

## DIGITAL AND AI TOOLS IN STATE FINANCIAL POLICY: EUROPEAN EXPERIENCE AND A CASE FOR UKRAINE

HENNADII ZHUYKOV<sup>1</sup>, SVITLANA PROKHORCHUK<sup>2</sup>, DMYTRO MAZUR<sup>3</sup>,  
YURI KULYNYCH<sup>4</sup>, HALINA MAZUR<sup>5</sup>, OLEKSANDR MAZUR<sup>6</sup>

<sup>1</sup>Department of Finance, Accounting and Taxation, International University of Business and Law, Ukraine

<sup>2</sup>Department of Finance, Accounting and Taxation, International University of Business and Law, Ukraine

<sup>3</sup>Department of Human Resources Management and Labor Economics,  
PrJSC “Higher Education Institute “MAUP””, Ukraine

<sup>4</sup>Department of Finance, National University of Food Technologies, Ukraine

<sup>5</sup>Department of Finance, Accounting and Taxation, International University of Business and Law, Ukraine

<sup>6</sup>Department of Finance, Accounting and Taxation, International University of Business and Law, Ukraine

Email: <sup>1</sup>mubip2024@gmail.com; <sup>2</sup>lana\_audit7@ukr.net; <sup>3</sup>mazur.dmytro91@gmail.com;  
<sup>4</sup>mazurgalina1404@ukr.net; <sup>5</sup>mazurgalina1404@ukr.net; <sup>6</sup>mazur3103@ukr.net

### ABSTRACT

In the current conditions of global digital transformation, public finances face challenges and opportunities associated with the introduction of digital technologies and artificial intelligence (AI). The relevance of the study is due to the need to assess how digitalization and AI affect the effectiveness of financial policy in different countries, especially in the context of the challenges that Ukraine faces when reforming public finances in a period of economic and social change. After all, a high level of digital services and the active use of e-government do not always translate into increased fiscal transparency, budget discipline, and the effectiveness of financial policy. The article carries out a comprehensive interdisciplinary analysis of the impact of digital instruments on financial policy using the example of Ukraine, its neighbors from the European Union (Poland, Slovakia, Hungary, Romania) and Turkey, a candidate country with active digitalization. The methodology is based on a systematic combination of quantitative and qualitative indicators - from the share of the ICT sector in gross value added, the volume of public and private funding of scientific research, the level of digital skills of the population and the use of AI, to indices of e-government development and transparency of the budget process. Particular attention is paid to imbalances between the digital skills of the population, the institutional capacity of the state, the innovative activity of business and the quality of budget management. The results revealed significant differences in the level of digital readiness, innovation potential and institutional capacity of countries to use digital technologies in financial policy. Ukraine is characterized by high demand for digital services, but has limitations in the human resources of researchers and weak institutional support for transparency and citizen participation. The comparative analysis confirmed that to increase the effectiveness of financial policy, a transition from the simple provision of digital services to a comprehensive institutional transformation that integrates AI and digital tools into all stages of the budget cycle is necessary. In addition, the most effective impact of digitalization on financial policy is observed in countries with a high level of digital skills, a developed R&D infrastructure, a powerful ICT sector, and balanced indicators of budget transparency and citizen participation (Poland, Slovakia). On the other hand, in Ukraine, despite the high digital activity of citizens and the dynamic development of e-government, the effect of digitalization is restrained by insufficient institutional capacity, a low level of budget transparency, a weak innovation sector and a decrease in human scientific and technological potential. The practical significance of the work lies in the formulation of recommendations for Ukraine on the adaptation of European models of digital transformation of finance, which can become the basis for building a transparent, accountable and efficient financial system. The study is also useful for other countries with similar socio-economic challenges that seek to integrate innovations into public financial management.

**Keywords:** *Digitalization, Artificial Intelligence, Financial Policy, E-Government, Digital Skills, Budget Transparency, Institutional Capacity, Public Finances, Ukraine, European Union, Turkey.*

## 1. INTRODUCTION

In today's conditions of accelerated digital transformation of the economy, digitalization and artificial intelligence technologies are becoming crucial in the formation and implementation of the state's financial policy. The spread of big data, automated analytical systems, e-government and AI solutions is fundamentally changing approaches to the formation and implementation of financial policy. At the same time, the effectiveness of using these tools depends not only on the level of technological development, but also on the institutional capacity of the state to integrate digital innovations into the public finance system in compliance with the principles of transparency, accountability and citizen participation.

The need for this study is due to the fact that in many countries of the world there is an asymmetric impact of digitalization on financial management. Even with high indicators of digital skills of the population, significant prevalence of e-government or active use of AI, the public sector does not always achieve improvement in budget discipline, fiscal transparency or the quality of management decisions, which is connected to a complex of factors - from the insufficient development of the ICT sector and R&D infrastructure to the lack of qualified researchers, limited innovative business activity and the weakness of public control institutions. That is why the key analytical question is not only what is implemented, but how effectively these digital and AI tools change financial policy in practice.

This issue is particularly relevant for Ukraine, which is simultaneously facing military challenges, post-crisis recovery, and European integration transformations. On the one hand, Ukraine demonstrates a high level of using digital government services and rapid implementation of certain financial digital solutions, but on the other hand, it faces limitations in innovation potential, a shrinking research base, and institutional imbalances in the area of budget transparency and public participation. This creates a situation where digital services are actively used, but are not always transformed into a permanent increase in the effectiveness of financial policy.

Thus, the research is aimed at identifying the causes of such imbalances, determining the factors that ensure the real impact of digital and AI solutions on financial policy, as well as comparing the effectiveness of digitalization in EU countries and Turkey to form evidence-based recommendations for Ukraine.

## 2. LITERATURE REVIEW

The digital transformation of economic systems today is characterized by the intensive spread of digital technologies and the growth of their role in making management decisions (Abdulaziz & Khaled (2025) [1]; Andrioaia et al. (2025) [4]; Djakona et al. (2021) [15]). On this basis, not only the tools of public financial management are changing, but also the logic of the functioning of fiscal mechanisms, budget planning, public financial control and regulatory influence (Abousifein & Leyland (2026) [2]; Andriushchenko et al. (2024) [5]; Melnyk et al. (2021) [35]; Nikiforov et al. (2024) [40]). In this context, financial policy is increasingly viewed as a dynamic system of management decisions that should ensure the sustainability of public finances, contribute to increasing the efficiency of resource allocation, and create institutional prerequisites for long-term socio-economic development (Pasko et al. (2021) [45]; Pilko et al. (2024) [47]; Shaposhnykov et al. (2021) [53]).

In the scientific literature (Buiak et al. (2023) [7]; Filyppova et al. (2025) [20]; Hryhoruk et al. (2025) [22]) digitalization and digital transformation are mostly interpreted as comprehensive modernization of public administration and economic relations, which occur as a result of the introduction of digital platforms, automation of procedures, development of electronic services and expansion of analytical information processing capabilities. A significant part of the research (Dubyna et al. (2023) [17]; Ivanova et al. (2020) [23]; Kholiavko et al. (2022) [25]; Kozmenko et al. (2021) [32]; Shkolnyk et al. (2019) [59]) emphasizes that the digital transformation of financial policy is manifested in changing approaches to tax administration, modernizing the budget process, increasing the transparency of public finances, and applying e-governance tools (Panchenko et al. (2024) [43]; Shchur et al. (2025) [54]; Shkarlet et al. (2015) [57]). At the same time, digital technologies are considered as a factor in increasing the efficiency of public financial decisions by reducing transaction costs, improving control procedures, and improving the quality of interaction between the state and economic agents.

A separate area of modern scientific research (Alamsyah & Astuti (2025) [3]; Danylyshyn et al. (2021) [10]; Hrubliak et al. (2025) [21]) is the analysis of the impact of artificial intelligence on financial policy mechanisms. The studies note that artificial intelligence and machine learning tools contribute to increasing the capacity of state institutions to promptly process large amounts of information, form predictive models, identify risks,

and support management decision-making processes. Given the growing scale of digital data and the complexity of economic relationships, the possibilities of using artificial intelligence in the field of public finance are gaining practical significance, in particular in terms of forecasting budget revenues, assessing the effectiveness of budget programs, risk-based control, and improving state financial audit procedures (Kobelia et al. (2023) [29]; Maksymiv et al. (2022) [31]; Shestakovska et al. (2024) [55]).

In European countries, the integration of digital solutions into financial policy is considered as a component of the overall strategy for digital modernization of the public sector. Scientific works (Shkarlet et al. (2016) [56]; Shkolnyk (2008) [58]; Xie & Wu (2024) [66]), devoted to the European experience, emphasize the systematic nature of digital reforms, which are implemented through a combination of technological innovations, institutional development and the formation of an appropriate regulatory environment. An important aspect is the focus on the transparency of financial processes, increasing the accountability of state bodies and ensuring the effectiveness of data-based budget management. Along with this, researchers (Kosach et al. (2025) [30]; Kovalenko et al. (2019) [31]; Ostrovska et al. (2024) [43]); emphasize that the digital transformation of the financial policy of European countries requires a clear definition of the framework principles for using digital technologies, including ensuring the protection of personal data, cybersecurity, ethical standards and preventing discriminatory effects that may arise from the use of algorithmic tools.

Within the framework of scientific research ( Melnyk et al. (2021) [35]; Nikiforov et al. (2024) [40]; Tkachuk (2017) [61] ) on the use of artificial intelligence in public financial management, the balance of potential benefits and risks remains an important issue. On the one hand, the use of algorithmic models allows to increase the accuracy of forecasts, to ensure more effective detection of deviations in financial flows, to optimize the resource provision of state programs and to minimize losses from inefficient use of budget funds. On the other hand (Shaposhnykov et al. (2021) [53]; Zybareva et al. (2021) [73]), the risks of algorithmic opacity, the difficulty of explaining individual decisions, the possibility of erroneous conclusions due to poor-quality data, as well as the problem of legal liability for the consequences of using automated analytical systems are relevant. Thus, the application of artificial intelligence in financial policy requires the simultaneous

development of mechanisms for regulating, controlling and evaluating the effectiveness of digital instruments.

The Ukrainian context of digital transformation of financial policy is characterized by a combination of active development of electronic government services and existing institutional constraints that hinder the full-scale implementation of innovative technologies in the field of public finance. Domestic scientific works (Andriushchenko et al. (2024) [5]; Tulchynska et al. (2022) [62]; Macovei et al. (2025) [33]) consider digitalization as a necessary condition for increasing the transparency of financial management, improving budgetary discipline and strengthening the state's ability to mobilize financial resources. At the same time, it is noted that the implementation of technological solutions is often fragmented, which complicates the formation of a holistic digital model of budget and tax management. Additional limitations are the uneven development of digital infrastructure, the shortage of human resources, increased cybersecurity risks and the need to harmonize national legislation with European regulatory approaches in the digital technologies and artificial intelligence.

The generalization of scientific approaches gives grounds to assert that research on financial policy in the context of digital transformation and the use of artificial intelligence is mostly focused either on individual technological aspects of digitalization or on general issues of e-governance development. At the same time, approaches that would comprehensively combine the issues of financial policy, digital transformation and integration of artificial intelligence, taking into account European experience and Ukrainian realities, remain insufficiently systematized. In view of this, further development of theoretical and methodological substantiation of directions for adapting financial policy to the digital environment, determination of criteria for the effective use of artificial intelligence tools and formation of practical mechanisms for minimizing relevant risks in the public financial management system are relevant.

The purpose of the article is a comprehensive analysis of the digitalization impact and artificial intelligence technologies on the effectiveness of the state's financial policy based on a comparative study of Ukraine, EU neighboring countries (Poland, Slovakia, Hungary, Romania), and Turkey

### 3. METHODOLOGY

The study is based on the principles of systematicity, comparability and cause-and-effect analysis, which allowed assessing not only the level

of digital readiness of countries, but also the effectiveness of the transformation of digital and AI tools in financial policy. The system analysis method was used to build a conceptual model of the impact of digitalization and artificial intelligence on financial policy, which covers the relationship between digital infrastructure, innovation activity, human capital, e-government and budget transparency. Comparative analysis was used to compare Ukraine with neighboring countries. Statistical and trend analysis methods were used to analyze the dynamics of digital and innovation indicators over time. The indicator analysis method was used to assess digital readiness and institutional effectiveness of financial policy. For this purpose, internationally recognized indicators and ratings were used, in particular, the E-Government

Development Index (EGDI), the Open Budget Survey, indicators of digital skills of the population and the use of generative AI. To summarize the results and form a typology of countries by the effectiveness level of the impact of digitalization and artificial intelligence on financial policy, the method of grouping and qualitative comparative analysis was applied. In general, the methodological tools used ensured the comprehensiveness, scientific validity and practical orientation of the study, which allows considering the obtained results as a basis for further applied and political and economic developments in the field of digital financial policy.

The proposed methodology of this study is summarized in Figure 1.

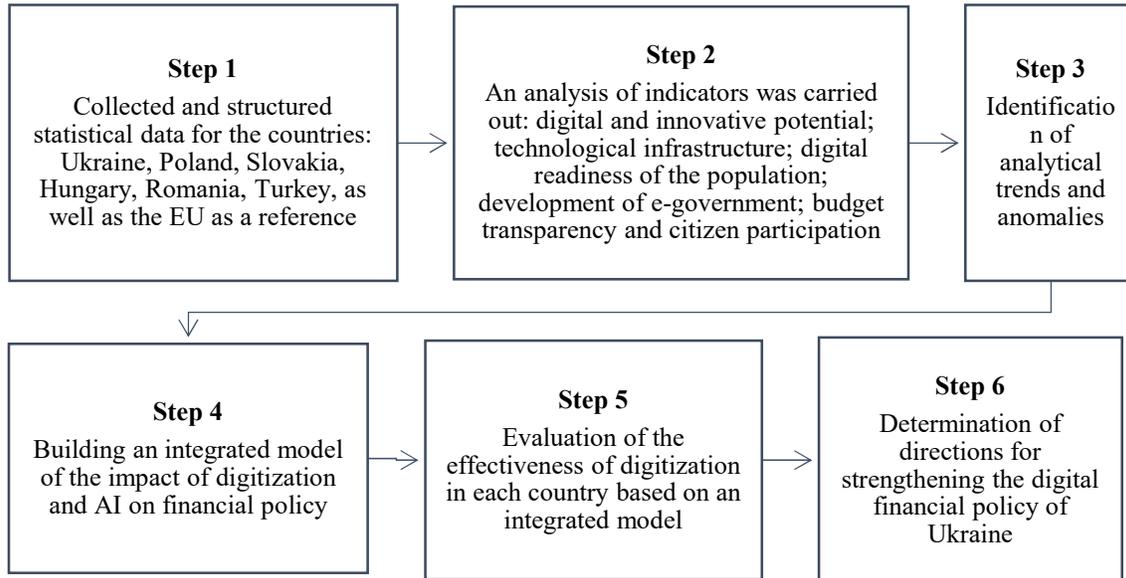


Figure 1: Research methodology

Source: compiled by the authors

The study will show how the interaction of the components of digital development determines the effectiveness of the state's financial policy.

The study formed a target sample of countries, which included the neighboring member states of the European Union (Poland, Slovakia, Hungary, Romania), as well as Turkey as a neighboring country, a candidate for accession to the EU. The above-mentioned sample is methodologically justified for several reasons. First, the studied countries are characterized by a common post-socialist and transformational heritage, which led to similar starting conditions for the formation of financial institutions, budgetary and tax systems, as well as administrative culture. Second, all selected

countries face similar challenges of fiscal discipline, in particular the problems of tax gaps, shadow economy, limited fiscal space and the need to increase the efficiency of budget expenditures. Under these conditions, digital technologies and systems based on artificial intelligence are considered as tools for improving the quality of financial management, which creates a common field for comparative analysis. Third, the countries studied demonstrate different levels of digital maturity of public administration and financial administration, which is manifested in differences in indicators of e-government, digital public services, use of big data and artificial intelligence in tax and budget administration. The inclusion of Turkey in

the sample has a special methodological value, which, while not being an EU member, is actively implementing digital and AI solutions in the field of public finance, in particular in tax administration, electronic document management and analytical support for fiscal decisions. Thus, the selected sample of countries ensures methodological comparability, allows tracing the cause-and-effect relationship between digitalization, the use of artificial intelligence and the effectiveness of financial policy, and creates a basis for identifying practices relevant for implementation in Ukraine, taking into account its institutional and economic characteristics.

#### 4. RESULTS

The digital readiness of the financial system is a fundamental prerequisite for the effective formation and implementation of modern financial policy of the state. It determines the ability of institutions, the market and the population to adapt to digital technologies, including artificial intelligence, to implement them in everyday operations and use them in decision-making processes. Without a developed digital infrastructure and the availability of highly qualified human capital, digital financial policy cannot function fully, since technological solutions will not be effectively integrated into the work of financial institutions, and users will not be able to use them.

The first dimension of digital readiness is digital infrastructure – a set of hardware, software, network and organizational components that ensure the functioning of digital financial services. As Sadchykova & Yevsienko (2025) [50] note, digital infrastructure is a driver of the development of the

credit system and the financial market in general, since it forms the basis for digital lending, payments and processing of financial information. The presence of an appropriate technical and organizational base under the conditions of modern digitalization becomes a productive resource for the transformation of financial services and the expansion of financial accessibility.

Digital infrastructure includes access to high-speed internet, cloud computing, data centres, secure digital transaction systems, as well as common elements of digital public infrastructure, including interoperable public registries, electronic identification and digital government services. As the OECD (2024) [14] emphasises, digital public infrastructure should be open, secure and capable of supporting both public and private services, as it lays the foundation for an integrated digital economy and society, and enhances the efficiency of financial management.

One of the basic quantitative indicators of the digital readiness of the economy and the financial system is the share of the information and communication technology (ICT) sector in gross value added (GVA). This indicator reflects the development level of digital infrastructure, the concentration of digital services, the technological maturity of the economy and its ability to generate added value based on digital solutions. In the context of financial policy, the growing role of ICT means expanding opportunities for the digitalization of the budget process, tax administration, financial monitoring and the implementation of artificial intelligence tools in public finance management (Fig. 2).

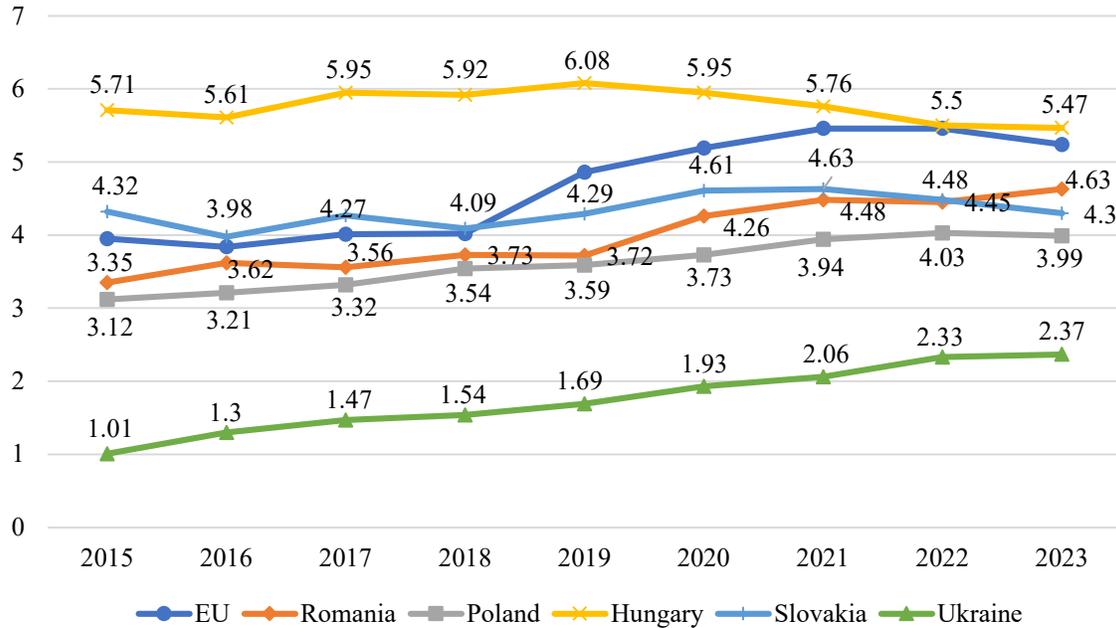


Figure 2: Dynamics of share of the ICT sector in gross value added, %

Source: compiled by the authors based on information from [11; 12]

An analysis of the dynamics of the ICT sector's share in gross value added for 2015-2023 demonstrates the steady growth of the digital component of the economy of EU countries - Ukraine's neighbors, as well as significant, albeit relatively slower, progress in Ukraine.

On average, the share of the ICT sector in GVA in the EU increased from 3.95% in 2015 to 5.24% in 2023, which indicates a systemic digital transformation of economies and the consolidation of ICT as one of the key sectors for creating added value. The highest values over the entire period are demonstrated by Hungary (over 5.5%), which reflects the active development of digital services, outsourcing of IT services and the integration of digital technologies into industry and public administration.

Poland, Romania and Slovakia show more moderate but stable growth rates. Their indicators fluctuate within 4.0-4.6% in 2023, which is consistent with the model of gradual digital modernization with an emphasis on infrastructure, digital skills and e-government services. Importantly, these countries are actively using digital platforms in the areas of tax administration, budget control and financial supervision, which is directly related to the quality of financial policy.

Against this background, Ukraine demonstrates the lowest values, although the growth dynamics are positive: from 1.01% in 2015 to 2.37% in 2023. This means that in eight years the share of ICT in GVA

has more than doubled, but the gap with EU countries remains significant - in 2023 it is more than 2 times compared to even the least digitally saturated neighboring countries.

From a fiscal policy perspective, this suggests that Ukraine's digital infrastructure has not yet reached the critical mass needed to fully leverage sophisticated digital tools, including big data analytics and artificial intelligence in fiscal management. At the same time, the growth trend itself confirms the structural prerequisites for accelerated digital transformation, provided that targeted government policy is in place.

Business sector expenditure on research and development (BERD) is not only an indicator of business innovation activity, but also a fundamental mechanism that contributes to the intensive digitalization of the economy and increases the effectiveness of fiscal policy. Wu et al. (2025) [65] investigated the impact of digital finance on the transformation of R&D achievements in the context of Chinese provinces and concluded that the development of digital finance contributes to an increase in the speed of transformation of scientific research results into real products and services, which, in turn, affects aggregate economic indicators and enhances the effectiveness of financial regulation and the implementation of financial policy.

The importance of this direction is also confirmed by the findings of Kan & Sun (2022). [25], who

argue that digital finance significantly contributes to increasing R&D investments, as it expands financial coverage and lowers barriers to access to financing, especially for enterprises that use digital financial services in their daily activities.

Therefore, the dynamics of business sector spending on research and development as a share of GDP is one of the key indicators of the innovative capacity of the economy and an important

prerequisite for digitalization, in particular the introduction of artificial intelligence in financial policy. Fig. 3 clearly demonstrates the significant differences between Ukraine's neighboring countries, members of the European Union, Turkey and Ukraine, which allows to draw a number of meaningful conclusions regarding the role of business innovations in the formation of the digital financial system.

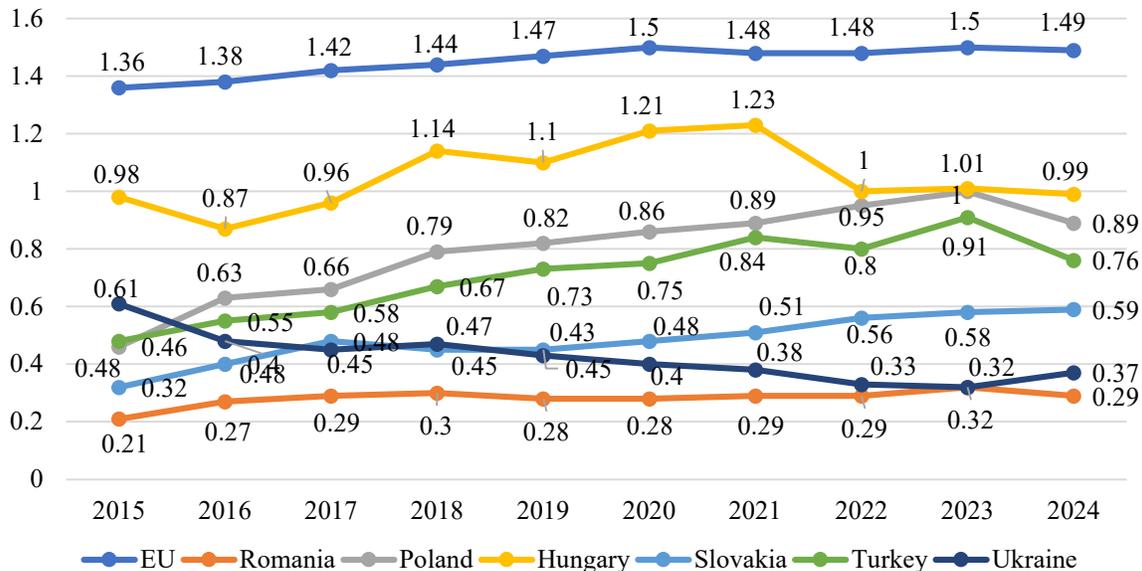


Figure 3: Dynamics of the share of expenses of the business sector on scientific research and development (Business enterprise expenditure on R&D (BERD)), % to GDP

Source: compiled by the authors based on information from [11; 12; 51]

The share of business sector spending on scientific research and development to GDP in the EU during 2015-2024 remains stably high and fluctuates within 1.36-1.50% of GDP. These dynamics indicate an institutionally entrenched model of innovative development, in which the business sector is a key investor in the creation of new technologies. It is under these conditions that a favorable environment is formed for the development of digital infrastructure, financial technologies and artificial intelligence tools, which are subsequently integrated into tax administration, budget planning and financial supervision. The high stability of the indicator also indicates the predictability of financial policy and effective mechanisms for stimulating innovation by the state.

Poland and Hungary demonstrate different, but methodically indicative trajectories. In Poland, there is an almost linear increase in the share of business spending on R&D – from 0.46% of GDP in 2015 to about 1% in 2023, which brings the country closer to the average European values. This indicates the

gradual formation of an innovation-oriented development model, where the digitalization of the financial system relies on domestic technological potential. In Hungary, the dynamics are more volatile, but the overall level of spending remains relatively high, especially in the period 2018-2021, which reflects an active, albeit cyclical, innovation policy on the part of businesses. Both countries are examples of how transformational economies can create the prerequisites for the use of sophisticated digital tools in financial management in a relatively short period.

Romania and Slovakia are characterized by lower values, but demonstrate stable positive dynamics. Their indicators are growing slowly, but without sharp declines, which indicates a gradual increase in the innovative potential of the business sector. In the context of digital financial policy, this means that digital solutions are being implemented in a more evolutionary way, with an emphasis on the adaptation of existing technologies, rather than on breakthrough innovations. At the same time, this

model often provides better institutional compatibility between business and public financial authorities.

Turkey stands out as a special case. Despite its status as an EU candidate country, it has shown a significant increase in business sector spending on R&D – from 0.48% of GDP in 2015 to a peak of over 0.9% in 2023. This reflects a targeted state policy to stimulate innovation, particularly in the areas of digital technologies, finance and public administration. The Turkish experience is important for Ukraine, as it shows that even outside the EU it is possible to form a relatively strong innovation base for the digitalization of the financial system.

The situation in Ukraine is the most problematic. Fig. 3 records a downward trajectory of business sector spending on R&D from 0.61% of GDP in 2015 to about 0.37% in 2024. This means a narrowing of the innovation base precisely at a time when digitalization and artificial intelligence are becoming key tools for increasing the efficiency of fiscal policy. At the same time, the high correlation coefficient between this indicator and GDP (0.99) indicates that the impact of business innovations on economic growth in Ukraine is very strong. Thus, the problem lies not in the lack of a connection between innovations and economic results, but in the insufficient scale of investment in R&D.

In conclusion, the analysis confirms that the business sector's spending on scientific research and development is a critically important prerequisite for the digital readiness of the economy and the financial system. For Ukraine, this means that increasing the effectiveness of financial policy, in particular through the use of digital technologies and artificial intelligence, is impossible without increasing business investment in R&D. It is in this area that the key reserve for reducing the gap with

the EU countries and forming a modern, digitally oriented financial policy lies.

Public funding of research and development (R&D) is a key instrument of public financial policy in the field of innovation and digitalization. Public funding not only provides financial support for fundamental and applied scientific projects, but also creates the institutional conditions for the implementation of innovations on a large scale, creating a basis for the digital transformation of the economy and increasing the efficiency of financial policy. Czarnitzki & Hussinger (2018) [9] investigate the impact of public subsidies on R&D in German enterprises and show that both direct and state-induced R&D spending lead to an increase in innovative output (e.g. patent activity), which indicates the effectiveness of public-private synergy in the field of innovation investment. These results are consistent with the findings of Kijek et al. (2016) [27], which indicate an additional effect of public support for R&D on stimulating the private sector. On the other hand, the research of Petrin & Radicic (2023) [46] summarizes empirical studies of the econometric impact of public R&D spending on private investment and emphasizes that in most cases public spending complements private spending, creating synergies that enhance innovation potential.

That is, it is advisable to consider the dynamics of the share of government allocations for scientific research and development in the total amount of R&D spending not in isolation, but in close connection with the business sector's spending on scientific research and development, since it is the ratio of government and business funding that determines the quality of the institutional environment for the digitalization of the economy and the effectiveness of financial policy.

Table 1. Share of government allocations for R&D in total R&D expenditures, %

Years	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
EU	2,89	2,86	2,78	3,01	3,24	3,56	3,91	4,08	4,15	5,03
Romania	1,61	1,75	4,47	7,71	8,34	6,49	3,45	6,35	10,35	2,5
Poland	5,05	15,49	9,24	5,83	4,69	3,53	4,44	4,19	15,95	9,84
Hungary	0,6	0,13	0,4	0,03	0,03	0,29	6,4	8,98	3,96	3,49
Slovakia	1,88	1,53	1,69	1,85	2,35	1,97	2,16	2,87	4,33	2,27
Turkey	10,05	11,10	14,01	15,76	14,39	9,37	11,54	10,94	4,52	4,86
Ukraine	-	-	-	-	-	-	-	9,1	9,3	11,7

Source: compiled by the authors based on information from [11; 12; 51]

Analysis of the data in Table 1 indicates that the EU over the period 2015-2024 is characterized by a gradual trend towards an increase in the share of public allocations in the structure of total R&D spending, especially after 2020. This growth occurs

in parallel with a relatively stable and high level of business sector spending on research and development. This combination indicates a model of “shared responsibility”, within which the state increases funding for fundamental and strategic

research, while business focuses on applied innovations, digital solutions and commercialization of R&D results. It is this model that provides the highest return on innovation investments and has a positive impact on the long-term financial sustainability of the economy.

For the countries of Central and Eastern Europe, there is a much greater volatility of the share of state allocations for R&D. In Poland, Romania and Hungary, sharp fluctuations in this indicator often coincide with periods of changing budget priorities or intensification of state support programs for innovations. At the same time, changes in the dynamics of business sector spending on R&D are recorded during these same periods, which confirms the close relationship between budget policy and business innovation activity. The growth of the state share in the conditions of an underdeveloped private innovation sector, as a rule, does not give a sustainable effect, while the synchronous growth of both components creates the prerequisites for the digital transformation of industry, the financial sector and public administration.

The situation in Ukraine is particularly telling (official data on this indicator has only been available since 2022), which shows a sharp increase in the share of state R&D allocations in total spending. This growth occurs against the background of a decrease or stagnation in business sector spending on scientific research and development. This asymmetry indicates a forced strengthening of the role of the state in conditions of war and high risks for private business. From the point of view of financial policy, this means that budget instruments actually compensate for the decline in innovative activity of the business sector, but without the restoration of private investment in R&D, this model cannot ensure sustainable digitalization of the economy.

Thus, public R&D funding plays a multiplier role, namely: it not only directly supports research, but also, by stimulating private R&D spending, creating a favorable innovation environment and strengthening human capital, contributes to a deep

digital transformation. This impact is directly related to the effectiveness of financial policy, since innovations and digital technologies significantly change the structure of budget processes, increase the efficiency of tax administration, contribute to the formation of new financial instruments and reduce the costs of performing public functions. It is through these mechanisms that public R&D funding becomes an integral part of the modern policy of digital transformation of the economy.

The spread of AI use by businesses reflects the level of readiness of the business environment to integrate innovative tools that can increase productivity, decision-making accuracy, flexibility in responding to market changes, and, at the same time, enhance the quality of financial administration and monitoring.

Artificial intelligence in the economic context performs several key functions that are directly related to the effectiveness of financial policy. First, it helps automate routine operations, which reduces errors, speeds up data processing, and reduces administrative costs. Second, machine learning algorithms and analytical models support the forecasting of economic indicators, risks, and tax revenues, which is especially important for strategic planning and budget forecasting. As Malik et al. (2024) [35] point out, artificial intelligence technologies significantly increase the predictive power of financial reporting by integrating big data and analytics, which allows for increased awareness when making financial decisions and assessing risks in financial systems. The integration of AI into financial processes contributes to improved management of financial flows and risks, which is an important prerequisite for increasing the efficiency of public finances. Yemets & Kurii (2025) [67] indicate that the introduction of artificial intelligence in the field of financial management contributes to the automation of risk management processes, the acceleration of processing large amounts of financial information, and the increase in the accuracy of analytical conclusions (Fig. 4).

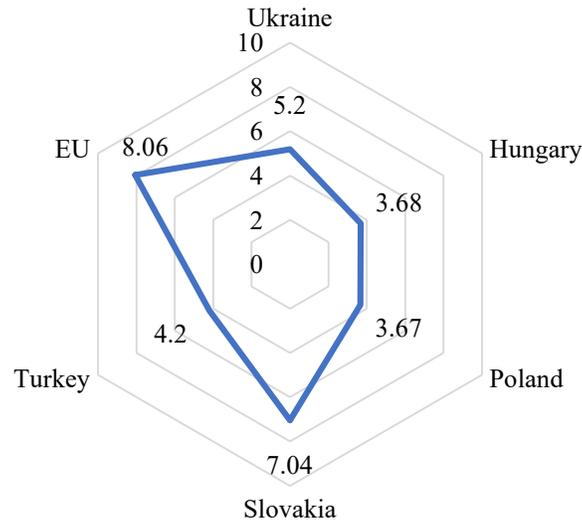


Figure 4: Share of enterprises using artificial intelligence technologies in the total number of enterprises (2024)

Source: compiled by the authors based on information from [10; 11]

The 2024 figures show significant variability in the share of enterprises with AI implementation. The highest values are observed for the EU (8.06%), Slovakia (7.04%), and Ukraine (5.2%), while Romania (1.51%) and Poland (3.67%) have lower rates of AI use among enterprises. Turkey (4.2%) and Hungary (3.68%) occupy intermediate positions. These differences reflect the diffusion level of digital technologies in the corporate sector and the readiness level of the business environment to use advanced tools to increase productivity, analytical capabilities and financial efficiency.

For countries with a high share of enterprises using AI, including Slovakia, this indicates a more effective integration of digital solutions into business processes, which allows not only to increase competitiveness, but also to strengthen the financial policy system through better quality data, predictive models and automated analytical tools. For Ukraine, a rather high share of enterprises using AI (5.2%) indicates a significant potential for digital transformation of the business environment, which, with appropriate support from the financial system and public policy, can be mobilized to improve the efficiency of fiscal administration, budget forecasting and risk assessment.

At the same time, the relatively low figures in Romania and Poland suggest that, despite national efforts in digital transformation, businesses in these countries have not yet reached a critical AI level, adoption, which limits the possibilities for using these data in financial policy and government processes. In this context, it is important to note that, according to global reviews (McKinsey & Company

(2025) [37]), while many organizations are already using or experimenting with AI, a large part of them is still at the pilot or partial deployment stage, rather than full integration into strategic functions.

Thus, the analysis of the share of enterprises using artificial intelligence technologies shows that the AI integration level into corporate structures is closely correlated with the economy's ability to implement digital tools in the field of financial policy. Countries with a higher share of these enterprises have better prerequisites for using AI in forecasting budget indicators, assessing tax risks and supporting effective financial management, while low implementation rates may limit these opportunities. In turn, for Ukraine, this indicator is a positive signal that the digital potential of business can become an important support for strengthening the digitalization of financial policy, provided that a favorable regulatory and institutional environment is created and relevant competencies are developed.

A key component of the digitalization of the economy and the financial system is human capital, which includes the level of digital and financial skills, the ability to adapt to new technologies, and the receptivity to digital innovations. Brechko (2019) [6], Matvieieva et al. (2024) [36] emphasize that digital literacy, along with financial literacy, is a basic component of the development of the information society, without which the integration of citizens into the digital economy is impossible, and therefore the effective implementation of digital financial policies. This is consistent with international observations that the human factor is a key determinant of digital transformation and the

readiness of countries to integrate digital solutions into their economic and social spheres. Figueiredo (2024) [19] argues that in the EU, countries with a higher level of digital skills demonstrate better economic performance and more stable development of digital markets. In addition, the OECD report highlights that digital financial literacy and the ability to use digital financial services safely are critical for building financial resilience and inclusion in the digital economy.

The dynamics of the number of scientists per one million population in the studied neighboring countries of Ukraine (Romania, Poland, Hungary, Slovakia, Turkey) and Ukraine itself for the period 2015–2023 is an important indicator of the development of scientific and research potential, which directly affects the country's ability to innovate, including in the field of digitalization and the formation of effective financial policy (Fig. 5).

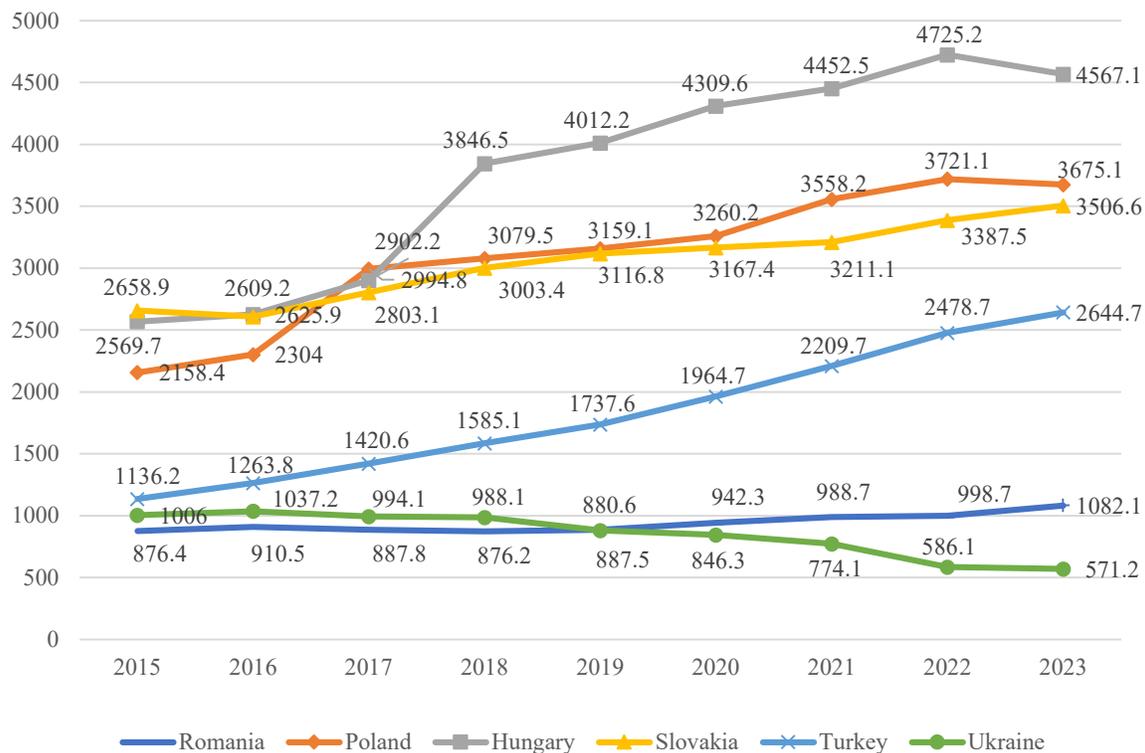


Figure 5: Dynamics of the number of researchers (in full-time equivalent) per million inhabitants  
Source: compiled by the authors based on information from [11; 12; 51]

Analyzing the data in Fig. 5, it can be noted that Poland, Hungary and Slovakia demonstrate a steady growth in the number of scientists, reaching over 3,500 scientists respectively in 2023. Turkey also shows a positive trend, growing from 1,136 in 2015 to over 2,600 in 2023. In contrast, Ukraine has a significantly lower level of scientific potential - from 1,006 in 2015 to 571 in 2023, with a tendency to reduce this number. The situation in Ukraine is explained by a number of complex factors. First, the outflow of scientific personnel abroad has a significant impact due to better working conditions, higher salaries and more attractive opportunities for career development in foreign countries. Second, insufficient state funding of science and research

limits the opportunities for conducting modern research, updating the material and technical base and attracting young talents. Third, the instability of the economic and political situation, including the war, worsens the conditions for scientific activity and encourages many scientists to leave the country or switch to other areas of activity. In addition, there are problems with organizational support for innovative activities and a low level of integration of science with business, which also reduces motivation for scientific work.

This difference in scientific potential has a direct connection with the effectiveness of the financial policies of states. A higher concentration of scientists contributes to a greater volume of research

and development, which is the foundation for the implementation of innovative digital technologies in the financial system. According to research, a strong scientific potential allows the state to develop more accurate analytical tools for budget planning, tax revenue forecasting and risk management, which improves the quality and effectiveness of financial policies (OECD 2021) [49].

For Ukraine, the decline in the number of scientists indicates the threat of loss of scientific and technical potential, which complicates the digital transformation of the financial sector and hinders the development of innovative mechanisms of public financial management. At the same time, the positive experience of countries with a higher level of scientists emphasizes the need to form a state policy aimed at supporting science, stimulating scientific activity and preserving human resources as a key resource for the development of digital and effective financial policy.

Thus, supporting and developing scientific potential through preserving and increasing the number of scientists is a critically important element of the strategy for digitalizing the financial system, which directly affects the increase in transparency, flexibility, and efficiency of financial policy in modern conditions.

Research also highlights the importance of digital literacy and AI integration for economic efficiency. Niam et al (2024) [39] analyze the role of artificial

intelligence and digital literacy in increasing labor efficiency and automating routine tasks in the economic sector and prove that the combination of digital and AI competencies contributes to increasing productivity, reducing administrative burden and supporting innovative business processes. Although the research focuses on work processes, the findings have direct relevance to government financial policy: higher digital skills and active use of AI contribute to more accurate, faster and transparent processing of financial data in the public sector and reduce transaction costs.

Therefore, indicators of the population's digital skills and the level of use of generative AI tools are important markers of the digital capacity of society, which affects the effectiveness of the implementation of the state's financial policy. The ability of citizens to possess digital skills and use of generated AI systems forms the basis for the use of modern digital financial services, facilitates access to electronic government services, contributes to a greater coverage of non-cash transactions and increases financial literacy. This, in turn, directly affects the quality of the performance of state functions in the field of tax administration, budget transparency, forecasting of revenues and expenditures, as well as the government's ability to implement an effective policy of digital transformations (Fig. 6).

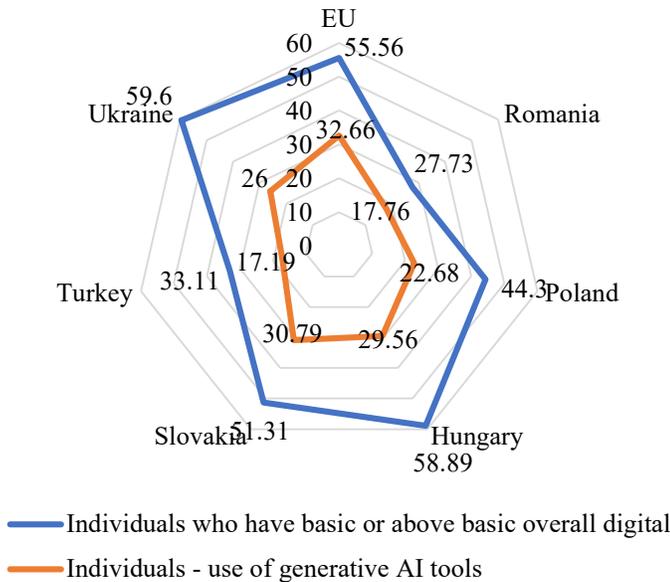


Figure 6: Share of individuals with basic or higher general digital skills and use of generative AI tools among the population (2024), %

Source: compiled by the authors based on information from [11; 14; 64]

The 2024 figures show significant differences across countries as follows: the highest levels of digital skills are in Ukraine (59.6%) and Hungary (58.89%), which indicates a relatively high level of potential digital inclusion of the population. However, the use of generative AI tools in these same countries (26% for Ukraine and 29.56% for Hungary) is significantly lower than the overall level of basic digital skills in the EU, which indicates that AI technologies are not yet fully integrated into the everyday digital behavior of the population. In the EU, both basic digital skills and the use of generative AI are at a relatively high level, which explains the wider adoption of digital financial instruments, a high level of e-citizenship and access to e-services.

Romania and Turkey have significantly lower values for both indicators, which limits the impact of digitalization on financial policy – both in terms of the implementation of digital services in the public sector and in the ability of citizens to fully use these services (e.g. digital tax platforms or financial applications). At the same time, Poland and Slovakia have an average level of both indicators, demonstrating an intermediate stage of digital maturity.

These differences highlight that digital literacy and the use of AI not only contribute to increasing the competitiveness of the economy, but are also important prerequisites for improving the effectiveness of government financial policies. Countries with high levels of digital literacy of citizens are better able to implement digital tax administration systems, electronic budget accounting, open financial data and AI-based analytical platforms, which ensure faster decision-making, better transparency and lower transaction costs. In turn, low awareness of AI and digital tools can hinder these processes, as it limits both the population's access to digital financial services and the capacity of government institutions themselves to effectively implement innovative solutions.

For Ukraine, where the share of citizens with basic digital skills is quite high, the main challenge is the transition from “digital literacy” to the active implementation of AI tools in the daily activities of citizens and businesses. This requires not only a favorable state policy for the development of digital competencies, but also targeted programs to increase AI literacy, support access to modern technologies and stimulate the use of AI tools in the financial

sector and public administration. This approach will maximize the potential of digitalization to improve the effectiveness of financial policy and ensure reforms in the public sector using intelligent technologies.

Indicators of citizen activity in using electronic government services are an important component of society's digital readiness and a direct marker of how effectively the state is transforming digital technologies into practical tools for interacting with citizens. These services cover a wide range of actions - from submitting applications and obtaining certificates to paying taxes and administrative services, which directly affects the implementation of the state's financial policy. E-government helps reduce administrative costs, increase transparency, accountability and accessibility of services, as well as create conditions for operational monitoring of financial flows and planning of budget expenditures. E-government integrates technologies into the process of providing public services, which makes public administration more effective, and financial policy more predictable and transparent.

Kachula (2025) [24] confirms the importance of e-government development for effective financial management and argues that digital tools contribute to increased transparency and accountability in resource allocation, as well as optimization of government spending and revenues. In addition, the UN E-Government Survey 2024 [18] emphasizes that the development of e-government supports the implementation of the Sustainable Development Goals and contributes to increasing the efficiency of public services through the application of digital strategies and models focused on the needs of citizens and businesses.

The E-Government Survey Index (EGDI) is related to E-government activities: empirical studies show that systematically developed E-government contributes to the growth of administrative efficiency and productivity in the field of public administration (Doran et al. (2023) [16]; Cosmulese et al. (2026) [8]). This means that countries with better positions in the EGDI usually demonstrate more integrated digital platforms for the provision of electronic services, including financial and tax services, which allows to increase transparency, reduce costs and speed up data processing in public finances (Figure 7).

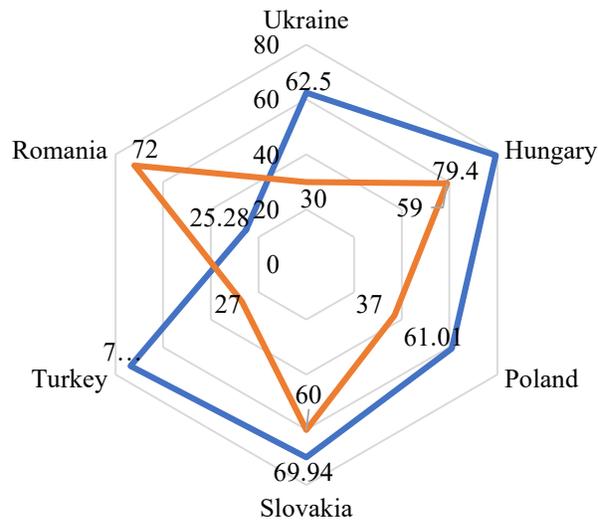


Figure 7: Use of E-Government Services by Individuals (%) and E-Government Development Index (EGDI) (2024)

Source: compiled by the authors based on information from [11; 12; 18]

Turkey and Ukraine have the best EGDI ratings among these countries (27 and 30 respectively), indicating a relatively high level of development of E-government at the institutional level. Turkey also demonstrates the highest share of citizens-users of E-government (73.7%), indicating a conscious use of digital government services by the population and a high level of synchronization between institutional capabilities and behavioral readiness of citizens. This situation contributes to more efficient tax administration, budget planning and financial monitoring, since a significant part of the interaction between citizens and the state takes place digitally and automatically.

Ukraine, in terms of the share of E-government users (62.5%), also demonstrates a fairly high level of digital participation of citizens, which is consistent with the high position of the EGDI (30) in combination with the active use of digital services, is a sign that Ukraine has a strong demand for digital government services and is an important prerequisite for optimizing financial management and reducing transaction costs in the public sector.

The opposite picture is observed in Romania, which has the worst ranking position (72) and a very low level of citizen activity in using E-government (25.28%). This indicates that institutional digital transformation does not ensure the accessibility and attractiveness of services for citizens. In this situation, the potential of E-government remains unused, which hinders the opportunities for digital tax administration, budget transparency and rapid analysis of financial data.

Hungary and Slovakia demonstrate high shares of E-government use (79.4% and 69.94% respectively) at low ranking positions (59 and 60). This indicates a certain asymmetry between the behavioral activity of the population and the quality of institutional digitalization – citizens actively use online services, but the overall level of digital maturity of government systems is limited by insufficient telecommunications infrastructure, low-quality online services or weak human capital in the public sector. These imbalances are important to consider in financial policy, as they can reduce the effectiveness of implementing more complex digital financial models, including the use of AI analytics

In addition, research by Seiam & Salman (2024) [52] shows that the development of E-government is positively correlated with increased government efficiency and reduced corruption, which directly affects the coordination of public finances, transparency of budget expenditures and tax administration. This emphasizes the importance not only of creating digital platforms, but also of their quality, accessibility and active use by citizens, so that they contribute to a real increase in the efficiency of fiscal policy.

High EGDI rankings combined with a high share of E-government users are an optimal configuration for modern financial policy. Ukraine has a favorable combination of these two parameters compared to some neighboring countries, but to fully utilize the digital potential in finance, it needs to strengthen the institutional quality of government systems and improve the accessibility of complex digital services.

The Open Budget Survey (OBS) 2023 indicator [42] plays a key role in assessing the effectiveness of the state's financial policy, as it measures not only the formal aspects of the state budget, but also the real level of public participation in budget processes (Public Participation), control by independent institutions (Budget Oversight) and openness of budget information (Transparency). These

indicators reflect not only the technical capacity of the state, but also the quality of interaction between citizens, control institutions and public finances - which is of great importance for increasing the efficiency of public resource management, reducing corruption risks and increasing public trust (Fig. 8).

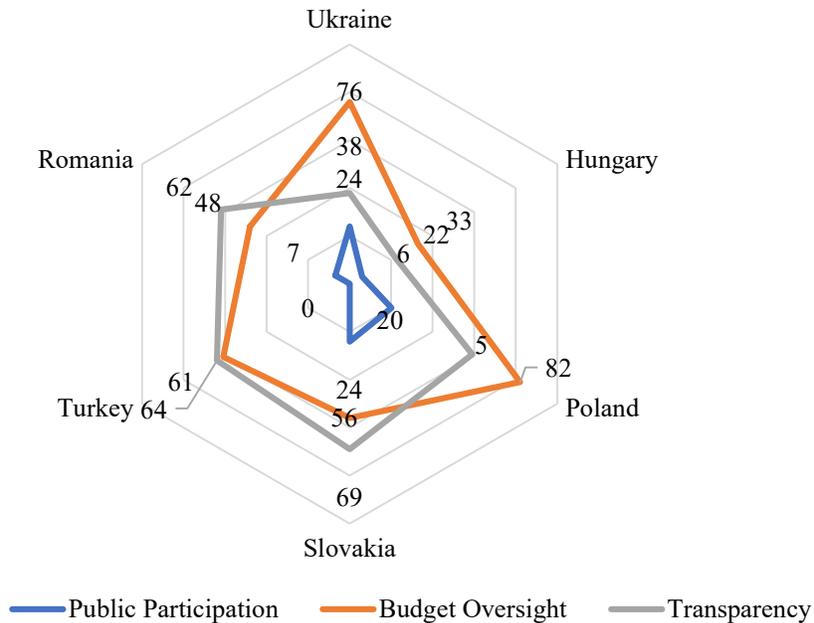


Figure 8: Index Open Budget Survey 2023 in section Public Participation, Budget Oversight, Transparency  
Source: compiled by the authors based on information from [11; 12; 18; 42]

The analysis of the OBS 2023 level shows significant cross-country differences. Poland shows one of the highest scores in both control (82) and transparency (59), reflecting a well-structured system of budgetary oversight and open access to budgetary information. This creates the prerequisites for strengthening fiscal policy through public engagement, increased parliamentary oversight, and accountability of budgetary decisions.

Slovakia and Turkey have high Transparency scores (69 and 64 respectively) but lower Public Participation scores, indicating a situation where information is available but mechanisms for citizen engagement in the budget process are weak. This combination limits the potential for transparency to actually influence financial decisions, as access to information does not always translate into the ability to influence policy.

Ukraine has a very low level of Public Participation (24) and only moderate Transparency (38) but a relatively high level of Budget Oversight

(76). This picture indicates that control structures (e.g., independent audit, parliamentary committees) work quite effectively, but the interaction between citizens and the budget process is limited. This means that without active participation of society in the formation of budget priorities, the effectiveness of fiscal policy is limited in its social legitimacy and consideration of citizens' needs.

The lowest scores in Hungary (Public Participation – 6; Transparency – 22) and Romania (Public Participation – 7) signal significant gaps in transparency and public engagement. This structural weaknesses in budget communication and oversight can lead to low public trust in public finances, weak accountability, and less efficient resource allocation.

From the perspective of the digitalization role, these indicators are closely related to E-government and the digital skills of the population. For example, countries with high values of transparency and control often have better developed digital services for public access to budget information, which, in

turn, contributes to higher digital literacy and more active use of E-government.

Thus, the OBS 2023 analysis shows that effective fiscal policy is formed not only through systemic institutions, but also through openness, accountability, and citizen engagement, which contributes to greater transparency in the allocation of budget resources, more effective audit of expenditures, and building trust between the state and society. Public participation in the budget process, access to clear and open information play a

key role in shaping effective fiscal policy instruments that meet the needs of citizens and strengthen the foundation of digital democracy.

Therefore, the effectiveness of the state's financial policy in the context of digital transformation is formed as a result of the interaction of structural, institutional, technological and human factors. For this purpose, it is advisable to apply a multi-level analytical model that combines macroeconomic, innovation and management indicators of digital development (Fig. 9).

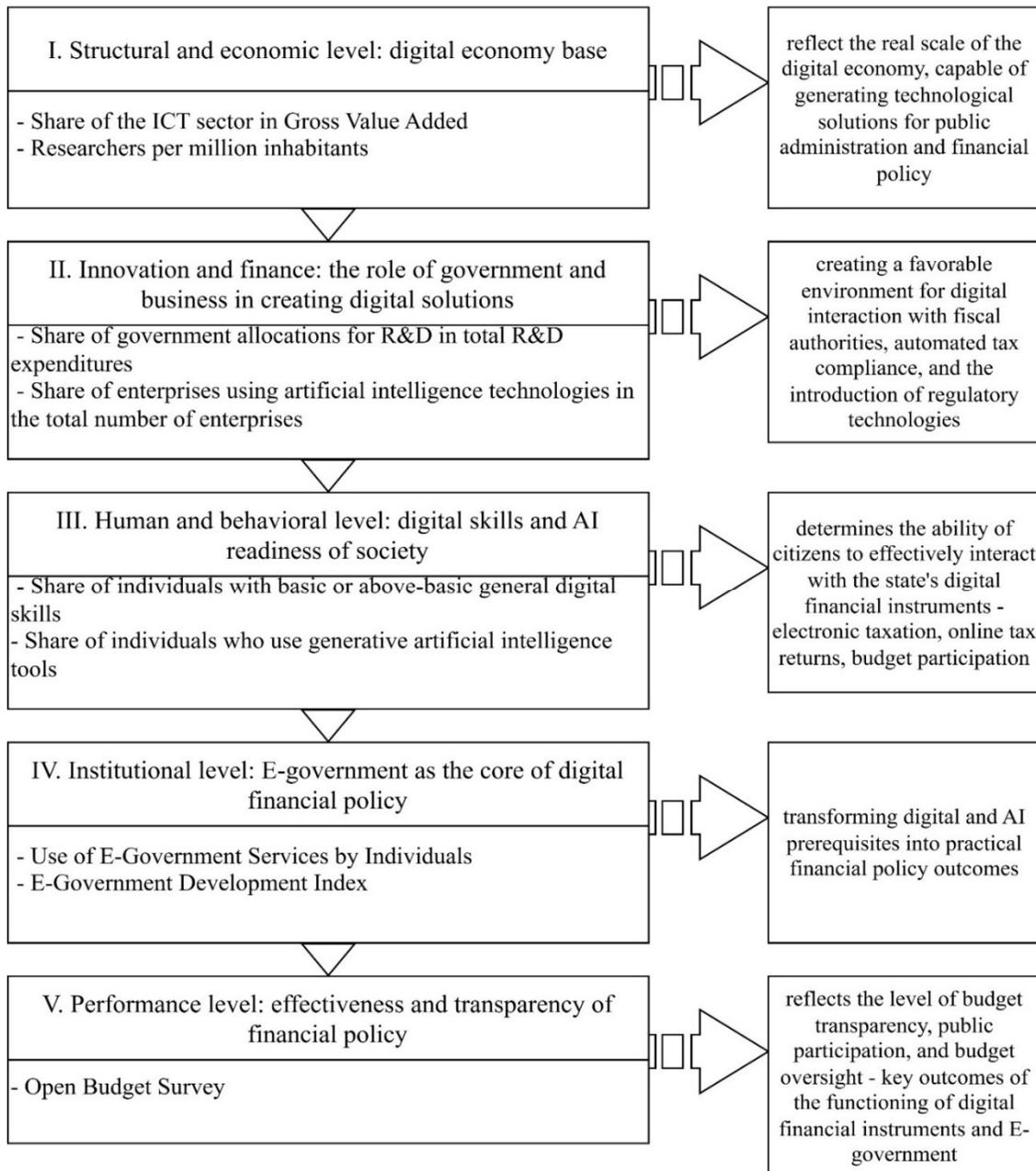


Figure 9: Integrated model of the impact of digitalization and artificial intelligence on the effectiveness of state financial policy. Source: compiled by the authors

The model demonstrates a consistent chain of interaction between the digital economy (ICT sector, scientific personnel), innovative investments (public R&D, AI in business), digital skills and the use of AI by the population, institutional maturity of E-government and, ultimately, the level of transparency and effectiveness of financial policy, as measured by the Open Budget Survey.

The proposed model allows for cross-country comparisons; to identify bottlenecks in the digital

transformation of financial policy; to formulate practical recommendations for Ukraine, taking into account the experience of EU neighboring countries and Turkey.

Summarizing the results of the study, Table 2 shows an integrated assessment of the extent to which digitalization and the introduction of artificial intelligence technologies are actually transforming into increasing the efficiency of state financial policy in the countries studied.

*Table 2. Comparative assessment of the effectiveness of the impact of digitalization and artificial intelligence technologies on the formation and implementation of financial policy in the study countries*

Country	Level of digitalization and AI	State of institutional transparency	Level of public participation	Result (level)	Key challenges and opportunities
Poland	High (ICT, AI, digital skills)	High (OBS: transparency and control)	Moderate (Public Participation 20)	High	Stable implementation of AI and digital services; requires increased public participation
Slovakia	Moderate	Moderate (OBS: transparency is high)	Moderate (Public Participation 24)	Moderate	Growth of E-government; limited innovation investments; AI and R&D development needed
Hungary	High digital potential	Low (low transparency and participation)	Very low (Public Participation 6)	Limited	Lack of transparency and public engagement; institutional accountability needs to be developed
Romania	Low/ rising	Low (low participation and transparency)	Very low (Public Participation 7)	Low	Low public participation; increased public investment in R&D and digital infrastructure needed
Turkey	High (active AI, e-gov)	Moderate (OBS: medium transparency)	Very low (Public Participation 0)	Moderate	High level of digital services; increased citizen participation in the budget process is necessary
Ukraine	Medium (high digital skills, limited AI)	Moderate (OBS: high control, low transparency)	Low (Public Participation 24)	Moderate	Significant potential; needs to expand public participation and support innovation in financial policy

*Source: compiled by the authors*

This summary approach makes it possible to identify asymmetries between the level of digital readiness and the quality of budget transparency, accountability, and citizen participation, as well as to form informed conclusions about strengths, structural limitations, and potential areas for adapting best European practices to improve Ukraine's financial policy.

## 5. DISCUSSION

The analysis conducted allows to state that digital transformation and the use of artificial intelligence create qualitatively new conditions for the implementation of financial policy, changing both the content of management decisions and the

mechanisms for their adoption.

Completely agreeing with the opinion of Shyshkina et al. (2025) [60] and Zhang et al. (2025) [68; 69] that in modern conditions, financial policy increasingly relies on tools of digital analytics, forecasting and automated management, which increases its potential for rapid response to macroeconomic challenges, and also contributes to increasing the efficiency of budget resource management. At the same time, the digitalization of financial policy is not a purely technological process, since its effectiveness is determined by the level of institutional capacity of the state, the quality of regulatory support and the level of public trust in digital management solutions.

Sharing conclusions of Melnyk et al. (2021) [38]

and Nikiforov et al. (2024) [40], which today is the European experience indicates the introduction of digital technologies in the field of public finance, which is accompanied by the formation of a systemic approach to the modernization of public administration, which, in turn, covers institutional, regulatory and technological components. In these conditions, digital tools contribute to increasing the transparency of budget processes, strengthening control over the effectiveness of public spending, improving the administration of tax revenues and strengthening fiscal discipline. At the same time, within the framework of European models, there is a desire to ensure a balance between the innovativeness of digital solutions and the need to protect citizens' rights, in particular in the field of personal data processing, ethical aspects of algorithmic influence and the prevention of discriminatory effects.

In recent years, Ukraine has demonstrated a noticeable intensification of digital reforms, which creates the prerequisites for increasing the efficiency of financial management. At the same time, the digitalization of individual elements of the budget and tax system contributes to the optimization of administrative processes, reducing the time spent on the interaction of economic agents with state institutions and increasing the transparency of financial transactions. However, supporting the opinion of Hrubliak et al. (2025) [21] that the national features of the implementation of financial policy in the context of digital transformation are characterized by the presence of a number of limitations, among which the key ones are the unevenness of digital capabilities in different sectors of the economy, the shortage of specialized competencies in the field of analytics and cybersecurity, as well as the need for systematic adaptation of the regulatory environment to new technological realities.

The use of artificial intelligence in financial policy has significant potential in terms of improving budget forecasting, risk-based tax control and increasing the effectiveness of public financial audit (Andrioiu et al. (2025) [4]). At the same time, it is important to consider that the effectiveness of these tools directly depends on the quality of the data on which the algorithms are trained, the transparency of the models and the ability to explain the results obtained in the process of automated analysis. In the absence of proper control, there is a risk of making management decisions based on incomplete or distorted data, which can negatively affect the fairness of fiscal regulation and the overall effectiveness of financial policy.

In addition, the introduction of artificial intelligence into the sphere of public finance raises the issue of legal responsibility and institutional accountability, since the use of algorithmic systems should not replace the processes of professional management control and economic justification of management decisions. In this context, the strategic task is to form a comprehensive model of integrating artificial intelligence into financial policy, which would combine technological innovations with mechanisms of state regulation, ethical standards and a system of independent audit of digital solutions.

Given the results of the study, it is appropriate to emphasize that the further development of Ukraine's financial policy in the context of digital transformation and the use of artificial intelligence requires a systemic approach, which should include the development of institutional capacity of state authorities, improvement of digital infrastructure, training of specialists with competencies in the field of financial analytics and data management, as well as harmonization of national regulation with European approaches. The implementation of these measures will contribute to increasing the adaptability of financial policy to structural changes in the economic environment, strengthening the sustainability of public finances and creating conditions for long-term development.

## 6. CONCLUSIONS

The study allowed for a comprehensive assessment of the impact of digitalization and artificial intelligence technologies on the formation and implementation of the state's financial policy using the example of Ukraine's neighboring countries - EU members (Poland, Slovakia, Hungary, Romania), the candidate country Turkey and Ukraine.

The result of the study is the construction of an integrated model that combines indicators of digital infrastructure, innovative activity, human capital, the level of digital skills of the population, the development of AI, e-government and budget transparency, which made it possible to move from the analysis of individual digital practices to the assessment of their real fiscal effectiveness and institutional impact. This made it possible to identify characteristic types of digital evolution of financial policy and to identify structural imbalances in each country.

Poland and Slovakia are characterized by a relatively balanced model of the impact of digitalization on financial policy. Particularly

indicative are the high values of budgetary supervision (Poland – over 80 points, Slovakia – over 55 points), which, combined with developed E-government, ensures the transformation of digital tools into a real increase in the efficiency of financial policy. It is these countries that demonstrate the most harmonious connection between digital prerequisites and results.

Hungary and Turkey are distinguished by a high level of digitalization of certain areas, but weak institutional implementation of this potential. Hungary has one of the highest shares of ICT in GVA and high rates of E-government use, however, extremely low values of public participation and budget transparency (Public Participation – 6 points, Transparency – 22 points) significantly offset the effect of digital tools. Turkey, in turn, demonstrates high spending by the business sector on R&D and active implementation of AI, but the zero level of public participation in the budget process according to OBS is one of the most striking negative results of the study.

This confirms one of the key findings of the study – digitalization without institutional transparency and citizen participation does not create prerequisites for quality financial policy.

Romania and Ukraine are fundamentally different in terms of internal characteristics. Romania is characterized by low values of digital skills of the population and use of E-government, combined with relatively good indicators of budget transparency (Transparency - over 60 points). This indicates the institutional efforts of the state, which, however, are not supported by a sufficient level of digital readiness of society. Ukraine, on the contrary, demonstrates one of the most paradoxical combinations of indicators in the sample: a high share of citizens using E-government, relatively high digital skills of the population and rapid implementation of digital services, but a low share of ICT in GVA, a reduction in the number of researchers and weak participation of citizens in the budget process. Particularly striking is the contrast between the high level of budget control (76 points) and low values of transparency and public participation. That is, one of the most important results of the study is the identification of the Ukrainian model as a model of "demand ahead of institutions", when digital services are actively used by citizens, but are not integrated into systemic budget management.

Summarizing, the most convincing results of the study are, firstly, confirmation that high digitization without institutional transparency and democratic mechanisms of participation (Hungary, Turkey)

does not ensure effective financial policy, secondly, countries with a harmonious combination of digital readiness, AI-intensity and budgetary openness (Poland, Slovakia) demonstrate the highest effectiveness of digital financial policy, thirdly, the identification of the Ukrainian model as a model "demand ahead of institutions", where digital financial services are actively used by citizens, but not yet fully integrated into systemic budget management. It is this grouping that makes it possible to clearly outline a strategic orientation for Ukraine - the transition from service digitalization to institutional digitalization, where AI, e-government and digital data become the basis of transparent, accountable and long-term effective financial policy. Further development of digital and AI-oriented financial policy in Ukraine will depend on deep institutional reform, development of human capital, restoration of R&D potential and balancing of digital services with real mechanisms of openness and accountability.

Questions raised by the research, but which remain open, are defined levels of institutional transparency, which is the critical minimum that allows digital and AI tools to really improve the quality of financial policy, and how quickly digital and AI tools can compensate for institutional constraints in countries with unstable political and economic environments.

#### AUTHOR CONTRIBUTIONS

Conceptualization: Hennadii Zhuykov, Svitlana Prokhorchuk, Dmytro Mazur, Yuri Kulynych, Halina Mazur, Oleksandr Mazur.

Data curation: Hennadii Zhuykov, Halina Mazur, Oleksandr Mazur.

Formal analysis: Svitlana Prokhorchuk, Dmytro Mazur, Yuri Kulynych.

Investigation: Hennadii Zhuykov, Svitlana Prokhorchuk, Dmytro Mazur.

Methodology: Hennadii Zhuykov, Svitlana Prokhorchuk, Dmytro Mazur, Yuri Kulynych, Halina Mazur, Oleksandr Mazur.

Project administration: Svitlana Prokhorchuk.

Resources: Svitlana Prokhorchuk, Halina Mazur, Oleksandr Mazur.

Supervision: Hennadii Zhuykov, Svitlana Prokhorchuk.

Validation: Dmytro Mazur, Yuri Kulynych, Halina Mazur, Oleksandr Mazur.

Visualization: Hennadii Zhuykov, Svitlana Prokhorchuk, Oleksandr Mazur.

Writing – original draft: Dmytro Mazur, Yuri Kulynych, Halina Mazur, Oleksandr Mazur.

Writing – review & editing: Hennadii Zhuykov, Svitlana Prokhorchuk.

## REFERENCES:

- [1] Abdulaziz, A., & Khaled, H. (2025). The moderating effect of corporate liquidity on the relationship between financial reporting quality and dividend policy: evidence from Saudi Arabia. *Journal of Financial Reporting and Accounting*, 23(6), pp. 2514–2532. <https://doi.org/10.1108/JFRA-05-2023-0247>
- [2] Abousifein, M.E., & Leyland, N. (2026). The Financial Toxicity of Endometriosis: Unseen Costs and Policy Gaps. *Journal of Obstetrics and Gynaecology Canada*, 48(1), 103188. <https://doi.org/10.1016/j.jogc.2025.103188>
- [3] Alamsyah A., & Astuti, R.F. (2025). Analyzing public discourse on DeFi and CBDC using advanced NLP techniques: insights for financial policy and innovation. *Digital Policy, Regulation and Governance*, 27(6), pp. 703–723. <https://doi.org/10.1108/DPRG-09-2024-0240>
- [4] Andrioaia, I, Dascalu, Iu., Grosu, V., Cosmulese, C. G., Zhavoronok, A. & Pinkas, H. (2025). Financial and intangible factors explaining the market value of firms: Evidence from the Romanian capital market. *Accounting and Financial Control*, 6(1), pp. 60-68. [https://doi.org/10.21511/afc.06\(1\).2025.06](https://doi.org/10.21511/afc.06(1).2025.06)
- [5] Andriushchenko, O., Popelo, O., Tulchynska, S., Shepelenko, S., Falko, M., & Shut, S. (2024). Blockchain technologies as a factor of the financial sustainability management of the enterprise and the e-commerce development. *Journal of Theoretical and Applied Information Technology*, 102(17), pp. 6302-6316. <https://www.jatit.org/volumes/Vol102No17/1Vol102No17.pdf>
- [6] Brechko, O. (2019). Financial and digital literacy as basic components of the development of the modern information society. *Regional aspects of the development of productive forces of Ukraine*, 24, pp. 129-135. Available at: <http://dspace.tneu.edu.ua/handle/316497/38305>
- [7] Buiak, L., Hryhorkiv, M., Hryhorkiv, V., Bashutska, O., & Pryshliak, K. (2023). Computer Modeling of the Economy Dynamics of Ukraine, Taking into Account the Socio-Economic Clustering of Society. *Journal of Information Technology Management*, 15(4), pp. 64-79. <https://doi.org/10.22059/jitm.2023.94710>
- [8] Cosmulese, C.G., Zhavoronok, A., Greshko, R., Ostrovska, N., Kharabara, V., Tkach, V. (2026). FinTech as a Factor of Asymmetric Transformation of the Banking Sector: European Experience and Potential for Ukraine. *Journal of Theoretical and Applied Information Technology*, 104(2), pp. 138-153. <https://doi.org/10.5281/zenodo.18454300>
- [9] Czarnitzki D., & Hussinger K. (2018). Input and output additionality of R&D subsidies. *Applied Economics*, 50(1), pp. 1324-1341. <https://doi.org/10.1080/00036846.2017.1361010>
- [10] Danylyshyn, B., Dubyna, M., Zabashtanskyi, M., Ostrovska, N., Blishchuk, K., & Kozak, I. (2021). Innovative Instruments of Monetary and Fiscal Policy. *Universal Journal of Accounting and Finance*, 9(6), pp. 1213-1221. <https://doi.org/10.13189/ujaf.2021.090601>
- [11] Database. Eurostat. Available at: <https://ec.europa.eu/eurostat/data/database>.
- [12] Database. State Statistics Service of Ukraine. Available at: <https://www.ukrstat.gov.ua>
- [13] Digital literacy research in Ukraine Digital literacy research in Ukraine. Ministry of Digital Transformation of Ukraine. Available at: [https://osvita.diia.gov.ua/uploads/3/16239-povna\\_doslidzenna\\_cifrovoi\\_ta\\_si\\_gramotnosti\\_v\\_ukraini\\_2025\\_pptx\\_pptx.pdf](https://osvita.diia.gov.ua/uploads/3/16239-povna_doslidzenna_cifrovoi_ta_si_gramotnosti_v_ukraini_2025_pptx_pptx.pdf)
- [14] Digital public infrastructure for digital governments. OECD. *Public Governance Policy Papers* (2024). Available at: [https://www.oecd.org/en/publications/digital-public-infrastructure-for-digital-governments\\_ff525dc8-en.html](https://www.oecd.org/en/publications/digital-public-infrastructure-for-digital-governments_ff525dc8-en.html)
- [15] Djakona, A., Kholiavko, N., Dubyna, M., Zhavoronok, A., & Fedyshyn, M. (2021). Educational dominant of the information economy development: a case of Latvia for Ukraine. *Economic Annals-XXI*, 192(7-8(2)), pp. 108-124. <https://doi.org/10.21003/ea.V192-09>
- [16] Doran N. M., Puiu S., Bădîrcea R. M., Pirtea M. G., Doran M. D., Ciobanu G., & Mihit L. D. (2023). E-Government Development – A Key Factor in Government Administration Effectiveness in the European Union. *Electronics*, 12(3), pp. 641. <https://doi.org/10.3390/electronics12030641>
- [17] Dubyna, M., Popelo, O., Zhavoronok, A., Lopashchuk, I., & Fedyshyn, M. (2023). Development of the credit market of Ukraine under macroeconomic instability. *Public and*

- Municipal Finance*, 12(1), pp. 33-47. [http://dx.doi.org/10.21511/pmf.12\(1\).2023.04](http://dx.doi.org/10.21511/pmf.12(1).2023.04)
- [18] E-Government Survey (2024). Accelerating Digital Transformation for Sustainable Development. UNITED NATIONS. Available at: <https://desapublications.un.org/sites/default/files/publications/2024-09/%28Web%20version%29%20E-Government%20Survey%202024%201392024.pdf>.
- [19] Figueiredo, S.A. (2024). Digital readiness and economic growth. *Economy and Finance*, 11(3). <http://dx.doi.org/10.33908/EF.2024.3.3>
- [20] Filyppova, S., Zhavoronok, A., Tochylyna, Yu., Ozarko, K., Neykov, S., & Krylov, D. (2025). The Impact of Artificial Intelligence on the Development of the Digital Business Ecosystem. *Journal of Theoretical and Applied Information Technology*, 103(9), pp. 3945-3958. Available at: <https://www.jatit.org/volumes/Vol103No9/29Vol103No9.pdf>
- [21] Hrubliak, O., Zhavoronok, A., Popelo, O., Kharabara, V., Dubyna, M., & Lopashchuk, I. (2025). The impact of financial globalization on the economic growth of countries: A case for Ukraine. *Investment Management and Financial Innovations*, 22(4), pp. 209-226. [https://doi.org/10.21511/imfi.22\(4\).2025.17](https://doi.org/10.21511/imfi.22(4).2025.17)
- [22] Hryhoruk, I., Yakubiv, V., Sydoryk, Y., Maksymiv, Y., & Popadynets, N. (2021). Modelling of Prognosis for Bioenergy Production in Ukraine. *International Journal of Energy Economics and Policy*, 11(6), pp. 27–34. <https://doi.org/10.32479/ijee.11741>
- [23] Ivanova, N., Popelo, O., Shkarlet, S., Dubyna, M., & Zhuk, O. (2020). Infrastructural and Regional Development: Theoretical Aspects and Practical Issues. *Studies of Applied Economics*, 38(4). <https://doi.org/10.25115/eea.v38i4.4002>
- [24] Kachula, S.V. (2025). The role of electronic government in the management of public finances. *Problems of modern transformations*, 20. <https://doi.org/10.54929/2786-5738-2025-20-08-06>
- [25] Kan L., & Sun, R. (2022). Research on the impact of digital finance on innovation and R&D of technology-based SEMs – Moderating role based on financial flexibility. *American Journal of Industrial and Business Management*. 12(11). <https://doi.org/10.4236/ajibm.2022.1211090>
- [26] Kholiavko, N., Dubyna, M., Zhavoronok, A., Safonov, Yu., Krylov, D., & Tochylyna, Yu. (2022). The ICT sector in economic development of the countries of Eastern Europe: a comparative analysis. *WSEAS Transactions on Business and Economics*, 19, pp. 169-185. <https://doi.org/10.37394/23207.2022.19.18>
- [27] Kijek T., Matras-Bolibok A., & Rycaj E. (2016). Do Public R&D Expenditures Foster Business R&D Investments? *International journal of synergy and Research*, 5. <http://dx.doi.org/10.17951/ijsr.2016.5.0.147>
- [28] Kistiunik, O., Raichava, L., Mykhalchenko, O., Popelo, O., Tulchynska, S., Krasovska, G., (2023). The impact of the national economy digitalization on the efficiency of the logistics activities management of the enterprise in the conditions of intensifying international competition. *Journal of Theoretical and Applied Information Technology*, 101(1), pp. 123-134. <http://www.jatit.org/volumes/Vol101No1/11Vol101No1.pdf>
- [29] Kobelia, M., Tkachuk, I., Popelo, O., Zhavoronok, A., & Vinnychuk, O. (2023). Modelling financial influence of political and oligarchic interests of the governed-sponsored enterprises on the creation and implementation of the financial policy in the state. *Journal of Hygienic Engineering and Design*, 42, pp. 271-279. Available at: <https://keypublishing.org/jhed/wp-content/uploads/2023/04/22.-Abstract-Iryna-Tkachuk.pdf>
- [30] Kosach, I., Popelo, O., Volok, R., Ievsienko, M., Kolotylo, L., & Khrebtan, Y. (2025). Development of Foreign Economic Activity in Ukraine in the Digital Transformation Context of the Banking System. *Financial and Credit Activity Problems of Theory and Practice*, 6(65), pp. 11–27. <https://doi.org/10.55643/fcaptop.6.65.2025.5034>
- [31] Kovalenko, V., Kuznetsova, L., Sergeeva, E., Todorova, N., Mylashko, O., & Tej, J. (2019). Cluster approach to banking supervision with reference to bank risk profile. *Economic Annals-XXI*, 177(5-6), pp. 82-91. <https://doi.org/10.21003/ea.V177-07>
- [32] Kozmenko, S., Shkolnyk, I., Kozmenko, O., Orlov, V., & Shukairi, F. (2021). Modeling of the financial systems stability on the example of Ukraine. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 16(2), pp. 377-411. <https://doi.org/10.24136/eq.2021.014>
- [33] Macovei, A.-G., Popelo, O., Zhavoronok, A.,

- Dankiewicz, R., Cosmulese, C.G., and Popova, L. (2024). Pre- and post-effect of COVID-19 on the insurance industry: A study based on Romanian companies. *Insurance Markets and Companies*, 15(2), pp. 74-84. [https://doi.org/10.21511/ins.15\(2\).2024.07](https://doi.org/10.21511/ins.15(2).2024.07)
- [34] Maksimiv, Y., Yakubiv, V., Pylypiv, N., Piatnychuk, I., Hryhoruk, I., & Hokh, V. (2022). Biological assets in accounting of socially responsible activities of agricultural enterprises *Custos e Agronegocio*, 18 ( 2 ), pp. 458-476.
- [35] Malik Y., Ojah H., al-Shiblawi G., Hameedi K. (2024). The role of Artificial intelligence technologies in enhancing predictive ability of financial statements: Big Data as an interactive variable. *Financial and Credit Activity Problems of Theory and Practice*, 5(58), pp. 136–149. <https://doi.org/10.55643/fcaptop.5.58.2024.4490>
- [36] Matvieieva, N., Pushkar, T., Serohina, D. (2024). The human factor of digitization of innovative activity in Ukraine in terms of international comparisons. *Economy and society*, 59. <https://doi.org/10.32782/2524-0072/2024-59-40>
- [37] McKinsey & Company (2025). The state of AI in 2025: Agents, innovation, and transformation. Available at: [https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai?](https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai?_ga=2.181111111.181111111.181111111-181111111-181111111)
- [38] Melnyk, V., Zhytar, M., Shchur, R., Kriuchkova, N., & Solodzhuk, T. (2021). Assessment of the performance of the financial architecture of the Ukrainian economy: Budgetary, stock and social aspects. *WSEAS Transactions on Business and Economics*, 18, pp. 386-395. <https://doi.org/10.37394/23207.2021.18.39>
- [39] Niam, A., Insani, M. R., Sukmawati, S., & Hike, F. (2025). The Role of Artificial Intelligence and Digital Literacy in Enhancing Employee Effectiveness and Efficiency in the Economic Sector. *Journal of Economics and Management*, 3(1), pp. 18–25. <https://doi.org/10.70716/ecoma.v3i1.134>
- [40] Nikiforov, P., Abramova, A., Zhavoronok, A., Bak, N., Yaremchuk, V., & Kulynych, Y. (2024). Strengthening green taxation within the framework of fulfilling the green deal conditions in the context of formation of the environmental security system of EU countries. *International Journal of Sustainable Development and Planning*, 19(3), pp. 1099-1109. <https://doi.org/10.18280/ijssdp.190328>
- [41] Novomlynets, O., Marhasova, V., Tkalenko, N., Kholiavko, N., Popelo, O. (2023). Northern outpost: Chernihiv Polytechnic National University in the conditions of the Russia-Ukrainian war. *Problems and Perspectives in Management*, 21(2-si), pp. 31-39. [https://doi.org/10.21511/ppm.21\(2-si\).2023.05](https://doi.org/10.21511/ppm.21(2-si).2023.05)
- [42] Open Budget Survey (2023). Available at: <https://internationalbudget.org/open-budget-survey>
- [43] Ostrovska, N., Hrubliak, O., Shaposhnykov, K., Zhavoronok, A., Krylov, D., & Popelo, O. (2024). Digital Currency of the Central Banks: Trends of the Euro Area and Prospects of the Use Within the Implementation of the European Green Deal. *Journal of Theoretical and Applied Information Technology*, 102(7), pp. 2954-2967. Available at: <https://www.jatit.org/volumes/Vol102No7/17Vol102No7.pdf>
- [44] Panchenko, O., Shyshkina, O., Dubyna, M., Shchur, R., Sadchykova, I., & Bazilinska, O. (2024). The Role of Artificial Intelligence in the Cybersecurity System of Banking Institutions in the Conditions of Instability. *Journal of Theoretical and Applied Information Technology*, 102(19), pp. 6950-6965. Available at: <https://www.jatit.org/volumes/Vol102No19/8Vol102No19.pdf>
- [45] Pasko, O., Chen, F., Oriekhova, A., Brychko, A., & Shalyhina, I. (2021). Mapping the literature on sustainability reporting: A bibliometric analysis grounded in Scopus and Web of Science Core Collection. *European Journal of Sustainable Development*, 10(1), pp. 303-322. <https://doi.org/10.14207/ejsd.2021.v10n1p303>
- [46] Petrin, T., & Radicic, D. (2023). Instrument policy mix and firm size: is there complementarity between R&D subsidies and R&D tax credits? *The Journal of Technology Transfer*, 48, pp. 181–215. <https://doi.org/10.1007/s10961-021-09908-8>
- [47] Pilko, A., Shchur, R., Chepyha, B., Sakun, O., & Matskiv, V. (2024). Analysis of the Influence of Monetary Instruments on the Size of the Domestic Public Debt. *Financial and Credit Activity Problems of Theory and Practice*, 5(58), pp. 49–60. <https://doi.org/10.55643/fcaptop.5.58.2024.4499>
- [48] Popadynets, N., Andrusiv, U., Zelinska, H., Krasnorutskyy, O., Yakubiv, V., Maksymiv,

- Y., Hryhoruk, I., Shchur, R., & Lapchuk, Y. (2023). Efficiency of use of fuel and energy resources of Ukraine: assessment, simulation and forecasting. *Energy Policy Journal*, 26(4), pp. 63-80. <https://doi.org/10.33223/epj/169743>
- [49] Report on supporting financial resilience and transformation through digital financial literacy, OECD. G20/OECD-INFE (2021). Available at: [www.oecd.org/finance/supporting-financial-resilience-and-transformation-through-digital-financial-literacy.htm](http://www.oecd.org/finance/supporting-financial-resilience-and-transformation-through-digital-financial-literacy.htm)
- [50] Sadchykova, I., & Yevsiienko, M. (2025). Digital infrastructure as a driver of credit system development in Ukraine. *Problems and prospects of economics and management*, 2(42), pp. 384-398. [https://doi.org/10.25140/2411-5215-2025-2\(42\)-384-398](https://doi.org/10.25140/2411-5215-2025-2(42)-384-398).
- [51] SDG9 Monitoring. Available at: <https://surl.li/xjcjhd>
- [52] Seiam, D.A., & Salman, D. (2024). Examining the global influence of e-governance on corruption: a panel data analysis. *Future Business Journal*, 10, pp. 29. <https://doi.org/10.1186/s43093-024-00319-3>
- [53] Shaposhnykov, K., Kochubei, O., Grygor, O., Protsenko, N., Vyshnevska, O., & Dzyubina, A. (2021). Organizational and Economic Mechanism of Development and Promotion of IT Products in Ukraine. *Estudios de economia aplicada*, 39(6). <https://doi.org/10.25115/eea.v39i6.5264>
- [54] Shchur, R., Pilko, A., Chepyha, B., Bilyi, M., & Stabias, S. (2025). Application of Sem and Qardl Models in the Practice of Analysis of the Influence of Exchange Rate Volatility on Macroeconomic Indicators. *Financial and Credit Activity Problems of Theory and Practice*, 1(60), pp. 20-32. <https://doi.org/10.55643/fcaptop.1.60.2025.4669>
- [55] Shestakovska, T., Briushkova, N., Semchenko-Kovalchuk, O., Marchenko, N., Zholobetska, M., & Nikolayenko, Y. (2024). Finance as a critical component of successful implementation of creative innovations in the modern economic system. *Multidisciplinary Science Journal*, 6, 2024ss0222. <https://doi.org/10.31893/multiscience.2024ss0222>
- [56] Shkarlet, S., & Dubyna, M. (2016). Features of the cognitive approach application to the essence of the financial services market identification. *Economic Annals-XXI*, 158(3-4(2)), pp. 70-74. <https://doi.org/10.21003/ea.V158-16>
- [57] Shkarlet, S., Kholiavko, N., & Dubyna, M. (2015). Territorial reform in the system of strategic management of energy-economic and information spheres of the state. *Economic Annals-XXI*, 5-6, pp. 103-107. Available at: <https://ea21journal.world/index.php/ea-v151-25/3>
- [58] Shkolnyk, I. O. (2008). Peculiarities of financial markets functioning in developing countries in the context of financial globalization. *Actual Problems of Economics*, 84, pp. 63-66.
- [59] Shkolnyk, I., Kozmenko, S., Kozmenko, O., & Mershchii, B. (2019). The Impact of the Economy Financialization on the Level of Economic Development of the Associate EU Member States. *Economics & Sociology*, 12(4), pp. 43-58. <https://doi.org/10.14254/2071-789X.2019/12-4/2>
- [60] Shyshkina, O., Shkarlet, S., Dubyna, M., & Shchur, R. (2025). The Role of Cloud Technologies in Modern Development of Banking Institutions. *Journal of Vasyl Stefanyk Precarpathian National University*, 12(2), pp. 143-157. <https://doi.org/10.15330/jpnu.12.2.143-157>
- [61] Tkachuk, I. (2017). Asset operations of Ukrainian banks on the current stage of banking system development. *Banks and Bank Systems*, 12(1-1), pp. 119-127. [https://doi.org/10.21511/bbs.12\(1-1\).2017.04](https://doi.org/10.21511/bbs.12(1-1).2017.04)
- [62] Tulchynska, S., Lagodiienko, N., Popelo, O., Radin, A. M., Moskalenko, A. (2021). Methodical Approach to Forecasting the Intensification of Innovative Development of Regions Using the Mathcad Program. *International Journal of Circuits, Systems and Signal Processing*, 15, pp. 1591-1601. <https://doi.org/10.46300/9106.2021.15.171>
- [63] Tulchynska, S., Popelo, O., Revko, A., Butko, M., & Derhaliuk, M. (2022). Methodological Approaches to the Evaluation of Innovation in Polish and Ukrainian Regions, Taking into Account Digitalization. *Comparative Economic Research. Central and Eastern Europe*, 25(1), pp. 55-74. <https://doi.org/10.18778/1508-2008.25.04>
- [64] Use of artificial intelligence by the population of Ukraine. Kyiv International Institute of Sociology. Available at: <https://surl.li/ggyvyhh>
- [65] Wu, Y., Li, Y., & Xiong, L. (2025). Policy coordination mechanism: Rural financial inclusion and public governance in developing

- countries, *Finance Research Letters*, 85(B), 107971.  
<https://doi.org/10.1016/j.frl.2025.107971>
- [66] Xie Z., & Wu, Y. (2024). Digital finance, financial regulation and transformation of R&D achievements. *Heliyon*, 10(9).  
<https://doi.org/10.1016/j.heliyon.2024.e30224>
- [67] Yemets, O., & Kurii, D. (2025). Use of Artificial intelligence in financial management of an enterprise in the conditions of ensuring economic security. *The Actual Problems of Regional Economy Development*, 2(21), pp. 369–379.  
<https://doi.org/10.15330/apred.2.21.369-379>
- [68] Zhang, J., Liu, Q., & Yang, S. (2025). Sustainability Policy and Corporate Financial Integrity: Assessing the Impact of China's Energy-Use Rights Trading Scheme on Earnings Management. *Sustainability*, 17(23), 10759. <https://doi.org/10.3390/su172310759>
- [69] Zhang, Q., Shi, Y., Zhao, X., & Yang, J. (2025). Climate vulnerability, macroprudential policy, and financial risk. *Risk Management*, 27(25). <https://doi.org/10.1057/s41283-025-00179-3>
- [70] Zhavoronok, A., Kholiavko, N., Popelo, O., Dubyna, M., Verbivska, L., Fedyshyn, M. (2024). Higher education for sustainable development in the digital era: Mapping the bibliometric analysis. *Problems and Perspectives in Management*, 22(4), pp. 202–216.  
[https://doi.org/10.21511/ppm.22\(4\).2024.16](https://doi.org/10.21511/ppm.22(4).2024.16)
- [71] Zhavoronok, A., Shchur, R., Zhezherun, Y., Sadchykova, I., Viadrova, N., & Tychkovska, L. (2022). The role of the credit services market in ensuring stability of the banking system. *International Journal of Safety and Security Engineering*, 12(6), pp. 667–679.  
<https://doi.org/10.18280/ijssse.120602>
- [72] Zhytar, M., Sosnovska, O., Shchur, R., Lisnichuk, O., & Navolokina, A. (2022). Scientific and methodical approach to the assessment of diagnostics of the economic security of economic. *Financial and Credit Activity Problems of Theory and Practice*, 5(46), pp. 209–221.  
<https://doi.org/10.55643/fcaptop.5.46.2022.3872>
- [73] Zybarena, O., Kravchuk, I., Pushak, Y., Verbivska, L., & Makeieva, O. (2021). Economic and Legal Aspects of the Network Readiness of the Enterprises in Ukraine in the Context of Business Improving. *Estudios de economía aplicada*, 39(5).
- <https://doi.org/10.25115/eea.v39i5.4972>