденцій цифровізації та інформатизації процесів функціонування сучасного суспільства. Метою роботи була розробка підходу побудови освітнього процесу навчального закладу за допомогою SMART-технологій (Specific, Measurable, Assignable, Realistic, Time-Related) для покращення якості освітнього процесу. В роботі було використано підхід, що об'єднує окремі математичні моделі теорії цифрових автоматів та дозволяє опитувати за розробленим алгоритмом пристрої, які знаходяться у зоні моніторингу, разом з методами синтезу, економічного аналізу, логічного узагальнення, а також графічним та бібліографічним методами для унаочнення результатів (обладнання мережі навчального закладу – камери та датчики контролю середовища, індивідуальні електронні пристрої учасників освітнього процесу – смартфони, планшети, розумні годинники тощо). Було сформовано середовище «розумного навчального закладу», де відбулася підтримка прийняття рішень на основі інформації зі SMART-пристроїв та забезпечення зворотного зв'язку за потребами студентів. Особливість розподіленої обробки інформації була реалізована за допомогою додаткового керованого комутатора, в керування яким було внесено зміни на основі теорії автоматів. Апробація підходу відбувалася у Державному податковому університеті (м. Ірпінь) за допомогою добровільної участі здобувачів освіти 2-4 курсів освітнього рівня «бакалавр» у березні-квітні 2024 року. Отримані результати порівнювалися з результатами роботи, отриманими без задіяння SMART-пристроїв та показали зростання якості надання освітньої послуги на 1,2 % завдяки покращенню якості відвідування та активізацією участі здобувачів вищої освіти в процесі отримання знань. Практична цінність даної роботи полягає у можливості застосування даного рішення для підвищення якості освітньої послуги у вищих навчальних закладах, що сприяє зростанню задоволеності споживачів послуги

Ключові слова: цифровізація освіти, моніторинг виконання освітніх послуг, розподілена обробка інформації, обмін інформацією управління, матриця переходів, вхідний сигнал

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Exploring the assessment system of municipal finance management: Ensuring sustainability and resilience in Latvian communities

Karlis Ketners*
Doctor of Philosophy
Vytautas Magnus University Agriculture Academy
LT-53361, 11 Studentu Str., Kaunas, Latvia
https://orcid.org/0000-0001-7891-2745

Mara Petersone
Doctor of Philosophy
Riga Technical University
LV-1048, 6A Kipsalas Str., Riga, Latvia
https://orcid.org/0000-0001-7720-1482

Abstract. The conducted research proposes a system of financial ratios as part of a composite index to assess the sustainability and adaptability of municipalities, which includes analysing the structure and dynamics of budgetary indicators. The purpose of the study was to develop a methodology aimed at identifying factors affecting financial sustainability and providing practical recommendations for improving the sustainability of municipalities in a volatile economic environment. The methodology of the study included an analysis of the state of municipal finances, an assessment of budgetary resources, the identification of risks and the development of measures to minimise them based on financial statements, interviews, and expert assessment of key indicators. The study identified key indicators of the financial stability of Latvian municipalities, including the level of independence from inter-budget transfers and the ratio of own expenses to income. Based on the results obtained, it was determined that municipalities with a high share of their own income demonstrate a better ability to adapt to economic shocks. In turn, the regional analysis highlighted significant differences in the structure of income and expenditure, where municipalities that were more dependent on transfers faced budgetary planning constraints. In addition, the use of the coefficient system helped to assess financial stability, both in static and dynamic terms, identifying the risks associated with a high debt burden and low liquidity. Due to the fact that the research methodology was based on the analysis of financial statements and expert assessments, it provided the development of a composite index for risk forecasting. Thus, the results highlighted the need to increase the financial autonomy of municipalities and optimise debt policy. The proposed recommendations of the study were aimed at reducing regional disparities and strengthening the financial stability of local budgets. The importance of the findings lies in providing tools that allow developing sound recommendations for improving budget management and adapting to economic challenges

Keywords: financial stability; organisational stability; composite coefficient; economic challenges; regional imbalances; economic adaptability

INTRODUCTIONS

Sustainability in public administration is determined by the ability to adapt and maintain efficiency in the face of various shocks. In municipal government, this sustainability ensures the continuous provision of public services, which is especially important in the context of increasing attention to sustainability issues in local government

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*Corresponding author

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policy. It is important to note that this requires preparedness for possible budget shocks and the ability to detect financial risks early. However, budget planning decisions should be based on the principles of sustainability, including adaptation to new data, alignment of budget priorities with common goals, and flexibility in the face of changing external factors. In this context, municipalities are required to develop financial models that support the existing infrastructure, respond to changes affecting its condition, and maintain the ability to provide services. Economic sustainability and sustainable financing ensure balanced regional development and contribute to reducing socio-economic inequality.

Sustainability as a concept has taken a central place in the framework of urban governance, becoming a response to the challenges facing researchers, policy makers, and practitioners. It is a universal approach that focuses on the need for foresight and readiness to manage urban systems in the face of various shocks. For example, T. Ahrens & L. Ferry (2020) analysed the financial stability of local governments in England in the context of the COVID-19 pandemic and found that the crisis had exacerbated existing financial imbalances, but individual municipalities had demonstrated the ability to adapt through strategic resource management. R. Levine *et al.* (2020) investigated the relationship between local financial structures and the economic stability of territories, and the results of their study showed that decentralised systems contribute to greater flexibility in times of crisis. According to the general opinion of these researchers, decentralisation and flexibility are becoming especially important to ensure the sustainability of resource flows and critical infrastructures necessary for the smooth functioning of households and businesses.

In the scientific literature, sustainability is often analysed in the context of policies and practical frameworks aimed at overcoming the consequences of natural disasters, conflicts, and terrorism. An example of such research is the study by S. Woodruff *et al.* (2021), devoted to the analysis of urban sustainability through the study of policies implemented in US cities and demonstrating that the integration of sustainable strategies into urban planning contributes to more effective adaptation to environmental changes and socio-economic challenges. However, there is also criticism of such initiatives. S. Fastenrath *et al.* (2019) have insisted that such initiatives often prioritise the interests of the private sector by redistributing the tasks of public administration and reducing the level of democratic participation. As an example of a transformational innovation policy aimed at strengthening urban sustainability, the authors examined the "Resilient Melbourne" strategy and at the same time critically analysed it, pointing to a shift in priorities towards the interests of the private sector, which is accompanied by a redistribution of public administration tasks and a decrease in the level of democratic participation.

Despite the growing interest in sustainability as a key element of urban governance, issues of infrastructure and resource allocation are being studied primarily. In particular, S.A. Argyroudis *et al.* (2020) developed a framework for assessing the sustainability of critical infrastructure in a multi-risk environment, including transport facilities, and emphasised the importance of a comprehensive risk assessment to improve the reliability and security of infrastructure. T.J. Nipa & S. Kermanshachi (2022) concluded that standardised approaches to sustainability assessment are necessary. Both studies were primarily focused on financing new infrastructure and improving operational efficiency, ignoring the need to integrate the day-to-day financial operations of cities into the framework of sustainability. The ability of municipalities to effectively attract, allocate, and use financial resources has significant weight in their sustainability and adaptability. In this context, ensuring the sustainability of municipalities through the management of financial flows and resources becomes the main task of systemic management and part of sustainability strategies, since only with financial autonomy is it possible to successfully counter external shocks and ensure the sustainable development of territories (Chohan, 2022). However, the financial sustainability of local governments remains poorly understood.

It is important to consider that understanding the differences between municipalities in the levels of economic sustainability and sustainable financing is necessary to develop effective regional development policies. Economic sustainability is characterised by the ability of municipalities to adapt to unforeseen economic shocks, whereas sustainable financing is associated with responsible management of financial resources for long-term development and environmental protection. One of the main conditions for sustainability is economic diversification, reducing vulnerability to shocks and fluctuations. Financial sustainability, in turn, describes the ability of municipalities to anticipate, absorb, and respond to shocks affecting their budgets and service delivery.

Based on the above, the purpose of this study was to develop an integrated approach to assessing the financial sustainability of municipalities, including ensuring their adaptability and sustainability in the face of economic and social challenges. To achieve the purpose of the study, the following tasks were set: to determine the main elements of the composite coefficient of financial stability of municipalities; to develop and test a system of coefficients for assessing financial stability; to propose approaches to reforming the system of equalisation of local budgets aimed at strengthening financial stability and ensuring socio-economic stability of municipalities.

MATERIALS AND METHODS

The study was based on a combination of theoretical and empirical methods, including the analysis of secondary data, interviews with representatives of municipalities and the Ministry of Finance of the Republic of Latvia (2024), and the use of statistical and comparative analysis methods. The selected methods allowed investigating dynamic and static indicators, including income, expenses, debt

obligations, and volumes of inter-budget transfers, and the use of official accounting data (Analysis of financial indicators of local self-government bodies (2020), On borrowings and guarantee obligations of local self-government bodies, Official statistics on the State Budget of the Republic of Latvia for 2020-2024) provided a high level of accuracy, helped in identifying key factors affecting the financial sustainability of municipalities.

To assess financial stability, a system of composite coefficients was developed, including indicators of cost coverage with own income, the degree of dependence on inter-budget transfers, debt burden, and budget sustainability. The composite coefficient helped to comprehensively assess the adaptability of municipalities to economic shocks and their ability to support sustainable development. And the use of time series (January-March 2024) provided an opportunity to assess the adaptability of municipalities to economic shocks. The main objective of the study was to identify and evaluate dynamic and static indicators characterising the financial situation and sustainability of local governments, with an emphasis on the stability of income, expenses and providing liquidity to support operational activities. For the analysis, a set of coefficients was proposed to determine financial stability and financial management in three categories according to their nature and content (coefficients of budget balance, coefficients of independence and sustainability, and coefficients of management efficiency and expenses), in accordance with the studies by R. Cabaleiro *et al*. (2012), B. Mcdonald (2017), and E. Padovani *et al*. (2010). Based on the available data, five groups of coefficients were recommended:

1. Coefficients of the balance of the local budget, reflecting the degree of revenue coverage of expenditures, including deficit coverage and uniformity of expenditures.

2. Coefficients of financial independence from the resources of the central government.

3. Expense policy orientation coefficients, with a focus on current expenditures, investment activities, administrative expenses, and expenditures on public goods.

4. Financial stability coefficients describing the ratio of income and expense components.

5. Debt dependency ratios that determine debt levels, solvency, and debt management costs.

The chosen system helped to integrate various aspects of financial stability and conduct a comprehensive analysis. This approach identified risk factors and developed recommendations for strengthening the resilience of municipalities (Sebestova *et al*., 2018). In addition, an analysis of the dynamics of financial indicators based on the processing of reports was applied. This method helped to identify changes in the structure of income and expenditure of municipalities in the context of changing economic circumstances. Comparative analysis methods were used to analyse the collected data, which helped to assess the differences between municipalities in key financial indicators. This approach has helped to identify patterns and factors affecting the sustainability of budgets.

In addition, in the period from January to March 2024, interviews were conducted with representatives of 25 municipalities and 4 representatives of the Ministry of Finance of Latvia. The respondents included mayors, finance directors, and heads of departments of the Ministry of Finance, which provided a variety of points of view and depth of analysis. The main interview questions were aimed at studying budget management practices, the level of dependence on inter-budget transfers, debt burden and strategies for increasing financial independence. The interviews were conducted in compliance with the standards of confidentiality and voluntary participation, which complies with the Code of professional ethics of the International Sociological Association (ISA, 2024). The ethical aspects of the study included the mandatory receipt of informed consent from all respondents and depersonalisation of data (anonymity), which guaranteed confidentiality. This approach fully complied with international standards (Ethics and data protection, 2021) and ensured the integrity of the results. Additionally, expert assessments provided by representatives of the Ministry of Finance of the Republic of Latvia complemented the analysis and contributed to the clarification of key coefficients and their thresholds, which ensured the verification of the results and increased their practical significance. This methodology demonstrates a consistent approach to data collection, analysis, and interpretation, providing optimal conditions for achieving research goals.

RESULTS

The municipal finance management assessment system is a set of tools aimed at analysing and diagnosing the financial stability of local budgets (Łukomska-Szarek *et al*., 2024). It is based on the principles of transparency, responsibility and sustainability, which allows not only assessing the current state of municipal finances, but also to predicting their changes under the influence of external and internal factors. In conditions of increasing economic instability, the role of such systems is increasing, as they allow timely identification of risks and take preventive measures.

One of the key objectives of the assessment system is to ensure balanced development of municipalities, which is achieved through an analysis of the structure of income and expenses, debt burden, and the level of dependence on external transfers (Białek-Jaworska, 2021). Such approaches help to identify the strengths and weaknesses of financial management, identify priorities, and develop strategies to achieve long-term sustainability. In addition, an important aspect is also the assessment of the effectiveness of budget spending, which includes the study of areas that are most important for the socio-economic development of the regions. By itself, the assessment system is not an isolated accounting and forecasting tool, it relies on the use of financial coefficients, which are quantitative indicators that characterise various aspects of budget management. Among them are the coefficients of the balance of the local budget, financial independence, the orientation of spending policy, sustainability, and debt dependence.

The study identified key groups of coefficients (Table 1), which are the basis for assessing the financial stability of municipalities in Latvia. Each group of coefficients reflects individual aspects of budget sustainability and financial independence of municipalities, which provides a holistic approach to their analysis.

Table 1. Analysis of groups of coefficients of financial stability of local budgets

Group	Key coefficients	Main assessment factors	Reference values
Coefficients of local budget balance	Total budget coverage ratio	Covering total expenses and deficits with income excluding borrowings	≈1
	Coefficient of budget deficit coverage		≤10%
Coefficient of financial independence	Coefficient of financial autonomy	Share of income dependent on the efforts of municipalities	High value
	Coefficient of tax independence of the budget	Share of tax revenues in the total revenue structure	40-60%
	Coefficient of direct financial dependence	Share of transfers and subventions in own income	≤30%
Expense policy coefficients	Current expense ratio	For current expenses in total expenses	50-70%
	Administrative expense ratio	Cost of maintaining the administration in the amount of socially significant expenses	5-15%
	Coefficient of social orientation of the budget	Share of expenses for social functions in the total expense structure	≥20%
Coefficients of budget sustainability	Coefficient of overall financial stability	Covering current expenses at the expense of own tax and non-tax income	≥50%
Coefficients of debt dependency	Coefficients of debt dependency	Ability to cover debt obligations with own income	≤20%
	Debt burden	Share of debt management expenses in current expenses	≤20%

Source: developed by the authors

The first group of coefficients is the coefficients of the local budget balance. The value of this coefficient, close to unity, minimises the risk of financial instability. The reference value of the budget deficit coverage ratio for individual municipalities should not exceed 10%. The second group includes the coefficients of financial independence of local authorities and the coefficient of financial independence. These indicators measure the degree of dependence of municipalities on centralised resources, and also demonstrate the share of income generated by the efforts of local authorities, including income from taxes and property. A special case is the tax independence coefficient, which estimates the share of tax revenues in the total income structure. The coefficient of direct financial dependence illustrates the share of transfers, subventions, and other forms of co-financing in the budget's own revenues. The third group of coefficients is represented by coefficients characterising the budget policy in the field of expenditures. A high value of the current expense ratio may indicate a lack of resources allocated to investment projects. The administrative expense ratio determines the share of administrative expenses in the total expenditure on public goods. The social orientation coefficient of the budget is also used, reflecting the share of expenditures on education, culture, health, sports, social policy, and environmental protection. The fourth group of coefficients is budget sustainability coefficients, which analyse the ratio between income and expenditure, assessing the financial stability of municipalities. The coefficient of overall financial stability shows the extent to which current budget expenditures are covered by their own tax and non-tax revenues. However, in the case of Latvia, the significance of this ratio is close to zero. The fifth group covers the debt dependency ratios of local authorities. The reference value of this indicator should not exceed 20%, which makes it possible to ensure budget stability even in the face of economic shocks.

The proposed system of coefficients can be used for a static assessment of the financial condition of local governments. The static measurement of the financial position based on classical methods of financial reporting analysis helps to assess the budgetary situation and the system of public service provision as a whole. Using comparative analysis methods, it is possible to assess the budget status relative to reference values and determine resilience to potential risks. In particular, according to official statistical information (Analysis of financial indicators of…, 2020), it was chosen to demonstrate the overall financial condition of municipal budgets using the example of a common value (throughout the Republic of Latvia) and 4 sample municipalities – Riga, Daugavpils, Jurmala, and Ventspils (Table 2).

Table 2. Key indicators of some municipal budgets of Latvia for 2022-2023, millions EUR

Year	Municipality	Planned income	Actual income	Planned expenses	Actual expenses	Surplus/ Deficit	Changing the balance of funds	Change in balances (%)
2022	Riga	1.038	1.162	1.182	1.112	-144.4	-37.6	24%
	Daugavpils	119.1	125.6	132.2	123.1	-13.2	-1.6	12%
	Jurmala	101.5	103	128	105.1	-26.5	2.1	-11%
	Ventspils	63.6	66.8	77.8	64.2	-14.2	3.1	17%
	General value	3.251	3.442	3.795	3.379	-544.7	62.9	26%
2023	Riga	1.237	1.285	1.433	1.317	-195.6	35.5	-19%
	Daugavpils	131.4	132.2	141.1	131.7	-9.7	5	-32%
	Jurmala	104.2	103	140.3	106.5	-36.1	0.7	-4%
	Ventspils	67.6	62.6	88.6	75.6	-20.97	-8.85	-41%
	General value	3.641	3.685	4.322	3.841	-680.8	-156.2	-21%

Source: developed by the authors based on OECD (2024)

The choice of municipalities for the analysis in Table 2 was determined by their significant role in reflecting the financial characteristics of Latvia. Riga was included as the capital and largest city of the country, which makes it a key example in terms of budget structure, financial capabilities, and management practices. Daugavpils is the second largest city, characterised by a greater degree of dependence on transfers and a different economic base. Jurmala was chosen due to its unique role as a tourist centre, which makes it possible to analyse the impact of seasonality and investment attractiveness on the local budget. Ventspils, which is a significant port city, illustrates the specifics of budget planning in conditions of active use of infrastructure potential. Thus, these municipalities provide a comprehensive analysis of financial sustainability, considering diverse regional contexts.

In 2022, the total planned revenues of all municipalities amounted to EUR 3.251 billion, and the actual revenues exceeded the plan by 5.9%, reaching EUR 3.442 billion. This indicates a high level of budget revenue execution. However, despite the increase in revenues, municipal expenditures in 2022 amounted to EUR 3.379 billion against the planned EUR 3.795 billion, which also indicates a slight under-fulfilment of the expenditure side of the budget. This resulted in a deficit of EUR 544.7 million, which is a significant figure for most municipalities. Nevertheless, at the end of the year, the total balance of funds still showed an increase of 26% from the remaining funds at the beginning of the year, which indicates a slight improvement in liquidity and financial stability. In 2023, the situation changed. The total municipal revenue amounted to EUR 3.685 billion, which is 6.5% higher than in the previous year. However, expenses increased to EUR 3.841 billion, which also led to a budget deficit of EUR 680.8 million. Thus, despite the growth in the revenue side of the budget, expenditures turned out to be higher, which indicates an increase in the deficit and a higher burden on local budgets. The change in fund balances in 2023 was negative and amounted to EUR 156.2 million, which represents a 21% decrease in municipal liquidity, which may indicate financial difficulties that urgently need to be addressed to ensure the sustainability of budgets for future periods. In addition, for greater clarity, an analysis of regional disparities is presented in Table 3.

Table 3. Analysis of regional imbalances in Latvia's municipal budgets

Municipality	Income change (2023-2022), %	Expense change (2023-2022), %	Deficit 2022, million EUR	Deficit 2023, million EUR	Main conclusions
Riga	10.6	18.4	50	-32	High revenue growth and a significant increase in expenses led to a deficit in 2023.
Jurmala	0	1.3	-2.1	-3.5	Lack of income growth and a small deficit, requiring improved income diversification.
Daugavpils	5.3	7	2.5	0.5	Stable financial management with a moderate increase in income and expenses.
Ventspils	-6.3	17.8	2.6	-13	Declining revenues and rising expenses have increased the budget deficit.

Source: developed by the authors

The analysis of regional imbalances in the budgets of municipalities in Latvia points to key challenges in ensuring financial stability. The main factors are differences in the growth rates of income and expenses, and in the ability to adapt to changing conditions. Regions with more diversified economic bases demonstrate greater resilience to financial challenges, while dependence on external financing increases budgetary risks. These data confirm the need for targeted reforms, including stimulating own incomes, optimising the cost structure and equalising financial support for the most vulnerable municipalities.

In addition, for a deeper understanding of the financial condition of municipalities in Latvia, it is necessary to compare their indicators with reference coefficients (Table 1). Thus, the budget coverage ratio (total budget coverage ratio), according to calculations, exceeded the planned revenues, which led to a deficit. The deficit was EUR 544.7 million in 2022 and EUR 680.8 million in 2023. According to the reference value, the budget coverage ratio should be close to 1, which means that expenses should be covered by income without borrowing. However, in this case, the municipalities did not comply with this requirement, which indicates financial instability. The budget deficit of EUR 680.8 million in 2023, despite the increase in income, exceeded the acceptable level, indicating the high financial dependence of municipalities on external financing. The reference value of this coefficient should not exceed 10%. Despite the revenue growth in 2023, the dependence of local budgets on transfers and external financing remained high.

At the end of 2023, the total amount of borrowings by government agencies of the Republic of Latvia amounted to more than EUR 930 million (Main aggregates of general…, 2023), which confirms the significant dependence of the authorities on external sources, but does not exceed 20%. These indicators do not deviate from the reference values of financial independence coefficients, which assume a high level of self-financing of municipalities, but, however, they are not in the minimum values and require attention. Debt dependency ratio and debt burden have demonstrated a significant debt burden, which is almost 6%. The high debt burden on Latvian municipalities indicates a potential threat to their financial stability and requires attention to debt financing policies. The analysis of expenditures in 2019-2023 emphasised that these indicators fall within the established reference values, however, they tend to deteriorate. In 2019, the debt burden was about 0.4% (EUR 45 million), while in 2021 this figure reached 18.4% (EUR 2.331 million), which indicates an insufficiently efficient allocation of funds. In addition, these indicators highlighted the limitations of opportunities for long-term economic growth and development.

Based on the analysis of the financial indicators of the municipalities of Latvia for 2022 and 2023, it can be concluded that the financial situation of the municipalities remained tense. Despite the increase in revenues in 2023, municipalities continued to face budget deficits and an increased debt burden, which indicates the need to take comprehensive measures to improve financial management, optimise costs and reduce dependence on external sources of financing. To ensure long-term financial stability, municipalities should focus on increasing tax independence, rationalising spending, and reducing debt burden. For countries with a decentralised management system, such as Latvia, the introduction of effective systems for assessing municipal finances is becoming especially important. This is primarily conditioned by the need to ensure the even development of the regions and reduce socio-economic inequality. The assessment system can serve as a basis for developing financial equalisation policies that enhance the resilience of the most vulnerable municipalities. In addition, the analysis revealed that the regions of Latvia show significant differences in the level of dependence on transfers from the central budget and their own ability to budget self-government. Figure 1 presents the official statistics for 2023 and the projected values up to 2026.

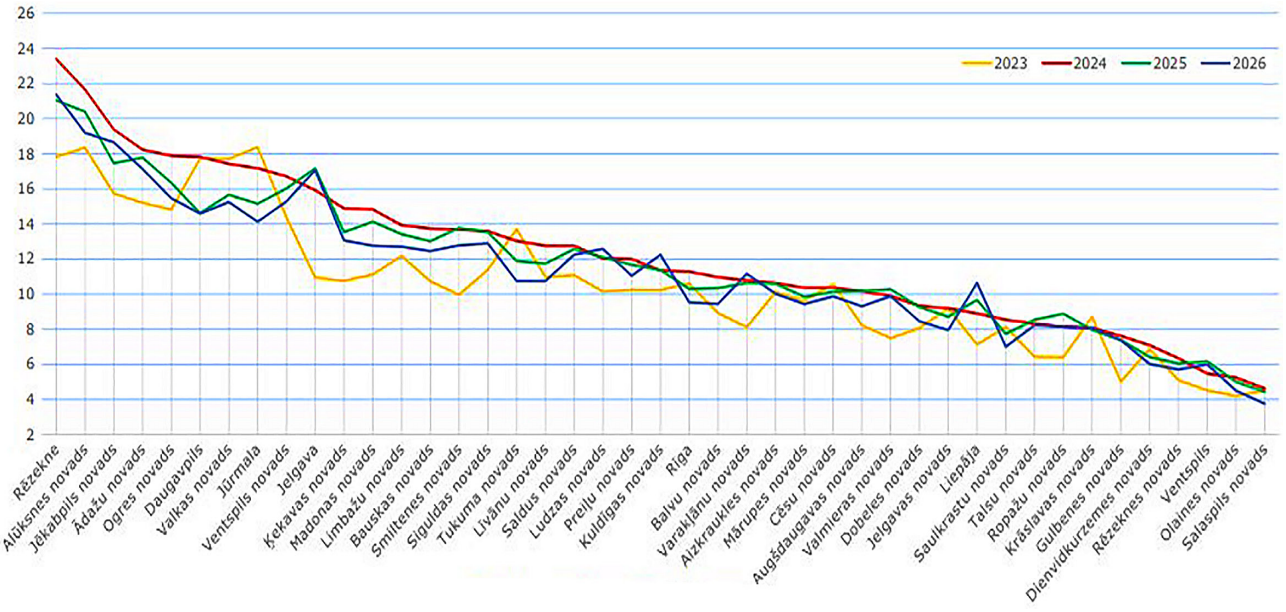

Figure 1. Amounts of obligations assumed by local governments (%), 2023

Notes: Number of annual payments on loans, guarantees, and other long-term obligations as a percentage of the planned revenues of the 2023 core budget (excluding PFIF contributions and targeted transfers from the state budget). Rezekne Municipality has overdue payments in the amount of EUR 4.3 million as of 11/30/2023, and the total amount of obligations for 2023, including overdue payments, is 29.9%
Source: developed by the authors based on the On local government borrowing and guarantee obligations (2024)

This graph shows a decrease in the dependence of Latvian municipalities on debt obligations, which indicates an increase in their financial stability. Despite the general trend towards reducing the debt burden, the situation varies by city. Some municipalities have been able to significantly reduce their debt (Rezekne, Daugavpils, Jurmala, Siguldas Novads, Salaspils Novads), while others are showing less significant results (Riga, Valmiera District and Kuldiga District). This difference is explained by both economic factors and the effectiveness of financial management. A lower debt burden allows cities to allocate more funds to infrastructure development and increases their resilience to external crises. In general, to determine the prospects for improving the financial stability of municipalities in the Republic of Latvia, it is worth analysing the distribution of the state budget by sector for 2020-2023 (Figs. 2-3).

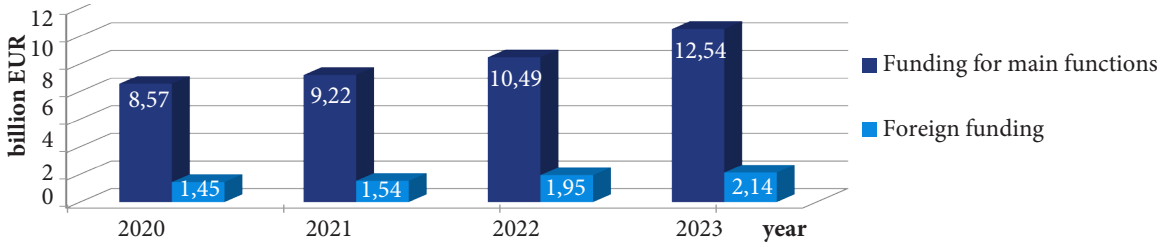

Figure 2. General state budget, 2020-2023

Source: developed by the authors based on data of Ministry of Finance of the Republic of Latvia (2020, 2021, 2022, 2023)

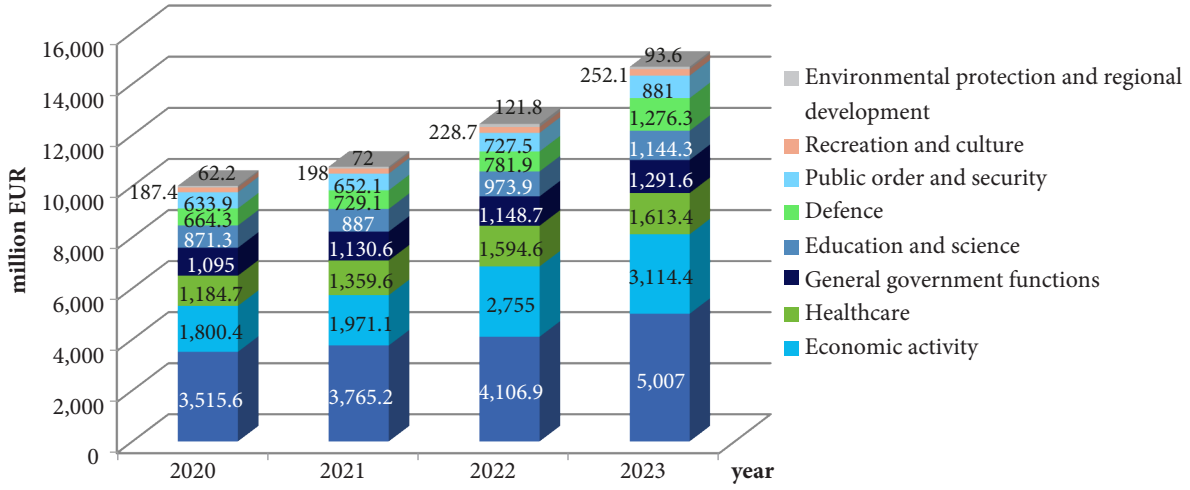

Figure 3. Distribution of the state budget by sector, 2020-2023

Source: developed by the authors based on Ministry of Finance of the Republic of Latvia (2020, 2021, 2022, 2023)

An analysis of the distribution of Latvia's state budget funds in 2020-2023 shows a steady increase in total expenditures, which indicates an increase in government funding in various areas. The bulk of the funds are allocated to key government functions such as education, healthcare, and social protection. There is also an increase in the share of foreign financing, which indicates the attraction of external resources for the implementation of projects. However, the growth of various budget items is uneven, which requires separate assessment and attention.

An analysis of Latvia's budget expenditures during the period under review shows a steady increase in total government spending, which indicates an expansion in the scope of government influence and an increase in social obligations. The main priorities are aimed at social protection, healthcare, and education, which emphasises attention to improving the lives of citizens and developing human potential. There has also been an increase in spending on environmental protection and safety, reflecting the growing importance of environmental and social issues. An integrated financial position indicator can be used to simplify financial analysis. This indicator includes the ratio of income to expenses (risks of spending and deficit obligations), the ratio of transfers and subventions in income (dependence on income), the share of tax revenues (income stability), and the ratio of debt obligations to total expenses (dependence on debt). Given the importance of unforeseen circumstances for some municipalities, such as, for example, COVID-19, it is possible to add a proportion of unforeseen expenses to total expenses (risks of expenses for unforeseen events). Additional studies can be supplemented with various coefficient weights using expert methods, establishing a linear objective minimisation function for this integrated indicator and evaluating the projected outcomes and policy interventions.

The data obtained as a result of the analysis can be used for an integrated assessment of local budgets and the structure of the rating of local authorities according to the criterion of budgetary sustainability. The methodology requires setting thresholds to assign municipalities to a specific financial type, depending on the level of the budgetary situation. To assess the balance, financial independence and sustainability of the budget, the orientation of the budget policy of local government and the policy of debt sustainability, a system of the above-mentioned coefficients was proposed. The proposed approach analyses the financial situation of local authorities in terms of the sustainability and resilience of the budget situation. As can be seen from Figure 4, the static analysis used revealed significant differences in the incomes of municipalities, but did not allow them to be grouped into clear groups. Some municipalities have shown extreme results.

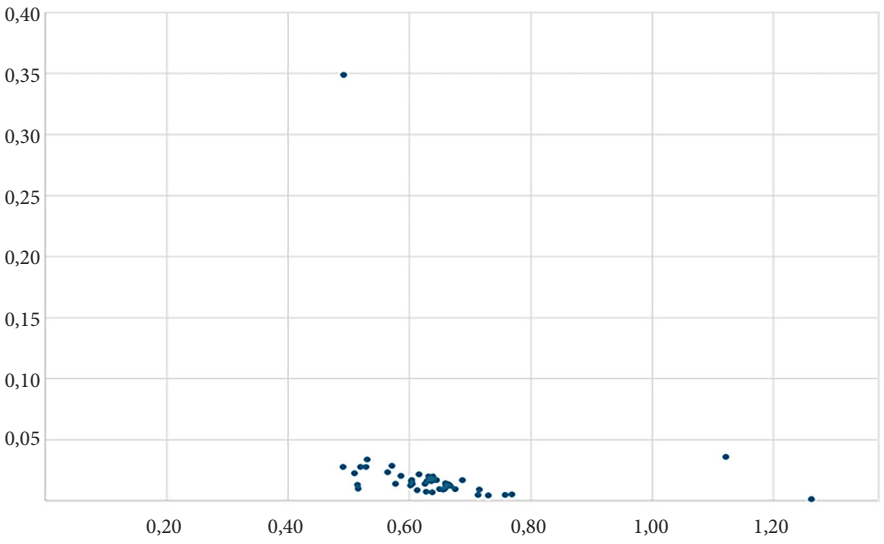

Figure 4. Initial results of the integrated coefficient weighted by the share of total revenues of local authorities
Notes: X-axis – share of municipal income in total income; Y-axis – integrated coefficient
Source: developed by the authors based on Ministry of Finance of the Republic of Latvia (2024)

The problems identified in the analysis of financial indicators of local government systems are related to the level of financial autonomy, which directly depends on the level of own revenues of local budgets, a high proportion of current expenses and dependence on various investment projects with foreign financing and borrowed funds. The example of Latvia demonstrates the main sustainability factors, such as the structure of expenditures, the impact of transfers and the equalisation fund, and the structure of own and target budget revenues. In the context of the medium-term impact, the consequences of the COVID-19 pandemic are still present (Arhipova *et al.*, 2022), and the existing debt problems should also be mentioned. Thus, the main shocks and risks are associated with a reduction in tax revenues due to changes in legislation (for example, such as an increase in the minimum amount of fixed capital for limited liability companies (SIA) or changes in the Law on Budget and Financial management of Latvia aimed at unifying and establishing differentiated standards for contributions to local budgets), and the economic situation, changes in the functional and economic structure of expenditures, and other major problems of financial sustainability of local authorities, such as, for example, pandemics and the cost of unforeseen events.

Based on this, it can be concluded that the key elements of the indicator of financial stability of municipalities in Latvia are, but are not limited to, independence from intergovernmental transfers (assessment of the municipality's dependence on transfers from higher levels of government: a higher degree of financial independence indicates greater stability), and covering the own expenses of local budgets (assessment of the ratio of the municipality's own income to its expenses – this indicator reflects the municipality's ability to support its activities with its own financial resources). And the municipal financial management assessment system is a multifunctional tool that can significantly improve the quality of decision-making at the local level. It serves not only to diagnose the current state, but also for strategic planning, which is especially important in conditions of increasing economic uncertainty. For an objective assessment of the financial situation of local budgets in a dynamic aspect, it is proposed to use three main indicators: the deficit (primary balance) in relation to total expenditures, the ratio of current account balances to total expenditures, and the total amount of borrowings (debt to expenditure ratio). These indicators can be analysed based on monthly and quarterly reports with a clear assessment of trends. Unlike a static assessment, a graphical approach can be used to analyse changes in these indicators (Fig. 5).

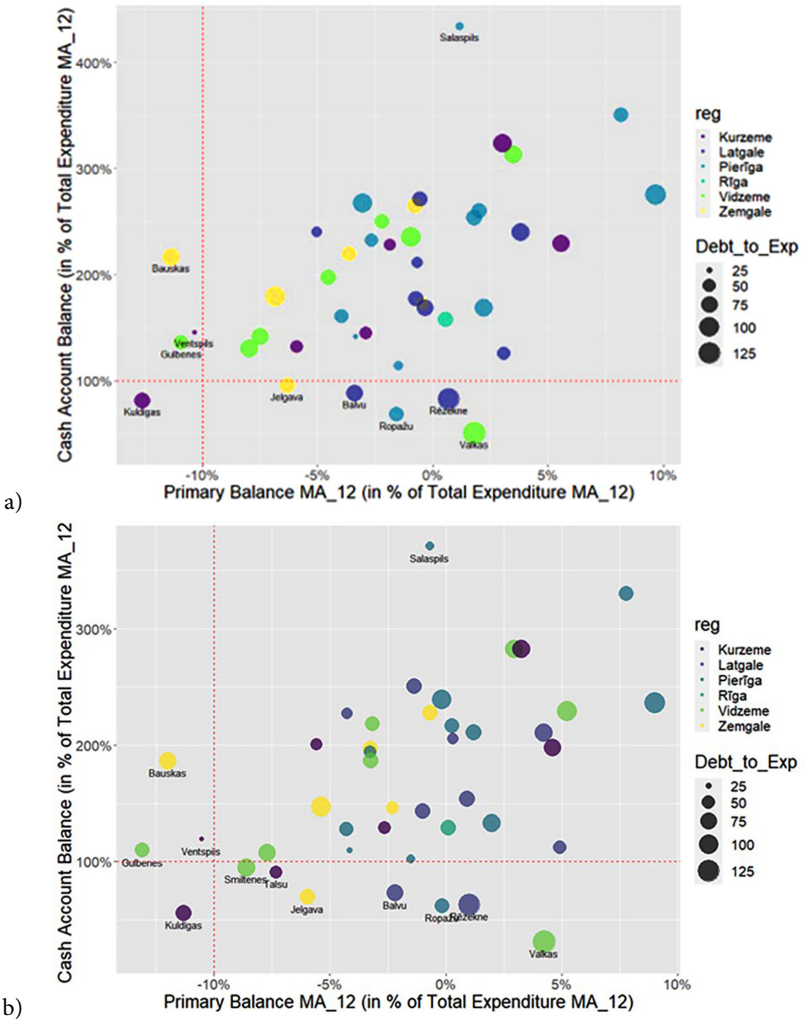

Figure 5. Initial dynamic measurement results for local authorities

Notes: a) January 2024, b) March 2024

Source: developed by the authors based on Ministry of Finance of the Republic of Latvia (2024)

The presentation of the state of the municipal budget through the volume of debt obligations and the balance of funds gives an idea of its resilience to possible changes and the risk of insolvency. The 100% and 50% cash ratio thresholds are used to evaluate the effectiveness of cash management and identify potential liquidity problems. The availability of short-term loans for budget management also signals liquidity problems. When experts compare estimates of the financial condition of municipalities with estimates based on a dynamic approach, their conclusions often coincide. However, the accuracy of these estimates may be affected by several factors, including reserve funds for investment projects and targeted financing, long-term debt balances from previous years, and their repayment dates. However, it is important to understand that static analysis alone does not provide a complete and transparent picture of the financial situation of local authorities, so both static and dynamic approaches must be considered. The interpretation of both coefficient measurements is necessary for an effective understanding of the sustainability of municipal budgets. In addition, when assessing liquidity and cash balances, it is necessary to consider the specific activities of local authorities. Although static coefficients can exceed standards found in the literature, dynamic measurement often reveals hidden financial vulnerabilities. This dual approach provides a more complete and accurate assessment of the financial condition of municipalities.

Based on the results of the study, some recommendations aimed at improving the financial stability of municipalities in Latvia can be offered. The most important priority is to reduce the dependence of municipal budgets on inter-budget transfers by increasing the share of own revenues. To this end, it is recommended to strengthen measures that stimulate economic development at the local level, such as supporting small and medium-sized businesses, improving tax collection efficiency, and introducing tools to attract investment. This will ensure a more stable income base, reduce vulnerability to external economic shocks and increase the independence of municipalities in decision-making. Additionally, it is recommended to optimise the debt policy of municipalities. The identified risks associated with a high debt burden require a review

of approaches to borrowing management. It is proposed to introduce strict limits on the volume of borrowings and strengthen control over the use of borrowed funds, directing them primarily to investment projects that ensure long-term economic effects. An important step is also to improve budget planning through the use of the developed coefficient system, which will allow municipalities to identify weaknesses in financial management in a timely manner, adapt to changing economic conditions and make informed decisions to ensure sustainable development.

DISCUSSION

The relationship between financial management and municipal performance has been the focus of many researchers. In particular, the consequences of financial inefficiency and non-compliance with governance standards for the sustainability of municipalities were studied by S. Mishi *et al.* (2022). The findings highlighted the importance of transparency in the use of budgetary funds, and the need for systematic monitoring to identify cases of financial abuse and mismanagement. The researchers also concluded that insufficient financial discipline and weak control lead to the accumulation of debts and deterioration of the quality of municipal services provided. These results show some overlap with current scientific research. Both studies highlighted the importance of developing assessment systems to diagnose the current state of municipal finances. The current study focused on creating a system of coefficients that assessed sustainability through levels of financial independence and debt burden. Similarly, the study by S. Mishi *et al.* (2022) emphasised that financial stability is impossible without strict control over debt management and budget funds. However, the essential difference lies in the focus: the current research focused on the adaptation of municipalities to economic shocks through an increase in the share of their own income, whereas the study by S. Mishi *et al.* focused on assessing the consequences of corruption and lack of discipline. Corruption and inefficiency in Latvia, although recognised as important, were considered in the context of their impact on long-term fiscal sustainability, rather than as a primary concern.

In parallel with this, M. Frintrup & D. Hilgers (2023) investigated the driving forces and risk factors determining the financial stability of municipalities, also focusing on debt burden and liquidity. Their study proposed measures to ensure long-term budget balance, including restrictions on the use of borrowed funds. During the analysis, the researchers found that factors such as debt burden and limited liquidity significantly affect the ability of municipalities to maintain stability in the face of external economic shocks. In addition, the study emphasised that sustainability is achieved through strict control over borrowing and maintaining a high level of income generated at the local level. The authors focused on the need to control adjusted income as one of the main tools for assessing sustainability, while the methodology developed in the current study has become more comprehensive, including the development of a composite index and a systematic approach to assessing all key indicators, including social and administrative costs. The study by M. Frintrup & D. Hilgers was based on strategic revenue planning, while in the context of current study, the focus was on estimating through a set of composite coefficients. Thus, this study appears to be more multifaceted in the context of analysing the financial stability of municipalities. It should also be noted that the study focused on minimising dependence on external transfers, while German researchers sought to optimise the use of available resources through increased transparency and long-term planning.

In addition, it is important to consider the broader context of sustainability, particularly in the context of the implementation of the sustainable development goals (SDGs). This is quite accurately reflected by H. Masuda *et al.* (2022). The researchers examined the role of local authorities in achieving the sustainable development goals, including an assessment of the intermediary role of municipalities in stimulating partnerships between various stakeholders. The focus was on the ability of municipalities to act as intermediaries forming partnerships between the public, private and civil sectors. It has been revealed that local governments can effectively integrate various resources and efforts to achieve sustainable development, but the success of such initiatives largely depends on institutional readiness, management flexibility, and the ability to adapt to social and economic challenges. Among the key conclusions of the study, it was noted that cooperation and the involvement of all stakeholders contribute to improving the effectiveness of SDG implementation, especially in conditions of limited resources. Comparing the study with the analysis of the sustainability of municipalities in Latvia, the similarity in the emphasis on adaptability and sustainable resource management can be noted. Both approaches emphasised the importance of strategic planning and the need to consider external challenges. However, the current study, despite the proximity of the goals, had a narrower focus, focusing on the financial aspects of sustainability. However, the developed methodology was favourably distinguished by its detail and the development of a coefficient system, which helped to more accurately assess the financial condition of municipalities and develop recommendations. Thus, the main difference between the studies was the approach to key sustainability tools. Meanwhile, H. Masuda *et al.* focused on coordinating efforts between different actors, and the study suggested an autonomous path for municipalities through increasing financial independence and optimising budget processes. This creates a meaningful basis for comparison, where the current study stands out for its applied nature and the development of methods that can be integrated into budget management.

A logical continuation of the analysis of the sustainability of municipalities from an international perspective was the study of financial resilience through the European model. The study by C. Barbera *et al.* (2023) examined the financial sustainability of municipalities, including crisis analysis. The researchers emphasised that the key factors

of financial resilience are the ability to adapt, ensure budget balance and long-term planning. Particular attention was paid to the interaction between the financial autonomy of municipalities and their dependence on central transfers. The results showed that the flexibility of budget management and timely adaptation to changing conditions can significantly reduce the negative impact of crises. Comparing the studies, it can be noted that the researchers paid great attention to financial autonomy and sustainability and came to similar conclusions that reducing dependence on external financing is a key condition for increasing the sustainability of municipal budgets. In the framework of the study by A. Vysochyna *et al*. (2022) revealed that successful economic development directly depends on financial autonomy and the ability to effectively manage local budgets. The results of this study coincide with the conclusions of current study, especially in the aspects of decentralisation and the need to increase financial independence, which emphasises the importance of own income as the basis for sustainable budget management. In addition, both approaches focused on debt policy and prevention of risks associated with excessive debt burden. However, the conducted research stands out for its emphasis on the development of a system of composite coefficients that allow not only assessing current sustainability, but also predicting possible risks. This difference highlights the uniqueness of the approach in which municipal finance management is considered as a systemic tool for ensuring sustainability.

The study by K.A. Wójtowicz & S. Hodžić (2022) confirmed that the main differences in the sustainability of cities are conditioned by their internal financial capabilities, rather than external shocks. The researchers also suggest that the most important element of sustainability is the ability of municipalities to diversify their sources of income and manage expenses in a way that minimises their debt burden. Their study also revealed that cities with a higher level of financial independence coped better with crises, and insufficient liquidity became a critical constraint for less stable municipalities. Conclusions of K.A. Wójtowicz & S. Hodžić confirms the results obtained, however, the study has a more structured approach, presenting a system of composite coefficients that assess stability in a static and dynamic perspective. The difference also lay in the fact that the current study paid considerable attention to regional disparities, analysing the impact of economic and social factors on the financial condition of municipalities.

The approach based on the composite coefficient system used in the current study helped to create a comprehensive tool for assessing both the current state and forecasting possible risks to the financial stability of municipalities using the example of Latvia. The scientific originality of the study lies in the integration of theoretical approaches with applied methods of analysis. Unlike other studies focused on specific aspects of sustainability, this study offered a holistic view of municipal financial resource management, focusing on independence from inter-budget transfers, cost structure, and debt burden. In addition, the proposed composite index is a tool that can be adapted and applied to municipalities in other countries, considering their specifics, which expands the scientific and practical significance of research. The study also offered some recommendations for reforming Latvia's local budget equalisation and debt management system. The developed methodology can be used to improve financial management not only in the Republic of Latvia, but also in other countries with a decentralised management system.

CONCLUSIONS

The conducted research has confirmed that the financial stability of municipalities in the Republic of Latvia depends on a set of factors, among which independence from inter-budgetary transfers, and balanced income and expenses are of fundamental importance. In the course of the study, it was revealed that municipalities with a high share of their own income are more adaptable to economic shocks, which contributes to their sustainable development. The developed system of composite coefficients helped to comprehensively assess the current state of municipal budgets, identify the main risks, and suggest ways to minimise them. Additionally, the analysis of regional differences highlighted the disparity in the level of financial independence of municipalities, which is explained by the different structure of income and expenses. Less well-off regions tend to show high dependence on transfers and limited budget planning capabilities. The application of the proposed methodology allowed not only to record these differences, but also to develop recommendations for reducing budget inequality by stimulating the growth of municipalities' own incomes.

One of the key conclusions of the study is the need to strengthen the tax independence of municipalities through the diversification of income sources, which can be achieved by stimulating economic activity at the local level, supporting entrepreneurship and optimising tax policy. The results obtained emphasise the importance of implementing the proposed assessment system for making informed decisions in the field of budget planning. The coefficient system can be adapted for use in other countries, considering their economic and institutional characteristics, which expands the scientific and practical significance of the conducted research.

Future research areas may focus on a deeper analysis of the interrelationships between the financial stability of municipalities and their socio-economic development, including an assessment of the impact of innovative management tools, such as, for example, the digitalisation of budgetary processes, both in Latvia and abroad.

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CONFLICT OF INTEREST

None.

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Дослідження системи оцінки управління муніципальними фінансами: забезпечення сталості та стійкості в латвійських громадах

Карліс Кетнерс
Доктор філософії
Сільськогосподарська академія Університету Вітаутаса Магнуса
LT-53361, вул. Студенту, 11, м. Каунас, Латвія
https://orcid.org/0000-0001-7891-2745
Мара Петерсоне
Доктор філософії
Ризький технічний університет
LV-1048, вул. Кіпсалас, 6А, м. Рига, Латвія
https://orcid.org/0000-0001-7720-1482

Анотація. Проведене дослідження пропонує систему фінансових коефіцієнтів у складі комплексного індексу для оцінки стійкості та адаптивності муніципалітетів, що включає аналіз структури та динаміки бюджетних показників. Метою дослідження була розробка методики, спрямованої на виявлення факторів, що впливають на фінансову стійкість, та надання практичних рекомендацій щодо підвищення стійкості муніципалітетів в умовах нестабільного економічного середовища. Методологія дослідження включала аналіз стану муніципальних фінансів, оцінку бюджетних ресурсів, виявлення ризиків та розробку заходів щодо їх мінімізації на основі фінансової звітності, інтерв'ю та експертної оцінки ключових показників. Під час дослідження були визначені ключові індикатори фінансової стійкості латвійських муніципалітетів, серед яких рівень незалежності від міжбюджетних трансфертів та співвідношення власних витрат до доходів. На основі отриманих результатів було визначено, що муніципалітети з високою часткою власних доходів демонструють кращу здатність адаптуватися до економічних шоків. У свою чергу, регіональний аналіз виявив значні відмінності у структурі доходів і видатків, де муніципалітети, які більше залежать від трансфертів, стикаються з обмеженнями при бюджетному плануванні. Крім того, використання системи коефіцієнтів дозволило оцінити фінансову стійкість як у статиці, так і в динаміці, виявивши ризики, пов'язані з високим борговим навантаженням та низькою ліквідністю. Завдяки тому, що методологія дослідження базувалася на аналізі фінансової звітності та експертних оцінках, вона забезпечила розробку комплексного індексу для прогнозування ризиків. Таким чином, отримані результати підкреслили необхідність підвищення фінансової автономії муніципалітетів та оптимізації боргової політики. Запропоновані рекомендації дослідження спрямовані на зменшення регіональних диспропорцій та зміцнення фінансової стійкості місцевих бюджетів. Важливість отриманих результатів полягає у наданні інструментарію, який дає змогу розробити обґрунтовані рекомендації щодо вдосконалення бюджетного менеджменту та адаптації до економічних викликів

Ключові слова: фінансова стійкість; організаційна стійкість; композитний коефіцієнт; економічні виклики; регіональні диспропорції; економічна адаптивність

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Monitoring technology for the efficiency of utilisation and development of the export-import potential of economic entities of the state sector

Lyudmyla Malyarets*
Doctor of Economics, Professor
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0002-1684-9805

Oleksii Budarin
Postgraduate Student
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0000-0001-9399-9914

Abstract. This study aimed to identify approaches for assessing the efficiency of utilisation and development of the export-import potential of Ukrainian state-owned enterprises, considering the influence of external and internal factors. Additionally, a comprehensive monitoring system was developed to enhance competitiveness and facilitate strategic planning in their operations. The research methodology was based on the application of quantitative and qualitative methods for analysing economic performance indicators of state-owned enterprises and their external trade potential. A SWOT analysis was conducted on the proposed multi-level monitoring system, which was also assessed through a change management model. The study contextualised the strategic planning of the export-import potential of economic entities in the state sector of the economy. The impact of political, economic, social, technological, environmental, and legal factors on the export import activities of state-owned enterprises was identified, with particular emphasis on the challenges arising from full-scale military aggression. A 17-stage monitoring technology for export import potential has been proposed, integrating quantitative and qualitative analysis methods, including profitability assessment, competitiveness evaluation, and import and export dependency analysis. The implementation of the proposed technology has been examined through the lens of Kurt Lewin's transformational model, which entails a phased adaptation to changes and the consolidation of new approaches in strategic management. The findings of the contextual study also confirm the significance of international support, market diversification, and innovation in restoring export-import potential. The study focused on the public sector of the economy and the need to adapt monitoring tools to the specific conditions of enterprises. The conclusions drawn may serve as a basis for developing strategies to support state-owned enterprises, enhance their competitiveness, and ensure sustainable development amid external and internal challenges

Keywords: contextual analysis; strategic planning; competitiveness; foreign trade activity; trade balance

INTRODUCTIONS

A prerequisite for Ukraine's sustainable economic development is the continuous expansion of its presence on the global market. The importance of this precondition is enshrined in the country's National Economic Strategy until 2030 (Resolution of the…, 2021). Achieving national economic goals is possible through the objective assessment and effective utilisation of the export-import potential of economic entities. The lack of a universal approach to monitoring the realisation of the export-import potential of state-owned enterprises underscores the relevance of this research.

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*Corresponding author

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N.T. Hung *et al.* (2024) delineated a country's economic potential as comprising two key components: export and import potential. Exports are pivotal to a nation's economic growth, involving the sale and transfer of goods or services beyond its customs territory in exchange for foreign currency. E.P. Molepo & A.C. Jordaan (2023) asserted that these foreign earnings contribute directly to a country's gross domestic product (GDP) and fuel its economic expansion. Historically, specific sectors have been more instrumental in shaping a nation's export capacity. For instance, agriculture accounted for 14% of Ukraine's GDP in 2020. L.M. Malyarets *et al.* (2023) highlighted those external factors significantly influence a country's export potential. S.A. Alimova & M.N. Khalilova (2022) quantified the impact of Russia's military aggression, revealing a 48% decline in Ukraine's export revenues. Conversely, M. Nehrey & R. Finger (2024) observed a remarkable resilience in export potential. Their comparison of first-quarter export figures for 2023 (USD 15,699.4 million) and 2022 (USD 10,305.5 million) suggests a gradual but discernible recovery toward pre-war levels.

When assessing and planning a country's economic development, it is essential to consider its import potential – the capacity to import goods, services, or technologies. Similar to exports, a country's import potential is influenced by external factors and challenges, such as regional political instability. J. Grant *et al.* (2023) found in their research that in the initial months of the full-scale invasion, import volumes decreased by 21%. In 2023, an 11% increase in import volumes was documented compared to the previous year, facilitated in part by the emergence of new import categories, such as weapons. A. Wojtowicz (2024) emphasised the need for a comprehensive assessment of a country's export-import potential. According to her findings, in the first quarter of 2023, the export-to-import ratio was 0.66. According to the National Bank of Ukraine, the country is effectively overcoming macroeconomic challenges, and its export-import potential is sufficiently high to suggest annual GDP growth of 4-6% in the coming years.

Various approaches have been proposed for evaluating the export-import potential of specific economic sectors or entire countries. For instance, R. Baki (2024) suggested a classification approach for potential market alternatives, positing that export potential is determined by the characteristics of the target market for specific goods or services. H. Telnova *et al.* (2023) recommended considering export potential within the context of a country's or trade alliance's trade policy, particularly for specific goods or services. Their research also indicated that trade policy can be a tool for shaping a country's or a specific economic sector's import potential. H. Mu & D. Zhang (2023) developed a ranking of factors influencing export-import capital, with regional economic level, scientific and technological progress, and GDP being the most significant.

A gap in these studies was their focus on entire countries or economic sectors, limiting the adaptability of the proposed approaches and tools to individual enterprises. This research aimed to investigate the specifics of evaluating the effectiveness of realising the export-import potential of Ukrainian state-owned enterprises. The objectives were to create a multi-level monitoring technology and develop recommendations for its application.

MATERIALS AND METHODS

This research employed both quantitative and qualitative methods to analyse the factors influencing the export-import potential of economic entities of the state sector. A quantitative contextual analysis was conducted using the PESTLE framework, which considers the impact of political, economic, social, technological, environmental, and legal factors on the development of economic entities of the state sector. The primary objective of this contextual analysis was to gain a comprehensive understanding of external factors and to plan export-import strategies that maximise positive impacts while minimising or avoiding negative ones. Beyond contextualising the exportimport potential of economic entities of the state sector, the analysis enabled the development of a monitoring technology for this potential.

The monitoring technology was designed considering the fact that the emergence and subsequent development of an economic entity's export-import potential is influenced by a combination of external factors, both controllable and uncontrollable. The proposed technology integrates qualitative and quantitative analysis methods, including profitability, deviations of actual production results from planned ones, export dependency ratio, import dependency ratio, profitability of export activities, profitability of imported resources, net trade balance, and competitiveness index.

The analysis of external influences allowed to develop an export-import monitoring strategy that maximises existing opportunities while remaining resilient to adverse impacts. The proposed technology comprises seventeen (n = 17) steps, each analysed in terms of the enterprise's export-import objectives and the tools to achieve them. The strategy was also evaluated through a SWOT analysis, examining the strengths, weaknesses, opportunities, and threats of using a multistage technology for assessing the strategic planning of export-import potential in state-owned entities. Based on the SWOT analysis, conclusions were drawn regarding the feasibility of using the proposed tool to monitor the effective development of the export-import potential of economic entities of the state sector.

Recommendations for implementing the multi-level monitoring technology were grounded in Kurt Lewin's three-step change model, known for its effectiveness in implementing change. This model conceptualises the implementation of a new monitoring technology as a change process comprising three key phases: unfreezing, changing, and refreezing (Yli-Kerttula & Varis, 2023). The implementation of the 17-step monitoring model was viewed in this study as a sequence of steps: preparing the economic entity for monitoring, conducting monitoring using the 17-step technology, and ensuring long-term positive changes resulting from the technology's implementation. At each

stage of implementing the monitoring technology, various factors can either accelerate or hinder the transformation process. Based on the application of Kurt Lewin's model, the factors with the greatest impact on the implementation of the proposed monitoring framework were identified. These factors were considered when developing recommendations for evaluating the strategic planning of the export-import potential of state-owned enterprises.

RESULTS

Contextualising strategic planning for export-import potential in the state sector of the economy

According to data from the Ukrainian Ministry of Economy, as of April 2024, there were 3,116 state-owned enterprises in Ukraine, of which 845 (27%) were engaged in production activities and only 475 (15%) were profitable (Ministry of Economy of Ukraine, 2024). Examples of profitable state-owned enterprises include the National Joint Stock Company "Naftogaz of Ukraine", the state enterprise "National Power Company "Ukrenergo", and the private joint-stock company "Ukrhydroenergo". The significant imbalance between the number of unprofitable and profitable enterprises is a major problem, as the latter serve as the driving force behind economic development and social well-being. The stagnation of state-owned enterprises may indicate that their export-import potential is not fully assessed or realised. Drawing on industry reports and selected academic research, this study identified factors influencing the operations of economic entities of the state sector, including their utilisation and development of export-import potential. The factors identified through a PESTEL analysis are presented in Table 1.

Table 1. PESTEL analysis of export-import potential formation in economic entities

Factor	Comment
Political	Economic entities must realise their export-import potential amidst full-scale military aggression against the country. The restoration of export-import levels to pre-war figures is possible with the support of international partners
Economic	Full-scale military aggression has exacerbated the economic crisis, leading to an increase in the number of unprofitable enterprises
Social	State-owned economic entities are among the key employers and sources of social stability. Fullscale military actions have resulted in a workforce outflow, worsening the staffing crisis in the state sector of the economy
Technological	The emergence of new technologies and investment in innovation enhance efficiency and improve the competitiveness of economic entities. However, due to full-scale aggression and the resulting economic crisis, investment in production technology development has declined
Environmental	Business operations are governed by national and international environmental standards. Due to full-scale military invasion, certain territories have become unsuitable for economic activities
Legal	The state regulates the activities of economic entities through legislation, including through provisions of the Law of Ukraine No. 549-IV "On State Control over International Transfers of Military and Dual-Use Goods" (2003), Law of Ukraine No. 185-V "On Management of State-Owned Property" (2006); Draft Law of Ukraine No. 2142a "On Ensuring Large-Scale Export Expansion of Ukrainian Producers by Insurance, Guaranteeing and Reducing the Cost of Export Lending" (2015)

Source: created by the authors based on the materials of the Law of Ukraine No. 549-IV (2003), the Law of Ukraine No. 185-V (2006), Draft Law of Ukraine No. 2142a (2015)

From the table above, it is evident that the use of export-import opportunities by enterprises is influenced by a combination of factors. Some of these, such as legal support from the state or technological progress in the industry, drive the export-import development of an economic entity. Other factors, such as the need to operate under full-scale military aggression or a reduction in resources for conducting economic activities, instead hinder the process of realising the enterprise's export-import potential. An illustration of this assertion is the dynamics of Ukrainian export-import changes from 2021 to 2024, which vividly demonstrates the impact of Russian aggression, leading to a sharp decline in foreign trade operations, and the recovery potential of enterprises (Table 2).

Table 2. Dynamics of Ukraine's export-import operations in 2021-2024

Year	Trade turnover, million USD	Export		Import		Balance, million USD
		Export, million USD	Changes in % from the previous year	Import, million USD	Changes in % from the previous year	
2021	141,377	68,088	38	73,289	35	-5,201
2022	103,676	44,173	-35	59,503	-19	-15,331
2023	99,420	359,580	-19	63,456	7	-27,497
2024*	82,060	30,839	12	51,221	11	-20,382

Notes: * – data for 2024 are for the first 9 months; percentage changes are compared to data from the first 9 months of 2023
Source: compiled by the authors based on State Statistics Service of Ukraine (2024), S. Shamborovskyi (2024)

Since the beginning of Russia's full-scale invasion of Ukraine, the export component, which according to N. Jia *et al.* (2024) accounted for 30% to 50% of the country's GDP, has suffered the most significant losses. In the first months of the war, the country's exports decreased by 50%, but from August of the same year, a gradual recovery to pre-war levels was observed (Devadoss & Ridley, 2024; Kutsmus *et al.*, 2024). Based on the provided statistics, it can be argued that the country's export-import potential exhibits high resilience and a capacity for rapid recovery amid full-scale aggression.

From a political standpoint, the restoration of enterprises' export-import potential is possible thanks to international support, which involves reorienting towards new markets. As of 2023, the main consumers of Ukrainian exports were Poland, Romania, Turkey, China, Hungary, Germany, and Italy. International agreements signed after February 2022 have opened up new markets for the country to strengthen the export-import capabilities of the state sector of the economy.

International support is one of the factors in overcoming the economic crisis caused by fullscale military aggression. State-owned enterprises, whose assets account for about 13% of the total value of assets of all Ukrainian enterprises, have become the most vulnerable to the crisis. Only 27% of state-owned economic entities are operational, and only 15% of them are profitable. Therefore, it can be argued that state-owned economic entities require additional support to unlock their export-import potential.

The achievement of this goal is possible, in part, through the rational use of human potential, which is the driving force behind the competitiveness and investment attractiveness of economic entities of any ownership type. One barrier to utilising human resources is the migration crisis, the long-term trends and consequences of which are difficult to predict. The International Organization for Migration (2024) report noted that, with the onset of fullscale invasion, approximately 3 million Ukrainian citizens emigrated abroad, and another 3.5 million became internally displaced persons. The same report also stated that 4,734,000 individuals returned to their usual places of residence, indicating that migration processes are reversible. S. Kubiciel-Lodzińska & B. Solga (2023) suggested that depending on military actions, irreversible migration losses could range from 500,000 to 5.5 million citizens. Given that the overwhelming majority of migrants are of working age, there may be a shortage of personnel in state-owned enterprises in the medium to long term.

In addition to the aforementioned factors, technological factors also influence the exportimport potential of economic entities. These generally have a positive impact on the development of the export-import potential of the economic entity, as the implementation of the latest technologies, artificial intelligence, robotic production, and so on, enhances their competitiveness and investment attractiveness. However, when analysing this aspect of exportimport potential, it is important to consider that the implementation of technological innovations is costly and not always accessible to state-owned entities.

The state of the country's ecology is one of the factors that slows down the effective use and development of the country's export-import potential. R. Quitzow *et al.* (2022) in their study noted that conducting military operations within the country leads to the pollution of land and water areas, and the depletion of other natural resources, which makes economic activity impossible in certain areas. While the economic entities in the agricultural sector suffered the most significant losses, the negative impact of pollution was also recorded in other sectors.

At the legislative level, the state promotes a level playing field for economic entities and the continuous improvement of their export-import potential. This support was expressed through the adoption of the Law of Ukraine No. 185-V "On Management of State-Owned Property" (2006), which stipulates the accountability of economic entities and monitoring of their activities to create better conditions for the formation of export-import potential.

Based on the analysis, it can be concluded that economic entities of the state sector operate in predominantly unfavourable conditions, significantly reducing the utilisation and development of their export-import potential. With the beginning of the full-scale invasion, the problems of utilising and developing such potential have intensified due to new economic, social, environmental, and other challenges. The dynamics of the return of export-import values to pre-war levels suggest the reversibility of negative processes in the state sector of the economy. Reversing the crisis and preventing stagnation is possible through government support for enterprises, the implementation of innovative processes, and participation in international economic development initiatives.

Monitoring the utilisation and development of an economic entity's export-import potential

The sustainable development of state-owned economic entities necessitates strategic planning. Such planning is grounded in an understanding of the internal and external factors and trends that influence the enterprise's performance. A key objective of planning is to select and implement strategies that maximise the benefits of favourable factors and trends while minimising or avoiding the impact of negative ones. Strategic planning for state-owned entities is based on a multicomponent analytical technology presented in Table 3. The implementation of the proposed technology is justified by the national policy aimed at improving the efficiency of resource utilisation by state-owned economic entities. The state's oversight of economic entities is outlined in documents such as memoranda from the Ministry of Finance, reports from the National Anti-Corruption Bureau, and periodic audits by the Audit Chamber. The effectiveness of the proposed technology has also been confirmed by case studies of specific economic entities of the state sector. A distinctive feature of the proposed technology is the combination of quantitative and qualitative assessment criteria with informed strategic planning for export-import activities of enterprises.

Table 3. Monitoring technology for the utilisation and development of the export-import potential of an enterprise

No.	Stage of the technology	Instrumental support
1	Defining the goals and tasks of monitoring	Enterprise audit, including the involvement of independent experts. Contextual analysis of the enterprise's activities using PESTEL analysis and Porter's Five Forces Model. Formulation of smart goals, considering the enterprise's strategic vision
2	Quick assessment of business activities	Analysis of industry reports and accounting documentation, observations, case study method
3	Forming a system of indicators for the effective use and development of the enterprise's export-import potential	Benchmarking method, formulation of smart goals, creation of an enterprise development "roadmap"
4	Analysis of trends in the changes of partial indicators for the use and development of the enterprise's export-import potential	Descriptive statistics method
5	Comparative analysis and control of partial indicators for the use and development of the enterprise's export-import potential with normative or benchmark values	Benchmarking method, analysis of the enterprise's activities in the context of industry reports, analysis of success stories of other enterprises within the industry at the national or international level, case study method
6	Calculation of the effectiveness of export-import potential implementation	Building an integral taxonomic indicator of development
7	Assessment of the dynamics of export-import potential use and development	Comparative analysis of data over a specific period
8	Evaluation of the relationship between the use and development of export-import potential	Multidimensional canonical analysis method
9	Analysis of the environmental impact on the formation and implementation of export-import potential	Regressive analysis, cointegration method, PESTEL analysis, Porter's Five Forces Model
10	Assessment of the impact of internal environment factors on the use and development of export-import potential	SWOT analysis, observations, surveys, focus groups, in-depth interviews
11	Assessment of optimal values for export-import potential indicators	Multifactorial regression analysis
12	Forecasting export-import potential use indicators	Growth curves, scenario forecasting methods, benchmarking, case study method
13	Comparative analysis of export-import potential use and development indicators with optimal and forecast values	Benchmarking, contextual market or segment analysis, analysis of segment accounting documentation over a certain period
14	Control of deviations in the values of export-import potential use and development indicators	Benchmarking method, contextual analysis, PESTEL and SWOT analyses
15	Assessment of reserves for enhancing the effectiveness of export-import potential implementation	Benchmarking, analysis of external influences that hinder the full use of export-import potential
16	Formulation of a rational managerial decision to support the normal process of export-import potential use and development	Economic analysis and management decision-making methods
17	Monitoring the processes of export-import potential use and development	Continuous monitoring, starting from the second stage of the technology

Source: compiled by the authors based on J. Grant *et al.* (2023), H. Mu & D. Zhang (2023), N.T. Hung *et al.* (2024)

To ensure the effectiveness of the proposed monitoring, specific metrics and tools are recommended for evaluating the efficiency of realising an enterprise's export-import potential. Qualitative tools provide a deep understanding of the context in which a state sector enterprise operates. Recommended qualitative tools include observation, contextual analysis, industry report analysis, case studies, focus groups, and interviews. These and other approaches help interpret data obtained using quantitative analysis tools. Recommended quantitative tools for analysing the utilisation and development of the export-import potential of state-owned enterprises include:

1. Profitability of the enterprise, used to assess the potential for profit generation in the short term. It is a criterion for effective financial, operational, and investment activities of the enterprise:

$$F = E/P, \quad (1)$$

where F is the efficiency of activity; E is the result of management decisions and efforts; P is the costs (resources).

2. Deviation of actual production results from planned ones. There is an inverse relationship between the deviation of production results and its efficiency. This is used to calculate deviations for:

- volume:

$$OQ = (Qf - Qi)\ NI\ PI, \quad (2)$$

where Q is the output volume; N is the standard consumption of resources per unit of output; P is the price per unit of resource f; I is the indices of the actual and planned values of the quantities;

- price:

$$Op = Qf\,(Pf - PI)\,NI; \quad (3)$$

- standard:

$$On = Qf\,Pf\,(Nf - NI). \quad (4)$$

3. Export dependency ratio is used to understand the share of exports in the total volume of products sold by the enterprise:

$$Kexp = (Vreal/Vexp) \times 100\%, \quad (5)$$

where *Vexp* is the export volume in value or physical terms; *Vreal* is the total volume of products sold.

4. Import dependency ratio allows predicting the price and assessing the competitiveness of the final product (a smaller share of imported raw materials or components means a lower price), as well as assessing the production's ability to develop sustainably under changing economic and political realities:

$$Kimp = (Vtotal/Vimp) \times 100\%, \quad (6)$$

where *Vimp* is the volume of materials imported by the enterprise; *Vtotal* is the total volume of materials used in production.

5. Profitability of export activities allows determining the ratio of profit from exports to total export activity. A higher profit from lower export volumes indicates high profitability of the enterprise's export activities:

$$Rexp = (Vexp/Pexp) \times 100\%, \quad (7)$$

where *Pexp* is the profit from export activities; *Vexp* is the export volume.

6. Profitability of imported resources. A higher profit generated from a smaller volume of imported resources indicates high import profitability for the enterprise:

$$Rimp = (Vimp/Pimp) \times 100\%, \quad (8)$$

where *Pimp* is the profit from imported resources; *Vimp* is the volume of imported resources.

7. Net trade balance. For a well-performing enterprise, the volume of exports exceeds the volume of imports, resulting in a positive trade balance:

$$TB = Vexp - Vimp, \quad (9)$$

where *TB* is the trade balance; *Vexp* is the volume of exports; *Vimp* is the volume of imports.

8. Competitiveness index provides an understanding of the enterprise's development vector:

$$Icomp = (Qcomp/Qour) \times (Cour/Ccomp), \quad (10)$$

where *Qour* and *Qcomp* are the quality of the enterprise's products and competitors' products, respectively; *Cour* and *Ccomp* are the costs of the enterprise's products and competitors' products, respectively.

When using the proposed monitoring technology, it is recommended to consider that the primary objective is to enhance the enterprise's competitiveness. The importance of this task is underscored by the significant role that state sector entities play in contributing to GDP, employment, and addressing other economic and social challenges. It is also essential to acknowledge that, despite their crucial role, a majority of state-owned enterprises are unprofitable, necessitating more rigorous monitoring of the factors contributing to their low competitiveness.

Monitoring state-owned enterprises involves considering the multi-faceted nature of competitiveness, with key aspects including indicators of economic development, employee living standards, and investment attractiveness. Most of the tools proposed within the technology for monitoring the realisation of an enterprise's export-import potential are used to determine the economic development level of the economic entity. These indicators include import and export dependency ratios, profitability of export activities, and profitability of import activities. Additional indicators that can be included are the gross product of the economic entity, the volume of output, and the profitability of operating activities.

Indicators of employee living standards are equally important as they can be used to foster long-term cooperation with the economic entity, avoid a labour crisis, and improve production efficiency. The dependence of an enterprise's profitability and competitiveness on employee living standards necessitates monitoring the latter. Recommended tools for this monitoring include average monthly nominal wages, social benefits for employees, vacancy fill rates, and employee disposable income. High levels of economic development and employee living standards enhance investment attractiveness, which is essential for the sustainable development of state-owned economic entities.

Investment attractiveness indicators for an enterprise include its earnings before interest and taxes (balance) and foreign direct investment. It is also recommended to use comparative indicators to assess an enterprise's investment attractiveness relative to other economic entities. One such indicator is whether the economic entity is profitable. Additionally, analysing the economic entity's involvement in innovative activities is crucial, as it significantly increases the chances of attracting investment. Thus, a multi-factor analysis of an enterprise's competitiveness is a key component of monitoring the efficiency of its export-import potential.

The implementation of the proposed monitoring system considers numerous internal and external factors. A thorough understanding of these influences is achieved through a SWOT analysis. The purpose of such an analysis is to examine and classify the impacts on the enterprise's strengths, weaknesses, opportunities, and threats. Based on an understanding of these potential positive and negative influences, strategic objectives are formulated. Key influencing factors are presented in Table 4.

Table 4. SWOT analysis of the proposed monitoring system

Strengths	Weaknesses
◆ comprehensive assessment; ◆ a variety of tools; ◆ versatility	◆ complexity in use; ◆ lack of readiness among managers to use certain tools
Opportunities	**Threats**
◆ improved competitiveness; ◆ increased production efficiency; ◆ enhanced investment potential; ◆ support for sustainable development of the economic entity	◆ lack of certain data; ◆ subjective evaluation

Source: developed by the authors

Based on the table presented, the implementation of the proposed monitoring system is deemed appropriate, as its benefits and potential outweigh the associated drawbacks and risks. The primary advantage of this system lies in its versatility; it can be applied to monitor the export-import potential of enterprises regardless of their specific activities. This versatility is attributed to the diversity of methods, allowing for the selection of approaches and tools that best suit a particular business scenario. It is also significant that the proposed monitoring technology incorporates both quantitative and qualitative tools, enabling a comprehensive and more in-depth assessment of enterprise performance and facilitating the selection of appropriate management strategies. The diversity of assessment tools can also be viewed as a drawback of the proposed technology, as the selection and implementation of specific approaches require training for those responsible for monitoring. Despite these limitations, the use of the proposed technology is justified given its potential benefits. Based on the table, key benefits include enhancing the efficiency and competitiveness of the economic entity.

An analysis of the risks associated with implementing the proposed technology provides insights into how to overcome them, including through the use of Kurt Lewin's change model. This model views change as a sequence of interrelated stages: preparation for change, the actual change involving the implementation of new strategies and methods, and the consolidation of these changes over time. The main stages of the recommended model are presented in Figure 1.

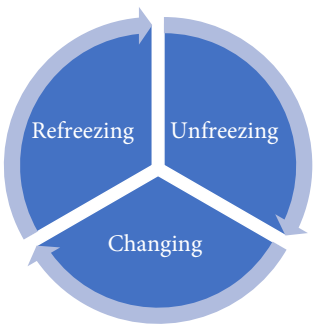

Figure 1. Kurt Lewin's transformation model

Source: compiled by the authors based on J. Yli-Kerttula & K. Varis (2023)

As illustrated in the figure, the transformation process is cyclical, aligning with the idea of continuous monitoring, starting from the second phase of the proposed technology. The figure also indicates that the change process consists of three phases, each with its own characteristics. When using the proposed model, it is essential to consider that the existing system for managing the enterprise's export-import potential is often stable and resistant to change. Transformation processes begin when the factors driving change outweigh those resisting it. This implies that the change process should begin with a comprehensive cost-benefit analysis to justify the proposed transformations. As supporting arguments, it is recommended to reference the results of the SWOT analysis, which highlights the importance of using the new monitoring system to realise the exportimport potential of the state-owned enterprise. At this stage, it is crucial to solidify the economic entity's readiness for change by reviewing strategic planning, signing memoranda, and taking similar actions.

The second phase involves the actual implementation of changes, meaning the new monitoring system for the effective use and development of the economic entity's export-import potential becomes operational. The effectiveness of this phase may be influenced by the threats identified in the SWOT analysis, such as a lack of specific data for monitoring and the possibility of subjective evaluation of the use and development of the economic entity's export-import potential. When planning change strategies at this stage, it is important to remember that the risk of missing specific data on state-owned economic entities is relatively low due to the state's regulatory requirements for the accountability of such enterprises. The main document ensuring the accountability of enterprises is Law of Ukraine No. 185-V "On Management of State-Owned Property" (2006). This law guarantees public access to information regarding the activities of stateowned economic entities. In addition to national platforms, state-owned economic entities often use internal, more secure intranet networks to provide access to information used for monitoring their activities.

A more significant challenge at this stage may be the lack of preparedness among stakeholders in using specific monitoring tools or their reluctance to adopt certain quantitative or qualitative analysis approaches. Overcoming these obstacles can be achieved through theoretical and

practical training for stakeholders in the use of specific monitoring tools. Training should be designed to cover the following aspects: presentation of the key capabilities and benefits of the proposed tool; specific features of using the tool in different monitoring situations; potential difficulties in using the proposed tool and ways to overcome them; and the compatibility of the proposed tool with other tools for monitoring the efficiency of using and developing the enterprise's export-import potential. When planning training for stakeholders, it is also recommended to consider the risk of subjective monitoring, which may be caused by a lack of a comprehensive approach to assessing the enterprise's performance, the presence of ethical dilemmas in the assessment, and so on. In such cases, it is recommended to provide additional training on the use of specific monitoring tools and the objective interpretation of the resulting data. When planning such training, it is recommended to specify the criteria for objective monitoring, consider factors that may influence the conduct of such monitoring, and propose ways to minimise the risks of subjective evaluation.

The final stage of the transformation process should also consider the system's inertia and its tendency to revert to its previous state if changes are not refreezing, that is, solidified in some way. To solidify these changes, it is proposed to make them part of the economic entity's strategy by declaring a commitment to monitoring the efficiency of utilising and developing export-import potential in the company's charter. Documenting these changes can serve as a basis for implementing an incentive system to encourage stakeholders to conduct objective monitoring of the use and development of the export-import potential of state-owned economic entities. An example of such an incentive could be a bonus for the timely provision of information and conducting monitoring following specified criteria.

The implementation of the proposed technology for evaluating the strategic management of export-import potential should be viewed as a multi-stage transformation process. The strategies for each stage should be selected in a way that generates long-term effects and minimises the risk of reverting to old, less effective practices.

DISCUSSION

The findings presented align with previous research on the impact of Russia's full-scale invasion on Ukraine's export-import performance. S. Steinbach (2023) emphasised that Russia's military aggression was a key factor in the decline of Ukraine's export potential. According to the researcher, the primary reason for the decline in exports was the blockade of export routes for certain products, including agricultural goods. A.M. Countryman *et al.* (2024) highlighted that the decline in Ukraine's export potential triggered a global crisis, leading to significant losses. The data presented by these experts indicate that the blockade of Black Sea export routes resulted in losses in global net welfare ranging from USD 5 billion to USD 20 billion. These losses are attributed to Ukraine's leading position in the global export of certain goods, including agricultural products. According to A. Sadlowski & A. Zajac (2024), before the full-scale invasion, Ukraine accounted for approximately 50% of global sunflower oil production, 20% of barley, and 10% of wheat. Until February 2022, nearly half of the wheat purchased under the United Nations World Food Programme came from Ukraine. V.P. Kalenska (2023) also noted a significant decline in import potential, emphasising that negative trends were already evident in 2020 due to COVID-19 restrictions and rising energy prices. The full-scale invasion accelerated these negative trends: while imports amounted to USD 89,774.6 million in 2019, before the pandemic, they halved to USD 44,000.6 million in 2022. The cited sources clearly demonstrate that the full-scale war significantly reduced Ukraine's overall export-import potential, as well as that of individual enterprises, corroborating the findings of this study.

Previous research corroborates the thesis presented in this article regarding the need for continuous analysis of the realisation of an enterprise's export-import potential. P. Heine *et al.* (2024) argued that a key objective of such monitoring is to identify risks to the utilisation and development of export-import potential, assess their likelihood and potential losses, and analyse the consequences of specific strategic decisions. These arguments resonate with the monitoring technology presented in this research, a core element of which is continuous observation and analysis of the results.

The importance of certain elements of the proposed evaluation technology, such as innovation and competitiveness, has been supported by previous research, particularly by Z. Najafi-Tavani *et al.* (2023). Based on data from 263 managers and executives of 194 exporting companies, the researchers concluded that there is a direct link between the use of innovative business models and the differentiation of exporters. According to the experts, this link is most noticeable in moderately competitive environments, where the use of technology becomes a crucial condition for an enterprise's differentiation. The link between innovation and enterprise competitiveness was also confirmed in a study by L.C. Ortigueira Sanchez *et al.* (2022), who analysed the experiences of 237 small and medium-sized enterprises in Peru. The researchers concluded that government programs supporting innovation are a driving force behind enterprise competitiveness at both regional and international levels. I. Ahmad *et al.* (2023) demonstrated that neglecting to assess innovative transformations and other aspects of import-export potential can lead to significant financial losses for economic entities. By analysing the experiences of Pakistani enterprises, the researchers estimated that losses from misjudging the export potential of national enterprises could range from USD 2 billion to USD 5 billion. Such losses can significantly reduce the efficiency of economic entities of the state sector and even lead to the liquidation of some. The cited studies support the idea presented in this article regarding the importance of assessing an economic entity's competitiveness as a component of its export-import potential.

Furthermore, the findings of this study align with previous research regarding the importance of assessing and developing a firm's export-import potential. D.N. Coudounaris & P. Björk (2023), in their analysis of Estonian small and medium-sized economic entities, highlighted the significance of internal factors such as employee qualifications, motivation, and commitment to long-term cooperation. The need to analyse human capital as a key element of a firm's export-import capacity was also emphasised by K. Amit *et al.* (2024), who studied the impact of the brain drain on enterprise competitiveness and assessed the prospects for labour force recovery to support sustainable export-import development. They argued that the return of skilled workers is possible after the cessation of hostilities, and many internally displaced persons have already returned to their home regions due to instability. In support of this argument, the researcher cited changes in export routes and the emergence of new export centres in Ukraine since the full-scale invasion. Regions such as Vinnytsia, Volyn, Zakarpattia, Lviv, Rivne, Ternopil, Cherkasy, and Chernivtsi have become new export hubs. The emergence of new logistical solutions and the reorientation of certain regions indicate opportunities for the sustainable development of the country's and individual enterprises' export-import potential. This aligns with the findings presented in this study, which suggest that continuous monitoring can contribute to the restoration and enhancement of the export-import capabilities of state-owned enterprises. These findings are encouraging, considering the relatively small percentage of operating and profitable economic entities of the state sector in Ukraine.

Understanding the factors influencing the development of export-import potential can be achieved through qualitative analysis methods such as observations, interviews, focus groups, and case studies. These methods and tools have also been proposed in this study as elements of assessing the strategic planning of a firm's export-import activities. The importance of a comprehensive approach to assessing export-import potential was also explored in the research of N. Sharkasi *et al.* (2023), who studied the export-import potential of Vietnamese economic entities. Using two rating models, the researchers compiled a list of factors that influence the utilisation and development of an economic entity's export-import potential. A multi-factor model for assessing export-import potential was also developed by A.K. Dissanayake & U.D. Udari (2023), proposed analysing external factors in terms of whether they facilitate or hinder the utilisation and development of export-import potential. Despite the differences in the cited analytical models, they converge on the idea that an economic entity's export-import potential is a multi-component structure shaped and developed by numerous variables. Based on this, a combination of quantitative and qualitative tools is essential for a comprehensive assessment of an economic entity's potential and a deep understanding of strategies for its development. This assumption resonates with the monitoring technology proposed in this study, which includes several dozen quantitative and qualitative evaluation criteria.

A significant distinction of this study from previous research lies in its context, which is characterised by two key features. Unlike prior studies, this research focuses on the utilisation and development of export-import potential in a country at war. This implies that Ukrainian economic entities are developing their export-import potential within a more complex context and under the influence of a greater number of factors compared to enterprises in countries not experiencing armed conflict. The uniqueness of this study is also attributed to its focus on economic entities of the state sector, which are generally less competitive and more vulnerable to contextual changes.

CONCLUSIONS

A multi-level framework has been developed to assess the effectiveness of realising export-import opportunities for state-owned enterprises. This framework incorporates both quantitative and qualitative aspects of enterprise operations, which is essential given the numerous external and internal factors influencing businesses, particularly in the context of a full-scale war. Implementing this framework supports strategic management of exports and imports in the state sector of the economy, helping to mitigate the risks posed by the war.

Through the contextual analysis, key factors influencing the export-import potential of economic entities were identified: political, economic, social, technological, environmental, and legal. Among the analysed factors, the most significant is the development of export-import opportunities for enterprises in the context of large-scale military aggression against Ukraine, the reduction of resources for business operations, support for state-owned enterprises at the national and international levels, and the social demand for stability.

Based on the contextual analysis of the factors influencing the formation of export-import potential, a 17-step technology for monitoring the effectiveness of its use and development by economic entities was developed. The proposed technology encompasses a comprehensive approach to analysing the implementation of export-import capacity within an economic entity. This approach involves the use of both quantitative and qualitative tools to assess specific components of the economic entity's potential implementation.

By analysing trends in the recovery of the country's export-import potential to pre-war levels, it was concluded that developing the export-import potential of individual state-owned economic entities is feasible. It was recommended to view the development of this potential, including the continuous monitoring of employed strategies, as a multi-stage transformation process. Kurt Lewin's change model can facilitate the effective implementation of these proposed transformations. The presented results and recommendations can serve as a foundation for developing strategies to manage the export-import potential of

economic entities in the face of external and internal challenges. The recommendations can also be useful for improving the performance of state-owned economic entities by increasing their profitability and competitiveness.

Future research could include a comparative analysis of state-owned and privately-owned entities, as well as expanding the analytical base for studying the export-import potential of private enterprises. Integrating cutting-edge digital tools, such as artificial intelligence and robotics, could improve the accuracy and efficiency of monitoring and exploring the long-term social and economic implications of implementing the proposed monitoring technology.

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CONFLICT OF INTEREST

None.

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Технологія моніторингу ефективності використання та розвитку експортно-імпортного потенціалу суб'єктів господарювання державного сектору економіки

Людмила Малярець
Доктор економічних наук, професор
Харківський національний економічний університет імені Семена Кузнеця
61166, пр-т Науки, 9а, м. Харків, Україна
https://orcid.org/0000-0002-1684-9805

Олексій Бударін
Аспірант
Харківський національний економічний університет імені Семена Кузнеця
61166, пр-т Науки, 9а, м. Харків, Україна
https://orcid.org/0000-0001-9399-9914

Анотація. Метою дослідження було визначити підходи до оцінювання ефективності використання та розвитку експортного та імпортного потенціалу державних підприємств України, враховуючи вплив зовнішніх і внутрішніх факторів, а також розробити комплексну систему моніторингу, що сприятиме підвищенню конкурентоспроможності та стратегічного планування їхньої діяльності. Методологія дослідження ґрунтувалася на застосуванні кількісних та якісних методів аналізу економічних показників ефективності діяльності державних підприємств та їхнього зовнішньоторговельного потенціалу, а також методі SWOT-аналізу запропонованої багаторівневої системи моніторингу, яка була оцінена також і через модель управління змінами. У дослідженні проведено контекстуалізацію стратегічного планування експортно-імпортного потенціалу суб'єктів господарювання державного сектору економіки. Визначено вплив політичних, економічних, соціальних, технологічних, екологічних та правових факторів на експортно-імпортну діяльність державних підприємств, з акцентом на виклики, спричинені повномасштабною воєнною агресією. Запропоновано 17-етапну технологію моніторингу експортно-імпортного потенціалу, яка поєднує кількісні та якісні методи аналізу, включаючи оцінку рентабельності, конкурентоспроможності, імпортної та експортної залежності. Впровадження запропонованої технології розглянуто крізь призму трансформаційної моделі Курта Левіна, яка передбачає поетапну адаптацію до змін та закріплення нових підходів у стратегічному управлінні. Результати контекстуального дослідження також підтверджують значення міжнародної підтримки, переорієнтації на нові ринки та інновацій для відновлення експортно-імпортного потенціалу. Дослідження було сфокусовано на державному секторі економіки та потребі в адаптації інструментів моніторингу до специфічних умов підприємств. Отримані висновки можуть бути використані для розробки стратегій підтримки державних підприємств, підвищення їхньої конкурентоспроможності та сталого розвитку в умовах зовнішніх і внутрішніх викликів

Ключові слова: контекстуальний аналіз; стратегічне планування; конкурентоспроможність; зовнішньоторговельна діяльність; торговий баланс

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Impact of trade agreements and international markets on the agricultural sector

Elti Shahini*
Postgraduate Student
Simon Kuznets Kharkiv National University of Economics
61166, 9A Nauky Ave., Kharkiv, Ukraine
https://orcid.org/0009-0004-8299-4236

Abstract. The aim of this study was to comprehensively examine the impact of trade agreements and international markets on the development of the agricultural sector, in particular on the case of Albania and Austria. The study aimed to identify the mechanisms through which trade agreements stimulate production, export orientation and cooperation in agriculture. The findings indicate that the reduction of trade barriers and tariffs contributes to a significant increase in the competitiveness of agricultural products on international markets. By simplifying export procedures and reducing trade-related costs, producers can better integrate into global supply chains, which provides access to new markets. This is especially true for countries with developed agricultural sectors, where tariff reductions allow them to expand their exports, increasing production volumes and improving product quality to meet international standards. It also improves the efficiency of the domestic market, stimulating innovation and investment in the agricultural sector, which in turn has a positive impact on the country's overall economic development. In Albania, for example, trade agreements with the EU have increased exports, while Austria has gained access to significant subsidies through its participation in the EU's common agricultural policy. In addition, structural changes in the agricultural sector under the influence of international trade have led to increased production efficiency in Austria and adaptation to new market requirements in Albania. The conclusions show that international trade not only opens new markets for agricultural products, but also stimulates technological development and integration of agricultural sectors into global economic processes

Keywords: globalisation; supply and demand; pricing; dumping; protectionism; investment

INTRODUCTIONS

The development of models and mechanisms for the impact of trade agreements and international markets on the agricultural sector remains one of the key challenges facing both developed and developing economies. In the context of globalisation, trade liberalisation and growing competition in international markets, agricultural products are becoming not only an economic resource but also an instrument of political influence. Participation in global trade agreements determines not only the country's export opportunities, but also affects domestic agricultural policy, the development of farming, rural areas and food security. This issue is especially important for countries with a strong agricultural sector, where market fluctuations and the impact of international trade restrictions can have serious consequences for the national economy and the welfare of citizens. At the same time, despite numerous studies in this area, the interaction of specific agreements with the structural features of agricultural markets remains insufficiently studied. This makes it important to analyse the impact of trade agreements not only on macroeconomic indicators, but also on the development of individual segments of the agricultural sector. In this context, the study of models of the impact of trade agreements on the agricultural sector is of particular relevance, as changes in market conditions under the influence of international regulations can lead to both positive and negative consequences for agricultural producers. Research on the impact of trade agreements on the agricultural sector has repeatedly been the subject of attention of

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*Corresponding author

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scholars. In particular, the works of Y. Kunimitsu *et al.* (2020) and P. Wang *et al.* (2023) demonstrated that liberalisation of agricultural markets can contribute to economic growth, but also threatens traditional forms of agriculture.

Studies on the agricultural sector in the context of global market processes focused on various aspects related to the impact of international agreements on local agricultural economies. Among them are the works of R.D. Thrasher (2021) and D.A. Irwin (2020), which showed that for countries with a strong agricultural base, joining international organisations and concluding free trade agreements open up new opportunities for exports, but also create challenges in the form of increased competition with foreign producers. Other studies, such as those by B. Jiménez-García & J. Rodríguez (2022) or X. Yao *et al.* (2021), focus on the impact of bilateral and multilateral agreements on individual countries' economies. They point out that tariff reductions and simplification of customs procedures contribute to the growth of agricultural exports, which, in turn, leads to an increase in the profitability of agricultural enterprises.

The issue of environmental sustainability remains critically important in the context of modern agricultural practices, which is especially reinforced by the impact of international trade agreements. In T. Białowąs & A. Budzyńska (2022) clearly emphasised that international agreements contribute not only to the growth of agricultural production and exports, but also stimulate the intensification of agricultural processes. There is a growing need for trade agreements to not only stimulate economic growth, but also respond to the challenges of environmental sustainability. As noted by A. Poletti *et al.* (2021) or J.M. Balogh & A. Jámbor (2020), the introduction of stricter environmental responsibility requirements at the international level would help reduce the negative environmental impact of agricultural intensification. The consequences of non-compliance with such standards could be catastrophic for both the environment and agricultural production in the long run.

Another important issue raised in current research is the impact of international co-operation agreements on the development of agricultural technologies and the efficiency of agricultural production. The study by Y.E.L. Doukas *et al.* (2022) showed that international cooperation, in particular between EU countries, promotes the introduction of new technologies and innovations in agriculture, which, in turn, increases the competitiveness of agricultural products in international markets. At the same time, authors such as N. Chaparro-Banegas *et al.* (2024) pointed out that technological barriers remain a significant problem for developing countries, where the agricultural sector lacks innovative solutions. However, most studies focused on individual countries or markets, while comparative studies analysing different patterns of trade agreements' impact on the agricultural sector in different economic conditions remain rare. Therefore, it is important to conduct a more detailed analysis of how trade agreements affect the agricultural sector in countries with different levels of economic development and political systems.

This study aimed to reveal the main models and mechanisms of the impact of international trade agreements and global markets on the agricultural sector, which is important for understanding economic processes in the context of globalisation. The key objectives of the study were as follows:

1.Analysing the main types of trade agreements and their impact on the agricultural sector in different countries.

2.Assessment of the role of international organisations and agreements in shaping agricultural trade rules and regulations.

3.Analysing strategies for adapting national economies to the new requirements of international markets and their impact on the development of farming and agribusinesses.

MATERIALS AND METHODS

The study used a comprehensive approach that combines both quantitative and qualitative methods of analysis to examine the patterns and mechanisms of impact of trade agreements and international markets on the agricultural sector. The study included several stages, each with its own objectives and goals. The first stage involved collecting and selecting a sample of materials for analysis. The sample covered a wide range of sources, such as documents of the World Trade Organisation (Agreement on Agriculture, 2024), reports of the Food and Agriculture Organisation of the United Nations (FAO) (2024). This ensured a representative sample and reflected the international and national specifics of the impact on the agricultural sector.

The second stage of the study involved a comprehensive content analysis of the collected documents covering a wide range of international trade agreements, national legislation and reports of international organisations. The main objective of this stage was to study in detail the key aspects of trade agreements, in particular such elements as agricultural quotas, tariff regulation, farm subsidies, and various forms of non-tariff barriers affecting access to international markets. Particular attention was paid to the study of quotas, a mechanism that regulates the amount of products that can be exported or imported under preferential conditions. In addition, non-tariff barriers, such as product quality requirements, sanitary and phytosanitary standards, were also studied, which also have a significant impact on the structure of production and export opportunities (Agreement on Sanitary and Phytosanitary Measures, 1998). These barriers often result in restricted access to foreign markets, especially for developing countries. In addition, attention was paid to the impact of market trends on the structure of production and export opportunities in the agricultural sector. A particularly important aspect was the analysis of changes in world prices for major agricultural commodities (High food prices…, 2024).

The third stage involved a comparative analysis of the impact of international trade agreements on the agricultural sector in Austria and Albania (Decision of the Council of Ministers…, 2014, October; Agreement on the European Economic Area, 2016, European Union and Albania, 2021;

August; Austria – CAP Strategic Plan, 2024). The main focus was on the differences in approaches to farmer support, market regulation, and participation in European and global economic associations, such as the European Union and its common agricultural policy (CAP) (2024). The implications of globalisation and market opening for agriculture in the two countries were also analysed. In this context, the paper examines how integration into world markets affects smallholder farmers, rural development and the changing structure of production. Particular attention was paid to how international agreements facilitate or hinder sustainable agriculture and food security.

Finally, the findings were summarised and conclusions were drawn on the main trends in the impact of trade agreements and international markets on the agricultural sector in Austria and Albania. The key factors impacting the dynamics of agricultural production, including trade preferences, export opportunities and regional market characteristics, were identified. The results of the study helped to outline new approaches to studying the impact of global markets on national agricultural policies in the context of international trade and changing economic conditions.

RESULTS

Models and mechanisms of influence of trade agreements and international markets. Trade agreements play an important role in the development of the agricultural sector by creating favourable conditions for expanding market opportunities and providing access to international markets. Typically, countries that sign such agreements benefit from lower tariffs, reduced administrative barriers, and new sales channels. This is especially true for the agricultural sector, where products are often seasonal and need to be sold quickly to prevent losses. Reducing or completely eliminating customs barriers allows agricultural producers to freely export their products to partner countries, which significantly increases their competitiveness. Access to international markets opens up new opportunities to increase production, expand exports and optimise production costs.

In addition to economic benefits, trade agreements help diversify risks for the agricultural sector. Opening new markets allows producers to avoid dependence on domestic demand, especially in times of economic instability. It also helps to avoid situations where a surplus of products on the domestic market can lead to lower prices and, as a result, financial losses for farmers. Access to foreign markets allows producers to tap into global demand for agricultural products, which may vary depending on seasons, climatic conditions, or changes in consumer preferences in different countries. In addition, free trade agreements, such as the European Economic Area (EEA) (2016) or various bilateral agreements, have an important effect on the economies of the participating countries. They create conditions for the development of international cooperation, which, in turn, contributes to economic growth through increased trade. Thanks to such agreements, countries receive not only economic benefits from increased exports, but also the opportunity to adapt their production processes to global standards, which increases their long-term sustainability on the global stage. As a result of trade liberalisation, the profitability of the agricultural sector increases, which has a positive impact on the national economy. Another important aspect is to stimulate investment in infrastructure and innovation. Given that international markets are much more competitive, producers need to improve their production efficiency to remain competitive. This may include technological innovations, improved logistics processes, better storage of products, and the development of transportation infrastructure. Investments in infrastructure, including the development of transport networks and modernisation of production facilities, can reduce the cost of shipping and storage, reduce losses and improve the quality of exported goods.

Institutional harmonisation and regulatory coordination provided by trade agreements is also an important element. Compliance with international standards is becoming a critical aspect of successful operation in global markets. The harmonisation of regulations, such as food quality and safety requirements, reduces trade barriers and simplifies certification and quality control procedures. This is especially important for agricultural products, which often require strict compliance with sanitary and phytosanitary regulations to be admitted to markets with high standards. For example, exports of organic products to the European Union require compliance with strict environmental standards and certificates (Standards, tools and labels, 2024).

Trade agreements have a long-term impact on the sustainability of the agricultural sector by promoting exports, improving product quality, and increasing the efficiency of production processes. They create favourable conditions for attracting foreign investment and, at the same time, stimulate the agricultural sector to improve environmental and social standards, which contributes to the sustainable development of both national economies and the global agro-industrial sector. This development does not take place in a vacuum, as international agricultural trade is a complex and multidimensional system based on different economic models that explain the mechanisms of movement of goods between countries.

Trade agreements and trade patterns interact to create a comprehensive infrastructure for the development of the global agricultural market. One of the most famous and fundamental models is the Theory of Comparative Advantage (Faccarello, 2023). According to this model, each country should specialise in the production of those goods in which it has a relative advantage. This means that even if one country can produce everything more efficiently than others, it still benefits from specialising in goods that are relatively less costly to produce. For example, countries with large land resources, such as Ukraine, Canada, or Argentina, have a comparative advantage in growing grain crops, while countries with more favourable climatic conditions, such as Italy or Mexico, can specialise in growing fruits and vegetables. This leads to more efficient use of

resources and lower production costs on a global scale. This model not only explains the movement of goods, but also serves as a basis for developing international trade strategies for many countries, especially those whose economies are heavily dependent on agricultural exports. An important aspect is that specialisation allows countries to concentrate their resources on products that provide them with the greatest economic benefit. This helps to improve the quality of goods, increase their production, and expand markets, which is a key factor in the agricultural sector.

However, in addition to the theory of comparative advantage, there are other models that help to better understand the structure of international trade. One of them is the gravity model of trade (Gantuya *et al*., 2021), which assumes that the volume of trade between countries depends on their economic size and geographical proximity. This model states that large economies trade more with each other because they have a higher demand for goods and services. At the same time, countries that are closer to each other are more likely to cooperate because transportation costs are lower and delivery times are shorter. The gravity model of trade is particularly relevant for the agricultural sector, as many agricultural products have a limited shelf life and require rapid delivery to markets. For example, fresh fruits, vegetables, dairy products, and meat are perishable, so it is critical for such products to be able to transport them over short distances or using efficient logistics solutions. This model helps to explain why agricultural products are often exported to neighbouring countries or regions with high food demand. For example, the European Union countries actively cooperate in agricultural trade, as geographical proximity helps to reduce transportation costs and ensures fast delivery of goods.

In addition, the value chain model plays an important role in modern international agricultural trade (Pylypenko *et al*., 2024). It emphasises the importance of integrating countries into the global economy not only through the production of raw materials, but also through participation in various stages of the production process. For the agricultural sector, this means that countries can specialise not only in growing commodities, but also in processing, packaging, storage, and transportation. This approach allows them to increase the added value of their products and improve their competitiveness in international markets. The value chain model is important for countries seeking to diversify their export opportunities. For example, countries that export raw materials such as grain can develop infrastructure to process it and produce end products such as bakery products that have much higher added value. This not only increases export revenues, but also contributes to job creation and economic growth at home.

International agricultural trade is based on the interaction of several key models, each of which helps to explain different aspects of the process. The comparative advantage model emphasises the importance of specialisation, the gravity model draws attention to the impact of economic size and geographic proximity, and the global value chain model emphasises integration into the global economy through participation in all stages of the production process. At the same time, international trade agreements and the activities of key organisations play an important role in shaping trade rules, product quality standards, financial support, and the general conditions for the agricultural sector. Together, these models and mechanisms of influence of agreements and organisations create a holistic view of how international trade in agricultural commodities takes place, and determine the dynamics, efficiency and opportunities for economic development of countries.

The role of international organisations in the world agricultural market. The World Trade Organisation (WTO) is the central institution for regulating global trade, including agricultural trade. One of the key regulatory instruments is the Agreement on Agriculture (AOA) (2024). This agreement establishes clear rules relating to three main aspects: support for domestic subsidies, customs tariffs and market restrictions. Implementation of this agreement is aimed at gradual liberalisation of international trade in agricultural products and reduction of inequalities between developed and developing countries.

One of the main provisions of the Agreement on Agriculture is the gradual reduction of subsidies provided by governments to their agricultural producers. Prior to joining the WTO, many countries used domestic subsidies to support their agricultural sector, which helped protect producers from fluctuations in global markets and ensure price stability. However, the agreement requires signatory countries to reduce direct subsidies to farmers and gradually move towards more competitive market conditions. For example, countries such as the US, EU, Australia, and Canada have been forced to revise their agricultural policies, including reducing subsidies and tightening export regulations. In the European Union, this led to the reform of the CAP, which includes subsidy cuts and increased transparency in the provision of state support to farmers. On the other hand, developing countries such as India and Brazil, although signatories to the agreement, have somewhat different conditions for implementing the provisions of the agreement. According to WTO rules, these countries have more time to adapt their agricultural systems and can continue to provide some support to their farmers, albeit in a limited way. However, the general trend is toward reducing subsidies and opening markets to international competition. This allows them to integrate their agricultural sector into the global economy and provides access to new markets.

The WTO's activities contribute not only to improving the quality of agricultural products, but also to expanding markets. Countries that have signed agreements with the WTO, such as China, India, Japan, and many others, have been able to improve their export opportunities by accessing the markets of the EU, the US, and other major economies. For example, China has significantly increased its agricultural exports since joining the WTO in 2001 (Table 1), especially in sectors such as fruit, vegetables, and cereals.

Table 1. China's exports since the signing of the WTO agreement

Year	Trade value (USD)
2000	249 billion
2005	761 billion
2010	1 trillion 577 billion
2015	2 trillion 273 billion
2020	2 trillion 589 billion
2023	3 trillion 308 billion

Source: compiled by UN Comtrade Database (2024)

At the same time, the WTO requires member countries to increase transparency in trade relations and subsidy reporting. This helps to avoid excessive protectionist policies, which used to be widespread in many countries. For example, in 2014, the European Union was forced to reform its system of agricultural subsidies due to complaints from developing countries in the WTO. As a result, new rules for supporting the agricultural sector were introduced, which better meet the requirements of free trade (Singh, 2017).

The European Union (EU) and the common agricultural policy (2024) are important in the context of agricultural sector development. The CAP's impact covers a wide range of issues, including support for farmers, control over environmental standards, and food security. One of the key objectives of the CAP is to ensure stable production of quality agricultural products that meet strict environmental and health requirements. This has become the foundation for agricultural development within the EU, while encouraging countries that have trade relations with the EU to adapt their agricultural policies to the requirements of the European market. The main advantage of the CAP is the system of subsidies that supports farmers in their activities. Subsidies help to ensure stable incomes, which is especially important for small and medium-sized farms. This helps to maintain the sustainability of production, even in times of economic instability or natural disasters. However, it is important to note that the CAP not only provides financial support, but also requires farmers to comply with environmental standards. Farmers must implement practices aimed at preserving the environment, such as reducing the use of chemical fertilisers, optimising water use, introducing technologies to reduce greenhouse gas emissions, and improving biodiversity.

The impact of the environmental component of the CAP can be seen in many EU member states. For example, in France, farmers are forced to significantly reduce the use of pesticides and fertilisers due to CAP requirements, which has led to the transition to organic farming in many regions of the country (Lenormand, 2023). In Germany, considerable attention is paid to innovations in the field of agrotechnology, in particular the introduction of "precision farming", which allows optimising the use of resources while reducing the negative impact on the environment (Biagini *et al*., 2023). Such technologies have become a key tool for meeting the CAP's stringent environmental standards and have a significant impact on increasing the competitiveness of the EU's agricultural sector in the global market. For non-EU countries seeking to export their products to the European market, compliance with CAP standards is a prerequisite. For example, Ukraine, which signed the Association Agreement between the European Union and its Member States and Ukraine (2024), has to adapt its agricultural products to EU standards, in particular in terms of environmental safety and product quality. This agreement provides for close trade relations, which opens up access to the European market for Ukrainian producers, but at the same time requires significant investments in modernisation of production.

The impact of the CAP is manifested not only through improved environmental conditions, but also through expanded export opportunities for countries that adhere to its standards. For example, Poland, after joining the EU, was able to significantly expand its export opportunities in the agricultural sector (Table 2), especially in meat and dairy production. Thanks to the modernisation of agriculture and compliance with CAP requirements, Polish farmers have gained access to the world's largest market, which has contributed to the development of the country's agricultural sector.

Table 2. Poland's exports since the signing of the EU agreement

Year	Trade Value (US$)
2004	73 billion
2008	171 billion
2012	179 billion
2016	196 billion
2020	254 billion
2023	318 billion

Source: compiled by UN Comtrade Database (2024)

Another example is Spain, where farmers are actively using CAP subsidies to develop sustainable viticulture and olive plantations. Thanks to compliance with EU environmental requirements and the use of new technologies, Spanish producers have been able to significantly increase their exports to other EU countries, including France and Germany. Countries outside the EU, such as Turkey and Morocco, are also seeking to comply with CAP requirements to ensure access to European markets for their agricultural products. They are adapting their production processes by introducing environmentally sustainable technologies, which allows them to remain competitive in the face of stringent requirements of European consumers. The CAP is also important for African, Caribbean, and Pacific (ACP) countries that have signed partnership agreements with the EU (Economic Partnerships, 2024). These agreements provide preferential access to EU markets for agricultural products from these countries, but require compliance with certain standards of quality and environmental sustainability. This allows ACP countries to expand their export opportunities while modernising their agricultural sectors. The impact of the European Union and the common agricultural policy is multifaceted. Not only do they stimulate the development of the agricultural sector within the EU, but they also set the rules of the game for global agricultural trade. Compliance with the CAP's strict environmental, health and safety standards are becoming a prerequisite for all countries seeking access to the European market. This helps to improve the quality of agricultural products and ensures sustainable development of agriculture, which has positive consequences for both the economy and the environment at the global level.

The Food and Agriculture Organisation of the United Nations (FAO), which is one of the leading international institutions that influences global processes of food security and sustainable agricultural development, also has a significant impact on the agricultural sector. Established in 1945, the FAO is actively working to address critical issues related to food production, environmental protection, and adaptation of agricultural systems to global challenges such as climate change, hunger, and land degradation. The organisation cooperates with developing countries as well as developed countries, providing technical, financial and political support in the development and implementation of effective agricultural policies. One of the key aspects of FAO's activities is monitoring of global food markets. The organisation analyses global trends in supply and demand for major agricultural products, which allows member countries to better plan their food strategies. This is important not only for developed countries, but also for developing ones, as FAO provides them with forecasts and analytical tools to formulate effective national agricultural policies. For example, during the global food crisis of 2007-2008, FAO was an important source of information on food price spikes, helping governments to make more informed decisions on export and import operations (High food prices…, 2024). Countries that have signed agreements with FAO are obliged to implement its recommendations and use the technical resources provided to develop their agricultural sector. These countries include all 194 UN member states, including the European Union as a regional member. FAO's activities are global, but different countries have different levels of cooperation with this organisation. For example, Brazil, which is one of the world's leading agricultural exporters, actively cooperates with FAO to disseminate its innovative methods of growing crops in Africa. At the same time, the European Union countries are focused on implementing high standards of food safety and environmental protection, which is also supported by FAO projects. It is also important to note the role of FAO in the fight against hunger, which is one of the main missions of the organisation. According to the FAO *et al.* (2024), in 2023, about 733 million people in the world suffered from malnutrition, and this figure is growing due to worsening climate conditions and social conflicts. The organisation develops strategies to overcome the food crisis, in particular by providing financial assistance and technical support to countries with high levels of hunger.

When analysing current global trade agreements and financial instruments, it is worth noting the influence of the International Monetary Fund (IMF) (2024) and the World Bank. These two institutions play a crucial role in supporting economic development, especially in developing countries. Their activities have a direct impact on the modernisation of agricultural sectors, economic stability, and the implementation of structural reforms aimed at attracting investment and improving economic efficiency. The World Bank focuses on financing projects aimed at long-term economic development. One of the key areas is agriculture. The Bank provides loans and technical assistance to increase agricultural productivity, develop infrastructure, manage water resources, and provide access to modern technologies. For example, in many African countries, the World Bank finances projects aimed at modernising irrigation systems, improving storage and processing conditions for agricultural products (Batchelor & Schnetzer, 2018). This allows local farmers to increase yields and improve access to domestic and international markets, contributing to regional economic growth.

The International Monetary Fund (2024), in turn, focuses on macroeconomic stability and support for countries in times of financial crises. The IMF provides loans to countries facing balance of payments deficits, high budget deficits, and other financial difficulties. However, these loans are often linked to requirements for economic reforms, including reforms in the agricultural sector. These reforms are usually aimed at increasing the transparency of public administration, liberalising trade, and reducing budget expenditures, in particular by cutting subsidies. An example is Albania, which has repeatedly cooperated with the IMF to receive financial assistance to stabilise its economy. As part of these agreements, the government was forced to revise its agricultural policy, including reducing state support for farmers and opening markets to competition. This also

included reforming the land market to attract foreign investment in the agricultural sector and increase its competitiveness. In 2014, Albania implemented an agricultural subsidy reform program that met the requirements of cooperation with the IMF (Decision of the Council of Ministers for…, 2014). Although the reforms have led to some challenges for small farmers, in the long run they have contributed to the stabilisation of the economy and the development of the agricultural sector. The reforms implemented by Albania in cooperation with the IMF were aimed at liberalising markets and developing the country's export potential. However, as in other countries, these measures caused certain socio-economic challenges, in particular for small farmers who could not always compete with large international producers. At the same time, in the long run, these reforms were aimed at increasing the productivity of the agricultural sector and attracting new investments, which had a positive impact on the overall economic development of the country. It is worth noting that participation in IMF and World Bank programs is not always without conflicts and risks for developing countries. Although financial assistance provides access to new technologies and modernisation of agricultural sectors, it is often accompanied by strict requirements for market liberalisation, which can lead to negative consequences for certain segments of the population, in particular small farmers who become less competitive in the face of global market changes.

Free Trade Agreements (FTA) are one of the key mechanisms that stimulate the development of international agricultural trade. These agreements provide for the reduction or complete elimination of customs duties on goods and services, which allows participating countries to gain access to new markets and increase the efficiency of their economies. FTA are an important tool for the development of the agricultural sector, as they allow producers to gain direct access to international markets with minimal barriers to trade. Free trade encourages producers to improve product quality, reduce costs and increase international competitiveness. Free trade agreements encourage manufacturers to adopt innovative technologies that help optimise production processes and increase productivity. After the signing of the FTA between Chile and China (State Council of the People's Republic of China, 2019), Chilean producers significantly expanded their export potential by gaining access to the large Chinese market. However, free trade agreements can also pose challenges for the domestic markets of the participating countries. Opening up markets through tariff reductions can lead to increased competition from foreign producers, which in turn puts pressure on domestic producers. For example, after the conclusion of the North American Free Trade Agreement (NAFTA) between the United States, Canada, and Mexico, Mexican farmers faced significant competition from large American agricultural corporations, which led to a reduction in some types of production in Mexico (Denata *et al*., 2023). This has necessitated the adaptation of Mexican producers to new market conditions, including the introduction of new technologies and increased productivity.

The economic and political impact of trade agreements on the agricultural sector in Albania and Austria. Trade agreements are an important tool for shaping the economic climate for the agricultural sector, which directly affects farmers' incomes and the profitability of agricultural enterprises. These agreements have different impacts on agriculture in different countries, depending on the level of economic integration and agricultural policy. For example, Albania and Austria, which, although in different economic conditions, face the need to adapt their agricultural sectors to the requirements of global markets, are worth considering.

Albania, as a country in transition, continues to undergo a complex process of reforming its agricultural policy. This is especially important in an environment where agricultural productivity remains relatively low and the technological base needs to be modernised. However, thanks to trade agreements, in particular with the European Union (European Union and Albania, 2021), Albanian farmers have gained access to new markets for their products. One of the key points is access to the European market, which stimulates production and increases export opportunities for certain agricultural products, such as fruits, vegetables, and dairy products. For example, food exports, primarily of grapes, have increased significantly since the agreement with the EU, which has boosted the development of this sector in Albania (Table 3).

Table 3. Albania's exports since the signing of the EU agreement

Year	Trade Value (US$)
2009	1 billion 087 million
2013	2 billion 331 million
2015	1 billion 929 million
2018	2 billion 875 million
2021	3 billion 562 million
2023	4 billion 306 million

Source: compiled by UN Comtrade Database (2024)

However, it should be noted that trade with developed countries places high demands on product quality. The Agreement on Sanitary and Phytosanitary Measures (2024), which is actively supported by the WTO, provides for strict standards that Albanian farmers must meet in order to be able to export their products to Europe or other regions. This creates serious challenges for small farmers, who often do not have sufficient resources to implement the

necessary technologies or modernise their production. As a result, Albanian farmers are often forced to limit their trade opportunities, which affects their income and ability to develop their farms.

In contrast, Austria, as a full member of the European Union, enjoys significant advantages in the agricultural sector through its participation in the EU's CAP. This policy provides member states with substantial subsidies and grants, which stabilises farmers' incomes and keeps Austrian farmers highly competitive on international markets. For example, the CAP provides financial support to Austrian farmers to introduce new technologies and improve the environmental sustainability of their production, which allows them not only to meet the needs of the domestic market but also to actively export their products outside Europe (Austria – CAP Strategic Plan, 2024). The Austrian agricultural sector is highly technological and has access to diverse markets, which allows it to maintain stable income even in the face of global economic challenges. At the same time, it should be noted that international trade agreements may lead to certain inequalities in the development of the agricultural sector in both Albania and Austria. Large agricultural enterprises benefit from such agreements, as they have sufficient resources to scale up production and adapt to international quality standards. They can easily integrate into global markets, gaining access to new export and profit opportunities.

International trade agreements act as a powerful catalyst for structural change in the agricultural sector of countries, affecting not only production but also employment and labour organisation. Their impact on agricultural development varies across countries depending on their level of economic development, access to technology and ability to adapt to global market demands. For countries such as Austria, international trade provides an incentive for innovation, which leads to higher production efficiency and lower production costs. However, these developments also have significant social and economic consequences, including the loss of agricultural jobs.

Austria, as a developed country with a high level of agricultural mechanisation, has long benefited from international trade. Trade agreements have contributed to the active development of agricultural infrastructure and the introduction of new technologies, which, in turn, have increased productivity and reduced unit costs. For example, Austrian farmers widely use automated systems for animal care and land cultivation, which significantly reduces the amount of manual labour and increases the quality of their products (Edan *et al*., 2023). However, this shift to more mechanised production has had implications for the agricultural labour market. In particular, many workers who were traditionally engaged in manual labour have lost their jobs due to the automation of production processes. In the long run, this restructuring of agriculture allows Austria to remain competitive on international markets, but it requires retraining of the workforce and investment in the development of new skills.

Albania, whose economy is still heavily dependent on traditional forms of agricultural production. Despite the potential benefits of international trade agreements, Albania's agricultural sector faces numerous challenges to improving its competitiveness. One of the main barriers is the lack of sufficient investment in modernising agricultural infrastructure, which makes Albanian agriculture less efficient compared to developed countries. Local farmers, who mainly use traditional production methods, have limited access to technology and cannot always ensure compliance with high international quality standards. This makes it difficult for them to enter international markets, even if trade agreements exist that provide such access. Trade agreements for Albania, while opening up new export opportunities, require significant changes in the way production is organised. In particular, local farmers have to adapt to the new requirements of international standards, such as food safety and environmental regulations. For example, the Sanitary and Phytosanitary Agreement (SPS Agreement) (The WTO Agreement…, 2024) imposes strict requirements on the safety of agricultural products, which requires significant investments in technological innovations such as quality control at different stages of the production cycle. For many small-scale farmers who traditionally work with old technologies, these requirements put serious pressure on their financial viability and ability to compete internationally. This, in turn, leads to a need to change the structure of employment, including a growing demand for skilled workers capable of implementing new technologies and managing modernised production processes.

It is worth noting that trade agreements have a mixed impact on the social aspects of agriculture. On the one hand, they help to increase efficiency and open up access to new markets, which can potentially boost economic growth. On the other hand, modernisation and standardisation requirements put additional pressure on small farms and workers, who often do not have access to financial resources or support to adapt to new conditions. For example, in the case of Albania, local farmers face limited opportunities to invest in new technologies, which puts them at a disadvantage compared to large agricultural holdings or farmers in developed countries. Austria, which has access to financial support under the EU's common agricultural policy, has been able to effectively use international trade agreements to modernise its agricultural sector and increase its competitiveness. Even here, however, there is a downward trend in agricultural employment as automation of processes reduces the need for manual labour. In the long run, this may create additional social challenges, such as retraining workers and providing new jobs in related industries. Investments in agricultural infrastructure play a key role in ensuring the sustainable development of the agricultural sector, especially in the context of international trade agreements. The development of this area allows countries to effectively integrate into world markets, increase productivity and ensure global competitiveness. Accordingly, the effective use of investments in logistics,

technology, and storage is becoming a crucial factor for the success of the agricultural sector in global trade.

Austria is a prime example of how international trade agreements, including participation in the European Union and the CAP, have helped to attract significant investment in agricultural infrastructure. Thanks to agreements with the EU, Austrian farmers have access to a wide range of financial resources and technical assistance, which allows them to modernise production facilities, introduce new technologies and improve supply chains. For example, the Austrian agricultural sector pays considerable attention to the development of transport logistics, which ensures fast and safe delivery of products both in the domestic market and abroad (Erixon *et al*., 2020). The introduction of new technologies for storing and handling products also contributes to the competitiveness of the Austrian agricultural sector. This is particularly important in the fiercely competitive international market, where the speed and quality of product delivery are crucial factors for success. In addition, international trade agreements encourage the development of sustainable practices in Austria's agricultural infrastructure. European environmental standards, which are binding on all EU member states, encourage Austrian farmers to adopt practices that minimise their environmental impact. This includes the use of renewable energy sources, efficient waste management and the reduction of greenhouse gas emissions. As a result, Austria's agricultural infrastructure is not only more productive but also environmentally sustainable, enabling it to hold a strong position on international markets.

In contrast, the situation in Albania is more complex due to the limited level of investment in agricultural infrastructure. Despite the significant potential for agricultural sector development, Albania faces serious challenges in modernising its infrastructure capacity. Trade agreements with the EU and regional partners have undoubtedly created conditions for attracting foreign investment, but their volume is still insufficient to have a significant impact on the agricultural sector. As a result, Albanian farmers remain less competitive on international markets due to the lack of adequate infrastructure for transporting and storing products. One of the main challenges for Albania's agricultural infrastructure is the underdeveloped logistics network, which does not allow for efficient delivery of products to foreign markets. Many farmers do not have access to modern technologies for storing agricultural products, which leads to significant losses of products after harvest. This, in turn, limits their ability to compete with more developed agricultural economies such as Austria. However, efforts to attract foreign investment, including from international organisations, may change the situation. In particular, the World Bank and the European Investment Bank have already begun to finance several projects aimed at developing agricultural infrastructure in Albania, which could significantly improve the situation in the long run.

Trade agreements, while playing an important role in the development of the global economy, can cause a number of problems for the agricultural sector, including increased competition from foreign producers, dumping practices, and the need for protectionist measures. In the case of Austria, a country with high standards of agricultural production, there is a need to protect domestic markets from the influx of cheaper products from other countries that do not adhere to such strict quality and environmental standards. Products imported from countries with lower production standards can be significantly cheaper due to lower production costs, which puts Austrian farmers at a disadvantage. To prevent the negative consequences of this situation, the Austrian government has been forced to apply protectionist measures aimed at protecting local producers. This includes higher duties on certain imported products, restrictions on the import of goods that do not meet national standards, and financial support for local agricultural enterprises. At the same time, this approach raises complex economic and political questions, as it may contradict the principles of free trade enshrined in international trade agreements, such as those governed by the WTO. Austria, as part of the European Union, is bound by the general rules of the EU's common market, which limits its ability to unilaterally impose such measures, as most decisions on protectionism are taken at the EU level.

Albania, on the other hand, as a country with a less developed economy and agricultural sector, faces significant difficulties in competing with more economically powerful countries. Dumping practices, often used by large producers from developed countries, pose a serious threat to Albanian farmers. Dumping is the artificial reduction of prices for exported goods in order to capture the market, which puts Albanian farmers in an extremely difficult situation. Most of Albania's small and medium-sized agricultural enterprises operate with relatively low productivity, due to limited access to modern technology and lack of investment. As a result, Albanian agricultural products are often unable to compete on price with dumped products from abroad. In addition, due to weak state support and limited access to finance, many Albanian farmers are unable to invest in improving their production, modernising their machinery or adopting new technologies. This reduces their competitiveness on international markets, even though there are certain trade agreements in place that could theoretically open up access to new markets. Such conditions create additional risks for the Albanian agricultural sector, as farmers may lose domestic market share due to the influx of cheap imported goods, which leads to a drop in income and, in some cases, bankruptcy for small producers. It is also worth noting that while issues such as dumping and protectionism are common to many transition economies, Albania remains vulnerable due to the low level of institutional support for farmers. The absence of effective mechanisms for state aid or export promotion makes Albanian producers vulnerable to external factors, which reduces their ability to compete on equal terms with foreign producers. State support policies for agriculture are a key factor in ensuring the competitiveness of the agricultural

sector, especially in international markets, where competition is becoming increasingly fierce due to globalisation. In many countries, state support policies are aimed at ensuring the stability of farmers' incomes, maintaining high production standards and developing agricultural enterprises, which allows them not only to survive in the domestic market but also to actively participate in export operations.

Austria, as a member state of the European Union, benefits from its participation in the CAP. As a result, Austrian farmers have access to stable sources of funding, which allows them not only to maintain production levels but also to actively innovate and develop technologies. EU support helps Austria to maintain high quality standards that meet international requirements and also stimulates the development of organic farming, which has become one of the hallmarks of the Austrian agricultural sector. For example, in 2022, Austria was one of the leaders in Europe in terms of the share of organic land under organic farming, which was made possible by government support. Among European countries and globally, Liechtenstein has the highest share of organic land at 43.0%, followed by Austria, the EU country with the highest share of organic land at 27.5% (FiBL, 2022). According to the FiBL, the percentage of organic land should rise to 35% by 2030. In addition, Austrian government policy is focused on improving the efficiency of small and medium-sized agricultural enterprises, which are the backbone of agricultural production. Conditions are created for farmers to modernise their farms and receive additional support when implementing environmental innovations or upgrading their technical facilities. This allows even small farms to remain competitive in open markets and fierce competition.

On the other hand, Albania, as a country in transition, does not have such extensive financial resources to support the agricultural sector. This poses serious challenges for Albanian farmers, who face limited opportunities to modernise production and integrate into international markets. However, the Albanian government is taking active steps towards agricultural development through cooperation programmes with the European Union and other international organisations. These programmes are aimed at increasing productivity, supporting small and medium-sized farms, and improving rural infrastructure. In particular, EU programmes for transition countries, such as Instrument for Pre-Accession Assistance for Agriculture and Rural Development (IPARD) (IPARD III implementation…, 2024), help Albania to secure funding for projects aimed at increasing the competitiveness of farms. The IPARD programmes provide financial assistance to farmers seeking to modernise their production and meet European quality standards. Although this process requires considerable effort, it opens up prospects for Albanian farmers to enter new markets, including the European one. However, even with international support, the Albanian government has to address a number of critical issues. Firstly, it concerns the lack of infrastructure and technology, which significantly complicates the production and processing of agricultural products. In addition, many Albanian farmers face difficulties in accessing finance and credit, which limits their ability to grow and invest in new technologies. This creates a gap between large agricultural enterprises and small farms, where the latter often remain at the level of traditional farming methods, limiting their productivity.

Nevertheless, it is worth noting that in the face of global challenges and growing demands for agricultural products, state support policies are crucial for the success of the agricultural sector. The examples of Austria and Albania show how the level of state support affects the ability of countries to develop their agricultural sector, introduce innovations and enter international markets. Trade regulations are also important in this context. In the case of Albania and Austria, these requirements are largely determined by international standards and agreements that set specific requirements for the quality, safety and environmental responsibility of agricultural products. However, the implementation of these standards and the challenges faced by these countries differ due to their different economic status and level of integration into international markets.

DISCUSSION

The study on the models and mechanisms of the impact of trade agreements and international markets on the agricultural sector, based on the examples of Albania and Austria, showed that trade agreements have a significant impact on the development of the agricultural sector, creating conditions for expanding markets and increasing the competitiveness of agricultural products. Reducing tariff barriers, simplifying customs procedures and introducing modern technologies stimulated by international cooperation creates new opportunities for agricultural enterprises, increasing their competitiveness and efficiency. Such measures allow agricultural producers not only to increase production but also to improve product quality. This is in line with the research of many international scholars who emphasise the role of trade agreements in improving the efficiency and modernisation of agriculture. In the works of such researchers as E.D. Farsani *et al.* (2024) or N. Sansika *et al.* (2023) emphasised that international integration of agricultural markets is a key element for increasing productivity and introducing innovative technologies, which has a positive impact on the quality and volume of products.

The study confirms the positions set out in the works of H.T.T. Doan & H. Zhang (2023), who noted that reducing tariff barriers stimulates an increase in production volumes and improves product quality. The authors point out the importance of countries' participation in international agreements for access to new technologies and productivity growth in agriculture. In turn, the study findings show that the introduction of modern technologies, such as automation systems and the use of digital platforms to manage logistics processes, helps to increase production efficiency and reduce costs. This is in line with the findings of this study on the importance of reducing tariff barriers for the competitiveness and development of the agricultural sector.

In particular, in Albania, which faces challenges due to economic transition and insufficient infrastructure, accession to the WTO and participation in trade agreements with the European Union have stimulated the modernisation of the agricultural sector, but also revealed weaknesses, such as the lack of state support for small farmers and dependence on imported products, which threatens food security. Such challenges are noted in the study by M. Osmani *et al.* (2022) and E. Gjokutaj (2021), which emphasises that economic policies aimed at liberalisation without parallel support for agriculture lead to increased inequality in rural Albania. This inequality can have a negative impact on the formation of national identity and social integration, as agrarian communities remain vulnerable to changes in the global economy. The results of the study confirmed the existence of significant challenges in the development of the agricultural sector in Albania. In particular, the dependence on agricultural imports makes it difficult for farmers to form a sustainable economic model, leading to lower investment and limited development of local enterprises. This also affects political stability, as there is a growing risk of social tensions due to economic difficulties. Study I. Tomorri *et al.* (2022) also emphasised that without structured agricultural development programmes and infrastructure support from the Albanian government, farmers remain isolated from national and international markets. These conclusions are in line with the findings of this study, which point to the need for state support for farm growth, which in turn will allow the agricultural sector to integrate into global value chains.

In Austria, on the other hand, the agricultural sector is supported through participation in the European Union's CAP, which allows farmers to receive subsidies and financing for production development. Thanks to stable policies and strong institutions, Austria has been able to create the conditions for building an agricultural sector that is focused on sustainable development and export orientation. Centralised regulation of quality standards and environmental responsibility also plays an important role, contributing to the sustainable development of the agricultural sector and increasing the country's export potential. However, as the study by G. Malorgio & F. Marangon (2021), the high standards and requirements of the CAP can create difficulties for smaller firms that do not always have the resources to meet the requirements. This is confirmed in this study, which emphasises the importance of state support and resources for small and medium-sized farmers to adapt to modern requirements and standards. In general, Austrian policy aims to preserve agricultural traditions and environmental responsibility, but to achieve maximum effectiveness, it is necessary to ensure that all actors in the agricultural sector adapt. The study also found that political stability and economic conditions in Austria create favourable conditions for agricultural development, while in Albania, frequent political changes and economic instability have a negative impact on the integration of farmers into the national economy. The study by S. Ullah *et al.* (2024) confirmed that a stable political system and strong institutions contribute to the development of the agricultural sector by providing access to markets and financing.

The study examined the global value chain model, which shows that modern agro-industrial processes are often interstate and require coordination between different countries. These findings are in line with the work of J. Zhang *et al.* (2021), who studied agricultural supply chains in Asia and Europe. The authors emphasised the importance of international cooperation to ensure the efficiency of global supply chains and reduce the risks associated with the export and import of agricultural products. The study confirms these theses, especially in the case of grain trade between Albania and the EU, where the efficiency of logistics and transportation is an important factor in maintaining stable markets. However, it is also important to note that the results of this study differ to some extent from the work of E.W.F. Peterson (2019), which argues that free trade agreements in the agricultural sector have a predominantly positive effect on all types of producers. This study suggests that the effectiveness of such agreements depends on the degree of support farmers receive at the national level, as well as their access to inputs and modern technology. In cases where governments do not invest sufficiently in agricultural development or do not establish support programmes for farmers, the effects of the agreements may not be as positive. Prospects for further research focus on the need for a more detailed analysis of the interaction between international trade agreements and government policies in the field of agriculture. In particular, it is important to study the impact of environmental standards set by international agreements, such as the European Green Deal, on the development of agriculture in Eastern Europe and Central Asia. Given the tendency to increase environmental requirements in international trade, the study of their impact on local markets, especially in the context of climate change, is becoming increasingly relevant.

This study demonstrated the significant impact of trade agreements and international markets on the agricultural sector, pointing to the complexity and multidimensionality of the processes associated with global agricultural integration. Participation in agreements opens up new opportunities for exports, access to advanced technologies and new markets, which is crucial for countries seeking to improve the efficiency and modernise their agricultural sector. The study also highlights that participation in international agreements alone is not enough to ensure the sustainability and competitiveness of the agricultural sector. It is important to have comprehensive state support, including financial subsidies, investments in infrastructure and development programmes for small and medium-sized farms. Government policy should ensure access to inputs, modern technologies and markets, which allows agricultural enterprises to remain competitive even in the face of fierce competition and global economic instability.

CONCLUSIONS

The article examined the impact of trade agreements and international markets on the agricultural sector of

countries. The study examined in detail the main models of international agricultural trade, including the comparative advantage model, the global value chain model, and the international cooperation model. In addition, a detailed analysis of the impact of bilateral, regional and multilateral trade agreements on agriculture in countries such as Austria and Albania were carried out. For example, bilateral agreements between countries can facilitate market access and stimulate exports, while regional agreements, such as those involving Albania and the EU, have a more systemic impact on the agricultural sector, covering not only market access but also product quality standards, innovation, and investment. Multilateral trade agreements, such as the WTO's Agreement on Agriculture, establish a global framework for agricultural trade that affects all member countries. Each of these types of agreements creates different conditions for the development of the agricultural sector in the countries involved in trade. Trade agreements play an important role in stimulating the growth of agricultural exports and increasing their competitiveness. For Austria, this means access to a wider range of consumers on a global level and a stronger position in European market chains. However, in the case of Albania, while the agreements open up new markets, they also pose serious challenges, especially for small farmers who do not always have access to the necessary resources to innovate and meet new standards. This is due to both structural constraints in Albania's agricultural sector and the lack of technology and infrastructure. Overall, the study results show that international trade agreements are an important factor in stimulating agricultural activity. They provide countries with access to new markets, the latest technologies and financial resources, which helps to develop their agricultural sector. In the case of Austria, such agreements help to expand export opportunities and integrate into European and global markets, strengthening the role of the agricultural sector in the country's economy. For Albania, they represent an opportunity for agricultural modernisation, but the integration process is often accompanied by significant challenges for small farmers, who face difficulties in adapting to new conditions and competitive environments.

A major limitation of the study was the lack of availability of up-to-date data on small farms in Albania, as well as the difficulty of assessing the long-term impact of international trade agreements on the agricultural sector in both countries. Prospects for further research are to study the impact of international trade agreements on agricultural development in different countries, taking into account their economic context and the specifics of the agricultural sector. The study points to the importance of analysing not only the direct economic impact, but also institutional conditions, innovation, and infrastructure capacities that may be limiting factors for less developed countries. Further research could include consideration of effective adaptation strategies for smallholder farmers in such countries, as well as support mechanisms that can help them meet new standards and requirements of international markets.

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CONFLICT OF INTEREST

None.

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Вплив торговельних угод та міжнародних ринків на аграрний сектор

Елті Шахіні
Аспірант
Харківський національний економічний університет імені Семена Кузнеця
61166, пр-т Науки, 9а, м. Харків, Україна
https://orcid.org/0009-0004-8299-4236

Анотація. Метою цього дослідження було комплексне вивчення впливу торговельних угод та міжнародних ринків на розвиток аграрного сектору, зокрема на прикладі Албанії та Австрії. Дослідження було спрямоване на виявлення механізмів, за допомогою яких торговельні угоди стимулюють виробництво, експортну орієнтацію та кооперацію в сільському господарстві. Результати дослідження свідчать, що зниження торговельних бар'єрів і тарифів сприяє значному підвищенню конкурентоспроможності сільськогосподарської продукції на міжнародних ринках. Завдяки спрощенню експортних процедур та зменшенню витрат, пов'язаних з торгівлею, виробники можуть краще інтегруватися в глобальні ланцюги поставок, що забезпечує доступ до нових ринків. Це особливо актуально для країн з розвиненим аграрним сектором, де зниження тарифів дозволяє їм розширювати експорт, збільшуючи обсяги виробництва та покращуючи якість продукції відповідно до міжнародних стандартів. Це також підвищує ефективність внутрішнього ринку, стимулюючи інновації та інвестиції в аграрний сектор, що, у свою чергу, позитивно впливає на загальний економічний розвиток країни. Наприклад, в Албанії торговельні угоди з ЄС сприяли збільшенню експорту, а Австрія отримала доступ до значних субсидій завдяки участі в Спільній аграрній політиці ЄС. Крім того, структурні зміни в аграрному секторі під впливом міжнародної торгівлі сприяли підвищенню ефективності виробництва в Австрії та адаптації до нових вимог ринку в Албанії. Висновки показують, що міжнародна торгівля не тільки відкриває нові ринки для сільськогосподарської продукції, але й стимулює технологічний розвиток та інтеграцію аграрних секторів у глобальні економічні процеси

Ключові слова: глобалізація; попит і пропозиція; ціноутворення; демпінг; протекціонізм; інвестиції

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Methods of financial valuation of intellectual assets of an enterprise and peculiarities of their reflection in accounting

Oksana Perchuk*
PhD in Economics, Associate Professor
Hryhorii Skovoroda University in Pereiaslav
08401, 30 Sukhomlynskyi Str., Pereiaslav, Ukraine
https://orcid.org/0000-0002-6484-7011

Olena Yosypenko
Lecturer
Hryhorii Skovoroda University in Pereiaslav
08401, 30 Sukhomlynskyi Str., Pereiaslav, Ukraine
https://orcid.org/0009-0008-3537-3073

Abstract. Changes in the accounting principles caused by changing business conditions, economic development, rising living standards, emergence of new needs and scientific and technological progress create an urgent need to reflect and value intellectual assets of enterprises in accounting. The purpose of this paper was to review the current principles and methods of analysing intellectual assets at enterprises, and to compare the global experience in this area with the Ukrainian one. In writing the paper, analytical and comparative methods of scientific analysis were used to formulate final conclusions about the specifics of valuation and reflection of intellectual assets in accounting. The study described the main approaches to the valuation of intangible assets in accordance with international and Ukrainian auditing standards. The methods that should help auditors to more effectively evaluate such assets and reflect them in accounting were considered. Significant differences in the approaches and standards reviewed were shown, which is not a positive sign for the Ukrainian audit system. For a more effective future of Ukrainian economic development, the country should change its auditing standards so that they become more and more similar to international standards. Different approaches to the classification of intellectual capital, including its division into human, structural and consumer capital, were investigated. It was found that the valuation of intangible assets should take into account not only the value of goodwill, but also the role of the asset in the specific conditions of the enterprise. The analysis showed that the introduction of digital technologies in intangible asset management has a positive impact on the development of new business models, especially in sectors with intensive use of intellectual property rights. The peculiarities of amortisation of intellectual assets, including the criteria for determining the need for amortisation and the methods of its calculation in accordance with Ukrainian legislation, were summarised. The results of the study will be useful for auditors in formulating public policy, especially in the context of the development of Ukrainian accounting legislation

Keywords: Ukrainian economy; entrepreneurship; intellectual property; asset valuation; intangible assets

INTRODUCTION

Accounting is based on a strict system of documentation and accounting, which guarantees the reliability of data. Changes in the strategic guidelines of business entities under the influence of scientific and technological progress make it necessary to develop effective methods of valuation of intellectual assets for an adequate assessment of the financial condition of enterprises. This topic is in the centre of scientific interests of many economists both in Ukraine and abroad. Among Australian scholars, it is worth highlighting R. David & I. Abeysekera (2021), who studied

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*Corresponding author

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international standards for the valuation of intangible assets (with a focus on comparing them with Australian standards). In their work, they showed the differences between US and Australian auditing standards and the standards of some other countries. The work of D. Annand & D. Marchard (2019) was important, they described the American standards for the audit of intangible assets briefly and vividly.

When writing their research, Ukrainian scientists paid special attention to the analysis of Ukrainian standards for the audit of intangible assets, explored the essence of this concept and drew conclusions about the correctness of using certain approaches or methods in certain situations. In particular, V. Senchenko (2023) studied the state policy in the field of use and valuation of intangible assets. He managed to determine the level of readiness of the Ukrainian economy to introduce advanced technologies and innovative production methods, which are largely based on the use of intangible assets. I.P. Moiseyenko *et al.* (2023), in their work, concluded that an enterprise can independently choose the method of amortisation (taking into account the expected conditions) to obtain future economic benefits from an intangible asset. Yu.A. Bila (2024) studied the impact of integrated reporting on the modification of the accounting paradigm. As a result, new accounting paradigms have been formed, including bioenergy assets, social relations accounting, valuation, and accounting of intellectual capital, linguistic variables for analysis and mathematical modelling. O. Kundrya-Vysotska *et al.* (2023) determined that the economic properties of intangible assets make it impossible to fully reflect them in the financial statements of business entities. At the same time, the share of intangible assets in business structures engaged in mergers and acquisitions is increasing due to simplified criteria for their recognition as a result of business combinations. The authors also described and clarified the behaviour of the appraiser during the audit. V.V. Yasischena & N.M. Holovay (2022), in their study, also analysed the process of amortisation of intellectual assets and described an algorithm for determining the feasibility of amortisation depending on several key variables. R.O. Savchenko *et al.* (2021) assessed the development and changes in intangible assets of the country's enterprises, as well as worked on the assessment of Ukrainian norms and rules for the valuation of intangible assets, and developed recommendations for such valuation. Thus, as part of the development and changes in accounting principles in the current environment, as well as the growing role of intangible assets of Ukrainian enterprises, it becomes relevant to consider the methods of financial valuation of intellectual assets of enterprises and the specifics of their reflection in financial statements.

The purpose of the study was to review the current accounting standards for intangible assets in force in the leading countries of the world and in Ukraine. The novelty of the work lied in comparing Ukrainian standards for auditing intellectual assets with the standards of other countries, as well as in formulating appropriate recommendations that could help improve the procedure for assessing and recording this type of assets in the accounts.

MATERIALS AND METHODS

In the process of studying the methods of financial valuation of intellectual assets of enterprises and the peculiarities of their reflection in accounting, a set of analytical and comparative methods of scientific analysis was applied. The main method was the analytical method, which was used to review and systematise approaches to the valuation of intellectual assets in international practice and in Ukrainian conditions. The analytical approach made it possible to structure the existing scientific papers and practical studies on the valuation of intangible assets, and helped to identify the basic principles governing the reflection of intellectual assets in accounting documents. In particular, the essence of the concept of "intangible assets" was analysed. The comparative method was used to determine its differences from the concept of "intangible objects". After that, using logical and analytical methods, the features of intangible assets in comparison with conventional audit objects were identified, and their role in the functioning of modern enterprises was determined.

A detailed analysis of the Ukrainian regulatory framework for the valuation, audit and reporting of intellectual assets was carried out; the features of the reflection (valuation, depreciation, etc.) of intangible assets depending on their characteristics are described; methods of working with intangible assets for their reflection in financial statements are described and some other aspects of working with intangible assets are highlighted.

Legal and regulatory documents relating to the Ukrainian standards of valuation and recognition of intellectual assets of enterprises were analysed, in particular: Tax Code of Ukraine (2010) as amended on 01.08.2024; Order of the Ministry of Finance of Ukraine No 1327 "On Approval of the Methodological Recommendations on Accounting for Intangible Assets" (2009) as amended on 06.11.2023; Order of the Ministry of Finance of Ukraine No 242 "On Approval of the National Accounting Regulation (Standard)" (1999) as amended on 03.11.2020; the Law of Ukraine No 2658-III "On the Valuation of Property, Property Rights and Professional Valuation Activities in Ukraine" (2001) as amended on 20.06.2024; the Law of Ukraine No. 996-XIV "On Accounting and Financial Reporting in Ukraine" (1999) as amended on 01.01.2024.

Certain documents of international legislation on the valuation and accounting for intellectual assets of enterprises were analysed. In particular, International Financial Reporting Standards (2013), International Accounting Standard 1 (2017), International Accounting Standard 8 (2012). The article describes the features of international auditing standards in the valuation of intangible assets, their most common methods and approaches. The application of the comparative method helped to identify differences between the principles of valuation of intellectual assets abroad and

in Ukraine. Particular attention was paid to identifying differences in the legal framework and practical approach to determining the value of intangible assets, their amortisation, and accounting treatment. Abstraction allowed to assess the effectiveness of different valuation methods.

Elements of the systematic approach were used for a deeper analysis. This made it possible to consider intellectual assets not only as separate financial categories, but as part of the overall system of managing intangible assets of an enterprise. The use of a systematic approach allowed us to determine how to properly integrate intellectual assets into the overall financial accounting of an enterprise so that they could influence its profitability and financial stability. Based on the data obtained, the article assesses the effectiveness of existing methods of auditing intellectual assets in Ukrainian and international practice.

RESULTS AND DISCUSSION

Characteristics of intangible assets as an accounting item

The principles and specifics of accounting in Ukraine are constantly changing and adjusting to the current problems and challenges that constantly arise in the process of development of society and economy. International Accounting Standards, issued and developed by the International Accounting Standards Board (IASB) (based in London), are designed to promote flexibility, maximum efficiency and, last but not least, similarity in accounting principles between countries (to facilitate the analysis of the level of development of companies by economists from different countries and to enhance international integration in general). International accounting standards, although they define general principles of measurement, presentation and reporting, are rather advisory in nature (Parfentii & Kaporina, 2019). This leads to significant differences in national auditing standards. In Ukraine, the accounting system is a kind of compromise between market and administrative approaches, which is largely dependent on tax legislation. This state of affairs limits the information content of the accounting system and makes it difficult to make informed management decisions (De Villiers & Sharma, 2020). It is believed that the final transition to international auditing standards should help solve a huge number of problems in Ukrainian accounting, and, in particular, make the Ukrainian process of valuation and accounting of intangible assets more efficient.

The role of accounting and auditing is to minimise errors and misstatements in financial information (David & Abeysekera, 2021). Accounting should, through the implementation of information, ensure the connection between the main subjects and objects, their functions, subsystems, etc. An accountant must be able to collect information for accounting and be sure of its comprehensibility, relevance, reliability, and comparability (i.e., information must be comparable to assess its truth). The problem of providing reliable information is also relevant for the transition to international auditing standards (Jardon & Martinez-Cobas, 2021).

In general, scientists have many difficulties with the definition of "intellectual assets", as it is relatively new. A similar situation exists with the definition of the basic principles of valuation and analysis of such assets, the formation of criteria for their measurement and reflection in the accounting system. Intellectual capital is a multifaceted concept that includes not only the knowledge and experience of employees, but also other intangible assets such as patents, trademarks, and know-how. Although intellectual capital is often associated with the human factor, its scope is much broader and includes all types of intellectual property that can generate economic benefits. According to the current legislation (National Valuation Standard No. 1 "General Principles of Valuation of Property and Property Rights" (Resolution of the Cabinet of Ministers of Ukraine No. 1440, 2003) as amended on 11.08.2022), intangible assets are defined as objects that do not have a physical form but have economic value. For the purposes of this paper, the concept of "intellectual assets" is considered to be a close synonym for the concept of "intangible assets". In today's environment, it is people, with their special intellectual and social abilities, who are one of the main drivers of economic development; human ideas are becoming the backbone of economic development in the modern world. Thus, the valuation of intangible assets is now turning into a strategic complement to the quality of the company's operations, becoming an integral part of the economic and financial assessment (Edvinsson *et al.*, 2022). Intellectual capital can be divided into conditional subgroups. There are various classifications of it, in particular, 38 auditing standards distinguish between intellectual assets and goodwill (IAS 38 Intangible Assets, 2024). M.A. Ali *et al.* (2023), in their work, identified three types of intellectual capital, which are schematically presented in Figure 1.

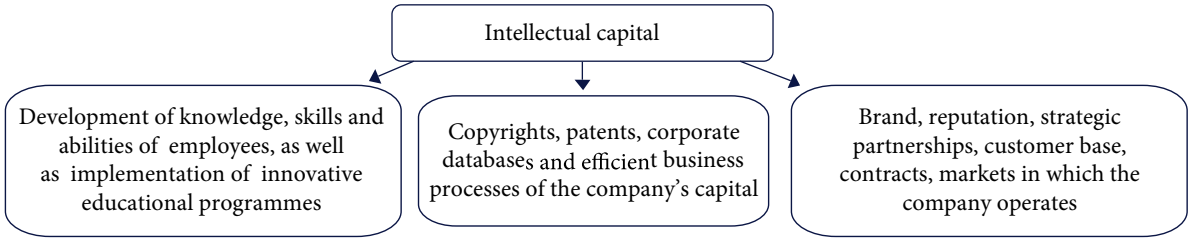

Figure 1. Types of intellectual capital

Source: compiled by the authors

Therefore, these components of intellectual capital include human, structural and consumer capital. Human capital is a set of knowledge and skills of employees that achieve the company's goals; structural capital is computer and software, databases and other intangible potential of the company that has a clear price; consumer capital includes components of the company's recognition and popularity, its connections in various fields of activity. Both intangible assets and intangible objects can be recorded on a company's balance sheet. These are not the same in essence, because any intangible object can be valued, but not every one of them can be used to benefit and not everyone can be sold. Therefore, at the beginning of the measurement, it should be determined whether the intangible item has the characteristics of an asset. In particular, this is relevant when an intangible is being valued for the first time, as in this case it must be proved that it can generate benefits and income for its owner, and only then can it be considered an asset. However, this distinction is often overlooked in modern terminology. In general, the valuation of intangible assets should take into account not only the value of the so-called "goodwill"; it should be carried out taking into account the role of this asset in the conditions of a particular enterprise. At the same time, S.V. Labunska & M.V. Sobakar (2022) found that although internal goodwill is not recognised in financial accounting, the information obtained on its valuation is important for both internal and external users. The researchers explained that the value of goodwill helps to establish an accurate assessment of the company and allows identifying its competitive advantages.

The valuation of intangible assets can only be considered reliable if it is carried out by recognised professionals and experts in the field, and the expert opinions issued must have not only economic but also legal force. Due to the nature of intangible assets, which are associated with the absence of their physical entity (carrier), it is important to have documents that could confirm the ownership of this object to a particular enterprise.

Regular revaluation of intangible assets is a necessary procedure that has two main purposes: to optimise the management of these assets and to determine their fair market value when buying and selling them. The need for such a procedure lies in the frequent changes in the real value of these assets due to various fluctuations at the micro and macroeconomic levels. At the same time, their book value remains constant for a long time. Such an unfair valuation of intangible assets may lead to distortions in future financial flows and financial results, which will have a negative impact on the company's operations. At the level of Ukrainian legislation, this is regulated by the Order "On Approval of the National Accounting Regulation (Standard)" (Order of the Ministry of Finance…, 1999) and the Order "On Approval of Methodological Recommendations on Accounting for Intangible Assets" (Order of the Ministry of Finance…, 2009). If there is a developed market for an asset, its value is determined by reference to market prices. Otherwise, the value is determined on the basis of an expert assessment.

The biggest challenge in valuing intangible assets is to separate out the share of the cash flow generated by the business from the cash flow generated by them; in valuing intellectual assets, it is important to value them based on the real economic effect they generate. The need for this is because intangible assets often have no basis for valuation other than the cash flows they generate (Barker *et al*., 2022). As noted by T.D. Kosova *et al.* (2022), the share of intangible assets, their depreciation rate and efficiency of use are important markers of the innovativeness of an enterprise and its impact on the development of the national economy. L.V. Vasyurenko (2024) concluded that the concept of accounting for intellectual property as intangible assets needs to be updated, considering the wide range of needs of users who perceive financial statements as a commodity that is valuable to the extent of the usefulness of the information described in it. Therefore, it becomes possible to measure tangible assets by the economic effect they generate. Intangible assets can be valued using absolute indicators (excess profit, royalties, price advantage, cost savings, sales volume) or relative indicators (absence of royalties, share in the licensee's profit).

Description of Ukrainian and foreign methods and approaches to valuation of intellectual assets

There are about 40 different methods for valuing intellectual assets, but there are several main ones (Kianto *et al*., 2020). The first is the method of direct measurement of intellectual capital. This category combines methods that allow for the monetary valuation of both individual intangible assets and components of intellectual resources. In this method, the value of an intangible asset is estimated by determining the value of the elements of the asset. The second method is the market capitalisation method, which is calculated as the difference between the company's market capitalisation and its real assets; this value is taken as the true value of intangible assets. It reflects the economic value of an object in the market (i.e., the price that market participants consider fair at a particular time). The third method is the asset-based method (or Return on Assets, ROA). It also reflects only the economic value of an object and is based on traditional accounting rules for auditing. This method involves calculating the return on assets (ROA) ratio by dividing the company's average income after taxes by the amount of its tangible assets. The resulting figure is compared to the industry average. If the company's value is higher than the average, the resulting positive percentage is multiplied by the company's tangible assets, and thus its intangible assets are determined. The fourth method is conventionally called the scoring method. In this case, researchers evaluate and identify various components of intangible assets; then they generate, add and compile them into indices (indicators) using the following operations, which form the basis for determining the company's intangible assets.

N. Pravdiuk *et al.* (2023) classified the documents used by enterprises in transactions with intangible assets. The authors identified three types of documents related to intangible assets: documents confirming ownership (e.g., patents), contracts governing the use of intangible assets (licence agreements), and documents reflecting the movement of intangible assets in the enterprise. R. Trequattrini *et al.* (2022) described the impact of digital technologies on the management of intangible assets in an enterprise. In conclusion, the researchers found that such technologies have a positive impact on the development of new business models for companies, especially those operating in sectors with intensive use of intellectual property rights. According to M. Gumbau-Albert & J. Maudos (2022), in addition to investments in information and communication technologies (ICT), modern enterprises must make additional investments in intangible assets, which is a prerequisite for the quality use of ICT potential. This also indicates that reporting and accounting for such assets is a critical necessity in the current business environment, as intangible asset expenditures are as large as tangible asset expenditures.

In turn, international auditing standards also propose some accounting standards for intangible assets (IFRS in your pocket 2023, 2023). The valuation methods for intangible assets are diverse and can be based on the following approaches: historical cost, replacement cost, market value, and discounted value of future benefits. These valuation methods are only suitable for intangible assets that have been acquired in the past, whereas it will be more difficult to value human capital or a brand that has been created. The Law of Ukraine No. 996-XIV (1999) suggests that intangible assets should be recorded in the financial statements at historical cost (i.e., the cost at which the asset was acquired). In fact, an enterprise is only recommended to choose this valuation method, although it has the right to record the value of intangible assets using other valuation methods. This suggests that Ukrainian legislation insists that assets should be recorded on balance sheets at their acquired cost. In general, foreign practice (in particular, US GAAP (Annand & Marchard, 2019)) favours fair value measurement. Fair value is the price at which an asset could be sold or bought in an open market when both parties to the transaction have access to all relevant information.

In accordance with the Law of Ukraine No. 2658-III "On the Valuation of Property, Property Rights and Professional Valuation of Activities in Ukraine" (2001), three approaches are used to value intangible assets in Ukraine: market, income and cost approaches. The cost approach is to determine the value of an asset based on the costs required to reproduce or replace it. In this case, an asset is considered as a set of separate elements, each of which is valued separately. The income approach is based on an analysis of future income that an asset may generate, while the market approach is based on a comparison with prices for similar assets in the market. Moreover, the net financial result, i.e. after deducting expenses, taxes, etc., is considered to be income. Most often, accountants and auditors use the discounted income method, which is based on adding up all expected future cash flows from an asset if it is put into operation. The market value method, in turn, is somewhat similar to the cost method, but when using it, it is only possible to replace the selected property with another similar (or similar) property at a similar price on the market. When using this method, a study is carried out with the analysis of data on supply, demand, and price of the products being valued. The main disadvantage of this method is the need for a large amount of information to create a sufficient database for market price estimation.

According to the Law of Ukraine No. 2658-III (2001), different types of intangible assets may be valued using different methods. For example, the income approach is used to value individual intangible assets and their aggregate, goodwill, franchise rights, patents, and inventions. However, it should be noted that in order to use this method efficiently, the people conducting the valuation must be experts and have significant experience in asset valuation. Only the cost approach can determine the value of R&D results (research and development), licences to engage in certain types of activities, industrial designs, corporate practices and procedures, skilled labour, and information support. But this method is not suitable for valuation of brand-new projects, and it does not always allow for fair valuation because it does not take into account consumer demand (Rud, 2021). In turn, the market approach is suitable for the valuation of property assets, but only if there is sufficient information, and it is possible to identify the main indicator by which the assets can be compared (to determine the usefulness of intangible assets). Thus, according to this Law, in most cases, the income approach is used in the valuation of intangible assets. Failure to follow these principles may mislead the appraiser.

There are some differences in the amortisation of intellectual assets. In general, intangible assets can be amortised, but not all of them. Under the current Tax Code of Ukraine (2010), not all intangible assets are subject to amortisation. For example, goodwill is not amortised and is not deductible for tax purposes. For other intangible assets, the useful life and amortisation method are determined by the entity independently, depending on the expected economic benefits. If such benefits are difficult to estimate, the straight-line amortisation method is used. In general, V.V Yasischena & N.M Holovay (2022) proposed a simple algorithm to determine whether an intangible asset is subject to amortisation or not. To determine whether an intangible asset should be amortised, a number of criteria should be assessed: whether the contract for the use of the asset can be extended or renewed, whether there are reasonable expectations of future economic benefits associated with the extension, whether there are no significant additional costs associated with the extension, and whether there are no significant changes in the conditions of use of the asset after the extension. If any of these criteria are not met, the asset is depreciated.

Assessment of intangible asset valuation standards in the Ukrainian business environment

An analysis of the main methods of valuation of intangible assets described in foreign literature has made it possible to identify four main methods: the method of direct measurement of intellectual capital, the market capitalisation method, the profitability method (ROA) and the scoring method. Each of them is aimed at different types of assets and has its pros and cons. The first method is too labour-intensive and always has an individual character. It allows for a combination of monetary and non-monetary valuation values, provides a clear and understandable characterisation of the measured object, but it cannot be used to make comparisons between assets, which makes it limited in use. The second method is its opposite, as it is based on the valuation of an asset at its market capitalisation, i.e., solely on comparison. This variant of valuation is not entirely correct, which is explained by the peculiarities of the market participants' activities. In the process of trading on the stock market, investors make a choice to buy or sell a company based on the expected profit and risk they will receive after the purchase. Thus, the price of the company formed during trading creates the expected marginal return that market participants believe is fair. In other words, the amount of intangible assets on a company's balance sheet is difficult to relate to the company's capitalisation during trading on the stock exchange, as it is not constant. That is, a company's capitalisation can change quite rapidly within weeks, days, or even hours. In this case, it is impossible to explain the change in the company's price by the change in the value of the company's intellectual assets (Klimenko *et al.,* 2021). The two methods of valuation of intangible assets described above should be the most commonly used in accounting. The other two approaches (ROA and the scoring method) are better used in specific cases or as alternatives for comparing the resulting intangible asset valuations using several methods.

International Standards on Auditing and foreign practice generally suggest that intangible assets should be recorded at historical, cost or fair value. At the same time, Ukrainian practice suggests applying only historical cost. The historical cost method is the most favourable for the state, as it allows for an increase in tax revenues to the budget. However, it is not the most efficient method throughout the country: an increase in the tax burden on enterprises slows down their development and increases the price of their products. This approach is generally detrimental to the country's economic development, especially given the problems with corruption and frequent cases of mismanagement of public funds. Thus, it would be more efficient to use fair value as the basis for valuation of intangible assets, as it increases the efficiency of estimating and predicting future cash flows from investment in or lending to a project, rather than being limited to the project's past value. Such a valuation would be more lenient for businesses and would facilitate their development. This is especially true for those types of businesses in which intangible assets are of the highest value, such as in the IT industry and for companies engaged in scientific and technological development.

R. Barker *et al.* (2022) summarised the approaches to valuation of intangible asset groups analysed by him. Their work described the following recommendations: rights to use natural resources, as well as rights to commercial designations, are valued using the income approach, rights to use property – using the comparative approach, and copyright (and related rights) can be valued using both the income and comparative methods (depending on the absence or presence of close analogues to the copyright being valued). The situation with rights to industrial property objects is complicated. There is considerable variability in the choice of intangible asset valuation method. For example, in the case of incomplete data, the cost approach may be used to value an asset, and if an analogue exists, the comparative approach may be used in the same case; if the asset is an object of own production or there is a clear purchase price for it, then the income or cost approach may be used; if all three approaches show approximately the same results, then the one with the most complete information base is taken. Other intangible assets are measured using either the income approach (if the assets are effectively free of charge) or the cost approach (if the assets are paid for). To ensure the reliability and comparability of intangible asset valuation results, it is important to adhere to the chosen valuation method over a long period of time. This allows tracking the dynamics of changes in the value of the asset and making informed management decisions. Frequent changes in the valuation method make it difficult to analyse and compare results for different periods.

According to the study of O.M. Yeremyan (2022), to increase the efficiency of the audit of intangible assets, it is necessary to develop clear audit algorithms and detail the auditor's working documentation. In turn, V. Senchenko (2024) found that the valuation and registration of intangible assets owned by regional authorities in Ukraine in modern conditions is a priority task. Given the improvement of the efficiency of state and regional property management, the prerequisites for creating a reliable and reliable property base for generating cash flows and, accordingly, making a profit from the use of intangible assets for commercial purposes are being formed. In her study, L. Dobrovolska (2024) outlined the key tasks of accounting in the context of the Russian-Ukrainian war. These include improving the theoretical and methodological basis for organising enterprise accounting, analysing the prospects for determining losses at enterprises, and developing a methodology for accounting for war losses.

In summary, this study showed that there are significant differences between Ukrainian and foreign standards for the valuation of intellectual assets. Although Ukraine has formally adopted international standards, in fact, the difference between Ukrainian and international standards exists and is significant. This is due to the country's rather distinctive regulatory and legal principles in these matters,

despite the gradual transition to international standards. In addition, there is still no single method of valuation of intangible assets in the international economy, as each method has its own advantages for use in specific circumstances. The development of a single method for valuing intellectual assets could greatly simplify the process of valuation and comparison for accountants; however, this is still a task for the future.

CONCLUSIONS

This paper examined the essence of intangible assets. The main approaches to the classification of intangible assets were described, the types of such assets were shown, the problems of harmonising regulatory and legal legislation with accounting were described, the importance of revaluing intellectual assets over time and some other issues were substantiated. In addition, the difference between the concepts of "intangible object" and "intangible asset" was shown, which is especially important to understand when conducting an assessment. A more detailed understanding of these concepts will allow for a more effective approach to audit and revaluation.

The main approaches and methods of valuation of intangible assets were also described. Four main ones were highlighted: the method of direct measurement of intellectual capital, the market capitalisation method, the return on assets method, or ROA method, and the scoring method. The article showed the main disadvantages, advantages, threats, and peculiarities of calculating these methods. In addition, the article describes the peculiarities of the International Standards on Auditing in relation to the valuation and accounting for intangible assets; in particular, it describes the approaches of these standards to the choice of the method of accounting for assets by form of value.

In addition, the paper described the Ukrainian specifics of accounting for intellectual assets. Based on the regulatory framework and comments of some scholars, the article described three approaches to valuation of intangible assets: income, cost and market, each of which is suitable for valuation of only certain types of intangible assets. That is, the effectiveness of each of these methods depends on the specifics of the asset being valued. The paper also described the peculiarities of amortisation of intellectual assets and shows an algorithm for determining the need for amortisation.

The analysed information suggested that there are significant differences in the accounting for intangible assets in Ukraine compared to international standards. To ensure the future effective development of the country, it is necessary to gradually move to international auditing standards in all areas, which will improve the quality of internal audit and make the country more attractive to foreign investors. Further research can be aimed at finding optimal approaches to the financial valuation of an enterprise's intellectual assets, as well as developing methods for unifying international standards for their correct reflection in the accounting system to ensure reliability and implementation of the enterprise's strategic goals.

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Способи фінансової оцінки інтелектуальних активів підприємства та особливості їх відображення у бухгалтерському обліку

Оксана Перчук
Кандидат економічних наук, доцент
Університет Григорія Сковороди в Переяславі
08401, вул. Сухомлинського, 30, м. Переяслав, Україна
https://orcid.org/0000-0002-6484-7011

Олена Йосипенко
Викладач
Університет Григорія Сковороди в Переяславі
08401, вул. Сухомлинського, 30, м. Переяслав, Україна
https://orcid.org/0009-0008-3537-3073

Анотація. Зміни в принципах бухгалтерського обліку, викликані мінливими умовами ведення бізнесу, економічним розвитком, підвищенням рівня життя, появою нових потреб і науково-технологічним прогресом, створюють актуальну потребу у відображенні та оцінці інтелектуальних активів підприємств у бухгалтерському обліку. Метою роботи став огляд сучасних принципів та методів аналізу інтелектуальних активів на підприємствах, порівняння всесвітнього досвіду в цій діяльності з українським. При написанні роботи були використані аналітичні та порівняльні методи наукового аналізу для формування остаточних висновків про особливості оцінки та відображення інтелектуальних активів у бухгалтерському обліку. В дослідженні описані основні підходи до оцінки нематеріальних активів за міжнародними та українськими стандартами аудиту. Були розглянуті методи, які мають допомогти аудиторам більш ефективно проводити оцінку таких активів та відображати їх в бухгалтерському обліку. Були показані значні відмінності в розглянутих підходах і стандартах, що не є позитивною ознакою для української системи аудиту. Для більш ефективного майбутнього українського економічного розвитку, країна повинна змінювати свої стандарти аудиту таким чином, аби вони ставали усе більш схожими на міжнародні. Було досліджено різні підходи до класифікації інтелектуального капіталу, зокрема його поділ на людський, структурний та споживчий капітал. Встановлено, що оцінка нематеріальних активів повинна враховувати не лише вартість гудвілу, але й роль активу в конкретних умовах роботи підприємства. Аналіз показав, що впровадження цифрових технологій в управління нематеріальними активами позитивно відображається на розробці нових бізнес-моделей, особливо у секторах з інтенсивним використанням прав інтелектуальної власності. Було узагальнено особливості нарахування амортизації на інтелектуальні активи, включаючи критерії визначення необхідності амортизації та методи її нарахування згідно з українським законодавством. Результати дослідження стануть у пригоді аудиторам для формування державної політики, особливо у контексті розвитку українського законодавства з бухгалтерського обліку

Ключові слова: економіка України; підприємництво; інтелектуальна власність; оцінка активів; нематеріальні активи

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Університет Григорія Сковороди в Переяславі
08400, вул. Сухомлинського, 30, м. Переяслав, Україна
Тел.: +38(044)293-11-10
E-mail: info@ue-bulletin.com.ua
https://ue-bulletin.com.ua/uk

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