ISSN: 1683-1942
E-ISSN: 2304-6155

Харківський національний економічний університет імені Семена Кузнеця

ЕКОНОМІКА РОЗВИТКУ

Міжнародний економічний журнал

Заснований у 2002 році
Періодичність випуску: 4 рази на рік

Том 24, No. 2

Харків – 2025

ISSN:1683-1942
E-ISSN: 2304-6155

Засновник:
Харківський національний економічний університет імені Семена Кузнеця

Рік заснування: 2002

Рекомендовано до друку та поширення
через мережу Інтернет Вченою радою
Харківського національного економічного університету імені Семена Кузнеця
(протокол № 2 від 27 червня 2025 р.)

Ідентифікатор медіа: R30-02690
(Рішення Національної ради України
з питань телебачення і радіомовлення
№ 177, протокол № 3 від 25 січня 2024 р.)

Журнал входить до переліку наукових фахових видань України
Категорія «А». Спеціальності: С1 (051) Економіка; С3 (071) Облік і оподаткування;
D1 (072) Фінанси, банківська справа, та страхування; D2 (075) Маркетинг;
D5 (076) Підприємництво, торгівля та біржова діяльність;
D7 (292) Міжнародні економічні відносини
(Наказ Міністерства освіти і науки України № 349 від 24 лютого 2025 р.)

Журнал представлено у міжнародних наукометричних базах даних, репозитаріях та пошукових системах:
Фахові видання України, Національна бібліотека України імені В. І. Вернадського, Crossref,
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Економіка розвитку : міжнар. екон. журн. / [редкол.: Т. В. Шталь (голов. ред.) та ін.]. – Харків : Харківський національний економічний університет імені Семена Кузнеця, 2025. – Т. 24, № 2. – 151 с.

Адреса редакції:
Харківський національний економічний університет імені Семена Кузнеця
61166, пров. Інженерний, 1-А, м. Харків, Україна
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E-mail: info@ecdev.com.ua
https://ecdev.com.ua/uk

ISSN: 1683-1942
E-ISSN: 2304-6155

Simon Kuznets Kharkiv National University of Economics

ECONOMICS OF DEVELOPMENT

International Economic Journal

Founded in 2002
Frequency of issue: Four times per year

Volume 24, No. 2

Kharkiv – 2025

ISSN: 1683-1942
E-ISSN: 2304-6155

Founder:
Simon Kuznets Kharkiv National University of Economics

Year of foundation: 2002

Recommended for printing and distribution
via the Internet by the Academic Council
of Simon Kuznets Kharkiv National University of Economics
(Minutes No. 2 June 27, 2025)

Media identifier: R30-02690
(Decision of the National Council
of Television and Radio Broadcasting of Ukraine
No. 177, Minutes No. 3 of January 25, 2024)

The journal is included in the list of scientific professional publications of Ukraine
Category "A". Specialties: 0311 Economics; 0312 Political sciences and civics;
0411 Accounting and taxation; 0412 Finance, banking, and insurance;
0414 Marketing and advertising; 0416 Wholesale and retail sales
(Order of the Ministry of Education and Science of Ukraine No. 349 dated February 24, 2025)

The journal is presented in the international scientometric databases, repositories and scientific systems:
Professional publications of Ukraine, Vernadsky National Library of Ukraine, Crossref,
Polska Bibliografia Naukowa, Universitäts Bibliothek Leipzig, BASE, Litmaps, Scopus, EconBiz, WorldCat,
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European University Institute (EUI), Cambridge University Library, Open Ukrainian Citation Index (OUCI)

Economics of Development / Ed. by T. Shtal (Editor-in-Chief) et al. Kharkiv: Simon Kuznets Kharkiv National University of Economics, 2025. Vol. 24, No. 2. 151 p.

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ЕКОНОМІКА РОЗВИТКУ

Том 24, № 2

Редакційна колегія

ECONOMICS OF DEVELOPMENT Volume 24, No. 2

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ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 339.9
DOI: 10.63341/econ/2.2025.08

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The impact of geopolitical trends on the technological renewal of industrial enterprises as a basis for the convergence of investment processes in the Ukrainian economy

Abstract. The global economy is influenced by geopolitical trends that create new challenges and opportunities for the development of national economies. The studied geopolitical factors indicate that it is important for Ukraine to integrate its economy into global financial processes, introduce the latest technologies and develop international cooperation. The purpose of this study was to identify the impact of geopolitical trends on the technological upgrading of industrial enterprises in Ukraine and to substantiate their role as a key factor in the convergence of investment processes, taking into account the specifics of the Ukrainian economy's integration into global markets. The study was conducted using

Article's History: Received: 11.12.2024; Revised: 11.04.2025; Accepted: 27.06.2025

Suggested Citation:
Prokhorova, V., Mushnykova, S., Abernikhina, I., Babichev, A., & Slastianykova, K. (2025). The impact of geopolitical trends on the technological renewal of industrial enterprises as a basis for the convergence of investment processes in the Ukrainian economy. *Economics of Development*, 24(2), 8-25. doi: 10.63341/econ/2.2025.08.

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the methods of theoretical generalisation, statistical data analysis, comparison and logical and structural modelling. The study summarised and structured geopolitical trends and identified their impact on the nature of investment flows into industry. The factors that facilitate or impede the attraction of foreign investment in the technological renewal of Ukraine's industry in the context of geopolitical instability were substantiated. The relationship between the technological renewal of industry and the convergence of investment processes in Ukraine was substantiated, and the synergy between technological renewal and investment was investigated. A model of adaptation of industrial enterprises of Ukraine to changing geopolitical conditions through technological renewal was proposed, which is aimed at increasing their investment attractiveness. Recommendations for the state policy to stimulate technological renewal of industry in the context of geopolitical instability have been developed. The practical value of this study lies in the identification of key factors that affect the investment attractiveness of enterprises in the context of geopolitical uncertainty. This allows for creating a mechanism for managing and adjusting the impact of geopolitical risks, which will help to increase competitiveness in the domestic and foreign markets

Keywords: geopolitical factors; investment volumes; direct investment; adaptation model; public policy

INTRODUCTION

The world economy is influenced by geopolitical processes that create new challenges and opportunities for the development of national economies. For Ukraine, which is at the epicentre of geopolitical changes, these processes are of particular importance. On the one hand, political and economic instability create barriers to attracting investment, while on the other hand, they open up opportunities for integration into global markets through the modernisation and technological upgrading of the industrial sector. Geopolitical factors such as sanctions, trade wars, and changes in global supply chains have a significant impact on investment flows. Studies by K.E. Meyer *et al*. (2023) and J. Benchimol & L. Palumbo (2024) emphasised the role of sanctions regimes in transforming international financial relations. G. De Souza *et al*. (2024) and L. Zou *et al*. (2024) focused on the growing importance of trade conflicts for the redistribution of economic resources. These processes necessitate the adaptation of strategies of transnational corporations and national economies to new conditions.

As identified by J. Aizenman *et al*. (2024), geopolitical news affects the stability of financial markets, including stocks, currencies, and bonds. At the same time, M.E. Hoque *et al*. (2024) findings showed that certain markets, such as oil, gas, and gold, have shown relative resilience to geopolitical risks, particularly during the Ukraine-Russia conflict. This indicates their importance as tools for risk management and investment stability. The Ukrainian crisis, according to B. Gao & Z. Xu (2024), affects multinationals at three levels: through supply chain adjustments, national policy making, and the response of international organisations such as the WTO. This highlights the need for coordination between governments, businesses and global institutions to minimise risks and adapt to challenges.

As noted by X. Yu *et al*. (2024), the convergence of investment processes ensures the integration of national capital markets and creates new opportunities for economic growth. For Ukraine, this opens up prospects for attracting foreign capital but at the same time requires stabilisation of domestic conditions for investment, including risk reduction and development of the technological base. According to A. Kostruba (2024), the development of foreign business and investment are critical to Ukraine's economic recovery. In this context, technological upgrades, the introduction of Industry 4.0 principles, automation, and the transition to renewable energy sources are key factors in increasing competitiveness. This also contributes to Ukraine's integration into global investment processes, forming a new economic environment. The study by Y. Yakymenko & V. Yurchyshyn (2024) emphasised the importance of international support in creating favourable conditions for attracting investors. Effective cooperation with international organisations will allow Ukraine not only to restore its economy but also to create the preconditions for long-term sustainable development.

These aspects show that for Ukraine, given the global challenges, it is necessary to integrate the economy into global financial processes, introduce advanced technologies and strengthen international cooperation. Geopolitical stability and strategic initiatives become the basis for attracting investments and adapting to dynamic changes in the world market. The purpose of this study was to identify the impact of geopolitical trends on the technological renewal of industrial enterprises in Ukraine and to substantiate their role as a key factor in the convergence of investment processes, taking into account the specifics of the integration of the Ukrainian economy into global markets.

MATERIALS AND METHODS

The study used a comprehensive approach to analysing the impact of geopolitical trends on the technological renewal of Ukrainian industrial enterprises. The main methods used in the study are the methods of theoretical generalisation, analysis of statistical data, comparison and logical and structural modelling. The method of theoretical generalisation was used to systematise scientific approaches to determining the relationship between geopolitical processes and economic development. The article analysed scientific publications covering the impact of geopolitical instability on investment processes, as well as economic aspects of the integration of national economies into world markets. The use of this method made it possible to formulate the conceptual framework of the study and identify the key factors that influence the process of technological renewal of enterprises in the global economy.

The method of statistical data analysis was used to assess the dynamics of investment flows into the Ukrainian industry and the degree of integration of the country's economy into global financial processes. The main sources of statistical information were the data of the State Statistics Service of Ukraine, the World Bank, the International

Monetary Fund (IMF), the European Bank for Reconstruction and Development (EBRD), as well as analytical reports of international economic institutions for 2012-2024. The analysis of these data allowed to identify patterns and trends in the development of Ukraine's industrial sector in the context of geopolitical instability. The method of comparison was used to compare the experience of other countries (Poland, the Czech Republic, Germany, France) that have faced similar challenges in attracting investment in industry in the face of geopolitical instability. This made it possible to assess the effectiveness of different approaches to stimulating investment in technological upgrades.

Several scientific methods were used to develop a model of adaptation of industrial enterprises to changing geopolitical conditions through technological renewal, which depends on such factors as the level of technological renewal (*TOR*), financial sustainability (*FS*), environmental friendliness of processes (*EPP*) and geopolitical risks (*GR*). The method of theoretical synthesis was used to analyse and summarise the theoretical foundations and models describing the relationship between technological renewal, financial sustainability, environmental performance and geopolitical risks. In particular, the research papers and concepts on the impact of geopolitical factors on the economy and investment processes were studied. The method allowed formulating the theoretical basis of the model and identifying the key factors that affect the investment attractiveness of an enterprise in a changing geopolitical environment.

The theoretical generalisation helped to identify existing approaches to understanding the investment attractiveness of enterprises and determine which of them are most relevant for Ukraine in the context of geopolitical instability. Logic-structural modelling was used to develop the authors' adaptation model. This method helped to build a mathematical model that takes into account the relationship between all the main factors: technological innovation, financial sustainability, environmental friendliness of processes and geopolitical risks. Logic-structural modelling made it possible to clearly define how changes in each of the factors affect the investment attractiveness of an enterprise and what interrelationships exist between them. The sequence of the study included an analysis of scientific literature and regulatory documents on the impact of geopolitical factors on economic processes; collection and processing of statistical data on investment in Ukrainian industry and the level of its technological upgrading; comparative analysis of international experience in attracting investment in technological upgrading in the context of geopolitical instability; development of a logical and structural model of adaptation of industrial enterprises to geopolitical changes; formulation of recommendations for public policy.

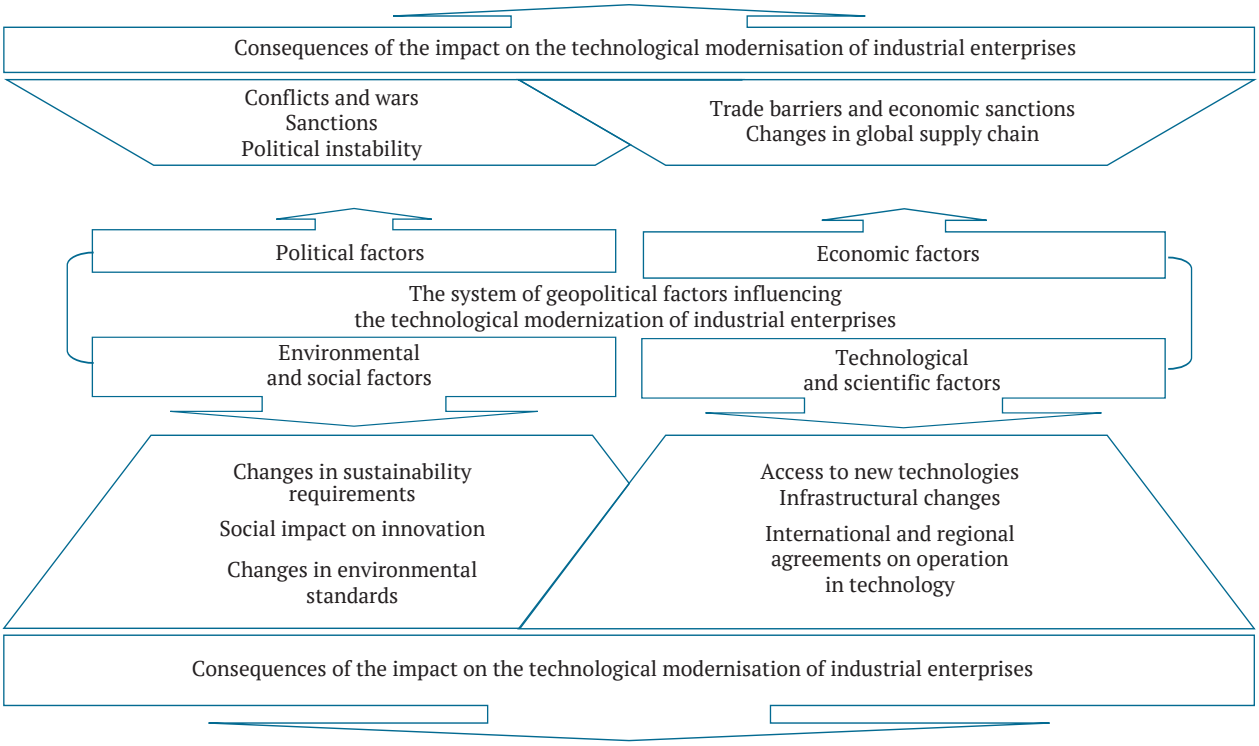
RESULTS

International economic cooperation is developing under the influence of several key trends that reflect global changes in the economic and political spheres. The trend towards fragmentation of globalisation, i.e., global investment flows are increasingly oriented along geopolitical lines. This means that countries are starting to invest more in their regions or allies rather than in global projects. An example is the United States and China, which are creating separate economic blocs, which is reflected in the inflows of foreign direct investment (FDI) to different regions (The 2024 geopolitical reading list, 2023; World investment report 2024, 2024). The trend of supply chain redistribution is caused by geopolitical tensions, trade conflicts between the US and China, the war in Ukraine and sanctions against Russia. This stimulates states and businesses to diversify suppliers and strengthen regional economic ties. In turn, this leads to the growth of reshoring (return of production) (Unterberger & Müller, 2021) and friendshoring (transfer of production to friendly countries) (Klarin & Sosnovskikh, 2024). Trends in energy investments – sanctions against Russia have stimulated the development of new energy chains and the search for alternative energy sources. This was an impetus for increased investment activity in renewable energy, although some countries temporarily returned to using coal to ensure energy security (Esonye *et al*., 2023; Larysh, 2024; Rubbaniy *et al*., 2024). The trend of financial vulnerability of infrastructure projects, which is associated with the fact that in 2023 global FDI flows decreased by 2%, in particular due to a reduction in international financing for these projects. The price had a greater impact on the least developed countries that depend on international financing for the development of critical sectors (World investment report 2024, 2024).

To summarise the above, it is concluded that investments are becoming more regional, i.e., industrial sectors, especially those integrated into global production chains, are trying to locate production closer to key markets. And regional development strategies are aimed at providing access to the resources needed for the transition to a green economy, which helps strengthen partnerships between developed economies and mineral-rich countries (Top geopolitical risks of 2024, 2024). Thus, current geopolitical changes are contributing to a rethinking of approaches to investment, with an emphasis on security, sustainability, and regional cooperation. The system of geopolitical factors (Fig. 1) allows structuring the impact on the technological modernisation of enterprises and determining which aspects of politics, economy, society, environment and science have the greatest impact on investment processes in a changing geopolitical situation.

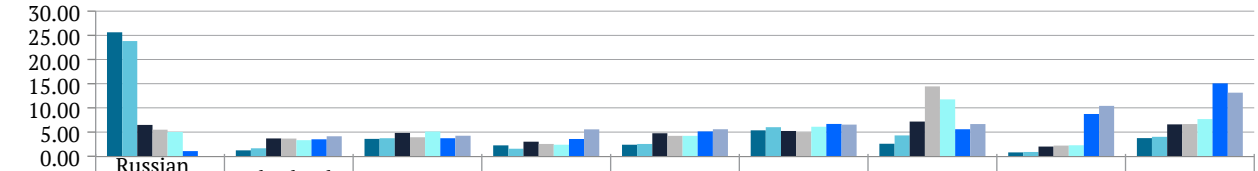
As discussed above, geopolitical trends have a significant impact on the technological upgrading of industrial enterprises, as they shape the context for technology development, change access to resources, and prioritise investment processes (Prokhorova *et al*., 2019). In the case of Ukraine, these trends are particularly relevant due to its geographical location and economic ties with the European Union, the United States, and Asian countries. The key factors that facilitate or impede the attraction of foreign investment in the technological modernisation of Ukraine's industry in the context of geopolitical instability are: changes in the structure of trade and investment flows; support from international organisations and funds; development of the military-industrial complex; changes in environmental and energy standards. Their impact should be considered in more detail. Changes in the structure of trade and investment flows. After the beginning of the Russo-Ukrainian War, there was a significant reduction in trade with Russia. In Figure 2 and Figure 3 the dynamics of exports and imports to Ukraine's trading partners are shown.

Risks to the safety of production facilities; interruption or termination of supplies due to military operations; reduced investment in technological development due to the reorientation of resources to defence; restrictions on the import of technologies and components; increased costs due to the need to look for alternatives or change supplier; raising barriers to access to foreign markets and investment; uncertainty in the business environment, which can scare off investors; increased insurance and risk management costs; imposing duties, quotas, or restrictions on exports or imports; instability in global supply chains, which complicates technological upgrades; switching to alternative suppliers and revising procurement strategies; risks of shortages or delays in the supply of critical technologies; strategies for diversifying suppliers and production locations; logistics and transportation issues that may delay technological upgrades.



Technological upgrades in response to social pressure for environmental responsibility; changes in environmental standards that may require technological upgrades (e.g., reducing CO_2 emissions); technologies aimed at improving working conditions, safety and well-being; perception of new technologies in the labour market (e.g., automation and its impact on employment); reorientation to clean energy sources and technologies for resource conservation; political restrictions and sanctions can reduce access to advanced technologies or patents; risks of technological lag due to lack of access to foreign developments; use of technologies to limit dependence on external sources of supply (localisation of production); modernisation of production facilities to ensure high efficiency and compliance with environmental requirements; developing infrastructure to support new technologies (e.g., 5G Internet, industrial robots, green technologies); international science and technology alliances that can facilitate access to new technologies or support innovative projects; regional integration processes that allow countries to reduce barriers to access technological innovations.

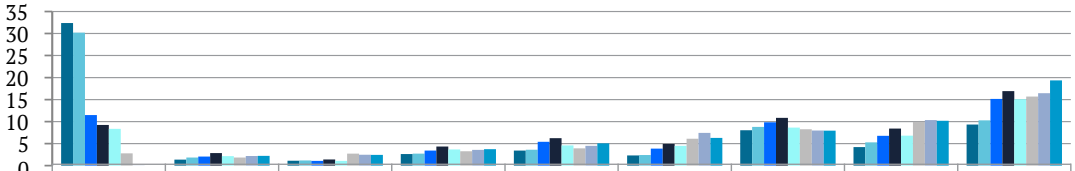
Figure 1. The system of geopolitical factors influencing the technological modernisation of industrial enterprises
Source: developed by the author



	Russian Federation	Netherlands	Italy	Spain	Germany	Turkey	China	Romania	Poland
2012	25.62	1.21	3.60	2.24	2.39	5.36	2.58	0.80	3.74
2013	23.80	1.64	3.72	1.56	2.53	6.01	4.31	0.88	4.02
2019	6.48	3.69	4.83	3.00	4.76	5.23	7.18	2.01	6.58
2020	5.50	3.66	3.92	2.54	4.21	4.95	14.43	2.20	6.65
2021	5.02	3.32	5.10	2.38	4.21	6.09	11.76	2.27	7.68
2022	1.07	3.49	3.73	3.56	5.13	6.67	5.59	8.74	15.07
2023	0.00	4.12	4.25	5.55	5.58	6.55	6.65	10.41	13.14

Figure 2. Structure of Ukraine's exports

Source: calculated by the authors based on Economic statistics / Foreign economic activity (n.d.)



	Russian Federation	Hungary	Romania	Italy	USA	Turkey	Germany	Poland	China
2012	32.39	1.37	1.1	2.64	3.43	2.31	8.04	4.21	9.33
2013	30.19	1.82	1.17	2.71	3.59	2.41	8.8	5.29	10.27
2019	11.49	2.06	1.06	3.41	5.4	3.87	9.85	6.76	15.14
2020	9.23	2.85	1.39	4.33	6.24	4.92	10.85	8.42	16.91
2021	8.35	2.16	1.09	3.67	4.58	4.48	8.63	6.81	15.08
2022	2.79	1.85	2.72	3.26	3.93	6.1	8.25	9.93	15.68
2023	0.01	2.18	2.46	3.58	4.5	7.43	7.96	10.35	16.43
I half 2024	0	2.21	2.45	3.73	5.07	6.3	7.93	10.18	19.35

Figure 3. Structure of Ukraine's imports

Source: calculated by the authors based on Economic statistics / Foreign economic activity (n.d.)

According to the State Statistics Service of Ukraine, in 2012, the share of exports to Russia was about 25.62% of total Ukrainian exports. But by 2019, this figure had dropped to 6.48%, and the downward trend continued for the next 5 years. Between 2012 and 2019, the volume of exports to Russia fell by 74.7%. Imports have also declined significantly. While in 2012 it accounted for 32.39% of Ukraine's total imports, in 2019 it dropped to 11.49%, in 2020 to 9.23%, with a further downward trend in recent years. Between 2012 and 2019, the volume of imports from Russia decreased by 64.53%.

Such a significant reduction in trade with Russia has encouraged businesses to look for new markets and sources of investment, particularly in Europe and Asia. The growth in the shares of exports (to) and imports (from) Europe and Asia at the end of 2023, with this trend continuing in the first half of 2024 (Fig. 2-3), indicates that this process is continuing and Ukraine is significantly expanding its trade with the leading countries of Europe and Asia. According to the NBU's annual statistics on foreign direct investment (FDI), 75% of foreign capital in Ukraine's economy was reinvestment of income earned by a foreign investor in Ukraine (In 2023, $4.25 billion..., 2023; Prokhorova *et al.*, 2024). As of the end of 2023, the accumulated volume of FDI amounted to $54,261 million. The main investor countries in 2019-2023 were as follows (Table 1).

Figure 4 clearly shows the dynamics of the shares of the main investor countries in the structure of foreign direct investment volumes in Ukraine. Cyprus and the Netherlands have remained stable investment partners of Ukraine over the past 5 years. The share of investments from Russia in the total volume of foreign direct investment in Ukraine was insignificant compared to other countries, amounting to only 2.19% in 2019, and has been on a steady downward trend over the past 5 years.

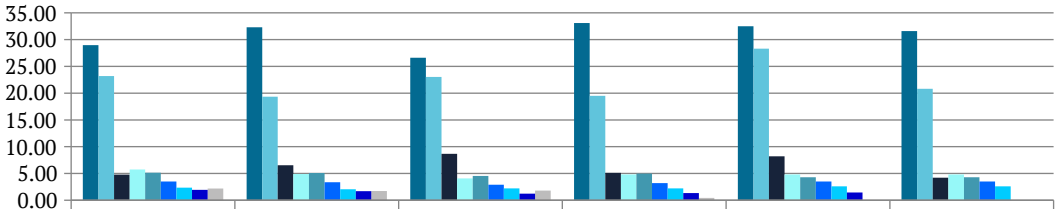
Table 1. Volumes of investments in Ukraine and key investor countries

Investor country	2019	2020	2021	2022	2023
Cyprus	28.96	32.29	26.62	33.10	32.50
Netherlands	23.18	19.33	23.02	19.50	28.30
Switzerland	4.79	6.53	8.66	5.10	8.20
Great Britain	5.75	4.90	4.08	4.80	4.80
Germany	5.15	5.09	4.55	4.97	4.30

Table 1. Continued

Investor country	2019	2020	2021	2022	2023
Austria	3.49	3.35	2.89	3.20	3.50
France	2.36	2.06	2.21	2.20	2.60
Poland	1.94	1.70	1.24	1.34	1.44
Russian Federation	2.19	1.73	1.81	0.43	0.00
Volume of foreign direct investment in Ukraine, mln. USA	5,860	–868	6,687	1,152	4,247
Total accumulated volume of foreign direct investment, mln.	54,210	52,091	65,746	50,987	54,261

Source: calculated by the authors based on S. Mushnykova *et al*. (2024), Investment activity in Ukraine (2024)



	2019	2020	2021	2022	2023	I quarter 2024
Cyprus	28.96	32.29	26.62	33.10	32.50	31.6
Netherlands	23.18	19.33	23.02	19.50	28.30	20.8
Switzerland	4.79	6.53	8.66	5.10	8.20	4.2
Great Britain	5.75	4.90	4.08	4.80	4.80	4.8
Germany	5.15	5.09	4.55	4.97	4.30	4.3
Austria	3.49	3.35	2.89	3.20	3.50	3.5
France	2.36	2.06	2.21	2.20	2.60	2.6
Poland	1.94	1.70	1.24	1.34	1.44	0
Russian Federation	2.19	1.73	1.81	0.43	0.00	0

Figure 4. Dynamics of shares of major investor countries in the structure of foreign direct investment volumes in Ukraine

Source: calculated and systematised by the authors based on S. Mushnykova *et al*. (2024), Investment activity in Ukraine (2024)

Support from international organisations and funds. Attracting investments from international donors and financial institutions plays an important role in supporting economic growth and modernisation of industrial enterprises in Ukraine. In 2024, international donors and financial institutions will continue to actively invest in Ukraine. The European Union, the EBRD, the International Finance Corporation (IFC), and individual governments are allocating significant amounts of money to support reconstruction, infrastructure modernisation, and business development. The EU provides Ukraine with grants, guarantees, and technical assistance to help restore and develop various sectors of the economy. For example, through 2024, the EU has invested around €1.4 billion through programmes such as renewable energy support and infrastructure projects to help attract private investment and strengthen the economy. In total, the EU plans to provide up to €50 billion in support to the country through the Ukraine Facility until 2027. The EU4Business (n.d.) programme provides additional support for small and medium-sized enterprises, in particular in war-affected regions (EUsigns €1.4 billion to UNeighbours East, 2024). The EBRD also plays a key role in supporting Ukraine. In 2023, the Bank invested a record €2.1 billion and is providing €1.5 billion in 2024. Financing is channelled to support the private sector, including through lending to partner financial institutions and trade finance programmes. In addition, the EBRD receives significant support from the EU and other donors, including the governments of Canada, Norway and Spain (EBRD planning..., 2024). These efforts are aimed at stimulating economic growth, developing sustainable infrastructure, and ensuring Ukraine's energy independence in the face of war and further integration with the EU.

The geopolitical support of Ukraine by the EU, the US, and other countries facilitates access to international financing programmes, which allows for the modernisation of technologies at enterprises. The most significant international programmes for financing technological upgrading and development of Ukrainian industrial enterprises are summarised in Table 2. The international programmes presented in Table 2 emphasise the active participation of international partners in the restoration and modernisation of Ukrainian industry, focusing on sustainable development and innovation; they also provide opportunities for Ukrainian enterprises to attract financing, modernise production facilities and introduce advanced technologies, which contributes to the growth of their competitiveness and investment attractiveness in international markets.

Table 2. International programmes for financing technological upgrading and development of industrial enterprises in Ukraine

International programme/ organisation	Brief description of the programme or areas of technological renewal and development of enterprises
European Union (EU)	EU funds: The EU funds various programmes to support infrastructure development, energy efficiency, green economy and SMEs in Ukraine. The main programmes include the Eastern Partnership Programme, Horizon Europe's Enterprise and Innovation Support Programme and other projects under the European Neighbourhood Instrument (ENI). EU4Business Initiative: This programme supports entrepreneurs in Ukraine by helping to attract investment for the development of small and medium-sized businesses.
World Bank	The World Bank provides loans and grants to support infrastructure projects, agricultural development, healthcare, education and the energy sector. The main programmes are the Health System Modernisation, Water Supply and Sanitation Efficiency Improvement, and Energy Saving Project. The IFC, a member of the World Bank, specialises in supporting the private sector, including investments in Ukrainian enterprises that innovate and promote sustainable development.
EBRD	The EBRD is actively investing in energy efficiency, renewable energy, small and medium-sized businesses and infrastructure projects. The bank also provides loans and financial instruments to support businesses, develop the digital economy and modernise transport infrastructure. The main areas of investment in Ukraine include the Green Economy Programme, the Small Business Support Initiative and the Innovative Development Programme.
United States Agency for International Development (USAID)	USAID funds projects in the areas of energy, agriculture, health, democracy and governance. The programmes aim to improve economic resilience, support transparent governance, and strengthen democracy. USAID programmes, such as the Energy Security Project and AgroInvest, support technological development, productivity and economic stability. During Russia's war against Ukraine, USAID has delivered life-saving humanitarian assistance, helped ensure that Ukrainians have heat and electricity despite Russia's attacks on their energy systems, supported Ukrainian agricultural producers and food exporters so they can continue to supply grain to countries around the world, and helped Ukrainian partners advance critical anti-corruption and European integration reforms. USAID's key programmes in Ukraine: Democracy, Human Rights, and Governance; Economic Development; Critical Infrastructure; Health; Transition; and Humanitarian Assistance. Since the beginning of the war on 24 February 2022, USAID has provided $2.8 billion in humanitarian assistance, $3.4 billion in development assistance, and $26.8 billion in direct budget support.
UNIDO	In order to fulfil its mandate in Ukraine under the unique circumstances, UNIDO has developed a special programme for the green recovery of industry, covering three key areas: creating new opportunities for people, supporting businesses and attracting investment, and promoting the development of a green economy. Over the past year, UNIDO has conducted a comprehensive diagnostic study of Ukraine's industry, which provided important baseline data and in-depth analysis at various levels – micro, meso and macro. With the support of development and funding partners, UNIDO has initiated new projects in the following areas.
IMF	The IMF provides loans to Ukraine to support macroeconomic stability and to implement reforms aimed at stabilising the financial system. IMF programmes include Extended Fund Facility to support macroeconomic stability, including support for reducing the budget deficit and strengthening the banking system. IMF financing is usually accompanied by conditions for economic, legal and governance reforms.
United Nations Development Programme (UNDP)	UNDP supports Ukraine in implementing sustainable development projects, fighting poverty, strengthening democratic institutions and improving the environment. UNDP programmes also include support to small and medium-sized enterprises in the transition to sustainable production. One of UNDP's key projects is the SME Development Programme, which supports environmentally responsible businesses and sustainable development projects.
Innovate Ukraine (Great Britain)	The UK government is investing £16 million in the restoration and sustainable development of Ukraine's energy sector, including the replacement of fossil fuels. The programme, implemented by the UK Innovation Agency, will attract an additional £5 million from the private sector and involves the cooperation of more than 50 UK and Ukrainian organisations. The key projects include new heating technologies, renewable energy battery solutions, and geothermal energy. The projects will last for two years and will be supported by accelerators to further attract investment.
Fund for International Cooperation and Development (TaiwanICDF)	TaiwanICDF provides support to Ukraine in the areas of agriculture, healthcare, infrastructure development and competitiveness. Projects often include technological upgrades and support for export-oriented enterprises.
German Society for International Cooperation (GIZ)	GIZ supports projects in the areas of sustainable development, energy efficiency, environment, education and training. GIZ programmes, such as the Energy Efficiency Support in Ukraine, aim to increase energy savings, develop renewable energy sources and improve economic efficiency.
Nordic Environment Finance Corporation (NEFCO)	NEFCO finances environmental modernisation and energy efficiency projects, supporting the development of clean energy, carbon emission reduction and environmental protection. In particular, NEFCO supports renewable energy programmes and projects to reduce the environmental impact of industry. Currently, financial support is being used for environmentally sound repairs and reconstruction of municipal infrastructure, accommodation of internally displaced persons (IDPs) and capacity building for the development of local green recovery plans. The programme promotes the development of a green economy and energy transition during the recovery process, and supports further integration with Europe. The programme was launched in July 2022, and project implementation is ongoing with the first projects already completed. About 50 projects are currently being implemented: Repair of critical infrastructure (district heating and water supply and sewerage) in 12 communities in Kyiv Oblast; Modernisation of water supply systems in six communities; Energy efficiency in five small towns (Andrushivka, Radomyshl, Khmelnytskyi); Housing for IDPs, 20 projects in different cities (Chernivtsi, Dubno, Kovel, Lviv, Makariv, Zhytomyr, Ivano-Frankivsk, Khmelnytskyi, Nemishaievo, Novovolynsk, Ternopil, Chortkiv, Kivertsi, Zolochiv, Rivne, Novohrad-Volynskyi).

Source: summarised by the authors based on EU4 Business (2024), EU signs €1.4 billion of new guarantee and grant agreements to support Ukraine's recovery and attract private sector investments (2024), EBRD planning 1.5-bln-euro investment in Ukraine in 2024, versus 2.1 billion euros in 2023 (2024), Ukraine and UNIDO signed the Green Industrial Recovery Program in Ukraine for 2024-2028 (2024)

The international programmes for financing technological upgrades and development of Ukrainian industrial enterprises listed in Table 2 illustrate the current global investment processes that are technology-oriented and in line with global trends in sustainable development, digitalisation, automation, and the transition to renewable energy. Green energy and renewable energy sources: key areas include solar and wind energy, with a focus on expanding the use of solar panels and wind turbines and developing more efficient and affordable technologies for energy generation. Hydrogen energy is seen as a promising environmentally friendly resource to reduce dependence on fossil fuels. Also important are technologies for the development of batteries and energy storage systems that ensure a stable supply of energy from renewable sources (Sotnyk *et al.*, 2023).

Energy efficiency and sustainable development: this includes smart grids, which allow for more efficient management of electricity distribution and reduce losses, as well as technologies for building green buildings that consume less energy and water, reduce CO_2 emissions, and use environmentally friendly materials. In addition, the transition to a circular economy, where products and materials are recycled and reused to reduce waste, is an important part of global trends (Iarmosh *et al.*, 2021; Li *et al.*, 2024). Digitalisation and automation: this area includes the Internet of Things (IoT), which allows devices and equipment to be connected to the network for real-time monitoring and control. The use of artificial intelligence (AI) and machine learning to analyse data, optimise production processes, forecast demand, and automate tasks is also important. Robotics is actively used to automate production, increase productivity and reduce labour costs (Aljohani, 2024).

Digital security and blockchain: the growing importance of cybersecurity in protecting data and networks due to digitalisation requires investment in the latest technologies to protect businesses from cyberattacks. Blockchain technologies are used to ensure transparency, reliability and security in transactions, supply chains, financial transactions, data management and smart contract management. Smart cities: infrastructure management technologies, such as traffic, energy, water and waste management systems, are becoming important for smart cities. Unmanned vehicles such as autonomous cars and delivery drones are being introduced to reduce logistics costs. Environmental and quality of life monitoring systems that track air, water, and noise pollution are becoming an important part of the infrastructure.

Biotechnology and medicine: the use of personalised medicine based on a patient's genetic profile allows for the development of individualised treatments. In addition, artificial intelligence helps to speed up the development of new drugs, improve diagnostics and the choice of treatment. Agribiotechnology is also used to increase agricultural productivity and develop new crop varieties. Financial technologies (FinTech): mobile payment systems, digital currencies, and mobile banking applications are developing rapidly. Investment and asset management tools use AI to create customised investment strategies, while decentralised financial services (DeFi) ensure transparency and security of financial transactions using blockchain technologies (Zhang *et al.*, 2022). Additive manufacturing (3D printing): 3D printing is actively used to create prototypes, spare parts, and even finished products, which significantly reduces production costs. In medicine and bioprinting, medical implants, prostheses, and organs are created from biocompatible materials. In the construction industry, 3D printing technologies are used to create modular building components that reduce construction costs (Jewell & Stones, 2024).

The above-mentioned technologies expand the capabilities of enterprises, contribute to solving global challenges such as climate change, energy security, food supply and the creation of new jobs in high-tech industries. Investors are actively investing in companies that take geopolitical trends into account when upgrading and modernising their production, which contributes to their sustainable development and global competitiveness.

Development of the military-industrial complex: the conflict with Russia has led to the need to strengthen Ukraine's defence capabilities, which stimulates the development of military technologies and raises the requirements for technological standards that are being introduced into civilian industries. Strengthening Ukraine's defence capabilities and developing military technologies cover several key areas aimed at modernising the army, increasing technical equipment and improving infrastructure. This requires additional attraction of various types of funding, including investments. Foreign investors are interested in investing in Ukraine's industry even in the current unstable economic environment: as of 01.10.2024, the volume of foreign direct investment amounted to USD 2,960 million. The volume of foreign direct investment in Ukraine is 2,960 million US dollars. Table 3 systematises the directions of development of military technologies in Ukraine.

Table 3. Areas of development of military technologies in Ukraine

Development direction	Brief description
Unmanned aerial vehicles (UAVs)	Ukraine is actively developing and deploying UAVs for reconnaissance, surveillance and even combat missions. For example, in cooperation with Turkey, it is developing strike drones, such as the Bayraktar TB2, which are used to detect and destroy targets on the front line. Ukraine's own developments are also gaining popularity. For example, the PD-1 and Leleka-100 UAVs, which are used to gather intelligence, monitor and adjust fire.
Cybersecurity and cyber defence	In response to cyber threats, Ukraine is developing cyber defence systems, in particular to protect critical infrastructure, military networks and government agencies. Initiatives in the areas of cyber intelligence, data protection and cyber threat detection are also important. Cooperation with NATO and other partners allows Ukraine to introduce advanced technologies to detect and prevent cyber-attacks, as well as to train personnel to respond effectively to cyber threats.

Table 3. Continued

Development direction	Brief description
Missile and artillery systems	Ukraine is developing missile weapons systems such as the Vilkha and Neptun systems. The Vilkha missile systems are capable of delivering precision strikes over long distances, which enhances defence capabilities. Artillery systems modernisation programmes are aimed at increasing accuracy and range, improving mobility and integrating with digital fire control systems.
Armoured vehicles and modernisation of combat vehicles	The production and modernisation of armoured vehicles, including armoured personnel carriers (BTR-3, BTR-4) and tanks (T-64, T-72), are a priority. The latest models are equipped with modern defence systems, including dynamic defence and active defence systems. The use of digital control systems that increase the accuracy and efficiency of combat operations, as well as integration with modern communications and surveillance systems.
Electronic warfare systems (EW)	Ukraine is actively developing electronic warfare technologies to counter drones, intercept and jam signals, and protect its own communications. Systems such as Mandat and Bukovel can be used to create radio interference and protect military units from enemy control systems.
Maritime defence technologies	Given the threat from the sea, Ukraine is developing its own anti-ship missiles (in particular, Neptune) and modernising its fleet. The anti-ship missiles are designed to protect against attacks by naval forces, particularly from the Black Sea. Other areas include the development of high-speed boats and a maritime surveillance system.
Integration of digital control systems	Digitalisation of command-and-control structures allows Ukraine to manage military units and resources more effectively. Automated systems for managing troops and combat operations are being introduced to ensure coherence and increase efficiency. Systems such as Kropyva allow for real-time monitoring of military operations, improving accuracy and coordination between different units.
Personal protective equipment and equipment	Modernisation of military equipment, including the latest models of body armour, helmets and tactical equipment that meet modern standards of protection and mobility. Use of digital devices, such as GPS navigators, thermal imagers and night vision devices, to enhance situational awareness.

Source: compiled by the authors based on M. Lopatin (2024)

The development of these areas increases Ukraine's defence capability. This requires technological and technical upgrading of the defence industry enterprises, providing them with modern technologies and standards. The analysis of international programmes for financing technological upgrades and development of industrial enterprises (Table 2) made it possible to summarise trends in global investment processes, which are focused, among other things, on the transition to renewable energy. Changes in environmental and energy standards. Ukraine's integration into the European market involves adaptation to the EU standards, in particular in the area of environmental protection and ecological requirements. This requires industrial enterprises to invest in environmentally friendly technologies, primarily in renewable energy and energy efficiency (Table 4).

Table 4. Environmental and energy standards of the EU, to which Ukrainian industrial enterprises need to be adapted for further integration into the European market

EU standards	Characteristic
Industrial Emissions Directive (IED, 2010/75/EU)	The IED Directive sets out rules for reducing industrial emissions into the air, water and soil. It requires the use of Best Available Techniques (BAT) to minimise pollution. Enterprises must implement modern technologies to reduce harmful emissions and control them within permitted limits. Each company must obtain an operating permit that includes specific environmental requirements that meet the terms of the IED.
The European Emissions Trading System (EU ETS)	The EU ETS sets quotas for greenhouse gas emissions and allows businesses to trade emissions. Ukrainian companies integrating into the European market must meet these requirements and work to reduce CO_2 emissions. It also encourages investment in technologies that reduce greenhouse gas emissions. Joining the ETS involves the gradual introduction of emissions accounting systems and upgrades to meet quotas and participate in emissions trading.
Waste Management Directive (2008/98/EC)	This directive regulates waste management and requires businesses to minimise waste generation, promote reuse, recycling and safe disposal. It also provides for the creation of national waste management plans and the development of waste reduction programmes. Businesses are required to implement separate waste collection strategies, reduce hazardous waste, and seek ways to reuse materials.

Table 4. Continued

EU standards	Characteristic
Drinking Water Directive (98/83/EC) and Waste Water Treatment Directive (91/271/EC)	Ukrainian companies that discharge wastewater must meet water treatment and quality requirements to avoid pollution of water bodies. The Directive defines water quality standards and treatment methods that must meet strict norms. Wastewater treatment facilities must provide high-quality wastewater treatment to prevent pollution of surface and groundwater.
REACH Regulation (1907/2006)	REACH regulates the registration, evaluation, authorisation and restriction of chemicals. Businesses that manufacture or import chemicals must go through the process of registering and assessing the safety of these substances, as well as provide appropriate labelling and information about their potential risks to health and the environment. Compliance with REACH means that companies are required to carry out risk assessments of chemicals, provide data on chemicals and comply with all restrictions on their use.
Energy Efficiency Directive (2012/27/EU)	The directive encourages businesses to improve energy efficiency and reduce energy consumption. The requirements include energy audits for large enterprises, the introduction of energy-saving technologies, and the use of energy management techniques. The directive provides for a reduction in energy consumption through modernisation of equipment, reduction of heat losses and use of renewable energy sources.
Air Protection Directive (2008/50/EC)	This directive regulates air quality, including concentrations of harmful substances such as SO_2, NO_x, PM_{10} and others. Ukrainian enterprises must comply with the standards that provide for the reduction of emissions of harmful substances into the atmosphere and control of air quality. To achieve compliance, companies must install emission control systems, reduce energy consumption from fossil sources and switch to cleaner fuels.
The EU Renewable Energy Directive (2018/2001/EC)	actively promotes the transition to renewable energy sources, and this directive sets targets for increasing the share of renewable energy in total energy consumption. Ukrainian enterprises are required to gradually switch to renewable energy sources such as solar, wind, and biomass. This will encourage companies to invest in energy solutions that use renewable resources, reducing their dependence on fossil fuels.

Source: summarised by the authors based on Council Directive No. 91/271/EEC (1991), Regulation (EC) of the European Parliament and of the Council No. 1907/2006 (2006), Directive of the European Parliament and of the Council No. 2008/50/EC (2008), Directive of the European Parliament and of the Council No. 2008/98/EC (2008), Directive of the European Parliament and of the Council No. 2010/75/EU (2010), Directive of the European Parliament and of the Council No. 2012/27/EU (2012), Directive (EU) of the European Parliament and of the Council No. 2018/2001 (2018), Understanding the European Union's emissions trading systems (EU ETS) (2024)

Compliance with these standards is mandatory for companies seeking to enter the European market or cooperate with EU partners. The functioning of the investment process ensures the investment flow, as it is the material basis for the realisation of investment goals. Without the organisation of efficient flows, the implementation of the investment process is impossible. Technological upgrades of industrial enterprises stimulate the integration of various investment flows, which allows for the pooling of resources from different sources for more efficient project financing. The main investment flows that are integrated through technological upgrading include foreign direct investment and domestic investment. Investors can be individuals, corporations (national or multinational), financial institutions (banks, investment funds, insurance companies, and others), states or governments, and international organisations. Figure 5 schematically shows the integration of investment flows that ensure the technological renewal of industrial enterprises.

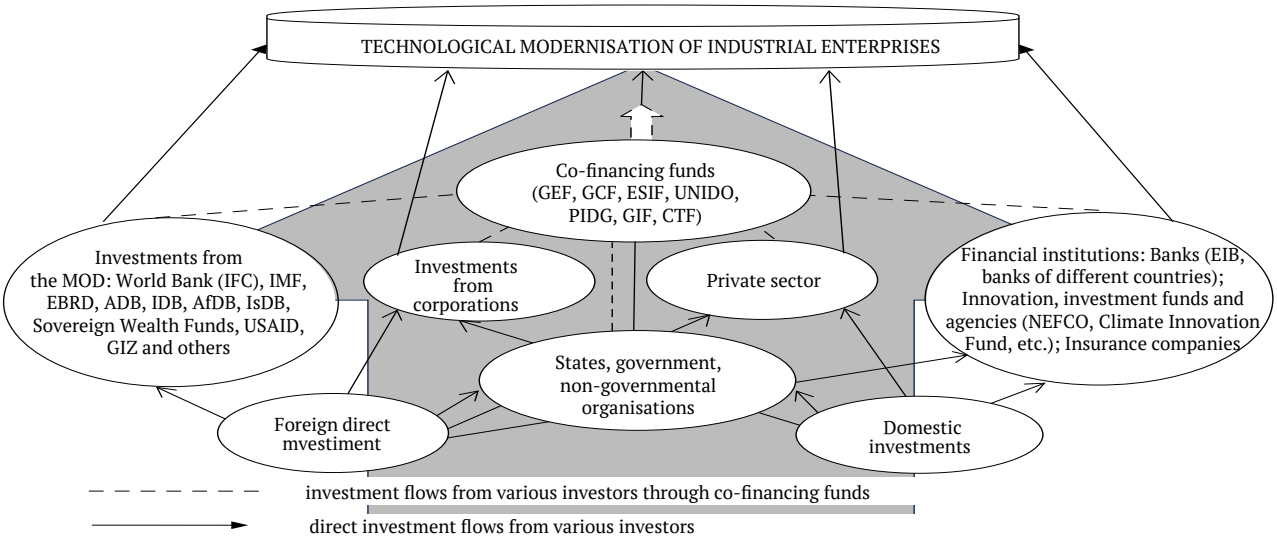


Figure 5. Schematic integration of investment flows to ensure technological modernisation of industrial enterprises
Source: developed by the authors

Convergence implies the convergence of investment approaches, structures, and strategies in different countries due to the globalisation of capital markets. Convergence promotes technological renewal through: access to capital, knowledge exchange (integration of international companies creates opportunities for technology transfer and dissemination of best practices), and increased competition. The convergence of global investment processes and technological upgrades mutually reinforce each other, creating the preconditions for sustainable economic growth. The combination of investment flows from different investors facilitates large-scale modernisation projects, allowing Ukrainian enterprises to adapt to new technological requirements faster, strengthen their competitiveness and meet European standards. Technological upgrades and the convergence of investment processes form a two-way relationship that ensures Ukraine's integration into the global economy. This allows attracting capital, increasing competitiveness, and strengthening the country's economic stability in the face of global instability. The relationship between the technological renewal of industry and the convergence of investment processes in Ukraine is shown in Figure 6.

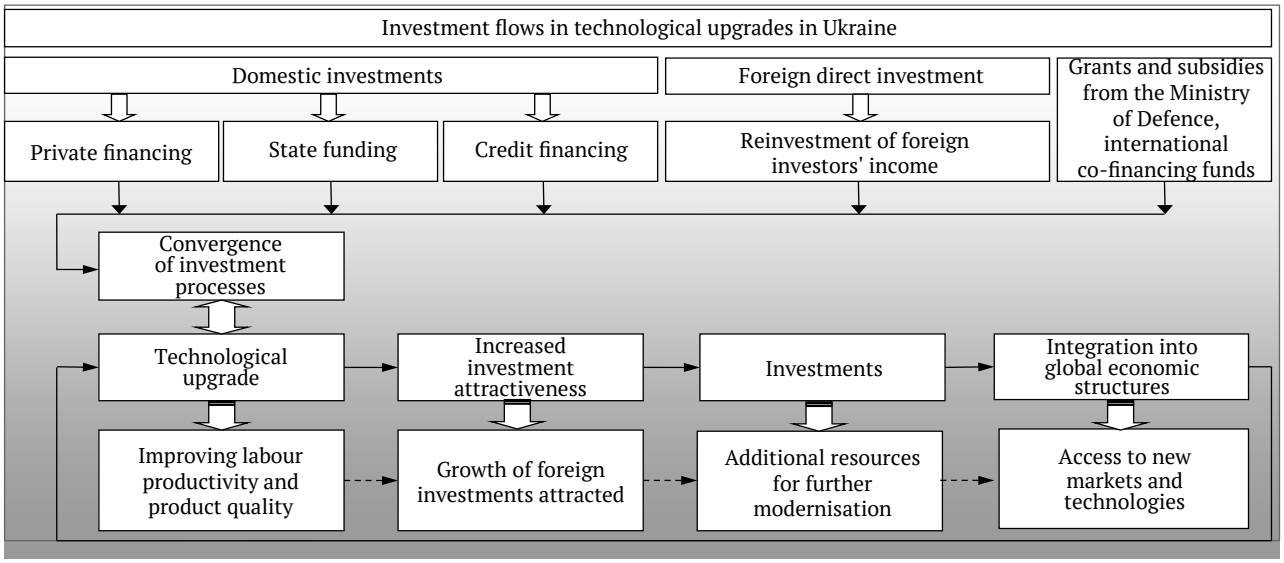


Figure 6. Justification of the relationship between technological modernisation of industry and convergence of investment processes in Ukraine

Source: developed by the authors

Technological upgrading of industrial enterprises is a key factor for increasing their productivity, product quality, and ability to meet international standards. This creates a basis for attracting investment, as investors are interested in high-tech enterprises that can ensure high profitability and rapid growth, as well as enterprises with modern technologies that can integrate into global supply chains faster and more efficiently. The convergence of investment processes implies the harmonisation of national investment practices with global standards. Technological upgrading contributes to this process by attracting foreign investors who seek to invest in industries with a high level of technology, transparency and efficiency of financial flows through the introduction of digital technologies. Technological upgrading creates the preconditions for Ukraine's active participation in international economic processes by increasing foreign trade through the production of competitive products, cooperation with international organisations and participation in economic development programmes, and investment attractiveness, as technologically advanced enterprises become part of global value chains, making them more interesting for international capital.

Investments are the only component of GDP that is not consumed but lays the foundation for future economic growth. To ensure sustainable economic development, a level of investment of 20% of GDP or more is required. If this figure is lower, the country gradually loses its economic prospects. Since 2008, Ukraine has never reached this threshold. In the five years before the war, the share of investment in GDP averaged only 15% (Who are the largest..., 2024). In 2023, thanks to business activity and significant (about 4%) public investment, especially in the defence sector, the investment rate rose to 17% (Davydenko, 2024). The five largest state-owned companies invested UAH 135 billion ($3.9 billion) in two years, which is equal to the investments of the ten largest private companies (The country's largest..., 2024). In total, the top twenty investors increased their capital expenditures (CAPEX) by 33%, investing UAH 173 billion ($5 billion), although a significant portion of these funds was directed to restore damaged infrastructure. For example, DTEK and Ukrenergo spend more than half of their investment budgets on reconstruction, which does not create new capacity for the economy (Metinvest is among..., 2024).

Despite the war, businesses are mostly financing their capital expenditures from their resources, as access to external financing remains limited. Capital investments are not only about the development of companies but also about the sustainability and growth of the economy as a whole. DTEK, Metinvest, and Epicenter are among the leaders in investment. In 2023, domestic investment in Ukraine's economy exceeded UAH 390 billion. The majority,

72%, was financed by entrepreneurs themselves, 15% came from state and local budgets, and bank loans accounted for only 3%. The main sectors for investment are agriculture, food, real estate, and defence. Each of these sectors received 10-12% of total investment (There is work…, 2024). Despite this, the main problem remains the lack of new large foreign investors. In 2023, foreign direct investment (FDI) inflows amounted to $4.25 billion, which is several times higher than in 2022 but significantly lower than pre-war levels. More than 90% of these funds were directed to Ukrainian companies, with $3.2 billion being reinvested profits, indicating restrictions on capital outflows (In 2023, Ukraine received…, 2024).

As of the beginning of 2024, the total volume of accumulated FDI amounted to $55.2 billion, which is less than the pre-war level and significantly lower than in neighbouring countries. For comparison, in Poland, this figure reaches $270 billion (Are foreign investors…, 2024). The Ukrainian economy remains less attractive to foreign capital due to the high risks associated with the war. At the same time, reinvestment by existing companies demonstrates that businesses continue to operate and support the economy. In terms of annual investment inflows, Ukraine lags far behind many other countries. According to World Bank data for 2022, Poland attracted $35 billion in FDI, the Czech Republic – $10.5 billion, Germany – $47.3 billion, and France – $105.4 billion. The structure of accumulated investments in 2023 shows that $37.1 billion (68.4%) were equity investments, while $17.1 billion (31.6%) were debt instruments (Are foreign investors…, 2024). This indicates a lack of interest from foreign investors in Ukraine. The main reason for this is the high level of military risks, which significantly complicates doing business and makes the prospects for return on investment unpredictable. At the same time, Ukrainian entrepreneurs do not leave their companies to fend for themselves. The volume of reinvested profits indicates that business activity remains at an acceptable level despite the difficult conditions. In turn, the adaptation of Ukraine's industrial enterprises to changing geopolitical conditions through technological upgrades requires a holistic approach that combines strategic planning, investment attraction, and innovation. The key aspects that need to be taken into account are shown in Table 5.

Table 5. Key aspects of adaptation of Ukrainian industrial enterprises to changing geopolitical conditions through technological upgrading

Aspects	Brief description
Analysis of the geopolitical environment and risks	Assessment of external factors affecting the company's operations (political instability, sanctions, trade barriers, etc.). It can be carried out using SWOT analysis, PESTEL analysis, risk management. As a result of the assessment, a certain set of risks and opportunities for the company should be formed.
Assessment of the current state of them enterprise	Analysis of the technological level (outdated processes, automation, digitalisation). As a result of the analysis, key performance indicators (KPIs) that need to be improved should be identified. Also at this stage, it is necessary to assess the current level of financial stability and investment attractiveness of the enterprise for further comparison after technological modernisation.
Developing a strategy for technological modernisation	Selection of priority technologies (Industry 4.0, energy-saving technologies, robotisation, use of IoT). Integration of sustainable development concepts (ESG). Search for strategic partners to implement new technologies.
Implementation of technological upgrade projects	Creating a roadmap for technological changes with clear stages. Involvement of international standards (ISO 9001, ISO 14001). Conducting staff training for the effective integration of new technologies.
Evaluation of results and flexible adjustments	Continuous monitoring of the modernisation efficiency using KPIs. Amendments to the strategy depending on changes in the geopolitical environment.

Source: developed by the authors

The mathematical description of the model of adaptation of industrial enterprises to changing geopolitical conditions through technological upgrading can be presented as a multifactor optimisation problem. It takes into account the key parameters that determine the efficiency of the processes of updating and increasing investment attractiveness. The purpose of the model is to maximise the investment attractiveness of enterprise *I*. The objective function formula is:

$$I = f(TO; FS; EPP; GR) \rightarrow max; \quad (1)$$

$$I = w_1 TO + w_2 FS + w_3 EPP + w_4 GR, \quad (2)$$

where w_1, w_2, w_3, w_4 are weighting coefficients that reflect the importance of each parameter. Technological update:

$$TO = \alpha_1 PAP + \alpha_2 DL + \alpha_3 R\&D, \quad (3)$$

where *PAP* is the level of automation (percentage of automated processes (share of automated processes, $0 \leqslant A \leqslant 1$); *DL* is the level of digitalisation (use of digital technologies such as IoT, bigdata; (share of implemented digital technologies, $0 \leqslant D \leqslant 1$); R&D – research and development expenses (as a percentage of the total budget of the enterprise); α_1, α_2, α_3 – weighting coefficients. Financial stability:

$$FS = \frac{P}{C} - R_f, \; R_f \leq ALR, \quad (4)$$

where *P* is the company's profit; *C* – total costs of the enterprise; R_f is the risk of financial losses due to external factors (estimated in shares from 0 to 1); *ALR* is the acceptable level of risk. Environmental friendliness EPP:

$$EPP = \frac{C_{EPP}}{C}, \; EPP \geq EPPmin, \quad (5)$$

where C_{EPP} is the cost of environmental measures; *EPPmin* is the minimum regulatory level of environmental friendliness. Consideration of geopolitical risks:

$$GR = \beta_1 DMD + \beta_2 LDIR, \quad (6)$$

where *DMD* is the degree of diversification of sales markets (the share of the export market that is independent of risky regions); *LDIR* is the level of dependence on imported resources (share of imports in total raw material costs); β_1, β_2 – weighting coefficients.

The weighting coefficients of the respective factors that determine the priority are set by experts. The model takes into account both internal factors (technological innovation, financial stability) and external factors (geopolitical risks, environmental friendliness). Depending on the specifics of the enterprise, the weighting coefficients can be adapted to focus on certain aspects. This model provides a comprehensive view of the investment attractiveness of an industrial enterprise by integrating several factors that affect sustainable development. The formula will balance the following aspects: technological innovations, financial stability (taking into account risks), environmental friendliness (a requirement of Western investors), and management (consideration) of geopolitical risks. Each factor has its own weight, and the formula can be used for decision-making, scenario analysis, or optimisation of the company's development strategy. Taking into account the above, the authors offer some recommendations that, in the authors' opinion, are considered appropriate to include in the state policy to stimulate technological renewal of industry in the context of geopolitical instability. To create a favourable investment climate, it is necessary to:

1) simplify the regulatory environment, namely, to reduce bureaucratic procedures for foreign investors and introduce a "single window" for registration of investment projects; to provide guarantees of investment protection by establishing clear mechanisms for protecting investors' rights and ratifying and complying with international treaties on investment protection;

2) create financial incentives, i.e., provide tax breaks (e.g., income tax cuts for companies investing in technological upgrades; tax holidays for new production facilities using innovative technologies); create a Fund for Supporting Technological Development by establishing a public or public-private fund to finance innovative projects and provide grants and subsidies for technological upgrades;

3) improve infrastructure (development of industrial parks and special economic zones (SEZs) and investment in digital infrastructure);

4) stimulate public-private partnerships (PPP) through joint investment projects: cooperation between the state and the private sector in strategically important industries (machine building, energy, agriculture), providing state co-financing of innovative projects and public-private support mechanisms (providing state guarantees to attract foreign investment);

5) develop human capital through the implementation of state training programmes for new technological industries, support for cooperation between universities and enterprises (Pylypenko *et al.*, 2021);

6) expand the international cooperation;

7) create a system for monitoring technological upgrades: regular analysis of the impact of state support on industrial modernisation and flexible response to changing geopolitical conditions.

A comprehensive strategy, including financial incentives, infrastructure development, attracting foreign investment, and improving human capital, will facilitate the technological modernisation of Ukrainian industrial enterprises.

DISCUSSION

A review of contemporary scientific studies focused on the impact of geopolitical risks on economic processes and technological modernisation of industrial enterprises demonstrates a wide variety of approaches to addressing this issue. Researchers emphasise various aspects of this topic, including international trade, investments, energy security, and the adaptation of economies to new challenges. The study by M.S. Hossain *et al*. (2024) thoroughly proved that geopolitical risk poses significant challenges to international economic, social and political systems. In particular, it has a significant impact on attracting foreign direct investment. The study, conducted in five Southeast Asian countries – Indonesia, South Korea, Malaysia, the Philippines, and Thailand – showed how geopolitical risk, as measured by the GPRI index, affected the investment attractiveness of these countries during 1996-2019. The results of the analysis, which uses stationarity and cointegration testing methods, showed the existence of a long-run cointegration between such variables as FDI, GPRI, GDP, inflation, interest rates and trade openness (TOP). According to the results of regression analysis (OLS, fixed effects, Arellano-Bonda and GMM panel data), GPRI and TOP have a negative impact on FDI in these countries, while GDP, inflation and interest rates have a positive effect on foreign investment. This confirms that geopolitical risk is a significant deterrent to investment, as investors tend to avoid countries with high political or economic instability. At the same time, economic stability and TOP contribute to investment growth.

A study by B. Gao & Z. Xu (2024) highlighted that crisis situations, such as the Ukrainian crisis, undermine investment attractiveness due to increased geopolitical risks, which in turn affects global supply chains and international trade. They noted that not only economic factors are important for transnational corporations (TNCs), but also political stability, which determines the direction of investment. This correlates with the studies of the above researchers and is consistent with the concept that Ukraine should work through international organisations such as the WTO to stabilise the legal framework and reduce risks, which will help create a more favourable environment for investors.

At the same time, as M. Li *et al*. (2024) noted, Ukraine should focus on developing decentralised energy systems to increase energy security and reduce dependence on external energy suppliers. Such initiatives, in particular in the context of rebuilding energy infrastructure, create favourable conditions for attracting investment in the energy sector, which is in line with current global trends. This allowed Ukraine not only to reduce geopolitical risks but also to create a basis for sustainable economic development. Thus, in order to attract foreign investment, countries need not only to reduce geopolitical risks but also to create favourable conditions, in particular through a stable economic environment, risk mitigation and active integration into global trade. Taking these factors into account will allow governments to formulate strategies aimed at attracting investment, which is important for economic development and strengthening macroeconomic stability.

M. Li *et al*. (2024) and M. Laryš (2024) raised the issue of energy security in the context of geopolitical instability, in particular, the decline of Russia's dominant role in the EU energy market. M. Laryš (2024) noted that Russia has lost the ability to use gas as a "weapon", which opens up opportunities for diversification of energy suppliers, including through renewable sources. This highlights the importance of investing in green energy and the development of energy networks, such as solar panels, wind turbines, energy storage batteries and hydrogen technologies. This focus is an important element in ensuring energy independence and resilience to geopolitical crises.

J. Cifuentes-Faura (2023) emphasised the need for a comprehensive approach to Ukraine's recovery, focusing on the principles of sustainability, energy efficiency and environmental friendliness. At the same time, the researcher emphasised the importance of developing infrastructure to create smart cities that use green technologies and promote sustainable development. Such approaches, the author noted, can reduce CO_2 emissions, improve energy efficiency and reduce the consumption of natural resources.

Innovative technologies, such as additive manufacturing (3D printing), are actively supported in the face of global change. C.M. Jewell & J.A. Stones (2024) noted that 3D printing not only helps to reduce production costs but also ensures more efficient use of resources through the ability to create prototypes and spare parts without the need for large material costs. At the same time, these technologies support the principles of the circular economy and green technologies, as they allow recycling materials and reducing waste. This, in turn, is an important part of the recovery of the Ukrainian economy, which requires technological upgrades and innovations to improve competitiveness in international markets.

D. Gřešica *et al*. (2024) also considered 3D printing as one of the promising technologies for the development of sustainable business models, particularly in construction and manufacturing. They noted that 3D printing can reduce the cost of materials and energy, which is an important aspect for achieving sustainable development in industry. J. Cifuentes-Faura (2023) also placed a significant emphasis on reconstruction, proposing a comprehensive approach to the reconstruction of Ukraine based on the principles of sustainability, energy efficiency and environmental friendliness. According to J. Cifuentes-Faura (2023), green technologies and energy efficiency are key to rebuilding Ukraine, creating smart cities and increasing competitiveness in global markets.

Thus, these studies revealed the multidimensional impact of the Ukrainian crisis and geopolitical risks on global processes and demonstrate the prospects for adapting to new realities through energy, economic and innovative approaches. Technological upgrading and investment attraction are fundamental aspects for ensuring Ukraine's sustainable development. The transition to innovative technologies, energy efficiency, digitalisation, and green transformation will help modernise the economy and increase its competitiveness. Creating a favourable environment for investors, including through transparency, stability and strategic initiatives, will help attract the resources needed for Ukraine's recovery and long-term prosperity.

Continuing the study of the issues raised in the above-mentioned scientific works, the authors systematised the impact of geopolitical factors on the technological upgrading of industrial enterprises, in particular in the context of conflicts, sanctions and changes in global supply chains. The authors substantiated the relationship between the technological renewal of industry and the convergence of investment processes, which ensures Ukraine's integration into global economic structures. Recommendations for state policy to stimulate technological upgrading of industry in the context of geopolitical instability, including optimisation of mechanisms for attracting foreign investment, are proposed. These recommendations are somewhat theoretical in nature, as some points require additional research and mathematical justification.

CONCLUSIONS

Given geopolitical changes, in particular the war in Ukraine, changes in trade and investment flows, as well as the fragmentation of globalisation, the country's economy is under significant pressure. Factors such as military conflict, sanctions against Russia, trade wars between major economies (in particular between the USA and China) create obstacles to stable economic development, in particular due to a decrease in foreign investment. On the other hand, they open up new opportunities for the modernisation of the industrial sector and integration into new economic blocs, in particular the European Union, which stimulates domestic investment and the transition to new technologies. One of the important trends is the change in the orientation of investments towards regional economic blocs. The risks associated with the war in Ukraine and global political conflicts force companies to apply strategies of reshoring (returning production) and friendshoring (transferring production to friendly countries). This, in particular, has a positive effect on the development of the domestic economy, as it requires the renewal of production capacities and the introduction of new technologies. At the same time, Ukraine manages to receive significant support from international financial institutions, in particular the European Union and the EBRD. These investments are aimed at restoring infrastructure and developing the energy and environmental sectors, which is an important step towards increasing the country's competitiveness in the international market.

Despite the difficulties, domestic investments, in particular in the agro-industrial complex and the defence sector, contribute to economic recovery. However, due to the high level of geopolitical risks, Ukraine still has limited access to large foreign investments compared to other countries, such as Poland or the Czech Republic. This emphasises the need to improve the investment climate in the country, in particular by improving the transparency of business processes, protecting investor rights and the stability of legislation. For the sustainable development of industrial enterprises in an unstable geopolitical situation, it is important to implement technological renewal and adapt strategies to new realities. This not only increases the investment attractiveness of enterprises but also allows them to integrate into global economic processes. To this end, a model of enterprise adaptation has been developed that takes into account investment risks and opportunities and also includes recommendations on state policy that

will promote technological innovation, increased competitiveness, and sustainable development of industry in conditions of geopolitical instability. Given the complexity of geopolitical challenges, future research should focus on developing adaptive models for industrial enterprises that integrate technological renewal, investment risk management, and strategic alignment with emerging regional economic blocs to enhance competitiveness and resilience.

ACKNOWLEDGEMENTS
None.

FUNDING
None.

CONFLICT OF INTEREST
None.

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Вплив геополітичних тенденцій на технологічне оновлення промислових підприємств як основа конвергенції інвестиційних процесів в економіці України

Анотація. Світова економіка перебуває під впливом геополітичних тенденцій, які створюють нові виклики та можливості для розвитку національних економік. Досліджені геополітичні чинники свідчать про важливість інтеграції економіки України у світові фінансові процеси, впровадження новітніх технологій та розвитку міжнародного співробітництва. Метою даного дослідження було виявити вплив геополітичних тенденцій на технологічне оновлення промислових підприємств України та обґрунтувати їх роль як ключового чинника конвергенції інвестиційних процесів з урахуванням специфіки інтеграції української економіки у світові ринки. Дослідження проведено з використанням методів теоретичного узагальнення, статистичного аналізу даних, порівняння та логіко-структурного моделювання. У дослідженні узагальнено та структуровано геополітичні тенденції та визначено їх вплив на характер інвестиційних потоків у промисловість. Обґрунтовано фактори, що сприяють або перешкоджають залученню іноземних інвестицій у технологічне оновлення промисловості України в умовах геополітичної нестабільності. Обґрунтовано взаємозв'язок між технологічним оновленням промисловості та конвергенцією інвестиційних процесів в Україні, досліджено синергію між технологічним відновленням та інвестиціями. Запропоновано модель адаптації промислових підприємств України до мінливих геополітичних умов, яка спрямована на підвищення їх інвестиційної привабливості через технологічне відновлення. Розроблено рекомендації щодо державної політики стимулювання технологічного відновлення промисловості в умовах геополітичної нестабільності. Практична цінність дослідження полягає у визначенні ключових факторів, що впливають на інвестиційну привабливість підприємств в контексті геополітичної невизначеності. Це дозволить створити механізм регулювання та коригування впливу геополітичних ризиків, що сприятиме підвищенню конкурентоспроможності на внутрішньому та зовнішньому ринках

Ключові слова: геополітичні чинники; обсяги інвестицій; прямі інвестиції; модель адаптації; державна політика

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 330.322.54:364
DOI: 10.63341/econ/2.2025.26

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Justification of the discounting rate components for the implementation of socially oriented projects

Abstract. The purpose of the study was to provide a theoretical and methodological justification of the key elements that form the discount rate for social projects. Particular attention was paid to the factors that affect its value, taking into account the unique features of social initiatives: a long payback period, low commercial profitability and high social impact. Approaches to determining the discount rate were summarised, focusing on methodologies for economic calculations of different types of projects. Classical models (capital asset valuation model) and alternative methods (comparative sales, related investments, internal rate of return, hybrid approaches) were considered, considering the specifics of industries. For example, in the IT sector, the risks of obsolescence are important, and for infrastructure projects, the long-term nature of investments and government regulation are important. The activities of rating

Article's History: Received: 24.12.2024; Revised: 01.04.2025; Accepted: 27.06.2025

Suggested Citation:
Aleksieienko, I., Berest, M., Lytvynenko, A., Lytvynenko, E., & Malyshko, V. (2024). Justification of the discounting rate components for the implementation of socially oriented projects. *Economics of Development*, 24(2), 26-40. doi: 10.63341/econ/2.2025.26.

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agencies (S&P, Fitch, Moody's) that assess long-term investment risks were analysed, as well as regulations, in particular, the Order of the Cabinet of Ministers of Ukraine No. 312 "On Approval of the Procedure and Methodology for Assessing an Investment Project with Significant Investments". The authors substantiated the level of risks that should be considered when determining the discount rate: economic, political, market and social. For social projects, the risks may be of a different nature, as they often have lower profitability but a greater social impact. Approaches to determining the discount rate in developed countries (USA, Japan, Germany) were compared and the possibility of their adaptation to Ukraine was assessed. Methodological recommendations for determining the discount rate for social projects with a more balanced approach to risks, taking into account not only financial but also social, political and regulatory risks, were developed. The proposed recommendations will help investors to better assess the risks and benefits of socially oriented projects

Keywords: risk level; cost of capital; risk premium; financing; project benefit; investors

INTRODUCTION

Determining the discount rate is an important stage and a key component of modern investment valuation methods, including the calculation of the value of a company and certain elements of its assets, as well as the assessment of the feasibility of investment projects and other aspects. Due to the large number of methods for determining the discount rate, it is important to analyse and synthesise the factors that influence this rate, as well as assess its significance for the final results of the valuation. This will allow choosing the most appropriate method that best suits the current economic situation in Ukraine. The main challenge of the study is to select discount rates that adequately account for both economic and social benefits in long-term public benefit projects. Many social and environmental initiatives, such as renewable energy, healthcare, education, and infrastructure projects, require a special approach to assessing their effectiveness due to their long-term nature and significant social impact (Zuo *et al.*, 2024). The question is how to determine a discount rate that reflects not only the economic benefits but also the broader social and environmental impacts of such projects.

The study by P.W. Saługa *et al.* (2021) analysed the discount rate for onshore wind farms in Poland. The authors used the risk-adjusted discount rate to assess the risks of projects, comparing them to traditional thermal power plants. The study showed that risk-adjusted discount rate reflects the risks of projects but does not take into account the environmental benefits of the transition to renewable energy, which could improve the long-term attractiveness of such projects. F. Cherbonnier & C. Gollier (2023) investigated risk-adjusted discount rates for projects in low-income countries. They suggest that these countries should use lower rates due to the higher social benefits of such projects. Their study highlighted those economic costs may be lower in lower-income countries, but global economic factors such as fluctuations in traditional energy prices, changes in global capital markets, and a country's inflation rate were not considered in detail. United States Agency for International Development studied social discount rates for renewable energy projects in rural communities in the United States (The social impact..., 2024). They used the social discount rate to assess aspects such as job creation, energy savings, and environmental impact. The study indicated significant social benefits from these projects, but it covered only a few regions, which limits the broad applicability of the results. M.A. Rauf & B. Frayne (2023) studied investments in affordable housing in urban areas of Canada, applying a social discount rate to estimate social and economic returns. Their analysis showed that such projects have long-term benefits, such as reduced homelessness and improved health. However, the study is limited to the Canadian context and does not take into account the conditions of other countries.

L. Zhou *et al.* (2022) investigated the cost-effectiveness of public health measures during the COVID-19 pandemic, including vaccination campaigns, using social discount rates. They noted long-term public health benefits and economic savings from preventing disease outbreaks. However, the study did not consider other economic factors, such as inflation, currency risks and exchange rate fluctuations, which could affect decision-making. W. Intaraburt *et al.* (2022) studied water reclamation projects in Thailand, using different discount rates (from 3% to 11%) to assess the financial viability of projects. The results showed that although the projects were not financially viable, the inclusion of environmental benefits made them profitable in many scenarios. However, the study did not consider possible changes in climate conditions. M. Haacker *et al.* (2020) analysed social discount rates in healthcare, pointing out that the standard 3% rate does not correspond to the rate of economic growth in low-income countries. The authors recommended using a higher rate of 5% for low-income countries, but the study did not pay enough attention to social factors that may affect the health of the population.

Thus, the discount rate plays a crucial role in assessing the economic viability of socially oriented projects. It allows taking into account not only financial aspects but also long-term social and economic benefits, which is important for the implementation of projects aimed at improving the quality of life and sustainable development of the community. A review of previous studies shows that the choice of discount rate depends on various factors, including risks, the economic situation in the country, and the specifics of the project. Thus, the assessment of the components of the discount rate for socially oriented projects is a key issue, as the correct determination of this rate will allow investors to accurately assess risks and make informed decisions on investments in such projects, which led to the need for the current study. The purpose of the study was to provide a theoretical and methodological substantiation of the components of the discount rate for socially oriented projects.

THEORETICAL OVERVIEW

The concept of a discount rate (discount) is broadly defined as a coefficient used to calculate the present value of future cash flows. In the field of valuation, discounting reflects the rate of return on invested capital and profitability in the post-forecast period. According to this indicator, an investor can invest in the asset being valued at the valuation date to cover all investment risks. The discount rate includes a premium for the risk associated with investing in the business being valued: the greater the risk, the higher the discount rate. As M. Busu (2022) noted, the time value of money is a fundamental financial concept, and the discount rate plays a crucial role in investment decisions and financial planning. A clear explanation of the concept of the social discount rate is provided by J. Broughel (2020), who defined it as "the interest rate for consumption". He explained its importance as the rate at which a unit of current consumption is exchanged for a unit of future consumption. This interest rate reflects the time preferences of consumers and, under certain conditions, can represent the risk-free market interest rate. All other things being equal, this approach is quite effective for each individual country, for each individual investment project, regardless of its focus on solving any social problems, but with minor adjustments. Namely, the addition of the cumulative effect when justifying its level, according to H. Yin (2019), M. Korol (2020) and R. Barrell & D. Karim (2020). On the one hand, the established level of the risk-free interest rate in each country already takes into account the economic characteristics of its development, while on the other hand, if risk premiums are added to its size, this justifies the specifics of implementing socially important investment projects.

In support of this view, the scientific work of G.E. Kendall *et al*. (2019) and D.C. Hornero & S.M. Montalván (2021) explained the meaning of the concept of entrepreneurial social discount rate. The scope of its application is determined by projects implemented through state support for entrepreneurship development programmes. Then, a premium for the unsystematic risk of a new enterprise and consideration of the loss aversion factor are added to the social discount rate. A.O. Zolkover *et al*. (2020) considered the social discount rate as a weighted average cost of capital (WACC). This approach implies that the social discount rate should be calculated as a weighted average between the marginal social opportunity cost of capital, the social rate of time preference, and, in the case of open economies, the cost of borrowing on external financial markets. For the purposes of the current study, the discount rate is the interest rate used to bring future cash flows to their present value; in the scientific context, it is a key element in the analysis of the economic efficiency of investments, as it takes into account the impact of time on the value of money. The higher the discount rate, the lower the value of future cash flows, as they are depreciated by inflation, risks, and opportunity costs (Danchuk *et al*., 2021). In economic models, the discount rate determines how profitable long-term projects are and is used to calculate indicators such as net present value and internal rate of return (Shahini *et al*., 2023).

In general, the discount rate, as noted by J. Bosshardt & E.M. Cerutti (2020) and M.S. Gasparian *et al*. (2021), has 3 main purposes: reflecting the rate of return at which future cash flows are brought to present value at the measurement date; reflecting the degree of risk associated with an investment in the object being valued; and demonstrating the cost of capital that the company has raised. The discount rate is an indicator for other interest rates, setting a benchmark for the cost of borrowed and invested funds, and serves as a "price tag" for lending rates, and also notes that the discount rate is mainly used to calculate the present value of future cash flows (Burawat, 2019; Maystrenko, 2022). By discounting future income or flows to their present value, investors can determine the present value of an investment. This is particularly important in valuation practices, where experts determine the fair market value of assets that may not have a competitive market.

Central banks use the key policy rate as a monetary policy tool to influence economic activity (Spytska, 2023). In general, the impact of the key policy rate varies across countries and economic environments. For example, in some African countries, changes in the discount rate have shown that interest rates have incomplete transmission to lending rates (Musimbi *et al*., 2023). Moreover, central bank communications have become an influential tool for directing market interest rates and shaping inflation expectations, which in turn affect the key policy rate (Kuncoro, 2020). As emphasised by O. Maistrenko (2023), changes in the key policy rate affect the cost of borrowing for banks, which in turn affects interest rates in the economy. For example, as noted by O. Kuzmak & Y. Bondar (2024) and M.F. Ullah *et al*. (2024), a cut in the key policy rate can stimulate borrowing and spending, while an increase in the key policy rate can help control inflation and slow down economic overheating. Recent studies have highlighted the importance of the discount rate in managing monetary policy, especially in response to economic crises or uncertainties. The discount rate is an important monetary policy tool that affects fluctuations in interbank interest rates and the bank deposit market.

MATERIALS AND METHODS

The study began with a review of existing scientific approaches to determining the discount rate for different types of investment projects. A special emphasis was placed on social projects, where economic indicators are often not decisive, and the main goal is to achieve public benefit. The inclusion criteria covered studies that examined methods for estimating the discount rate for various types of investment projects, including social projects, with a focus on such aspects as long payback, low commercial profitability, and high social impact. Articles were also selected that included a comparative analysis of traditional economic approaches, such as the capital asset pricing model (CAPM) and the WACC, with their adaptation to social projects. The exclusion criteria included the elimination of sources that did not take into account the specifics of social projects or that dealt exclusively with commercial initiatives without social aspects. Studies that did not contain detailed descriptions of methodologies or provide practical recommendations for determining discount rates for long-term social projects were also excluded. The search terms included combinations of terms such as "discount rate", "social projects", "CAPM", "WACC", "investment risks", "social effect", "long-term payback", "economic efficiency". The most relevant literature on the issue of determining the discount

rate was selected, highlighting the functions performed by this rate and what can be influenced by the discount rate. Attention was focused on the study and comparison of various methods of determining the discount rate. Traditional methods, such as CAPM, WACC, internal rate of return, cumulative build-up method, linked investment method, dividend discount model, subjective valuation method, hybrid approaches method, and comparable sales method, which are the most commonly used for estimating the cost of capital in investment projects, were considered. At the same time, alternative approaches that incorporate social aspects, such as the social discount rate, which allows for the consideration of social risks and benefits that go beyond commercial indicators, were explored.

The legal framework of Ukraine, in particular paragraphs 22-27 of the Order of the Cabinet of Ministers of Ukraine No. 312 (2024), was examined. The requirements for using the 5% rate for projects with public funding and a social component were studied. Separately, the recommendations of international rating agencies (S&P, Fitch, Moody's) on how to take risks into account when calculating the discount rate, as well as their impact on the long-term viability of social projects, were studied (Baron *et al*., 2020; Franchuk *et al*., 2020; Abdullayeva & Ataeva, 2022). Particular attention was paid to their approach to assessing long-term risks in unstable economic environments such as Ukraine. Approaches to determining the discount rate in different countries were compared, namely the United States, Japan, and Germany, and the possibility of adapting such models for Ukraine, given the country's economic conditions, was considered.

RESULTS AND DISCUSSION

Methods of determining the discount rate and their application

The discount rate is a key measure of risk and expected return on investment that reflects the change in the value of a business over time. It determines the present value of future cash flows given the level of risk associated with a particular asset or company. For example, a small regional bank that lacks diversification and operates in a limited market is exposed to higher risk than a large systemic bank that is highly diversified and operates in international markets. In this case, the discount rate for the smaller bank will be higher, as investors expect greater compensation for the risk of non-return on their investments.

Discounting involves the conversion of future cash flows into their present value, which allows for the comparison of different investment options, taking into account market risks and available alternatives. On the asset side, the discount rate is used to estimate the value of future cash flows and determine their present value (Farag *et al*., 2022). For liabilities, it reflects a company's economic cost of raising capital, including interest rates on debt or the cost of raising equity. For investors, the discount rate is an indicator of the expected return they seek from investing in a company's shares or debt (Dyduch *et al*., 2024). The higher the risk associated with a company or asset, the higher the expected return, and thus the higher the discount rate. The discount rate plays an important role in evaluating investment decisions and risks associated with future cash flows, and helps investors make more informed decisions about the value of assets (Shuplat *et al*., 2022).

Choosing an appropriate discount rate that takes into account the specifics of an investment or project is extremely important, as an incorrect rate can lead to inaccurate valuations and poor investment decisions. In addition, the discount rate may need to be adjusted over time to reflect changes in the risk of the investment or market conditions. In summary, there are many methods that can be used to help determine the discount rate, each with its own advantages and disadvantages. Some methods of determining the discount rate and their characteristics are shown in Table 1.

Table 1. Description of discount rate calculation methods

Method name	General characteristic
The method of cumulative construction	Includes the addition of a risk-free rate, considering all possible compensation for the existing risks associated with the subject being evaluated
The method of comparative sales	This method consists in comparing the appraised object with other similar objects that have recently been sold. Regarding discounting, cash flows from real estate and its market value are taken into account
The method of related investments	It can be used in two ways: for equity and debt financing and by individual component parts in the structure of the object. Assumes that the discount rate is calculated according to generally accepted technology
WACC	The method is based on the proportions of each type of capital in the overall financing structure and considers the cost of debt after taking into account tax benefits. The WACC discount rate reflects the average cost of financing the company from various sources
Method of internal rate of return	This approach is implemented in two versions: basic and modified. It involves fixing the discount rate in accordance with the internal rate of return on the investor's equity
LIBOR rate method	In this case, the discount rate is determined based on the value of the currency on the London foreign exchange market, while it is especially important to take into account the risk factors of a particular country
CAPM	The discount rate is defined as the expected return on a share or investment, considering the risk
The method of hybrid approaches	Sometimes a combination of several methods is used to determine the discount rate, especially when the project involves attracting several sources of capital or has a different degree of risk over time
The method of subjective assessment	In some situations, especially for early-stage projects or unique investments, the discount rate may be determined by management subjectively, based on its own judgment and experience
Dividend discount model	For stock valuation purposes, dividend discount model calculates a discount rate based on expected dividend payouts and the current stock price

Source: created by the authors based on A. Mints *et al*. (2019), V. Bilozubenko *et al*. (2020), and N. Hurzhyi *et al*. (2022)

Taking into account the shortcomings of some methods of calculating the discount rate, the cumulative method of construction does not take into account the beta coefficient, but uses the equity risk premium and the company-specific risk premium. This approach circumvents the problem of lack of data on beta, especially when stock market data is not available. In this case, the appraiser should pay special attention to the expert opinion of various factors when determining additional risk premiums, and collect sufficient data to adjust the calculations. This method is commonly used to determine the discount rate when valuing small businesses and small closed companies. At the same time, the basic part of the discount rate for a closed company can be calculated using the CAPM model. However, a number of premiums for specific risks should be added to the value obtained: a risk premium for the small size of the company (if relevant); a premium for unfavourable capital structure (if identified by the appraiser); and a premium for the company's "closeness", i.e., the absence of its public status. Thus, the discount rate is a combined one, since it combines the results obtained using two methods – CAPM and the cumulative method of constructing the discount rate. An alternative approach to determining the discount rate involves analysing the options for financing infrastructure and road construction projects by raising capital from various sources. In this context, the WACC model provides a methodological basis for calculating the discount rate. It reflects the average cost of financing from all sources available to the company, taking into account the share of each source in the overall capital structure. The economic significance of the WACC is that it is a key factor in the decision-making process.

Risk assessment and determination of the risk premium for investing

The aspect that investors should not neglect when financing is risk. This element of the model, the average market rate of return, is an important component because it is used to compare the performance of investments, industries, and/or companies and is analysed in the context of risk, as sectors with higher risk levels usually have higher rates of return to compensate. As a direct calculation of the average return on all publicly traded equities is quite time-consuming, in practice the equity risk premium is usually determined using historical data. This premium reflects the additional return that an investor receives as compensation for assuming the systematic risk associated with investing in equities. The risks of investing in the shares of a particular company may include a country risk premium if the merger is with a non-resident company. The market premium is determined by comparing the return on securities on the market with risk-free investments over a long look-back period (Laeven & Valencia, 2020; Nguyen & Dang, 2023).

For unlisted banks, the risk premium is determined based on industry averages. In doing so, analysts use the returns of an index comprising at least 50 stocks from many sectors of the economy. The more stocks are included in an index, the more comprehensive information it provides about trends in the securities market. The use of this method is most justified in cases where there is reliable data on similar publicly traded companies. As a rule, these are companies whose shares are more or less actively traded on the stock market and there is access to information on the prices of actual transactions. Valuation of closed Ukrainian companies and unlisted joint stock companies is also possible using the CAPM model. To accurately apply this method, it is necessary to determine the beta coefficient by analysing data on similar public companies and make adjustments to take into account the individual risks of a particular company. In addition, the beta coefficient is a fairly universal tool for measuring the risks of not only individual public companies. Using the method of modifying partial indicators to determine the beta coefficient provides a basis for assessing the systemic risk of a country; economic sectors; bank; company operations; equity or debt capital risk of a company (Pronoza *et al.*, 2023).

It is clear that company-specific risks should also be taken into account, such as the risk of company closure. Investing in a closed joint-stock company is riskier due to the lower transparency compared to open companies whose shares are listed on an organised market (open companies are required by law to provide information about their activities to the public) (Kubiczek & Tuszkiewicz, 2022). In addition, there are risks associated with investing in small companies. There are two possible solutions to adjust the CAPM for low liquidity: taking into account the risks of purchasing low-liquid shares by adding an appropriate risk premium to the discount rate obtained by the CAPM and adjusting the result of the assessment of the profitability of shares (without considering low liquidity) by applying a discount for the lack of liquidity.

In turn, when calculating the discount rate using the cumulative discount method, the discount rate starts with the risk-free rate of return, to which is then added the return that compensates for the risk of financing a particular company. Thus, the discount rate under the cumulative method includes a risk-free rate of return and a rate of return that compensates for unsystematic risks specific to the company being valued. The following risk factors are generally presented and taken into account in the valuation theory of other countries, as set out in Table 2.

Table 2. List of key risk factors of other countries

Risk factor	Additional reward for risk, %
The main person in the management, management efficiency	0-5
The scale of the company	0-5
Sponsorship structure	0-5
Industrial and spatial diversity	0-5
Diversity of client base	0-5
Income: profitability and predictability	0-5
Other specific risks	0-5

Source: created by the authors

In Ukraine, several factors have been identified that contribute to unsystematic risk. These include the presence of a key person in the organisation, the size of the organisation, debt (the ratio of equity to debt), insufficient product diversification, insufficient diversification of production within the company, limited company history, peculiarities in business development (by industry and type of activity), and equipment obsolescence (especially relevant for Ukrainian enterprises). Comparing this data with the data in Table 2, it is worth concluding that the non-systematic risk factors are largely consistent with each other, except for the item "Other specific risks", which is related to the specifics of Ukrainian companies. This assessment model has two main limitations. Although the list of risk factors in Table 2 does not formally limit the scope of the analysis, it directs the appraiser's attention to these factors rather than those hidden under the "other" heading. The lack of clear methodologies for analysing the most important risk factors leads to the fact that the appraiser is forced to determine the level of risk under analysis based on assumptions.

These model limitations can be addressed with varying degrees of effectiveness. Under the cumulative model, the valuer should conduct a thorough analysis of the types of risks specific to the company and gradually increase the discount rate as they are identified. Thus, by understanding the key risk factors inherent in any company and the marginal premium that can be allocated to a particular risk, the valuer must determine the extent to which each risk factor affects the company's condition. Difficulties arise due to the need for a specialist to use methods that minimise subjectivity in risk assessment. To reduce subjectivity in risk assessment, sensitivity analysis is an effective tool that allows modelling different scenarios for key risk indicators and assessing their impact on the result. This helps the appraiser to more accurately determine which risks have the greatest impact and adjust the discount rate accordingly. Another method is to use comparative analysis based on historical data or market analogues to justify the level of risk, while reducing the impact of subjective factors.

The cumulative construction method does not include a beta indicator, while it takes into account the equity risk premium and the firm-specific risk premium. This method addresses the lack of beta data when information from stock markets is limited. The appraiser should rely on expert judgement of various factors in setting the additional consideration and collect a significant amount of information to make adjustments. The cumulative method is commonly used to calculate the discount rate when valuing small businesses and private companies. In addition, the basic part of the discount rate for a closed company can be calculated using the CAPM, but at least 3 additional risk premiums should be added to the value obtained: related to the small size of the company being valued; associated with a capital structure that is unfavourable for the company (if noticed by the appraiser); and related to the company's "closeness". In this scenario, the discount rate is set by combining the results obtained using 2 methods – CAPM and cumulative method to establish the above rate.

One component of the discount rate is the risk-free rate of return. An asset is considered risk-free when an investor, having invested funds at the beginning of a certain period, can accurately predict its value at the end of that period (Burban, 2023). Thus, a risk-free asset must provide a constant (stable) income and have a zero probability of default or non-fulfilment of obligations. Only a security issued by the government can be considered such an asset. Such income is expected to be approximately equal to the yield on long-term government treasury bonds. The only type of government securities that meets the requirements of a risk-free asset is a liability with maturity that coincides with the maximum period when it is possible to invest available funds (Kubiczek, 2020). At the expiry of the maturity of government securities and the time period for disposing of surplus funds, the investor can confidently state that he knows what the return on the funds used by him will be at the time of the initial investment.

As for other terms, the most commonly used are the risk-free interest rates on bank deposits or the coupon rate on Eurobonds issued by issuers, including government agencies. The risk-free rate of return reflects the income without risk, and in developed countries, such as the United States, Japan, and Germany, it is calculated based on government bond yields (Tynaliev *et al*., 2024). For example, the risk-free rate of return in the US is usually based on the yield on 10-year treasury bonds, as they are considered the safest investment due to government backing and low default risk. This is often used for calculations such as WACC or discounted cash flow, as noted by Z. He & A. Krishnamurthy (2020). However, this approach is not appropriate for Ukraine, as investors do not consider investments in Ukrainian government securities to be risk-free, as noted in the works by I. Yagli & B. Deviren (2023), after the outbreak of Russia's war against Ukraine in 2022, investors became more cautious about investing in Ukrainian bonds due to growing political risks and economic instability. Research have shown that the events of the war have led to sharp fluctuations in bond markets, which has led to increased volatility in the yields of these assets. Investors tend to avoid such high-risk markets, which reduces demand for Ukrainian government securities. Comparing risk-free rates in Ukraine and other countries in the same currency makes it possible to assess the level of country risk.

According to the Order of the Cabinet of Ministers of Ukraine No. 312 (2024), paragraphs 22-27 recommend using a social discount rate of 5% for the hryvnia. However, the rate is subject to annual recalculation by the Ministry of Economy of Ukraine. This recalculation is based on the social opportunity cost method, which takes into account the cost of acquiring capital by the public sector and the inflation rate (Gutsalenko *et al*., 2018). The results of the recalculation must be published on the official website of the Ministry of Economy no later than 1 June. If a new "social discount rate" is not provided for, the previously established rate will be applied. The 12% rate is applied to projects in regions with a developed market and an active business environment, according to R.S. Kvasnytska *et al*. (2019). Such regions may include large cities and industrial centres in developed or emerging economies with high levels of investment, entrepreneurial activity and corporate presence. These may include cities in North America, Western Europe or fast-growing urban centres in Asia and Latin America. An adjustment to the cumulative discount rate may be justified by adding a risk premium. Figure 1 shows the classification and gradation of potential project risk levels.

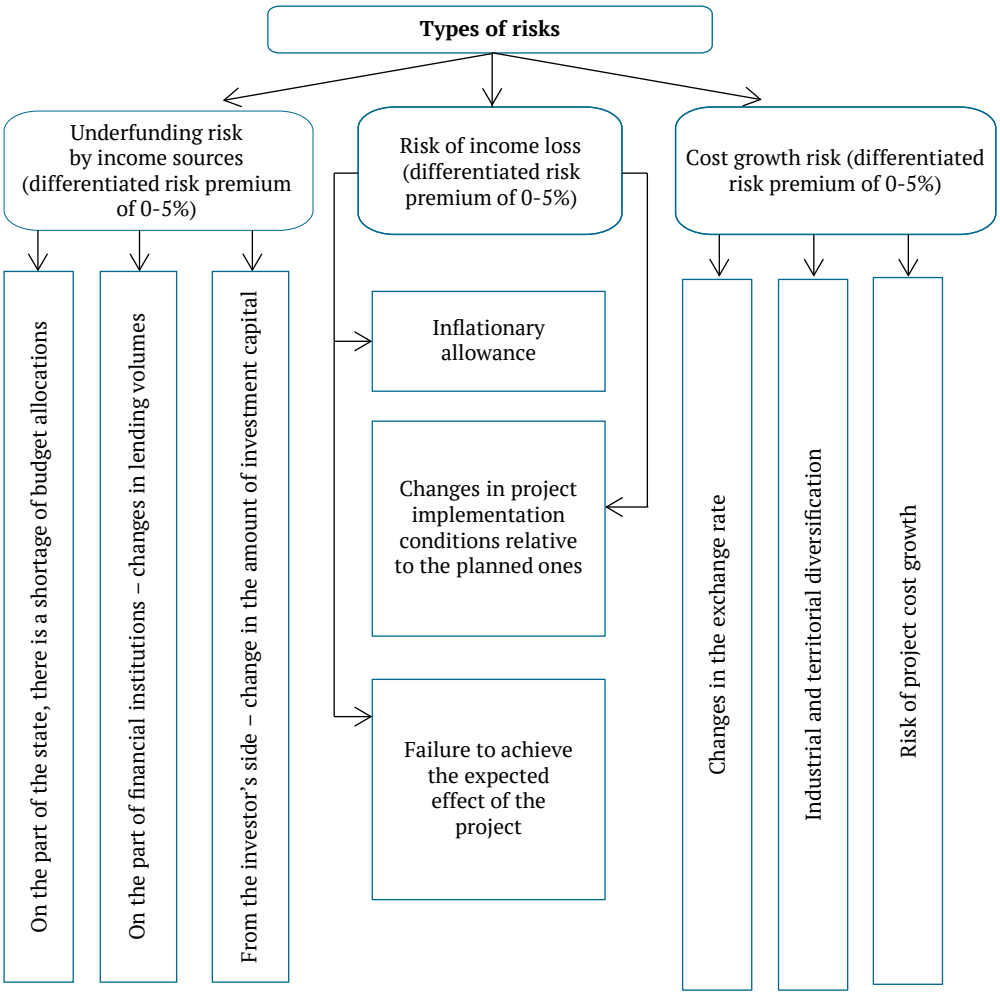

Figure 1. Categories of risks determining the impact on the level of the discount rate
Source: created by authors

Thus, as shown in Figure 1, the overall risk premium can be defined as a weighted average of the premiums for individual types of risks. The gradation of the underfunding risk premium depending on the source of revenue will be in the range of 0-5%. The amount of the risk premium that takes into account the shortfall in budget revenues is proposed to be estimated using the issuer default rating. The data presented in Table 3 shows how leading rating agencies such as S&P, Fitch, and Moody's assess long-term investment risks.

Table 3. Assessment of leading rating agencies regarding the risks of long-term investments

Risk rating conditions	S&P	Fitch	Moody's	Additional risk premium, %
The state has extremely powerful resources for making interest payments on loans and returning the principal amount of the debt	AAA	AAA	Ahh	0
The state demonstrates an extremely high ability to make interest payments on its debt obligations and settle its own debt, which corresponds to long-term ratings	AA+ AA AA-	AA+ AA AA-	Aa1 Aa2 Aa3	1
The state of the economy greatly affects and makes the country dependent on it, which affects the ability of the state to pay interest and debt, despite the fact that this ability is highly valued	A+ AND AND-	A+ AND AND-	A1 A2 A3	2
Solvency of the country is considered satisfactory	BBB+ BBB BBB-	BBB+ BBB BBB-	Wow1 Wow2 Wow3	3
Although the country remains solvent, potentially challenging economic conditions could impair its ability to meet payment obligations	BB+ VV BB-	BB+ VV BB-	Ba1 Ba2 Ba3	4

Table 3. Continued

Risk rating conditions	S&P	Fitch	Moody's	Additional risk premium, %
The country's solvency level is quite low	B+ IN IN-	B+ IN IN-	B1 B2 B3	5

Source: created by the authors based on M. Baron *et al*. (2020), V. Franchuk *et al*. (2020), and M. Abdullayeva & N. Ataeva (2022)

As noted by K. Bannikova (2022), Ukraine's credit rating is currently set at C (negative), which is due to Russian aggression and military operations in the country, the size of the premium for the risk of budget revenue shortfall should be set at the maximum level of 5%. According to the study, the amount of additional remuneration for the risk of a probable shortfall in the receipt of funds from financial institutions can be set according to the gradation shown in Table 4.

Table 4. The ranking system of the financial organisation according to the rating and the corresponding compensation for the risk (according to the rating of the National Bank of Ukraine and/or the Ministry of Finance, rating agencies)

Risk rating conditions	Risk premium, %
The bank or institution is located in the first 10 points according to the rating assessment at the time when the project is launched	0
The bank or institution is located at points 11 to 20 according to the rating assessment at the time when the project is launched	1
The bank or institution is located at points 21 to 30 according to the rating assessment at the time when the project is launched	2
The bank or institution is located at points 31 to 40 according to the rating assessment at the time when the project is launched	3
The bank or institution is located at points 41 to 50 according to the rating assessment at the time when the project is launched	4
The bank or institution is located below 50 points according to the rating assessment at the time when the project is launched	5

Source: created by the authors

If the source of project financing is the capital of investors (legal entities), the amount of compensation for the risk of incomplete or untimely receipt of funds may be set according to the ranking system set out in Table 5. The assessment of the investor's financial condition, level of solvency and probability of default may be determined in accordance with the "Procedure for assessing the financial condition of a potential beneficiary of an investment project", the "Regulation on determining the amount of credit risk for active banking operations by banks of Ukraine" or other methods of similar purpose, as added by K. Bannikova (2022).

Table 5. Gradation of the risk premium depending on the solvency of investors

Risk rating conditions	Risk premium, %
Investors demonstrate exceptional ability to meet their obligations with minimal risk of default	0
Investors demonstrate adequate ability to fulfil their obligations with minimal risk of default	1
The average level of the ability of investors to implement own obligations	2
The investor's ability to fulfil obligations is estimated to be below average	3
The investor's financial condition is unstable and has signs of insolvency	4
The investor has a high level of probability of default	5

Source: created by the authors

In the current environment, it is also worth analysing the size of the risk premium, which takes into account the potential loss of income. When setting interest rates in an unstable economy, inflation risk plays a key role and can be divided into expected and unexpected components (interest rate risk), as shown in Table 6, along with the risk premium.

Table 6. Gradation of the risk premium according to the state of the economy

Risk rating conditions	Risk premium, %
The state of the economy is absolutely stable (the minimum social accounting rate takes into account the insignificant level of inflation)	0
Normal stable economy	1
Correspondence of actual inflation forecast	2

Table 6. Continued

Risk rating conditions	Risk premium, %
Manifestation of insignificant volatility of actual and forecast inflation indicators	3
Instability of economic processes at the macro level (significant discrepancies between the projected and actual level of inflation)	4
Manifestation of crisis phenomena in the country's economy (the projected level of inflation is difficult to determine)	5

Source: created by the authors

Also, the risk of not receiving an effect from the project and the risk of changing its conditions can be diversified in the following directions, indicated in Table 7. Another source of risk that should be analysed is increased costs. One of the risk factors of cost growth is the instability of the national currency, while the implementation of investment projects in the field of road construction is closely related to the cost of construction materials, which also largely reacts to fluctuations in exchange rates. The analysis of such risks is shown in Table 8.

Table 7. Gradation of the risk premium according to the degree of risk manifestation

Risk rating conditions	Risk premium, %
The risk management system is implemented according to the plan	0
risk response system is quite effective, but minor changes are needed	1
The degree of manifestation of risks has changed compared to the previous period	2
Risks will be revealed and will have an impact on changing the effect of project implementation at the level of failure to achieve the expected result	3
The impact of risks is underestimated, as a result – the presence of capital gains (preserving the value of invested capital)	4
The catastrophic nature of the manifestation of risks, as a consequence – unprofitability of the entity	5

Source: created by the authors

Table 8. Dependence of the value of the risk premium on the stability of the exchange rate

Risk rating conditions	Risk premium, %
The exchange rate has been stable for a long time and does not affect the cost of construction works and the cost of materials	0
Exchange rate fluctuations are possible only within the framework of forecasted seasonal changes, but they do not affect the cost of construction works and the cost of materials	1
The exchange rate can fluctuate within the limits predicted by the National Bank without significant deviations	2
The presence of minor deviations of the national currency exchange rate from the forecast, which affects the cost of construction works and materials	3
Fluctuations in the exchange rate of the national currency go beyond the forecast indicators and significantly affect the cost of construction works and materials	4
The exchange rate of the national currency is difficult to predict, significant fluctuations reflect crisis phenomena in the economy	5

Source: created by the authors

The risk of production and territorial diversification has the potential to significantly affect the cost of the project, the impact of which can be distributed according to the following scheme indicated in Table 9.

Table 9. Gradation of the risk premium depending on production and territorial diversification

Risk rating conditions	Risk premium, %
A simple project without territorial and industry diversification	0
Project implementation involves minimal production or territorial diversification	1
The implementation of the project involves production or territorial diversification, which may affect the conditions for receiving cash flows from the project	2
The project is geographically diversified, but does not involve significant industry diversification, as a result of which cash flow is generated mainly for one type of product	3
The project is sectorally diversified, but does not involve significant territorial diversification, as a result of which cash flows are formed for different types of production	4
The project envisages significant territorial and industry diversification	5

Source: created by the authors

As already emphasised, the economy of Ukraine is rather unstable, so the possibility of an increase in the cost of project implementation should also be taken into account, the impact of which can be distributed according to Table 10.

Table 10. Gradation of risk premium depending on economic fluctuations

Risk rating conditions	Risk premium, %
It is stable, there are no prerequisites for an increase in the cost of resources and related needs	0
There are changes in the economy, but they are at an insignificant level	1
Characteristically moderate and cyclical increase in prices for materials and related needs	2
It is characterised by a stable and moderate increase in prices for materials and related needs	3
Within inflationary phases, it is marked by changes in prices for materials and related needs	4
Shows significant fluctuations in the cost of materials and related needs that exceed the rate of inflation	5

Source: created by the authors

The discount rate is the main mechanism for analysing risks and potential return on investment. It reflects the present value of future cash flows and takes into account all the risks associated with a particular asset or business. The choice of an appropriate discount rate is crucial for making informed investment decisions, as an incorrectly chosen rate can lead to distorted valuations (Krylovskyi, 2024). There are many approaches to determining the discount rate, each with its own advantages and disadvantages. For example, methods such as the cumulative or CAPM approach allow for flexible changes in the rate depending on the specifics of a particular project or company. Factors such as capital structure, business size, transparency, and risks associated with sectoral or regional diversification all affect risk premiums (Buzhymska *et al.*, 2024). In Ukraine, particular attention should be paid to specific risks, such as economic instability, inflation, currency fluctuations and political uncertainty, which increase risk premiums and, consequently, the level of the discount rate (Zakharchuk *et al.*, 2022). Therefore, the minimum acceptable rate for assessing the value of equity capital of state-owned enterprises can be chosen at the level of the social rate with a yield of up to 5%.

V. Kazlauskienė (2015) and V. Lipkan *et al*. (2018), based on the global and European practice of determining the appropriate discount rate for socially important projects managed by the government, advocated the use of a social discount rate. This rate is usually derived from a comprehensive statistical analysis of the country's macroeconomic indicators. However, the authors themselves point out that this approach may not be sufficiently effective for developing countries, especially those with a relatively short history of economic development. Examples of such countries include Ukraine, Georgia, Kazakhstan, Moldova, and Angola. These countries face economic challenges, including instability and a short history of market reforms, which limits the ability to make accurate forecasts based on macroeconomic data (Ismayil-Zada, 2023).

The method also does not take into account the cumulative impact of current trends in economic progress or the specific conditions associated with different stages of a country's life cycle. For developing countries, other scholars suggest using a gamma-estimation model. According to D. Zhangallimbay & J.G. Castillo (2021), the main advantages of this model are that it allows for a social discount rate below 12%, provides high cost-effectiveness by integrating a wide range of expert opinions, and flexibility in adjusting the rate depending on the project time horizon (Kulanov *et al.*, 2020; De Goede, 2021). Despite its strengths, the gamma model is based on the principle of hyperbolic discounting, which tends to favour short-term benefits over long-term ones. This inherent bias is a limitation for its use in long-term social investment projects, where long-term returns are more typical but may be ignored in favour of immediate gains. Therefore, the model may not always be suitable for projects that require a long-term perspective.

As for other studies that also focused on the analysis of risks affecting the discount rate, O. Oliinyk *et al*. (2020) emphasised the importance of the discount rate when considering long-term receivables, proposing an algorithm that takes into account traditional factors such as inflation and individual company risks. In turn, L. He (2020) contributed to the discussion by highlighting the possibility of opportunistic actions when choosing discount rates for fair value measurement, which may cast doubt on the reliability of financial statements.

The study by L. Luo *et al*. (2020) highlighted that risk reflects fluctuations in economic factors such as GDP growth, inflation, and interest rates. Persistent shocks, such as economic recessions, can lead to increased long-term uncertainty, affecting discount rates and making it more difficult to predict future earnings. Research highlighted the need for models that account for sustained economic crises that affect both consumption growth and project productivity. S. Foudi (2024) noted that the rapid development of technology, especially in the areas of artificial intelligence, robotics, and renewable energy, has created both opportunities and risks. Technological obsolescence can make investments obsolete faster than expected, leading to higher discount rates that take into account the short life of certain technology projects.

Methodological recommendations for setting the discount rate for socially oriented projects

In general, these guidelines are based on the integration of both economic and social factors that influence the overall assessment of projects. A key element is the proper consideration of risks, as social projects often have a lower level of risk compared to commercial projects, but are more difficult to predict due to their non-profit nature and dependence on social change. In this context, it is important that the discount rate takes into account both the risks associated with the average market rate of return and specific social risks.

The determination of the discount rate should begin with the calculation of the risk-free rate, which reflects the return on assets that do not have a risk of default. In an environment of economic instability typical of transition

economies such as Ukraine, the risk-free rate can be roughly estimated based on long-term government bond yields, but with a risk premium for political and economic uncertainty. An important element is to consider the risk premium associated with the specific features of the project. For social projects, the risk is often lower due to government or international support, but this does not exclude the possibility of risks associated with insufficient funding, policy changes, or unfavourable social conditions. To adjust the discount rate, additional risk premiums should be considered, depending on factors such as project size, innovation, asset liquidity and organisational efficiency.

The cumulative method should be used to calculate the discount rate. This method involves adding additional premiums to the base risk-free rate for each identified risk. The appraiser should conduct a thorough analysis of the project and gradually increase the discount rate in accordance with the identified risks. For example, risks associated with inflation, political instability, financial unpredictability and changes in the regulatory environment can add between 1% and 5% to the overall discount rate (Oleksy-Gebczyk, 2024). In addition, it is important to consider the liquidity of the project. Projects with low liquidity should have a higher discount rate, as investors need to be rewarded for taking on this risk.

Liquidity can be considered by applying a risk premium or by introducing a discount on expected cash flows. The final aspect to consider when determining the discount rate for social projects is the impact of social factors. Projects that have significant social value and are supported by government programmes or international donors may have a lower discount rate due to lower risk. However, it is necessary to ensure that the social risk premium is not underestimated to avoid underestimating the project and its potential negative impacts. Thus, the discount rate for social projects should be determined taking into account the risk-free rate, as well as additional premiums for project risks, including liquidity, economic and political stability and project scale. It is important to monitor conditions on an ongoing basis and adjust the rate as necessary.

CONCLUSIONS

The study provided a theoretical and practical justification for the methodology for determining the discount rate for socially oriented projects. The main result was the development of an adapted approach to taking into account the risks specific to such projects, which have less commercial benefit but provide a significant social impact. In particular, the optimal method for calculating the discount rate was determined, combining classical and alternative approaches, including CAPM and the comparative sales method. The study found that traditional financial methods do not fully reflect social risks, so additional coefficients for socially oriented projects were proposed. It was found that approaches based on international practices need to be adapted to Ukraine's economic situation, in particular, taking into account political and economic risks. The findings show that a more balanced approach to risk management contributes to the long-term sustainability of projects and their social benefits.

The study found that social projects need to take into account specific risks, such as economic instability, the political situation, and changes in the regulatory framework. Qualitative indicators indicate the need for a balanced approach to risk calculation, which reduces the risk premium and increases the investment attractiveness of social projects. Quantitative indicators indicate the long-term viability of projects, provided that the discount rate is applied correctly. Recommendations are made for the implementation of an adapted methodology for evaluating socially oriented projects in conditions of economic instability, which can improve the investment climate and ensure the sustainable development of such initiatives.

From a quantitative perspective, this study has outlined several risk premiums, providing a clear framework for assessing risks in different economic environments. The recommendations arising from this work highlighted the need to continually reassess discount rates as economic conditions change to ensure the accuracy of financial projections. However, the study faced limitations such as the difficulty of modelling risks in a highly volatile environment, which can affect the accuracy of discount rate calculations. Future research should focus on improving risk assessment models, especially in an unstable economy.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Обґрунтування складових ставки дисконтування для реалізації соціально орієнтованих проектів

Анотація. Метою дослідження було теоретико-методологічне обґрунтування ключових елементів, що формують ставку дисконтування для соціальних проектів. Особливу увагу приділено факторам, що впливають на її величину, враховуючи унікальні особливості соціальних ініціатив: тривалий термін окупності, низьку комерційну рентабельність та високий соціальний вплив. Узагальнено підходи до визначення ставки дисконтування, акцентовано увагу на методиках економічних розрахунків різних типів проектів. Розглянуто класичні моделі (модель оцінки капітальних активів) та альтернативні методи (порівняльних продажів, пов'язаних інвестицій, внутрішньої норми прибутковості, гібридні підходи) з урахуванням специфіки галузей. Наприклад, в IT-секторі важливими є ризики морального старіння, а для інфраструктурних проектів – довгостроковий характер інвестицій та державне регулювання. Проаналізовано діяльність рейтингових агентств (S&P, Fitch, Moody's), які оцінюють довгострокові інвестиційні ризики, а також нормативно-правові акти, зокрема, Постанову Кабінету Міністрів України № 312 «Про затвердження порядку та методики оцінки інвестиційного проекту зі значними інвестиціями». Автори обґрунтували рівень ризиків, які слід враховувати при визначенні ставки дисконтування: економічні, політичні, ринкові та соціальні. Для соціальних проектів ризики можуть мати інший характер, оскільки вони часто мають меншу прибутковість, але більший соціальний ефект. Проведено порівняння підходів

до визначення ставки дисконтування в розвинених країнах (США, Японія, Німеччина) та оцінено можливість їх адаптації до умов України. Розроблено методичні рекомендації щодо визначення ставки дисконтування для соціальних проектів із більш збалансованим підходом до ризиків, що враховує не тільки фінансові, але й соціальні, політичні та регуляторні ризики. Запропоновані рекомендації допоможуть інвесторам краще оцінити ризики та вигоди соціально орієнтованих проектів

Ключові слова: рівень ризику; вартість капіталу; премія за ризик; фінансування; вигода проекту; інвестори

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 336.74:004.738.5
DOI: 10.63341/econ/2.2025.41

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Prospects for the implementation of the digital currency of the National Bank of Ukraine in the context of global digitalisation

Abstract. The purpose of this study was to assess the economic implications of implementing a central bank digital currency (CBDC) in Ukraine (e-hryvnia) within the framework of global digitalisation. The study covered the period from 2023 to 2024. The study employed an analytical approach based on a comparative analysis of international experiences in CBDC implementation, focusing on China, Sweden, the Bahamas, Nigeria, the United States, and the European Union. The study examined pilot projects, strategies, and conceptual frameworks designed for the implementation

Article's History: Received: 11.02.2025; Revised: 14.05.2025; Accepted: 27.06.2025

Suggested Citation:
Lavruk, V., Havryliuk, V., Burlakov, O., Burdeniuk, S., & Poprozman, N. (2025). Prospects for the implementation of the digital currency of the National Bank of Ukraine in the context of global digitalisation. *Economics of Development*, 24(2), 41-53. doi: 10.63341/econ/2.2025.41.

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of the e-hryvnia and the level of digitalisation within the financial infrastructure of Ukraine. The key findings of the study are critical factors influencing the successful integration of digital currencies into national economies. The analysis indicated that countries actively adopting CBDCs seek to address technological, economic, and social readiness challenges. Furthermore, the findings suggested that the implementation of the e-hryvnia in Ukraine could be justified and effective, provided that the necessary technical and economic conditions are met to facilitate its seamless integration into the national financial system. The dynamics of the payment system development of Ukraine reflect its preparedness for the introduction of a digital currency. In 2023, a total of 7.91 billion cashless transactions were conducted, amounting to UAH 6.14 trillion. In 2024, within the first nine months alone, transactions reached 6.4 billion, with a total value of UAH 4.79 trillion, representing a 7.72% increase in the number of transactions and a 4.45% rise in transaction volume compared to the corresponding period in 2023. Moreover, by 2024, the proportion of cashless transactions in the total volume of payments had increased to 94.5% by number and 64.81% by value. The study concluded that the successful introduction of a digital currency in Ukraine will require continuous enhancement of the country's payment infrastructure and the implementation of measures to ensure the security and transparency of financial transactions

Keywords: monetary transactions; payment system; payments; macroeconomic stability; monetary policy

INTRODUCTION

The relevance of the study on the implementation of the National Bank of Ukraine's digital currency is determined by global digitalisation trends that encompass all aspects of economic and financial life. Central bank digital currencies (CBDCs) are considered a promising tool for enhancing monetary policy, ensuring financial stability, and increasing access to financial services. The implementation of CBDCs in countries such as China, Sweden, and the Bahamas demonstrated their potential to improve payment systems, reduce transaction costs, and enhance financial transparency. For Ukraine, which is actively integrating digitalisation into its economy and adopting innovative technologies, the development and implementation of the "e-hryvnia" is not only an opportunity to strengthen the national financial system but also a crucial step towards integration into global digital economic trends. In this context, assessing its economic feasibility, analysing potential challenges, and identifying the conditions necessary for the successful implementation of the e-hryvnia are of paramount importance.

Within this field of study, there is currently a limited level of experimentation with digital currencies in Ukraine, which may result in a lag in financial innovation. S.O. Hrytsai (2024) examined this issue, noting that since 2016, the National Bank of Ukraine has been developing the concept of the e-hryvnia, and in 2018, it launched a closed pilot project to test its functionality. The author identified key areas for the development of the e-hryvnia, including its use for retail payments, cross-border transfers, and transactions involving virtual assets. However, several gaps require further analysis, such as the macroeconomic impact of the e-hryvnia, the absence of a well-developed regulatory framework, and the need for improvements in the payment infrastructure.

The growing interest in CBDCs is driven by their potential to enhance financial stability and modernise payment systems. M. Korol & V. Spivak (2021) reported that 80% of central banks worldwide are exploring the possibilities of CBDCs, with 14% already implementing pilot projects. The advantages of CBDCs include lower transaction costs, improved macroeconomic data collection, and enhanced transparency of financial flows. However, challenges remain concerning the impact of CBDCs on monetary policy and the necessity of establishing a unified regulatory framework. Interest in CBDCs has been increasing due to their role in modernising payment systems and improving financial stability. I. Shevchenko (2023) investigated this subject, highlighting the advantages and disadvantages of CBDCs and their influence on digital commerce and monetary policy. The author identified three main areas of CBDC utilisation: value preservation, payment systems, and credit leverage. However, research gaps persist, particularly in relation to the effects of CBDCs on financial stability and monetary policy and the need to ensure adequate protection for investors and consumers.

In the broader study of CBDCs, particular attention is given to their economic impact and demand among businesses and the general public. M. Khutorna *et al*. (2021) explored different models for implementing CBDCs, identifying key determinants of their adoption, including economic, social, and legal factors. Nevertheless, critical issues such as cybersecurity, financial stability, monetary policy implications, and a comprehensive regulatory framework remain insufficiently addressed. The low level of trust in CBDCs due to their novelty and the lack of sufficient experience in many countries complicates their implementation. V.O. Kornivska (2023) examined this aspect, focusing on the institutional factors influencing the adoption of CBDCs. The author noted that a high level of trust in the national currency and a stable monetary policy are essential conditions for the success of CBDCs. However, the effects of digital currencies on financial stability and socio-economic aspects remain underexplored, necessitating further research.

In the digital economy, particularly in Ukraine, there is an urgent need to address the digitalisation of key economic sectors and the development of appropriate infrastructure. E. Dovgal *et al*. (2021) analysed the opportunities and risks associated with the digitalisation of the economy of Ukraine. The authors highlighted that digital transformation has the potential to create new jobs, reduce unemployment levels, and facilitate integration into global economic trends. Nonetheless, issues such as cybersecurity, reducing dependence on imported equipment, and ensuring regulatory oversight of the digital economy remain insufficiently studied. The implementation of CBDCs faces

challenges related to regulation, integration into existing financial systems, and the maintenance of monetary stability. E. Moch (2024) analysed the strategies of China, Sweden, and the United States in adopting CBDCs. The author noted that China is actively implementing the digital yuan (e-CNY) to enhance payment system efficiency and financial inclusion, Sweden is developing the e-krona due to the decline in cash usage, while the United States remains focused on research, considering the global role of the US dollar. However, gaps persist in understanding the impact of CBDCs on banking system structures, cybersecurity, and the international financial order, necessitating further examination.

The digitalisation of financial systems has become a key area of development (Gulaliyev *et al.*, 2023). E. Llazo *et al*. (2024) examined digitalisation trends in financial systems across various countries, highlighting the importance of integrating financial innovations such as fintech, blockchain, and cryptocurrencies. The authors pointed to the increasing share of electronic transactions and the growing use of digital technologies, particularly in developing countries such as Kyrgyzstan. However, the effects of digital technologies on financial market stability, cybersecurity, and the adaptation of regulatory frameworks to contemporary challenges remain insufficiently explored. The purpose of this study was to assess the economic implications of introducing a CBDC to the financial system of Ukraine and identify the key conditions for its effective implementation within the context of global digitalisation. The objectives include analysing international experiences in CBDC introduction and its impact on economic indicators and identifying the main advantages and risks associated with introducing a digital currency in Ukraine, considering the current state of its payment infrastructure and financial technologies.

MATERIALS AND METHODS

The study is analytical, focusing on the assessment of the economic implications of implementing a CBDC in Ukraine. Given that CBDCs represent a rapidly evolving financial instrument, this study also aimed to provide a comprehensive examination of the potential impact of the e-hryvnia on the economic landscape of Ukraine. The study covered the period from 2023 to 2024, allowing for an in-depth analysis of current trends and potential scenarios for the development of the e-hryvnia within the context of global digitalisation. This timeframe facilitated an exploration of how changes in the international economic system, such as the increasing popularity of cryptocurrencies, may influence the implementation of a CBDC in Ukraine. The study includes a thorough analysis of international experiences in implementing CBDCs, drawing on case studies from China, Sweden, the Bahamas, Nigeria, the United States, and the European Union. These countries and regions were selected due to their distinctive approaches to CBDC adoption: China exemplifies large-scale international initiatives, Sweden is moving towards a nearly cashless society, the Bahamas innovates for small economies, Nigeria seeks to address financial inclusion challenges, while the United States and the EU focus on global impact and adaptation to the international financial system. The study relied on academic literature and publications from international organisations that provided detailed insights into the implementation of CBDCs in these countries, examining their economic, social, and technological dimensions. To assess Ukraine's preparedness for the implementation of a digital currency, an analysis was conducted of official publications by the National Bank of Ukraine (Growth of payment infrastructure…, 2024; The second year…, 2024), which outlined pilot projects and conceptual frameworks for the launch of the e-hryvnia. These publications provided valuable data on the preparatory stages and infrastructure required for the successful implementation of the e-hryvnia in Ukraine. The collected data encompassed not only financial infrastructure but also Ukraine's payment systems, including the volume of cashless transactions, the number of payment cards in circulation, and other indicators reflecting the level of digitalisation in the country's payment infrastructure.

The methodology included content analysis and comparative analysis. Content analysis was employed to examine studies, official publications by central banks, and reports from international organisations regarding CBDC implementation in various countries. This method enabled the systematic classification of different approaches to CBDC development and adoption, identifying the technological, economic, and social factors influencing its implementation. The analysed publications were carefully reviewed to determine the key success factors and challenges associated with digital currency deployment. Moreover, comparative analysis was applied to assess Ukraine's readiness for CBDC implementation, particularly by evaluating pilot projects and concepts developed by the National Bank of Ukraine. Comparing financial infrastructure and payment system data allowed for an assessment of the degree of digitalisation in the payment systems of Ukraine and their capacity to integrate emerging financial technologies.

RESULTS

The role of central bank digital currencies in the global economy

CBDCs have become one of the key topics in global financial innovations as they offer new opportunities for ensuring stability, inclusivity, and efficiency within financial systems. The development of financial technologies and the growing popularity of cryptocurrencies have driven countries to explore and implement CBDCs as an official form of digital money. Unlike private cryptocurrencies, which operate outside of centralised regulation, CBDCs are aimed at supporting the existing monetary system by ensuring value stability and control over the money supply.

Their status as an official means of payment issued by a central bank is one of the main characteristics of CBDCs. They differ from cryptocurrencies such as Bitcoin or Ethereum, which lack state support and are often subject to market fluctuations due to this lack of backing. Central banks can regulate money circulation, maintain macroeconomic stability, and ensure the security of financial transactions through the central control they provide. Cryptocurrencies, on the other hand, have a decentralised nature, granting users more freedom but also creating risks of financial loss due to cyber threats or market instability (Dionysopoulos *et al.*, 2024).

Support for the effectiveness of monetary policy is a key task of CBDCs. Digital currencies allow central banks to regulate liquidity more precisely and respond swiftly to

changes in financial markets. For example, CBDCs could be used to automate the distribution of social benefits, stimulating the economy during times of crisis. However, due to their volatility, private cryptocurrencies cannot serve as a useful tool for monetary policy, limiting their impact on macroeconomic processes (Spytska, 2023). Moreover, there is much to discuss regarding the role of CBDCs in ensuring financial stability. Since most modern financial systems are based on trust in government institutions, CBDCs could enhance this trust by providing transparency and reducing risks associated with the shadow economy. For instance, digital currencies could help prevent money laundering, tax evasion, and other illegal financial activities. However, private cryptocurrencies are rarely used for such purposes due to their decentralised nature, which creates additional challenges for regulators (Ishchuk & Ishchuk, 2023).

CBDCs are already being implemented by many countries around the world, including China, Sweden, and the Bahamas. Retail and wholesale models, which have different economic and social implications, are among the various approaches that central banks are considering for creating their models. While the wholesale model of CBDC is aimed at optimising interbank settlements, the retail model is designed to provide broad accessibility for citizens. These models demonstrate different strategic priorities of countries and show the flexibility of CBDCs in addressing specific problems within each economy (Khutorna *et al*., 2021).

The implementation of CBDCs is a response to the modern challenges of digitalisation and the increasing role of financial technologies in the global economy. The need to modernise payment infrastructure is the primary motivator for creating CBDCs. There is a need to establish a reliable, universal, and accessible payment method in response to the growing popularity of mobile payments and electronic wallets. CBDCs can offer the convenience and speed characteristic of private cryptocurrencies but without their risks of volatility or inadequate regulation.

An important aspect of CBDCs is their role in enhancing financial inclusion. In many countries, a significant proportion of the population lacks access to banking services, which restricts their economic participation. Through CBDCs, central banks can establish a direct channel for financial services accessible to all citizens, thereby reducing reliance on intermediaries and stimulating economic growth (Tan, 2023). For example, in countries with underdeveloped banking infrastructure, such as Nigeria, CBDCs could serve as an effective tool for expanding financial accessibility.

Despite these advantages, CBDCs face several challenges. One of the most significant risks is the potential transfer of deposits from commercial banks to CBDCs, which could undermine the existing banking system. If citizens choose to store their funds in CBDCs rather than in bank deposit accounts, this may lead to a reduction in the volume of credit that banks can offer, thereby diminishing economic activity. To mitigate this risk, central banks may impose limits on the amount of CBDCs individuals are allowed to hold. Ensuring cybersecurity is another critical issue. As CBDCs operate within a digital environment, they are vulnerable to cyber threats such as hacking attacks and disruptions to payment system infrastructure. Central banks must invest in advanced data protection technologies and establish backup systems to minimise the risk of financial or data losses (4 key cybersecurity threats..., 2021).

A comparison with private cryptocurrencies highlights the role of regulation. Private cryptocurrencies, such as Bitcoin and Ethereum, operate without centralised oversight, which absolves states of responsibility for their regulation. This creates financial stability risks, as the volatility of such assets may result in market fluctuations and loss of investor confidence. In contrast, CBDCs are controlled by central banks, ensuring stability and reducing economic risks. CBDCs also impact international transactions. They have the potential to reduce the cost and time required for cross-border payments, which play a crucial role in the global economy. By eliminating intermediaries such as correspondent banks, CBDCs can streamline international trade and financial exchanges. This is particularly relevant for countries that engage extensively in global commerce. Table 1 presents a comparison of key characteristics between CBDCs and private cryptocurrencies, specifically in terms of their issuer, regulatory framework, value stability, and role in the economy.

Table 1. Comparison of characteristics of CBDCs and private cryptocurrencies

Characteristic	CBDCs	Private cryptocurrencies
Issuer	Central bank	Private companies or decentralised systems
Regulation	Subject to state oversight	No centralised control
Value stability	High, supported by the state	Dependent on market volatility
Role in monetary policy	Instrument for managing money supply	No direct impact on monetary policy

Source: compiled by the authors based on M. Khutorna *et al.* (2021), O. Oliinyk (2024)

Table 1 highlighted the fundamental differences between CBDCs and private cryptocurrencies, emphasising the advantages of CBDCs in terms of monetary policy and financial stability. Unlike private cryptocurrencies, which are characterised by volatility and a lack of centralised regulation, CBDCs ensure value stability, government oversight, and can serve as an effective tool for managing the money supply. These features position CBDCs as a promising solution for modernising financial systems and enhancing trust in state institutions within the global economy.

International experience in implementing digital currencies: successes and challenges

CBDCs are emerging as a crucial instrument in modernising financial systems across numerous countries. They offer the potential to reduce transaction costs, enhance transparency, and promote financial inclusion. Each country approaches the implementation of CBDCs according to its own economic, technological, and social context. However, this process is accompanied by challenges. The approach of China to CBDC implementation, particularly through

the introduction of the digital yuan (e-CNY), illustrates the integration of domestic economic priorities with global strategic objectives. The primary aim of this initiative is to improve the payment infrastructure of the country, increase access to financial resources, and strengthen the influence of China in the international financial system. The People's Bank of China issues the currency, while authorised intermediaries, such as commercial banks and fintech companies, manage its distribution through a two-tier operational system. This structure ensures scalability while maintaining centralised control. One of the key features of e-CNY is its potential application in trade and cross-border payments. The involvement of China in the mCBDC Bridge project, which connects multiple central banks, aims to optimise and reduce the costs of international transactions.

From a strategic perspective, e-CNY has the potential to reduce reliance on the US dollar in global financial settlements. Moreover, the concept of "controlled anonymity" in e-CNY is significant, as it safeguards user transaction privacy while allowing state authorities access to data when necessary. This model seeks to balance individual privacy protection with financial system security. Nevertheless, it has also attracted criticism for the risks associated with excessive state oversight. Despite notable achievements, the implementation of e-CNY faces several challenges. Expanding the payment infrastructure requires substantial investment, while increasing user adoption necessitates improved financial literacy. Furthermore, the global expansion of e-CNY may raise concerns among other nations regarding the growing economic influence of China. These factors require careful consideration in future digital currency strategies (Wang, 2022).

Sweden is among the first countries actively pursuing the implementation of a CBDC, known as the e-krona. This initiative is driven by a substantial decline in cash usage and the widespread adoption of cashless payments. The Swedish central bank (Riksbank) initiated the development of the e-krona to ensure continued accessibility to payment services, particularly for individuals who are unable to utilise conventional banking services due to geographical or technological barriers. A distinctive feature of Sweden's approach is a high level of digitalisation and financial literacy. Over recent years, the proportion of transactions conducted in cash has declined from 40% to 13%. This trend is supported by the widespread use of mobile payment applications and online banking. The Swedish government also set ambitious goals to position the country among the global leaders in the effective use of digital technologies (Ozturkcan *et al.*, 2019).

The objective of the e-krona project is to address several critical challenges. Even if the use of cash is further reduced, e-krona makes digital payments accessible to everyone. Through this digital currency, the state establishes an alternative payment instrument that operates continuously, thereby enhancing the resilience of the financial system. However, Sweden faces several challenges in adopting the e-krona. The most noteworthy issue is the technical integration of the new payment system with existing financial platforms. In addition, there are concerns that a complete transition away from cash could hinder certain groups, such as the elderly, from accessing financial services due to limited technological literacy. As the Swedish e-krona is regarded as a potential model for other nations, Sweden's experience has attracted international interest. The Swedish central bank is actively collaborating with other states and financial institutions to develop universal standards for CBDCs, ensuring that local and global economic needs are considered.

The Sand Dollar, the new CBDC of The Bahamas, represents an innovation designed to enhance financial accessibility in a society where access to conventional banking services is limited. Many Bahamian islands face geographical fragmentation and frequent hurricanes, which pose challenges to financial inclusion. To address these issues and support financial system stability, the Sand Dollar was introduced to reduce reliance on cash transactions. One of its key advantages is its ability to facilitate secure and swift transactions via mobile applications and prepaid cards, allowing customers to make payments even in remote areas. The Central Bank of The Bahamas implemented various transaction limits for different types of wallets, catering to the diverse needs of users: from individuals with lower transaction limits to business wallets with higher thresholds. This approach aims to balance accessibility with regulatory compliance.

Despite its innovative potential, the Sand Dollar faces several challenges. One major issue is its low adoption rate among businesses and the general population, largely due to inadequate public awareness campaigns during its implementation phase. The COVID-19 pandemic further complicated the digital currency's rollout. Moreover, technical limitations and restricted interoperability with international payment systems have diminished its appeal to tourists and foreign users. Moving forward, key priorities for the development of the Sand Dollar should include improving marketing strategies, expanding cooperation with global payment networks, and enhancing transparency in its technical infrastructure to strengthen consumer trust. The central bank must also prioritise educational initiatives aimed at improving financial literacy and raising public awareness of the benefits of digital currency usage. Such measures would not only build trust in the Sand Dollar but also serve as a model for other nations looking to implement CBDCs, particularly in resource-constrained and geographically isolated environments.

The introduction of eNaira in Nigeria is a step towards modernising the country's financial system, which has long struggled with low levels of banking inclusion and the widespread popularity of cryptocurrencies among the youth. On 25 October 2021, the Central Bank of Nigeria officially launched eNaira as part of its financial technology development strategy. The primary objectives of eNaira include reducing the costs of monetary transactions, enhancing transaction transparency, and expanding financial accessibility. By enabling citizens to make payments via digital wallets, eNaira simplifies financial transactions, particularly for individuals in remote areas and within the informal economy. Moreover, the Central Bank of Nigeria gains improved regulatory oversight of financial flows, thereby strengthening monetary policy. eNaira facilitates social welfare payments, improves international remittance efficiency, and increases tax revenues. Nevertheless, the implementation of eNaira in Nigeria encountered numerous obstacles. One of the primary concerns is public distrust

towards the government's initiative, driven by fears of excessive state control and financial surveillance. Many Nigerians perceive eNaira as a potential tool for monitoring financial transactions, which has hindered its widespread adoption (Chukwuere, 2021).

Another challenge is the low level of digital literacy among a substantial portion of the population, which complicates the use of electronic wallets. There are also technical barriers associated with limited access to the Internet and electricity in certain regions of the country. Another issue is the high volatility of Nigeria's currency, the naira, which affects the stability of eNaira. Furthermore, young people who actively engage with cryptocurrencies tend to favour riskier financial instruments due to their potential for rapid wealth accumulation, making eNaira less attractive to this demographic. Despite these challenges, eNaira holds considerable potential for the development of Nigeria's financial sector. To ensure its success, it is crucial to expand information and educational campaigns aimed at fostering public trust and enhancing awareness of the benefits of digital currency. Moreover, the development of a flexible regulatory framework that considers local market dynamics and the integration of eNaira with modern financial technologies will be essential for ensuring its competitiveness.

In the United States, the introduction of a CBDC remains in the research phase. The Federal Reserve is focusing on assessing the impact of a digital dollar on the international financial system and macroeconomic stability. The primary challenges for the United States include maintaining the dominant role of the dollar in the global economy, ensuring cybersecurity, and striking a balance between private financial institutions and state-backed currency (Central bank digital currencies, 2024). The European Union is also actively developing the digital euro project, which aims to strengthen the eurozone's position in international transactions and enhance financial integration among member states. The main challenge for the EU lies in harmonising legal frameworks and ensuring technical compatibility between the financial systems of different countries. Another key task is fostering public trust in the digital euro among citizens accustomed to cash transactions (The digital euro project..., 2023).

Despite substantial progress, the implementation of CBDCs is accompanied by a range of challenges, including technical, financial, legal, and social considerations. Central banks must address issues related to scalability, cybersecurity, and interoperability with existing systems. A crucial objective is the establishment of a regulatory framework that ensures effective oversight of digital currencies while preventing their use in illicit financial activities. The development of CBDCs across different countries demonstrates considerable variations in approaches and priorities. In each case, implementation depends on economic conditions, the level of technological infrastructure, and the social needs of citizens. Table 2 summarises the key aspects of CBDC adoption, including innovations, social impact, and the necessary steps for improving the effectiveness of these projects.

Table 2. Additional aspects of implementing CBDC in different countries

Country	Innovations in implementation	Social impact	Next steps
China	Use of e-CNY for cross-border payments via the mCBDC Bridge; two-tier operational system with banks and fintech companies	Expanded access to digital payments for a broad segment of the population; reduction of dependence on the US dollar	Enhancement of financial literacy; expansion of international integration
Sweden	Integration of the e-krona into the existing banking system; ensuring access to payments in the event of a cashless society	Reduction in cash usage to 13%; increased financial inclusion	Bridging of the digital divide among the elderly; strengthening of public trust in digital currency
The Bahamas	Sand Dollar with a multi-tier wallet system adapted for different user groups	Improved access to financial services in remote areas; reduced reliance on cash	Enhancement of the integration with international payment systems; public awareness campaigns to promote the currency
Nigeria	eNaira as a tool for social payments and small business support; mobile electronic wallets for simplified transactions	Increased transparency in transactions; financial inclusion for people in remote areas	Information campaigns to boost public trust; adaptation to international standards
USA	Conducting research to assess the impact of a digital dollar on the global financial system and economic stability	Examination of the potential impact on international transactions; establishment of trust in a new form of currency	Development of a regulatory framework; assurance of cybersecurity
EU countries	Development of a digital euro to strengthen financial integration and improve the efficiency of international transactions	Harmonisation of legal frameworks and financial systems across member states; promotion of public trust in the digital euro	Completion of technical integration; user education initiatives

Source: compiled by the authors

Table 2 highlights the diverse approaches to CBDC implementation across different countries, underlining distinct objectives and challenges. Innovations such as cross-border payments in China and banking system integration in Sweden demonstrate the flexibility of CBDCs in addressing local and international financial issues. The key achievements of these projects include their social impact, particularly in reducing reliance on cash and expanding financial accessibility. However, for CBDCs to succeed, it is essential to address existing challenges, including

technical integration, building user trust, and harmonising regulatory frameworks. Overcoming these obstacles will enhance the global effectiveness of such initiatives.

The e-hryvnia pilot project: prospects and challenges for Ukraine

The concept of the e-hryvnia, a digital currency proposed by the National Bank of Ukraine, represents a step towards modernising the financial system of the country. The e-hryvnia is designed to provide a secure, innovative, and efficient payment method that aligns with global trends in the development of CBDCs. The project's development began in 2016, with the first pilot programme launched in 2018. The National Bank continues to refine the e-hryvnia concept, considering the results of pilot testing and international experience. Ukraine has a well-developed cashless payment infrastructure, encompassing contactless and tokenised cards, mobile payment systems, and internet banking. These factors create favourable conditions for the successful implementation of digital currency. However, the project requires modernisation of the existing financial infrastructure and substantial investment to ensure its effectiveness (Maslov, 2023). The e-hryvnia is intended to serve as an alternative to conventional payment instruments, offering a simpler, faster, and more secure method of conducting transactions. Reducing the number of intermediaries in payment processes is expected to lower transaction costs while enhancing the speed and transparency of financial settlements (Kredina *et al.*, 2022). The introduction of the e-hryvnia could also optimise business processes within the banking sector and strengthen financial stability.

However, the project is accompanied by numerous challenges. One of the primary tasks is establishing a robust legal framework for regulating the use of the e-hryvnia, which would help prevent cybercrime and mitigate financial security risks (Studinski & Studinska, 2023). The choice between a centralised and decentralised model for the e-hryvnia represents another strategic decision that must account for the specific characteristics of Ukraine's financial system. In addition, integrating the e-hryvnia into the existing financial ecosystem requires consideration of consumer habits and efforts to familiarise the public with this new form of currency (Tyshchenko & Tyshchenko, 2024). A successful implementation has the potential to position Ukraine as a leading country in the field of digital currencies on the international stage. The digital currency, particularly the e-hryvnia project being developed by the National Bank of Ukraine, has the potential to transform the country's monetary policy. The implementation of the e-hryvnia could constitute a crucial step in the context of global digitalisation and the advancement of financial technologies, influencing Ukraine's economic stability and financial infrastructure (Kyrychok *et al.*, 2023).

Digital currency may enhance the effectiveness of monetary policy. By enabling the accrual of interest on digital currency, the National Bank of Ukraine would gain a novel tool for achieving its objectives, such as controlling inflation and stabilising the economy. This could strengthen the interest rate channel of monetary transmission, allowing the central bank to exert more effective influence over the money supply and credit activity within the country. For instance, in cases where inflationary pressures need to be mitigated, the National Bank of Ukraine could increase interest rates on the e-hryvnia, thereby encouraging savings and reducing consumer demand. The introduction of the e-hryvnia could lower transaction costs for market participants. This would contribute to a reduction in the proportion of cash payments within the economy and foster the development of cashless transactions. A decline in payment processing costs would have a positive impact on the overall financial stability of the country by easing the burden on the banking system and facilitating greater access to financial services for the population.

Another crucial aspect is the enhancement of transparency in financial transactions. Digital currency would ensure greater visibility of transactions, aiding efforts to combat money laundering and other financial crimes. This increased transparency could also foster greater trust in the national currency and strengthen its role in international settlements. Citizens would gain confidence in the security of their financial transactions, knowing they are safeguarded and monitored by state authorities. Furthermore, the introduction of the e-hryvnia could serve as a catalyst for innovation within the financial sector. The utilisation of smart contracts and other technological solutions would enable the optimisation of payment processing and the development of new opportunities for financial institutions. This could lead to the emergence of novel business models and services tailored to the needs of the modern consumer (Makarov & Arzhevitin, 2022).

However, the introduction of digital currency also presents certain risks. Appropriate regulation is required to mitigate potential negative consequences, such as excessive volatility or security threats. The National Bank of Ukraine must consider these factors when developing the e-hryvnia concept. For instance, ensuring a high level of cybersecurity is crucial for protecting user data and preventing fraud. Digital currency has the potential to transform Ukraine's monetary policy, enhancing its efficiency and transparency. However, for successful implementation, it is essential to thoroughly analyse all aspects, including risks and challenges, to ensure the stability and security of the country's financial system. Engaging the public in discussions regarding digital currency innovations is vital to securing its acceptance and support among the population. Only through such an approach can the e-hryvnia project be successfully implemented, strengthening Ukraine's position in the context of global digitalisation.

Between 2023 and 2024, Ukraine witnessed an increase in the volume of cashless transactions alongside improvements in its payment infrastructure, creating favourable conditions for the introduction of the e-hryvnia digital currency. In 2023, the number of transactions made using payment cards reached 7.91 billion, with a total value of UAH 6.14 trillion. During the first nine months of 2024, transaction volume increased to 6.4 billion, with a total value of UAH 4.79 trillion, reflecting a 7.72% rise in the number of transactions and a 4.45% increase in transaction value compared to the same period in 2023 (The second year…, 2024; Interim results…, 2025).

The share of cashless transactions in total payments has shown a consistent upward trend. In 2023, it accounted for 93.5% in terms of transaction volume and 65% in terms of transaction value (Growth of payment

infrastructure, 2024). By 2024, these figures had risen to 94.5% and 64.81%, respectively, indicating a continued decline in the use of cash. Among cashless transactions, in-store payments remained dominant, accounting for over 73% of total transactions and 45.7% of transaction value in 2024. Card-to-card transfers represented 32.2% of transaction value, while online payments for goods and services accounted for 14.4% (The second year..., 2024). In 2023, 115.1 million payment cards were issued in Ukraine, of which 52.1 million were actively used for spending transactions. In 2024, the number of cards in circulation increased by 6% to 122 million, with 54 million remaining active. Over 60% of active cards are contactless, while tokenised cards now account for more than 27% (How many payment..., 2024).

The development of payment infrastructure has also demonstrated positive dynamics. In 2023, the number of POS terminals stood at 449.5 thousand, rising by 9% to 512.9 thousand in 2024. The ATM network remained stable at approximately 15.8 thousand machines. Furthermore, the highest concentration of payment infrastructure is in the Kyiv, Dnipropetrovsk, Odesa, Kharkiv, and Lviv regions, which together account for 48.38% of all devices (The second year, 2024). Particularly noteworthy is the increasing use of NFC technology. In 2024, over 56% of all transactions conducted via payment terminals were made using smartphones and other NFC-enabled devices. Contactless cards accounted for an additional 37.8% of transactions, while transactions involving physical card insertion constituted only 5.8%. Ukrainian-issued payment cards have also exhibited significant activity abroad. In 2024, a total of 252.2 million transactions, amounting to UAH 257.1 billion, were conducted outside Ukraine. Although the total value of overseas transactions declined by 6.95%, the number of transactions increased by 2.19%, indicating sustained demand for card-based payments among Ukrainians residing abroad.

The data from 2023-2024 indicate an increase in the popularity of cashless transactions in Ukraine. This trend is driven by the progressive digitalisation of the financial system and the population's adaptation to emerging payment technologies. Ukraine's readiness for the implementation of digital currency is underscored by the continuous development of its payment infrastructure, the growing use of contactless and tokenised cards, and an increasing integration with international markets. These trends reflect an enhancement in financial transparency, a reduction in dependence on cash, and the banking system's ability to address contemporary challenges. By ensuring Ukraine's competitiveness on the global stage and strengthening public trust in the national financial infrastructure, such developments foster innovation in the financial sector.

The introduction of the e-hryvnia represents a strategic step, necessitating careful consideration of national realities and international experience. An analysis of successful CBDC implementations in countries such as China, Sweden, the Bahamas, and Nigeria provides valuable insights for the development of an effective strategy. These cases highlight the importance of a comprehensive approach, from pilot testing to long-term monitoring of implementation outcomes. One of the critical steps in this process is the formulation of a clearly defined e-hryvnia implementation strategy accounting for social, technical, and economic factors. For instance, when China launched the e-CNY, its priorities included strengthening payment infrastructure, enhancing monetary regulation, and integrating the digital currency into international transactions. Ukraine must establish clear objectives, such as reducing financial transaction costs, increasing financial inclusion, and decreasing cash usage. These objectives should be reflected in a detailed implementation framework outlining specific phases and timelines for execution.

Pilot testing of the e-hryvnia is also of paramount importance. China's experience demonstrates that a multi-stage pilot programme can be successfully deployed across regions with differing economic characteristics. To accommodate local needs and optimise the functionality of the e-hryvnia, Ukraine should conduct pilot projects in various regions, including urban and rural areas. This approach would help identify potential organisational and technical challenges at an early stage. The development of payment infrastructure represents another crucial element. Sweden's e-krona project highlights the importance of ensuring that payment terminals and modern financial technologies are accessible even in the most remote areas. Expanding the network of POS terminals, supporting NFC-enabled payments, and facilitating Internet banking access in underserved regions should be a government priority. Particular attention must be given to ensuring that all citizens have equitable access to digital financial services.

The involvement of commercial banks and fintech companies in the implementation of the e-hryvnia is of critical importance. Nigeria's experience with the eNaira demonstrates that the private sector plays a pivotal role in driving adoption among the population. The National Bank of Ukraine should actively engage with commercial financial institutions, encouraging them to integrate the e-hryvnia into their operational and payment systems. Such collaboration would accelerate the acceptance of the digital currency and expand its reach within the financial ecosystem. One of the most significant challenges in implementing a digital currency is cybersecurity. The example of the Bahamas with their Sand Dollar underscores the importance of ensuring transparency in financial transactions and the protection of user data. Ukraine must adopt state-of-the-art data protection systems, incorporating data encryption, multi-factor authentication, and regular security audits. These measures will enhance trust in the new currency and mitigate fraud risks.

Another crucial element is the legal framework. In developing the digital euro, which may serve as a model for Ukraine, the European Union has been actively working on legislative alignment. Clear regulations governing the use of the e-hryvnia should address its legal status, usage policies, and data protection mechanisms. Establishing a well-defined regulatory structure will foster public confidence in this new financial instrument and ensure transparency. Furthermore, public awareness of the benefits of the e-hryvnia represents a critical step in its adoption. The Ukrainian government should launch an information campaign to promote the advantages, security, and convenience of digital currency. Engaging financial experts and leveraging social media and conventional media channels will help disseminate knowledge about the digital currency. The technical integration of the e-hryvnia with

international payment systems could also provide a competitive advantage. Participation in global initiatives, such as China's mCBDC Bridge, illustrates the potential for optimising cross-border transactions. Ukraine should strive to integrate the e-hryvnia with international payment platforms, facilitating its use beyond national borders, particularly among Ukrainians residing abroad.

Continuous monitoring and evaluation of the digital currency's implementation must be ongoing. Regular assessments of its effectiveness and user experience studies will enable policymakers to adjust the strategy and address potential shortcomings. This approach will ensure system flexibility and contribute to its long-term improvement. The successful implementation of digital currencies in other countries demonstrates that their adoption is feasible only when tailored to national needs. Ukraine has the potential to emerge as a leader in digital currency innovation, offering its citizens enhanced financial services, reinforcing economic stability, and strengthening its position on the global stage.

DISCUSSION

CBDCs represent one of the key innovations in the modern financial system, attracting the attention of researchers worldwide. This study examines the prospects for the implementation of the e-hryvnia in Ukraine, focusing on its impact on economic stability and the country's payment infrastructure. To enhance the understanding of global trends, the study draws comparisons with existing research, particularly regarding the influence of CBDCs on the international financial system. The study by S. Prodan *et al*. (2024) focused on global trends, challenges, and opportunities associated with the introduction of CBDCs, particularly in relation to sustainable development, technological adoption, and integration with the "green" financial system. Both studies highlight the importance of payment infrastructure development, security, and legal regulation for the successful implementation of CBDCs. However, while S. Prodan *et al*. (2024) emphasised global aspects, such as sustainable development and the reduction of economic inequality, the present study concentrated on localised factors, particularly the implementation of the e-hryvnia in Ukraine. The researchers provided a broader analysis of international experiences with CBDC adoption, whereas current study conducted a detailed examination of the e-hryvnia's impact on the financial system of Ukraine. A key area of overlap is financial inclusion, though S. Prodan *et al*. (2024) placed greater emphasis on global trends, while this study focuses on regional challenges.

The study by B. Li (2024) examined the technical and strategic aspects of digital currency adoption by the People's Bank of China, specifically the Digital Currency Electronic Payment (DCEP) system. The author provided a comprehensive analysis of the two-tier operational system, which combines centralised control with flexibility and highlights the role of 'controlled anonymity' in enhancing transaction security and combating financial crime. However, the primary focus of the study was on the potential of DCEP to reduce transaction costs, improve payment efficiency, and expand financial inclusion, particularly in rural areas. In contrast, the present study analysed the implementation of the e-hryvnia, with a focus on national challenges, such as the need for regulatory modernisation and the promotion of digital currency adoption among the population. While the Ukrainian project aimed to address domestic payment infrastructure issues, the Chinese initiative is actively engaged in global projects such as the mCBDC Bridge. Despite these differences, both studies underscore the fundamental role of infrastructure in the successful deployment of CBDCs.

The study by A. Alqarni (2024) focused on the role of digital currencies in international trade, highlighting both opportunities and challenges. Both studies acknowledged the benefits of digital currencies, including reduced transaction costs, faster settlement times, and enhanced financial inclusion, yet they differ in emphasis. A meta-analysis conducted by A. Alqarni (2024) underscored the impact of digital currencies on small and medium-sized enterprises in international trade, whereas the present study focused on macroeconomic effects and the stabilisation of Ukraine's financial system. Both studies stressed the importance of legal frameworks and security; however, A. Alqarni (2024) highlighted the harmonisation of regulatory standards for international trade. The technological aspect in the study placed greater emphasis on blockchain solutions to ensure transparency, whereas the present study examined the integration of the e-hryvnia into the payment infrastructure.

The study by D. Horváth (2023) focused on the social aspects of CBDC implementation, highlighting the importance of educational campaigns and cultural adaptation to new technologies. The researcher employed qualitative research methods, such as interviews and expert discussions, whereas, in the Ukrainian context, quantitative data from national statistics play a key role. This contrasts with the present study, which centred on economic challenges, particularly the modernisation of Ukraine's financial infrastructure. Despite these differences, both studies reach similar conclusions regarding the significance of transparency and financial inclusion. In the study by G. Akybayeva *et al*. (2024), the primary focus was on the global context of CBDC adoption. The authors examined case studies from Brazil and China, analysing the potential of digital currencies to reduce transaction costs, accelerate payments, and enhance transparency. A key proposition in their work is the introduction of CBDCs as an alternative to crypto assets, which, according to the authors, do not meet contemporary economic requirements. In contrast to the global perspective presented by the authors, the present study focused on the local aspects of e-hryvnia implementation, considering the specific characteristics of the Ukrainian economy.

The study by S. Alam *et al*. (2022) explored digital currencies, their impact on financial systems, and the challenges of implementation across different countries. It devoted considerable attention to the prospects and challenges of introducing the digital rupiah in Indonesia, including its impact on the banking system, decentralisation, technological barriers, and transparency concerns. In particular, authors emphasised the necessity of a robust technological infrastructure to support the digital rupiah. Moreover, their study focused on the conflict between centralised and decentralised currencies, whereas the present study is more concerned with the examination of a specific national digital currency project and its potential effects on monetary policy and economic stability. They also underscored the risk

of disintermediation and possible transformations within banking architecture. A key similarity between both studies is the recognition of the need for a reliable legal framework for digital currencies. However, S. Alam *et al*. (2022) devoted more attention to cryptocurrency regulation and its implications for financial stability.

When discussing the findings of N.E. Egbuna (2022) in comparison with the present study, it is important to note the differing approaches to analysing the impact of digital currencies. The author examined the case of the eNaira in Nigeria, illustrating an approach to financial inclusion in developing countries. In contrast, the present study draws on international experience to adapt innovations to the Ukrainian context. Both studies acknowledged that CBDCs have the potential to enhance transaction transparency, promote financial inclusion, and reduce operational costs. This approach provides a more balanced perspective on the opportunities and challenges of CBDCs by integrating global insights with local considerations.

The study by Y. Fu (2023) focused on the e-CNY, its strategic role in China's financial system, its potential to reduce the dominance of the US dollar, and the integration of blockchain technologies. Y. Fu (2023) explored the development of a two-tier system that combines blockchain technology with centralised control, which could be adapted to the Ukrainian context to enhance cashless transactions. The author advocated for blockchain as a foundational technology to ensure the security and efficiency of transactions. Both studies underscored the importance of digital currencies in the transformation of the global financial landscape. A common feature is their emphasis on the necessity of integrating new technologies to strengthen financial stability and transparency.

The study by O. Castrén *et al*. (2022) examined the global implications of CBDC implementation for financial systems, focusing on financial network modelling and structural changes in the banking sector. The authors analysed macroeconomic indicators such as inflation and interest rates, noting that one of the key advantages of CBDCs lies in reducing dependence on commercial banks, thereby contributing to financial stability. In contrast, the present study concentrates on the local aspects of e-hryvnia a doption, such as the modernisation of payment infrastructure, the enhancement of monetary policy efficiency, and the expansion of financial inclusion. This allows for a deeper understanding of national challenges, in contrast to the more theoretical approach of O. Castrén *et al*. (2022) which is oriented towards global comparisons. Both studies concur on the importance of CBDCs in improving financial systems. X. Gao (2024) examined the advantages of digital currencies, such as high efficiency and low transaction costs, which can reduce expenses and improve accessibility in international payments. The author focused on a general analysis of the international use of digital currencies, highlighting their potential in global trade relations. Both studies emphasised challenges such as technical security concerns and regulatory oversight. However, while both studies recognised the potential of digital currencies, X. Gao (2024) focused on their global impact, while this study analysed their national adaptation.

The study by M. Ge (2022) and the present research concurs on the importance of digital currencies as a tool for modernising financial systems. Both highlighted the need to establish a clear legal framework to ensure transaction transparency and security. They also acknowledged the role of digital currencies in reducing the costs associated with cash circulation and enhancing financial inclusion. The study by J. Müller & Á. Kerényi (2022) explored the impact of CBDCs on the global financial system, focusing on their role in ensuring financial stability, monetary policy, and global competitiveness. Particular emphasis is placed on the interaction between digital versions of the US dollar, the euro, and the yuan and the regulatory challenges associated with digital currencies. The researchers highlight that CBDC implementation may reduce financial transaction costs, enhance transparency, and integrate the international financial system. However, it also presents risks to the banking sector, particularly the potential diminishing of the role of commercial banks as intermediaries. A shared aspect between the two studies is the recognition of CBDCs' potential in transforming financial systems. Both studies examined the importance of integrating digital currencies into national and international financial frameworks, emphasising their advantages, such as cost reduction and increased transparency. The study confirmed the importance of infrastructure development, regulatory frameworks, and financial inclusion for the effective implementation of CBDCs. While most studies underline common themes, such as the necessity of technological support and legal regulation, the local contexts of CBDC adoption may vary depending on national conditions and priorities.

CONCLUSIONS

The introduction of the National Bank of Ukraine digital currency (e-hryvnia) holds potential for modernising the economy of the country and strengthening its position in the international financial environment. The analysis of international experiences, including those of China, Sweden, the Bahamas, and Nigeria, highlighted the advantages of digital currencies in promoting financial inclusion, reducing transaction costs, increasing transparency, and integrating modern technologies into financial infrastructure. Nevertheless, Ukraine must consider national specificities, particularly the need to establish a legal framework, enhance cybersecurity, and modernise its payment infrastructure. The dynamics of the payment system of Ukraine development indicate its readiness for the introduction of a digital currency. In 2023, the country recorded 7.91 billion cashless transactions, amounting to a total of UAH 6.14 trillion. In the first nine months of 2024 alone, the number of transactions reached 6.4 billion, with a total value of UAH 4.79 trillion, representing a 7.72% increase in transaction volume and a 4.45% rise in transaction value compared to the same period in 2023. The share of cashless transactions in total payments rose to 94.5% by volume and 64.81% by value in 2024. These trends confirm the decreasing reliance on cash within the economy of Ukraine.

The implementation of the e-hryvnia will enhance the effectiveness of monetary policy by introducing new instruments, such as interest rates on digital assets. This will enable more effective management of the money supply, stimulate economic growth, reduce inflationary risks, and improve access to financial services. In addition, digital currency will reduce the volume of cash transactions,

thereby increasing financial transparency, curbing the shadow economy, and strengthening trust in the national currency. The integration of the e-hryvnia into the financial ecosystem of Ukraine will necessitate an expansion of the payment infrastructure. In 2024, the number of POS terminals increased by 9%, reaching 512,900, demonstrating a high level of business adaptation to modern payment technologies. Furthermore, over 60% of active payment cards in Ukraine are contactless, while the proportion of tokenised cards has exceeded 27%. These indicators confirm the readiness of the country to implement innovative financial solutions.

Despite these positive trends, the project faces several challenges. Among them is the need to establish a regulatory framework governing the use of the e-hryvnia and ensure a high level of cybersecurity to protect user data and prevent fraud. Public awareness campaigns aimed at improving financial literacy and engaging experts in discussions on digital currencies will contribute to fostering trust in this innovation. Based on this analysis, the introduction of the e-hryvnia represents a strategically significant step for Ukraine, enabling the modernisation of the financial system, strengthening economic stability, enhancing competitiveness, and fostering innovative development. For the project to succeed, it is essential to consider international experience, the specific characteristics of the national economy, and the social needs of the population. Only a comprehensive approach, including infrastructure modernisation, the establishment of a legal framework, and public outreach, will ensure the effectiveness of the e-hryvnia and its acceptance within society. Further research should include a more thorough development of the legal and regulatory framework for the e-hryvnia.

ACKNOWLEDGEMENTS
None.

FUNDING
None.

CONFLICT OF INTEREST
None.

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Перспективи впровадження цифрової валюти Національного банку України в умовах глобальної діджиталізації

Анотація. Метою даного дослідження було оцінити економічні наслідки впровадження цифрової валюти центрального банку України (е-гривні) в умовах глобальної діджиталізації. Дослідження охоплювало період з 2023 по 2024 роки. Методологія дослідження включала аналітичний підхід, що базувався на порівнянні міжнародного досвіду впровадження цифрових валют, зокрема у Китаї, Швеції, Багамських островах, Нігерії, США та Європейського союзу. Під час дослідження було вивчено пілотні проєкти, стратегії та концепції, розроблені для запуску е-гривні, а також рівень цифровізації фінансової інфраструктури України. Основними результатами дослідження стало визначення ключових аспектів, що впливають на успішне впровадження цифрових валют в економіку різних країн. Зокрема, аналіз показав, що країни, які активно інтегрують цифрові валюти, намагаються вирішити питання технологічної, економічної та соціальної готовності до таких змін. Також було визначено, що впровадження е-гривні в Україні може бути обґрунтованим і ефективним, якщо врахувати технічні та економічні умови, що сприятимуть її успішній інтеграції в національну фінансову систему. Динаміка розвитку платіжної системи України демонструє наскільки вона готова до впровадження цифрової валюти. У 2023 році було проведено 7,91 млрд безготівкових операцій на загальну суму 6,14 трлн грн, а в 2024 році за перші дев'ять місяців операції досягли 6,4 млрд грн із сумою 4,79 трлн грн, що свідчить про приріст на 7,72 % за кількістю та 4,45 % за обсягом порівняно з аналогічним періодом 2023 року. У 2024 році відсоток безготівкових операцій у загальному обсязі платежів зріс до 94,5 % за кількістю та 64,81 % за сумою. Висновки дослідження показують, що для успішного впровадження цифрової валюти в Україні необхідно продовжувати вдосконалювати платіжну інфраструктуру та реалізувати заходи щодо забезпечення безпеки та прозорості фінансових транзакцій

Ключові слова: грошові операції; платіжна система; платежі; макроекономічна стабільність; монетарна політика

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 339.92
DOI: 10.63341/econ/2.2025.54

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Research and analysis of opportunities for regional economic integration among the countries of the Organization of Turkic States

Abstract. This study was conducted to develop a comprehensive model of economic integration among the member countries of the Organization of Turkic States. The model takes into account inter-industry relationships that contribute to the economic development of the region. The use of statistical and comparative analysis of economic indicators from both member countries and regional cooperation partners enabled the assessment of integration potential and the identification of key pathways for its deepening. The results of the study demonstrated that analysis of the economic development of the member countries of the Organization of Turkic States reveals steady growth in gross domestic product, despite global economic shocks. It was found that these countries have been able to maintain economic stability through the rational use of domestic resources, development of the energy sector, attraction of foreign investment, and diversification of their economies. A comparison of economic growth rates between the member states of the Organization of Turkic States and those of the European Union indicates that, although the level of gross domestic product per capita in the Turkic states remains lower, these countries possess significant potential to enhance this indicator through further infrastructure development, support for entrepreneurship, and gradual integration into the global economy. Based on the findings, a comprehensive model of economic integration among the member states of the Organization of Turkic States has been developed, demonstrating strong potential to boost trade activity and foster regional economic growth. The analysis confirmed that integration in areas such as reducing trade barriers, improving transport infrastructure, and encouraging investment can significantly facilitate the mutual exchange of goods and services. The results indicated that strengthening economic cooperation will contribute to the sustainable development of the member countries of the Organization of Turkic States. This will ensure the effective use of shared economic potential, expand investment opportunities, enhance competitiveness in international markets, and create favourable conditions for the integration of trade initiatives

Keywords: international trade; infrastructure development; investment opportunities; economic competitiveness; intergovernmental initiatives

Article's History: Received: 19.02.2025; Revised: 09.05.2025; Accepted: 27.06.2025

Suggested Citation:
Hasanova, J., & Najafova, K. (2025). Research and analysis of opportunities for regional economic integration among the countries of the Organization of Turkic States. *Economics of Development*, 24(2), 54-67. doi: 10.63341/econ/2.2025.54.

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INTRODUCTION

The relevance of the study lies in the fact that, in the context of heightened global competition, instability in energy markets, and the need for economic diversification, the countries of the Organization of Turkic States (OTS) are actively seeking new mechanisms for regional cooperation. Their geographical proximity, shared economic interests, cultural and historical ties, and significant resource potential create favourable conditions for the development of multi-level cooperation in the areas of trade, investment, logistics, and energy. An analysis of integration processes within the OTS is both timely and essential for understanding the prospects for economic growth and enhancing the competitiveness of the participating countries within the global system. The research problem centres on identifying the main areas of economic cooperation that can yield the greatest benefit for the participating countries. The issue of strengthening integration in the energy sector is highly relevant, as it supports economic development and contributes to resolving energy security challenges. It is also important to examine mechanisms for attracting investment and increasing trade activity, which are key to ensuring sustainable development and deeper economic integration among the countries.

The study by C. Demir (2022) emphasised the growing strategic importance of the OTS in the Eurasian space and focuses on the role of interstate cooperation as a factor in consolidating the regional influence of the Turkic countries. O. Baghırov (2022) examined the economic potential of the OTS, concentrating on the analysis of the level of cooperation between member and observer countries in the fields of trade, transport, and energy. The researcher also identified directions for the further expansion of economic interaction aimed at strengthening the organisation's economic role. Scholars A.F. Çetinkaya & N. Demirel (2023) conducted a study on the possibilities of regional economic integration among the OTS countries, with a focus on the impact of the organisation's formation on trade between its members. Their research underlined the significance of integration and cooperation in strengthening economic ties and enhancing trade relations among the countries. In the study by M. Akçapa (2023), it was noted that the OTS is a key regional institution for the Turkic world. Changes in the international system and regional developments have heightened its importance, particularly for countries such as Azerbaijan, Kazakhstan, Kyrgyzstan, and Uzbekistan. Each of these states possesses distinct strategic advantages – most notably, Turkey's regional power and Azerbaijan's energy resources. Consequently, for the organisation to be effective, it is crucial that the more influential countries join forces. K. Vorisova & M. Nazirov (2023) examined the formation and evolution of the OTS, analysing key stages in its development and the impact of decisions made by national leaders on the organisation's transformation. They paid particular attention to the dynamics of cooperation among member states, assessing the current state and potential for further economic and political integration within the organisation.

In turn, N. Aktaş & N. Demirel (2021) noted that thirty years of cooperation, based on a shared cultural heritage, have led to the establishment of several platforms for interaction. The OTS has become an important international entity, gaining increasing significance as a player in the Eurasian arena due to the strengthening of cooperation among the Turkic countries. Their study explored the prospects of the organisation in the context of balancing regional forces in Eurasia and its status as a significant international actor with long-term strategic interests. E. Aydilek (2022) analysed the growing influence of international organisations, highlighting their role in promoting peace, security, and prosperity, as well as in fostering intergovernmental relations. The study examined the current potential and future prospects of the OTS within the framework of global and regional relations, particularly considering its historical foundations and the military and economic potential of its member states. The scholar D. Necati (2022) investigated the strengthening of cooperation among the Turkic countries within the framework of the OTS, with a particular focus on the organisation's role in the geopolitical context. The study also considered competition with China and India, and how these dynamic impacts the global balance of power. J. Hasanova & K. Najafova (2024) assessed the interaction between the EU and Azerbaijan in the context of energy relations, particularly in relation to gas production and transit. Their work emphasised the strategic importance of Azerbaijan as a key energy supplier for the EU.

The complex impact of economic integration among the OTS countries on the development of regional cooperation remains insufficiently studied. Most existing research focuses on individual aspects – such as trade or energy – while overlooking the interrelationships between various areas of cooperation. The absence of a systematic approach to analysing integration processes limits the understanding of this cooperation's potential to promote economic growth, ensure energy security, and enhance global competitiveness. This creates gaps in the implementation of new approaches to assessing regional integration opportunities, which would otherwise consider a broad range of economic, geographical, and resource-related factors. The study aimed to determine the potential for regional economic integration among the OTS countries. To achieve this goal, it was necessary to analyse the dynamics of economic growth in the OTS countries – specifically gross domestic product (GDP) and GDP per capita – in comparison with EU countries; to examine the role of private consumption and investment in driving economic growth in these states; to assess the impact of net exports on the GDP of Kazakhstan and Azerbaijan; and to develop a comprehensive integration model that accounts for inter-industry linkages and fosters stable economic growth across the region.

MATERIALS AND METHODS

To achieve the objective of the study, a comprehensive analysis of the economic development of the OTS member countries was conducted. This included a comparison of their GDP, growth rates, and economic stability in the context of global economic shocks. The analysis of the economic structure of the OTS countries involved examining the role of the private sector and urbanisation in economic development. For this purpose, statistical data from the World Bank (n.d.a; n.d.b), the United Nations Statistics Division (n.d.), and the United Nations Economic Commission for Europe (n.d.) were utilised. These sources enabled

an assessment of the economic structures of the member states and the identification of how these factors influenced GDP growth and socio-economic indicators.

A comparative analysis was also carried out to evaluate the growth rates of the OTS economies and their GDP per capita in relation to selected EU countries – specifically Poland, Bulgaria, and Romania – using data from the International Monetary Fund (2025). This analysis focused on macroeconomic stability indicators and development trends. Furthermore, it was determined which economic development factors are most significant for the OTS countries when compared to the more developed economies of the EU.

To assess the role of private consumption and investment in supporting economic growth, their impact on the GDP of Kazakhstan and Azerbaijan was analysed – particularly by identifying mechanisms that either promote or constrain the effectiveness of investment projects in both countries. The study also examined the impact of net exports on the economic stability of OTS countries, using statistical data from sources such as Trading Economics (Turkmenistan unemployment rate, n.d.) and the UN Comtrade Database (n.d.). This allowed for an objective assessment of the significance of the export-import balance within the macroeconomic development structures of the participating states.

Geopolitical risks and global economic shocks were taken into account as factors potentially affecting the economic situation of the OTS. The analysis of these risks enabled the identification of possible vulnerabilities in the economies of member states arising from global crises and external pressures. It also made it possible to outline areas for enhancing economic resilience – specifically, through the diversification of foreign trade, reducing dependence on individual markets and resources, and expanding intra-regional cooperation.

The development of a comprehensive integration model – taking into account inter-sectoral relationships and contributing to the region's sustainable economic development – was conducted following the analysis of statistical indicators such as GDP, imports, and exports within the OTS countries. This process also incorporated insights from the International Monetary Fund (Transcript of press briefing..., 2024), which underscores the importance of regional trade and structural reforms, as well as principles outlined on the European Commission (2022) concerning economic integration – namely, the harmonisation of standards, regulatory simplification, and the development of a common market. The purpose of developing this model was to identify effective mechanisms for deepening economic integration among the OTS member countries, thereby optimising trade and investment processes and strengthening regional cooperation. To this end, an analytical approach was employed, incorporating the study of macroeconomic indicators, analysis of foreign trade dynamics, and evaluation of the effectiveness of existing trade agreements.

RESULTS AND DISCUSSION

To understand the economic trends of the member and observer countries of the OTS, it is essential to consider not only GDP growth rates but also the key factors that influence them. Table 1 presents the dynamics of GDP in these countries, taking into account critical indicators of economic sustainability, such as growth in energy exports, infrastructure investment, and levels of domestic demand. This approach enabled a more comprehensive assessment of their economic resilience and development prospects.

Table 1. GDP growth rates of OTS member and observer countries, taking into account key factors of economic sustainability (%)

Countries	Average score 2010-2018	2019	2020	2021	2022	2023	2024	Key factors influencing GDP
Members								
Azerbaijan	1.7	2.5	−4.3	5.6	4.6	1.12	2.3	Growth of energy exports, infrastructure investments
Kazakhstan	4.5	4.5	−25	4.3	3.2	5.1	4.8	Raw material orientation, stable foreign investments
Kyrgyzstan	4.1	4.6	−8.4	6.2	7	6.15	5.9	Labour migration, dependence on remittances, support for small businesses
Turkey	6.4	0.8	1.9	11.4	5.6	5.11	4.6	High domestic demand, developed exports
Uzbekistan	6.6	6	2	7.4	5.7	6.29	6.1	Reforms, attraction of foreign investments, expansion of trade
Observers								
Hungary	2.6	4.9	−4.5	7.2	4.6	−0.91	1.5	Dependence on the EU, internal political fluctuations, external markets
Turkish Republic of Northern Cyprus (TRNC)	3.2	0.2	−16.2	3.9	...	...	...	Political non-recognition, limited market access
Turkmenistan	9	6.3	−3.4	4.6	1.8	6.3	3.9	Energy exports
Average	5.5	1.7	0.8	9.6	5.1	3.6	4.74	

Source: created by the authors based on World Bank (n.d.b)

According to Table 1, the average real GDP growth rate of the full member countries of the OTS in 2021 was 9.6%. This substantial increase reflects an active economic recovery following the recession caused by the COVID-19 pandemic. The marked acceleration in growth in Kyrgyzstan, Turkey, and Uzbekistan can be attributed to a combination of factors, including increased domestic consumption, expansion of exports, state business support programmes, and the effective implementation of anti-crisis measures. In Turkey, government stimulation of domestic demand played a key role; in Kyrgyzstan, growth was supported by an increase in private remittances from abroad; while in Uzbekistan, the liberalisation of foreign trade and the activation of investment policy had a positive effect.

In 2022, the average GDP growth rate for member countries declined to 5.1%, indicating a slowdown in economic development amid global economic turbulence, rising energy prices, and disrupted logistics chains. Nevertheless, this rate remained above the global average, suggesting the relative resilience of the OTS member economies. The most significant positive contributions to sustaining growth came from countries with established foreign economic relations, diversified export structures, and active engagement in regional integration initiatives (Ihnatenko *et al*., 2023).

The total GDP of the OTS countries reached a record level in 2022, highlighting sustained positive growth dynamics. Between 2010 and 2022, the group's combined GDP nearly doubled, a result of increased investment, stabilisation of macroeconomic indicators, and support for small and medium-sized enterprises. In 2023, the economic situation deteriorated for some countries. For instance, Hungary recorded a decline in GDP due to high inflation, tight monetary policy, and reduced demand from the EU. The TRNC, facing political uncertainty and limited access to international financial markets, continues to exhibit unstable economic performance. The most significant decline was observed in the tourism sector, contributing to overall economic contraction. Recovery in the TRNC remains slow, hindered by weak economic diversification and dependence on foreign aid.

However, countries with full membership in the OTS – such as Uzbekistan, Kyrgyzstan, and Turkey – continue to demonstrate stable economic growth, even in the face of external shocks. This can be attributed to the broader institutional support available to full members within the OTS, their participation in joint infrastructure projects, access to preferential trade regimes, and greater attractiveness to foreign investors. Consequently, the differences in GDP dynamics between full members and observer states are, in part, due to the degree of their integration into the organisational structures of the OTS and the extent to which they benefit from the opportunities provided by this platform.

The growth rates of the OTS member countries and their levels of GDP per capita are important indicators for comparing regional economic development. Analysing these indicators in the context of the OTS, and comparing them with those of EU countries, allows for a comprehensive assessment of the economic progress of both regions. Such an analysis helps identify development strengths and weaknesses, as well as the key factors that either facilitate or hinder further economic growth. This, in turn, is essential for formulating evidence-based economic policy recommendations and long-term development strategies for each region. Table 2 presents comparative data on the GDP and GDP per capita levels of the OTS member countries and selected EU countries.

Table 2. GDP and GDP per capita of OTS member countries and selected EU countries (Poland, Bulgaria, and Romania) for 2023-2024

Countries	GDP at current prices (billion USD)		GDP per capita (USD)	
	2023	2024	2023	2024
Azerbaijan	85.3	89.0	8,250	8,600
Kazakhstan	237.0	245.7	11,852	12,150
Kyrgyzstan	12.1	13.4	1,680	1,743
Turkey	955.6	980.2	10,986	11,258
Uzbekistan	89.5	93.8	2,386	2,480
TRNC	3.1	3.2	…	…
Turkmenistan	80.2	82.1	8,801	8,956
Hungary	190.5	194.2	18,742	18,965
Poland	796.1	812.5	20,251	20,891
Romania	325.8	339.6	16,583	17,153
Bulgaria	95.2	98.4	14,301	14,790

Source: created by the authors based on World Bank (n.d.b)

An analysis of the levels of economic development of the OTS countries compared to selected EU member states reveals significant disparities in both total GDP and per capita income. Turkey continues to occupy a leading position among the OTS members, exhibiting stable economic growth and a diversified economic structure. Kazakhstan also demonstrates high performance, reflecting its substantial potential stemming from abundant natural resources and large-scale infrastructure projects. By contrast, the economies of Kyrgyzstan and Uzbekistan remain less developed, as indicated by lower levels of population well-being. This reflects the existence of structural barriers such as low productivity, limited industrialisation, and restricted access to investment. Nevertheless, these countries show encouraging growth dynamics, which may suggest gradual economic progress under conditions of effective reform implementation.

Hungary, Poland, Romania, and Bulgaria – as representatives of the EU – exhibit higher socio-economic standards. This can be attributed to their deeper integration into

European markets, consistent macroeconomic policies, and the development of high-tech industries. Comparisons with these countries offer valuable benchmarks for the OTS states in terms of enhancing competitiveness, attracting investment, and modernising their economies. The role of private consumption and investment in driving economic growth in the OTS member countries was further examined, alongside the impact of net exports on the GDP of Kazakhstan and Azerbaijan.

Net exports are a key driver of economic growth in the OTS region, particularly in resource-rich countries such as Kazakhstan (Kazakhstan economic data..., n.d.) and Azerbaijan (World Integrated Trade Solution, 2022). In Kazakhstan, where oil and gas constitute a significant share of GDP, net exports are crucial for maintaining a positive economic balance. However, economic growth slowed to 3.2% in 2022, due to a deceleration in critical sectors, including oil production and general industrial output.

Turkey has shown considerable resilience to external economic shocks, recording growth of 11.4% in 2021 (World Bank, n.d.a). Nonetheless, the earthquakes in 2023 had a substantial adverse effect on the country's economy, leading to a decline in GDP and export growth due to the redirection of financial resources towards reconstruction efforts. Uzbekistan has maintained steady growth, driven by private sector activity and structural reforms, registering a 5.7% increase in GDP in 2022. However, its economy remains dependent on remittances, which account for approximately 13% of GDP (German Economic Team, 2023).

Overall, the study highlights the significant role of private consumption and investment in supporting economic growth among the OTS member states. This influence is particularly evident when considered alongside net exports, which have a pronounced impact on GDP – especially in Kazakhstan and Azerbaijan. To gain a deeper understanding of the economic processes within both OTS member and observer countries, Table 3 presents the distribution of economic sectors in the GDP structure of these states. This allows for an assessment of which sectors dominate in each country and how their development influences the broader economic situation across the region.

Table 3. Share of economic sectors in the GDP structure of OTS member and observer countries (%)

Year	Country	Agriculture	Industry (non-manufacturing)	Industry (manufacturing)	Services
Members					
1990	Azerbaijan	29.7	13.6	19.3	37.4
2010		5.9	59	5.1	30
2021		6.4	45.4	7.5	40.7
2022		5	55.4	6	52
2023		6.1	44.5	8.1	49.2
2024		6.3	45.0	8.0	50.7
1990	Kazakhstan	31.8	17.3	7	43.9
2010		4.7	30.3	11.7	53.4
2021		5.4	22.9	14.8	56.9
2022		5.6	16.1	29.5	48.6
2023		4.7	17.7	35.1	52.4
2024		4.5	17.2	36.4	52.5
1990	Kyrgyzstan	33.6	10.5	27.6	28.3
2010		18.8	10.1	18.1	53
2021		15.3	14.2	14.4	56.1
2022		12.8	15.3	22.5	49
2023		11.6	14.8	27.2	51.7
2024		11.1	14.5	26.5	48.3
1990	Turkey	14	10.3	28.3	47.4
2010		10.2	10.7	17.1	62
2021		6.2	10	24.8	59
2022		9.3	10.8	30.4	53.1
2023		7.2	12.3	32.8	48.3
2024		7.1	12.1	33.5	47.5
1990	Uzbekistan	33	19.9	16.6	30.5
2010		30.3	12.4	11.5	45.7
2021		26.1	12.6	20.9	40.4
2022		25	27	12.1	47.8
2023		24.3	26.1	12.3	48.6
2024		23.5	25.3	12.1	39.5

Table 3. Continued

Year	Country	Agriculture	Industry (non-manufacturing)	Industry (manufacturing)	Services
Observers					
1990	Hungary	12.9	14.8	20.1	52.2
2010		3.6	8.4	21.3	66.7
2021		4	8.6	20	67.4
2022		3.7	22.2	25.6	50.6
2023		3.2	23.3	26	47.6
2024		3.1	22.8	26.5	47.7
1990	TRNC	5.6	9.9	2.2	82.3
2010		5.5	10.8	2.8	80.9
2021		8.3	12.8	3.7	75.2
2022		–	–	–	–
2023		–	–	–	–
2024		–	–	–	–
1990	Turkmenistan	32.3	4	25	38.7
2010		11.5	12.9	47	28.5
2021		11.1	9.6	35	44.3
2022		10	8.5	28.7	40.5
2023		10.4	9.7	30.6	39.8
2024		10.2	9.5	31.4	39.3

Source: created by the authors based on United Nations Statistics Division (n.d.), United Nations Economic Commission for Europe (n.d.)

According to the table, the GDP structure of various OTS member countries has undergone significant changes between 1990 and 2024. In 1990, agriculture accounted for a substantial share of GDP in countries such as Azerbaijan and Kazakhstan. However, by 2024, this share has declined markedly. This trend reflects the transformation of the agricultural sector in these countries and a gradual shift towards a more diversified economic model. Notably, there has been an increasing emphasis on industrial development – particularly in non-manufacturing sectors – and a growing contribution from the service sector, which has emerged as a key driver of economic growth. In both Kazakhstan and Azerbaijan, the share of industry within GDP has risen significantly. In Kazakhstan, the shift has been towards the manufacturing sector, resulting in a notable increase in its contribution to GDP (Tleubayev *et al.*, 2024). In contrast, Azerbaijan's industrial growth has been driven primarily by the expansion of the oil and gas sector and the attraction of foreign investment in extractive industries, leading to an increased share of non-manufacturing industry in the economy (Ismayilov *et al.*, 2024).

Meanwhile, in countries such as Hungary, Turkmenistan, Turkey, and Uzbekistan, the share of the manufacturing sector has remained consistently high over recent decades. This is largely attributable to a strong policy focus on industrial development, sustained investment in manufacturing, and the adoption of export-oriented economic strategies. As a result, these countries have succeeded in maintaining robust performance within the manufacturing sector.

One of the significant factors influencing the economic structure of a country is the services sector. The share of services in GDP has increased considerably, reflecting the active development of this sector in the OTS member states, where it now plays a pivotal role in shaping their economic structure. For example, in Hungary, the share of services in GDP reached 67.4% in 2021, driven by the active digitalisation of the economy, integration into European markets, and the development of information technology, financial services, and small business sectors. These factors have contributed to a strategic shift towards economic modernisation and the adoption of innovations in areas such as technology, finance, education, and entrepreneurship.

A clear trend can be observed across nearly all countries under analysis: the declining share of agriculture in GDP. The notable exception is Uzbekistan, where agriculture continues to be a significant component of the economy. Although the sector's contribution to GDP has declined from 33% in 1990 to 23.5% in 2024, it remains higher than in other OTS countries. This trend reflects broader developments such as rising urbanisation, the expansion of manufacturing industries, and the growth of the services sector. Together, these changes are enabling countries to reduce their dependence on agricultural production and move towards more diversified economic structures. To better understand broader economic trends within the OTS countries – particularly in relation to inflation – it is important to consider average consumer price indicators. Figure 1 illustrates changes in inflation across OTS member states, offering a basis for comparing economic processes and assessing the level of price stability across different countries.

The inflation rate in the OTS countries from 2010 to 2024 reflects several important economic trends. Between 2010 and 2016, inflation remained relatively stable, fluctuating within moderate levels – an indication of overall economic stability and effective inflation control. However, starting in 2017, inflation began to rise gradually, largely due to increasing prices for energy resources, food products, and raw materials, alongside broader global economic shifts. The most significant surge occurred in 2021 and

2022, when inflation increased sharply as a result of the COVID-19 pandemic, disruptions in global supply chains, soaring energy prices, and geopolitical tensions – particularly the war in Ukraine (Kucher & Mazurenko, 2024).

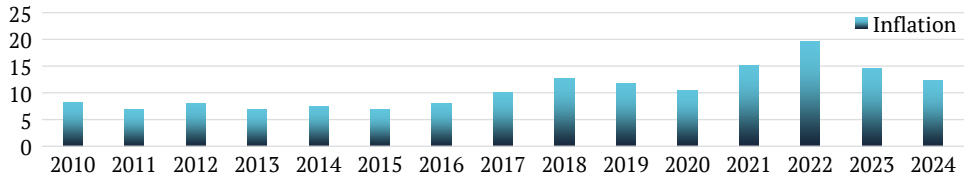

Figure 1. Inflation: average consumer prices in OTS member countries, 2010-2024 (%)
Source: created by the authors based on International Monetary Fund (2025)

In 2023, the inflation rate declined to 14.46%, suggesting some improvement in the economic situation, driven by supply chain stabilisation and the partial easing of global economic shocks. Nevertheless, inflation remained elevated. By 2024, the inflation rate further decreased to 12.31%, reflecting partial economic stabilisation, especially improvements in supply chain logistics and more balanced economic policies. Despite these positive developments, inflation continues to remain high, primarily due to persistently elevated energy prices and other external economic pressures. To better understand the financial condition of the OTS member states and to assess their broader economic stability, it is essential to examine data on government budgets and public debt. Table 4 provides an overview of these indicators.

Table 4. State budget balance and public debt in OTS member and observer countries, 2019-2024 (% of GDP)

Country	State budget balance/GDP						Gross government debt/GDP					
	2019	2020	2021	2022	2023	2024	2019	2020	2021	2022	2023	2024
Members												
Azerbaijan	9.0	−6.7	4.1	6.1	6.7	5.8	17.7	21.3	26.4	17.3	18.2	18.0
Kazakhstan	−0.6	−7.0	−5.0	0.1	−0.1	0.2	19.9	26.4	25.1	23.5	23.4	22.8
Kyrgyzstan	−0.1	−3.3	−0.8	−1.3	–	−0.5	48.9	63.6	56.2	49.2	47.0	45.5
Turkey	−4.8	−5.1	−4	−1.6	−1.1	−1.2	32.6	39.7	41.8	31.2	33.4	34.3
Uzbekistan	−0.3	−3.3	−4.6	−3.9	–	2.5	28.5	37.4	36.6	34.9	35.1	34.5
Observers												
Hungary	−2	−7.5	−7.1	−6.1	−5.4	4.9	65.3	79.3	76.8	76.4	64.5	63.2
TRNC	3.3	−5.7	−3.2	–	–	–	–	–	–	–	–	–
Turkmenistan	−0.3	−0.1	0.4	0.9	1.2	1.4	15.3	13.1	10.1	5.8	5.1	4.9

Source: created by the authors based on International Monetary Fund (2024; 2025)

An analysis of the table reveals significant variation in the state budget balance and public debt levels among the OTS member and observer countries. Azerbaijan has maintained a stable positive budget balance alongside a low debt burden, reflecting sound and effective fiscal policy. In contrast, Kazakhstan and Turkey have experienced chronic budget deficits and elevated debt levels, particularly during periods of economic crisis. Kyrgyzstan and Uzbekistan exhibit moderate budget deficits accompanied by relatively high public debt, highlighting the need to enhance fiscal sustainability and improve public financial management. Hungary continues to carry a high level of public debt, whereas Turkmenistan demonstrates a positive budget balance and a gradual reduction in public debt, suggesting a degree of relative financial stability. In addition, the unemployment rate in OTS member countries for the period 2019 to 2024 has been examined, providing insight into how labour market trends correlate with broader economic developments across the region. Figure 2 illustrates changes in unemployment levels, enabling a more detailed assessment of the economic situation in each country.

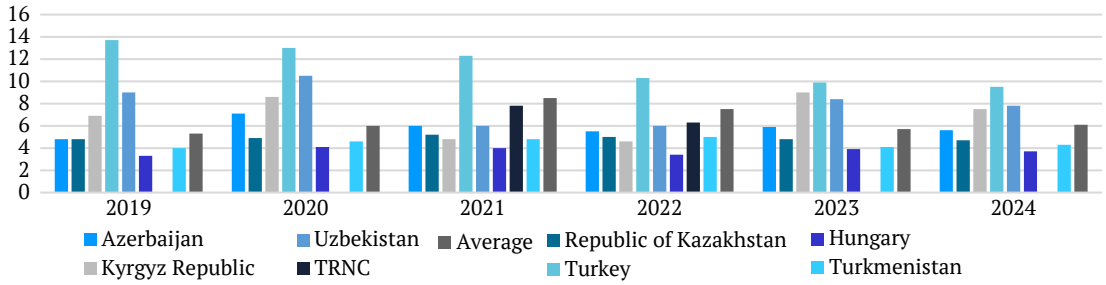

Figure 2. Unemployment rate in OTS member countries, 2019-2024 (%)
Source: created by the authors based on International Monetary Fund (2024; 2025), Turkmenistan unemployment rate (n.d.)

An analysis of the dynamics of unemployment rates in OTS member and observer countries between 2019 and 2024 reveals a general trend of gradual decline following a sharp rise in 2020, which was driven by the economic consequences of the COVID-19 pandemic. In several countries – such as Turkey, Kazakhstan, and Uzbekistan – a consistent decrease in unemployment has been observed, reflecting economic stabilisation, the recovery of domestic demand, and increased investment activity. For instance, in Turkey, the unemployment rate fell from 13.7% in 2019 to approximately 9.5% in 2024, largely as a result of the revitalisation of national production, support programmes for small businesses, and employment-focused reforms.

Conversely, Kyrgyzstan experienced a significant increase in unemployment, reaching 9.0% in 2023 after a period of relative stability (Bekmuratov *et al.*, 2024). This rise is likely attributable to macroeconomic imbalances, limited economic diversification, and a strong dependence on external remittances. In countries such as Turkmenistan and Hungary, the unemployment rate has remained relatively low and stable. This can be explained by the controlled nature of their labour markets, state regulation of employment, and targeted support for key industries. However, structural mismatches between the education system and labour market requirements, along with limited access to quality employment for young people, continue to pose long-term challenges.

According to calculations based on official statistics from the International Monetary Fund (2024), the economies of the OTS countries significantly expanded their participation in international trade between 2015 and 2024. This reflects their growing integration into the global economy. The total export potential of these countries in goods and services rose from USD 420.4 billion in 2014 to USD 730 billion in 2024. Despite this substantial increase, the share of these exports in total global trade has remained relatively stable. These figures confirm a steady trend of gradual growth in international trade activity among the OTS countries, thereby enhancing their presence and influence in the global economic arena (Fig. 3).

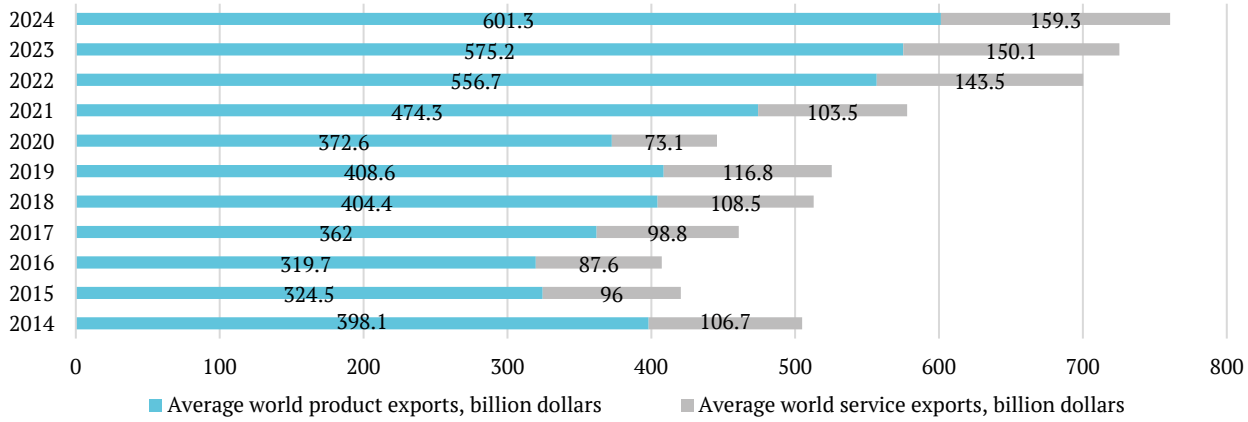

Figure 3. Exports of the OTS group of economies, 2014-2024 (regional level, billion USD)
Source: created by the authors based on International Monetary Fund (2024)

Throughout 2024, the OTS countries continued to actively integrate into the global economy, demonstrating a notable increase in export performance. This growth in the export of goods and services reflects both the stable development of their economies and their expanding engagement in international trade. Notably, approximately 59.3% of goods exported from OTS economies were directed to Europe, making it the primary destination for their export activity. Asia was the second largest export region, accounting for around 28.3% of total goods exports (Fig. 4).

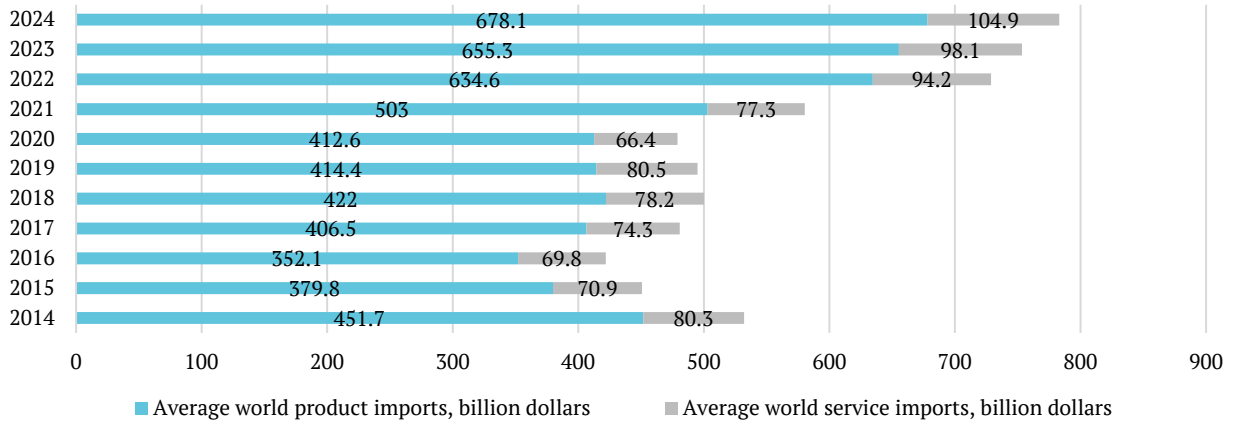

Figure 4. Imports of the OTS group of economies, 2014-2024 (regional level, billion USD)
Source: created by the authors based on International Monetary Fund (2024)

Throughout 2024, the OTS countries continued their active engagement in international trade, demonstrating strong performance in both imports and exports of goods and services. The average global import of goods reached USD 678.1 billion, while imports of services totalled USD 104.9 billion. Notably, Turkey accounted for 56% of the total import flow among OTS countries, underscoring its pivotal role in global trade and in the economic framework of the group. Hungary ranked as the second-largest exporter within the OTS, with total exports amounting to USD 181.3 billion.

In terms of export performance in 2024, Kazakhstan maintained its leading position, contributing 10.6% of the total exports of goods and services from the OTS region. It was followed by Azerbaijan, Uzbekistan, Turkmenistan, and Kyrgyzstan. These figures reflect the diverse economic contributions of individual countries to the region's overall export capacity, highlighting sectoral strengths and leading roles in various domains. Overall, these results illustrate the increasing significance of the OTS countries in international trade. Turkey serves as the principal importer, while other member states – such as Hungary and Kazakhstan – hold leading positions in different segments of the export landscape. Furthermore, Table 5 presents data on the volume of international trade across the OTS member economies, offering insight into key trends and the influence of trade flows on their economic development.

Table 5. Value of international trade by OTS country economies, 2019-2024 (billion USD and %)

Volume of exports of goods and services, %						Country	Volume of imports of goods and services, %					
2019	2020	2021	2022	2023	2024		2019	2020	2021	2022	2023	2024
23.4	16.4	26	44.6	52.3	54.5	Azerbaijan	20	16.2	17.6	22.3	24.7	25.9
65.4	52.1	65.7	90.9	97.4	100.2	Kazakhstan	50	46.6	50	60.5	65.9	68.1
3	2.4	2.2	2.8	3.5	3.8	Kyrgyzstan	5.9	4.3	6.3	10.4	12.7	13.5
248	207.9	286.66	344.5	366.2	380.1	Turkey	239	243.4	301	404.1	427.8	440.1
17.2	14.8	16.4	20.2	22.7	24.3	Uzbekistan	27.3	23.5	28.8	35.5	37.2	39.4
153.9	143.3	168.7	181.3	193.4	198.7	Hungary	142.8	134.1	164	185.3	192.4	198.5
0.083	0.106	0.135	...	...	...	TRNC	1.6	1.3	1.6	...	...	...
14.3	8.7	12.1	16	18.6	19.8	Turkmenistan	8.3	9.5	11.1	9.4	10.3	10.9

Source: created by the authors based on International Monetary Fund (2024; 2025)

Between 2019 and 2024, the OTS countries demonstrated increasing activity in international trade, as evidenced by the steady growth in both exports and imports of goods and services. Notably, countries such as Azerbaijan, Kazakhstan, Turkmenistan, and Hungary consistently maintained a positive trade balance, indicating enhanced export potential and growing competitiveness in international markets. In Azerbaijan's case, there was a marked increase in export volumes, largely attributable to the country's expanding role in energy supplies to the EU following the onset of geopolitical tensions in 2022 (Hamidova & Samedova, 2024). This trend was reinforced by the signing of a memorandum on energy cooperation with the EU, which served as a catalyst for further export growth – particularly in the supply of natural gas to European markets.

Kazakhstan also displayed stable export growth, alongside a modest rise in imports. This pattern may be linked to the country's active efforts to diversify its foreign economic partnerships. Turkey, as the leading OTS country in terms of overall trade volume, continued to demonstrate strong growth in both exports and imports, reflecting the deep integration of its economy into global markets. Meanwhile, Kyrgyzstan and Uzbekistan recorded moderate export growth, but experienced a rapid increase in imports. This trend is likely due to their growing integration into global production chains, particularly through increased trade with China.

Overall, these trends reflect positive developments in the foreign trade activities of the OTS countries, highlighting their expanding trade relations at both regional and global levels. An analysis of the export structure of the OTS member states provides insight into the degree of economic diversification and their dependence on specific goods and resources. Accordingly, Figure 5 illustrates the export diversification of the OTS member countries in 2024, showing the share of major commodity groups in total export volumes.

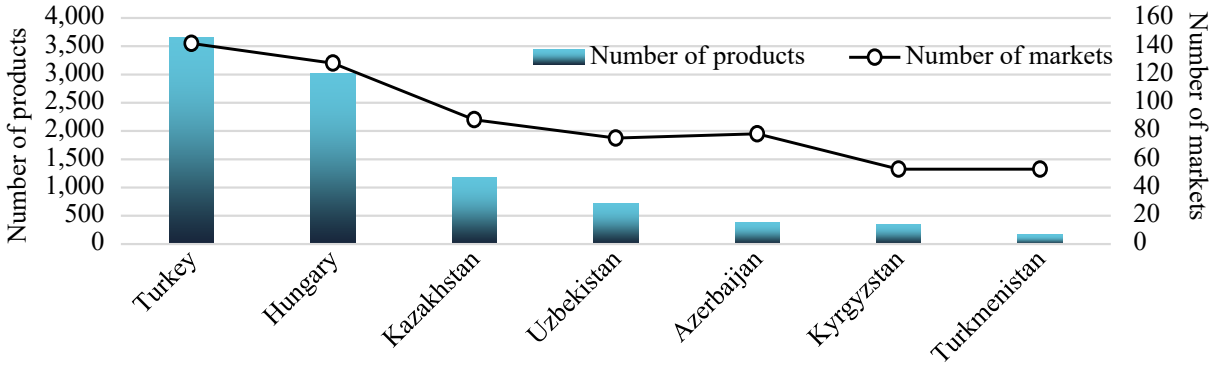

Figure 5. Export diversification of OTS participating countries in 2024 (number of product categories)
Source: created by the authors based on UN Comtrade Database (n.d.)

The structure of export activity among the OTS countries reveals significant differences in the level of diversification. Turkey and Hungary exhibit the highest degrees of integration into global trade. Forecasts for the coming year suggest that Turkey will enter a wide range of international markets with a broad spectrum of exported products, while Hungary is expected to access a similarly large number of markets, exporting several thousand product lines. In contrast, Central Asian countries such as Kyrgyzstan, Turkmenistan, Azerbaijan, and Uzbekistan continue to export a much narrower range of products to a more limited set of markets. Specifically, Turkmenistan maintains trade with relatively few markets and a restricted export product base, while Kyrgyzstan exports to an even smaller number of destinations with fewer product lines. These disparities can be partly attributed to the commodity-based nature of their export structures.

In Azerbaijan, for example, approximately 90% of exports between 2020 and 2022 were concentrated in the energy sector; similarly, in Kazakhstan, this figure exceeded 58% (UN Comtrade Database, n.d.). Meanwhile, the economies of Uzbekistan and Kyrgyzstan remain heavily reliant on gold exports, which constitute more than one-third of their total export volumes. This limited product diversification and dependence on raw materials pose challenges for economic resilience and hinder broader export expansion. Addressing this issue will require comprehensive structural reforms aimed at broadening the export base and enhancing competitiveness in international markets. To evaluate the level of economic integration and trade interaction among OTS member countries, it is essential to examine their respective shares in intra-regional trade. Accordingly, Table 6 presents data on the share of each country in the total volume of internal trade within the OTS region.

Table 6. Shares in intra-regional trade of OTS member and observer countries (%)

Country	Exports of goods (average for 2014-2024)	Exports of services (average for 2014-2024)
Members		
Kyrgyzstan	3.0%	5.1%
Turkey	40.0%	68.1%
Kazakhstan	22.4%	8.5%
Uzbekistan	12.3%	7.2%
Azerbaijan	11.5%	4.4%
Observers		
Hungary	12.9%	9.2%
Turkmenistan	3.2%	5.3%
TRNC	0.5%	…

Source: created by the authors based on UN Comtrade Database (n.d.)

Between 2014 and 2024, Kazakhstan and Turkey consistently maintained leading positions in intra-group exports and imports among the OTS countries. Turkey remained the dominant actor in regional trade, accounting for over 40% of goods exports and 68.1% of services exports, underscoring its pivotal role in shaping economic flows within the region. Kazakhstan, contributing 22.4% of intra-regional exports, also played a key role in the OTS economy and made a substantial contribution to regional trade dynamics. Alongside Uzbekistan, Azerbaijan, and Hungary, these countries collectively accounted for 36% of total trade flows within the group, highlighting their significance in fostering economic integration across the OTS.

The development of a comprehensive integration model that accounts for cross-sectoral interconnections represents a critical step towards achieving sustainable economic development in the OTS region. In the current context of globalisation and heightened economic competition, countries in the region face increasing pressure to integrate more effectively into global markets, optimise domestic economic processes, and pursue strategies that promote long-term growth. In response to these challenges, a model for assessing economic processes was developed using analytical tools and econometric methods. This model enables the incorporation of global economic trends into the analysis of regional development, supporting the evaluation of the OTS countries' progress towards deeper integration with the world economy.

The integration model for the OTS countries outlines a comprehensive set of measures aimed at strengthening economic cooperation and enhancing the efficiency of trade and investment processes across the region. A key pillar of this model is trade liberalisation, which involves reducing customs barriers, simplifying customs procedures, and harmonising regulatory standards. The implementation of this strategy could be realised through the establishment of a regional Free Trade Agreement (FTA) among the OTS member states, incorporating provisions for the reduction of both tariff and non-tariff barriers. Furthermore, the adoption of a unified customs code would promote greater transparency in foreign economic activities. A critical component of this process is the development of a unified digital customs clearance system, designed to streamline and accelerate cross-border trade operations.

Another central aspect of the integration model is the development of transport infrastructure and the modernisation of trade routes. These measures aim to reduce logistics costs and improve the speed and efficiency of goods movement across the region. A key initiative in this context is investment in the creation and expansion of international transport corridors. This includes the enhancement of railway networks, the upgrading of seaports, and the construction of logistics hubs at strategic regional locations. A particularly important initiative is the development of the "Middle Transport Corridor", which connects China, Central Asia, the Caucasus, and Europe via the Caspian Sea. For this

corridor to operate effectively, it is essential to modernise the railway infrastructure linking Kazakhstan, Azerbaijan, Georgia, and Turkey; increase the capacity of the Aktau and Alat ports; and implement a unified digital cargo tracking system to automate customs and logistics procedures.

Another key aspect of the integration model is the development of transport infrastructure and the improvement of trade routes, which contribute significantly to reducing logistics costs and facilitating the faster and more efficient movement of goods. Enhancing sea, rail, and air connectivity lays a solid foundation for the expansion of foreign trade and improves the accessibility of goods and services for consumers across the OTS countries. An equally important component of the model is the active promotion of e-commerce and the development of digital infrastructure. To unlock the full potential of online trade, it is essential to establish a unified e-commerce platform within the OTS framework. Such a platform would provide an effective mechanism for the exchange of goods and services without geographical limitations. In particular, the adoption of common standards for digital payments and electronic signatures across member states would reduce bureaucratic barriers and significantly accelerate the development of online trade in the region.

To ensure a stable investment climate, it is essential to establish favourable conditions for both domestic and foreign investors. A key step in this direction is the creation of a unified investment space within the OTS, which would involve reducing regulatory barriers, streamlining business registration procedures, and introducing robust mechanisms for the protection of foreign investments. In particular, the conclusion of bilateral investment protection agreements would play a crucial role in attracting capital to strategic sectors of the economy. A separate but equally important area is the role of political stability and security as a foundation for long-term investment. This requires the strengthening of interstate political relations, including the establishment of joint economic councils to coordinate regional development policies. The introduction of a shared economic cooperation programme with a 10-15-year horizon would support the development of a coherent integration strategy, helping to mitigate the risks of short-term political and economic volatility. The proposed integration model for the OTS countries is designed to promote sustainable economic development through enhanced cooperation in key areas: trade, investment, transport infrastructure, and e-commerce. The effective implementation of these components will support stable regional growth, improve competitiveness, and facilitate deeper integration into the global economy – objectives that align with the long-term development needs of the OTS countries in the context of globalisation.

The study of economic integration among the OTS countries is essential for understanding the region's prospects for growth and stability. Scholarly works on this topic focus on analysing the economic potential and mechanisms of interaction between these countries. Particular attention is given to the role of integration in strengthening economic ties, creating new opportunities for trade and investment, and enhancing the region's competitiveness in international markets. The findings of H. Eygü (2022) and D. Donghui (2024) underscored the pivotal role of Turkey in fostering cooperation among the Turkic states through soft power, including cultural and political initiatives, as well as a strategic orientation toward multilateral mechanisms for collaboration in areas such as energy and trade. Their analysis of macroeconomic variables confirms the existence of a long-term relationship between GDP, investment in research and development, and the level of educational attainment – highlighting the significance of these factors for the economic development of the Turkic countries. Additionally, the region's geostrategic position, along with its transport and economic linkages, are identified as key drivers of the Turkic countries' integration into global economic processes (Imrani *et al*., 2021). The results of these studies point to common themes, particularly the need to enhance regional economic cooperation, the importance of investing in research to ensure economic resilience, the critical role of transport infrastructure in connecting with global markets, and the dependence of successful integration on well-developed multilateral relations and harmonious geopolitical cooperation.

Studies by L. Hooghe & G. Marks (2019) and K. Kawasaki & K. Sato (2021) explored issues related to European integration, institutional processes within the Association of Southeast Asian Nations (ASEAN), and broader regional economic integration. These studies offer valuable comparative insights that may be relevant to understanding the integration potential of the OTS countries. Research on the effectiveness of European integration during global crises – such as the eurozone crisis – highlights the crucial role of intergovernmental ties in ensuring regional stability. Similarly, the ASEAN experience, which draws on EU integration practices, offers useful lessons for assessing how the Turkic states might adapt to emerging economic realities and external challenges. Regional economic integration models that prioritise intra-industry trade and cross-border production networks are particularly relevant to this study, as they underscore the importance of shared infrastructure and robust economic linkages for promoting growth among OTS countries. The findings related to sector-specific autonomy within integration processes also point to the need for a nuanced approach that accounts for the unique structural characteristics of each national economy within the region.

In parallel, scholars such as M. Zaman *et al*. (2021) have analysed various approaches to regional economic integration that differ from those applied in the context of the OTS countries. This work emphasised that regionalism is part of a complex developmental trajectory, rather than merely a response to trade barriers, and they place particular focus on political context and institutional frameworks. However, the emphasis on environmental and social dimensions contrasts with the findings of the present study, which centres on economic cooperation and infrastructure development. Moreover, the analysis of investment flows and trade openness policies in these studies reflects differences shaped by the specific trade and investment strategies of the OTS countries.

An examination of research on transport costs, political integration, and regional economic processes also reveals varied methodological approaches to understanding integration. Studies by M. Mustofaev (2022) focused on infrastructure-related factors, particularly the relationship between transport costs and geographical constraints,

often in the context of landlocked countries. In contrast, the current study considered integration processes among OTS countries through both economic and political lenses, treating infrastructure as one component of a broader integration strategy rather than the central focus. This highlights the importance of adopting a multidimensional perspective that incorporates regional specificities when analysing integration models.

The findings of this study differ from those of M. Pangestu & S. Armstrong (2018), whose work focused on social cohesion and integration within the EU, with particular emphasis on the economic and social dimensions of integration. This study examined how economic integration influences the development of social policies, especially in the area of social protection, and stress the importance of policy harmonisation to improve the effectiveness of integration processes. However, it did not address the specific context of integration among the OTS countries, where political and cultural factors play an equally, if not more, critical role. These factors significantly shape the dynamics of interstate cooperation, the capacity for compromise, and the level of mutual trust – elements that are essential to the success of integration initiatives in the region.

Similarly, the study by J. Sekali & M. Bouzahzah (2019) focused on financial integration in Asia and the impact of global and regional shocks on financial markets. While this work offered important insights into the financial dimensions of integration, it largely overlooked the political aspects that are crucial in the context of the OTS countries. Furthermore, although this study explored the relationship between financial development and environmental indicators, it did not directly address economic integration, which formed the core of the present research. Current study proposed a more comprehensive framework for analysing the integration of the OTS countries, incorporating economic, political, and cultural dimensions. It emphasised that the removal of trade barriers and increased investment can significantly enhance economic efficiency across the region. By employing various integration models, it becomes possible to account for both economic and social factors, thereby laying the foundation for a stable and cohesive regional integration platform.

CONCLUSIONS

A comprehensive analysis of socio-economic indicators, foreign trade dynamics, GDP structure, unemployment rates, and fiscal and debt stability across the member and observer countries of the OTS demonstrates that the gradual implementation of the regional economic integration model has created favourable conditions for the intensification of trade relations. The expansion of international trade volumes can be attributed to several key factors, including the reduction of customs tariffs, elimination of regulatory barriers, simplification of cross-border trade procedures, and improvements in the overall investment climate – particularly in countries such as Turkey, Kazakhstan, Azerbaijan, and Uzbekistan.

This positive trend in trade exchange has been supported by active logistical cooperation, including the development of railway corridors, the expansion of sea routes, and the enhancement of air transport infrastructure. These improvements have significantly accelerated export-import operations and increased the competitiveness of regional products. Furthermore, OTS member states have begun to strengthen their positions in global trade supply chains through advances in production technology, diversification of export structures, and the expansion of export markets. For instance, Turkey, Hungary, and Kazakhstan demonstrated a broad range of export products and access to a large number of international markets, whereas other countries such as Kyrgyzstan and Turkmenistan continue to exhibit more limited export diversification.

Regional economic integration efforts have also positively influenced the investment climate within OTS member countries. These developments have fostered increased investment activity and opened up new, profitable business opportunities. Political stability, ensured through the mechanisms of the OTS, serves as a crucial foundation for maintaining investor confidence and securing long-term investments. Moreover, integration into regional economic structures enables member states to create favourable conditions for attracting investment in innovative technologies and strategic infrastructure projects.

As a result, the implementation of regional integration processes within the OTS has not only strengthened economic ties among member states but also established a stable platform for long-term development, enhanced investment attractiveness, and contributed to the harmonisation of trade policies. The growing experience in the field of e-commerce is fostering the creation of a borderless trading environment. It is essential to enhance the user experience for both buyers and sellers, enabling them to navigate and participate in online trading platforms with ease. To support this, dedicated organisations and programmes should be developed to promote e-commerce adoption across OTS countries. Such initiatives would incentivise entrepreneurs to engage in online trade, join regional e-commerce platforms, and contribute to the growth of seamless cross-border commerce.

Among the limitations of the present study is restricted access to comprehensive data on actual economic relations between OTS countries, which constrains the depth of analysis. Another significant limitation lies in the unpredictability of global economic and political developments, which may influence regional integration processes and complicate the assessment of the long-term effectiveness and impact of the proposed measures. Key areas for further research into the potential of regional economic integration among OTS countries include examining the impact of digital technologies – such as blockchain and e-commerce – on the simplification of customs procedures and the facilitation of interstate trade. Future studies could also focus on the development of joint investment projects in strategic sectors, which would enhance economic resilience and foster sustainable growth across the region.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Дослідження та аналіз можливостей регіональної економічної інтеграції країн Організації тюркських держав

Анотація. Це дослідження було проведено з метою розробки комплексної моделі економічної інтеграції країн-членів Організації тюркських держав. Модель враховує міжгалузеві зв'язки, які сприяють економічному розвитку регіону. Використання статистичного та порівняльного аналізу економічних показників як країн-членів, так і партнерів по регіональному співробітництву дозволило оцінити потенціал інтеграції та визначити ключові шляхи його поглиблення. Результати дослідження засвідчили, що аналіз економічного розвитку країн-членів Організації тюркських держав свідчить про стійке зростання валового внутрішнього продукту, незважаючи на глобальні економічні потрясіння. З'ясовано, що ці країни змогли зберегти економічну стабільність завдяки раціональному використанню внутрішніх ресурсів, розвитку енергетичного сектору, залученню іноземних інвестицій та диверсифікації економіки. Порівняння темпів економічного зростання між державами-членами Організації тюркських держав і країнами Європейського Союзу вказує на те, що, хоча рівень валового внутрішнього продукту на душу населення в тюркських державах залишається нижчим, ці країни мають значний потенціал для підвищення цього показника шляхом подальшого розвитку інфраструктури, підтримки підприємництва та поступової інтеграції у світову економіку. На основі отриманих даних було розроблено комплексну модель економічної інтеграції між державами-членами Організації тюркських держав, яка демонструє потужний потенціал для активізації торговельної діяльності та стимулювання регіонального економічного зростання. Аналіз підтвердив, що інтеграція в таких сферах, як зменшення торговельних бар'єрів, покращення транспортної інфраструктури та заохочення інвестицій, може значно полегшити взаємний обмін товарами та послугами. Результати засвідчили, що зміцнення економічного співробітництва сприятиме сталому розвитку країн-членів Організації тюркських держав. Це забезпечить ефективне використання спільного економічного потенціалу, розширить інвестиційні можливості, підвищить конкурентоспроможність на міжнародних ринках, створить сприятливі умови для інтеграції торговельних ініціатив

Ключові слова: міжнародна торгівля; розвиток інфраструктури; інвестиційні можливості; економічна конкурентоспроможність; міждержавні ініціативи

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 336.77:334.012.61
DOI: 10.63341/econ/2.2025.68

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The impact of microcredit on the economic growth of developing countries: Evidence and perspectives from Albania

Abstract. While microcredit has been widely studied in various global contexts, research on its specific impact within Albania remains limited. This study examined the impact of microcredit on economic growth in Albania for the period of 2013-2023. The data retrieved from the World Bank and the Bank of Albania was analysed using the linear regression model to quantify the relationship between microcredit levels and real gross domestic product growth in Albania. The regression results showed a strong positive relationship highlighting the importance of accessible microcredit as an economic driver. The period of 2013-2023 was marked by an increase in the amount of microcredit in millions of euros, as well as the number of borrowers, which indicated the growing popularity of this option in Albania. The introduced findings have policy implications, suggesting that expanding access to microcredit can support Albania's growth objectives by enabling new businesses, creating jobs and increasing economic productivity. Based on comparative analysis of obtained findings and previously conducted research, it was recommended to enhance access to microfinancing options through regulations that facilitate the expansion of microcredit services, tax incentives, or partnerships with international organisations. It was also recommended to enhance equity by providing equal access to financing options for all population groups, including female and minority entrepreneurs. Although this study showed a strong relationship, further research is needed to establish causality and explore complementary factors that influence gross domestic product growth. Overall, the study highlighted the need for supportive financial policies and ongoing research to optimise the role of microcredit in sustainable development

Keywords: gross domestic product growth; poverty reduction; investment decision-making; income equity; employment opportunities; marginalised populations

Article's History: Received: 04.03.2025; Revised: 14.05.2025; Accepted: 27.06.2025

Suggested Citation:
Angjeli, E., Civici, A., & Bombaj, F. (2025). The impact of microcredit on the economic growth of developing countries: Evidence and perspectives from Albania. *Economics of Development*, 24(2), 68-76. doi: 10.63341/econ/2.2025.68.

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INTRODUCTION

Globally, the goal of eliminating poverty has drawn the attention of humanitarian organisations focusing on public security, development, and prosperity. As a result, governments and supporting organisations have worked together to reduce poverty. Poverty persists as a perpetually limiting social dilemma that necessitates appropriate innovations that complement social nature and characteristics, despite efforts made. Microcredits can become a tool to facilitate economic growth, alleviate poverty, and support sustainable development. However, recent academic research misses a unanimous assessment of the impact of microcredit on the economic progress of developing countries.

S.A. Nugraha *et al*. (2024) stressed that governments and non-governmental organisations engage in cooperation aimed to alleviate poverty locally and reduce its rates globally. Poverty persists as a perpetually limiting social dilemma necessitating appropriate innovations that complement social nature and characteristics, despite efforts made. Recent studies, including M.U. Niaz & A.A. Khan (2021), discussed a microcredit's role in fostering entrepreneurship and improving household income in emerging markets. As stressed by T.O. Aluko *et al*. (2024), microcrediting initiatives cut the long-term inequality and poverty by making subsistence payoffs less common. The research of D. Kanga *et al*. (2024) provided insights into microcredit's effectiveness in South Asian and Eastern European contexts, noting its positive impact on financial inclusion and growth of small and medium enterprises. S.U. Din *et al*. (2023) emphasised that microcredit improves financial access in underserved regions and fosters entrepreneurial activity. Similar conclusion was made by N. Abera & M. Asfaw (2019) who found that financial services' expansion in low-income countries positively impacted local economies and fostered growth. The idea was also supported by A. Barguellil & L. Bettayeb (2020) who found a positive association between microcredit access and gross domestic product (GDP) in developing regions.

According to the World Bank (2024), Albania is putting significant structural reforms into place that will promote fair growth, increase economic productivity and competitiveness, generate more jobs, and enhance public service delivery and governance. In 2024, private consumption, tourism, and construction are predicted to be the main drivers of Albania's robust 3.3% economic growth. In 2025, growth is anticipated to moderately accelerate to 3.4%. As employment and wages increase, poverty is predicted to continue to decrease. Structural reforms and the global recovery are key to the nation's medium-term prospects. Recent studies from the Bank of Albania validates that a robust non-banking financial sector is regarded as a crucial component of a sound and effective financial system, which may guarantee stability in the expansion and advancement of the economy and make it comprehensive, well-balanced, and advanced. Although non-bank financial institutions are still in their infancy in Albania, their significance is expected to grow in the future, much like in other industrialised nations where they play a significant part in financial intermediation.

Although microcredit is increasingly recognised globally as a driver of economic growth, empirical studies specific to Albania are limited. The majority of available literature on microcredit's impact focuses on larger or more financially developed economies, with fewer quantitative assessments available for smaller, emerging economies like Albania. World Bank (n.d.) reports provided some data on Albania's financial sector, but there is a need for more rigorous analysis that specifically addresses microcredit's effects on GDP and poverty alleviation in the Albanian context. Research on microcredit in Albania often emphasises social benefits, such as poverty reduction, and women's empowerment, rather than macroeconomic outcomes like GDP growth. The recent research of S. Fonesca *et al*. (2024) advocated for more in-depth, country-specific studies to understand microcredit's long-term economic impacts and guide policy development.

The cited research indicated the gap that this study seeks to fill by using Albania-specific data to quantify microcredit's influence on economic growth. While Albania has received some microcredit interventions, there remains a lack of comprehensive, quantitative analyses of their economic impact. Most literature addressing the effect of microcredit on GDP is either outdated or focused on qualitative impacts. This is reflected by A.A. Akanji (2020), who highlighted that the emerging economies require further empirical data to fully assess the economic benefits of microcredit. Considering the detected gap, this paper aimed to identify the extent to which microfinancing initiatives have contributed to the economic growth in Albania over the past decade.

MATERIALS AND METHODS

This paper employed secondary data covering a decade long period of 2013-2023. The data on microcredit disbursements and their effect on the socio-economic development of Albania were taken from World Bank (2024; n.d.); annual reports of the Bank of Albania (n.d.) retrieved from the institution's official website. Utilising these sources provides access to historical data and ensures a high level of data accuracy, as these are reputable for macroeconomic indicators. Two primary variables were analysed in the research: total microcredit disbursements, representing the aggregate annual loans extended by microfinance institutions, and real GDP growth which was measured as the annual percentage increase in Albania's real GDP. To quantify the relationship between microcredit and economic growth, the research employed a simple linear regression model:

$$y = \beta_0 + \beta_{1x} + \epsilon, \quad (1)$$

where y – GDP growth; x – total microcredit disbursements; β_0 – intercept; β_1 – slope coefficient; ϵ – error term. This specification allowed to capture the direct impact of changes in microcredit on economic growth, assuming that other factors remain constant. Linear regression has proven effective in analyses where variables exhibit direct relationships, as is commonly observed between financial indicators and GDP in emerging markets. Considering the use of the regression model in prior research, it was hypothesised that β_1 will be positive, reflecting a direct relationship between microcredit and GDP growth (Abdin, 2016).

To estimate the parameters of β_0 and β_1, the research employed the Ordinary Least Squares method. The coefficient β_1 was used to measure the change in GDP growth corresponding to a one-unit change in microcredit

disbursements. The estimation was based on the following assumption: if β_1 is significant and positive, it indicates that increases in microcredit correlate with higher GDP growth, suggesting that microcredit has contributed positively to Albania's economic development over the study period. The linearity assumption posited that the relationship between microcredit and GDP growth is linear. Authors conducted a scatter plot analysis and used the Ramsey RESET test to verify linearity, ensuring that the model specification aligns with the observed data. The research applied the Jarque-Bera test to confirm that residuals are normally distributed, an assumption necessary for the reliability of hypothesis testing and confidence intervals. Given the use of time series data, authors also checked for autocorrelation using the Durbin-Watson test to ensure that residuals from different time periods are independent.

RESULTS AND DISCUSSION

Economic analysis of microcredit growth in Albania (2013-2023)

In Albania, there is a growing demand for microcredits as a tool to overcome financial hurdles and support sustainable growth amidst uncertainty. As seen in Figure 1, there is a significant increase in both the number of borrowers and the total microcredit disbursed over the 2013-2023 period. The number of borrowers grew from 21,000 in 2013 to 224,430 in 2023. This is a remarkable growth, suggesting that microcredit services have become increasingly accessible and widely used over the decade. The detected trend reflects a rising demand for microcredit, which may be due to the growing number of individuals or small businesses seeking capital to invest in entrepreneurial activities or income-generating projects. The amount of microcredit disbursed also grew substantially, starting at 0.3 million euro in 2013 and reaching 23 million euro in 2023. This increase in microcredit volume aligns with the growing borrower base and suggests that more substantial funds are being disbursed per borrower over time, possibly due to an increased confidence in the microfinance sector or larger loan sizes available to established borrowers.

Between 2013 and 2016, the growth in the number of borrowers and microcredit disbursements was relatively modest. Starting from 2017, the number of borrowers was increasing significantly each year. This acceleration may be attributed to the improved accessibility and expansion of microfinance institutions; enhanced awareness and trust in microcredit as a financial service; supportive economic policies or government incentives encouraging the use of microcredit. The idea was confirmed in several studies, including S. Hussen *et al.* (2021) who stressed that microfinance could drive economic development by enabling individuals to launch or expand businesses, particularly in emerging economies with limited access to traditional credit. By providing financial access to underserved populations, microcredit promotes entrepreneurial activity and financial inclusion. The observed correlation aligns with theories suggesting that financial inclusion can enhance productivity, reduce unemployment, and ultimately drive GDP growth (Ramadhan & Robin, 2024; Saienko *et al.*, 2025). In Albania, microcredit has likely contributed to greater economic participation among low-income households, empowering them to generate income and improve their livelihoods, which is reflected in the steady GDP increase observed alongside microcredit expansion. The rapid growth in the number of borrowers suggests that microcredit has become more accessible and appealing, likely because it serves as an alternative to conventional banking for rural or economically vulnerable populations (Gerasymchuk *et al.*, 2023). As these individuals gain the ability to fund business ideas, the broader economy benefits through job creation, increased household income, and a reduction in poverty rates.

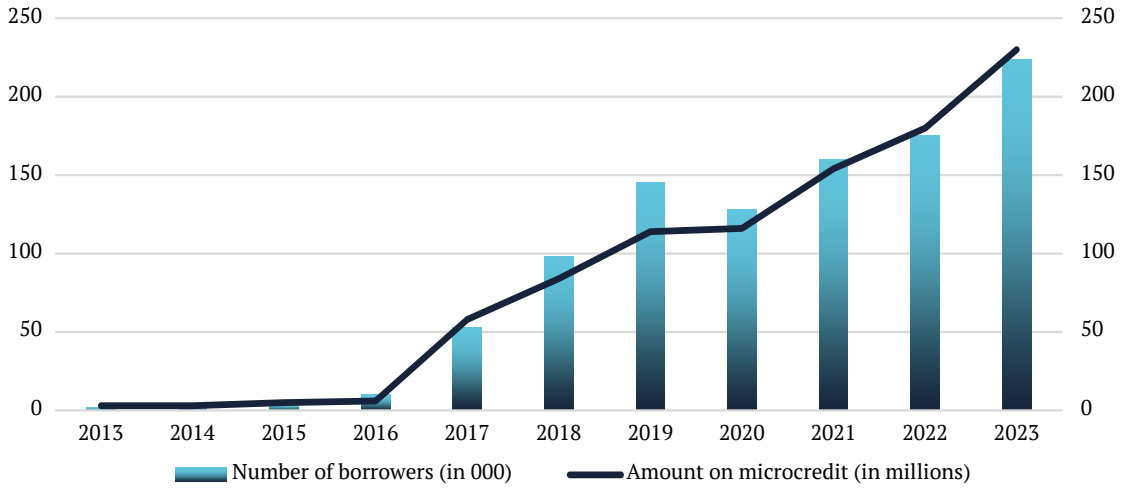

Figure 1. Evolution of the amount of microcredit in euros (million) and the number of borrowers (in thousands) for the period of 2013-2023

Source: created by the authors based on Bank of Albania (n.d.)

An examination of the global economic impact of COVID-19 revealed that the number of borrowers slightly decreased from 145,000 in 2019 to 128,351 in 2020 but quickly recovered by 2021. This dip could indicate temporary financial uncertainty or economic slowdowns affecting borrowing needs or repayment capacities during the pandemic. The rise in both the number of borrowers and the amount of microcredit suggests that microfinance

has played a role in enhancing financial inclusion in Albania. Increased access to credit can empower individuals to start or expand small businesses, thus stimulating local economic activity and job creation (Chyzh, 2023). Studies, including Y.H. Haziel *et al*. (2024) and X. Sima (2024), emphasised the role of microcredit in supporting small businesses, which can boost economic productivity. The data implies that an average loan amount may have increased, allowing borrowers to undertake more substantial investments. As microcredit disbursements grow, borrowers might shift from small-scale ventures to more capital-intensive businesses, potentially leading to higher incomes and further contributions to GDP growth.

Dealing with economic theory

The effect of microcredit can be tested in the context of Albania's economic growth revealed through GDP trends. The correlation was examined with the help of a single regression model to test a potentially liner relationship between two variables. The utilised approach is similar to D. Kanga *et al*. (2024), who interpreted a positive β_1 as evidence of microcredit's impact on economic productivity and growth in South Asia and Eastern Europe. As J. Ledgerwood (2013) noted, testing for linearity is essential in financial models to confirm the appropriateness of a linear approach. The assumption of constant variance (homoscedasticity) was verified using the Breusch-Pagan test. If this test indicates heteroscedasticity, robust standard errors will be employed to ensure valid inference. Heteroscedasticity is common in financial data, where variance often increases with larger values, as discussed in A. Memon *et al*. (2021). Non-normality can distort significance tests, as noted by N. Abera & M. Asfaw (2019), who emphasised that residual normality is critical in microcredit impact studies due to potential outliers. The results of applying the linear regression model are shown in the Figure 2, which demonstrates the evolution of real GDP (in billions of euros) and microcredit (in millions) in Albania for a ten-year period between 2013 and 2023.

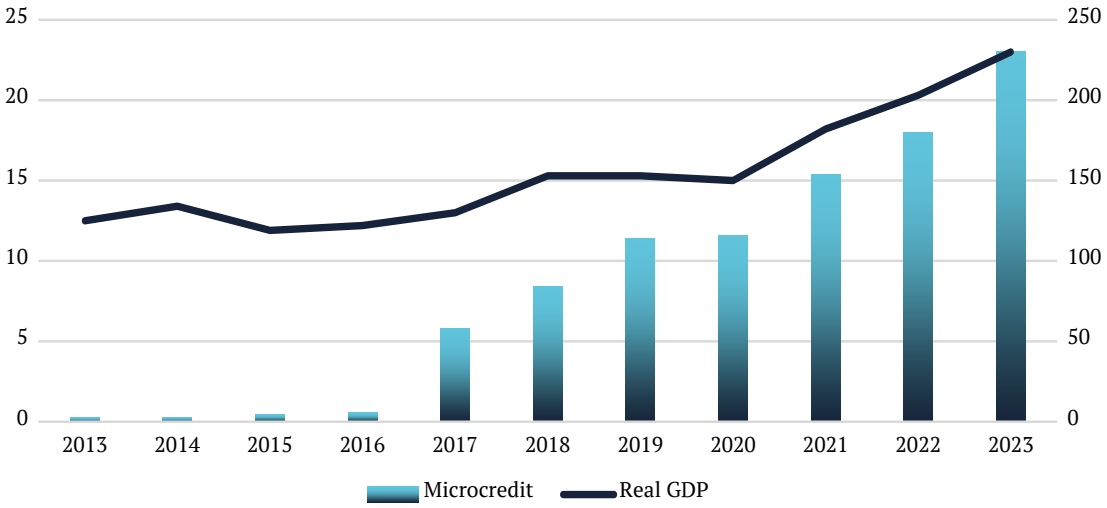

Figure 2. The evolution of real GDP (in billions of euros) and microcredit (in millions of euros) for the period 2013-2023
Source: created by the authors based on Bank of Albania (n.d.), World Bank (2024)

The provided figure revealed a strong positive correlation between microcredit disbursements and GDP growth in Albania. The regression analysis suggested that microcredit serves as a powerful tool to stimulate economic activity, as evidenced by the significant increase in GDP associated with rising levels of microcredit. The obtained results should, however, be treated cautiously, considering potential limitations of a single-variable regression model. The major limitation is that the impact of microcredit on GDP captures only one aspect of the complex dynamics driving economic growth. Other factors, such as government expenditure, foreign investment, or global economic conditions, could influence GDP and will be considered in future research. Additionally, the analysis relies on aggregate data for microcredit and GDP, which may mask sector-specific impacts or regional disparities. Furthermore, the use of the model implies an elevated risk of the autocorrelation bias, which, according to D. Loncar *et al*. (2009), could result in an overstated significance of a particular variable.

Figure 3 present the regression equation with the estimated coefficients. While the linear regression model shows that the intercept, 11.723, represents the estimated GDP growth rate when microcredit disbursements are zero. This value, though hypothetical, provides a baseline GDP growth rate in the absence of microcredit. More importantly, the slope coefficient, 4.3215, indicates a positive and substantial impact of microcredit on economic growth. Thus, the strong positive slope suggests that microcredit is not only a financial tool for individual empowerment but also a broader economic growth driver. The model's R^2 value of 0.9103 indicates that approximately 91.03% of the variability in GDP growth can be explained by variations in microcredit disbursements. This high R^2 suggests a strong fit for the model, meaning that changes in microcredit account for a significant portion of the changes in GDP growth over the period studied. This level of explanatory power is notably high for macroeconomic data, where multiple factors often contribute to growth. For instance, D. Loncar *et al*. (2009), in their analysis of microcredit's effect on emerging economies, reported R^2 values in a similar range when microcredit was a significant growth driver.

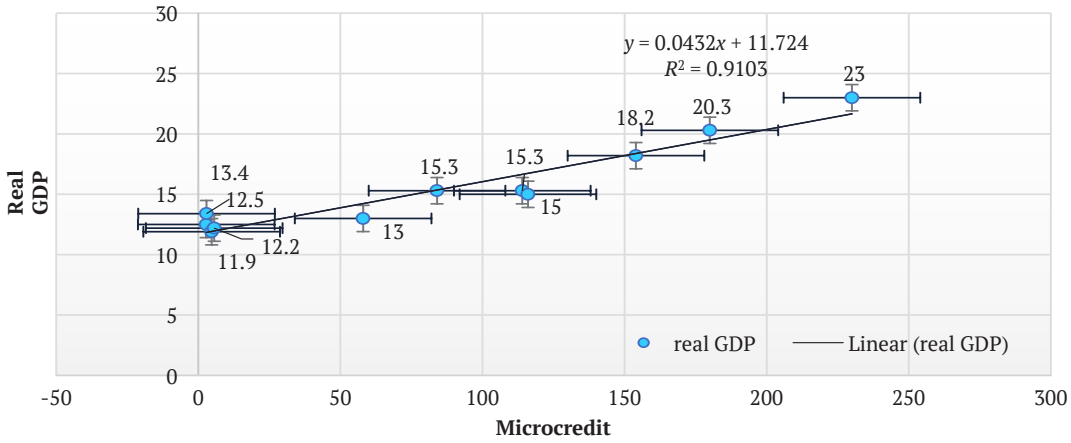

Figure 3. The regression equation between the real GDP and microcredit in Albania for the period 2013-2023
Source: created by the authors based on Bank of Albania (n.d.), World Bank (2024)

The strong R^2 in this model underscores that microcredit likely plays an essential role in Albania's GDP growth. However, regardless of comparatively high levels, it is important to remember that R^2 does not imply causation but rather indicates a correlation between microcredit and GDP growth, suggesting that other factors, such as state policy, trade, and foreign investment, may also influence this relationship. The correlation confirmed in this research, is consistent with the findings in previously conducted studies, including J.A. Azanlerigu & A.R. Kuntulo (2015) who found that microcredit positively influences entrepreneurial activity, which fosters economic growth. As explained by S. Ullah *et al*. (2024), microfinance is an effective tool for entrepreneurial development, especially for poor and young unemployed youth who struggle to win competitive edge in a stagnating labour market. M. Makara *et al*. (2024) conducted a series of 30 observations and in-depth interviews in Semonkong, Lesotho, and discovered that microfinancing can boost local economy by satisfying basic needs and amplifying consumption in low-income communities. The consistency with prior studies can be viewed as a validation of the introduced research.

Economic and social implications

This regression outcome reinforces the role of microcredit as a substantial contributor to economic growth in Albania. With each increase in microcredit disbursement, there is a corresponding growth in GDP, signifying that microcredit helps fuel economic activity. This effect can be explained through microcredit's ability to expand financial access for underserved individuals, enabling them to invest in small businesses, agriculture, and other income-generating activities. Numerous empirical studies provided evidence for microcredit's impact on economic growth. For example, X.H. Tang *et al*. (2023) stressed that microfinancing boosts a repertoire of projects to support sustainable development in South Asia. Similar conclusion was made in a more recent study of A. Memon *et al*. (2021) who examined the sustainability of microcredit in emerging markets, highlighting issues related to repayment pressure and interest rates that could impact borrowers in Albania. The findings introduced in the cited work were used to confirm the research hypothesis that that microcredit availability is expected to positively correlate with GDP growth in Albania. The hypothesis was also supported by A. Barguellil & L. Bettayeb (2020) who found a positive association between microcredit access and GDP in developing regions. While some studies on Albania, including M. Zeneli & A. Reci (2023) and E. Kolaneci & E. Pejo (2024), focused on qualitative assessments, quantitative evaluations are still limited. Quantitative studies, like this paper, underscore the broader economic impact of financial inclusion, relevant to Albania's context. This paper aims to quantify the relationship between microcredit and Albania's GDP growth from 2013 to 2023, adding a new perspective to Albania-specific research on microcredit.

The positive impact of microcredit on GDP growth suggests that microcredit likely promotes job creation and income stability, which are essential components of economic growth (Nechyporenko, 2023; Rexhepi, 2023). When entrepreneurs and small business owners receive microcredit, they often invest in expanding their businesses, which may result in higher employment and improved productivity (Shuplat *et al.*, 2022). This positive impact is consistent with previous research, including K. Ratnawati (2020) and A. Mishra *et al*. (2024), which argued that increased financial inclusion through microcredit can lift income levels and improve local economies. Another study on the role of microfinancing as a growth tool was conducted by S.R. Khandker (2005) who highlighted a microcredit's significant role in poverty reduction and economic mobility within lower-income populations, supporting theories that see microcredit as a developmental tool in emerging economies.

The regression results indicated that policies aimed at expanding microcredit availability could have measurable economic benefits. Policymakers might consider supporting microcredit institutions or creating incentives for traditional banks to engage in micro-lending programmes, as suggested by S.R. Khandker (2005) who observed that policy support enhances the scalability and effectiveness of microcredit interventions. Furthermore, the Albanian government might focus on regulatory frameworks that facilitate the operation of microfinance institutions, given their potential to contribute to GDP growth. Supportive policies could further enhance microcredit's reach, there-

by amplifying its positive impact on the economy. Studies from countries with similar economic profiles as Albania illustrate how microcredit can positively affect GDP growth and poverty alleviation. D. Loncar *et al*. (2009), for instance, studied Eastern European countries and observed that microcredit promoted economic activity, particularly within rural sectors and among small and medium enterprises. N. Abera & M. Asfaw (2019) provided evidence from low-income countries, noting that microcredit had helped increase income levels and reduce poverty in Ethiopia, findings which are applicable to Albania's rural economy. S.U. Din *et al*. (2023) found that in underserved areas, microcredit significantly enhanced income levels and reduced unemployment, aligning with goals of economic growth through increased financial access.

A. Barguellil & L. Bettayeb (2020) provided the cross-country analysis and suggested that expanding microfinance programmes correlates with economic growth, especially when combined with policies that address structural barriers to financial inclusion. This is relevant for understanding Albania's situation, where microcredit could serve as a bridge for addressing financial gaps. Given the positive association between microcredit and GDP, policymakers should consider creating supportive environments for microfinance institutions. This could include regulations that facilitate the expansion of microcredit services, tax incentives, or partnerships with international organisations that promote financial inclusion initiatives. By enhancing the reach and stability of microfinance services, Albania can further leverage microcredit as a tool for sustained economic growth. For Albania and other countries in similar stages of economic development, microcredit could be integrated into broader economic policies aimed at poverty reduction and inclusive growth (Wang *et al.*, 2024). For instance, expanding microcredit access in rural areas or regions with high unemployment could address regional economic disparities, helping to stabilise and diversify local economies. As studies in other countries have shown, targeted microcredit policies can bolster sectors like agriculture, small-scale manufacturing, and services, driving localised economic development (Shen & Lu, 2024). Microcredit has also been associated reinforced empowerment of particular population groups, including women, and educational outcomes in other contexts (Meena *et al.*, 2024). Analysing these factors within the Albanian context could reveal additional benefits of microcredit that are not captured by GDP alone, providing a more holistic view of its impact.

Although microfinancing initiatives have shown significant economic benefits, there are potential risks associated with increased lending to low-income populations. Over-indebtedness, especially among borrowers with limited financial literacy, could lead to financial instability, as it was discovered in previous studies of G. Illangakoon (2024) and S.A. Nyarko *et al*. (2024). Policies should therefore include measures to promote responsible lending practices, borrower education, and debt management support to mitigate these risks and ensure that microcredit remains sustainable. Overall, the findings support the view that microcredit has contributed positively to Albania's economic growth, with broad implications for financial inclusion and poverty reduction. By focusing on policy support, sustainable lending practices, and further research into the long-term effects, Albania could continue to harness microcredit as a transformative tool for economic development. This study underscores the value of microcredit in emerging economies and lays the groundwork for future research that can deepen understanding of its impacts and optimise its effectiveness.

CONCLUSIONS

The analysis of microcredit growth and borrower trends in Albania from 2013 to 2023 reveals a clear, positive correlation between microcredit expansion and economic growth, specifically in relation to GDP. The data showed substantial growth in both the number of microcredit borrowers, which rose from just 2,000 in 2013 to 224,431 in 2023, and the amount of microcredit disbursed, increasing 76-fold over the same period. This growth trajectory highlights a rising demand for microcredit services and an increasing confidence in microfinance as a means for individuals to access capital and invest in entrepreneurial activities.

This paper has demonstrated a clear and positive correlation between microcredit disbursements and GDP growth in Albania from 2013 to 2023. The regression analysis highlighted that as microcredit access and utilisation expanded, so did economic activity, suggesting that microcredit serves as a catalyst for economic growth. The model's high R^2 value further reinforced the significance of microcredit as a contributing factor, with microcredit disbursements explaining over 91% of GDP growth variability during this period. This finding aligns with global studies linking microcredit to increased entrepreneurship, job creation, and enhanced financial inclusion, reinforcing microcredit's role in stimulating development within underserved communities.

From a policy perspective, these results underscore the importance of supporting and scaling microcredit initiatives, particularly in developing economies where traditional financial services are limited or inaccessible. Albania's case illustrates how expanding access to credit can empower small business owners, farmers, and other individuals who lack conventional banking options, enabling them to participate more fully in the economy. Policymakers may consider creating incentives for microfinance institutions, enacting supportive regulatory frameworks, or integrating microcredit initiatives into broader economic development strategies. Such policies could amplify microcredit's impact, not only on GDP growth but also on poverty reduction, financial inclusion, and social mobility.

In conclusion, microcredit has emerged as a valuable tool for economic empowerment, capable of driving growth and resilience within vulnerable economies. However, further research is essential to explore the long-term impacts of microcredit on economic stability, wealth distribution, and the sustainability of small enterprises. Future studies could focus on identifying the conditions under which microcredit has the most significant impact and exploring potential risks or unintended consequences. As Albania's experience shows, microcredit can be an effective means of fostering economic development, yet it requires continuous adaptation and rigorous assessment to maximise its benefits for society.

ACKNOWLEDGEMENTS

None.

FUNDING
None.

CONFLICT OF INTEREST
None.

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Вплив мікрокредитування на економічне зростання країн, що розвиваються: докази та перспективи з Албанії

Анотація. Хоча мікрокредитування широко вивчається в різних глобальних контекстах, дослідження його конкретного впливу в Албанії залишається обмеженим. У цьому дослідженні проаналізовано вплив мікрокредитування на економічне зростання в Албанії за період 2013-2023 років. Дані, отримані від Світового банку та Банку Албанії, були проаналізовані за допомогою лінійної регресійної моделі для кількісної оцінки зв'язку між рівнем мікрокредитування та зростанням реального валового внутрішнього продукту в Албанії. Результати регресії показали сильний позитивний зв'язок, що підкреслює важливість доступного мікрокредитування як економічного рушія. Період 2013-2023 років відзначився збільшенням обсягів мікрокредитування в мільйонах євро, а також кількості позичальників, що свідчить про зростання популярності цієї опції в Албанії. Представлені результати мають політичне значення, оскільки припускають, що розширення доступу до мікрокредитування може сприяти досягненню цілей економічного зростання Албанії шляхом створення нових підприємств, робочих місць і підвищення економічної продуктивності. На основі порівняльного аналізу отриманих результатів і раніше проведених досліджень було рекомендовано розширити доступ до мікрофінансування за допомогою нормативно-правових актів, що сприяють розширенню мікрокредитних послуг, податкових пільг або партнерства з міжнародними організаціями. Також було рекомендовано підвищити рівень справедливості шляхом надання рівного доступу до варіантів фінансування для всіх груп населення, включаючи жінок та підприємців з числа меншин. Хоча це дослідження показало сильний взаємозв'язок, необхідні подальші дослідження для встановлення причинно-наслідкового зв'язку та вивчення додаткових факторів, що впливають на зростання валового внутрішнього продукту. Загалом, дослідження підкреслило необхідність підтримки фінансової політики та постійних досліджень для оптимізації ролі мікрокредитування у сталому розвитку

Ключові слова: зростання валового внутрішнього продукту; скорочення бідності; прийняття інвестиційних рішень; рівність доходів; можливості працевлаштування; маргіналізовані верстви населення

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 658.8
DOI: 10.63341/econ/2.2025.77

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Optimising online sales for small and medium-sized businesses: Integrating e-commerce and digital marketing

Abstract. Small and medium-sized enterprises (SMEs) play a fundamental role in ensuring the effective development of the country's economy, which is why the analysis of existing problems and challenges for them always remains a relevant issue for each country. Within the framework of this study, it was decided to assess the opportunities to improve the optimisation of e-commerce for SMEs, which became the main goal of the work. The primary research methods used were forecasting and systematic analysis, which made it possible to identify the most promising development strategies and predict the impact of technological integration on SME performance. Using statistical data from national and international sources, the study analysed the current state and projected growth of e-commerce in Kazakhstan. The analysis revealed that the share of SMEs in Kazakhstan's gross domestic product steadily increased, while the volume of e-commerce in retail trade reached 3,156.4 billion tenge in 2024, and 2,443.4 billion tenge in services. The share of e-commerce in total retail trade rose to 16.6%. Social media also plays a growing role in SME marketing strategies, with 76% of the population using social networks in 2024, projected to exceed 90% by 2028. The study proposed a set of optimisation approaches, including establishing customised e-commerce platforms, leveraging social media for direct sales, employing SEO and mobile optimisation, and applying content marketing strategies. While advanced tools such as artificial intelligence and augmented reality were found to offer considerable benefits for customer interaction and personalisation, their implementation is often hindered by financial constraints. Therefore, alternative low-cost strategies were also outlined. The conclusions obtained within the framework of the study can be used to more effectively shape the country's policy in the development of SMEs, as well as for business representatives themselves to more efficiently manage the online sales component in the enterprise

Keywords: gross domestic product; artificial intelligence; innovation; trading platforms; web technologies

Article's History: Received: 30.01.2025; Revised: 30.04.2025; Accepted: 27.06.2025

Suggested Citation:
Aidargaliyeva, N., Seisekenova, M., & Kydyrbayeva, E. (2025). Optimising online sales for small and medium-sized businesses: Integrating e-commerce and digital marketing. *Economics of Development*, 24(2), 77-86. doi: 10.63341/econ/2.2025.77.

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INTRODUCTION

Optimising online sales plays a critically important role in the success of small and medium-sized enterprises (SMEs). It is a process aimed at improving all aspects of a company's online presence to increase sales and enhance user experience. Primarily, it is one of the methods of achieving a higher level of competitive advantage compared to other companies. Optimising online sales is a fairly complex system, which includes increasing the company's visibility among potential customers, improving conversion rates, enhancing user experience with interacting with the company's products, working on social media promotion, etc. Considering the role of this component and its complexity, the formation of recommendations to increase the efficiency of online sales for SMEs remains relevant. In the context of this study, the assessment was conducted based on data from Kazakhstan, where SMEs are very actively developing.

Numerous scholars have been studying enterprise development issues in Kazakhstan. For instance, M. Sadyrova *et al*. (2021) examined the possibilities for SMEs considering the potential implementation of innovative systems. They also noted some problems in the country regarding the development of such companies (underdeveloped business environment, obstacles to the implementation of new technologies, insufficient efforts from the authorities in technology development), yet they provided insufficient recommendations to address all these negative aspects.

T. Bekzhanova *et al*. (2023), on the other hand, assessed the development of SMEs and their impact on unemployment dynamics in Kazakhstan. They emphasised the significant role of SMEs in national economic development, global economic growth, and job creation, as well as described the support measures they need to effectively develop in modern conditions. A. Kireyeva *et al*. (2021) evaluated the factors determining the innovation potential of Kazakhstani enterprises. The analysis showed the limited impact of competition on the development of innovative products, as well as the importance of increasing the level of qualification among enterprise employees. However, no recommendations were provided for enterprises and governmental authorities of the country.

In the study by S. Zamanbekov *et al*. (2020), the formation and functioning of industrial clusters in Kazakhstan were evaluated, emphasising the integration of SMEs with larger businesses to create additional opportunities for the development of both forms of business. Scholars developed practical approaches and recommendations to increase the efficiency of this integration through the use of models such as franchising and outsourcing, yet little attention was paid to examining the downsides of such integration. A. Syzdykova *et al*. (2021) described the positive and negative aspects of SMEs development in Kazakhstan, paying special attention to geopolitical factors and access to financing for such companies.

Thus, a significant number of scholars conducted research related to the analysis of SMEs development in Kazakhstan. In most of them, attention was also paid to assessing the innovative component, which is an integral part of the country's SMEs development. However, taking into account additional factors in the analysis and forming a new perspective on how the development of this sphere should occur, and which aspects deserve special attention, remains relevant. The aim of this study was to assess the current opportunities for optimising e-commerce for SMEs in Kazakhstan.

MATERIALS AND METHODS

Within the framework of the study, a large amount of statistical data was used, which, in one way or another, described the state of SMEs in Kazakhstan. The main source of information for these data was the official website of the Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2024a). With its help, the share of SMEs in the country's gross domestic product (GDP) was estimated. This source was crucial for analysing the economic contribution of SMEs to the national economy. Additionally, data were assessed that partially characterise the development of e-commerce in the country as a whole, including the volume of retail trade in this sphere and its share in the total volume of trade. These data were sourced from the Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2024b), which provided insights into the growth and significance of e-commerce for SMEs. Another source of information used in the study was the StatCounter (2024) website. It contains information regarding the prevalence of social networks in Kazakhstan (such as Instagram, Facebook, and others), which was evaluated to draw conclusions about the feasibility of using a particular network in forming a marketing strategy. It is worth noting that the data on the website are presented on a monthly basis. However, quarterly information was used for the purposes of the study. For this, the average value for 3 months was calculated, as shown below:

$$Q_n = \frac{(m_n + m_{n+1} + m_{n+2})}{3}, \quad (1)$$

where Q_n – quarterly value of the indicator; m_n – monthly value of the indicator. Although such calculation does not allow obtaining an exact value (for this, it would be necessary to have the original data), however, it is sufficiently close to reality for conducting analysis. Data regarding the use of social networks in Kazakhstan were also sourced from the Statista (2024a), concerning the percentage of the population using these platforms. It is worth noting that the data on the website are presented for the period from 2018 to 2028, meaning that the data from 2024 are projected. This was also taken into account when forming conclusions in the study. All constructions and calculations were carried out in Microsoft Excel. Additionally, the Kazakhstani inflation rate data, which comes from Statista (2024b), offers a thorough summary of inflation patterns from 1998 to 2028 and is a useful tool for examining the economic environment in which SMEs function.

The study employed a significant number of research methods. Comparison was used to assess different approaches to optimising online sales for SMEs, describing their drawbacks and advantages. Forecasting allowed drawing conclusions about the potential development of SMEs and the e-commerce sector in Kazakhstan in the future, assuming the continuation of current trends observed at the moment and over the past few years. Systematisation, in turn, was used to assess the peculiarities of

e-commerce in Kazakhstan within a unified data system, where they interact with each other. Through abstraction, it was possible to limit the number of factors evaluated in the study to make the conducted analysis more precise. Descriptive method was used to characterise the peculiarities of online sales development among SMEs in Kazakhstan, assessing their main features. The graphic method was used to visualise various types of data through charts. For the same purposes, the tabular method was also used, although it depicted other types of data that would not be as easily understood in graphs.

RESULTS

If the role of SMEs is to be generally described, they are of crucial importance for the economic and social development of countries, contributing significantly to GDP, job creation (including in remote regions), and innovation development. They contribute to sustainable development and improvement of living standards by reducing regional disparities and increasing tax revenues. The adaptability of SMEs allows them to implement innovations faster than large companies, thereby quickly adjusting to new operating conditions. Their growth enhances market competition, the quality of goods and services, as well as production efficiency, making the country more attractive to foreign investors. Therefore, finding new growth points for SMEs is always relevant. The state of SME development as a whole can be assessed using the indicator of the share of SMEs in Kazakhstan. This information is presented within the framework of Figure 1.

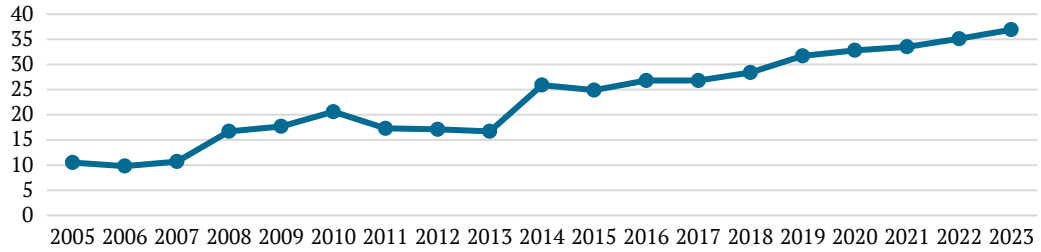

Figure 1. Share of SMEs in Kazakhstan's GDP from 2005 to 2023, %

Source: compiled by the authors based on Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2024a)

As can be seen, the share of SMEs in GDP is gradually increasing, highlighting their growing role. Such trends are generally beneficial for sustainable economic development, for the reasons already described earlier in the paper. In the process of development of such companies, competition between them is also increasing, hence the need to find new methods to improve their position in the market. Since e-commerce is also one of these methods, finding ways to optimise it is an important part of the development of this type of companies in current environment (Kryvovyazyuk, 2023). It is also worth considering the data in the context of e-commerce development in Kazakhstan. This information is shown in Table 1.

Table 1. Selected data on the development of e-commerce in Kazakhstan from 2015 to 2024

Years	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Change, %
Volume of e-commerce (retail trade), billion tenge	50.9	78.5	106.9	144.6	206.3	476.7	482	1,963.5	2,439.8	3,156.4	6,104.7
Volume of e-commerce (services) billion tenge	39.2	80.2	70.4	136.1	121.2	209.2	349.9	1,186.5	1,602.6	2,443.4	6,133.1
Volume of e-commerce (retail trade), considering inflation, billion tenge	50.9	68.5	86.9	110.8	150.2	325	304.3	1,078.2	1,263.7	1,563.4	2,969.1
Volume of e-commerce (services) taking into account inflation, billion tenge	39.2	70.0	57.2	104.3	88.2	142.6	220.9	651.6	860.2	1,290.1	3,190.5
Share of e-commerce in total retail trade, %	0.8	1	1.2	1.4	1.8	4.1	3.6	12.5	12.7	14.1	1,662.5

Source: compiled by the authors based on Bureau of National Statistics Agency for Strategic Planning and Reforms of the Republic of Kazakhstan (2024b), Statista (2024b)

As shown in Table 1, the volume of e-commerce trading in Kazakhstan has been rapidly increasing. By 2024, this trend has continued with even more notable growth, resulting in the e-commerce share of total retail trade volume rising to 16.6%. Therefore, it is not surprising that the role of e-commerce has been rapidly increasing recently, especially for SMEs. Optimising online sales in SMEs through integrating e-commerce and digital marketing involves several key strategies and technologies. For instance, a store should either create its own e-commerce platform or have a store on a third-party platform. Each of these approaches has its pros and cons. For example, a custom-built platform allows full customisation of design, structure, and user experience to align with the store's brand and values (Savytska *et al.*, 2024). Direct customer interaction enhances understanding of customer needs. Additionally, the website will feature only products or services from one store, potentially increasing sales and customer loyalty when approached correctly. Furthermore, without the need to pay marketplace commissions, higher margins can be maintained, or prices can be lower compared to competitors.

However, this method has its downsides. In particular, developing and launching a custom platform may require significant investments, which SMEs often lack, especially at the initial stage. Costs are also needed for ongoing traffic generation and website technical maintenance, which will occur regularly. Therefore, this approach is not suitable for all SMEs, and they more often choose the marketplace option. Nevertheless, over time, the number of companies with their own stores is likely to increase as the process of their creation and maintenance becomes streamlined.

An alternative to using an e-commerce platform without creating one is to establish a store on social media platforms such as Instagram, TikTok, and similar ones. Utilising e-commerce on social media opens up wide-ranging opportunities for businesses in sales, marketing, and customer interaction. By sharing content, videos, photos, and reviews, brands can attract attention and stimulate interest among potential buyers. Social media platforms also offer advanced advertising targeting tools, allowing businesses to reach specific consumer groups based on interests, demographics, geographic location, and other parameters. This increases the effectiveness of advertising campaigns and profitability (Hasani *et al.*, 2023). Moreover, many social platforms provide functionality where users can view products and make purchases without leaving the social network; they also offer tools for analysing advertising campaigns and applying some social media-specific features that can also be used for marketing purposes (for example, conducting live streams). All these factors contribute to the high popularity of such platforms among SMEs and individuals who often do not officially register their activities. Therefore, competition on such platforms is also high. Despite this, social media platforms are already perceived as an integral part of marketing strategies for any companies in current realities. It is worth analysing data that evaluates the use of various social media platforms in Kazakhstan. This information is shown in Table 2.

Table 2. Use of social networks in Kazakhstan by quarter in the period from 2021 to 2024, %

Period	YouTube	Pinterest	Facebook	Instagram	Twitter	VKontakte	Other
2021 Q3	16.3	14	12.6	18.6	14.3	14.8	9.4
2021 Q4	22.8	22.7	14.1	10.7	8.8	14	6.9
2022 Q1	23	15.4	25.4	13.9	8.5	9.3	4.5
2022 Q2	25.6	17.1	16.6	14.7	13	9.1	4.0
2022 Q3	22.9	17.5	17	15.7	12.4	10.2	4.4
2022 Q4	21.8	24.4	14	10.6	12.7	10.5	6.2
2023 Q1	23.7	23.6	15.3	10.1	14.1	8.2	5
2023Q2	20.6	19	19.1	12.3	15.6	8.6	4.9
2023 Q3	16.9	17.2	18.6	17	10.6	15.1	4.7
2023Q4	17.8	29.5	18.8	8.6	11.3	9.4	4.6
2024 Q1	17.3	27.1	19.3	12.3	9	10.2	4.9

Source: compiled by the authors based on StatCounter (2024)

As can be seen from Table 2, the main social networks that are popular in Kazakhstan are Pinterest, Facebook, and YouTube. However, a more or less adequate marketing campaign can be conducted on Facebook and Instagram, although creating a page on any social network is important. Perhaps an effective option is still also the creation of a YouTube channel, but for this, the type of activity of the company must also be suitable. Also relevant is data on what proportion of the general population uses social media. This data can be seen in Figure 2.

As can be observed from Figure 2, the percentage of the population using social media in Kazakhstan is gradually increasing. The data indicate that by 2028, over 90% of the population will be using social media. Currently, this figure is almost 76%, which is also a significant indicator, indicating the relevance of using such an approach for product promotion. However, the fact that even greater growth of this value can be expected in the future confirms its relevance. Search engine optimisation (SEO) for an SME's online store is also a key component of a successful digital marketing strategy (in case the SME has its own website). It helps improve the visibility of one's website in search engines, leading to increased traffic and, consequently, sales growth (Sharabati *et al.*, 2024). Optimisation can be achieved through enhancing various functions. One of them is technical optimisation: speeding up page loading, adapting design, increasing website security (Si *et al.*, 2025). Attention should also be paid to content. It is advisable to hire specialists who will use relevant keywords in texts, headings, meta tags, and image attributes, regularly publish useful content

that addresses the queries and needs of one's target audience, and provide detailed descriptions of products and their characteristics. Other important aspects include focusing on customers from specific regions, analytics, and monitoring of customer behaviour, optimising website performance on mobile devices (Fitriasari *et al.*, 2024).

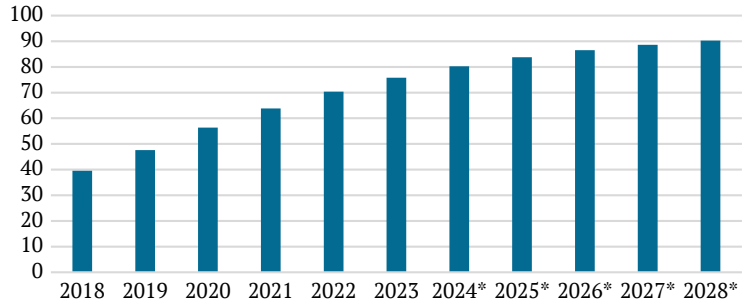

Figure 2. Share of the population using social networks in the period from 2018 to 2028 (forecast), %
Note: * – forecast value generated by representatives of the statistical website Statista
Source: compiled by the authors based on Statista (2024a)

Another important aspect of online sales optimisation is the creation of quality content marketing (Almeida López *et al.*, 2022). Its main role is to attract and retain customers. An effective content marketing strategy can improve brand visibility, build trust, and stimulate sales. Some recommendations for optimising content marketing include assigning a dedicated employee responsible for all aspects of this part of the business. Although this may incur costs, it significantly increases advertising efficiency and thus allows for revenue growth. The content manager should clearly understand the needs of the business's target audience and be able to segment it. Additionally, they should have skills in content creation: both visual and textual components (although content creation components can be outsourced). By using available tools (social media advertising, websites, email newsletters, or even collaboration with influencers), the goal of such an employee should not only be to promote products but also to build a specific community around them. Although achieving such results is quite challenging, it is worth striving for in the long run.

Another aspect is optimising customer relationship management and marketing automation. Implementing and optimising these systems allows automating routine tasks, better understanding customer needs, and increasing their loyalty. In general, there are plenty of opportunities to automate customer interaction. The newest among them is artificial intelligence, which can act as a conversational partner for customers, analyse the information provided by them, and draw appropriate conclusions. This also allows for personalised services or products for each individual customer. Therefore, implementing artificial intelligence in enterprises to solve various tasks is generally quite effective, but it is still a rather expensive solution, which may not be accessible to many enterprises. However, there are other solutions, such as chatbots, which are less effective but can also help address some issues that arise.

Some other tips that can make the process of purchasing goods or services more enjoyable and thus increase sales can be noted. For example, using location data of customers to send them personalised messages and offers when they are near a physical store. The implementation of augmented reality (AR) technology, which allows trying out products before making a purchase, can also be beneficial. Due to the increasing adoption of cryptocurrencies among the population, enabling payment with them can also be effective. In general, there are quite numerous approaches to make the process of purchasing goods and services more convenient for users. The question often lies in how accessible it actually is for small businesses. Thus, they must make decisions on their own regarding which of these approaches they have the ability to use and which ones they cannot use.

DISCUSSION

Overall, recommendations for SMEs have largely been described earlier in the paper. It can be summarised that to increase the efficiency of their operations, companies should pay more attention to the implementation of digital technologies, which can enhance their capabilities in terms of sales growth. It is also worth paying more attention to marketing issues, using different approaches to potential customers to make their interaction with the business as pleasant as possible. Such an approach will help increase SMEs' sales and improve their market position compared to other companies. It is also worth mentioning separately the placement of their company pages on various social networks, building a community around the product or enterprise, and expanding the customer base using these platforms.

The significant role of SMEs in the qualitative development of countries and regions was emphasised by C. Erdin & G. Ozkaya (2020). The study showed that regions with a high level of prosperity often have a higher share of SMEs, indicating their importance for economic development. The authors also emphasise the key role of SMEs in innovation development across the country, considering it a critical aspect for enhancing the competitiveness of national products in the modern world. F. Manzoor *et al.* (2021), in turn, investigated the role of SMEs in the development of rural areas in developing countries, highlighting the need to consider specific factors and rural characteristics. They concluded the importance of analysing the relationship between SME development and improving life in rural areas. Within the framework of this study, the role of SMEs in the development of the country, including their role in the development of rural territories, was described, as such companies have more flexible opportunities to create jobs

in rural areas and provide income opportunities for local populations. This is another reason why stimulating the development of such enterprises is relevant.

E.E. Beaton & E. Dowin Kennedy (2021) discussed how social enterprises can address market failures through strategies like market mending, which SMEs can also adopt in their e-commerce ventures. This concept helps SMEs balance market deficiencies and economic challenges while optimising their market positions. By combining social responsibility with economic engagement, SMEs can foster sustainable growth and contribute to both local and global markets.

S.K. Naradda Gamage *et al*. (2020) highlighted strategic responses SMEs can use to thrive in a competitive, globalised economy. Their focus on adaptability and innovation aligns with this paper's recommendations for SMEs to embrace digital technologies and marketing strategies to improve their market positioning. The adoption of e-commerce platforms is crucial for SMEs to remain competitive and resilient. Further complementing this discussion, R. Stekelorum (2020) emphasised the importance of CSR practices in enhancing SME competitiveness, particularly within supply chains. This study offered a framework for SMEs to integrate CSR with marketing strategies, which can differentiate their brands and build long-term customer trust. In the context of e-commerce, CSR becomes a key component of creating positive brand perceptions and ensuring business sustainability.

The evaluation of the impact of e-commerce and digital marketing implementation strategies on the financial performance and sustainability of micro-, small, and medium-sized enterprises (SMEs), particularly during the COVID-19 crisis, was conducted by J. Gao *et al*. (2023). Evaluating preliminary information, they found a significant positive impact of e-commerce usage on the sustainability indicators of companies. Companies that actively began using e-commerce platforms in their operations showed significantly better performance indicators compared to others, indicating the need to transition from traditional business models to e-commerce (Adam & Alarifi, 2021; Sabaih *et al*., 2021). Similar conclusions were also drawn by B.H. Sugiharto (2024), who concluded that e-commerce has a significant positive impact on companies' sustainability indicators. This study did not focus much on how SMEs use such technologies, but it was also noted that in modern conditions, the use of e-commerce significantly improves their market performance and competitiveness. This trend was echoed by B.H. Sugiharto (2024), who found that SMEs using e-commerce platforms exhibited enhanced competitiveness and market performance. Such findings point to the critical need for SMEs to transition from traditional business models to e-commerce, aligning with the ongoing digital transformation of global economies (Istrefi *et al*., 2025). In this context, V. Gvozdytskyi (2023) emphasised the importance of digital tools in driving business growth, particularly in response to external challenges such as geopolitical instability and the COVID-19 pandemic. An analysis underlines the necessity for SMEs to adapt their e-commerce strategies to local conditions, a perspective that resonates with the situation in Kazakhstan, where e-commerce is increasingly becoming a key driver of economic resilience.

S. Wahyuni *et al*. (2020) and M. Ihnatenko *et al*. (2023) analysed the implementation of e-commerce in the different sized enterprises. The researchers emphasised the active digitalisation of businesses in the studied region, where the main motives for integrating e-commerce are innovative development, operational optimisation, the need to increase marketing efficiency, and expanding the potential market. The use of e-commerce contributed to increasing the competitiveness of SMEs due to economic efficiency and improving interaction with consumers. However, companies face difficulties, including consumer distrust and internet infrastructure problems. This study also showed that e-commerce usage in Kazakhstan is constantly increasing. The reasons for this are similar to those noted in this work: the need to increase business efficiency and gain a more competitive market position. The main problem in this context often becomes a lack of funding, which, however, can be addressed through government intervention. Therefore, more active implementation of digital technologies and e-commerce is an effective way to increase the efficiency of SMEs' operations in the country as a whole.

The study by Y. Amornkitvikai *et al*. (2022) examined sustainable e-commerce development among SMEs in Thailand, highlighting key trends such as the use of social networks, delivery services, and the increasing significance of the B2B segment. The researchers emphasised the positive impact of e-commerce on the country's sustainable development but also pointed out existing problems. This study did not focus on assessing the impact of e-commerce on sustainable development. However, it is worth noting that due to the more active use of advanced technologies in enterprises, more active use of e-commerce can be observed, thereby positively impacting sustainable development.

The possibilities of optimising the use of e-commerce as a marketing environment for online stores in the city of Medan were studied by F. Safrin & F. Simanjorang (2023). The researchers noted that the most popular e-commerce platforms for marketing in the region were Instagram, Shopee, and TikTok. They identified several factors that are important for attracting users. They highlighted the simplicity of order processing, the effectiveness of payment systems, fast and easy product delivery, and the presence of high-quality visual components of the products being sold. Additionally, communication with customers, conducting promotional activities, and other similar actions were noted to play an important role (Sadeeq *et al*., 2020). Furthermore, it is important to optimise the products created for each market segment, as well as the approach to their advertising. Thus, each product may sell differently on each platform, which should also be taken into account when forming a strategy. This study also mentioned the role of social networks in the development of SMEs. However, such promotion methods have their drawbacks, primarily due to high competition in promoting products on social networks. Therefore, such enterprises should carefully work on their strategies for working on such platforms in order to be able to gain their market share.

The opportunities of using social networks as a marketing strategy for SMEs were also assessed by C.C. Lin (2021). The researcher noted that the main marketing goals for SMEs at the growth stage are brand awareness, online purchases,

and sales potential, which can largely be achieved through social networks. The most effective platform was found to be Facebook, followed by Twitter, Instagram, and YouTube. Thus, the researcher recommended using social networks to maximise marketing efficiency. This study also mentioned the possibilities of using such technologies to increase marketing effectiveness, and SMEs are indeed recommended to use them in their promotion strategies.

Marketing promotion strategies for SMEs in developing countries were described by S.P. Goldman *et al*. (2020). The researchers concluded that managers of small online stores should prioritise targeting foreign markets to increase business efficiency and sales potential. They recommended studying foreign markets and using their own advantages (primarily lower costs) to gain a share of the external market. This study did not evaluate the possibility of SMEs in Kazakhstan entering foreign markets; however, it should be noted that this strategy could indeed be effective. The main reason for this is the abundance of certain types of resources, as well as comparatively low labour costs. However, there are also challenges in this strategy, particularly the possibility of selling products to foreign markets due to geopolitical instability. Assuming a successful entry into the foreign market, the enterprise can gain a significant advantage over its competitors.

Consumer segmentation based on their relationships with online technologies was conducted in the work of B. Gyenge *et al*. (2021). They noted that understanding the cultural and technical characteristics of consumers is crucial for more effective promotion of new products and services. Therefore, companies should adapt their social networks and other resources to specific types of audiences they intend to interact with (Falahat *et al*., 2020; Ndubisi *et al*., 2021). This study also mentioned that optimising content for specific consumer groups is an important part of the marketing strategy. However, caution should be exercised with such experiments, as incorrect interaction with the public can only worsen the situation.

CONCLUSIONS

The study justified the role of SMEs in the development of Kazakhstan's economy and described the reasons for the rapid growth of e-commerce. It was shown that adopting a comprehensive approach to e-commerce and digital marketing requires SMEs to develop their own e-commerce platforms. Each of these approaches has its advantages and challenges. On the one hand, creating an individual platform offers full customisation and direct interaction with customers, potentially increasing sales and loyalty. On the other hand, it requires significant investment and ongoing expenses for attracting and servicing customers, which SMEs often lack.

An alternative approach to e-commerce without creating an independent platform involves using social networks such as Instagram, Facebook, and TikTok. These platforms offer SMEs huge opportunities for sales, marketing, and customer interaction, facilitated by the ability to share content and use tools to promote their own products. Despite high competition, social media platforms have become an integral part of the marketing strategies of almost all companies. It was shown that social networks are becoming increasingly popular in Kazakhstan each year. In the first quarter of 2024, Facebook had a user share of 19.3%, while Instagram remained a popular platform with 12.3% usage. Meanwhile, the general population's social media usage has reached 76%, projected to exceed 90% by 2028. Therefore, using as many platforms as possible to promote products is a quality approach to business development.

The research also indicates that the e-commerce industry is expanding quickly. In 2024, the volume of e-commerce in retail trade reached 3156.4 billion tenge, while for services it amounted to 2443.4 billion tenge. The share of e-commerce in total retail trade rose to 16.6%, confirming its growing significance for SMEs. The study also mentioned other approaches to increasing SME sales. In particular, the need for search engine optimisation, technical improvements to online store functionality, and website design were described. Special attention was paid to creating content to retain and attract customers. It was also concluded that the use of cutting-edge technologies, such as artificial intelligence, for automating and optimising some internal processes is important.

For future research, it is relevant to assess the development characteristics not only of SMEs but also of others, especially those traded on the Kazakhstan Stock Exchange or related to strategically important sectors of the economy (agriculture, pharmaceuticals, engineering). Analysing their condition will allow for important conclusions about which sectors of the country's economy need increased support from the government and what needs to be done to strengthen their positions on the international stage.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Оптимізація онлайн-продажів для малих та середніх підприємств: інтеграція електронної комерції та цифрового маркетингу

Анотація. Малі та середні підприємства (МСП) відіграють основну роль у забезпеченні ефективного розвитку економіки країни, тому аналіз існуючих проблем та викликів для них завжди залишається актуальним питанням для кожної країни. У рамках цього дослідження було вирішено оцінити можливості покращення оптимізації електронної комерції для МСП, що стало основною метою роботи. Основними методами дослідження були прогнозування та системний аналіз, які дозволили визначити найбільш перспективні стратегії розвитку та спрогнозувати вплив технологічної інтеграції на ефективність МСП. Використовуючи статистичні дані з національних та міжнародних джерел, у дослідженні було проаналізовано поточний стан та очікувані темпи зростання електронної комерції в Казахстані. Аналіз показав, що частка МСП у ВВП Казахстану стабільно зростала, тоді як обсяг електронної комерції в роздрібній торгівлі досягнув 3 156,4 мільярда тенге у 2024 році, а в сфері послуг – 2 443,4 мільярда тенге. Частка електронної комерції у загальному обсязі роздрібної торгівлі зросла до 16,6 %. Соціальні мережі також відіграють зростаючу роль у маркетингових стратегіях МСП, оскільки 76 % населення використовували соціальні мережі у 2024 році, а до 2028 року прогнозується перевищення 90 %. У дослідженні було запропоновано низку підходів до оптимізації, включаючи створення індивідуальних платформ для електронної комерції, використання соціальних мереж для прямого продажу, застосування SEO та мобільної оптимізації, а також впровадження стратегій контент-маркетингу. Хоча передові інструменти, такі як штучний інтелект та доповнена реальність, можуть значно покращити взаємодію з клієнтами та персоналізацію, їх впровадження часто ускладнюється фінансовими обмеженнями. Тому також були визначені альтернативні стратегії з низькими витратами. Отримані висновки можуть бути використані для більш ефективного формування політики країни щодо розвитку МСП, а також для самих підприємців із метою більш ефективного управління онлайн-продажами в підприємствах

Ключові слова: валовий внутрішній продукт; штучний інтелект; інновації; торгові платформи; веб-технології

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 621.311:338.45
DOI: 10.63341/econ/2.2025.87

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Technical solutions for improving the sustainability of energy systems as a component of the state's economic sustainability

Abstract. The destruction of Ukraine's energy systems as a result of the fighting caused significant economic losses, which made it necessary to assess their impact on industry, the business environment and macroeconomic stability. The purpose of the study was to determine the main economic consequences of destabilisation of energy infrastructure and evaluate the effectiveness of technical measures for its restoration. It was found that power outages caused a 40% decrease in production capacity in metallurgy, 35% in the chemical industry, and 28% in mechanical engineering, which led to a reduction in exports, job losses, and a slowdown in economic growth. The increase in the cost of energy resources and logistics costs led to an increase in the cost of production by 10-15%, which negatively affected the competitiveness of enterprises. In 2022, the price of electricity reached 1,800 UAH/MWh, and in 2024 it increased to 3,100 UAH/MWh, which created an additional financial burden on the manufacturing sector and households. Analysis of investment flows showed

Article's History: Received: 29.01.2025; Revised: 28.04.2025; Accepted: 27.06.2025

Suggested Citation:
Semenenko, O., Movchan, O., Remez, A., Kliat, Yu., & Cherneha, T. (2025). Technical solutions for improving the sustainability of energy systems as a component of the state's economic sustainability. *Economics of Development*, 24(2), 87-102. doi: 10.63341/econ/2.2025.87.

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a reduction in foreign capital investment to USD 2 billion in 2022 and a partial recovery to USD 5.2 billion in 2024 due to international financial support. The economic benefits of implementing measures to modernise the energy system, in particular, the introduction of autonomous energy sources, the creation of microgrids and storage systems, which will reduce electricity losses by 15-20% and increase the stability of energy supply, were studied. The use of cost-benefit analysis confirmed the cost-effectiveness of such measures, since the cost-benefit ratio exceeded 1.6. Mechanisms for financing reconstruction, including state and international programmes, were proposed, which can cover up to 70% of the costs, which will help to stabilise the energy sector and restore economic activity

Keywords: military operations; financial costs; investment attractiveness; business environment; infrastructure modernisation

INTRODUCTION

The armed aggression against Ukraine caused a large-scale destruction of energy infrastructure facilities, which caused significant challenges for the functioning of the economy, in particular, in terms of providing industry, transport, utilities, and critical infrastructure facilities with stable energy supply. Energy destabilisation during the war period became a systemic threat to the economic security of the state, increased the dependence of production processes on external factors, and created barriers to investment activity. The problem of sustainability of energy systems in the context of armed conflict required quantitative substantiation and adaptation to the conditions of long-term economic recovery.

Within the framework of modern economic discourse, the concept of economic stability is defined as the ability of the national economy to adapt to shocks and ensure reproduction at the strategic level in the context of crisis impacts (Dykha *et al*., 2024). One of the key prerequisites for such stability is the stability of the functioning of energy systems, in particular, their ability to maintain continuous power supply with partial or complete failure of individual generation, transmission, or distribution facilities. In this context, the categories of energy security, energy autonomy and technical stability of energy systems are used, which require a comprehensive economic analysis, considering the costs of modernisation, substantiation of investment decisions, and assessment of the benefits of implementing new technical solutions.

The analysis of scientific sources demonstrated the focus on the aspects of energy security, macroeconomic stability, and investment attractiveness of Ukraine in the context of armed conflict. The study by Y. Chen *et al*. (2024) investigated the importance of macroeconomic stability for sustainable development, with a focus on the relationship between energy policy and growth dynamics. However, this study did not provide an assessment of the economic impact of energy infrastructure disruptions on production activities and the business environment. The paper by O. Kubatko *et al*. (2023) focused on the threats to energy and economic security that arose as a result of military operations. Approaches to strengthening the sustainability of the energy sector have been developed, but no quantitative assessment of the economic losses caused by rising energy costs or the impact of these changes on investment activity in the generation sector, has been carried out. A. Yakymchuk *et al*. (2022) presented a conceptual model of energy security management in the face of threats, but did not cover the financial aspects of implementing technical solutions, in particular, the feasibility of various scenarios for the reconstruction of energy facilities from the standpoint of their economic efficiency was not evaluated.

Predictive modelling of the macroeconomic situation in Ukraine after the start of a full-scale invasion, carried out by O. Dobrovolska *et al*. (2024), covered the dynamics of the main economic indicators. However, the instability of energy supply as a separate factor affecting inflationary processes, employment, and investment inflows was not properly considered. The study by O. Kovalchuk *et al*. (2024) applied machine learning methods to model economic security, considering the interdependencies between key macroeconomic variables. However, the study did not consider the structural transformations caused by the disruption of energy systems, which limited the ability to interpret the results in an applied context. Comparative analysis of the levels of economic security in Ukraine and the countries of the European Union, conducted by V. Tokar (2024), provided an idea of key indicators of sustainability, but did not cover the specifics of the economic consequences of the destruction of energy infrastructure. The mechanisms used for its restoration in European countries were also insufficiently analysed.

The study by Y. Kuchmak *et al*. (2024) considered the regulatory and legal instruments for ensuring the economic security of Ukraine. However, the focus was not on the financial risks that arose as a result of energy instability or the effectiveness of state support for the energy sector. A. Kucher & V. Mazurenko (2024) analysed threats to industrial enterprises in the context of economic security, while the impact of power outages on the financial viability and competitiveness of producers, and adaptive strategies used to mitigate energy risks, remained outside the scope of the analysis. The study by V. Panchenko *et al*. (2024) concerned the macroeconomic impact of global financial crises, in particular in Ukraine. It did not consider the consequences of energy destabilisation as a factor that significantly affects the economic balance in emergency situations. V. Lytvynchuk & T.Y. Kolomiiets (2024) analysed macroeconomic indicators after the start of a full-scale invasion, but aspects of investment in the restoration of energy capacities and financial mechanisms for stimulating the modernisation of the energy sector remained out of consideration.

In general, the available research allowed forming an idea of the general macroeconomic and security contexts of the functioning of the energy sector of Ukraine in the context of the crisis. A number of gaps were identified, including the lack of a comprehensive approach to assessing economic losses caused by the destruction of energy infrastructure; insufficient analysis of the relationship between

energy instability, investment activity and the business environment; limited coverage of the economic efficiency of technical solutions aimed at improving the stability of the energy system in the post-crisis period. The purpose of the study was to substantiate the economic feasibility of implementing technical solutions to improve the stability of Ukraine's energy systems in the context of their partial or complete destruction as a result of armed conflict.

MATERIALS AND METHODS

The study was of a complex applied nature and was based on a combination of macroeconomic analysis with an assessment of the technical and economic parameters of the functioning of the energy infrastructure. The time frame of the study covered the period before and after the outbreak of hostilities (2020-2024), which allowed tracking the dynamics of economic indicators and assessing the impact of energy supply instability on the macroeconomic situation. The analysis covered the assessment of production capacity losses in key industries, the dynamics of changes in electricity tariffs, and mechanisms for state and international financial support for the energy sector.

Data collection was carried out based on official statistical sources, financial reports of enterprises, and analytical studies of international organisations. Data from the State Statistics Service of Ukraine (n.d.), World Bank (n.d.), the Organisation for Economic Co-operation and Development (n.d.), the United Nations Development Programme (n.d.), European Bank for Reconstruction and Development (2024) and the National Bank of Ukraine (2025) were used. In addition, financial estimates and forecasts presented by the International Monetary Fund (n.d.) were considered, in particular, regarding the assessment of economic risks and macroeconomic adjustments in connection with energy crises. Analytical data from the International Energy Agency (n.d.) were used to assess the level of energy security and recommendations for the restoration of energy infrastructure.

The research methodology included the use of statistical and economic methods to assess the economic consequences of the destruction of energy systems and determine the effectiveness of modernisation measures. Variational statistics methods were used to estimate changes in production capacity in key industries, including determining arithmetic mean values, root-mean-square deviation, and average error of the arithmetic mean. The reliability of differences between economic indicators in different periods was checked using the Student's t test with an accuracy of 0.05.

To assess the financial impact of energy supply instability on industrial enterprises, a correlation analysis with a statistical significance level of $p \leqslant 0.05$ was used. The level of dependence between changes in the cost of electricity and the dynamics of production in metallurgy, chemical industry, and mechanical engineering was determined. In addition, an analysis of changes in investment activity in response to the destruction of energy infrastructure was carried out. To assess the economic efficiency of measures to improve the sustainability of energy systems, the cost-benefit analysis method was used. The ratio between the volume of investment in the modernisation of the energy system and the potential economic benefits from its stabilisation was determined. The analysis covered the financial costs of introducing autonomous energy sources, creating microgrids, and developing electricity storage systems. The payback rate of these measures and their potential effectiveness for reducing the risks of emergency shutdowns and stabilising industrial production were calculated.

Approaches to the interpretation of the results obtained included a comparative analysis of economic losses in regions with different levels of destruction of energy infrastructure. The influence of the increase in the cost of electricity on the production costs of enterprises is analysed and the consequences of the increase in tariffs on the competitiveness of the industrial sector were estimated. Changes in logistics costs due to energy instability and its impact on the cost of transportation of raw materials and finished products were analysed. The study also applied financial analysis methods to assess sources of financing for the modernisation of energy infrastructure. The effectiveness of state mechanisms for supporting the energy sector, in particular, international lending, grant financing and public-private partnership programmes, was evaluated. The level of financial burden on the state budget in the case of various reconstruction scenarios was determined. The results obtained helped to establish the relationship between the stability of energy supply and the level of industrial activity, assess the economic benefits of investment in the modernisation of the energy system, and determine effective financial mechanisms for its restoration.

RESULTS

Economic consequences of the destruction of energy systems and losses from power outages

The destruction of Ukraine's energy systems as a result of the fighting caused significant economic losses, which covered the industrial sector, transport, housing and utilities, and the business environment. Power outages caused by damage to the energy infrastructure as a result of Russian aggression led to large-scale interruptions in production processes, which affected the volume of output and efficiency of enterprises. A significant part of industrial facilities experienced a shutdown or reduction in production capacity, which led to a decrease in the level of exports and an increase in dependence on imported products. As a result, the structure of production chains has changed, which has further affected the country's economic stability.

Unstable power supply has created additional costs for businesses that have been forced to invest in backup energy sources, such as diesel generators and battery systems. This increased operating costs and the cost of final products, which in the long run reduced the competitiveness of manufacturers in the domestic and foreign markets. High energy costs have become particularly critical for energy-intensive industries, in particular, metallurgy, chemical industry, and mechanical engineering, which have experienced significant reductions in production volumes.

The dynamics of electricity prices is one of the key economic indicators that affects the cost of production, the competitiveness of enterprises, and the purchasing power of the population. Significant fluctuations in the cost of electricity have long-term consequences for the industrial sector, services, and housing and utilities. Changes in electricity tariffs in 2020-2024 reflect the impact of

macroeconomic factors such as military operations, infrastructure destruction, restrictions on access to energy resources, and the need to attract additional financial resources to restore destroyed energy systems (Fig. 1).

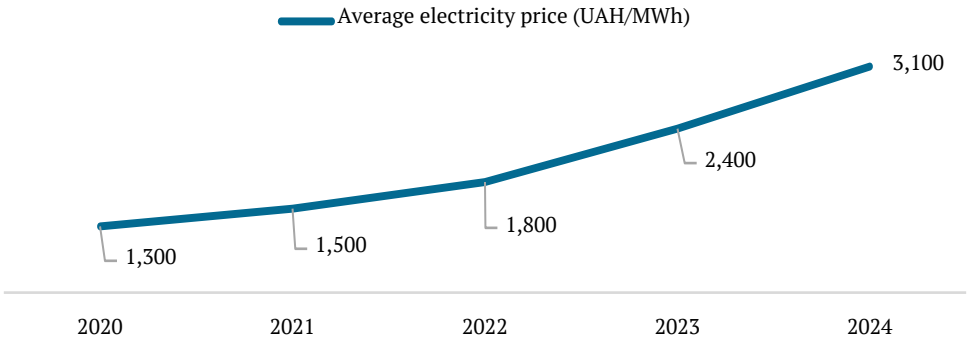

Figure 1. Electricity price dynamics (2020-2024)
Note: data reflects the average price of electricity for industrial consumers
Source: compiled by the authors based on State Statistics Service of Ukraine (n.d.)

In 2020-2021, the cost of electricity remained relatively stable, showing a moderate increase from 1,300 UAH/MWh in 2020 to 1,500 UAH/MWh in 2021. This was explained by the gradual transition to market pricing mechanisms, changes in tariff policy, and an increase in the cost of generation due to inflationary processes. Despite the increase in tariffs, the overall level of energy costs for industrial enterprises and the commercial sector remained acceptable, which contributed to the preservation of production activity. After the outbreak of hostilities in 2022, there was a sharp increase in the cost of electricity to 1,800 UAH/MWh, which was caused by the destruction of generating capacities, a reduction in supply in the energy market, and the need to import electricity. An additional factor was the increase in the cost of fuel, logistics, and disaster recovery of energy facilities. In the face of a shortage of electricity, enterprises were forced to increase the cost of backup energy sources, which additionally affected the total cost of products and services.

In 2023-2024, the cost of electricity continued to grow, reaching 2,400 UAH/MWh in 2023 and 3,100 UAH/MWh in 2024. This was conditioned by a further reduction in energy capacity, the need to attract significant investments in infrastructure restoration, and an increase in the cost of repairing and modernising the power system. High electricity prices created an additional burden on manufacturing enterprises, the transport sector, and utilities, which led to an increase in the overall level of inflation and a reduction in the solvency of businesses and the population. The transport sector has also been significantly affected by power outages. Electrified sections of railway transport suffered disruptions in operation, which led to delays in the transportation of critical goods, in particular, raw materials for industry and food products. Additional costs for diesel fuel and alternative routes increased logistics costs, which negatively affected the cost of transportation and final products for consumers. In the face of energy instability, transport companies were forced to reconsider their business models, which reduced the efficiency of logistics operations.

Housing and utilities faced rising costs to maintain energy infrastructure as networks suffered significant damage. Power outages in cities and villages led to interruptions in the operation of water supply, heat supply, and communications systems. This not only affected the quality of life of the population, but also required additional costs for emergency repairs and alternative means of energy supply. Budget expenditures of local communities to maintain the viability of critical infrastructure have increased accordingly, which has limited the ability to implement other social programmes.

The instability of energy supply has affected not only Ukraine's macroeconomic indicators, but also the global economy, in particular, the level of inflation, employment, and tax revenues. Increased spending on electricity and fuel has led to higher prices for goods and services, which has increased inflationary pressures in countries dependent on energy imports. Businesses that were unable to adapt to changes in energy supply were forced to cut staff or suspend operations, which led to an increase in the unemployment rate. The impact of the Russian-Ukrainian war on the global energy market was particularly felt by the countries of sub-Saharan Africa, where macroeconomic adjustments depended on the country's status as an exporter or importer of energy resources. Oil exporters, such as Nigeria and Angola, benefited in the short term from rising world prices, but the economic benefits were limited by structural problems and a lack of domestic refining infrastructure, while energy importers, such as Kenya and Senegal, faced significant increases in fuel and electricity costs, which worsened the state budget deficit and posed new challenges to fiscal policy (Taiwo *et al*., 2024). Reduced production and reduced commercial activity as a result of energy crises in these countries have reduced tax revenues, created additional fiscal pressures and exacerbated socio-economic instability.

The destruction of industrial facilities and power outages has led to a significant reduction in production capacity in key sectors of the economy. The decline in output has negatively affected export capacity, employment, and overall economic stability. The largest losses were recorded in industries that depend on continuous power supply, such as metallurgy, chemical industry, mechanical engineering, and energy. Data analysis allows assessing the dynamics of capacity reduction in these sectors and identifying the main factors that affected their stability (Table 1).

Table 1. Loss of production capacity in key sectors of the economy (2020-2024)

Sector of economy	2020 (%)	2021 (%)	2022 (%)	2023 (%)	2024 (%)
Metallurgy	5	3	40	38	35
Chemical industry	3	4	35	30	28
Mechanical engineering	2	3	28	25	22
Energy	1	2	45	42	40

Source: developed by the authors based on State Statistics Service of Ukraine (n.d.), World Bank (n.d.), National Bank of Ukraine (2025)

In 2020-2021, production capacity in the main industries remained relatively stable, showing slight fluctuations, which was conditioned by both general economic instability and the consequences of the COVID-19 pandemic. Metallurgy lost 5% of its capacity in 2020 and 3% in 2021, due to reduced demand for steel products, disruption of logistics chains, and restrictions on production activities due to quarantine measures. The chemical, mechanical, and energy industries also suffered moderate losses, not exceeding 4%, as most businesses faced a shortage of raw materials, a slowdown in global trade, and an uneven recovery in economic activity. The main factors of influence during this period were changes in domestic consumption, gradual adjustment of the structure of industrial production in accordance with market conditions, and the adaptation of enterprises to new economic realities after the pandemic.

Since the outbreak of hostilities in 2022, capacity losses in all sectors have increased dramatically. The energy industry suffered the most, losing 45% of its capacity due to the destruction of power plants and substations. Metallurgy and the chemical industry also experienced significant reductions – 40% and 35%, respectively, which was caused by the destruction of factories, lack of raw materials, and logistical restrictions. In 2023-2024, there was a slight recovery, but the level of losses remained high: metallurgy – 35%, chemical industry – 28%, mechanical engineering – 22%, energy – 40%. This indicates difficulties in restoring industrial capacity, the need for large-scale investments, and the dependence on stable energy supply to restore production processes.

Special attention should be paid to assessing financial losses in the regions that have suffered the greatest destruction of energy infrastructure. Destroyed power plants, transformer substations, and power lines caused prolonged power outages, which made it impossible for enterprises in these regions to function normally. The need to restore energy infrastructure requires significant financial investments, which can be received both from the state budget and through international financial assistance and investment.

The short-term economic consequences of the destruction of energy systems include immediate loss of production capacity, increased costs of enterprises and the population for energy supply, and a decrease in the level of economic activity. The long-term consequences include changes in the structure of the country's energy balance, the need to modernise energy systems, the decline in the competitiveness of some sectors of the economy, and the transformation of the economic model towards decentralised energy sources. In the context of the need for economic recovery, an important task is to ensure stable energy supply, which directly affects the functioning of enterprises and the investment attractiveness of the country. Energy stability determines the future prospects for economic development and forms the basis for restoring production, stimulating business activities, and attracting investment.

Impact of energy system sustainability on business environment and investment climate

The sustainability of energy systems is a determining factor for the formation of a stable business environment, since the level of reliability of energy supply directly affects the operational activities of enterprises, product competitiveness and investment attractiveness of the country. The business environment largely depends on the availability and cost of electricity, which determines the cost of production, the consistency of logistics processes, and the efficiency of resource management. Disruptions in the functioning of the energy infrastructure led to an increase in enterprises' costs for backup power supply systems, which significantly affects financial results and long-term business development strategy.

The dynamics of foreign and domestic investment reflects the impact of economic and political factors on the country's investment climate. Domestic investment is higher due to government support programmes, critical infrastructure financing, and enterprise capital reinvestment, while foreign investment is more sensitive to macroeconomic risks. In the period 2020-2024, there were significant fluctuations in capital investment, in particular, due to the COVID-19 pandemic, the outbreak of full-scale hostilities, international financial assistance, and economic recovery measures. The data presented in Figure 2 allow assessing trends in attracting investment and the potential for financing energy infrastructure.

The data indicate significant fluctuations in the volume of foreign and domestic investment in the period 2020-2024. In 2020, investment activity was limited by the effects of the COVID-19 pandemic, which led to a low level of foreign investment of USD 3.1 billion, while domestic capital investment remained relatively stable at USD 11.56 billion. In 2021, there was an increase in both domestic and foreign investment due to the economic recovery after the pandemic, which is confirmed by an increase in foreign investment to USD 6.5 billion and domestic up to USD 15.07 billion. This indicates an improvement in the business climate, an increase in the economic activity of enterprises and the implementation of state programmes to stimulate production.

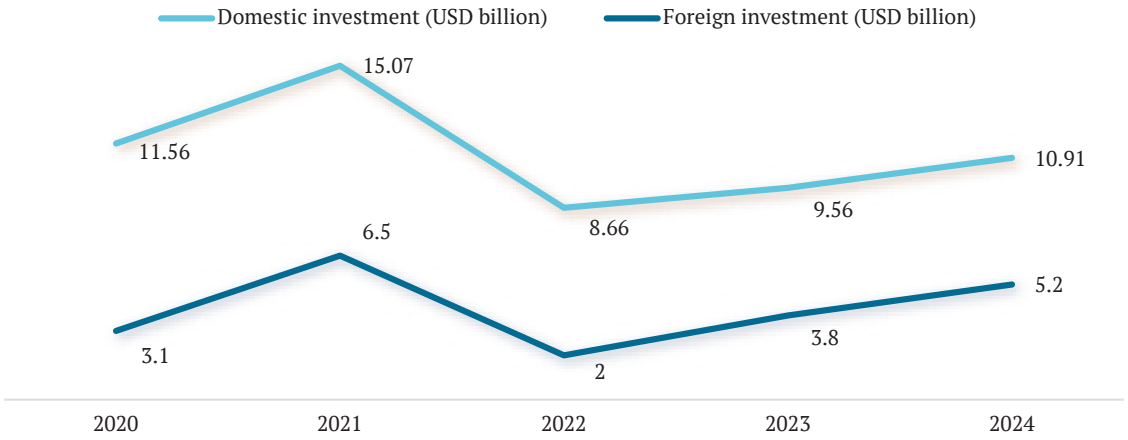

Figure 2. Comparative analysis of changes in foreign and domestic investment (2020-2024)
Note: domestic investment is higher than foreign investment due to the overwhelming share of government funding, business support programmes, and capital reinvestment of large enterprises. Foreign investment declined significantly in 2022 due to military action and increased risks to international investors, but in 2023-2024 there was a partial recovery due to international financial assistance and reconstruction support programmes. The difference between the indicators is also explained by the fact that domestic investments include financing critical infrastructure, restoring production and adapting businesses to new conditions
Source: compiled by the authors based on State Statistics Service of Ukraine (n.d.), World Bank (n.d.), Organisation for Economic Co-operation and Development (n.d.), European Bank for Reconstruction and Development (2024), National Bank of Ukraine (2025)

A sharp reduction in foreign investment in 2022 to USD 2 billion was conditioned by the high risks associated with military operations, infrastructure destruction, and the threat of capital loss, which forced international investors to reconsider their strategies. Simultaneously, domestic investment declined, but remained at USD 8.66 billion, since a significant part of the funds went to support critical industries and restore economic activity. In 2023-2024, there was a gradual increase in investment, in particular, due to international financial assistance, which contributed to an increase in foreign investment to USD 3.8 billion in 2023 and USD 5.2 billion in 2024. Domestic investment also showed positive dynamics, reflecting the adaptation of the economy to new conditions and the strengthening of the role of state mechanisms in the restoration of infrastructure and the energy sector.

Political instability significantly hinders the development of innovations in the field of renewable energy, which is confirmed by an analysis of data from 60 countries for 2002-2020 (Wang *et al.*, 2024a). It negatively affects investment in wind and solar energy, reducing government funding for research and access to international capital. The use of a two-way fixed effect model helped to minimise errors associated with endogenous factors and accurately assess the impact of political risks. The study by the International Energy Agency (n.d.) showed that this impact is amplified in countries with high levels of corruption and weak institutions, while high-quality public administration can partially compensate for the negative consequences.

Enterprises operating in conditions of unstable power supply are forced to adapt their production processes, which requires additional financial investments in the purchase and maintenance of autonomous energy sources. The cost of diesel generators, battery systems, and other backup mechanisms is increasing, which in the long run leads to an increase in the total cost of products and services (Borysiak *et al.*, 2022). This factor is especially critical for enterprises of the metallurgical, chemical, machine-building industries, and the food industry, where the continuity of the production cycle is a prerequisite for effective operation.

Instability in energy supply also leads to a reduction in investment in the real sector of the economy, as investors see the risks associated with unreliable energy supplies as one of the key barriers to long-term investment (Shahini & Shahini, 2024). The lack of guarantees of uninterrupted power supply makes it difficult to make decisions about opening new production facilities, which slows down economic development. Export-oriented business entities lose their competitive advantages due to the need to lay down additional costs for energy security, which makes it difficult for products to enter international markets.

Disruption of energy infrastructure also affects logistics processes, which is a critical factor for the functioning of industrial enterprises. Unstable power supply to railway transport and port infrastructure leads to disruptions in the supply of raw materials and exports of finished products. Additional costs for alternative routes and increased logistics risks negatively affect the efficiency of enterprises, which directly affects the level of business activity in the country. In the face of energy instability, businesses are forced to review their operating costs, increase funding for autonomous energy sources, and adapt their business models to new risks. Table 2 reflects the main factors influencing investment inflows and outflows, identifies the most affected sectors of the economy, and outlines possible mechanisms for restoring investor confidence through financial guarantees, infrastructure development, and alternative energy incentives.

Table 2. Analysis of the impact of energy infrastructure destruction on investment

Impact factor	Impact on investment	The most affected sectors	Mechanisms for restoring investor confidence
Destruction of energy infrastructure and power outages	Reduced capital investment in manufacturing industries, increased business costs	Metallurgy, chemical industry, mechanical engineering	Restoration of energy facilities, improvement of energy stability
Growth of enterprises' expenses for autonomous energy sources	Reduction of the profitability of enterprises, increasing the cost of production	Industrial enterprises, agricultural sector	Subsidising energy supply costs, supporting energy efficiency
Logistics instability and increased transportation costs	Falling investment attractiveness of the transport industry and logistics companies	Transport, logistics, trade	Investments in logistics infrastructure, compensation mechanisms
Declining confidence of foreign investors due to investment risks	Outflow of foreign capital, freezing of infrastructure projects	Financial sector, industry	Financial guarantees and insurance mechanisms for investors
Strengthening government programmes to support the energy sector	Increasing the investment attractiveness of the energy sector	Energy, manufacturing, infrastructure	State and international programmes for the development of the energy sector
Involvement of international financial institutions to restore infrastructure	Increased funding for reconstruction, improving the investment climate	Construction, industrial parks	Concessional lending and grant financing programmes
Renewable energy development as a risk reduction mechanism	Development of new investment directions, improvement of energy independence	Renewable energy, small businesses	Stimulating alternative energy, reducing the tax burden
Creating guarantees for businesses through energy risk insurance	Reducing risks to private capital, stimulating long-term investments	Industry, high-tech sectors	Ensuring the stability of the energy system and reducing investment risks

Source: developed by the authors based on V. Bohun *et al.* (2024), A. Hlushko (2024), L. Kvasnii *et al.* (2024)

The data presented in Table 2 show that the destruction of energy infrastructure has had a complex impact on the investment climate, in particular, due to a reduction in capital investment in manufacturing industries, an increase in business costs, and a decrease in the profitability of enterprises. The most vulnerable sectors were those that depend on uninterrupted power supply, in particular, metallurgy, chemical industry, mechanical engineering, and logistics. The outflow of foreign capital and the freezing of infrastructure projects further increased economic risks, which forced enterprises to adapt to new conditions due to reduced production volumes or the search for alternative energy sources.

Mechanisms for restoring investor confidence demonstrate potential opportunities for stabilising the economic situation. The implementation of state programmes to support the energy sector, attract international financing and develop renewable energy can become key tools for reducing investment risks. The country's investment attractiveness can be increased by introducing financial guarantees, insurance mechanisms for businesses, and stimulating alternative energy sources. Improving the stability of the energy system will not only contribute to the growth of domestic and external investment, but also create prerequisites for long-term economic recovery and expansion of production capacity.

Restoring the stability of the energy system is an important factor for attracting new investment, since reliable energy supply is one of the key conditions for the development of industrial parks, industrial clusters and technology parks. The stability of electricity supply contributes to the diversification of the economy, helping to expand production capacity and attract high-tech companies, for which the sustainability of energy supply is a critical factor in production efficiency. Mechanisms for reducing energy risks for businesses include the development of decentralised generation, the introduction of renewable energy sources, and the development of strategic electricity reserves. The use of solar and wind power plants allows enterprises to reduce their dependence on centralised supply, which improves the predictability of energy costs and increases the competitiveness of products.

Ensuring the stability of energy supply has long-term positive consequences for the economy, in particular, increasing employment, increasing investment activity and expanding the domestic market. Reducing energy risks creates prerequisites for restoring investor confidence, stimulating investment in industry, infrastructure, and the technology sector. Developing a sustainable energy system is an integral part of economic stability, as it provides predictable business conditions, helps to reduce risks, and improves overall resource efficiency. In this context, it is of key importance to estimate the financial costs of modernising the energy infrastructure and predict its economic benefits.

Financial costs of upgrading energy systems and potential economic benefits of improving their sustainability

Restoration and modernisation of energy systems requires significant financial resources, given the scale of destruction and the need to adapt infrastructure to modern challenges (Racek *et al.*, 2025). The main costs are related to the reconstruction of damaged generating capacities, the restoration of high-voltage networks, the construction of new substations, and the introduction of technological solutions to improve the stability of the power system. Investment needs include the purchase of new equipment, modernisation of energy management systems, and

integration of digital technologies that automate processes and reduce electricity losses.

Modernisation of conventional power generating capacities is a key step in restoring the stability of the energy system and ensuring uninterrupted power supply. Significant destruction as a result of the fighting requires large-scale capital investments for the reconstruction of thermal, nuclear, and hydroelectric power plants, and the renewal of power grids. Investments in this sector are aimed not only at restoring lost capacity, but also at improving the efficiency of the power system, optimising fuel costs, and reducing accidents. Table 3 shows the main categories of expenditures, their projected volumes and expected economic benefits from the implementation of modernisation projects.

Table 3. Estimation of costs for reconstruction of conventional power generating capacities

Expense category	Estimated costs (USD billion)	Projected economic benefits
Restoration of thermal power plants	10.5	Increase in electricity production, reduce fuel costs
Reconstruction of hydroelectric power plants	3.2	Improvement of supply reliability, reduction of water resource losses
Restoration of nuclear power plants	8.7	Stability of the power system, reduction of dependence on imported fuel
Modernisation of coal generation	4.5	Optimisation of emissions, improvement of environmental indicators
Repair and strengthening of power grids	6.0	Reduction of emergency shutdowns, improvement of load regulation

Note: estimated costs for the reconstruction of conventional power generating capacities are calculated based on analytical estimates of international and Ukrainian organisations studying the energy sector. The data was generated considering the estimates of the World Bank, European Bank for Reconstruction and Development, International Monetary Fund, and International Energy Agency analytical reports. When determining the costs, the experience of reconstruction of energy infrastructure in countries that faced large-scale destruction (Iraq, Syria, the Balkans after the conflicts of the 1990s) was also taken into consideration. Additionally, the estimates of the Ministry of Energy of Ukraine regarding the necessary financial investments in the restoration of generation facilities and network infrastructure were used

Source: developed by the authors based on World Bank (n.d.), International Monetary Fund (n.d.), International Energy Agency (n.d.), European Bank for Reconstruction and Development (2024)

The data presented show that the largest investments are required for the restoration of thermal and nuclear power plants, since they provide the main share of electricity in the total energy balance. Investments in thermal generation are estimated at USD 10.5 billion, which is explained by significant damage and the need to introduce modern technologies to improve fuel efficiency. The restoration of nuclear power plants requires USD 8.7 billion, which is conditioned by the high safety requirements and complexity of reconstruction works. Smaller amounts of funding are provided for the modernisation of hydroelectric power plants and coal-fired capacities, but their importance in the stability of the energy system remains important.

Improving the state of the power grid also plays a key role in reducing power losses and improving supply reliability. The cost of repairing and strengthening networks is estimated at USD 6 billion, which will reduce the number of emergency shutdowns and improve load regulation. The implementation of modernisation measures will not only stabilise the energy system, but will also help to reduce the cost of electricity, increase the competitiveness of enterprises, and create prerequisites for attracting additional investment in the manufacturing sector.

One of the key aspects of modernisation is the introduction of distributed generation, which reduces the dependence of regions on centralised supply and increases the stability of the energy system to external risks. The use of decentralised energy sources, in particular, solar and wind stations, reduces the cost of infrastructure disaster recovery, since local power supply reduces the load on central networks and minimises the risks of large-scale outages (Tkachenko & Ismayilov, 2024). The economic benefits of developing distributed generation are to reduce the cost of maintaining traditional power systems and reduce losses during electricity transportation.

The introduction of energy-efficient technologies in the modernisation process can significantly reduce operating costs and increase resource efficiency. The use of the latest energy-saving systems, optimisation of transformer stations, and the introduction of "smart" power grids help to reduce electricity losses and ensure its rational distribution among consumers (Kubiczek *et al.*, 2023). The long-term economic effect of such measures is expressed in reducing the cost of electricity for enterprises and households, which increases the competitiveness of the economy and helps to attract additional investment.

Financing modernisation processes requires an integrated approach, including public investment, the involvement of international financial institutions, and the introduction of public-private partnership mechanisms. The estimate of the cost of necessary capital investments depends on the level of infrastructure destruction, but preliminary calculations indicate the need to attract multibillion-dollar investments for the reconstruction and renovation of energy facilities. An important factor is the support of international financing programmes that allow not only restoring destroyed facilities, but also introducing the latest technologies that meet modern energy security requirements.

Modernisation of energy systems is of strategic importance for reducing dependence on imported energy carriers and increasing the level of energy autonomy of the country. Investment in the development of renewable energy sources contributes to the diversification of the energy balance and reduces the need for fossil fuels, which reduces the economy's vulnerability to price fluctuations in international energy markets (Ismayilov *et al.*, 2023).

Switching to local energy sources ensures stable supply and allows for predictable planning of energy sector costs.

Assessment of the economic effect of modernisation of the energy system includes reducing the cost of electricity, improving the efficiency of enterprises and creating favourable conditions for the development of innovative technologies. Improving the quality of electricity supply contributes to increasing production productivity, which is an important factor for export growth and improving the overall economic balance. Additional benefits from modernisation are associated with the formation of new jobs in the energy sector, which has a positive impact on the level of employment and socio-economic stability.

The development of renewable energy sources and decentralised supply systems is a strategic area for modernising the energy infrastructure, which increases its sustainability and reduces dependence on fossil fuels. Investments in solar, wind, and energy storage systems help to reduce emergency shutdowns, optimise energy balance, and ensure greater regional autonomy. Such measures also reduce the environmental burden, which is an important factor in international climate commitments. The presented Table 4 contains an assessment of investments in key areas of renewable energy development and projected economic benefits from their implementation.

Table 4. Evaluation of investments in the development of renewable energy sources and decentralised systems

Investment category	Estimated costs (USD billion)	Projected economic benefits
Construction of solar power plants	7.8	Reduction of the cost of fossil fuels, reduction of CO_2 emissions
Development of wind generation	6.4	Improvement of the stability of the power system, reduction of dependence on centralised generation
Investment in energy storage systems	4.9	Network load stabilisation, ensuring uninterrupted supply
Creation of distributed microarrays	3.5	Reduction of accidents and increasing regional autonomy
Integration of bioenergy plants	2.7	Development of agricultural energy, improvement of energy balance

Note: assessment of investments in the development of renewable energy sources and decentralised systems is based on the average cost of implementing similar projects in countries with similar energy challenges. The data are based on analytical estimates of the International Energy Agency, the World Bank, the European Bank for Reconstruction and Development, and research by the Ministry of Energy of Ukraine on the potential development of alternative energy
Source: developed by the authors based on World Bank (n.d.) Organisation for Economic Co-operation and Development (n.d.), United Nations Development Programme (n.d.), International Monetary Fund (n.d.), International Energy Agency (n.d.), European Bank for Reconstruction and Development (2024)

The largest investments are provided for the construction of solar power plants and the development of wind generation, which is explained by their high efficiency and the possibility of rapid implementation in different regions. Investments in solar energy are planned at the level of USD 7.8 billion, which will help to reduce CO_2 emissions and reduce the cost of fossil fuels, while developing wind generation (USD 6.4 billion) will increase the stability of the power system and reduce dependence on centralised generation. Investments in energy storage systems amount to USD 4.9 billion, which is conditioned by the need to stabilise loads in networks and ensure uninterrupted power supply in conditions of fluctuations in electricity generation from renewable sources.

The creation of distributed micro-networks and the integration of bioenergy plants are less capital-intensive areas, but their implementation can significantly improve the energy balance. Investments in micro-networks are estimated at USD 3.5 billion, which will help to increase the autonomy of regions and reduce accidents. Investments in bioenergy plants (USD 2.7 billion) will support the development of agro-energy and promote the use of local resources for energy production. In general, investments in renewable energy sources can not only increase the stability of the energy system, but also create prerequisites for reducing the cost of emergency repairs and improving the country's energy independence.

The economic benefits of implementing new energy solutions become apparent on the long-term horizon, when the efficiency of investment begins to exceed the cost of modernisation. Reducing energy supply costs, reducing accidents, and improving the regulation of network loads create conditions for stable economic development and improving the quality of life of the population. Ensuring the stable operation of the energy system is an important factor for maintaining macroeconomic equilibrium, which avoids crisis situations associated with electricity shortages. The development of a sustainable and modernised energy infrastructure is a necessary condition for sustainable economic development. Investments in the restoration and improvement of the energy system have not only short-term effects in the form of restoring energy supply, but also long-term benefits in the form of improving the competitiveness of enterprises, reducing dependence on foreign energy markets and creating a favourable environment for further growth of economic activity.

Economic efficiency of measures to improve the sustainability of energy systems and the feasibility of attracting investment

Improving the sustainability of energy systems is an important factor for ensuring the smooth functioning of the economy, reducing risks to industrial production and minimising financial losses from power outages. Assessment

of the economic efficiency of modernisation measures involves analysing the costs of implementing technological solutions and their impact on the stability of the energy system, the productivity of enterprises, and the overall competitiveness of the economy. Given the dependence of industrial enterprises on reliable electricity supply, special attention should be paid to measures that ensure energy autonomy and increase the efficiency of resource use.

Important areas for improving the sustainability of energy systems are the introduction of autonomous energy sources, in particular, solar and wind stations, which can reduce the load on centralised networks and reduce the likelihood of large-scale outages. The installation of microgrids, which combine local generation, energy storage systems and intelligent control systems, increases the flexibility of the energy infrastructure. The development of energy storage systems helps to reduce dependence on peak loads, ensure stable operation of enterprises, and increase the efficiency of using the generated electricity.

Assessing the economic efficiency of measures to improve the sustainability of energy systems is an important tool for determining optimal investment areas. Using the cost-benefit analysis method allows correlating the costs of implementing energy initiatives with the potential economic benefits achieved by reducing accidents, improving energy supply and energy efficiency. Table 5 provides an estimate of the financial costs of implementing various measures, projected economic benefits, and Cost Benefit Analysis, which demonstrates their long-term effectiveness.

Table 5. Economic efficiency assessment

Measures	Estimated costs (USD billion)	Projected economic benefits (USD billion)	Cost benefit analysis
Introduction of autonomous energy sources	7.5	12.3	1.64
Microgrid development	5.2	9.4	1.81
Energy storage systems	4.8	8.2	1.71
Increased capacity redundancy	3.6	6.5	1.81

Note: cost benefit analysis is used to evaluate the effectiveness of economic solutions by comparing the costs of their implementation and the projected benefits. In this case, the cost benefit analysis determines how profitable measures to modernise the energy infrastructure are by calculating the cost-benefit ratio. A value greater than one indicates that the economic benefits exceed the resources invested, which makes the corresponding measure economically feasible
Source: developed by the authors based on World Bank (n.d.), Organisation for Economic Co-operation and Development (n.d.), United Nations Development Programme (n.d.), International Monetary Fund (n.d.), International Energy Agency (n.d.), European Bank for Reconstruction and Development (2024)

The data in the table shows that all the measures considered are cost-effective, since the Cost Benefit Analysis exceeds 1. The highest indicator is the development of microgrids (1.81) and an increase in capacity redundancy (1.81), which indicates their high profitability in the long term. The introduction of autonomous energy sources and energy storage systems also has high cost-benefit analysis values (1.64 and 1.71, respectively), which confirms their effectiveness in stabilising the energy system and reducing the risk of emergency shutdowns.

Although the cost of implementing measures is significant, the projected benefits significantly exceed the invested funds, which indicates the feasibility of implementing them. The greatest economic benefits are expected from the introduction of autonomous energy sources (USD 12.3 billion), which is explained by their potential to reduce dependence on centralised energy networks and reduce fuel costs. Such measures can significantly improve the stability of energy supply, reduce electricity losses, and help to attract investment in the development of decentralised energy systems. Financing measures to modernise and improve the sustainability of energy systems requires an integrated approach, including government support, international financial assistance, and private investment. Attracting various financial mechanisms allows optimising costs and minimising risks for investors. The Table 6 shows the main sources of financing, their potential to attract investment, and the expected level of cost coverage.

Table 6. Opportunities to attract additional investment and mechanisms of state support

Financial mechanism	Assessment of the potential to attract investment (USD billion)	Expected cost coverage (%)
Government funding	6	40%
Grant programmes	3.8	25%
Public-private partnership	7.2	50%
Investment bonds	5.1	35%
International lending	10.4	70%

Note: assessment of the potential to attract investment is calculated based on historical data on the financing of energy projects, analytics of international financial organisations, and the capabilities of the state budget. The expected level of cost coverage is defined as the ratio of projected investments to the total financing needs for modernisation activities. The highest level of cost coverage is projected for international lending, while public-private partnerships and investment bonds have significant potential to raise funds, and government funding and grant programmes provide critical but limited support
Source: developed by the authors based on World Bank (n.d.), International Energy Agency (n.d.)

The Table 6 shows that international lending is the most promising source of financing for modernisation activities, as it allows attracting USD 10.4 billion, which covers 70% of the costs. This is conditioned by the significant efforts of international financial institutions, such as the World Bank, the International Monetary Fund, and the European Bank for Reconstruction and Development, to support the restoration of energy infrastructure. However, credit funds require careful planning for their repayment, which requires additional guarantees of financial stability.

Public-private partnerships and public financing are also important mechanisms for raising USD 7.2 billion and USD 6.0 billion, respectively, covering 50% and 40% of expenses. This indicates the need to actively attract private capital and create favourable conditions for investors. Grant programmes provide USD 3.8 billion (covering 25% of expenses), which is an important additional source of funding, since it does not require a refund. Investment bonds can raise USD 5.1 billion, which is 35% of the funding, providing the possibility of long-term attraction of private funds.

The development of sustainable energy systems has a significant impact on economic growth, as it ensures the continuity of production processes, creates new jobs in the field of renewable energy, and encourages the development of technological innovations. Investments in the modernisation of energy systems contribute to increasing the competitiveness of the industrial sector, since stable electricity supply is a critical factor for the smooth operation of enterprises and maintaining the country's export potential. The introduction of modern energy resource management technologies allows optimising electricity consumption and reducing production costs.

One of the key economic effects is the reduction of electricity losses in the networks, which reduces the cost of energy supply and reduces the burden on the budget due to the need for emergency infrastructure repairs. In addition, improving the efficiency of electricity generation and distribution contributes to reducing tariffs for industrial consumers, which is an important factor for the development of the manufacturing sector and attracting investment. Economic benefits include increasing the profitability of energy companies, which allows them to reinvest in further modernisation of the system.

The long-term effects of increasing the sustainability of energy systems are manifested in an increase in the share of renewable energy in the energy balance, reducing the impact of fluctuations in market prices for fuel and improving the environmental situation. Ensuring stable energy supply contributes to the growth of business activity, encourages the development of new technologies, and creates attractive conditions for external investment. As a result, measures to improve the stability of the energy system ensure macroeconomic stability, reduce dependence on crisis factors and create prerequisites for sustainable economic development.

The destruction of the energy infrastructure as a result of the fighting caused significant economic losses, manifested in a reduction in production capacity, a decrease in export potential, and an increase in the costs of enterprises for backup energy sources. Unstable energy supply led to an increase in the cost of electricity, which negatively affected the competitiveness of products and overall economic activity. The greatest losses were recorded in industrial sectors that are critically dependent on continuous energy supply, in particular, in metallurgy, chemical industry, and mechanical engineering. Significant fluctuations in the cost of electricity and rising costs for its emergency supply have increased inflationary pressures and created additional risks for businesses and households.

Instability in the energy supply has significantly affected the business environment and investment climate, leading to a reduction in foreign capital investment and an increase in the cost of operating activities of enterprises. The cost of autonomous power supply systems has become a significant financial burden, especially for industrial and transport enterprises. However, state programmes to support the energy sector and international investment have contributed to a partial recovery in the investment attractiveness of the economy. Financial support mechanisms, including international lending, public-private partnerships, and investment bonds, allow attracting significant resources for the reconstruction of energy infrastructure and stabilisation of the business environment.

Evaluation of the economic efficiency of measures to improve the sustainability of energy systems has shown the feasibility of investing in renewable energy sources, microgrids, and electricity storage systems. The implementation of such measures reduces electricity losses, reduces the cost of emergency repairs and improves the balance of the energy system. Modernisation of the grid infrastructure and optimisation of electricity generation contribute to improving energy efficiency, which is an important factor for economic growth and attracting long-term investment. Increasing the stability of the energy system creates prerequisites for macroeconomic stability and creates conditions for further economic development of the country.

DISCUSSION

The results obtained confirmed the significant impact of the destruction of energy infrastructure on the economic stability and investment attractiveness of the industrial sector. It was established that interruptions in energy supply caused significant losses in production, which led to a reduction in exports, an increase in the unemployment rate, and a slowdown in macroeconomic development. The analysis of the cost of modernisation of energy systems showed the high economic efficiency of the introduction of autonomous and renewable energy sources, which helped to reduce dependence on centralised supply and minimise the risks of emergency shutdowns. The study of investment flows showed that international financial support and reconstruction programmes played a crucial role in the partial recovery of capital investment, but the instability of the energy system continues to be a deterrent to attracting new investment. In addition, the simulation results confirmed the feasibility of using cost-benefit analysis to assess the effectiveness of modernisation measures, which helped to determine the most profitable areas of capital investment.

Analysis of the impact of the energy crisis in Ukraine has shown its direct relationship with the overall level of economic security of the state. The study by S. Ullah *et al*. (2024) demonstrated that internal and external conflicts cause short-term growth of energy security risks, while

long-term consequences largely depend on the level of financial development and technological innovation. The results obtained confirm that the stability of energy supply is a critical factor in macroeconomic dynamics, the level of inflation, and investment attractiveness. In contrast to the global approach of S. Ullah *et al*. (2024), the direct economic effect of the destruction of energy infrastructure and possible directions of its restoration were studied. The problem of energy shocks caused by the conflict between Russia and Ukraine was considered in the study by Y. He (2024), where their impact on South Korea's macroeconomic stability was analysed. The use of Bayesian estimation methods established that the increase in the cost of energy carriers led to a decrease in production volumes, a reduction in investment, and a drop in the consumption of petroleum products. Similar trends can be traced in Ukraine, as the rise in the price of electricity in 2022-2024 negatively affected the competitiveness of the industrial sector.

The global macroeconomic implications of the war between Russia and Ukraine, including its impact on energy security, food chains, and post-pandemic recovery, were highlighted in the study by G.M. Noorani *et al*. (2024). It was revealed that geopolitical instability was a factor of significant changes in energy supplies, which forced countries to actively develop alternative energy sources. In contrast to the global context covered by G.M. Noorani *et al*. (2024), the analysis considered national economic consequences with reference to the structural characteristics of the energy sector of Ukraine. H.H. Nguyen *et al*. (2024) analysed the impact of sanctions against Russia in 2022 on the energy markets of 57 countries. It was found that the sanctions pressure caused a significant increase in the value of energy assets in countries dependent on oil imports, while enterprises operating in the field of renewable energy received economic advantages. Compared to the focus of H.H. Nguyen *et al*. (2024) on the financial aspects of the global energy market, this study evaluated the cost-effectiveness of solutions within the national energy system.

The increase in the cost of energy carriers in 2021-2022 and its consequences for inflation, financial stability of households and industrial enterprises were analysed by B. Gajdzik *et al*. (2021). The researchers concluded that such crises accelerate the introduction of energy-efficient technologies and encourage states to step up investment in renewable energy. The analysis confirms this pattern: autonomous energy sources can reduce electricity losses by 15-20%. The study by E.H. Ateed (2024) analysed the multidimensional impact of the war between Russia and Ukraine on the global energy crisis, in particular, changes in the supply of natural gas to Europe. It was found that energy instability stimulated countries to expand domestic electricity production and develop renewable energy sources. Similar processes can be traced in Ukraine, where the destruction of energy sector facilities has led to the need to introduce microgrids and energy storage systems to increase the sustainability of the energy system.

Research by U. Kayani *et al*. (2024) was devoted to the analysis of reverse overflow mechanisms in the energy market in the context of military conflict. The use of the E-GARCH model helped to determine that the largest fluctuations were recorded in the Brent Oil market, while changes in the cost of natural gas and CO_2 emissions had a less pronounced effect. The data obtained confirm significant structural changes in the energy market. This led to an increased financial burden on industrial enterprises and a decrease in the investment attractiveness of the energy sector. The macroeconomic consequences of a sharp increase in energy prices in 2022 were discussed in the paper by M. Sun *et al*. (2024). The use of the CGE model established that sanctions against Russia led to a reduction in its gross domestic product by 5.5%, a decrease in household income by 4%, and a decrease in domestic investment by 6%. For energy-independent countries, these changes had potential economic benefits, while other economies were negatively affected.

The relationship between the markets of energy and agricultural goods during the conflict between Russia and Ukraine was analysed by N. Kutsmus *et al*. (2024) and D.H. Vo & M.P. Tran (2024). Using the TVP-VAR model and analysing data from Google Trends revealed that instability in energy markets caused significant fluctuations in prices for agricultural products. The intersectoral nature of the previously performed analysis was replaced by an emphasis on internal structural changes in production costs caused by energy instability in Ukraine. The issue of transformation of European energy policy after the outbreak of war between Russia and Ukraine was considered in the study by M.C. LaBelle (2024). It was established that the strategy of energy interdependence gave way to the concept of energy sovereignty, which led to a strengthening of the policy of energy solidarity and expansion of independent sources of supply. The study confirmed the need to reduce Ukraine's dependence on centralised energy systems and develop renewable energy as a key area for improving the sustainability of the energy system.

The study by R. Yasmeen & W.U. Shah (2024) focused on investigating the relationship between energy uncertainty, geopolitical conflicts, and the level of militarisation in the G7 countries. The use of the moment quantitative regression method helped to establish that the growth of energy uncertainty has a positive impact on the development of renewable energy, but at the same time complicates the stable expansion of both renewable and conventional energy sources. The main difference is the scale of the analysis: R. Yasmeen & W.U. Shah (2024) considered the G7 countries, while this study focused on the economic consequences of the energy crisis in Ukraine. Research by Q. Wang *et al*. (2024b) was devoted to a comprehensive analysis of evolution, areas of cooperation and promising trends in the field of geopolitics and energy security. The use of bibliometric analysis methods helped to identify three main stages of the development of this scientific area, emphasising the gradual shift of researchers' attention from the stability of energy markets to the problem of energy transition. The results obtained confirmed the need to find new technological solutions to strengthen the sustainability of the energy infrastructure.

The impact of the COVID-19 pandemic and the war between Russia and Ukraine on the energy security of Organisation for Economic Co-operation and Development countries was discussed in the paper by S. Yildirim *et al*. (2024). The analysis showed that global crises significantly increase the dependence of economies on energy imports, creating additional risks of instability. The

consequences of the destruction of Ukraine's energy infrastructure also confirm these trends, as they led to an increase in the cost of electricity and negatively affected industrial production. Strategies for ensuring energy security, considering geopolitical changes and policy measures to reduce dependence on conventional energy resources, were investigated by K.I. Ibekwe *et al*. (2024). The effectiveness of mechanisms of energy diversification and international cooperation in strengthening the sustainability of national energy systems was analysed. The transition to autonomous energy sources and decentralised systems was seen as an effective tool for minimising energy risks. The difference between the studies lies in the focus of the analysis: K.I. Ibekwe *et al*. (2024) considered the problem at the global level, while this study assessed the specific economic consequences of the energy crisis in Ukraine and possible ways to overcome them.

A comprehensive analysis of current research confirms that energy security is a key factor in macroeconomic stability and investment attractiveness of the industrial sector. It was established that the destruction of Ukraine's energy infrastructure has led to significant negative consequences, including a reduction in production volumes, a decrease in export potential, and an increase in the cost of electricity. The introduction of autonomous and renewable energy sources is seen as an effective tool for minimising the risks of emergency shutdowns and improving the sustainability of the power system. A comparative analysis of the literature showed that diversification of energy resources and modernisation of infrastructure remain the main areas for overcoming energy crises.

CONCLUSIONS

As a result of this study, a detailed assessment of losses in key sectors of the economy was carried out, in particular, in metallurgy, chemical industry, and mechanical engineering, which suffered a reduction in production capacity by 35-45% in 2022-2024. A comparative analysis of changes in the volume of domestic and foreign investment was carried out, which helped to identify the main risks for the recovery of the energy sector and identify effective mechanisms for attracting financing. It was found that the instability of energy supply caused an increase in logistics costs by 10-15% in the most affected regions, and also significantly affected the cost of industrial products.

Analysis of the sustainability of energy systems showed that prolonged power outages and a 139% increase in tariffs in 2020-2024 led to a reduction in the competitiveness of Ukrainian enterprises, a slowdown in economic recovery, and a decrease in the country's investment attractiveness. It was revealed that the development of autonomous energy sources, microgrids, and energy storage systems has a high economic potential, as it reduces electricity losses by 15-20% and increases the reliability of energy supply in crisis situations. The use of cost-benefit analysis determined that the introduction of modern energy technologies has a high cost-benefit ratio (from 1.64 to 1.81), which confirms the economic efficiency of measures to improve energy security.

Financial mechanisms for restoring energy infrastructure were considered and their effectiveness in the long term was evaluated. It was established that international lending can provide up to 70% of the necessary investments, while public-private partnerships can attract a significant amount of capital for the modernisation of critical energy facilities. Financing mechanisms were proposed, including government subsidies, international grant programmes, and the use of investment bonds for long-term capital raising. It was determined that state support for renewable energy sources is a key factor in stabilising the energy market and increasing its attractiveness for investors.

It is recommended to strengthen the state policy in the field of energy security by developing programmes of financial support for enterprises implementing autonomous energy sources and energy efficiency technologies. It is advisable to improve the mechanisms of energy risk insurance, which will help to reduce the level of investment uncertainty and attract additional capital to the energy sector. It is proposed to expand cooperation with international financial institutions and donors to finance the reconstruction of energy infrastructure and the implementation of strategic projects in the field of renewable energy. Further research may be aimed at analysing the long-term impact of energy system modernisation measures on the economic stability and competitiveness of industry. A promising area is to assess the effectiveness of the development of decentralised energy systems in the regional context, and to investigate the impact of renewable energy sources on the balance of energy markets.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Технічні рішення для підвищення стійкості енергетичних систем як складової економічної стійкості держави

Анотація. Руйнування енергетичних систем України внаслідок бойових дій призвело до значних економічних втрат, що зумовило необхідність оцінки їх впливу на промисловість, бізнес-середовище та макроекономічну стабільність. Метою дослідження було визначення основних економічних наслідків дестабілізації енергетичної інфраструктури та оцінка ефективності технічних заходів для її відновлення. Встановлено, що перебої в електропостачанні спричинили зниження виробничих потужностей у металургії на 40 %, у хімічній промисловості – на 35 %, у машинобудуванні – на 28 %, що призвело до скорочення експорту, втрати робочих місць та сповільнення економічного зростання. Зростання вартості енергоресурсів та логістичних витрат призвело до збільшення собівартості продукції на 10-15 %, що негативно вплинуло на конкурентоспроможність підприємств. У 2022 році ціна на електроенергію досягла 1 800 грн/МВт-год, а у 2024 році зросла до 3 100 грн/МВт-год, що створило додаткове фінансове навантаження на виробничий сектор та домогосподарства. Аналіз інвестиційних потоків показав скорочення іноземних капітальних інвестицій до 2 млрд доларів США у 2022 році та часткове відновлення до 5,2 млрд доларів США у 2024 році завдяки міжнародній фінансовій підтримці. Досліджено економічні вигоди від впровадження заходів із модернізації енергосистеми, зокрема, впровадження автономних джерел енергії, створення мікромереж та систем акумулювання, які дозволять зменшити втрати електроенергії на 15-20 % та підвищити стабільність енергопостачання. Використання аналізу «витрати-вигоди» підтвердило економічну ефективність таких заходів, оскільки співвідношення «витрати-вигоди» перевищило 1,6. Запропоновано механізми фінансування реконструкції, включаючи державні та міжнародні програми, які можуть покрити до 70 % витрат, що сприятиме стабілізації енергетичного сектору та відновленню економічної активності

Ключові слова: військові дії; фінансові витрати; інвестиційна привабливість; бізнес-середовище; модернізація інфраструктури

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 336.71:351.72
DOI: 10.63341/econ/2.2025.103

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Development of the financial monitoring system to increase the level of financial security of Ukraine in the conditions of threats

Abstract. The growth of threats to the financial system and the change in their directions necessitates the urgent need to improve the State Financial Monitoring Service (SFMS) of Ukraine. The purpose of the study was to determine the directions of development of the SFMS to increase the level of financial security of the country. Using the method of critical analysis, inconsistencies of legal norms regarding the SFMS were identified. This substantiated the need to expand the functions of the SFMS both to prevent criminal acts and illegal activities. It was established that increasing the level of financial inclusion of Ukrainians determines the growth of the social significance of the SFMS. The directions of institutional regulation of the SFMS, priorities for the development of this service, indicative control markers, and improvement of supervisory actions were proposed. Using the method of analysis and synthesis, an asymmetric response

Article's History: Received: 19.02.2025; Revised: 21.05.2025; Accepted: 27.06.2025

Suggested Citation:
Brezhnieva-Yermolenko, O., Hanziuk, S., Gurzhiy, T., Nitsenko, V., & Mazur, Yu. (2025). Development of the financial monitoring system to increase the level of financial security of Ukraine in the conditions of threats. *Economics of Development*, 24(2), 103-112. doi: 10.63341/econ/2.2025.103.

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to suspicious financial transactions by different categories of primary financial monitoring subjects was established. It was indicated that this violated the fundamental principle of the integrity of the SFMS and devalued its activities. It is substantiated to provide SFMS with the function of coordinating sectoral regulatory documents on financial monitoring, expanding administrative supervision over primary financial monitoring subjects, and strengthening imperative signs of punishment for failure to comply with the requirements of financial transaction control. The identified priorities for SFMS development, clarification of the norms of framework legislation in this area, and indicative markers of control of illegal transactions for financial security specialists are of practical value for institutional structures

Keywords: functions of monitoring; digitalisation of monitoring; financial inclusion; control areas; shadow economy

INTRODUCTION

The divergence of legal norms regarding the subjects of primary financial monitoring (SPFM) causes fragmentation of the system for neutralising threats to financial security, reducing the effectiveness of its component – the SFMS. The growth of external risks, in particular the use of financial instruments by the aggressor state in the hybrid war against Ukraine, and interaction with centres of international terrorism for this purpose is also significant for expanding the scope of state financial monitoring. The growth of the shadow economy, which provokes predicative crimes, also threatens the financial security of Ukraine, which indicates the need to improve the financial monitoring mechanism. This set of challenges and threats reduces the possibility of direct use in Ukraine of the experience of developed countries, acquired in peaceful conditions, in reorganising their financial intelligence services. Changing challenges require not only the prompt adaptation of the SFMS to them, but also ensuring the prospects for the development of the financial monitoring system to increase the level of financial security of the country. This determines the relevance of scientific research on this issue.

A significant number of scientific works are devoted to the problems of state financial monitoring. Thus, according to researchers H. Skrypnyk & V. Chernenko (2024), the conditions of hybrid warfare indicate the insufficient effectiveness of the SFMS and the need for its improvement. This conclusion is supported by O. Hordei & I. Yahodenko (2021), who studied the experience of relevant services in other countries. According to E. Sukholov (2023), the reason for this is the inconsistency of institutional measures, and according to the conclusions of the study by M. Perepelytsya (2021), the insufficient level of cooperation of the SFMS with the financial intelligence services of Western countries. A factor of negative impact on the effectiveness of the SFMS is the asymmetry of obtaining information by structures involved in combating money laundering and terrorist financing. According to M. Poliak-Sverhun (2024), improving SFMS should be aimed at forming a flexible and highly adaptive system for combating external risks.

This also reduces the ability to maintain secrecy regarding the process of raising suspicions of criminal activity. N. Poliova & V. Varenyk (2023) based on the study of the experience of the United States indicated the insufficient effectiveness of the Ukrainian national financial monitoring system, in particular, the lack of use of the monitoring tools and means of information exchange (in particular, the Secure Information Sharing System of FinCEN). US financial institutions are required to report to FinCEN activities that may indicate a wide range of risks. At the same time, a number of authors pointed to the imperfection of the legal framework of Ukraine regarding financial monitoring.

Ya.B. Dropa *et al*. (2021) stated that some subjects of the primary level of monitoring use various methods and schemes of shadow financial flows, pursuing their own interests, which requires improvement of the state monitoring system. This increases the need to improve the primary level monitoring system. In particular, in the article by V. Koval *et al*. (2023), the introduction of compliance control in financial institutions is proposed for this purpose. Ya. Pushak & N. Trushkina (2021) noted the presence of about two dozen interpretations of the concept of "state financial monitoring" given in the scientific works of Ukrainian researchers, regardless of the existence of a valid legislative framework on these issues, which indicates a significant discrepancy in the defined tasks and goals of financial monitoring. I.V. Kononova (2024) indicated that the inconsistency in the defined concept of "financial monitoring" due to the isolation of only some of its functions complicates its generally accepted scientific interpretation.

The review of literary sources indicated the presence of certain disagreements not only in determining the directions of development of the state financial monitoring system, but also in the interpretation of the concept of "state financial monitoring". The problem of applying the mechanism of state financial monitoring to increase the level of financial security of Ukraine in the conditions of threats also needs more careful consideration. This determined the purpose of the study – to identify the reasons for the insufficient efficiency of the state financial monitoring system, substantiate the need for changes, and suggest ways to improve the existing system.

MATERIALS AND METHODS

When conducting the study, both general and special methods of cognition were applied. The use of the specified set of methods was due to the significant divergence of the factors that lead to insufficient efficiency of the state financial monitoring system. The use of the method of critical analysis of the norms of legislation made it possible to identify problematic issues that, in order to achieve the purpose of the study and the tasks set, required research. At the next stage, using the specified method, recommendations that would eliminate the identified legal contradictions were proposed. The application of the comparative analysis method was preceded by the information search method. The search for information made it possible to identify statistical data provided on the websites of state and non-state services and organisations (State Financial Monitoring Service of Ukraine, n.d.; Transparency

International Ukraine, n.d.), international institutions (World Bank, 2021), in reporting documents of the National Bank of Ukraine (NBU) (National Bank of Ukraine, 2024) and scientific publications on banking and non-banking financial structures. Data was also obtained on changes in the receipt of notifications from SPFM about financial transactions with signs that are subject to control and the structure of sources of notifications to the SFMS with signs of illegal financial transactions. Based on this information, using the comparative analysis method, significant discrepancies were identified in the level of ensuring the tasks subject to national financial monitoring between banking structures that are controlled by the NBU and strictly adhere to the standards of the NBU and other SPFM.

The application of the comparative analysis method indicated the differentiation of the regulatory field of SPFM, which, at the next stage of the study using the analysis and synthesis methods, allowed to specify the consequences of such differentiation for the country's financial system. This became the basis for substantiating recommendations for eliminating these discrepancies. At the next stage of the study, using the analysis and synthesis methods indicated the asymmetry of responding to suspicious financial transactions of different categories of financial institutions. This, with further research, allowed to offer recommendations for eliminating the identified asymmetry in the control of financial transactions with signs that are subject to financial monitoring in banking and non-banking financial structures. The analysis and synthesis methods were applied to examine not only emerging threats but also transformations in the financial market, its digitalisation, and the increasing level of financial inclusion among Ukrainians as factors necessitating the improvement of the SFMS. The impact of these factors was investigated using the critical analysis method and recommendations were developed for the corresponding changes to the SFMS. Using the logical analysis method, the need to expand the functions of the SFMS of Ukraine to implement financial security tasks was substantiated, directions for institutional regulation of the state financial monitoring system to counteract and neutralise threats to the country's financial security were determined, priorities in the development of the SFMS, indicative markers of SPFM control for banking and non-banking financial institutions, improvement of supervisory actions for compliance by SPFM with the Legislation of Ukraine and industry norms regarding illegal financial transactions were determined.

RESULTS AND DISCUSSION

In the scientific literature, two main functions of financial monitoring are defined: control, aimed at ensuring the efficiency of the use of budget funds of Ukraine, and regulatory, aimed at identifying and stopping criminal financial transactions. At the same time, Law of Ukraine No. 361-IX (2020) singles out only one of the functions of state financial monitoring – detection and termination of criminal financial transactions. According to the norms of the Legislation of Ukraine, it is determined that the purpose of financial monitoring is to prevent the use of the country's financial system "for the legalisation of proceeds obtained through crime" (National Bank of Ukraine, n.d.). The main legal document that defines the powers of the SFMS – Resolution of the Cabinet of Ministers of Ukraine No. 537 (2015) supplements the tasks of the SFMS with the clause stating that if there are suspicions that a financial transaction (client) is connected with the commission of an act that is qualified as a crime under current legislation, the SFMS must report this to legal structures. At the same time, the separation of crime and illegal actions in the Legislation of Ukraine significantly narrows the functions of the SFMS. The normalisation of the concept of "financial monitoring" is also significantly complicated by different points of view on it: economic, financial, legal (Pushak & Trushkina, 2021). In this study, financial monitoring is defined as a permanent, consistent, multi-level, systematic, adaptive financial and legal process of analysing and identifying potential areas of threats to the country's financial security, assessing their impact, forming variable scenarios of the occurrence of dangers and neutralising the consequences of the impact of threats; control of the vulnerability of the country's financial system for the identification of threat factors, primarily from objects with a high level of danger, implementation of risk management measures and assessment of the level of effectiveness of these measures.

In the face of significant threats and new challenges to the country's financial security, the need to expand the functions of financial monitoring is increasing. Therefore, the functions of the SFMS are defined by Resolution of the Cabinet of Ministers of Ukraine No. 537 (2015), namely: implementation of institutional tasks to combat laundering of financial resources obtained through criminal means, financing of terrorism and proliferation of weapons of mass destruction; collection and analysis of information on financial transactions requiring monitoring; assessment of risks to the country's financial system; representation in international structures on the prevention and counteraction to the legalisation of financial resources should be supplemented. The following areas of expansion of the functions of the SFMS are proposed: ensuring the financial stability of the state and, for this purpose, organising counteraction to systemic risks; preventing not only financial crimes, but also illegal activities in the financial sector; interstate cooperation to prevent both international financial crimes and international illegal activities in the financial sector; protecting the population from financial dangers; supporting tax security; ensuring the stable development of the country's financial market.

Such obstacles to the activities of the SFMS as the prohibition of direct data exchange between structures and institutions of primary financial monitoring, which even concerns money laundering and terrorist financing, should be removed. This limits the possibilities of financial monitoring, since the execution of a financial operation of money laundering and the predicate crime can be separated both in time and geographically – even take place in different countries. Criminals can also use the method of dispersing the amount of money and its subsequent consolidation using the SPFM of various administrative or sectoral subordination. Prevention of such actions is also limited by the standardised methodology for assessing money laundering risks (State Financial Monitoring Service of Ukraine, n.d.).

It is also a certain problem that only fragments of data on violations are often provided to the Unified Information SFMS. The indicated fragmentation, in particular, is due to

the fact that the data, in accordance with the standardised procedure, is submitted by control of primary SPFM, which is a consequence of the prohibition of horizontal interaction of the specified subjects. This, accordingly, limits the monitoring of the transaction system that can be used by criminals, slows down, and sometimes makes verification impossible. Therefore, the norms governed by the SFMS need to be changed, in particular, regarding the expansion of the grounds for considering a financial transaction or the actions of the monitoring object to be illegal and the mandatory control of institutions and persons who were previously suspected of illegal actions.

Complex and lengthy legislative procedures do not allow for timely changes to the SFMS legislative framework, which reduces the effectiveness of financial monitoring. At the same time, industry standards and standards of individual institutional structures regulating the activities of SFMS require less time for their implementation. This leads to the differentiation of the SFMS regulatory field and causes fragmentation of the system of state neutralisation of threats to financial security, which creates additional risks for the country, in particular, in ensuring the stable functioning of the national economy. This also allows the management of some SFMS to facilitate financial offenses, deliberately slowing down countermeasures. The way out of this situation can be the complete exclusion of the human factor at certain levels of control, automated processing of information in real time and automated delivery of threat information to a centralised database and to a group of persons responsible for control. Increasing the level of digitalisation of the SFMS will allow to significantly reduce the specific costs of investigating each suspicion of criminal activity, even if the volume of suspicions increases as a result of the proposed expansion of the functions of state financial monitoring. This determines the priority in the development of the SFMS – relying on the innovative intensification of the process of state financial monitoring, rather than the extensive expansion of its personnel.

To reduce the shadow economy, it is necessary to lower the threshold level of control of financial transactions not only in terms of a one-time transaction amount, but also in terms of the use of dispersing the specified amount of funds into smaller amounts and, accordingly, increasing the number of transactions of the SPFM client over a certain period of time. At the same time, this requires a legislative expansion of the scope of state financial monitoring not only to counteract, in accordance with the Law of Ukraine No. 361-IX (2020), the legalisation of income obtained by crime, but also the legalisation of income obtained by illegal means (inconsistency of purchase and sale prices of goods, property, etc. with market prices, inconsistency of a person's standard of living with his level of income, etc.), which is not prohibited by the norms of the specified law.

Thus, the factors that determine the need to expand the functions of financial monitoring are: a high level of shadowing of the economy, the growth of corruption, inconsistency of powers of various institutional structures, unsettled regulatory and legal field in the sphere of budget security, insufficient level of coordination of industry regulatory documents, insufficient organisational support. The importance of financial monitoring increases in the conditions of a hybrid war, when the enemy does not hesitate to use all means, including the destruction of the financial system, and the significant emergency of the entire financial system of the country, when even the destabilisation of one of the structural elements can lead to the destruction of the entire financial system. In order to expand the functions of the SFMS, the list of signs of risks and factors that should be paid attention to during financial monitoring needs to be dynamically adjusted, and their signs must be entered for real-time verification in the data stream using digital tools. The practice of forming horizontal connections between financial institutions needs to be implemented in order to expand the possibilities of using digital technologies to analyse the actions of economic entities that cause suspicion. This practice should first of all be supported by relevant laws.

Indicative indicators of the SPFM for banking and non-banking financial institutions in the conditions of threats should be: certain directions and sudden changes in the scope of activities, the range of products/services of financial institutions and their clients; financial operations of SPFM clients in accordance with their risk profile; geographical location of the SPFM due to the possibility of direct or indirect influence on its activities of the aggressor state; geographic location of the place of registration of customers and counterparty institutions of the SPFM; channels/methods of transferring financial resources, etc. For non-banking financial institutions, the areas of control should also be counterparties that take part in illegal transactions with financial resources, sources of receipt of financial resources obtained by illegal means to clients and counterparties, which is due to the absence of restrictions in the legislative field regarding the structure of their capital. The protection of citizens from illegal financial transactions is important for the expansion of the functions of state financial monitoring. This is reinforced by a significant increase in the level of financial inclusion of Ukrainians, which was already ahead of Turkey's level in the period before the start of full-scale aggression (Fig. 1).

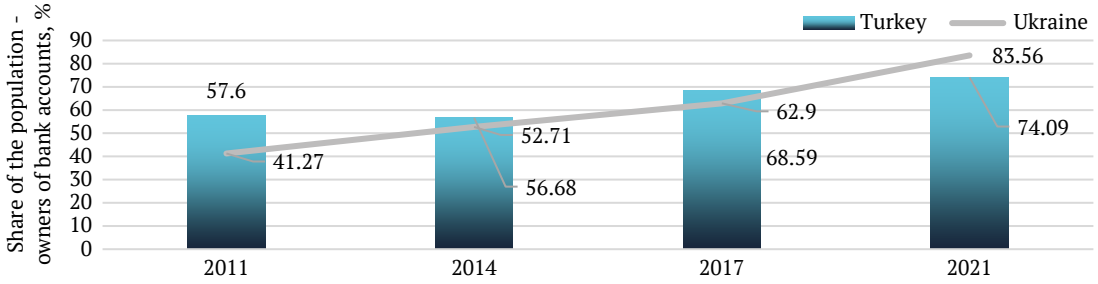

Figure 1. Comparative dynamics of the level of financial inclusion in Turkey and Ukraine
Source: constructed by the authors using data from World Bank (2021)

A significant increase in the financial inclusion of the population of Ukraine, on the one hand, is evidence of the development of the national system of financial services, an increase in the level of convenience for pensioners, individuals whose education/work is financed from the state budget, an increase in the volume of electronic payments, and, on the other hand, under the corresponding growth of the level of integration of the country's financial system, risks to financial security will be reflected in broad segments of the population. In such conditions, the reliability of the SFMS conditions the social stability of the country. The direction of the use of state financial monitoring to reduce risks in the integrated financial system of the country can be the expansion of its functions by using the capabilities of the Unified Information System of Financial Monitoring and automated referral to the specified system of notifications about potential threats and their subsequent analysis in real time using artificial intelligence tools.

It also requires an increase in the level of integration of the Unified Information System of Financial Monitoring with other industry information systems and databases, for example, with the State Register of Real Property Rights, which will protect citizens from outsiders' transactions with their property. This, in turn, requires the unification of information presentation in branch, departmental, regional databases. The level of corruption is also a factor in Ukraine's financial danger. Although according to the data of Transparency International Ukraine (n.d.), in the period of 2019-2023, with a certain unevenness of changes in the Index of Corruption Perception in Ukraine (Table 1), there is a significant improvement of the indicated index – by 4 points when comparing the data of 2019 and 2023, Ukraine's place in the ranking is not high.

Table 1. Corruption Perception Index in Ukraine

Year	Rating	Corruption Perception Index (points)
2019	120	32
2020	126	30
2021	117	33
2022	116	33
2023	104	36
2024	105	34

Source: constructed by the authors based on data from Transparency International Ukraine (n.d.)

In 2023, law enforcement agencies notified 257 persons of suspicion of corruption, but only 101 criminal proceedings were opened, for which 65 sentences were handed down by the court (State Financial Monitoring Service of Ukraine, n.d.). This indicates both the insufficient level of anti-corruption and the insufficiency of the evidence base regarding the facts of corruption. One of the directions for the formation of a sufficient evidence base regarding corrupt actions can be the expansion of the functions of SFMS to this area, which threatens the financial security of the country. The given example regarding the ratio of the number of court decisions to the number of suspected crimes also indicates the problem of evaluating the effectiveness of work in this direction. The functions of SFMS should be ensured by the implementation of framework legislation in this area and the reliance in the practical activities of the subjects of its primary link on industry norms and norms of institutional structures with a high level of adaptability to the challenges of time.

These functions should be expanded in the following directions: increasing the directions of state and internal control; dynamic adaptive change of indicators of suspicious financial transactions; expansion of the list and number of indicators. The proposal to expand the scope of the SFMS's control will lead to an increase in the number of notifications from the SPFM about financial transactions with features that are subject to financial monitoring. The increase in the workload of the SFMS requires appropriate organisational measures. At the same time, the available data indicate a significant decrease in the number of the SPFM (Fig. 2), which began in 2019. According to the indicator of 2023, the indicated decrease is almost 55% compared to the indicator of 2019, which signifies a significant decrease in the amount of information received by the SFMS.

During the same period, the number of notifications from the SPFM to the SFMS decreased by 8.3 times (Fig. 3), which accordingly reduced the workload of the SFMS.

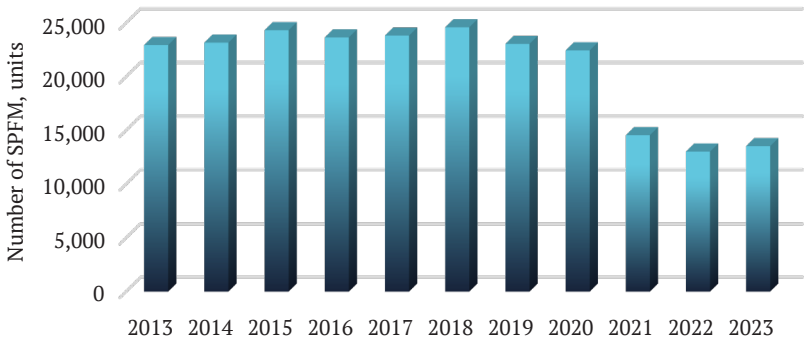

Figure 2. Number of SPFM, units
Source: constructed by the authors using data from M. Utkina (2024), State Financial Monitoring Service of Ukraine (n.d.)

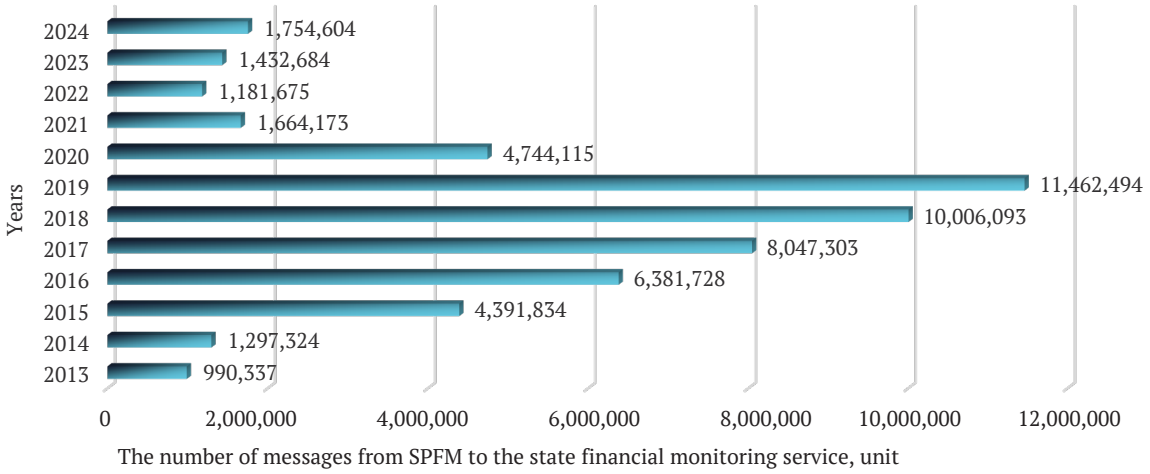

Figure 3. The dynamics of receiving notifications from the SPFM about financial transactions with the signs that are subject to financial monitoring, units

Source: constructed by the authors using data from State Financial Monitoring Service of Ukraine (n.d.)

Even the specific number of notifications from the SPFM about financial transactions with the signs that are subject to financial monitoring decreased from 497 in 2019 to 105 in 2023. This does not indicate a reduction of risks and threats, but a negative trend of decreasing attention of the SPFM to the control of these threats. From this point of view, the structure of message sources is significant. The vast majority of reports come from banking institutions (Fig. 4) and not from the SPFM of the non-banking sector. It is also significant that at the beginning of a full-scale war, i.e. during the period of acquiring the maximum value of the risks specified in the Methodology of their assessment (State Financial Monitoring Service of Ukraine, 2018) the share of messages from non-banking institutions, which was already insignificant, decreased by more than six times (Fig. 4).

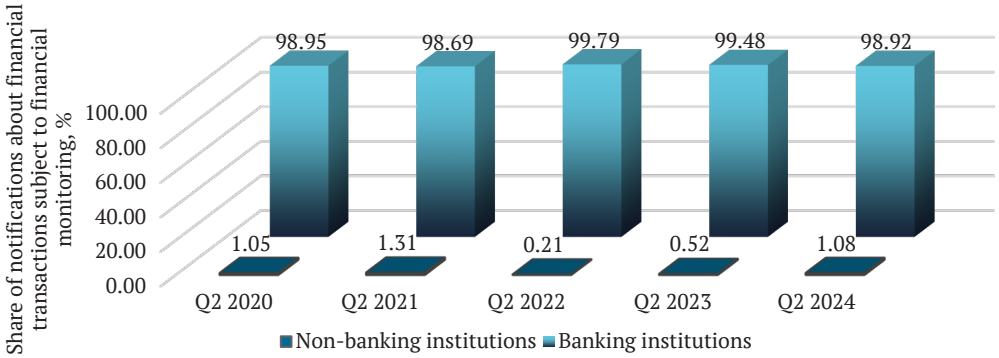

Figure 4. The structure of the sources of notifications to the SFMS for the period of 2020-2024 about financial transactions with the signs that are subject to financial monitoring, units

Source: constructed by the authors using data from State Financial Monitoring Service of Ukraine (n.d.)

This indicates the asymmetric response to suspicious financial transactions by structures and organisations involved in the fight against money laundering and terrorist financing and the proliferation of weapons of mass destruction, primarily by certain categories of the SPFM and, accordingly, their provision of information to the SPFM about suspicions of criminal activities, which forms a certain loophole for circumventing the current legal norms. This shows that the activities of the specified SPFM require additional regulatory measures and an increase in the level of control. By using the proposed approach to exclude the human factor at certain levels of control, processing information by closed software and hardware complexes directly in the SPFM in real time and sending threat information to a centralised database and their automated processing, the possibility of abuse in this sector of the financial market will be significantly reduced. In addition, the automated processing of information will reduce the burden of the financial monitoring service, even with the proposed increase in the areas of control.

The multi-sectoral affiliation of the SPFM also requires the SFMS to be given the function of coordinating the body of sectoral regulatory documents regarding financial monitoring, the expansion of administrative supervision over the SPFM, and the strengthening of the mandatory features of punishment for non-compliance with the requirements of the control of financial transactions specified in the current Law of Ukraine No. 361-IX (2020). At the same time, as shown in Table 2, the number of SPFM of the non-banking sector, even by their

individual types, is greater than the number of banks, and their total assets are commensurate with the total assets of banks, which indicates the commensurate number of financial operations of banking and non-banking institutions. At the same time, according to the SPFM profile of the non-banking sector, for example, pawnshops, lotteries, etc., these institutions are the most likely ways for money laundering.

Table 2. Changes in the number of banking and non-banking SPFM and their assets

Type of SPFM	Parameter	Years				
		2020	2021	2022	2023	06.2024
Insurance companies	Assets, UAH million	63,867	64,903	64,737	74,412	67,581
	Number, units	210	155	128	101	90
Financial companies	Assets, UAH million	186,572	216,406	243,997	250,454	258,917
	Number, units	960	922	760	559	548
Credit unions	Assets, UAH million	2,317	2,330	1,449	1,422	1,387
	Number, units	322	278	162	133	120
Pawn shops	Assets, UAH million	3,854	4,289	4,101	3,839	3,856
	Number, units	302	261	183	146	116
Banks	Assets, UAH million	1,822,841	2,053,232	2,351,678	2,944,684	3,125,617
	Number, units	73	71	67	63	62

Source: constructed by the authors based on data from the National Bank of Ukraine (2024)

In a wide range of scientific works, there is a legal interpretation of financial monitoring, which is limited only to the function of countering the legalisation of illegal income, financing of terrorist structures and organisations, financial support for the spread of weapons of mass destruction (Levytska & Osadcha, 2021; Pushak & Trushkina, 2021; Kononova, 2024). At the same time, Zh. Andriichenko (2020) and T. Yavorska *et al*. (2023) detailing the risk-oriented approach in the process of financial monitoring, noted that in the risk management system (Resolution of the Board of the National Bank of Ukraine No. 64, 2018) there is no risk of legalisation of illegal income among various types of risks. The studies of I. Rekunenko *et al*. (2020) and O. Rubai *et al*. (2023) indicated the differentiation of approaches to the interpretation of the concept of "financial monitoring" according to the level of its implementation, distinguishing the macro level, in which the international and national sub-levels are distinguished, and the micro level of subjects of economic activity.

The researchers identified the need to improve the SFMS in many areas. In the article D. Hrytsyshen *et al*. (2024) the need to expand the scope of control of the SFMS to areas related to ensuring the state security of the country was indicated. In the study by O. Smahlo (2022) the use of the SFMS mechanism to combat corruption and not only in terms of bribery, but also in terms of embezzlement of budget funds was proposed. M. Prodanchuk *et al*. (2023) proposed to expand the use of digital tools for this. These approaches are discussed in detail in the presented study.

A significant number of researchers pointed to the growing importance of state financial monitoring in wartime conditions. In the study of M. Utkina (2024) it was indicated that the conditions of martial law led to significant changes in the banking and financial spheres, which requires urgent changes to the regulatory and legal acts that regulate the conduct of state financial monitoring. It was emphasised that due to the delayed legislative procedures, certain institutional structures, in particular the NBU, introduce adaptive changes to the norms that regulate monitoring mechanisms, forms and tools. In the study by O. Rubai *et al*. (2023) it was outlined that the operational simplification of financial monitoring procedures after the start of a full-scale invasion, in particular, by the Resolution of the Board of the National Bank of Ukraine No. 60 (2022), facilitates the control of a certain group of transactions with cash funds aimed, in particular, at defence needs, reduce on-site inspections by representatives of the state financial monitoring system, etc. This is taken into account in the presented study. I. Sikora (2024) noted the importance of the SFMS for stimulating the implementation of new methods of controlling budgetary resources in wartime conditions, which leads to an increase in risks and uncertainty, and the operational assessment of the effectiveness of the financial mechanisms involved in the challenges of wartime.

The effectiveness of SFMS, according to the conclusions of Ya. Pushak & N. Trushkina (2021), is reduced due to the bureaucratised process of financial monitoring, its multi-level administrative structure, which complicates the analysis of information about actions that have signs of financial offenses and, according to N.M. Zayed *et al*. (2022), slows down decision-making on neutralising threats to the country's financial system. There are differences in scientific works in assessing the effectiveness of financial monitoring systems in European and North American countries. Thus, in the studies of O. Hordei & I. Yahodenko (2021) and D. Hrytsyshen *et al*. (2024) it is recommended to adapt the experience of financial intelligence of Western countries to implementation in Ukraine. At the same time, in accordance with the comparative analysis of financial monitoring structures in EU countries in the article by S. Khaliuk (2024) it was noted their complexity and fragmentation, insufficient adaptability to new threats even in stable economic and political conditions, and significant shortcomings in law enforcement.

A. Krytiev (2024) proposed horizontal integration of state information resources. The feasibility of forming horizontal connections of state information resources is indicated in the presented article. At the same time, the feasibility and possibility of creating a single state information space raises certain doubts. This is difficult to implement technologically due to the significant difference

in design solutions of local resources, the difference in the "generations" of the technical and software tools involved, and, most importantly, the difference in data presentation. In addition, the formation of a single information space will increase the risk of unauthorised access to information of varying degrees of secrecy for citizens and institutions of Ukraine and varying degrees of openness for international partners.

The use of functional limitations of state financial monitoring in scientific works and even time limitations, such as time limits for investigating crimes, leads to a narrowing of the possibilities for improving the mechanism of financial monitoring (Hrytsyshen *et al*., 2024). This intuitively takes the development of the financial monitoring system beyond the scope of research, which, in the context of changing challenges, reduces the effectiveness of its use for the tasks of the country's financial security. In view of the above, proposals to narrow the functions of state financial monitoring to limit the provision of institutional structures with timely and objective information on the conditions of the functioning of the financial monitoring system also seem unfounded. Limiting research to such components as institutional, methodological and regulatory support (Hrytsyshen *et al*., 2024) and leaving out of consideration its multi-level systemic nature, its complex structure, problems of various administrative arrangements, and SPFM also leads to narrowing of opportunities for improving the mechanism and development of the state financial monitoring system.

The proposals provided for improving the SFMS: expanding the functions of controlling the effectiveness of materials provided to legal structures, eliminating the asymmetry of control over the types of SPFM by implementing framework legislation in this area, providing the SFMS with the function of coordinating the body of industry regulatory documents on financial monitoring, expanding administrative supervision over the SPFM and strengthening the imperative signs of punishment for failure to comply with the requirements of controlling financial transactions, normalising the practice of forming horizontal connections between SPFM to increase the efficiency of countering illegal financial transactions even if they are partially implemented, will ensure the development of the SFMS, which will positively affect the state of financial security in Ukraine.

CONCLUSIONS

It is indicated that a rigid hierarchical functional and information structure of state financial monitoring has been formed according to the current legal acts in Ukraine. It is indicated that the complex structure of inter-sectoral information interaction and interaction between the parties of financial monitoring formed in the current legislation complicates the operative response to violations of the norms of the legislation. It is indicated that the differentiation of the legal field for different types of SFMS causes fragmentation of the system of state neutralisation of threats to financial security. It is indicated that not only new threats determine the need to improve the SFMS, but also dynamic changes in the financial market, its digitalisation and the growth of the level of financial inclusion of Ukrainians, which was already ahead of the level of Turkey in the period before the start of full-scale aggression. Since one of the inherent features of the shadow economy is the laundering of illegal income, this opens the possibility of using the mechanism of state financial monitoring, by expanding its functions, to ensure an integral influence on the pace and level of the shadow economy.

It is noted for the first time that the asymmetric response to suspicious financial transactions by structures and organisations involved in combating money laundering and financing of terrorism and the proliferation of weapons of mass destruction, primarily certain categories of the SPFM and, accordingly, their provision of information to the SFMS about suspicions of criminal activities also violates the cornerstone principle of integrity system of state financial monitoring, which can significantly devalue its activity. It is indicated that the functions of state financial monitoring should be ensured by the implementation of framework legislation in this area and the practical activity of the subjects of its primary link based on industry norms and norms of institutional structures with a high level of adaptability to the challenges of time. The directions of institutional regulation of the state financial monitoring system to counteract and neutralise threats to the financial security of the country, priorities in the development of the SFMS, indicative indicators of the SFMS control for banking and non-banking financial institutions, improvement of supervisory actions for compliance with the SFMS norms regarding illegal financial transactions have been determined. Further research will focus on identifying new factors that should be subject to financial monitoring and developing measures to neutralise their impact.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Розвиток системи фінансового моніторингу для підвищення рівня фінансової безпеки України в умовах загроз

Анотація. Зростання загроз фінансовій системі та зміна їх спрямованості зумовлює нагальну потребу в удосконаленні діяльності Державної служби фінансового моніторингу (ДСФМ) України. Метою дослідження було визначення напрямів розвитку ДСФМ для підвищення рівня фінансової безпеки країни. За допомогою методу критичного аналізу було виявлено неузгодженості правових норм, що стосуються ДСФМ. Обґрунтовано необхідність розширення функцій ДСФМ як щодо запобігання злочинним проявам, так і протиправній діяльності. Встановлено, що підвищення рівня фінансової інклюзії українців зумовлює зростання соціальної значущості ДСФМ. Запропоновано напрями інституційного регулювання діяльності ДСФМ, пріоритети розвитку цієї служби, індикативні маркери контролю та удосконалення наглядових дій. За допомогою методу аналізу та синтезу встановлено асиметричне реагування на підозрілі фінансові операції з боку різних категорій суб'єктів первинного фінансового моніторингу. Зазначено, що це порушувало фундаментальний принцип доброчесності ДСФМ та девальвувало її діяльність. Обґрунтовано надання ДСФМ функції координації галузевих нормативно-правових актів із питань фінансового моніторингу, розширення адміністративного нагляду за суб'єктами первинного фінансового моніторингу, посилення імперативних ознак покарання за невиконання вимог контролю за фінансовими операціями. Визначені пріоритети розвитку ДСФМ, роз'яснення норм рамкового законодавства в цій сфері та орієнтовні маркери контролю за незаконними операціями для фахівців із фінансової безпеки мають практичну цінність для інституційних структур

Ключові слова: функції моніторингу; діджиталізація моніторингу; фінансова інклюзія; сфери контролю; тіньова економіка

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 658.8.012.2
DOI: 10.63341/econ/2.2025.113

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LinkedIn as a key tool for targeted advertising in industrial B2B marketing

Abstract. As digital marketing becomes increasingly focused on reaching the right audience with the right message, many industrial B2B companies are turning to LinkedIn to connect with decision-makers in a more targeted way. While the platform is gaining popularity in professional circles, there is still a lack of in-depth research into how well LinkedIn works specifically for businesses that deal with complex products and long sales cycles. The aim of this study was to evaluate the effectiveness of LinkedIn as a targeted advertising platform in the context of industrial business-to-business (B2B) marketing. Utilising a combined methodology – comprising in-depth interviews of 25 industrial marketing professionals and secondary data from publicly available industry reports – this research assessed LinkedIn's adoption rates, targeting capabilities, performance metrics, and return on investment. Findings indicate a high adoption level of LinkedIn Ads, with an average of 32% of digital marketing budgets allocated to this channel. Although cost-per-click and cost-per-lead often exceed those of other social media platforms, the quality of leads generated is notably higher, reflecting strong conversion rates (5-9%). The precise segmentation features – particularly targeting by job title, industry, and company size – proved instrumental in reducing lead waste and improving campaign relevance. Despite the learning curve and the need for specialised technical content, most participants reported significant return on investment, largely attributed to reaching highly relevant decision-makers. Best practices for maximising LinkedIn's potential include dedicated

Article's History: Received: 11.02.2025; Revised: 07.05.2025; Accepted: 27.06.2025

Suggested Citation:
Oklander, M., Karandin, O., Ptashchenko, O., & Dybach, I. (2025). LinkedIn as a key tool for targeted advertising in industrial B2B marketing. *Economics of Development*, 24(2), 113-121. doi: 10.63341/econ/2.2025.113.

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landing pages, thorough A/B testing, and strategic retargeting. These results indicated LinkedIn's role as an essential platform for industrial B2B marketers aiming to balance higher upfront costs with the long-term value of engaged, high-intent leads. This research's findings can be used by industrial B2B firms to achieve higher lead quality and conversion rates by strategically allocating budgets to LinkedIn, leveraging advanced targeting and ABM features, and investing in technically robust content tailored to decision-makers

Keywords: corporate social media; account-based marketing; lead generation; return on investment; digital marketing strategy

INTRODUCTION

In the fast-changing world of industrial business-to-business (B2B) marketing, digital platforms have become essential for targeted advertising and customer engagement. Among these platforms, LinkedIn has emerged as a tool for industrial marketers aiming to connect with decision-makers, procurement professionals, and corporate buyers. With over 1 billion users globally, LinkedIn offers an environment for professional networking, thought leadership, and data-driven advertising, allowing companies to implement precise targeting strategies based on industry, job function, company size, and professional interests. Advancements in artificial intelligence (AI), automation, and programmatic advertising have accelerated the shift toward data-driven marketing in the industrial B2B sectors, further enhancing LinkedIn's capabilities as a strategic marketing tool. Unlike traditional digital advertising platforms, LinkedIn enables businesses to connect with highly relevant audiences through personalised content, sponsored posts, and lead-generation campaigns. Additionally, the platform's unique social-professional nature fosters trust-building and long-term relationship development, which are essential for B2B transactions that involve complex purchasing processes and high-value contracts.

LinkedIn has become a cornerstone in the landscape of B2B marketing, particularly in the realm of targeted advertising. Its distinctive positioning as a professional networking platform allows marketers to construct messages to specific industries, roles, and decision-makers, thereby optimising communication efficiency. From a strategic standpoint, LinkedIn's integration into B2B marketing is well supported in academic literature. S. Cartwright *et al*. (2021), through a systematic review, stressed the platform's strategic value within digital B2B ecosystems, noting its utility in long-term relationship building and lead nurturing. Moreover, the platform's effectiveness as a customer acquisition channel has been empirically confirmed in diverse regional contexts. D.W.M.N.C. Dasanayake (2022), focusing on the Asia-Pacific region, confirmed LinkedIn's superiority in reaching professional audiences and generating high-quality leads compared to other digital platforms. These findings align with broader research by Y.K. Dwivedi *et al*. (2023), who documented a significant rise in social media adoption within B2B environments and identified LinkedIn as a preferred channel due to its perceived professionalism and effectiveness.

Targeted advertising, one of LinkedIn's most valuable capabilities, has also been a focus of recent studies. H. Ji *et al*. (2024) explored the application of machine learning to refine LinkedIn's targeting mechanisms, enhancing ad relevance and return on investment. M.F. Nur & A. Siregar (2024) complemented these findings by demonstrating how cluster analysis can be integrated into LinkedIn campaigns for precise market segmentation. Importantly, LinkedIn's influence extends beyond marketing and sales into human resource management. E.P. Ododo *et al*. (2024) examined the platform's application in recruitment and selection, particularly in the IT industry. Their findings indicate LinkedIn's dual function as both a talent acquisition tool and a branding channel, highlighting how marketing efforts on LinkedIn increasingly intersect with organisational HR strategies. This convergence is especially relevant in tech-driven B2B environments where recruitment is often as strategic as customer acquisition.

Complementing these insights, Y. Wu (2025) provided a comparative perspective on new media advertising in B2B contexts, demonstrating that LinkedIn stands out among digital platforms due to its alignment with B2B market characteristics – namely, long sales cycles, multi-stakeholder decision-making, and the need for credibility-driven content. This study highlighted how LinkedIn's format supports sustained engagement and thought leadership, rather than fast-paced viral content typical of consumer-focused platforms. At the same time, the broader technological environment has influenced how LinkedIn is used in B2B contexts. M. Moradi & M. Dass (2022) analysed the role of AI in optimising social media campaigns and foresee continued integration of AI into LinkedIn marketing tools. W.Y.C. Wang & Y. Wang (2020) also emphasised the importance of analytics in transforming digital B2B strategies, enabling firms to measure and refine their content and advertising practices. Similarly, H. Fischer (2022) found that B2B sales teams increasingly rely on LinkedIn to derive value from data-driven insights, further integrating the platform into strategic sales planning.

Finally, LinkedIn's application is expanding beyond traditional marketing and recruitment. S. López-Carril *et al*. (2020) explored its growing use in education and professional development, noting that the platform fosters not just networking but also reputation building and thought leadership. This functionality enhances LinkedIn's positioning not merely as a digital channel, but as an embedded part of professional identity and organisational strategy. In summary, the existing literature and recent empirical studies collectively position LinkedIn as a highly effective and versatile tool for B2B marketing. Its value lies not only in advanced targeting and content dissemination capabilities but also in its capacity to integrate recruitment, sales, service, and professional engagement under a unified digital ecosystem. As LinkedIn continues to evolve through AI, data analytics, and platform diversification, its strategic importance for B2B firms – large and small – is set to expand even further. Therefore, the aim of this study was to

assess LinkedIn's efficacy as a platform for targeted advertising in the context of industrial B2B marketing.

MATERIALS AND METHODS

This study adopted a mixed-method approach, centred on semi-structured interviews and supported by secondary data analysis, to investigate the role and effectiveness of LinkedIn advertising in industrial B2B marketing. Conducted from January to February 2025, the research followed a cross-sectional design, capturing a snapshot of how LinkedIn was utilised and perceived within that period. The sample included 25 marketing professionals from industrial B2B firms in Ukraine – 14 from mid-sized enterprises (50-250 employees) and 11 from large firms (1,000+ employees). Participants were selected through purposive sampling, targeting individuals directly involved in managing LinkedIn advertising campaigns, and snowball sampling, expanding the respondent base via professional referrals. Sampling continued until data saturation was achieved, ensuring the emergence of no new themes.

Interviews followed a semi-structured guide designed to elicit detailed insights into LinkedIn advertising strategies, performance evaluation, and challenges. Key topics included organisational context, perceived benefits and adoption drivers, performance metrics (cost-per-click (CPC), click-through rate (CTR), cost-per-lead (CPL), conversion rates), audience targeting, content development, ROI perceptions, and best practices. The guide was pre-tested with three volunteer marketers, whose feedback helped refine question clarity, particularly regarding performance indicators. Interviews consisted of the following questions.

1. Have you run any LinkedIn ad campaigns over the past year for your company's B2B marketing efforts?
2. Roughly how much of your digital marketing budget do you usually dedicate to LinkedIn Ads?
3. What motivated your team to start using LinkedIn for advertising to industrial clients?
4. When you are setting up your campaigns, which audience filters do you rely on the most – job titles, industries, company size, or maybe something else?
5. Have you tried using LinkedIn's account-based tools like Matched Audiences or retargeting features? If so, what kind of results did you see?
6. How would you describe the quality of leads you are getting from LinkedIn compared to platforms like Facebook or X (formerly Twitter)?
7. What kinds of results are you seeing in terms of things like CPC, CTR, or conversions? Are those numbers meeting your expectations?
8. Do you think LinkedIn Ads are worth the investment? How does the return compare with other advertising platforms you have used?
9. Did you run into any difficulties getting started with LinkedIn's ad manager, especially when setting up more complex campaigns?
10. What kind of content tends to work best for your audience on LinkedIn – for example, technical whitepapers, case studies, or webinar invites?
11. When someone clicks your ad, do you send them to a general homepage, or do you build custom landing pages for LinkedIn visitors? If so, have you noticed any difference in how people respond?
12. Have you used webinars as part of your strategy on LinkedIn? If yes, how well did they perform in terms of clicks or conversions?
13. Do you regularly test different versions of your ads (like changing headlines, images, or calls-to-action)? What is your process, and what kind of impact has it had?
14. Have you ever followed up with people who clicked your LinkedIn Ads or downloaded a resource? Did retargeting improve your results?
15. Looking back at your experience, what would you say are the most effective tactics for getting good results from LinkedIn advertising in your industry?

Each interview, lasting approximately 30 minutes, was conducted via Zoom or Microsoft Teams. Ethical protocols were strictly followed: participants received an information sheet detailing the study's purpose, data usage, and confidentiality measures, and provided informed consent either in writing or via recorded verbal agreement (ICC/ESOMAR..., 2016). In addition to primary data, the study incorporated secondary sources, including LinkedIn Benchmark reports, industry publications (Content Marketing Institute, n.d.), and publicly available B2B marketing case studies. These sources provided contextual benchmarks and broader trends related to LinkedIn campaign performance.

Interview transcripts were analysed using thematic coding in NVivo software, employing an inductive approach. Two researchers independently coded the data, later reconciling discrepancies through discussion and consolidating codes into overarching themes. Qualitative findings were triangulated with secondary data to contextualise insights, particularly regarding CPL, CTR, and conversion benchmarks, highlighting both consistencies and deviations from platform-reported averages. Validity and reliability were reinforced through multiple strategies. Member checking allowed selected participants to verify interpretations. Rich contextual descriptions enhanced transferability, while an audit trail of coding decisions ensured dependability. Reflexive memos maintained throughout the study minimised researcher bias and supported confirmability, strengthening the overall trustworthiness of findings.

RESULTS AND DISCUSSION

The survey revealed that 84% of the professionals surveyed indicated their companies had used LinkedIn Ads in the past 12 months, suggesting widespread acceptance of the platform among industrial B2B firms. These findings corroborate previous insights from the Content Marketing Institute (n.d.), which reported that 80-85% of B2B marketers consider LinkedIn an essential channel. The high adoption rate implies that LinkedIn has become integral to reaching professional audiences and indicates the platform's perceived effectiveness in B2B marketing contexts (LinkedIn, 2024). On average, industrial B2B respondents allocated 32% of their overall digital marketing budget to LinkedIn campaigns, with allocations ranging from 15% to 40%. This approach reflects a strategic choice to invest heavily in LinkedIn, likely driven by the platform's strong targeting features, such as job title, seniority, and industry segmentation. While other social media platforms may be more cost-effective in certain metrics (e.g., CPC), the data indicates that

LinkedIn's specialised targeting capabilities warrant larger budget commitments in industrial B2B contexts. Notably, manufacturing, energy, and construction stand out as the leading sectors using LinkedIn Ads (Table 1).

Table 1. Key adoption metrics

Metric	Value
Adoption of LinkedIn Ads	84%
Avg. % of digital budget on LinkedIn	32%
Industries with highest adoption	Manufacturing (41%), energy (27%), construction (19%)

Source: created by the authors based on expert interviews' analysis

These industries typically deal with high-ticket items and lengthy sales cycles, making connecting with decision-makers even more crucial – a task that LinkedIn's professional emphasis effectively supports. The survey highlighted four key dimensions that industrial B2B marketers prioritise on LinkedIn: job title and seniority (92% of respondents), industry (88%), company size (72%), and geographic region (68%). The strong emphasis on job titles and seniority (92%) shows that advertisers are keenly aware of the importance of reaching decision-makers who affect capital-intensive purchasing decisions typical in industrial environments. Targeting by industry (88%) and company size (72%) enables marketers to further refine their campaigns, ensuring that messaging resonates with the distinct challenges encountered by organisations of varying sizes within specific market segments.

An equally notable finding is that 64% of respondents used LinkedIn's ABM features – such as matched audiences and retargeting – to engage with carefully curated lists of accounts. Among these ABM users, 78% rated these features as "effective" or "very effective", demonstrating LinkedIn's ability to align B2B campaign strategies with specific organisational targets. This reflects broader industry trends that recognise ABM as a powerful strategy to minimise "lead waste" by focusing on high-potential accounts instead of taking a broad approach with less targeted methods. Therefore, the precise audience segmentation available on LinkedIn helps industrial B2B marketers reduce lead waste, a challenge often faced on more consumer-focused platforms like Facebook or Instagram. Based on the survey data and open-source LinkedIn benchmark reports, the performance metrics for industrial B2B campaigns were generally favourable. Table 2 contrasts industrial B2B averages against broader LinkedIn global benchmarks.

The average CTR for industrial B2B campaigns slightly exceeds LinkedIn's general B2B benchmark. Several reasons could explain this above-average performance. Targeting precision: industrial advertisers often have highly refined audience segments, minimising irrelevant ad impressions. Technical relevance: the content (e.g., engineering case studies, and industrial product demos) resonates strongly with the niche audiences that encounter it. The industrial B2B CPC range is somewhat higher than the LinkedIn global average. This premium may result from intense competition for specialised keywords and job titles (e.g., "Plant Manager", "Senior Process Engineer", etc.), where few high-quality leads exist, and multiple industrial suppliers are bidding. Despite elevated CPCs, many respondents emphasised that the value of converting even a single lead often justifies higher click costs.

Table 2. Performance metrics

Metric	LinkedIn (B2B industrial) average	Reference (industry benchmarks)
CTR	0.45-0.60%	0.35-0.45% (LinkedIn global avg.)
CPC	$5.10-$7.50	$3.00-$5.00 (LinkedIn global avg.)
Conversion rate	5-9%	3-5% (LinkedIn global avg.)
CPL	$45.00-$60.00	$30.00-$50.00 (global B2B avg.)
Lead quality (rating)	4.2/5.0	-

Source: created by the authors based on expert interviews' analysis

A strong conversion rate highlights the effectiveness of LinkedIn's professional environment in facilitating lead generation. Typical calls-to-action in the industrial sector – such as "request a demo", "download technical whitepaper" or "register for a webinar" – tend to attract highly qualified professionals seeking detailed solutions. As can be seen from Table 2, CPL is higher than some B2C campaigns but remains reasonable for complex B2B industrial transactions, where products often involve large capital expenditures. In such contexts, generating a single lead with genuine purchasing authority can lead to substantial revenue. Survey participants rated LinkedIn-generated leads at an average of 4.2 out of 5.0 in quality, further validating the platform's capability to deliver well-targeted prospects. This rating stood in contrast to other channels such as Facebook (3.3) or X (3.1), reflecting LinkedIn's stronger professional and industry-specific user base. The average lead quality score suggests that LinkedIn prospects are generally well-informed, high-intent individuals – crucial in industrial sectors where consultative sales processes require substantial knowledge exchange. Respondents were also willing to accept a higher CPC or cost-per-lead, as these leads are more likely to convert into high-value, long-term customers. Consequently, industrial B2B marketers recognise the strategic value of LinkedIn in providing fewer but more qualified leads, which justifies a typically higher CPC and CPL.

Regarding marketing investment efficiency, 68% of respondents rated LinkedIn's ROI as "high" or "very high", particularly in comparison to other social platforms.

This perception arises from two main factors. Targeted reach – advertisers can identify senior-level stakeholders or technical experts who have a significant impact on or directly make purchasing decisions. Higher conversion rates – LinkedIn campaigns, especially those using advanced ABM strategies, frequently lead to more qualified leads. Cost management is regarded as a significant issue. Specifically, 56% of marketers view LinkedIn advertising as "somewhat expensive", making careful budget allocation and close monitoring of campaign performance essential. However, participants often noted that higher upfront costs can be recovered with just a few conversions, considering the large contract values typical in industrial B2B transactions (e.g., equipment procurement, large-scale services).

Another notable issue is the complex targeting setup. Specifically, 40% of respondents cited the learning curve associated with LinkedIn's Campaign Manager, particularly when configuring ABM lists, retargeting audiences, or applying layered demographic filters. While these features allow for highly refined targeting, their complexity can pose a barrier for smaller marketing teams or those new to the platform. Content production poses a significant challenge. Notably, 44% of respondents highlighted the need for specialised, technically robust content to engage niche decision-makers on LinkedIn. Unlike B2C environments, generic marketing copy tends to perform poorly in industrial contexts; engineers, project managers, and technical buyers expect content that demonstrates a high level of subject matter expertise. Developing whitepapers, technical case studies, and webinar materials can be resource-intensive, especially for firms with limited in-house capabilities.

Among the firms reporting successful campaigns, 68% utilised specialised landing pages customised to their LinkedIn ad messaging. These landing pages frequently addressed specific pain points and provided technical details or overviews of solutions. Respondents noted that such alignment could improve conversion rates by as much as 28% compared to directing clicks to a general homepage. Webinar-based campaigns have been shown to generate approximately 20% higher CTR compared to static eBook or whitepaper offers. In the industrial B2B sector, webinars are particularly effective as they provide live, interactive opportunities for detailed technical discussions. This approach allows potential buyers to assess a company's expertise in real time and may speed up the consideration phase in the purchasing funnel.

Another effective practice is ongoing A/B testing. For instance, 48% of respondents performed monthly A/B tests on aspects like ad copy, visuals, and audience parameters. Campaigns that continually tested at least two variations saw a 15% increase in CTR and a 12% decrease in CPL. This iterative optimisation highlights the importance of data-driven decision-making: what works for one industry segment or job function might be less effective for another. Retargeting users who previously engaged with technical content – such as visiting specific product pages or downloading a white paper – produced an average conversion rate of 7,8%, compared to 4,5% for audiences that did not receive retargeted ads. This suggests that maintaining brand visibility among interested prospects can significantly enhance lead-nurturing efforts, especially in the extended sales cycles typical of industrial purchases.

While advertising on LinkedIn tends to be more expensive in terms of CPC and CPL compared to other social networks, it continues to stand out as a highly effective platform for industrial B2B marketing – especially when the focus is on attracting high-quality leads rather than reaching as many people as possible. What makes LinkedIn particularly valuable is its ability to connect advertisers with senior professionals and technical experts, a group that is difficult to reach on broader platforms. According to M. Dzhulai (2023), given that it connects professionals worldwide, LinkedIn ought to be the primary source for building the employer brand on social networks in EU. In industries where buying decisions are complex, sales cycles are lengthy, and products are highly technical, this ability to reach the right people makes all the difference. Similar conclusions were drawn by C. Spilotro *et al*. (2023), who pointed to LinkedIn's strength in helping businesses grow internationally and connect with leads that are more likely to convert. They documented a successful LinkedIn-based international expansion strategy adopted by a mid-sized tech company, showcasing the platform's relevance for SMEs seeking global visibility. This study supports those insights.

Most interviewees said they see a strong return on their LinkedIn investments, despite the platform's relatively high ad prices. S. Saeidi & S. Hollensen (2024) suggested this is because LinkedIn allows for very specific targeting – by role, sector or seniority – making it possible to speak directly to those most likely to act. When messaging is carefully crafted and matched to the audience, results improve. They build on this by offering practical frameworks for leveraging LinkedIn, advocating for a combination of optimised profiles, curated content, and a strategic mix of organic and paid advertising. This finding is consistent with what R.M. Cortez *et al*. (2022) and N.V. Jenifer *et al*. (2023) reported: content that is tailored and thoughtfully designed for LinkedIn tends to drive more clicks and higher engagement. In addition to targeting, content quality and relevance play a pivotal role in campaign performance. R.M. Cortez *et al*. (2022) asserted that engagement on LinkedIn is closely linked to content that addresses specific professional challenges. N.V. Jenifer *et al*. (2023) further validated this by demonstrating a strong correlation between structured LinkedIn content strategies and increased user engagement.

To get the most out of LinkedIn advertising, companies must take a strategic and detailed approach. Success generally hinges on three things: using advanced targeting options to focus on specific job functions and companies; creating content that resonates with the technical needs of potential buyers; and regularly updating and testing ads to improve performance over time. These priorities correspond the work of M. Sundström *et al*. (2020), C.I. Enyinda *et al*. (2021), who highlighted the importance of continuous testing and ABM in sustaining engagement in the B2B space. C.I. Enyinda *et al*. (2021) emphasised function in integrating marketing, sales, and service, thereby facilitating the entire B2B sales cycle. Similarly, M. Sundström *et al*. (2020) highlighted how LinkedIn content shapes engagement in industrial contexts, revealing that audience interaction is influenced not only by content frequency but also by its professional relevance and tone, reinforcing LinkedIn's distinct niche within B2B digital ecosystems.

One interesting takeaway from the interviews is the growing role of influencer-style marketing, even in technical industries. Though still developing in B2B, endorsements from trusted experts on LinkedIn – especially those with real industry knowledge – can influence buying decisions. Another growing area of interest is influencer marketing on LinkedIn. J. Mero *et al*. (2022) identified multiple B2B influencer strategies – including employee advocacy and partnerships with niche opinion leaders – that significantly boost brand credibility and reach. They argued that when done authentically, this kind of promotion can also speed up the decision-making process. S. Harshitha *et al*. (2021) highlighted the potential of nano-influencers in B2B campaigns, arguing that even small-scale influencers can yield substantial impact when they possess deep industry knowledge.

New features on LinkedIn, like Conversation Ads and interactive video formats, are creating fresh opportunities for advertisers to interact with potential customers in more engaging ways. These tools are especially useful for campaigns that aim to educate or demonstrate complex products. A. De Jong *et al*. (2020) and S. Harshitha *et al*. (2021) both found that AI-powered tools – like automated bidding or predictive targeting – can improve ad performance by reducing guesswork and increasing efficiency. These innovations do not just lower costs; they also help ensure the right content reaches the right people at the right time. A. De Jong *et al*. (2020) emphasised the strategic significance of practice-based approaches in B2B marketing, where platforms like LinkedIn serve not just as communication tools but as dynamic spaces for co-creating value and knowledge.

Despite its increasing importance, the use of LinkedIn for industrial B2B marketing remains an underexplored area in academic literature. Existing studies primarily focused on business-to-consumer (B2C) digital marketing, creating a gap in understanding how LinkedIn's advanced targeting features affect customer acquisition and retention in industrial markets. Some researchers have examined LinkedIn's role in digital marketing strategies for small and medium enterprises (SMEs), highlighting its significance for international market expansion, while others have investigated the effects of social media marketing on B2B sales processes. Moreover, content marketing strategies through LinkedIn have been recognised as crucial in driving engagement and thought leadership among industrial marketers.

This research aimed to close the research gap by analysing LinkedIn's role as a targeted advertising tool in industrial B2B marketing, evaluating its effectiveness in lead generation, and investigating best practices for optimising ad performance. Given the growing reliance on LinkedIn for content marketing and B2B sales engagement, it was essential to explore the extent to which firms can leverage the platform's algorithmic targeting and AI-driven features for marketing success. This study contributes to the ongoing discourse on digital transformation in B2B marketing by leveraging empirical data, industry case studies, and expert insights. It offers strategic recommendations for companies looking to enhance their LinkedIn advertising efforts and provides valuable implications for marketing professionals, industrial enterprises, and academic researchers interested in the intersection of social media marketing and industrial B2B strategy.

As LinkedIn continues integrating automation and AI, it reflects a broader shift in marketing toward data-driven strategies. Built-in analytics, when combined with external tools, give marketers deep insight into what is working, what is not, and where to allocate resources next. To better understand the long-term impact of these tools, more studies are needed – particularly ones that follow campaigns over time in industries with long sales cycles and high-value transactions. That said, there are challenges. About 40% of respondents noted that LinkedIn's ad manager has a steep learning curve, especially when setting up advanced campaigns. Smaller marketing teams may find it difficult to keep up. Additionally, nearly half of the participants mentioned the difficulty of creating the kind of in-depth content that works well on LinkedIn. Generic messages do not resonate in this space – engineers and other technical buyers expect specific, expert-driven information, which requires time and resources to produce.

Still, those who invest in content and campaign management tend to see results. For example, companies that used landing pages aligned with their LinkedIn Ads reported better conversions than those who simply redirected traffic to a generic homepage. Similarly, webinars often performed better than downloadable content, especially when they allowed prospects to engage with subject-matter experts live. A/B testing also played a big role in improving campaign outcomes: teams that ran regular tests saw higher click rates and lower costs per lead. Retargeting also proved effective. When companies followed up with people who had previously engaged with technical content – like visiting a product page or downloading a white paper – the conversion rate improved noticeably. This kind of follow-up keeps the brand top-of-mind and is particularly useful when buyers are moving slowly through a long decision-making process.

LinkedIn has become more than just a place to advertise – it is now a key tool for building credibility and developing long-term relationships in the industrial space. As more companies adopt ABM, embrace technical storytelling, and invest in advanced analytics, LinkedIn's role in the B2B marketing landscape is only likely to grow. To be effective, however, companies must treat it as more than just another ad platform. It demands planning, testing, and cross-functional coordination to truly deliver value. In summary, LinkedIn is a high-cost, high-reward option for industrial marketers. Its precision targeting, professional audience, and expanding suite of AI tools make it one of the most powerful platforms available. Companies that succeed here are the ones willing to invest in expertise, creativity, and long-term thinking.

CONCLUSIONS

The findings of this study indicated LinkedIn's increasingly strategic role in industrial B2B marketing. With 84% of respondents reporting active use of LinkedIn Ads over the past year, the platform demonstrates strong penetration in industries characterised by complex products, extended sales cycles, and a need to reach high-level decision-makers. The platform's professional targeting capabilities – especially by job title, seniority, and industry – make it particularly

well-suited for industrial marketers seeking precision over volume. Budget allocation patterns reinforce this perceived value. On average, firms allocated 32% of their digital advertising budgets to LinkedIn campaigns, a substantial commitment that highlights confidence in the platform's ROI. Industries such as manufacturing, energy, and construction led in adoption, consistent with their need to reach technically competent and capital-influential audiences.

Performance metrics further validate the investment. Industrial B2B campaigns on LinkedIn outperform global averages in CTR (0.45-0.60% vs. 0.35-0.45%), conversion rate (5.0-9.0% vs. 3.0-5.0%), and lead quality (4.2/5.0), despite higher CPC and CPL. This suggests that while LinkedIn is not the most economical platform on a per-impression basis, it excels in delivering qualified, high-intent leads – an essential factor in sectors where even a single conversion can represent substantial revenue. Notably, 64% of surveyed marketers employed ABM strategies using LinkedIn's advanced features such as Matched Audiences and retargeting. Among these users, 78% rated ABM tools as "effective" or "very effective", illustrating LinkedIn's ability to support high-precision campaigns focused on key accounts. The emphasis on ABM aligns with broader trends in B2B strategy, where targeted engagement is favoured over generalised outreach.

Over half of respondents (56%) consider LinkedIn advertising "somewhat expensive", particularly for firms with constrained marketing budgets. In addition, 40% cited the complexity of LinkedIn's campaign management tools as a barrier, especially when building multi-layered ABM lists or configuring retargeting filters. Furthermore, 44% of participants noted that content creation remains a significant hurdle, as industrial buyers demand high-quality, technical, and educational content rather than generic marketing messages. Despite these constraints, firms that implemented best practices – such as specialised landing pages, webinar-based lead generation, and A/B testing – reported measurable gains. For instance, tailored landing pages led to conversion increases of up to 28%, while webinar offers generated 20% higher CTRs compared to static content formats.

Moreover, retargeting audiences who previously engaged with technical materials boosted conversion rates to 7.8%, confirming the importance of sustained engagement across the buyer's journey. Hence, LinkedIn has evolved into a high-impact channel for industrial B2B marketing – not due to volume, but due to its capacity to deliver fewer yet significantly more relevant leads. Its strength lies in precision, content alignment, and the ability to facilitate trust-building interactions with decision-makers. While higher costs and technical complexity may present obstacles, the empirical evidence indicates that for industrial marketers with clear objectives and strong execution capabilities, LinkedIn offers a return on investment that justifies its premium. Future research should investigate the long-term effects of evolving LinkedIn advertising features – including Conversation Ads and new targeting enhancements – on B2B lead generation and ROI.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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LinkedIn як ключовий інструмент таргетованої реклами в промисловому B2B маркетингу

Анотація. Оскільки цифровий маркетинг все більше зосереджується на досягненні потрібної аудиторії з правильним повідомленням, багато промислових B2B-компаній звертаються до LinkedIn, щоб більш цілеспрямовано налагоджувати зв'язок з особами, які приймають рішення. Хоча платформа набирає популярності в професійних колах, все ще бракує глибоких досліджень того, наскільки ефективно LinkedIn працює саме для компаній, які мають справу зі складними продуктами та довгими циклами продажів. Метою цього дослідження було оцінити ефективність LinkedIn як платформи для таргетованої реклами в контексті промислового маркетингу між бізнесом для бізнесу (B2B). Використовуючи комбіновану методологію, що включала глибинні інтерв'ю з 25 фахівцями з промислового маркетингу та вторинні дані зі загальнодоступних галузевих звітів, було оцінено рівень використання LinkedIn, можливості таргетування, показники ефективності та рентабельність інвестицій. Результати свідчать про високий рівень використання LinkedIn Ads: в середньому 32 % бюджетів цифрового маркетингу виділяється на цей канал. Хоча ціна за клік і ціна за лід часто перевищує аналогічні показники на інших платформах соціальних мереж, якість лідів, що генеруються, є значно вищою, що відображає високий рівень конверсії (5-9 %). Точна сегментація, зокрема таргетинг за посадою, галуззю та розміром компанії, допомогає зменшити втрати потенційних клієнтів і підвищити релевантність кампанії. Незважаючи на тривале навчання та потребу в спеціалізованому технічному контенті, більшість учасників повідомили про значну віддачу від інвестицій, що значною мірою пов'язано з доступом до релевантних осіб, які приймають рішення. Найкращі практики для максимізації потенціалу LinkedIn включають спеціальні цільові сторінки, ретельне A/B-тестування та стратегічний ретаргетинг. Ці результати засвідчили роль LinkedIn як важливої платформи для промислових B2B-маркетологів, які прагнуть збалансувати вищі авансові витрати з довгостроковою цінністю залучених потенційних клієнтів, які мають серйозні наміри. Результати цього дослідження можуть бути використані промисловими B2B-компаніями для досягнення більш високої якості лідів та коефіцієнтів конверсії шляхом стратегічного розподілу бюджетів на LinkedIn, використання розширених можливостей таргетингу та ABM, а також інвестування в технічно надійний контент, адаптований для осіб, які приймають рішення

Ключові слова: корпоративні соціальні мережі; маркетинг на основі акаунтів; генерація лідів; рентабельність інвестицій; стратегія цифрового маркетингу

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 336.76:005.94:504
DOI: 10.63341/econ/2.2025.122

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Investment banking innovations as a response to current threats to sustainable development

Abstract. The study was devoted to analysing the impact of the latest technologies, such as blockchain, artificial intelligence, algorithmic trading, and financial technologies, on investment banking in the period from 2019 to 2024. Within the framework of the paper, an analysis of the approaches of leading investment banking centre countries to the introduction of innovations was conducted. The main results showed that the implementation of blockchain allowed reducing the cost of processing financial transactions by up to 30% and lowered their execution time to several seconds, which substantially increased the efficiency of processes in international transfers. Artificial intelligence helped reduce costs by 15% by improving data analysis processes, and algorithmic trading covered 70% of the volume of transactions in the market, increased liquidity and decreased the cost of executing transactions by 30%. The introduction of financial technologies, which grew by 25% in 2023, made financial services available to a wide range of users, including through mobile platforms and innovative solutions such as crowdfunding. This study also determined that companies with a high level of innovation had 30% more successful projects. In addition, the analysis showed that the integration of environmental, social and governance aspects led to an improvement in the financial performance of institutions, in particular, an increase in market capitalisation by 4-6%. The results of the study highlighted the importance of investing in the latest technologies to ensure the sustainability of investment banking in the face of global threats to sustainable development, such as economic instability, climate challenges, and digital inequality. The practical importance of the study lies in the fact that it provided recommendations for financial institutions on the introduction of technological innovations that contributed to improving their financial stability

Keywords: economic efficiency; financial instruments; artificial intelligence; blockchain; digital currencies in investments

INTRODUCTION

Investment banking is undergoing profound transformations under the influence of rapid technological progress, global economic fluctuations, and social shifts. These changes create new challenges that threaten the stability of financial systems and require a rethink of investment approaches. In particular, economic instability, climate

Article's History: Received: 24.01.2025; Revised: 18.05.2025; Accepted: 27.06.2025

Suggested Citation:
Tkachov, Z., & Pryiatelchuk, O. (2025). Investment banking innovations as a response to current threats to sustainable development. *Economics of Development*, 24(2), 122-133. doi: 10.63341/econ/2.2025.122.

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change, and social inequality have become key factors contributing to the need for innovative solutions in investment banking. Such challenges not only undermine traditional financial decision-making models but also create new opportunities for sustainable development through the integration of environmental, social, and governance (ESG) criteria into the investment process.

The relevance of the study of innovations in investment banking is due to the need to adapt to modern global realities, and simultaneously, the formation of a more sustainable and responsible financial ecosystem. Despite the active efforts of international organisations, in particular, the United Nations and the European Union, to implement the concept of sustainable finance in practice, there are still a considerable number of challenges related to the effectiveness of these approaches. In this context, the search for innovative tools and strategies becomes critical to improving the viability of investment structures in an unstable and dynamic environment.

Research in investment banking innovation points to the need for new approaches that provide flexibility and adaptability in response to current challenges. For example, according to the conclusions of O.O. Kolomyitsev (2024), the introduction of blockchain technologies can substantially increase the transparency and security of investment processes, which, in turn, can reduce risks for investors. The author emphasised that this can stimulate greater confidence in financial institutions and improve their reputation in the market. Blockchain technologies, in particular, allow storing data unchanged, which increases their value for market participants.

M. Khutorna *et al*. (2022) and V.S. Kurdupa (2024) focused on the need to use algorithmic trading and artificial intelligence (AI) to optimise investment decisions. They noted that these technologies can improve the efficiency and speed of decision-making, but there is a risk of systemic errors that can lead to unpredictable consequences in financial markets. Algorithmic trading allows quickly processing of large amounts of data, which increases the competitiveness of banks in the market (Iorgachova & Kovalova, 2025). It is important to consider that the introduction of such technologies requires substantial investments in infrastructure and personnel training to avoid possible risks.

Research conducted by O.L. Plastun (2021) emphasised the importance of integrating ESG factors into investment decisions, noting that companies that implement these principles demonstrate higher financial stability. The author examined in detail exactly how ESG factors affect investment attractiveness and what benefits they bring in the long term. In addition, a study by M.E. Khutorna (2020) pointed out the potential of implementing digital currencies of central banks to improve payment systems and reduce transaction costs, which can be an important factor in the development of investment banking. The author analysed various models of digital currency implementation and their impact on financial stability. Notably, the introduction of digital currencies may change existing money circulation models and require new regulatory approaches.

In addition, according to E.A. Salakhov (2023), integrating AI into data analysis processes can substantially improve the accuracy of market trend forecasts and the effectiveness of investment decisions. E.A. Salakhov (2023) examined the benefits of using AI to analyse large amounts of information and make more informed decisions. AI can automatically identify market patterns, allowing investors to act proactively. However, it is important to account for the ethical aspects of using AI, in particular, the possibility of bias in algorithms that can affect the objectivity of decision-making.

An important study conducted by K. Chabanenko & A. Pavlova (2024) concentrates on the role of sustainable investment, underlining those investors who take into account environmental and social risks get better results in the long run. The authors analysed specific cases of successful investments that consider ESG factors and their impact on financial results. Another study conducted by V.O. Tkachuk & A.A. Tymkiv (2017) demonstrated that the introduction of new technologies, such as big data and analytics, can substantially improve the ability of banks to adapt to changing market conditions. The authors focused on examples of implementing these technologies in real-world conditions, which enables banks to respond faster to market changes. This may include developing new products and services that meet the changing needs of customers and allow banks to remain competitive. However, despite the availability of such research, there is a gap in understanding how these innovations can be integrated into overall investment banking strategies in the face of global threats. This study aimed to analyse how innovative solutions in investment banking can become an effective tool for solving modern sustainability challenges.

MATERIALS AND METHODS

The study covered the period from 2019 to 2024, which provided for the comprehensive examination of the latest trends and changes in investment banking and the financial sector in general. The main source of information was scientific publications, articles, reports of international organisations, and analytical research related to innovations in the financial sector and investment banking. Among them, the Organisation for Economic Co-operation and Development (OECD Roundtables on..., 2021), World Bank (2024), and International Monetary Fund (2024) publications should be highlighted. Materials from the Bank for International Settlements (2024) and PricewaterhouseCoopers (2024) (PwC) were also used, which provided important data on current trends in the industry. In particular, sources covering the use of the latest technologies, such as blockchain, AI, algorithmic trading, and aspects of integrating ESG factors into investment decisions were analysed. Research has shown how these technologies are changing traditional business models and contributing to the growth of financial institutions' efficiency (United Nations Environment Programme, 2023; European Commission: European Education and Culture Executive Agency, 2023; Deloitte, 2023).

In the course of the study, a comparative regional analysis was applied, which allowed evaluating different approaches to implementing innovations in financial institutions in leading investment banking centres, such as the USA, Estonia, China, India, and Ukraine. This diversity of regions has provided a deeper understanding of global trends and local features. Several regional practices were selected for comparison: in the US, innovations in

algorithmic trading and their impact on market stability were examined; in EU countries, the introduction of blockchain technologies to improve settlement processes was analysed; in Ukraine, ESG initiatives were investigated in the context of investment strategies.

Approaches to the introduction of AI for risk analysis and portfolio optimisation, and innovative solutions in the field of digital assets and financial technologies (fintech) were also compared (Statista, n.d.; Gartner, n.d.; Bloomberg, 2024). These cases represent different regions and contexts, which allowed analysing how innovation has affected the financial sustainability of each of the institutions. The comparison included an analysis of successful examples of technology implementation, including the cases where innovations did not bring the expected results. This helped identify key factors influencing the effectiveness of innovation implementation and form recommendations for further development (McKinsey & Company, n.d.; Accenture, n.d.; World Economic Forum, n.d.). The results obtained were interpreted in the context of current trends in investment banking.

RESULTS

Impact of innovative technologies on financial implications

During the period from 2019 to 2024, Ukrainian investment banking underwent major changes in response to the challenges of war, macro-financial difficulties, and restrictions on access to international capital. In the context of armed conflict, financial institutions were forced to adapt their strategies to ensure the sustainability and support of the economy. Ukrainian banks have started actively implementing digital technologies to improve customer service and reduce costs. For example, remote service has become the standard, and new platforms for online investing have gained popularity. This allowed maintaining activity in the capital market, despite difficult conditions. Investment banking in Ukraine has started to actively use green financial instruments. For example, in response to the needs of recovery and the transition to a green economy, banks began issuing green bonds to finance renewable energy projects such as solar and wind power plants. This was an important step towards achieving the Sustainable Development Goals.

Compared to investment banking in Europe and the United States, leading financial centres such as London, New York, and Frankfurt are dominated by innovative approaches focused on integrating new technologies into financial services. For example, London is actively developing projects related to financing climate change adaptation projects, were investment banks act as intermediaries between investors and environmental initiatives. In New York, the emphasis is placed on sustainability-linked instruments, which encourage companies to achieve sustainable goals through financial benefits. In addition, an important trend is the use of transition bonds, which support transition projects in the field of energy and ecology. These tools provide funding for companies looking to move to greener practices, even if they have not yet achieved full sustainability (Dua, 2022).

Thus, investment banking in Ukraine, although facing serious challenges, finds new opportunities for development through the introduction of innovative financial instruments and adaptation to market conditions. It is advisable to highlight the key innovative solutions that have played a decisive role in the transformation of the financial sector to summarise the technological changes that have been observed in investment banking both in Ukraine and internationally. The main innovative technologies that have affected the sector are blockchain, AI, algorithmic trading, and fintech (Table 1).

Table 1. Innovative technologies in investment banking: applications and system effects (2019-2024)

Technology	Scope of application	The main effect for banking
Blockchain	International payments, supply chains, smart contracts	Reduce costs, increase security, and increase transparency
AI	Data analysis, credit scoring, risks, fraud detection	Automation, improving forecasts, reducing errors
Algorithmic trading	Trading in securities, assets, market analysis	Increased liquidity, faster execution, lower costs
Fintech	Mobile payments, crowdfunding, P2P lending, online investing	Availability of financial services, reducing barriers to entry

Source: compiled by the authors based on OECD Roundtables on Competition Policy Papers (n.d.)

Innovative technologies in investment banking, such as blockchain, AI, algorithmic trading, and fintech, are substantially changing the landscape of financial services in Ukraine and the world. Blockchain provides transparency, security, and speed of financial transactions. The introduction of this technology reduces transaction processing costs by up to 30%, decreasing the transaction time from a few days to several minutes. For example, Ripple (n.d.) uses blockchain for international payments, and platforms such as Ethereum (n.d.) allow creating smart contracts that automate the execution of transactions without intermediaries. This increases security and reduces the risk of fraud. AI is actively used to automate processes such as big data analysis, credit risk assessment, and fraud detection. Due to AI, financial institutions can more accurately predict market trends and detect anomalies in data faster, which reduces the risk of losses. AI-based credit scoring systems can take into account not only traditional factors but also alternative data, such as consumer behaviour on social media.

Algorithmic trading uses complex mathematical models to automate trading strategies, which reduces the human factor in trading. The share of algorithmic trading in the market has reached 70% of the total volume of transactions, which increases market liquidity and reduces transaction costs. For example, Virtu Financial performs millions of transactions daily, making it an industry leader (Groette, 2024). Algorithmic trading also helps reduce the impact of emotions on decision-making, which can lead to more rational investments. Fintech includes new

platforms such as mobile payments, crowdfunding, and peer-to-peer lending. In 2023, financial technologies grew by 25% compared to the previous year, which indicates a growing demand for innovative financial solutions and an increase in the availability of financial services for consumers. Platforms like Robinhood allow users to make free trades on the stock market, making it much easier to access investments. Other companies, such as TransferWise (now Wise), provide international transfers with low fees, making them available to the general public (Agnihotri & Bhattacharya, 2023). Thus, innovative technologies in investment banking not only increase efficiency and reduce costs but also open up new opportunities for improving customer service. The introduction of these technologies allows financial institutions to adapt to new challenges and remain competitive in a rapidly changing market.

In the modern world, investment banking faces numerous challenges related to sustainable development. These challenges include climate change, social inequality, lack of transparency in financial processes, and growing cyber threats. In response to these threats, financial institutions are actively implementing innovative technologies that both help reduce risks and contribute to achieving the Sustainable Development Goals. Table 2 summarises the key threats to sustainable development in the field of investment banking, innovative solutions that are proposed to overcome them, as well as the expected positive impacts on the financial system.

Table 2. Compliance of innovative technologies with key threats to sustainable development in the field of investment banking

Threat to sustainable development	Innovative response	Expected impact on the financial system
Climate change	Using financial technologies to evaluate ESG	Reduce investment risks and increase business sustainability
Social inequality	Development of micro-credit platforms	Increasing access to financial services for the low-income persons
Lack of transparency	Blockchain integration to increase transparency	Increase confidence in financial institutions and reduce fraud risks
Cyber threats	Using AI for cybersecurity	Reduce cybercrime risks and protect customer data

Source: compiled by the authors based on K. Gounden *et al.* (2022), S. Bustamante *et al*. (2022)

The innovative technologies listed in Table 2 indicate the importance of adapting the financial sector to new challenges related to sustainable development. The use of financial technologies to assess ESG factors is a key component in this adaptation. In particular, these technologies help financial institutions and investors better understand the risks associated with investing in companies that do not meet sustainability standards. This assessment allows not only to reduce the risks of financial losses but also to support businesses that strive for sustainable development. In addition, the integration of ESG factors into financial decisions increases investor confidence, as it indicates the company's social responsibility and obligations to society and the environment. The growing role of these factors also contributes to the formation of new standards in the financial sector, where investors increasingly prefer companies that demonstrate a responsible attitude to environmental and social issues. In the face of increased public pressure and regulatory requirements, the use of technologies that allow assessing ESG factors is becoming critical for maintaining the competitiveness of financial institutions. Thus, innovative technologies help identify and reduce risks and create new investment opportunities that meet the principles of sustainable development.

The development of micro-credit platforms is another important step in reducing social inequality. Such solutions provide access to financial resources for low-income segments of the population, which contributes to economic growth and social development. Integration of blockchain technologies increases the transparency of financial transactions, which reduces the risk of fraud and ensures trust in financial institutions. This is especially important in the face of growing competition and regulatory transparency requirements. The use of AI for cybersecurity is an important aspect. In the face of growing cyber threats, such solutions help protect customer data and reduce the risks of cybercrime, which is critical to maintaining the stability of the financial system.

The introduction of new technologies has substantially changed the fundamental financial processes in investment banking. In particular, the use of AI and machine learning algorithms enables banks assessing credit risks faster and more accurately. According to Bloomberg (2024) banks that use AI for risk analysis have reduced their losses by 15%. It also helps to reduce the likelihood of default, which has a positive impact on the financial stability of institutions. Other banks, such as Wells Fargo, use AI to predict their customers' financial needs, allowing them to proactively offer products (Welch, 2023).

Blockchain technologies substantially reduce transaction processing time to a few seconds, while traditional methods can take days. This substantially increases efficiency and reduces maintenance costs. For example, according to Accenture (n.d.), the introduction of blockchain has reduced the cost of international transfers by 40%. Other companies, such as International Business Machines (IBM), have developed blockchain-based solutions to optimise supply chains, which also reduces processing costs and time. For example, Walmart uses blockchain to track products in its supply chain, enabling faster response to quality issues. It also increases consumer confidence in the company, as they can verify the origin of products.

Financial technologies (fintech) allow banks to offer new solutions, such as chatbots for customer support and mobile applications for account management. According to Accenture (n.d.) studies, 75% of customers rate the

improved service as critical for choosing a bank. It also helps banks remain competitive in the market. In addition, some banks have started using virtual reality (VR) and augmented reality (AR) technologies to provide interactive financial advice. Innovation in the financial sector depends on several crucial factors. Organisational aspects, such as the culture of innovation, play an important role in the introduction of new technologies. Technological aspects, in particular, the availability of modern infrastructure, are also of great importance. In addition, regulatory aspects, in particular, state support, can considerably affect the success of innovation initiatives.

The company's culture of innovation, including staff readiness for change, is critical to the introduction of new technologies. According to Pricewaterhouse Coopers (2024), companies with a high level of innovation showed 30% more successful projects. For example, banks that actively encourage the training and development of their employees are more likely to successfully implement new technologies. Some organisations invest in technology and innovation training programmes that empower their employees to stay up-to-date with the latest trends.

The availability of modern technical infrastructure and effective data protection systems are necessary conditions for the integration of new technologies. According to Gartner (n.d.), 50% of banks stated that insufficient infrastructure hinders the introduction of innovations. For example, small and medium-sized banks often find it difficult to find funds to upgrade their technologies. Many of them turn to external service providers for access to the latest solutions. Data security is also vital, as the growing threat of cybercrime requires banks to invest in new security technologies. Government support and compliance with legislation are essential for successful innovation implementation. According to a report by the Financial Stability Board (2023), 60% of financial institutions believe that regulatory barriers hinder innovation. For example, the complexity of regulatory requirements in different countries may restrain the international development of fintech companies. This can lead to situations where the same technology can be successfully implemented in one country, but will face serious obstacles in another. This means that many companies are forced to adapt their solutions following local legislation, which can be a costly and time-consuming process. These factors create conditions for the effective integration of new technologies and ensure stability in the financial sector.

In modern conditions, along with traditional challenges, new aspects arise that form real economic threats or challenges. The issue of cybersecurity is becoming increasingly relevant, as advancing digitalisation requires knowledge and information security skills from the students. In the context of globalisation, cyber threats can have serious consequences for financial institutions, which demands the ability to adapt to new technological realities and ensure data security from specialists. The development of central banking digital currencies (CBDCs) also introduces new challenges to the economic system. CBDCs can change traditional financial models by influencing monetary policy and access to financial resources (Elmoukhtar *et al.*, 2022).

The anti-crisis functions of innovations in a military or sanctions context are of special importance. In such situations, innovative solutions can be the key to economic adaptation, empowering countries to reduce the negative effects of economic shocks. However, institutional barriers and political risks can drastically hinder the effective implementation of these innovations. Political instability, lack of state support and appropriate institutions can seriously impede the development of new technologies and initiatives. Innovative technologies and their consequences have a remarkable impact on the financial sector. For example, blockchain technology provides a high level of transparency and security, which reduces transaction processing costs and prevents fraud. However, with the development of this technology, cybersecurity threats are growing. Hackers may attempt to hack into networks that use the blockchain to steal cryptocurrency or data. New security methods should be implemented to prevent such attacks (Ryead, 2022).

AI allows automating the analysis of large amounts of data, which increases the efficiency of credit scoring and personalisation of financial products. However, the use of AI also creates new vulnerabilities. For example, algorithms can be manipulated or biased, which leads to discrimination against certain groups of clients. It is important to develop ethical standards and regulations for the use of AI in the financial sector. Algorithmic trading allows making trades with high speed and accuracy, which increases market liquidity. However, it can also lead to sharp price fluctuations and even financial crises if algorithms respond to market events too quickly or incorrectly. Mechanisms for monitoring and verifying algorithms are needed to avoid negative consequences (Filho *et al.*, 2022).

Fintech companies are expanding access to financial services by providing opportunities for microcredit, mobile payments, and crowdfunding. This is especially important for low-income segments of the population who previously did not have access to traditional banking services. However, there are institutional barriers, such as underregulation, that can inhibit the development of fintech innovation. Political risks associated with changes in legislation may also affect the stability of these services.

In the face of the growing digitalisation of financial services, cybersecurity is becoming critical. Attacks on financial institutions can cause serious damage to both businesses and consumers. Investments in security technologies such as data encryption, multi-level authentication, and intrusion detection systems are essential to ensure customer trust and financial system stability. The introduction of CBDC can substantially change the structure of the financial system, offering new payment options, reducing transaction processing costs, and increasing financial inclusion. However, it also poses challenges in regulation, privacy, and trust in new forms of currency. Central banks should carefully assess the risks and benefits before implementing broad-based CBDCs (Moura *et al.*, 2021; Erlyn *et al.*, 2022). In the event of crises such as war or economic sanctions, innovative technologies can provide important tools for adapting financial systems. For example, technology can help create alternative payment systems that are independent of traditional banks or provide financing for businesses affected by conflicts. However, the speed of response and adaptability of these technologies are critical to effectively solving problems.

Comparison of the introduction of innovative technologies in different countries

Awareness of the importance of innovative technologies in the modern world has become the basis for their active implementation in different countries and regions. Each of them has its own characteristics that determine the success or failure of technologies, as well as influence their adaptation to local conditions. For a deeper analysis, it is advisable to compare several countries – Estonia, the United States, China, India, and Ukraine – according to the criteria of the level of digital infrastructure, state support for innovation, financial inclusion, institutional capacity, and the level of risks and cybersecurity.

The level of digital infrastructure is one of the key factors for innovation. Estonia demonstrates a high level of digitalisation, where almost all public services are available online. This was made possible by the introduction of blockchain and electronic identification technologies, which increase efficiency and reduce administration costs (Kniazieva *et al*., 2023). In the United States, digital infrastructure is also developed, but the level of internet access varies depending on the region, which can create barriers for some population groups. China, in turn, is actively developing its digital infrastructure, in particular, in cities where payment systems such as WeChat Pay and Alipay have become dominant (Mobile payment in China…, 2025). India, through initiatives such as Digital India, is trying to improve access to e-banking services, although there are still difficulties with internet access in rural areas (Girijan, 2024). Ukraine has the potential to develop digital infrastructure, while still facing challenges in internet availability and speed (Kniazieva *et al*., 2023).

State support for innovation is another important criterion. Estonia actively supports startups and innovative projects, which contributes to the development of new technologies. In the United States, there are a large number of funding programmes for startups and technology companies, which allow them to grow and develop. China is also showing active government support by investing in technology startups and innovative projects, enabling rapid adoption of new technologies. In India, government support exists, but the implementation of some initiatives is limited due to bureaucratic barriers. Ukraine, although it has some state support for the IT sector, needs to improve its overall policy on innovative development.

Financial inclusion is critical to ensuring public access to financial services (Fitriasari *et al*., 2024). Estonia demonstrates a high level of financial inclusion due to digital payment systems that allow citizens to easily access banking services. In the United States, financial inclusion remains an important issue, as some populations still face difficulties in accessing financial services. China has become a leader in financial inclusion due to mobile payment systems that have enabled millions of people previously not covered by banking services to access financial products. India is also making progress in financial inclusion through initiatives such as Jan Dhan Yojana, which provide access to bank accounts for low-income segments of the population. Ukraine is marked by growing financial inclusion, but there are still considerable distances to reach the level observed in the leading countries.

The country's institutional capacity affects the effectiveness of innovation implementation. Estonia has a high level of institutional capacity, which ensures the effective implementation of state initiatives. The United States also has strong institutions that support innovation, but sometimes bureaucratic obstacles can slow down processes. China, with centralised governance, can quickly implement policies, but this can lead to a lack of flexibility. In India, institutional capacity varies, with strong indicators in some regions, but in general, there are problems with implementing policies. Ukraine needs to improve its institutional capacity to support innovation, particularly in the regulatory environment.

The level of risks and cybersecurity is another important aspect in the context of the introduction of new technologies. Estonia demonstrates a high level of cybersecurity through the introduction of data protection technologies, as the country is a leader in digital transformation. The United States faces noteworthy risks associated with cybercrime, especially in the financial technology sector, where cyberattacks can have serious consequences. China is actively improving its cybersecurity, but there are concerns about data control and privacy. India has growing cybersecurity concerns as digitalisation progresses, but government data protection initiatives are starting to emerge. Ukraine, given the risks associated with conflicts and growing digitalisation, needs substantial efforts to improve its cybersecurity.

Thus, a comparison of cases of implementing innovative technologies in different countries demonstrates that success depends not only on technological progress but also on political will, institutional conditions, and cultural characteristics. Each region has its own unique challenges and opportunities that affect the effectiveness of implementing new technologies and the ability to adapt to a rapidly changing global environment.

Recommendations for financial institutions on innovation in sustainable development

Financial institutions must actively adapt to current challenges such as cyber threats, regulatory constraints, changing customer expectations, and the impact of digital currencies by integrating new technologies into their business processes. Modern technologies such as AI, blockchain, and big data analytics can substantially improve the efficiency of banks and financial institutions. The introduction of these technologies allows automating routine processes, reducing costs, and improving the quality of customer service, which, in turn, contributes to the achievement of Sustainable Development Goals, in particular, with regard to financial inclusion.

In the US, banks use AI in their chatbots to help customers manage their accounts, track expenses, and get financial advice. This technology allows the bank to reduce the burden on the support service while increasing customer satisfaction. Another example is the use of AI in credit scoring, where algorithms analyse huge amounts of data to assess the creditworthiness of potential borrowers, which allows making faster decisions. Analysis of technological trends is key. The management of banks should regularly analyse the latest technologies to identify opportunities for implementation. This allows not only increasing efficiency but also remaining competitive in the market. It is also important to create clear strategies for implementing new technologies that consider the specifics of the

business and the needs of customers. Such strategies may include phasing out technologies to reduce risks.

In the UK, banks have developed programmes to test new technologies in a controlled environment, which allows them to identify and fix problems even before they are introduced to the market. This has helped banks successfully integrate new solutions without substantial disruptions in customer service (Bank of England..., 2024). Investing in employee training is critical to successfully adapting to new technologies. Trainings and seminars will help employees learn new tools that will increase their productivity. For example, Citigroup implements digital technology training programmes for its employees, which allows them to better adapt to changes in the financial industry (Bilgin, 2024). The bank also actively attracts external experts to conduct pieces of training, which increases the level of knowledge of employees.

Continuous monitoring of innovation trends is critical to maintaining the competitiveness of financial institutions. In the face of rapid changes in technology and market conditions, institutions may lose their position if they do not follow new developments. The creation of specialised teams that monitor market trends will allow banks to quickly respond to changes in the financial industry. This may include analysing new products, services, and technologies. In Ukraine, banks have created analytical teams that monitor new financial technologies and provide recommendations for their implementation. Collaboration with startups can also drive innovation. Integrating startups into traditional business models allows banks to implement new solutions faster and more efficiently. Banks are also investing in startups that offer new financial solutions, such as mobile asset management platforms.

DISCUSSION

The results of the study highlighted the key role of integrating the latest technologies, constantly monitoring market trends, and implementing ESG responsibility principles in the strategies of financial institutions. These elements not only contribute to improving the efficiency of operations but also meet modern requirements of customers and society in general. The importance of these results lies in the fact that they demonstrate how financial institutions can adapt to a rapidly changing environment and remain competitive in the face of globalisation and technological progress. The role of ESG principles in ensuring long-term efficiency is critical because the integration of these principles increases the reputation of companies and attracts new investors. The availability of financial technologies is an important factor in sustainable development, as it allows more people to access financial services (Varela *et al*., 2023). Discussing the impact of implementing innovative technologies on financial sustainability, it can be noted that reducing transaction costs is one of the main advantages. For example, blockchain technologies substantially reduce the cost of processing transactions, which, in turn, contributes to improving the efficiency of financial institutions (Nurgaliyeva *et al*., 2024).

Notably, financial institutions that implement such technologies can reduce customer service costs by 20-30%, according to a study conducted by Y. Chawla (2020), which underscored the importance of data analytics in decision-making. However, evaluating the conflicting conclusions about algorithmic trading and its impact on market stability is also recommended. Studies show that while algorithmic trading can increase liquidity, it can also lead to market volatility if algorithms respond to changes too quickly or incorrectly. As noted by W.L. Filho *et al*. (2022), it is critical to implement control mechanisms to prevent negative consequences. An analysis of Ukraine's potential to adapt global innovations shows that the country has opportunities for development, but faces serious challenges. Compared to the leading investment banking centres in Europe and America, it is important for Ukraine to actively introduce new technologies and adapt them to local conditions to remain competitive in the global market, as stated by J. Jurana *et al*. (2024) and D. Faugoo (2024). This includes developing the infrastructure to support innovation and creating a favourable regulatory environment for financial technologies.

Comparing the results obtained with previous studies, it can be noted that in many cases the results confirm the conclusions of other scientists. For example, a study conducted by D. Saxena *et al*. (2021) indicates that 63% of financial institutions consider the introduction of new technologies critical for their future. This is consistent with the results obtained, which show that banks that actively integrate new technologies show substantially higher performance indicators. R.P. Nalliah *et al*. (2021) stressed that 75% of financial institutions consider investing in training their employees critical to successfully implementing new technologies. This indicates the need to create appropriate training programmes that would meet modern market requirements. A paper by B. Gregersen & B. Johnson (2021) also confirmed that 80% of companies that invest in training see a 25% increase in employee productivity.

An important aspect of the study is also the analysis of the use of big data analytics in financial institutions. Previous research shows that in 2019, only 45% of banks used data to make decisions (Jayalakshmi & Mahalingam, 2020). Increasingly more financial institutions are implementing data-based strategies that enable them to adapt to changes in customer behaviour and market conditions (Kuzmina *et al*., 2021). Institutions that use analytical tools have been determined to reach increased efficiency and lower costs.

N. Chalissery & T.M. Nishad (2021) emphasised that 70% of financial institutions that have implemented analytical platforms have noted improvements in decision-making. This enables companies to respond faster to changes in the market situation, which is critical for their competitiveness. The results confirmed the findings of these researchers, demonstrating that the introduction of analytical platforms and technologies allows financial institutions to reduce costs and improve the quality of decision-making, which is essential for their competitiveness. The findings of V. Sinining (2024) indicated that 75% of young investors prefer companies that adhere to ESG principles. This is in line with the results, showing that the integration of ESG principles not only increases the reputation of companies but also attracts new investors (Spijkers, 2020). In this regard, it is notable that financial institutions that ignore these factors risk losing their competitive position in the market. Therefore, it is important that financial institutions actively integrate ESG principles

into their strategies to ensure long-term sustainability and attract new investors. A study conducted by M. Cvetanović *et al*. (2024) also underlined the importance of working with financial technology startups. According to the data, 68% of banks planned to invest in technology startups to introduce innovations. This is confirmed by the results obtained, which indicate that such cooperation allows banks to adapt faster to technological changes and reduce the risks associated with the introduction of new solutions.

A.T.M. Neto & M.E. Camargo (2021) indicated that 70% of companies that cooperate with financial technology startups were able to reduce the cost of implementing new technologies by 30%. This highlighted the importance of such strategic alliances. A study by I. Morhachov *et al*. (2021) showed that 85% of financial institutions that actively innovate report an increase in customer satisfaction. This illustrates how new technologies can substantially improve customer engagement and increase their loyalty. The analysis of the results of the publications also demonstrates the remarkable impact of working with financial technology startups on reducing costs and improving the customer experience. This shows that financial institutions that actively innovate and attract financial technology partners can achieve major competitive advantages. In addition, the results proved that financial institutions that implement risk analytics perform better in terms of financial sustainability. S. Caucci *et al*. (2020) established that 80% of banks that used analytical tools to assess risks noted a decrease in financial losses. This shows that data analytics is an important tool for ensuring financial stability in the face of uncertainty.

D. Saxena *et al*. (2021) also indicated that banks that actively implement new sustainability solutions have substantially higher profitability indicators. This correlates with the results of the study, which demonstrated that the integration of ESG principles leads to improved financial performance and increased investor confidence. In addition, the study evaluated conflicting conclusions about algorithmic trading and its impact on market stability. In particular, the author analysed how algorithmic trading can lead to market volatility through fast and automated trades, which sometimes disregard fundamental indicators. This increases the risk for investors, as the market may react irrationally to information.

An investigation performed by O. Borodina *et al*. (2021) highlighted the growing role of digital platforms in the financial sector, claiming that 85% of users prefer online services to manage their investments. This parallels the data that demonstrate that integrating digital solutions helps improve the customer experience and reduce maintenance costs. The study also discussed the importance of financial technology accessibility in the context of sustainable development. An important aspect is that access to financial technologies allows small and medium-sized enterprises to receive financing and investment, which in turn supports economic development and reduces social inequality (Prymostka & Kysil, 2023).

D.B. Sariipek *et al*. (2021) indicated that 90% of young investors expect financial institutions to actively implement innovative solutions, which highlights the importance of adapting to the needs of new generations of clients. This once again focuses on the need to introduce technologies to ensure the successful development of financial institutions. Researchers S.I. Wahjono *et al*. (2021) presented evidence that 78% of investors are willing to support companies that implement sustainable business practices. This confirms the growing importance of environmental and social aspects in the strategies of financial institutions. The paper also examined the potential of Ukraine in adapting global innovations in comparison with the leading investment banking centres in Europe and America. The author analysed how Ukraine can use modern technologies, such as blockchain and AI, to increase competitiveness in the international market. This includes creating startups in the financial sector and attracting foreign investors.

Analysis of the results of these studies shows that financial institutions that actively innovate and pay attention to sustainable practices can attract the attention of young investors and ensure competitive advantages in the market. The study confirmed the findings of other researchers and highlights the importance of integrating the latest technologies and principles of responsibility (ESG) into the strategies of financial institutions. The introduction of innovative technologies has a substantial impact on financial sustainability, in particular, reducing transaction costs (Faichuk *et al*., 2023). However, there are conflicting conclusions about algorithmic trading and its impact on market stability, which requires additional research. In addition, the introduction of new technologies also contributes to improving the customer experience, making financial services more personalised and accessible. The use of AI and machine learning helps banks offer customised solutions to customers, which increases their loyalty and satisfaction. These approaches not only strengthen the position of financial institutions in the market but also contribute to their sustainable development in the future.

CONCLUSIONS

The study showed that in the period from 2019 to 2024, investment banking underwent substantial transformations due to the introduction of modern technologies. Innovations in this area contributed to strengthening financial sustainability in the face of modern challenges, in particular, by reducing costs, improving transaction efficiency, and expanding access to financial services. Notably, the integration of new technologies has had not only economic but also social and environmental consequences, which highlights the need to implement ESG principles in the activities of financial institutions. Innovations in investment banking both transformed key financial processes and became the basis for the formation of a new architecture of banking services. Blockchain technologies, for example, reduced the cost of international transfers by up to 30% and substantially decreased transaction processing time, which has helped improve transaction efficiency. AI allowed banks to reduce risks through more accurate credit scoring, which, according to the studies, helped diminish losses by up to 15%.

The growing role of fintech platforms also changed the landscape of financial services, making them more accessible to the general public. According to the World Bank, the level of access to financial services increased by 25%, which indicates a positive social effect of digitalisation. Algorithmic trading, which currently forms a great

part of market activity, has provided a new level of speed of operations and increased the liquidity of markets. Such tools reduce transaction costs and minimise the impact of the human factor. This indicates a growing interest in innovative financial solutions that simplify access to investment for the general population. The introduction of new technologies substantially changed fundamental financial processes in investment banking. For example, blockchain technologies reduced transaction processing time to a few seconds. This drastically increased efficiency and reduced maintenance costs. According to the data, the introduction of blockchain reduced the cost of international transfers by 40%. Consequently, innovative technologies not only increased the efficiency of business processes but also opened up new opportunities for the growth and development of banking institutions.

In addition, factors that influence innovation implementation, such as organisational aspects, technological infrastructure, and regulatory conditions, were also essential to the success of innovation. A company's culture of innovation can increase project efficiency by 30%, while the lack of a proper technical base prevents 50% of banks from implementing new technologies. This highlights the importance of investing in training and personnel development, as well as in the modernisation of technical infrastructure. The introduction of innovative solutions enabled banks to remain competitive in a dynamic market and meet the needs of customers. Possible areas for further research include exploring the long-term impact of innovative financial technologies on regulatory policies, exploring the ethical aspects of using AI in finance, and analysing the relationship between CBDC implementation and financial inclusion.

ACKNOWLEDGEMENTS
None.

FUNDING
None.

CONFLICT OF INTEREST
None.

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Інновації в інвестиційному банкінгу як відповідь на сучасні загрози сталому розвитку

Анотація. Дослідження було присвячене аналізу впливу новітніх технологій, таких як blockchain, штучний інтелект, алгоритмічна торгівля та фінансові технології, на інвестиційний банкінг у період із 2019 по 2024 рік. У рамках роботи було проведено аналіз підходів провідних країн-центрів інвестиційного банкінгу до впровадження інновацій. Основні результати показали, що впровадження blockchain дозволило знизити витрати на обробку фінансових транзакцій до 30 % та скоротити час їх виконання до кількох секунд, що суттєво підвищило ефективність процесів у міжнародних переказах. Штучний інтелект сприяв зменшенню витрат на 15 % завдяки покращенню процесів аналізу даних, а алгоритмічна торгівля охопила 70 % обсягу угод на ринку, підвищуючи ліквідність та знижуючи витрати на виконання угод на 30 %. Впровадження фінансових технологій, які зросли на 25 % у 2023 році, забезпечило доступність фінансових послуг для широкого кола користувачів, зокрема через мобільні платформи та інноваційні рішення, такі як краудфандинг. Дослідження також вказало на те, що компанії з високим рівнем інновацій мали на 30 % більше успішних проєктів. Крім того, аналіз показав, що інтеграція екологічних, соціальних та управлінських аспектів призвела до покращення фінансових показників установ, зокрема зростання ринкової капіталізації на 4-6 %. Висновки дослідження підкреслили важливість інвестицій у новітні технології для забезпечення стійкості інвестиційного банкінгу в умовах глобальних загроз сталому розвитку, таких як економічна нестабільність, кліматичні виклики та цифрова нерівність. Практичне значення дослідження полягає в тому, що воно надало рекомендації для фінансових установ щодо впровадження технологічних інновацій, що сприяли підвищенню їх фінансової стійкості

Ключові слова: економічна ефективність; фінансові інструменти; штучний інтелект; блокчейн; цифрові валюти в інвестиціях

ECONOMICS OF DEVELOPMENT
Journal homepage: https://ecdev.com.ua/
Vol. 24, No. 2
2025

UDC 330.341.1:331.101.262:658.8
DOI: 10.63341/econ/2.2025.134

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Marketing of values in the human capital formation hierarchy: Structural transformation and impact assessment

Abstract. Human capital determines the quality of well-being, innovations, resources, and competitiveness of the country in the international arena. The influence of the marketing of values plays an exceptional role in shaping its structure. Based on the above considerations, the purpose of the study was to model the impact of demographic, social, financial, and economic factors, as well as the marketing of values (Marketing 3.0) components, on human capital development through dynamic and regression analysis within a public-private partnership project. A pilot study, conducted through expert surveys (interviews and questionnaires) from 2022 to 2024, helped clarify the structure and impact of the marketing of values on human capital formation. A three-dimensional model and an adaptation matrix for assessing the influence of the marketing of values on human capital development were proposed. The influence rating of the components within the marketing of values was justified: 26.1% due to innovative and omnichannel marketing,

Article's History: Received: 02.01.2025; Revised: 15.05.2025; Accepted: 27.06.2025

Suggested Citation:
Golovnina, O., Mazur, I., Bilovodska, O., Denysenko, M., & Prokopenko, K. (2025). Marketing of values in the human capital formation hierarchy: Structural transformation and impact assessment. *Economics of Development*, 24(2), 134-149. doi: 10.63341/econ/2.2025.134.

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23.2% – due to social and ethical marketing, 17.4% – due to ecological marketing, 7.2% – due to aesthetic marketing. The component-by-component assessment revealed the greatest influence of environmental marketing on physiological capital (60%); omnichannel marketing on social capital (60%) and on the effect of public goods (50%); innovative marketing on entrepreneurial capital (60%) and intellectual capital (50%); social and ethical marketing on the effect of public goods (50%). It was proven that the effect of human capital formation is determined by the impact of the marketing of values components. The proposed concept outlining how the marketing of values affects the structure of human capital, along with the adaptive quantitative assessment matrix, should be applied to optimise the influence of the marketing of values on human capital across all levels of the national economy

Keywords: components of the marketing of values; structure of human capital; marketing analysis; welfare; public-private partnership

INTRODUCTION

The development of human capital is at the centre of the global strategy of world development, closely linked to the desire for sustainable socio-economic growth for the benefit of all segments of the population. Scientific and practical substantiation of the concept of the formation of productive forces in the form of human capital is one of the most important directions for the implementation of the socio-economic policy of the Ukrainian state. This is emphasised by the global growth of the role of intelligence and knowledge in socio-economic development, in the competitiveness of entities against the background of growing challenges and force majeure circumstances, including the long-term Russo-Ukrainian War.

Socio-economic challenges manifest themselves in the form of the acceleration of scientific and technological progress, the rapid spread of innovations, information technologies in the spheres of life, informatisation, production, dissemination of knowledge and acceleration of talented developments. Economic challenges, caused by the aggravation of institutional, innovative, environmental, socialisation, and globalisation factors, actualise the issue of finding innovative approaches, technologies, theories, tools, mechanisms, and financial opportunities to stimulate the development of human capital as the basis of national wealth and the welfare of the state. The concept of the marketing of values is becoming increasingly relevant. The problem is the lack of development of a theoretical basis for the essence and structuring of the marketing of values in the context of a changing political and economic situation, force majeure circumstances, the introduction of innovations and long testing periods, and the assessment of the impact on the formation of human capital.

A wide range of scientists have devoted scientific works to the methodology and practice of reproducing human productive abilities. In particular, Yu. Akbar *et al*. (2024) explored the impact of human capital on sustainable university performance, with sustainable human resource management serving as a mediating variable. D.I. Mustafa *et al*. (2024) demonstrated that value-added intellectual capital has a positive impact on corporate financial performance. V. Antoniuk (2022) systematically examined the multifaceted human capital losses caused by the war, including demographic decline, employment disruptions, destruction of educational infrastructure, and forced migration. The study emphasised the critical role of human capital in Ukraine's post-war economic recovery and modernisation, and proposed priority measures for its preservation and restoration. It provided a comprehensive analysis of the challenges to human capital reproduction in the context of the ongoing conflict and outlined strategic directions for mitigating these losses. However, despite the existence of various theoretical approaches to defining human capital, the scientific approach to its definition and structuring remains insufficiently explored.

Also, a range of recent studies has expanded the theoretical and practical understanding of the marketing of values from philosophical, aesthetic, ethical, and strategic perspectives. S. Malik & D. Kajale (2024) examined the philosophical foundations of value consciousness within culture, emphasising the theoretical and methodological importance of value theory in shaping cultural development. This theoretical base aligns with the work of O. Burlitska (2021), who traced the evolution of marketing paradigms from product-oriented approaches toward a marketing of values strategy, highlighting its foundational role in modern marketing thought. P. Brown (2020) contributed to the aesthetic dimension of the marketing of values by introducing the concept of aesthetic intelligence as a strategic tool for enhancing customer experience, emotional engagement, and brand loyalty through beauty, design, and sensory appeal.

In the domain of socially responsible and sustainable consumption, V. Dergachova *et al*. (2020) grounded their study in the principles of socio-ethical and the marketing of values, substantiating the development of the organic food market in Ukraine through regional opportunity analysis, consumer segmentation, and priority-setting for environmentally conscious consumption promotion. Similarly, O. Bilovodska *et al*. (2023) explored the reorientation of industrial regional development toward tourism by leveraging unique local resources. Their research applied SWOT and comparative analysis to identify competitive advantages – such as geographical location, environmental safety, and cultural attractiveness – and framed a strategy of sustainable and value-based development aligned with post-war consumer preference shifts.

A growing body of research has emphasised the behavioural implications of corporate social responsibility (CSR). S.V. Minh *et al*. (2023), using structural equation modelling and mediation analysis, demonstrated that community, environmental, and ethical responsibility directly influence customer satisfaction, which in turn mediates the relationship between CSR and repurchase intention. In a related context, K. Ahmed & B.R.S. Kaouther (2024) showed that emotional attachment, perceived similarity, and brand perception significantly affect consumer acceptance of

retailer brand substitution, pointing to the importance of value-based brand communication and ethically grounded brand transition strategies. The strategic integration of the marketing of values into human capital management has also gained attention. E. Golovnina *et al*. (2023a) as well as M. Odat & R. Bsoul (2024), emphasised the role of the marketing of values within the structure of human capital, presenting it as a tool for quantitatively assessing project manageability and aligning marketing efforts with social development priorities.

Thus, while scholars have examined economic development, innovation, and marketing, the interpretation and structuring of the marketing of values and its impact on human capital formation across different levels remain underexplored; modelling the socio-economic development of business entities requires further focused research and refinement. The purpose of this article was to enhance the theoretical, methodological, functional, and institutional foundations of the marketing of values by focusing on the evaluation of its impact on human capital development, using a model tested within the framework of a public-private partnership (PPP) project involving a roadside infrastructure facility.

MATERIALS AND METHODS

This article synthesised research from a broad spectrum of scholars on defining and structuring human capital components and the marketing of values, acknowledging that these concepts remain ambiguous and continuously evolve due to innovations and force majeure events. The research was conducted on the basis of fundamental provisions of economic theory, management and marketing theories, and scientific concepts regarding the analysis of the impact of state regulation on the formation and development of human capital, using methods of theoretical generalisation, the dialectical method of cognition, and system-structural analysis in the context of justification and development of models of human capital formation and the marketing of values, as well as abstract-logical synthesis regarding the clarification of the above categories. Inductive methods were used to form general conclusions, and deductive methods to determine the logic of structuring the stages and the subject of research in the sense of unity and interdependence of components. General scientific and specialised research methods were used, including: the principal components method in analysing the impact of state regulatory instruments on the formation of human capital; quantitative and graphical methods for modelling the components of the marketing of values and assessing their impact on the structure of human capital in accordance with the purpose and hierarchy of human capital formation.

To substantiate the impact of the marketing of values on the formation of the structure of human capital and assess the level of management of this impact, a study was conducted through expert interviews in 2022-2024 in the cities of Kyiv, Boryspil, Cherkasy, Odesa, and the Kyiv, Cherkasy, and Vinnytsia regions of Ukraine. The questions of the expert study were organised by clusters. The first cluster was the definition of the interpretation of the marketing of values in the context of its influence on the formation and development of human capital. The second was the definition of the interpretation of human capital in the context of its formation and development. The third was the definition of the structure of the marketing of values. The fourth was to determine the structure of human capital. The fifth was to determine the factors and assess the impact of the marketing of values on human capital. The sixth was the formation of factors and the assessment of the impact of the formation and development of human capital by the marketing of values. Survey subjects included: marketers of companies producing goods for the population and service companies in the tourism and transport industries, as well as representatives of local governments.

Expert interviews were conducted based on a combination of pilot research and in-depth interviews. The pilot group study was conducted with a group (263 people) both individually and in groups, online via Zoom, and through telephone screening, taking into account behavioural, qualification, situational, and technical aspects, and a fully open interview respecting ethical and legal norms (Ethics code..., n.d.). The in-depth interview was conducted anonymously based on a questionnaire and focus group work, and covered 26 people. Given that this study requires a deep understanding of the topic, the number of interviewees was determined by the principle of data saturation and the diversity of experts and their experience. A questionnaire was developed regarding the definition and structure of the marketing of values and human capital and their mutual influence. The questions are presented in Table 1.

Table 1. A questionnaire on the marketing of values and human capital

No.	Question
1	How do you understand the concept of the marketing of values?
2	What influencing factors should be taken into account when analysing the marketing of values?
3	Do you believe that, structurally, the marketing of values is a complex of diverse multi-directional marketing approaches (e.g., environmental, institutional, innovation-driven, socialisation-oriented, etc.)?
4	What components constitute the marketing of values?
5	In your opinion, should the institutional component be included in the structure of marketing of values?
6	In your opinion, should the ecological component represented by environmental marketing be included in the structure of marketing of values?
7	In your opinion, should social and ethical marketing be highlighted as a separate component within the structure of marketing of values?
8	In your opinion, what is the difference between social and ethical marketing and marketing of values?
9	Which specific components, in your opinion, should be included in the structure of marketing of values?

Table 1. Continued

No.	Question
10	Which components, in your opinion, should be included in the structure of social and ethical marketing within the framework of marketing of values?
11	Do you think it is appropriate to consider marketing of values at the micro-, meso-, macro-, and mega-levels? If yes, why?
12	In your opinion, does marketing of values influence the formation and development of human capital?
13	In your opinion, how exactly does marketing of values affect the formation and development of human capital?
14	In your opinion, does the development of human capital influence the improvement of marketing of values?
15	Which factors, in your opinion, determine the development of human capital under the influence of marketing of values (primary and secondary)?
16	What do you think is the structure of human capital formed under the influence of marketing of values?
17	Who do you think are the key actors in forming marketing of values at the micro-, macro-, and mega-levels?
18	In your opinion, how can the impact of marketing of values on the development of human capital be assessed?
19	In your opinion, how can the impact of human capital on the formation of marketing of values be assessed?
20	In your opinion, how can the impact of human capital on the development of marketing of values be assessed?

Source: created by the authors

Based on the interviews, the following components of the marketing of values structure were identified: socio-ethical, ecological, innovative, aesthetic, and omnichannel marketing. They influence the factors of human capital formation and the well-being of the population through the supply and demand of products and services on the market (pension size, subsistence minimum, wages, natural population decline, number of people leaving, emigrants, share of subsidies in expenditures, percentage of population with incomes below the subsistence minimum, savings, real difference between incomes and expenditures, tax burden, level of shadow economy with real shadow wages) and the formation of its structure (physiological, intellectual, entrepreneurial, and social capital, transactional effects, public goods, corporate rights).

The above enabled the development of a model for assessing the impact of the marketing of values on the structure of human capital and for conducting a direct assessment. For ranking the significance of structural influencing factors, the following question was asked: Which elements should be included in the structure of the marketing of values? Please select and rank your answers from 1 (most important) to 10 (least important): 1) Environmental marketing; 2) Innovation marketing; 3) Marketing of innovations; 4) Social and ethical marketing; 5) Aesthetic marketing; 6) Omnichannel marketing; 7) Relationship marketing; 8) Holistic marketing; 9) Multichannel marketing; 10) Digital marketing.

To assess the consistency of the experts' opinions, who ranked the 10 answers to the question about the structure of marketing of values, Kendall's concordance coefficient (W) was used, the value of which ranges from 0 to 1 (1 – complete consistency, and 0 – no consistency). For this purpose, a rank table was compiled, which displayed 10 answers from each expert; each expert assigned a rank from 1 to 10 to the 10 answers. For each answer, the sum of the ranks (R_j) assigned by the experts was calculated. The average rank ($\bar{R}$), the deviation of ranks from the average ($R_j - \bar{R}$) and their squares, and the sum of the squares of the deviations were calculated. The Kendall's concordance coefficient (W) was calculated using the formula:

$$W = \frac{12S}{m^2(n^3-n)}; \quad (1)$$

$$S = \sum_{i=1}^{n}(R_i - \bar{R})^2, \quad (2)$$

where W – Kendall's concordance coefficient; m – number of experts; n – number of objects being ranked ($n = 10$ answers); R_i – sum of ranks assigned by all experts for the i-th answer; $\bar{R}$ – average rank for all objects. An expert interview, at the stage of substantiating the assessment of the formation and mutual influence of the marketing of values and human capital, confirmed the relevance of clarifying the interpretation and structure of the marketing of values and human capital in the context of their structuring and influencing factors, as well as the substantiation of the assessment system. The obtained concordance coefficient of 0.838 was statistically significant; the experts' opinions were consistent because the calculated chi-square (χ^2) criterion exceeded the tabulated value for $df = n - 1$ degrees of freedom at a given significance level of 0.05. The formula for χ^2:

$$\chi^2 = m\,(n\text{-}1)\,W, \quad (3)$$

where χ^2 – value of the χ^2 criterion; m – number of experts. Under the conditions of applying the theoretical-multiple approach while adhering to the logic of forming relationships, methods of correlation-regression analysis and forecasting were applied. Modelling was carried out: the influence of demographic, social, financial, and economic factors on the formation of human capital was studied using data from 2015-2023 based on information from the State Statistics Service of Ukraine (n.d.a; n.d.b; n.d.c) and the World Bank open data (n.d.).

The influencing factors were grouped, cause-and-effect relationships, correlation coefficients, and forms of regression relationships were established, and the influence of demographic, social, financial, and economic factors on the formation of human capital was analysed (Tables 1-3). When forming a system for assessing the impact of the marketing of values on the formation of human capital, the value of the components of the latter was determined using the following formulas (4-7) (Golovnina, 2022). Physiological capital (R) based on the contribution to future generations (V) (which was determined by investment activity in the development of future generations and the reward

for creation) forms the labour force, and was increased by labour activity (x_0) and the wage rate as a reward for it (A_1):

$$R = V + A_1 x_1. \quad (4)$$

Entrepreneurial capital (P) increases physiological capital (R) based on the activation of entrepreneurial abilities and activity (x_2) and the reward for it (A_2):

$$P = V + R + A_2 x_2. \quad (5)$$

Intellectual capital (I) builds on previous stages, depends on the contribution to future generations (V), physiological (R), and entrepreneurial capital (P), as well as intellectual activity (x_3) and the rate of reward for it (A_3):

$$I = V + R + P + A_3 x_3. \quad (6)$$

Social capital (S) is the highest stage of human capital development, including the contribution to future generations (V), physiological (R), entrepreneurial (P), and intellectual (I) capital, the share of the effect of social activity – communication, interaction, trust, social networks (x_4) – and the rate of reward for social activity (A_4):

$$S = V + R + P + I + A_4 x_4. \quad (7)$$

In marketing analysis and modelling, and the assessment of the impact of the marketing of values structure on the structure of human capital, the local estimate (Y_i) in percentage was determined by the formula:

$$Y_i = \frac{X_i}{X} \times 100\%, \quad (8)$$

where X_i – number of positive (or negative) assessments of the impact of a specific component of the marketing of values on an element of the human capital structure; X – total number of cells in the assessment cube. The overall assessment of the impact of the marketing of values on human capital development was determined by the sum of local assessments. A special place was occupied by the method of studying three-dimensional space on the principles of analysis-synthesis and induction-deduction in modelling the concept of assessing the impact of the marketing of values on the structure of human capital. It enabled the assessment of the impact of management on the synergy of interaction, taking into account factors of direct and indirect influence. The sequence of the presented study was as follows: research into the relevance of the issue, review of the literature on the definition and formation of the marketing of values and human capital; formulation of the research task; conducting interviews to determine the factors of influence and the structure of the marketing of values and human capital; performing regression-correlation analysis to model the influence of demographic, social, financial, and economic factors on human capital; and assessing the influence of the marketing of values on the development of human capital.

It should be noted that the choice to conduct the study on the impact of the marketing of values on human capital development through modelling within a PPP project involving a roadside infrastructure facility was justified by the unique integration of public, business, and social interests. Roadside infrastructure serves as a dynamic point of interaction between personnel and consumers, enabling the practical application and observation of value-oriented marketing principles. Moreover, the choice of road infrastructure as the environment for modelling the impact of the marketing of values on human capital was explained by the fact that of the marketing of values was considered a field of managing the effectiveness of innovative projects aimed at stimulating human capital development. This was grounded in accelerating the promotion of goods in the market while balancing individual and societal demands. These demands were characterised by the factors shaping (structure) and developing (structural changes over time) human capital. The case of roadside infrastructure as a competitive environment for modelling the influence of the marketing of values on the state of human capital reveals the specifics of high-quality customer service at roadside facilities (such as motels, rest areas, car rental and repair services, petrol stations, banking services, etc.) aimed at creating an atmosphere of socio-individual safety during travel by motor vehicle along national and international highways, both for work and leisure – as a businessperson or tourist.

In addition, the improvement of service quality, accessibility, and customer satisfaction was directly proportional to the increase in well-being, the quality of human capital, and life safety, as well as to the enhancement of performance and profitability of market participants involved in the provision and consumption of roadside infrastructure services. At the same time, through high-quality services and the creation of personal development incentives, individuals are motivated to increase their labour activity, as well as their intellectual, entrepreneurial, and creative work. This, in turn, contributes to the improvement of the marketing of values – its structure, efficiency, and the socialisation of labour – as well as to the development of corporate and societal relationship culture, and ultimately to the growth of both individual and societal well-being. Various stakeholders in governance and entrepreneurship (territorial authorities, companies, households, the state, etc.) are involved in this process. Human capital determines individual success and national competitiveness and serves as the foundation of households, regions, companies, industries, and the national economy. Modelling in this context allows for the analysis of multilevel effects – individual, corporate, and regional – on human capital development, while also providing a scalable framework for broader socio-economic applications.

RESULTS

Values determine the goals of development and the means of achieving them. Traditionally, different aspects of the study of values in different fields of knowledge have a different subject and purpose of research. The knowledge economy, the structuring of relations between different fields of knowledge, levels of management and entrepreneurship, the features of the functioning of business entities within the framework of established institutional restrictions actualise combinations of partnership interaction according to the criteria of consistency of interests and processes. At the same time, the economic transformations of Ukrainian society are characterised by a reassessment of

values as a consequence of the existence of a conflict of opposing value systems and orientations. The restoration of historical and cultural memory with the recognition of national "value" turns it into a standard – a criterion that determines the further position, and, accordingly, the activities of the business entity. Appealing to the emotional needs of the consumer, which prevail over the functional, physical and useful features of the product, refers to the formation, design and implementation of its value. As the concept of the marketing of values develops, it is gradually filled with innovations, digitised, forms an emotional connection between the consumer and the brand, uses infocommunication, nano and biotechnology. Formation of uniqueness and value of the brand, trademark and image of corporate orientation uses the above and individualises values for consumers in accordance with emotional, spiritual, material needs and desires.

At the same time, human capital is an integrally diverse economic category that combines values according to individual and social characteristics. Thus, it is a self-growing value inherent in a person from birth with development throughout life in the structural unity of physiological, intellectual, entrepreneurial, and social components in the coordination of individual, corporate and social values and the implementation of the unity of structural relationships. Human capital is defined as a stock of health, knowledge, skills, abilities, and motivations and is gradually "formed by investments in the future generation, in increasing the stock for the purposeful development of entrepreneurial, intellectual, corporate, and social potential of an individual, household, company, region, state" (Golovnina *et al.*, 2023a).

Human capital has the specificity of formation according to the species structure, classified by: levels of development and types of benefits received, the nature of changes over time, and levels of management. Its value reflects the value of the total resources intended for its formation and further development. The latter is determined by the achieved level of well-being due to the joint activities of subjects – a household, a company, a region, a state. Like any form of capital, human capital accumulates when used and decreases when not used, is subject to inflationary depreciation, and is therefore considered in real and nominal terms. On the one hand, it is a limited resource, and on the other hand, "a form of capital capable of generating income with a synergistic effect, a strong influence on political, economic and social development". Human capital "is simultaneously an individual, collective, and public good that determines the national wealth of the state" (Golovnina *et al.*, 2023a; 2023b).

The basis of the marketing of values is historical and cultural memory, heritage, spirituality, creativity, self-improvement, individuality, and materialisation of the effect of historical and cultural heritage through the efficiency of state regulation of investments in revival and the organisation of PPP. At the same time, it takes into account such social requirements as increasing the level of well-being, environmental friendliness of the human environment, improving health, consumer requirements for the quality and quantity of products and services to meet the needs and requirements of the corporation in the responsibility of business in achieving prospective profitability, profitability, social activity and its positive synergy. The formation of the marketing of values of an economic entity as an agent of human capital requires its structuring according to the needs of viability in specific conditions of socio-economic formation, provided with opportunities for creativity under the influence of positive emotions when using innovations. The marketing of values is a "measure of sophisticated impact on the personality of the consumer through the subconscious, emotions and soul" based on pleasuring spiritual and material needs. It "involves historical and cultural memory and heritage, individuality, spirituality, creativity, self-improvement, which corresponds to the degree of development of human capital, activation of market and social-oriented public processes, institutionalisation, environmentalisation, innovation and socialisation" (Golovnina, 2023a; 2023b).

The marketing of values is systematically formed on a combination of innovative, ecological, socio-ethical, aesthetic and omnichannel marketing. It uses the traditional mechanism of holistic, integrated, internal and external marketing. At the same time, it is a vivid manifestation of the achieved level of intellectual, entrepreneurial and transactional capital. If innovations traditionally determine self-improvement and development, then innovative and omnichannel marketing as components of the marketing of values use the advantages and capabilities of information and communication technologies and digitalisation in creating and promoting goods on the market. Considering that ecology involves assessing the state of the natural environment, which determines the state of an economic entity, ecological marketing as an element of the marketing of values is aimed at meeting the needs of the target audience through products that help preserve the environment, updating the offer of ecological products and forming socially responsible consumption, greening projects, production, and promotion of ecological goods.

The marketing of values uses PR, promotes the introduction of waste-free and safe production methods, the creation and growth of a positive image of companies and corporations, forms the loyalty of clientele to innovative ecological products, and attracts influencers. However, without aesthetic content, the marketing of values loses its brightness and versatility, and, accordingly, its component has become aesthetic marketing as a combination of art – "ideas, beauty, inspiration, pleasant emotions, and the desire to be involved" (Golovnina, 2023b), which generates "satisfaction from the perception of the product, from its effect on positive feelings during the purchase and sale". Aesthetic marketing provides the consumer with "more positive emotions and joy, communication, unification of participants in the process and a new shopping experience, when each consumer becomes a creator, receives feelings and emotions of purchasing a good, appreciates not only the product, but also the feelings that the shopping experience gives" (Vasyutkina, 2018). Social and ethical marketing as an element of the marketing of values is combinatorially formed on the one hand under the influence, and on the other hand – determines the quality of the basic integrated, social, ethical, socially responsible marketing, marketing of relationships and innovations. Integrated marketing is aimed at subordinating the activities of corporate divisions to the interests of consumers by combining external and internal marketing, using digital and nanotechnology.

A significant tool of omnichannel marketing for building a complex of stable associations in the minds of potential buyers, combining the product, reputation, image and identity of the company in the eyes of the public, partners and customers, according to N.V. Proskurnina *et al*. (2021), K. Ahmed & B.R.S. Kaouther (2024) and N. Savytska *et al*. (2024), is branding. The marketing of values actively uses visual elements, namely, logo, name, symbolism, design, infographics for the brightness of the manufacturer's definition among competitors and a set of unique and weighty promises for the consumer (Kotler & Zaltman, 1971). In practice, socially oriented brands receive an increase in sales, a high level of staff motivation, image and competitiveness (Brown, 2020; Ahmed & Kaouther, 2024). Marketers, focusing on the characteristics of "values", determine the components of the marketing of values: a socially, environmentally and economically significant good, its cost, and specify the presented values for brand formation.

The institutional foundations that underscore the social relevance of actualising the concept of the marketing of values include the support of international organisations and national governments for projects aligned with socially significant concepts, such as sustainable development and the advancement of a knowledge-based society (Resolution of the UN General Assembly No. 39/248, 2015), the concept of human capital and human potential development, social responsibility of business (Khaminich & Lichter, 2015), as well as the principles on the protection of consumer interests (Resolution of the UN General Assembly No. 70/1, 1985).

The concept of sustainable development fits into the context of sustainable development outlined by the International Council for Science. It systematically combines the economic, environmental and social components of sustainable development of society (Resolution of the UN General Assembly No. 39/248, 2015). According to this, the goal of sustainable development is to meet the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable development is defined as the security and quality of life of people in the three-dimensional space of economic, environmental and social dimensions. The concept of human development, according to the United Nations Development Programme since 1990, is focused on the well-being and improvement of the quality of human life, the expansion and improvement of opportunities in all areas. Human development is recognised as "the process of expanding the freedom of people to live long and creative lives, to actively participate in ensuring justice, and sustainability of development on the planet" (Resolution of the Cabinet of Ministers of Ukraine No. 382, 2015).

According to the Decree of the President of Ukraine No. 722/2019 (2019), measures to ensure the national interests of Ukraine in terms of sustainable development of the economy, civil society, and the state, increasing the level and quality of life of the population, and observing constitutional human rights and freedoms have been recognised. Thus, Ukraine has active international support in pursuing an independent policy and institutional international and national foundations for the formation of a socially oriented Ukrainian market economy, the development of human capital, and the use of the advantages of the marketing of values in entrepreneurial activity. Modelling the structural components of the marketing of values corresponds to the purpose and hierarchy of human capital formation, which is clearly demonstrated in Figure 1.

The formation of human capital takes place on micro-, meso-, macro- and mega-levels according to specific concepts with the formation of the corresponding category. Modelling individual and household categories involves the reproduction and development of physiological, labour, entrepreneurial, intellectual potential and socially oriented structure at the micro level. Corporate and regional categories are formed according to the conditions of the socio-economic business model while streamlining corporate and regional formation, and realising intellectual, entrepreneurial and labour potential at the meso level. At the macro level: the national category – when implementing the all-Ukrainian concept of human development as a manifestation of the state's socio-economic policy, and the supranational category – when adapting the concept of human development according to the projects of world organisations. The levels and stages of the formation of the marketing of values are similar. The goal of improving the formation of the marketing of values is the development of human capital. A schematic characteristic of the influence of factors on the formation and development of human capital (force majeure, demographic, social, financial and economic), of the marketing of values, and of the needs on the structure of human capital is presented in Figure 2.

Approximately one-fourth of the territory of Ukraine has changed its free status to a territory restricted for use due to occupation, military operations, and a grey buffer state. This has put forward new requirements for the development of human capital and actualised the peculiarities of using flexible tools of the marketing of values. In conditions of force majeure, which include the Russo-Ukrainian War and the financial and political crisis, the factors of formation of socio-economic impact of the marketing of values on the formation of human capital are limited by the purchasing power of the consumer. They are characterised by the demographic state of the population with a tendency to natural and artificial reduction as a result of a historical downward trend, war, growth of emigrants, and people who left Ukraine; by the insufficient size for full existence of the person of social minimum standards – minimum wage and pension, subsistence minimum, insignificant share of subsidies in expenses, minimised size of expenses and savings, insignificant in comparison with developed countries percentage of remuneration of employees in GDP and a significant percentage of population with incomes lower than subsistence minimum. Factors based on the financial and economic impact on human capital are classified in the context of indicators of the tax burden, the real difference between income and expenditure, the level of the shadow economy, and real and shadow wages. The study made assumptions regarding the determination of the value of human capital: the nominal value was estimated in the national currency, the real value in the "hard" currency – US dollars. The econometric modelling made it possible to determine the influence of socio-demographic and financial and economic factors on the formation of human capital during 2015-2023, which is presented in Tables 2.

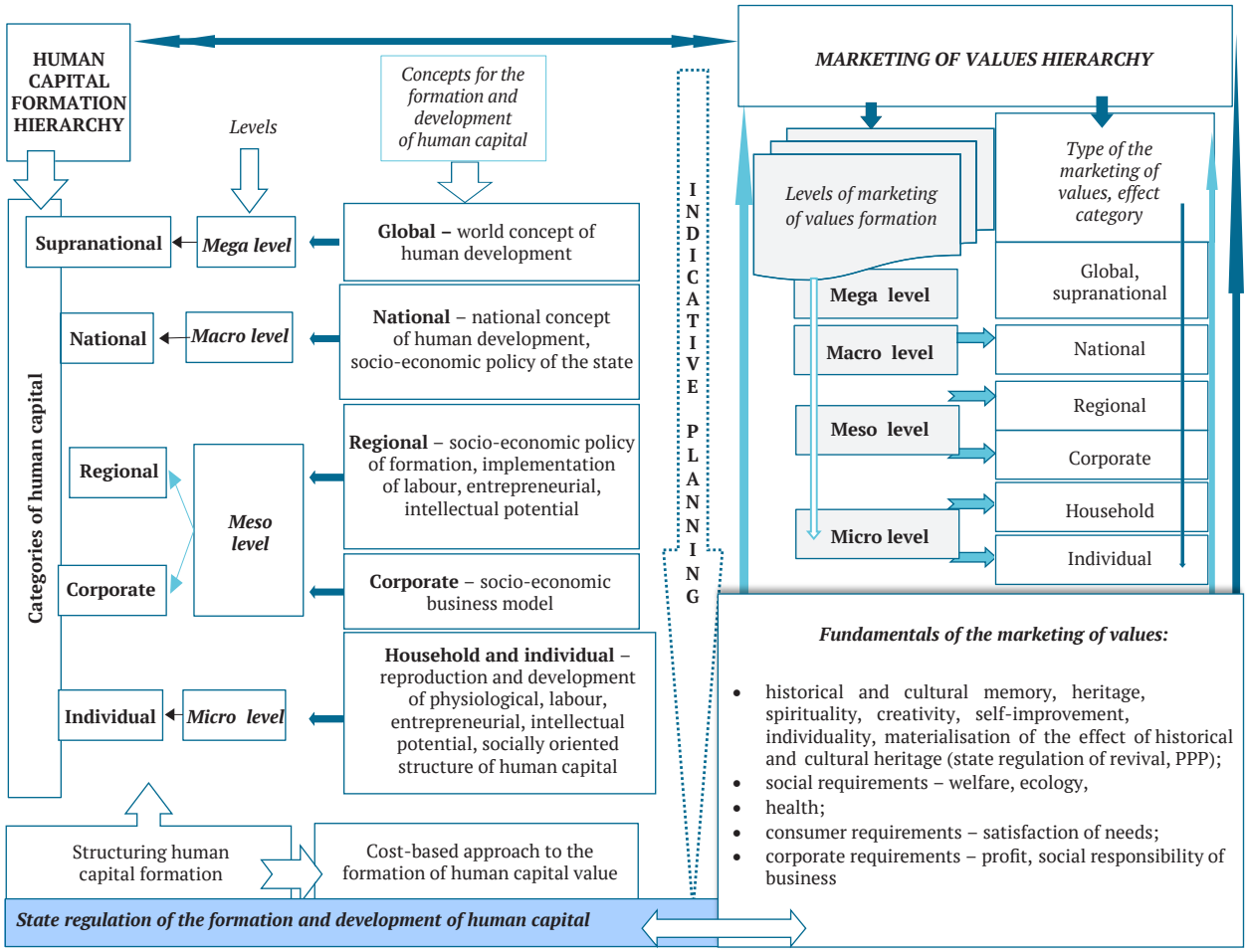

Figure 2. Peculiarities of the influence of environmental factors, marketing of values and needs on the formation and development of human capital

Source: formed by the authors

Table 2. Econometric model of the influence of factors on the formation of human capital

Independent factor *X*	Dependent factor *Y* – human capital	Coefficient correlations	Type of connection density	Form of communication, regression equation
Demographic characteristics				
Number of emigrants/ departures, thousand people	Nominal human capital, UAH	–0.768	Reverse, high	$Y = 0.66813 - 0.00086^{*} X$
Natural population decline, thousand people	Nominal human capital, UAH	–0.785	Reverse, high	$Y = 0.300092 - 0.55765^{*} X$
Social characteristics				
Nominal minimum pension, UAH	Nominal human capital, UAH	+0.978	Direct, very high	$Y = 492.77650 + 5.31979\ X$
Nominal subsistence minimum, UAH	Nominal human capital, UAH	+0.984	Direct, very high	$Y = -818.5845 + 4.47271\ X$
Real subsistence minimum, USD	Real human capital, USD	+0.931	Direct, very high	$Y = 10.01486 + 3.27386\ X$
Nominal minimum wage, UAH	Nominal human capital, UAH	+0.936	Direct, very high	$Y = 1{,}341.5479 + 1.78850\ X$
Share of subsidies in expenses, %	Nominal human capital, UAH	–0.949	Reverse, very high	$Y = 12{,}916.32 + 20{,}448.47\ X$
Nominal costs and savings, UAH	Nominal human capital, UAH	+0.969	Direct, very high	$Y = -58.68629 + 0.00258\ X$
% of wages and salaries in GDP	Nominal human capital, UAH	+0.873	Direct, high	$Y = 12{,}922.01 + 195.3774\ X$

Table 2. Continued

Independent factor *X*	Dependent factor *Y* – human capital	Coefficient correlations	Type of connection density	Form of communication, regression equation
Social characteristics				
% of population with income below the subsistence minimum	Nominal human capital, UAH	–0.515	Reverse, notable	$Y = 7{,}092.25306 - 309.98269\ X$
Financial and economic characteristics				
Level of shadow economy, % of official GDP	Real human capital, USD	–0.890	Reverse, high	$Y = 827.10411 - 12.36131\ X$
Real difference between income and expenses, $	Real human capital, USD	+0.913	Direct, very high	$Y = 35.78141 + 4.51457\ X$
Tax burden	Real human capital, USD	–0.882	Reverse, high	$Y = 1{,}059.96053 - 28.82437\ X$
Real shadow wage, $	Real human capital, USD	+0.949	Direct, very high	$Y = 47.58035 + 1.66663 - X$

Source: formed by the authors according to the 2015-2023 data of State Statistics Service of Ukraine (n.d.a; n.d.b; n.d.c), World Bank open data (n.d.)

It was found that such independent factors as the "number of emigrants/leavers" and "natural population decline" have a significant negative impact on the value of human capital, estimated by pair correlation coefficients, respectively, (– 0.768) and (– 0.785), causing its decrease. Social factors of correlation-regression influence on the formation of human capital demonstrate a high level of interdependence. The impact of direct action was characterised by nominal indicators: subsistence minimum (+ 0.984), minimum pension (+ 0.978), minimum wage (+ 0.936), and expenses and savings (+ 0.969). The higher the percentage of the population with incomes lower than the subsistence minimum, the smaller the size of human capital, which was confirmed by the value of the coefficient of negative correlation influence (– 0.515). The higher the percentage of wages of employees in GDP, the more effectively the national economy functions, with a high level of influence of the specified feature (+ 0.873) on the development of human capital (Table 2).

In conditions of a reducing well-being of the population and its significant dependence on social standards, the level of consumption decreases, and the motivational principles of the marketing of values are updated while ensuring their accessibility. Econometric modelling of the impact of these factors – socio-demographic and financial-economic characteristics – on the development of human capital during 2015-2023 makes it possible to determine the socio-demographic and financial-economic basis for specifying the project of the marketing of values, with the establishment of parameters for managing the formation of the result. The marketing impact assessment model of the marketing of values on the formation of the structure of human capital (Fig. 3) was based on the principle of maximum satisfaction of the consumer with certain characteristics of the product, which always exist, but occupy different places in the system of their values, depending on the moment of consideration of the issue, and combine diverse features of the target direction of the marketing offer.

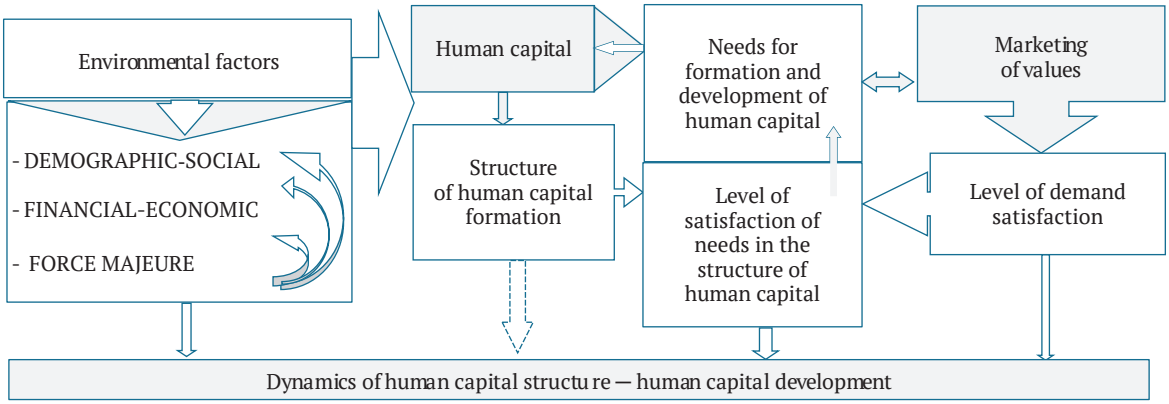

Figure 3. Model for assessing the impact of the marketing of values on the structure of human capital
Source: improved by the authors based on E. Golovnina (2023a)

There are two parties to the purchase and sale of a product, who are interested in the same issues for the purpose of their own satisfaction (product and profit and/or social effect), which, first of all, must find out at what level

of system formation they can be satisfied maximally/minimally. For this, a third party was introduced into the model – the subject of management (individual, company, region, state, world society). Thus, three-dimensional model was obtained for studying the possibility of the maximum degree of manageability of the structure of the marketing of values for optimising human capital and assessing the possibility of influence. In the model, one dimension was represented by the components of the marketing of values. The marketing of values, in this case, combines combinatorial forms of marketing, which are mandatory from the consumer's point of view, but which, in turn, can be detailed to achieve the result. A tree of three levels of marketing goals was systematically built. The highest level was the result of a combinatorial assessment with an indicative goal. It was subordinated to the second level with detailed assessments and their systematisation, which are presented in the process of developing various projects and intermediate stages of implementation. The second level includes elementary assessments of the third level, which are not detailed and are the foundation of the study.

Therefore, the marketing of values was represented by an integrated complex of innovative, socio-ethical, aesthetic, environmental, and omnichannel marketing. The second feature of the model of the impact of the marketing of values structure on the human capital structure was the justification for choosing a specific human capital structure for a particular study in accordance with the purpose and objectives, for example, elemental structures, human capital structures by type of goods, by time characteristics, etc. In this case, the classification of the structure of human capital by constituent elements was chosen, namely, by capitalised contribution to future generations, physiological, entrepreneurial, intellectual, social capital, corporate and transactional effects, and the effect of public goods.

The third feature of the model combines and manages the two previous levels with an orientation towards achieving and optimising the result. It was defined on the basis of the specifics of the first two dimensions, and was represented by a classification of management and entrepreneurship subjects that are common to the marketing of values and human capital formation. For example, it considers such subjects as an individual, a company/corporation, a region, a state, and a world society. It was the third level that implements, on the basis of streamlining management and system expectations, the target effect, respectively, at the personal, corporate, regional, national, and global (supranational) levels. Each level of hierarchy formation has its own characteristics (a set of criteria and scores) of using the marketing of values components in the formation of specific elements of human capital.

Based on the model, a local assessment of the existence/non-existence of the impact of each element of the marketing of values on a specific component of human capital formation was carried out, taking into account specific measures, methods, and tools from the position of management entities (in percentages) to the total number of cells of the conceptual cube. The overall assessment of the impact of the marketing of values on human capital development was determined by the sum of local assessments. The adaptation of the model for assessing the impact of the marketing of values on the structure of human capital was considered on the example of a roadside infrastructure project organised on the basis of a PPP. The features of the formation of the specified project reflect the state of the competitive environment for modelling the impact of the marketing of values on the state of human capital.

They reveal the features of the influence of high-quality customer service at roadside infrastructure facilities located along the roads (in motels, rest areas, car rental, car repair, gas stations, banking, insurance services, medical care, tourism, and travel organisation), creating a climate of social and individual safety for people during travel by road on highways in the country and abroad during work and leisure as merchants and tourists. This process involves various subjects of management and entrepreneurship (territories, companies, households, déjà vu). Human capital, which shapes individual success and the competitiveness of a nation, is the foundation of a household, region, company, industry, and national economy. Intellectual, entrepreneurial, and physiological capital occupy key positions and perform the main functions of socio-economic development, increasing labour productivity, in the development of artificial intelligence and innovation, to ensure sustainable economic growth and achieve social stability. The higher the quality and accessibility of the offer of services provided by the marketing of values complex on the basis of the formation of its specific structure, the higher the quality of structured human capital will be. For example, the physiological component of human capital is influenced through ecological marketing and product standardisation; the entrepreneurial, intellectual, transactional, and corporate component of human capital – through innovative and socially and ethically oriented marketing; awareness of the product and events related to it – thanks to omnichannel marketing, etc.

Improving the quality, and accessibility of customer service as well as the level of customer satisfaction with the services provided has a direct proportional impact on the growth of the level of well-being, quality of human capital, and safety of life, and on increasing the efficiency and profitability of the activities of market entities involved in the provision/reception of roadside infrastructure services. At the same time, based on quality services and the creation of motivations for personal development, a person receives an incentive for the growth of labour activity, intellectual, entrepreneurial, and creative work, which leads to the improvement of the marketing of values, its structure, productivity and socialisation of labour, corporate and social culture of relationships, and to increased individual and social well-being. The model of the PPP project for the development of roadside infrastructure combines the interests of various market entities in order to meet individual and social needs with minimal state budget costs and maximise the profits of business structures while increasing the quality and safety of transportation on the basis of equality, pooling of contributions, sharing of risks, costs, and results.

The detailed goals of PPP are the location, modernisation, and construction of roadside service facilities in accordance with international standards, medical care points, and assistance in the event of road accidents. This is a system of relations between the state and business, an instrument of international, national, regional, and

local socio-economic development, which is embodied in specific projects of joint implementation of the state and the private sector on the basis of state, communal, and municipal property. The combination of state capabilities and the realities of the private sector in the efficiency of private investments on the basis of PPP allows attracting private ideas, investments, releasing and effectively exploiting state resources (finance, land fund, etc.), ensuring high-quality infrastructure development. Taking into account the unstable economy, business interest in state support is growing to reduce risks, and improve reliability of investment projects for credit organisations, which corresponds to the Resolution of the Cabinet of Ministers of Ukraine No. 382 (2018) and the Resolution of the Cabinet of Ministers of Ukraine No. 1550 (2024).

The marketing of values in this area should contribute to maximising awareness and satisfying the interests of consumers when travelling on the roads of Ukraine and be aimed at meeting the needs of a physiological, intellectual, entrepreneurial, and socio-social nature. According to the results of the model for managing the impact of the marketing of values on the formation of human capital in the PPP project of a roadside infrastructure facility (Fig. 4), rating assessments were determined, which allow concentrating marketing activities in specific areas in order to obtain maximum effect.

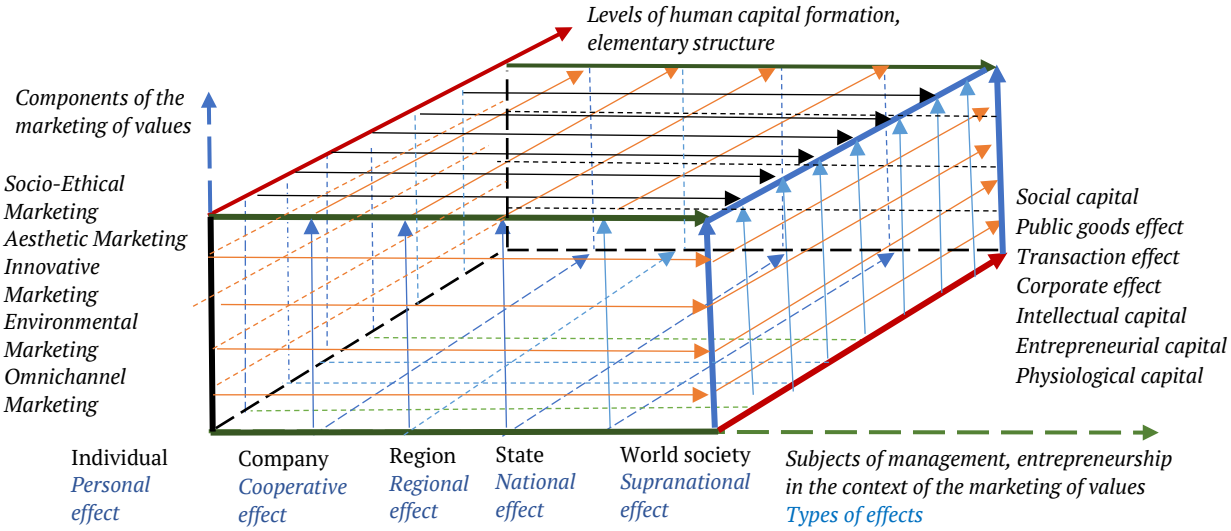

Figure 4. Assessment of the impact of the marketing of values on human capital formation
Source: developed by the authors

The coefficients for the overall assessment of marketing components were determined based on the sum of local assessments of each element of the marketing of values. Similarly, the coefficients for the overall assessment of human capital were derived from the sum of local assessments of each component of human capital. Based on the total rating assessment of human capital formation, the first place in terms of influence was shared by measures and techniques of innovative and omnichannel marketing – 26.1%. The second place in influence on the structure of human capital was occupied by socio-ethical marketing – 23.2%, followed by ecological marketing at 17.4%, and finally aesthetic marketing at 7.2%. The assessment of the component-by-component marketing impact on specific elements of human capital revealed the greatest influence of ecological marketing on physiological capital (60%), omnichannel marketing on social capital (60%) and the effect of public goods (50%), innovative marketing on entrepreneurial (60%) and intellectual (50%) capital, and socio-ethical marketing on the effect of public goods (50%).

Therefore, the presented assessment of the impact of the marketing of values on human capital formation groups information according to levels of individual and social value, in line with the criteria of the structure of human capital, the structure of the marketing of values, and the subjects of management and entrepreneurship. Based on a theoretical and methodological study of the features of the marketing of values and human capital, the formation of their structure was conducted through expert surveys and econometric modelling of factors influencing human capital. Consequently, a three-dimensional model for assessing the impact of the marketing of values on human capital development was built, which opens up opportunities for project management. An adaptation matrix assessment was carried out using the example of organising a PPP in the field of roadside infrastructure, which yielded a toolkit for coordinating the needs and interests of consumers, companies, and the state. At the same time, this toolkit allows adjustment of the input parameters of the constructed model and is valuable for forming and assessing the impact on human capital development strategies at all management levels, as well as for modelling the feasibility of implementing strategic innovative developments and targeted programming.

DISCUSSION

The results of this study, evaluating the impact of marketing of values on human capital development, are comprehensively substantiated. They include the conceptualisation of the structural components of marketing of values and human capital, identification of influencing factors, and application of econometric models to examine the

value foundations underlying human capital enhancement, as tested within the framework of a PPP project focused on roadside infrastructure. Additionally, an adaptation matrix and a three-dimensional model were employed to evaluate the hierarchical structure of the marketing of values influence and determine its resulting effects on human capital development. This framework differs from existing approaches by its interpretation of the marketing of values structure and the proposed techniques for analysing its impact on human capital development.

In particular, R. Markauskaitė *et al*. (2024) focused on the conflict between green and materialistic values, emphasising its adverse impact on consumer welfare. Using expert surveys, they revealed that increased awareness significantly reduces this conflict, highlighting the role of marketing of values in harmonising consumption behaviour with sustainability. This aligns with the broader discourse on consumer ethics and supports the thesis that marketing of values must integrate components to balance environmental priorities. S.M. Mehdi *et al*. (2024) explored Generation Z's attitudes towards organic food purchases and identified altruistic values, accessibility, and availability as primary determinants of behaviour. Simultaneously, hedonic values foster environmental self-identification. These findings reinforce the idea that marketing of values must be segmented and customised by generation, illustrating how health, sustainability, and consumer identity interlink in shaping market demand. Organic consumption, as argued, not only supports ecological goals but also contributes to national health, complementing the concept of human capital as a multidimensional construct.

P.V. Kadam (2024) provided a comprehensive view on how sustainable branding influences consumer behaviour, loyalty, and company culture. The author emphasises the strategic imperative of aligning corporate identity with consumer values. His conclusions illustrate how marketing of values functions as a bridge between brand ethics and long-term competitiveness, particularly in environments demanding innovation and responsibility. This supports the view that sustainability must be incorporated not only in communications but within the very foundation of business models. S. Bernayt (2021) supported the view that consumers increasingly prefer brands that reflect their own values. The shift towards sustainability has made it necessary for firms to ground marketing messages in ethical frameworks. Sustainable marketing, in this context, builds deeper and more enduring consumer relationships. This insight affirms the relevance of the formation and development of the marketing of values, which includes an environmental component to foster long-term loyalty and market differentiation in its structure.

P. Wang *et al*. (2021) demonstrated how consumers' values – such as exclusivity, conformity, and hedonism – affect their acceptance of sustainable initiatives by luxury brands. Particularly in China and the UK, hedonic motivations were found to influence purchase intentions. These findings highlight the importance of adapting sustainable marketing strategies to cultural contexts, reinforcing the multidimensional structure of the marketing of values that integrates both ethical and emotional appeals. L. Ruippo *et al*. (2022), through expert interviews on sustainable food packaging, concluded that environmental concerns dominate innovation priorities in this sector, while economic and social considerations are secondary. The study underlines the key role of government bodies and brand owners in advancing sustainable innovation, suggesting that stakeholder-driven governance is critical to embedding values in product development. This aligns with the notion of PPPs in advancing human and ecological welfare through value-based decisions.

U. Golob *et al*. (2022) examined the interaction between sustainability and branding and concluded that aligning brand values with stakeholder expectations is fundamental to reputation management and long-term brand equity. Their emphasis on corporate social responsibility, green image, and ideological alignment further supports the development of a cohesive marketing of values strategy, where stakeholder cooperation is central to value co-creation. P.R. Joyce *et al*. (2024) posited that marketing plays a decisive role in shaping organisational culture and employer branding, affecting talent acquisition and HRM strategies. Their perspective expands the scope of marketing of values to include internal stakeholders and affirms its importance in building human capital within the firm. It emphasises that values are not only communicated externally but also cultivated internally to foster organisational sustainability.

R. Manoharan *et al*. (2024) emphasised the transformative power of artificial intelligence as a tool for value creation, productivity growth, and cross-sectoral development. Their study complements the notion that technological innovation, when aligned with ethical and human-centred marketing strategies, becomes a vital component of both competitive advantage and societal advancement. This insight integrates digital transformation into the broader context of the marketing of values and human capital development. T. Paliienko (2023) considered human capital as an element of the innovation ecosystem that stimulates the creation of innovative industries and increased competitiveness, requiring active investment in education and healthcare. P.M. Vorona *et al*. (2023) focused on theoretical aspects, different approaches to measuring efficiency, and factors influencing investments in human capital. Their findings do not consider the marketing of values as a factor in innovation, labour productivity growth, profitability, or the analysis of the investment structure of human capital.

H. Paymash (2023) considered different approaches to the interpretation of human capital, highlighting the category of "human potential of people with special needs". "Professional marketing", marketing focused on people in general, and marketing for people with special needs are distinguished (complex of "degree, type, group of disability of persons", assessment of their potential in the labour market, formation of the offer of professions and jobs with division into workers with intellectual disabilities and with disorders and dysfunctions of various kinds). D. Raiko & I. Krolivets (2023) looked at the influx of marketing personnel (to promote the value of personnel in the company) from the stages of the structure (including inclusive hiring) – on corporate human capital (including the formation of human capital with limited capabilities). Their findings resonate with the conducted research, which demonstrates that marketing of values is considered in the context of various human values. Thus, the theory of human potential

marketing is becoming an integral part of the marketing of values. I. Shevchenko *et al*. (2023) developed a model linking digital technologies with human capital development. Their findings underscore the aim of enhancing economic systems by increasing the human capital index at macro and meso levels through effective digital integration, which supports the authors' thesis on the necessity of considering a multi-level hierarchy in human capital formation for accurately modelling the impact of the marketing of values.

S. Pahuwattanakorn *et al*. (2023) emphasised the importance of investing in human and intellectual capital by developing employees and fostering a culture of learning and innovation to enhance sustainability and competitiveness. Their study demonstrates that human capital is a key resource that increases organisational value and productivity, contributing to long-term economic sustainability in the context of Marketing 5.0, which supports the authors' findings. In conclusion, the influence of marketing of values on the development of human capital and the adaptive quantitative assessment matrix are appropriate across different levels. The findings of this study align with the broader literature, emphasising the role of the marketing of values system in the hierarchy of human capital formation and highlighting the modelling of demographic, social, financial, and economic factors influencing this relationship within the framework of a PPP project involving a roadside infrastructure facility.

CONCLUSIONS

The hierarchy of the marketing of values management was considered in connection with the hierarchy of human capital management. Modelling the structural components of the marketing of values corresponds to the purpose, hierarchy, and structure of human capital formation/development. To ensure effective demand, the marketing of values must take into account the level of real human well-being in society. The latter was characterised by factors of formation and development of human capital, which have become factors with a high level of influence on human capital, as was confirmed by estimates of correlation-regression analysis. Thus, the correlation coefficients with human capital by factors were: pension size (+0.978), subsistence minimum (+0.931; +0.984), legal (+0.936) and shadow wages (+0.949), natural and "artificially forced" population reduction (−0.768 and −0.785, respectively), the share of subsidies in expenditures (−0.949), and the percentage of the population with incomes lower than the subsistence minimum (−0.515), the share of wages of employees in GDP (+0.873), nominal spending and savings (+0.969), real difference between income and expenditure (+0.913), tax burden (−0.882), and level of shadow economy (−0.890).

Analysis of the results of the constructed econometric models allowed to substantiate the financial, economic and socio-demographic bases of human capital development as guidelines for the formation of the marketing of values system. Based on the principles of the marketing of values, a three-dimensional model of assessing the impact on the formation of human capital was proposed, which allows for local element-by-element assessments of the marketing of values structure on the elements of the human capital structure and to determine the overall level of impact. Taking into account the above, an adaptation matrix was proposed as a method for studying the interaction of factors for quantitative assessment of the impact of the marketing of values on the structure of human capital. The testing of theoretical justifications for assessing the impact of the marketing of values structure on the structure of human capital was implemented using the example of organising a PPP project in the field of roadside infrastructure. The influence of the marketing of values on the state of human capital reveals the features of high-quality customer service at roadside infrastructure facilities to create a climate of social and individual safety when travelling by road on highways in Ukraine and abroad.

Based on the total rating assessment, the formation of human capital depends to the greatest extent on innovative and omnichannel marketing activities at the level of 26.1%. A significant impact was exerted by socio-ethical marketing in the amount of 18.2%, environmental (15.6%) marketing. Due to the relatively insignificant impact on the formation of human capital of aesthetic marketing (6.5%), the latter needs to be improved. An element-by-element assessment of the impact of marketing on the structure of human capital revealed the greatest impact of ecological marketing on physiological capital (60%), omnichannel marketing on social capital (60%) and the effect of public goods (50%), innovative marketing on entrepreneurial (60%) and intellectual (50%) capital, and socio-ethical marketing on the effect of public goods (50%). It is advisable to continue research in the direction of forming a functional model that can be used to substantiate national, regional, local, and local development projects, taking into account the specification of functions, measures, investments, management tools, executors, and investors.

ACKNOWLEDGEMENTS

None.

FUNDING

None.

CONFLICT OF INTEREST

None.

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Маркетинг цінностей в ієрархії формування людського капіталу: структурна трансформація та оцінка впливу

Анотація. Людський капітал визначає якість добробуту, інновації, ресурси, конкурентоспроможність компанії та країни на міжнародній арені. Виняткову роль у формуванні його структури відіграє маркетинг цінностей. На основі зазначених міркувань метою дослідження було змоделювати вплив демографічних, соціальних, фінансових та економічних чинників, а також компонентів маркетингу цінностей (Маркетинг 3.0) на розвиток людського капіталу за допомогою динамічного та регресійного аналізу в межах проєкту державно-приватного партнерства. Пілотне дослідження, проведене методом експертного опитування (інтерв'ю та анкетування) у 2022-2024 роках, дозволило уточнити структуру та вплив маркетингу цінностей на формування людського капіталу. Запропоновано тривимірну модель і адаптаційну матрицю для оцінювання впливу маркетингу цінностей на розвиток людського капіталу. Обґрунтовано рейтинг впливу ознак структури маркетингу цінностей: 26,1 % за рахунок інноваційного та омніканального маркетингу, 23,2 % – соціально-етичного маркетингу, 17,4 % – екологічного маркетингу, 7,2 % – естетичного маркетингу. Здійснене покомпонентне оцінювання з'ясувало найбільший вплив екологічного маркетингу на фізіологічний капітал (60 %); омніканального маркетингу на соціальний капітал (60 %) та на ефект суспільних благ (50 %); інноваційного маркетингу на підприємницький капітал (60 %) й інтелектуальний капітал (50 %); соціально-етичного маркетингу на ефект суспільних благ (50 %). Доведено, що ефект формування людського капіталу визначається впливом компонентів маркетингу цінностей. Запропонована концепція, що окреслює вплив маркетингу цінностей на структуру людського капіталу, разом з адаптивною кількісною оціночною матрицею, має бути використана для оптимізації впливу маркетингу цінностей на людський капітал на всіх рівнях національної економіки

Ключові слова: складові маркетингу цінностей; структура людського капіталу; маркетинговий аналіз; добробут; державно-приватне партнерство

ЕКОНОМІКА РОЗВИТКУ
Міжнародний економічний журнал

Том 24, № 2
2025

Відповідальний редактор:
Н. Проскурніна

Підписано до друку 27.06.2025
Формат 60*84/8
Ум. друк. арк. 17,6
Наклад 50 прим.

Видавництво: Харківський національний економічний університет імені Семена Кузнеця
61166, пров. Інженерний, 1-А, м. Харків, Україна
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ECONOMICS OF DEVELOPMENT
International Economic Journal

Volume 24, No. 2
2025

Managing Editor:
N. Proskurnina

Signed to the print 27.06.2025
Format 60*84/8
Conventional Printed Sheet 17.6
Circulation 50 copies

Publisher: Simon Kuznets Kharkiv National University of Economics
61166, 1-A Inzhenerny Ln., Kharkiv, Ukraine
E-mail: info@ecdev.com.ua
https://ecdev.com.ua/en