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Digital Transformation of Banking Structures as a Tool for Implementing the Anti-Crisis Investment Policy of Ukraine

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ABSTRACT

The article examines the digital transformation of Ukraine's banking structures as a strategic tool for implementing anti-crisis investment policy for 2021–2025. Under the legal regime of martial law and macroeconomic instability, the mobilization of internal and external resources is of great importance for Ukraine's economic stability, necessitating the need to increase the effectiveness of this state policy and the relevance of the study. It has been proven that, under conditions of existential challenges posed by full-scale armed aggression and macroeconomic instability, the digitalization of the financial sector has transformed from a technological trend into a basic institutional mechanism for ensuring stability and investment activity. The purpose of the article is to theoretically substantiate and develop conceptual principles for using the digital transformation of the banking system as a public management mechanism for implementing the state's anti-crisis investment strategy. The study uses a combination of general scientific and specialized methods: a systems approach to analyze the interaction among financial market entities; institutional analysis to examine the regulatory and legal support for digitalization; a comparative method to compare domestic experience with practices in EU countries (Estonia, Poland, Lithuania). It was determined that the integration of digital banking services, artificial intelligence and Open Banking technologies forms a new architecture of state investment policy. The institutional capacity of state bodies to regulate the digital financial space was analyzed. The scientific novelty of the research results lies in the development of the author's conceptual model of interaction "state – digital bank – investor", which is based on the implementation of digital standards, ensuring cyber resilience and the use of innovative tools (digital military bonds, e-hryvnia). In the context of practical significance, specific recommendations were formulated for state authorities and the National Bank of Ukraine to harmonize the regulatory environment with EU norms (PSD2, eIDAS, DORA) and to strengthen the protection of critical information infrastructure.

KEYWORDS

public administration, digital transformation, banking structures, anti-crisis investment policy, institutional capacity, cyber resilience, open banking, financial technologies, digital economy, e-governance.

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Цифрова трансформація банківських структур як інструмент реалізації антикризової інвестиційної політики України

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АНОТАЦІЯ

У статті досліджено цифрову трансформацію банківських структур України як стратегічного інструменту реалізації антикризової інвестиційної політики впродовж 2021–2025 років. За умов правового режиму воєнного стану та макроекономічної нестабільності мобілізація внутрішніх і зовнішніх ресурсів є архіважливою для економічної стійкості України, що зумовлює необхідність підвищення ефективності цієї політики держави та актуальність дослідження. Доведено, що в умовах екзистенційних викликів, спричинених повномасштабною збройною агресією та макроекономічною нестабільністю, цифровізація фінансового сектору трансформувалася з технологічного тренду в базовий інституційний механізм забезпечення стійкості та інвестиційної активності. Мета статті полягає у теоретичному обґрунтуванні та розробленні концептуальних засад використання цифрової трансформації банківської системи як механізму публічного управління для реалізації антикризової інвестиційної стратегії держави. У дослідженні використано сукупність загальнонаукових та спеціальних методів: системний підхід – для аналізу взаємодії суб'єктів фінансового ринку; інституційний аналіз – для вивчення нормативно-правового забезпечення цифровізації; порівняльний метод – для зіставлення вітчизняного досвіду з практиками країн ЄС (Естонії, Польщі, Литви). Визначено, що інтеграція цифрових банківських сервісів, штучного інтелекту та технологій Open Banking формує нову архітектуру державної інвестиційної політики. Проаналізовано інституційну спроможність державних органів щодо регулювання цифрового фінансового простору. Наукова новизна результатів дослідження полягає у розробленні авторської концептуальної моделі взаємодії «держава – цифровий банк – інвестор», що базується на впровадженні цифрових стандартів, забезпеченні кіберстійкості та використанні інноваційних інструментів (цифрові військові облігації, е-гривня). У контексті практичного значення сформульовано конкретні рекомендації для органів державної влади та Національного банку України щодо гармонізації регуляторного середовища із нормами ЄС (PSD2, eIDAS, DORA) та посилення захисту критичної інформаційної інфраструктури.

КЛЮЧОВІ СЛОВА

публічне управління, цифрова трансформація, банківські структури, антикризова інвестиційна політика, інституційна спроможність, кіберстійкість, відкритий банкінг, фінансові технології, цифрова економіка, електронне врядування.

1. Introduction

The current stage of development of public administration in Ukraine is characterized by an intensive search for effective mechanisms for overcoming crisis phenomena in the economy. A special place in this process is occupied by the digital transformation of the banking sector, which is not only an object of state regulation but also a powerful tool for the implementation of anti-crisis investment policy. Under the legal regime of martial law, the ability of the state to ensure the continuity of financial flows and attract investment resources through digital platforms has become critical for maintaining national security.

The banking system, the elements of which are banking structures, is considered a key subsystem of the national economy, the digital modernization of which directly correlates with the institutional capacity of the state to minimize the consequences of existential threats. Institutional analysis, in turn, focuses on the role of the National Bank of Ukraine and the Ministry of Digital Transformation of Ukraine as entities that form the regulatory framework for the implementation of innovations (Open Banking, digital identification through BankID, cloud solutions, regulatory platform, etc.).

In the context of the modern paradigm of public administration, the digital transformation of banking structures is considered not only as a technical renewal of infrastructure, but as a fundamental change in the architecture of interaction between the state, financial institutions and investors. During 2021–2025, this process evolved from technological modernization into a systemic mechanism for public management of investment processes and became an integral part of the implementation of anti-crisis investment policy not only in Ukraine. And in the course of adaptation to the standards of the European Union, the digital transformation of banking structures also acts as a tool for harmonizing the regulatory environment and increasing the investment attractiveness of our country.

2. Literature Review

An in-depth analysis of the problem requires the involvement of fundamental analytical sources, in particular, in the materials of the round table on the topic: "The real sector of the Ukrainian economy in the face of systemic challenges", which took place on June 18, 2021, the National Institute for Strategic Studies emphasized that the real sector of Ukraine is experiencing deep systemic problems, exacerbated by the pandemic, structural disproportionality and degradation of infrastructure [10]. In this regard, the participants of the round table emphasized that modernization, institutional coherence and the development of industries with high added value are critically necessary. It was especially emphasized that the digitalization of the economy has become a key challenge and at the same time a condition for increasing competitiveness and sustainable growth. According to the results of 2022, experts emphasized that the global economy is recovering slowly, which reinforces the need for an active investment policy for modernization, reducing dependence on commodity markets [11]. Rising inflation and imbalances in global trade make the role of central banks decisive, as they are forced to switch to tighter monetary policy to contain price pressures. Therefore, digitalization and technological solutions are becoming key tools for increasing the resilience of economies, helping to overcome labor shortages, logistical disruptions, and strengthening competitiveness in the global environment.

It is important that, as of March 2022, the main state-owned banks have maintained operational stability, ensuring the continuity of payments and customer access to funds, which has become possible due to the digitalization of payment infrastructure and a large-scale transition to remote service channels. In the analytical review of the NISS [12], two key indicators demonstrate the scale of their role: 49% of the assets of the banking system and 65% of the authorized capital are concentrated in state-owned banks, which makes them system-forming in a crisis. It was digital services that made it possible to support social benefits, loan holidays and business operations, and the further stability of electronic payments will determine the ability of the economy to adapt to military challenges and maintain financial stability.

The public report of the Ministry of Digital Transformation of Ukraine on the results of 2023 states that digital transformation in Ukraine has significantly changed the institutional conditions for the functioning of the economy, expanding the Diia ecosystem to more than 130 services, of which more than 30 were implemented during the year, which created new channels of interaction between citizens, businesses and financial institutions with the state [17]. The integration of banks into digital services,

in particular through the eRecovery program, provided UAH 3.2 billion in payments for 34.5 thousand applicants, demonstrating the formation of a new model of financial inclusion and increasing trust in the state's electronic tools. In parallel, the development of innovation clusters, such as Brave1, which financed 137 Defense Tech projects for $2.3 million, indicates a shift in state investment policy towards technological solutions that strengthen institutional resilience in the face of crises and defense capability in wartime, and form new points of economic growth.

Review of analytical reports 2023–2025. makes it possible to compare, in particular, that in 2023 the average Digital Transformation Index of regions was 0.632, and the leaders were Dnipropetrovsk (0.908), Lviv (0.891), and Poltava (0.833) regions [1]. This indicated the high potential of the regions to attract investment and integrate financial and banking services into the country's digital ecosystems. In 2025, the average indicator of digital transformation of regions, measured on a new 100-point scale, was 30/100, and the highest results were again demonstrated by Dnipropetrovsk and Lviv regions (43 points each), which confirms the stable leadership of these regions in the development of digital infrastructure, financial services and investment attractiveness [3]. A comparison of the two periods shows that despite the change in the assessment methodology, regions with high digital capacity retain competitive advantages, and the growth of digital skills of the population (6 million people were trained in 2023) forms the basis for the further development of fintech solutions, banking innovations, and investment flows in 2025.

In 2024, digital transformation became a key factor in operational continuity. Banks ensured the full operation of remote channels, as well as became the main infrastructural core of government support programs, in particular, the implementation of anti-crisis financial instruments for businesses, which significantly reduced transaction costs and increased the speed of application processing. Investment activity remained restrained due to high uncertainty, but the NBU emphasizes that the digitalization of financial services and modernization of payment infrastructure create the foundation for the future recovery of investment demand and the expansion of financial markets after the reduction of war risks [9].

In the Global Risks Report 2024, the WEF identifies that the most critical short-term risks for the global financial system are disinformation, extreme weather events, social polarization, and cyber danger, with cyber risks among the top 4 threats of the next two years, which directly affect the resilience of banks and investment markets [25]. For the financial sector, the WEF highlights that the rise in cyber incidents and information attacks poses systemic risks to banking infrastructure, as global markets become increasingly dependent on digital platforms and technological disruptions can trigger financial chain crises. In the long term, the WEF warns that the combination of technological risks with geopolitical and climate factors is shaping a new investment reality in which capital will be redistributed to benefit sectors with high digital resilience, and banks will be forced to strengthen cyber defenses and adapt risk management models to the rapidly changing digital environment.

The OECD defines digital transformation as a systemic factor that changes the structure of the economy, financial markets, and public administration [14]. The development of communication infrastructure, data, digital security and artificial intelligence is creating new conditions for the functioning of banks and financial institutions, which are becoming dependent on high-speed communication, cross-border data flows and reliable digital platforms. In the field of finance, the OECD emphasizes that digital security and trust in data processing are critical prerequisites for investment activity, as the growth of cyber threats and the complexity of data regulation directly affect the cost of capital, riskiness of financial transactions and stability of banking systems. OECD institutional initiatives – in particular Data Free Flow with Trust, Digital Government, and AI development programs – create framework conditions for increasing transparency, innovation and investment attractiveness of economies in which digital infrastructure and regulation become key drivers of financial stability and economic growth [14].

The World Bank Group in 2023–2024 emphasizes that digital transformation has become a key driver of economic development, as digital infrastructure, data, and skills determine countries' competitiveness and ability to integrate into global financial markets. In the financial sector, the World Bank emphasizes that digital financial services, mobile payments, and data-driven regulation significantly increase financial inclusion, reduce transaction costs, and strengthen resilience of banks to shocks, while cybersecurity is becoming a systemic risk to banking ecosystems. In the field of investment, the World Bank Group notes that countries with developed digital infrastructure and transparent data circulation rules demonstrate higher investment attractiveness, and digital public

services and digital identification create conditions for scaling private investment and the development of innovative markets [15; 23; 24].

The issues of digitalization of public administration and the financial sector are in the focus of attention of scientists and international institutions. Theoretical aspects of e-governance and digital transformation are thoroughly studied in the works of T. Ivanova et al. [7] and A. Kozhyna et al. [8], which reveal the mechanisms of adaptation of state institutions to the conditions of the digital society. L. Galaieva et al. [5] and S. Diachenko and M. Garaieva [2]. Institutional foundations and strategies of investment policy in the context of war and economic crises are studied by H. Sytnyk et al. [16] and O. Zubchyk et al. [26], focusing on the stability of the national financial system.

However, despite a significant body of research, the role of banking structures as an integrated tool of the state's anti-crisis strategy in the context of long-term existential threats in Ukraine requires additional study. The functional role of banking structures as an integrated mechanism for implementing the state's anti-crisis investment policy under martial law has not been sufficiently disclosed in the scientific discourse. Most of the works focus on the technological aspects of digitalization or regulatory changes, while the issues of systemic interaction along the chain "state – digital bank – investor" in the context of crisis management remain fragmentarily researched. This necessitates a comprehensive analysis of the digital transformation of banks as a tool for public management of investment processes.

3. Problem Statement

The article is aimed at substantiating the role of digital transformation of banking structures as a tool for implementing the anti-crisis investment policy of the state and identifying priority areas for its improvement in 2021–2025.

4. Methods and Materials

The methodological basis of the study is a combination of systemic, institutional and functional approaches, which allows a comprehensive assessment of the impact of digitalization on the effectiveness of state regulation [4; 13]. The systematic approach is used to model the relationships between state institutions, the banking sector and investors as components of a single investment ecosystem. The institutional analysis made it possible to study the regulatory framework for digital transformation (Laws of Ukraine, NBU regulations, adaptation to the EU acquis) and assess the level of institutional capacity of public administration entities.

The comparative method was implemented by comparing digital banking models of Ukraine and EU countries (Estonia, Poland, Lithuania, Germany) according to the following criteria: the level of integration with state registers, the degree of implementation of Open Banking, regulatory rigidity, the development of the fintech ecosystem and cyber resilience mechanisms.

5. Results and Discussion

Digitalization of the banking sector in Ukraine in the specified period 2021–2025. has been transformed into an institutional mechanism that ensures the continuity of financial transactions even in the face of critical infrastructure failures [20]. This allowed the state to use banks as "digital hubs" for the implementation of targeted investment incentives and business support programs (for example, through the Diia platform). Thus, digital transformation serves as the basis for the formation of a transparent investment environment, where the risks of corruption and bureaucratic barriers are leveled through the algorithmization of processes and data openness. Digital transformation leads to a fundamental reconfiguration of management models, institutional mechanisms and formats of interaction between the state, the banking sector and investment entities.

In modern scientific discourse, there is a tendency to synonymize the concepts of "digitalization" and "digital transformation", however, within the framework of public administration, their significant semantic differentiation has been established [2; 5; 8]. Digitalization is defined as the process of implementing individual digital tools (remote service, electronic signature, online banking) into existing operational processes without changing their essential nature. Digital transformation is justified as a systemic paradigm change in management processes, business models and state regulatory

mechanisms, which provides a qualitatively new level of financial inclusion and efficiency of investment policy. Thus, the digital transformation of banks is a state-managerial phenomenon that transforms the structure of the financial market, the architecture of state control and the tools for implementing the investment priorities of the state.

The specificity of the Ukrainian model is the state-institutional nature of transformation, which distinguishes it from the predominantly market-oriented models of the EU countries. This is due to the need for a prompt response to the existential challenges of wartime. The Ministry of Digital Transformation of Ukraine, the National Bank of Ukraine, the Ministry of Economy of Ukraine, and the State Service for Special Communications and Information Protection are identified as key public administration entities in this area.

The Ministry of Digital Transformation of Ukraine ensures the formation of a single digital space through the development of the Diia ecosystem, the introduction of digital identification standards, and the integration of state registers with banking systems. The National Bank of Ukraine, as a mega-regulator, forms the regulatory framework for the functioning of Open Banking, ensures the cyber resilience of the payment infrastructure, and coordinates a pilot project on the introduction of the e-hryvnia [19]. The Ministry of Economy of Ukraine integrates digital banking platforms into the mechanisms for implementing government programs (in particular, "Affordable Loans at 5–7–9%" and grant support "eRobota") [9]. The State Service for Special Communications and Information Protection guarantees the security of critical information infrastructure, which is a prerequisite for investor confidence.

The foundation of the transformation is the adaptation of domestic legislation to EU standards, in particular: PSD2 (open banking), eIDAS (electronic identification), GDPR (data protection) and AMLD (financial monitoring). In 2021–2025, Ukraine demonstrated high dynamics of harmonization of these norms, which made it possible to increase the transparency of investment flows and ensure state control over the targeted use of resources [3; 9; 25].

Over the past five years, innovative technologies have been transformed from categories of banking services into public policy tools. Artificial intelligence is used for predictive risk analysis and monitoring of the effectiveness of public investments. Blockchain ensures the immutability and transparency of data within the framework of public investment programs. Cloud technologies guarantee the institutional continuity of the functioning of the financial system under martial law. Fintech platforms are the main distribution channels for government incentives for small and medium-sized businesses [9].

The digital transformation of banks is directly dependent on the institutional capacity of the state [14]. This implies not only the availability of a technological base, but also the formation of a stable regulatory environment, a high level of interagency coordination and the development of digital competencies of public administration entities.

Digital transformation of the banking sector of Ukraine in the period 2021–2025 is characterized by an exogenous acceleration of modernization processes due to the need to overcome the consequences of the COVID-19 pandemic and ensure institutional resilience in the face of full-scale armed aggression. Unlike the EU countries, where transformation processes are determined mainly by market competition, the domestic model has acquired a pronounced state-institutional character.

During the period under study, the transition from fragmented digitalization to integral digital ecosystems was recorded. According to the National Bank of Ukraine, as of 2024, the share of non-cash transactions by volume exceeded 90%, and the number of active mobile banking users shows an annual growth of 15–20% [9]. The key components of the transformation were the dominance of the mobile channel (more than 80% of individuals' transactions are integrated into digital platforms); compliance automation (implementation of AI systems for AML/CTF monitoring and dynamic scoring); digital verification (in particular, the use of the Diia ecosystem and the NBU's BankID made it possible to open accounts remotely in 95% of banking institutions). The National Bank of Ukraine acted as an architect of digital resilience by implementing strategic tasks for the modernization of the SEP (transition to the ISO 20022 standard and 24/7 mode). This ensured the continuity of public finances and private investors at times of peak infrastructure crises. Special attention is paid to the "e-hryvnia" project, which is considered as a tool for improving the efficiency of targeted public investments and social payments.

In 2022–2025, the banking system of Ukraine became the target of unprecedented cyberattacks. In coordination with the NBU and the SSSZZI, the transition to distributed cloud infrastructures (Cloud First) was implemented, which made it possible to diversify the risks of data loss. It was found that the

level of cybersecurity directly correlates with the investment attractiveness of the sector, as it minimizes non-market risks for foreign capital [21].

To substantiate the vector of development, a comparative analysis was carried out using the Digital Banking Index (DBI) and Fintech Penetration indicators. The choice of countries is determined by their specifics: Estonia as a benchmark for e-government; Poland as the main regional hub; Lithuania as a leader in fintech startup licensing.

Table 1. Comparative analysis of digital transformation indicators (2024 Estimates)

Country	Digital Banking Index (0-10)	Level Open Banking (API maturity)	Fintech penetration (%)	Justification for choosing a country
Estonia	9.7	High (full integration)	88	Reference model of banks' interaction with state registers.
Lithuania	9.2	High (liberal regulation)	82	Experience in creating a favorable environment for investment platforms.
Poland	8.8	Medium (dynamic growth)	75	Similarities between the market structure and SME support programs.
Ukraine	8.5	Implementation stage (PSD2)	78	High adaptability to crises when it is necessary to strengthen regulation.

Source: Compiled by the authors based on [6].

The digital transformation of banks has become a platform for the implementation of the state programs "Affordable Loans at 5-7-9%" and eRobota. Automation of applications through Diia and banking applications made it possible to reduce the processing time of documents by 60%, which correlates with the growth of the loan portfolio of small businesses during the war. This confirms the hypothesis that digitalization is not only a technological update but a tool for public management of investment processes.

Thus, in 2021–2025, the digital transformation of the banking system of Ukraine has entered the phase of institutional maturity, becoming the foundation for the implementation of the anti-crisis investment policy. The established infrastructure (SEP 4.0, BankID, Cloud solutions) ensures transparency of investment flows and minimization of existential threats. However, further development requires full harmonization with EU regulations and the introduction of full-fledged Open Banking to stimulate competition in the investment segment.

In 2021–2025, the digital transformation of banking structures was transformed into a strategic mechanism for implementing anti-crisis investment policy. In the context of military aggression and infrastructure destruction, digital technologies have ensured the transition from traditional fiscal methods to operational platforms for direct interaction between the state and investors [2].

Digitalization has led to a change in the logic of state management of investment processes. The introduction of automated scoring systems made it possible to reduce transaction costs and decision-making time on lending to business entities. The use of distributed ledger (blockchain) and open data technologies minimizes corruption risks in the management of public investment programs. Digital platforms have expanded access to investment instruments for the general population and small businesses, which is critical to the development of domestic investment resources. In 2021–2025, the state initiated several programs in which banks act as digital intermediaries. In particular, the "Affordable Loans at 5-7-9%" program ensured the integration of banks with state registers via an API and enabled the automation of borrower verification. Digital war bonds have become a tool for selling government securities through mobile applications of banks, and have become a tool for directly attracting private capital to the defense sector. The eRobota ecosystem, as a grant support for business, is based on the seamless interaction of the Diia platform and banking institutions, which ensures the targeted use of funds.

In the context of the research of S. Diachenko and M. Garaieva [2], existential threats are defined as factors that can paralyze the basic functions of the state. As already established, the digital transformation of banks neutralizes these risks due to infrastructure resilience if there is a transition to distributed cloud infrastructures (Cloud First), which makes it impossible to lose financial data in the event of physical destruction of administrative centers. Digital identification (Diia.Signature, BankID) provides access to financial transactions for displaced persons and businesses under occupation or

evacuation. Integration of banking security with state systems of SSSZZI prevents systemic paralysis of the financial system due to hybrid attacks.

In this regard, the author's conceptual model of interaction "State – Digital Bank – Investor" is proposed. The proposed model (see Fig. 1) visualizes systemic connections, where the state acts as a regulator and guarantor of standards (PSD2, eIDAS, GDPR), a digital bank is an operating platform with AI tools and open APIs, and an investor is an active entity that gets access to transparent investment products (military and infrastructure bonds).

In order to consolidate the status of digital transformation as an investment policy tool, amendments to the Law of Ukraine "On Investment Activity" [18] on the legalization of digital assets and tokenized recovery instruments are needed. The Law of Ukraine "On Financial Services" [22] is amended to implement the PSD2 rules on open banking and mandatory API standards. targeted investment subsidies and social benefits.

The digital transformation of banking structures in 2021–2025 has become the foundation of anti-crisis public investment management. The former model ensures not only the survival of the economy in wartime, but also creates prerequisites for high-tech post-war recovery based on European standards of digital resilience.

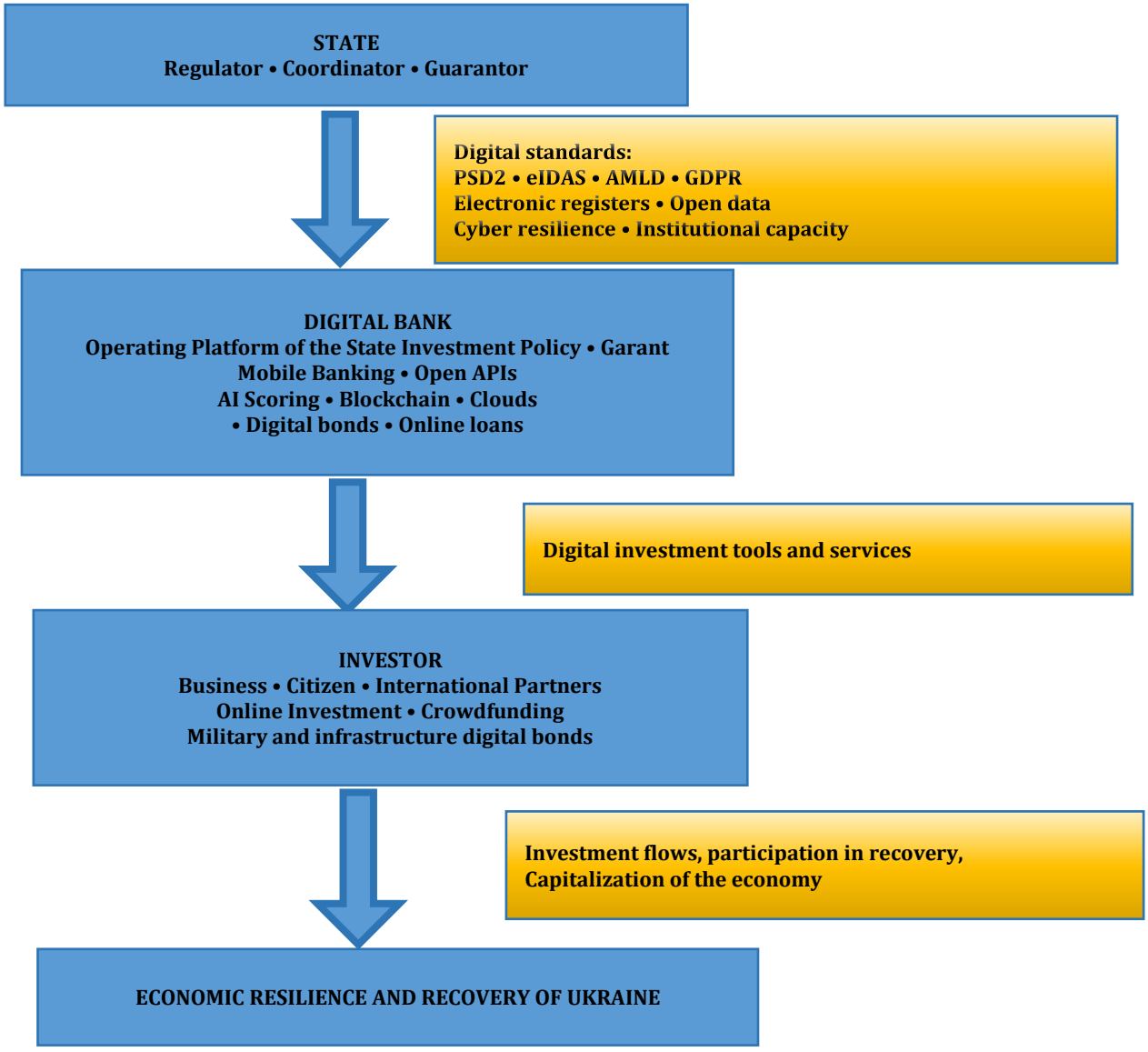

Figure 1. Interaction model "State – Digital Bank – Investor"

Source: Developed by the authors.

Thus, the mechanism of influence of digital transformation on investment activity is implemented through a sequential chain, where: digitalization of procedures – reduction of transaction costs – reduction of management decision-making time – increasing the availability of financial instruments – expanding the participation of SMEs and households in investment programs – growth of domestic

investment resources. In this context, digital tools are not only a technological innovation, but also a functional element of anti-crisis public administration.

Our comparative study of the digital transformation of banking structures in Ukraine and the European Union countries allows us to verify the level of digital maturity of the national financial system and determine the effectiveness of institutional mechanisms of anti-crisis investment policy. During 2021–2025, Ukraine demonstrated an accelerated pace of digitalization, determined by the need to ensure institutional resilience in the face of existential threats. During the study period, Ukraine made a qualitative transition to the "Digital First" model, which made it possible to get closer to the indicators of the leaders of the EU digital economy. This comparative analysis is based on the evaluation of four reference models. Estonia (Integration Model) is characterized by seamless synergy of the banking sector with state registers based on digital identity. Estonia's experience is fundamental for the development of the Ukrainian Diia ecosystem and BankID. Poland (Market-Differentiated Model) is characterized by a high concentration of fintech startups and developed digital tools for lending to SMEs integrated with fiscal services. Germany (Regulatory-Conservative Model) – demonstrates the priority of cybersecurity standards and strict supervision by BaFin, which provides the highest level of stability with lower innovation dynamics. Lithuania (Innovation and Investment Model) – positioned as a leading European fintech hub with the most simplified regulatory regime for digital investment platforms.

The fundamental difference of the domestic experience is the transformation of digitalization from a market process into a public administration tool. Ukraine is actively implementing PSD2, eIDAS, GDPR and AMLD regulations, which is a prerequisite for integration into the EU Digital Single Market. Based on the analysis of European practices, the authors see the expediency of implementing such separate mechanisms in the state policy of Ukraine, following the example of Estonia, Poland, Germany and Lithuania. In particular, it is necessary to create a single state financial data gateway and automate KYC/AML procedures based on verified state registers (Estonia). Following the example of Poland, it is appropriate to digitize state guarantees for small business investment projects. Following the example of Germany, introduce mandatory audits of the cyber resilience of critical infrastructure using the BaFin Cloud Circular methodology. Like Lithuania, the development of "regulatory sandboxes" for testing digital investment recovery tools is appropriate.

The institutional capacity of the state is a determinant of the success of anti-crisis measures. In the EU countries, this indicator is provided due to high trust in digital institutions, while in Ukraine, it is due to the adaptability of management structures to force majeure. At the same time, the results of the comparative analysis show that Ukraine has reached a level of digital maturity that is ahead of the average European values in some indicators (mobile banking, digital identification). The uniqueness of the domestic model lies in its anti-crisis orientation and ability to ensure the implementation of investment policy in the face of war risks. Further convergence with the models of Estonia and Lithuania will complete the formation of a transparent and secure digital financial environment.

In order to verify the level of digital maturity of the banking system of Ukraine and determine the institutional differences between the national and European models, a comparative case analysis of digital banking architectures in Ukraine, Estonia, Poland and Lithuania was carried out within the framework of the study. The choice of these countries is due to different types of institutional organization of digital transformation: integration (Estonia), market-differentiated (Poland), innovation and investment (Lithuania) and adaptive-anti-crisis (Ukraine). The generalized results of the comparison by key criteria (integration with state registers, the level of implementation of Open Banking, cyber resilience, and the role of the state in the formation of the digital financial ecosystem) are presented in Table 2.

The analysis of the data presented in Table 2 allows us to state that despite the differences in the speed of implementation of digital solutions and the degree of regulatory rigidity, the considered models demonstrate a common structural pattern: the effectiveness of digital transformation of banks depends on the coordinated interaction of regulatory, operational and investment levels.

It is this multi-level consistency that determines the institutional capacity of the state to use the banking sector as a tool for implementing anti-crisis investment policy. Summarizing the results of the comparative analysis, it is advisable to conceptualize the digital transformation of banking structures as *a three-level institutional model*, within which each level performs a separate function of ensuring investment sustainability, namely:

1. Regulatory level – formation of digital standards, harmonization with the EU acquis, cybersecurity;

2. Operational level – digital banking platforms, AI-scoring, Open API;
3. Investment level – digital bonds, online lending, grant programs.

Table 2. Characteristics of the systemic digital transformation of banking models (based on the results of the case study)

Criterion	Institutional significance of the criterion	Ukraine	Estonia	Poland	Lithuania
Integration with state registers	Increased transparency	High (Diia, BankID)	Full (X-Road)	Partial	High
Open Banking	Competition and innovation	Under implementation	Full	Developed	Developed
Cyber Resilience	Investor confidence	Adaptive	Systemic	Regulator	Regulatory flexibility
The role of the state	Type of governance model	Coordinator/ Architect	Integrator	Regulator	Liberal regulator

Source: Compiled by the authors.

The stability of the system is ensured by the synergy of three levels, and the imbalance of at least one of them reduces the effectiveness of the anti-crisis investment policy.

The proposed model explains that the stability of the system is determined not by the isolated efficiency of each level, but by their synergy: regulatory uncertainty reduces investor confidence, technological instability increases transactional risks, and weakness of investment instruments limits capital mobilization. Thus, the digital transformation of banks acts as an integrated mechanism for institutional stabilization of the economy in the face of crisis challenges.

Digital transformation of the banking system of Ukraine in 2021–2025 is accompanied by exogenous and endogenous risks, which are determined by the state of martial law and structural imbalances of the economy. Under these conditions, the effectiveness of the anti-crisis investment policy directly depends on the ability of the state to neutralize threats in the technological, institutional and legal planes. In the context of hybrid aggression, the banking system is the object of priority cyberattacks. The cyber resilience deficit correlates with a decline in investment confidence, making it impossible for digital bonds and tokenized assets to scale. The institutional capacity of public administration entities (NBU, Ministry of Digital Transformation, and Ministry of Economy) remains uneven. Existential threats are exacerbated by social inequality in access to technology and low levels of digital literacy of the population. This limits financial inclusion and deters the attraction of domestic investment through digital channels. The complex nature of risks requires the state to transition to an adaptive management model, where digital transformation is considered not only as a technological update but as an element of national security.

To optimize the use of the potential of digital technologies as a tool of anti-crisis policy, we have proposed systemic recommendations for public authorities. Firstly, harmonization with the acquis communautaire – completion of the full implementation of the EU Regulations (PSD2, GDPR, MiCA) to create a seamless financial space. platforms and tokenized reconstruction tools [22]. Thirdly, the introduction of Open Finance – the transition from open banking to a broader data exchange model, which will automate the scoring of SME investment projects. Fourthly, the creation of FinTech-Hub Ukraine, in particular, the formation of a national ecosystem to support startups that develop solutions for transparent management of recovery investments. programmable properties (smart contracts). Cyber defense, according to the BaFin model, involves the introduction of mandatory cyber resilience standards for all financial market participants integrated with the NBU Cyber Defense Center. Sixth, the digitalization of recovery programs, for example, the integration of the eRecovery platform with bank investment products to attract private capital to infrastructure projects. The seventh is the scaling of digital bonds. It is necessary to expand the functionality of mobile applications for access to municipal and corporate digital bonds.

The proposed model of public policy is based on the synergy of regulatory transparency, cybersecurity and innovative flexibility. The implementation of these measures will allow Ukraine to transform the banking sector into a driver of post-war high-tech reconstruction.

6. Conclusions

Digital transformation of banking structures is a comprehensive public administration mechanism that ensures transparency, sustainability and effectiveness of anti-crisis investment policy. It is based on the synergy of institutional capacity, adaptation of international digital standards and integration of innovative technologies into public administration processes, which is critical for Ukraine's economic security and further European integration. In 2021–2025. Digital transformation is a strategic determinant of ensuring Ukraine's economic sustainability. Digitalization of the financial sector in the face of existential threats has been transformed from a purely technological process into an integrated instrument of public administration that ensures the implementation of the state's anti-crisis investment policy.

The comparative analysis of digital banking models in Ukraine and the EU countries showed that, despite different development trajectories, the effectiveness of digital transformation is determined by the level of institutional coherence of regulatory, technological and investment mechanisms. The Ukrainian model is characterized by an adaptive-anti-crisis type of development, within which the digitalization of the banking sector has been transformed from a technological trend into a strategic tool of state investment policy.

Generalization of the results of the study made it possible to conceptualize the digital transformation of banking structures as a three-tier institutional model covering the regulatory, operational and investment levels. The stability of the system is ensured by the synergy of these levels, and their imbalance reduces the efficiency of the mobilization of investment resources in crisis conditions. Under martial law, digital banking instruments ensured the continuity of financial flows, reduced transaction costs, and expanded access of business entities to government support programs. The banking system of Ukraine has demonstrated a high level of institutional resilience by integrating digital services into the processes of state lending and investment (in particular, the "5-7-9%" and "eRobota" programs). This ensured the continuity of the functioning of the financial infrastructure in the face of armed aggression. Thus, the digital transformation of banks acts as an integrated mechanism for institutional stabilization of the economy and the formation of digital investment resilience. At the same time, the use of digital banking channels for the sale of military and infrastructure bonds allowed the state to quickly accumulate investment resources, minimizing transaction costs and corruption risks.

The concept of "digital investment resilience" is proposed to be understood as the ability of the financial and institutional system of the state to ensure the stability of investment processes in the face of external shocks through the use of digital banking instruments. The operationalization of the concept of "digital investment sustainability" is possible through the use of the following indicators:

– the level of continuity of the payment infrastructure;
– share of digital transactions;
– the degree of integration of banks with state registers;
– the level of cyber resilience of financial institutions;
– speed of processing requests from citizens and legal entities in public investment programs.

The formulated recommendations can be implemented in the activities of regulatory, operational and investment level entities, in particular, the National Bank of Ukraine as a regulator of the banking services market, the Ministry of Finance of Ukraine and the Ministry of Economy of Ukraine in the formation of state policy for the development and implementation of digital tools for the implementation of state investment policy, as well as the Ministry of Digital Transformation and the State Service for Special Communications and Protection information regarding the development of digital infrastructure and cyber resilience standards in the development of regulations on open banking, the introduction of "e-hryvnia" and cybersecurity standards for financial institutions.

This study is based mainly on the analysis of regulations, analytical reports and official statistics, which may limit the empirical verification of causal relationships. Further research requires the use of quantitative methods (regression analysis, assessment of the impact of digitalization on the lending activity of SMEs), as well as in-depth interviews with representatives of the banking sector. Also of scientific interest is the conceptualization of the impact of central bank digital currencies (CBDCs) on post-war recovery mechanisms and modeling scenarios for protecting the digital financial system from hybrid threats in the long term.

Authors' Contributions

A. Kozhyna: Software and formal analysis: responsible for the technical processing of statistical data; development of algorithms for assessing the effectiveness of anti-crisis measures; use of specialized software for visualizing digital transformation trends; conducted a critical review of mathematical calculations and correlations in the study.

S. Diachenko: Data validation and writing (original draft): ensured the verification of the reliability of empirical data on the activities of banking institutions; structured the initial text of the article; prepared an overview of the regulatory framework (in particular, PSD2, eIDAS, and DORA standards) and formulated conclusions regarding their implementation in Ukraine.

O. Zubchyk: Conceptualization and methodology: formulated the scientific hypothesis of the study; developed an original conceptual model of anti-crisis investment policy; substantiated methodological approaches to studying the institutional capacity of state bodies in the financial sector; identified key vectors for harmonizing Ukrainian legislation with EU requirements.

I. Tkachenko: Writing (review and editing): provided a scientific interpretation of the results obtained; conducted stylistic and content editing of the manuscript; ensured that the terminology complied with international standards of public administration; prepared an abstract and keywords, optimizing them for international scientometric databases.

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