

CHAPTER

INSTITUTIONAL AND REGULATORY FOUNDATIONS FOR THE DEVELOPMENT OF FINTECH INNOVATIONS IN BANKING UNDER THE CONDITIONS OF THE DIGITAL TRANSFORMATION OF THE ECONOMY

DOI: <https://doi.org/10.30525/978-9934-26-690-4-13>

Diana Zavadska

*Doctor of Economic Sciences, Professor,
Professor at the Department of Banking
Odesa National Economic University*

Summary

The chapter examines the institutional and regulatory foundations of fintech innovation development in banking under conditions of digital transformation of the economy. The transformation of banking models under the influence of digital technologies, open banking, virtual assets, digital public infrastructure, and ESG-oriented regulation is conceptualized as a systemic restructuring of financial intermediation. Theoretical and methodological approaches to the interpretation of fintech innovations in banking are systematized, while the complementarity between functional mapping and smart regulation approaches is substantiated. A synthetic four-contour model of fintech innovation development is proposed, integrating digital public infrastructure, experimental regulation, prudential-compliance mechanisms, and ESG-oriented governance. Comparative analysis of regulatory architectures in the European Union, the United Kingdom, the United States, and Ukraine reveals distinct approaches to the regulation of fintech innovations, virtual assets, and digital financial infrastructure. Attention is devoted to the institutional role of regulatory sandboxes, MiCA, DORA, the DLT Pilot Regime, and open banking frameworks in balancing innovation development and financial stability. The institutional functions of the National Bank of Ukraine, the Ministry of Digital Transformation of Ukraine, BankID, and Diia in the formation of the digital financial ecosystem are also analysed. The chapter further examines the integration of e-KYC, digital identification, API interaction, and document-sharing mechanisms into banking customer services. The interrelationship between fintech innovations, ESG risk management, sustainable finance, and ethical regulation of digital banking is identified. The findings demonstrate that banks are increasingly transforming into platform-based institutional structures combining financing, data processing, digital identification, ESG assessment, and risk management functions. In this context, fintech innovations form the institutional basis for the digital, innovative, and green transformation of the banking sector.

Introduction

The current stage of banking sector development is characterised by intensive digital transformation accompanied by changes in the institutional foundations of financial intermediation. Fintech innovations transform the structure of banking, channels of interaction with customers, and approaches to risk management, thereby creating preconditions for the transition towards platform-based business models. Simultaneously, regulatory requirements are becoming increasingly stringent, which necessitates the alignment of innovation-driven development with the objectives of financial stability.

In the academic literature, the digital transformation of banking and the development of fintech innovations are regarded as key drivers of the transformation of financial intermediation [3; 23; 41]. Contemporary studies emphasise the interrelationship between fintech, digitalisation, ESG factors, digital resilience, and the institutional readiness of the financial sector for technological change [27; 24; 40]. At the same time, insufficient attention has been devoted to the development of a coherent approach to the alignment of technological, institutional, and regulatory aspects of fintech innovation development in banking.

The development of open banking, digital identification, the API economy, and digital public infrastructure is transforming the mechanisms of interaction between banks, customers, and public services, thereby creating new requirements for risk management, cyber resilience, and data processing. Simultaneously, digitalisation increases the significance of ESG factors by extending approaches to the assessment of banking performance through the integration of financial and non-financial parameters.

Under such conditions, the development of a coherent approach to the analysis of fintech innovation development becomes increasingly relevant, taking into account the interrelationship between technological, institutional, and regulatory factors and their impact on the transformation of banking.

The purpose of the study is to substantiate the institutional and regulatory foundations of fintech innovation development in banking and to determine their influence on the transformation of banking operations and the financing of innovation. Under these conditions, fintech innovations function as a systemic driver of the transformation of banking business models, digital financial infrastructure, and mechanisms of regulatory coordination.

1. Theoretical, conceptual and institutional foundations of fintech innovation development in banking

Fintech innovations in the contemporary banking sector represent a new stage in the transformation of financial intermediation, accompanied by changes in value creation mechanisms, the organisation of banking processes, and interaction with customers. Technological change extends beyond the

automation of individual operations and encompasses the institutional foundations of banking sector functioning, thereby transforming the structure of financial services, the architecture of business models, and approaches to risk management.

According to the approach of the Financial Stability Board, financial technology is defined as technologically enabled innovation in financial services that generates new business models, products and processes and exerts a systemic impact on financial markets and institutions [21]. In banking, this reflects the transition from a vertically integrated organisational model towards an open architecture based on the use of APIs, digital platforms and partnership ecosystems [4; 14].

The theoretical interpretation of fintech innovations is based on the integration of innovation, diffusion, ecosystem, and digital transformation approaches. The innovation approach interprets fintech as a factor of structural renewal within the financial sector and transformation of financial intermediation models [26]. The diffusion of innovations approach explains the uneven adoption of fintech solutions through their relative advantages, compatibility, and organisational characteristics [39]. Within the ecosystem approach, emphasis shifts from the individual financial institution towards the interaction network of banks, fintech companies, technology providers, and public institutions [31]. The digital transformation approach extends the analysis to the level of the bank's business model, including data management, operational processes, and risk management [8].

Despite the differences between these approaches, their integration reflects a gradual transition from a technological interpretation of fintech towards its institutional and ecosystem-based understanding. Whereas the diffusion approach concentrates on the characteristics of innovation dissemination and the innovation approach focuses on the influence of innovations on the structure of the financial sector, the ecosystem approach shifts attention towards the coordination of interactions between banks, technology companies, and public institutions. As a result, fintech innovations evolve from isolated digital solutions into a systemic mechanism for transforming the architecture of financial intermediation.

The integration of these approaches forms the basis for interpreting fintech innovations as a multi-level phenomenon encompassing the technological, functional, and strategic dimensions of banking. In this context, financial technologies should be considered not merely as instruments for the digitalisation of individual processes, but as factors transforming the architecture of financial intermediation.

The methodological foundation of the study is based on the integration of systemic, institutional, and comparative approaches, which enable the analysis of interrelationships between technological change, regulatory mechanisms,

and the transformation of banking business models. The development of the conceptual model of fintech innovation development is based on methods of theoretical generalisation, structural-functional analysis, and conceptual modelling.

Within the functional approach, financial technologies reflect the functional decomposition of banking, encompassing payments, lending, compliance, investment services, and operational processes. Technologies transform the entire bank value creation chain, generating a transition from the branch as the dominant service channel towards data, APIs, and algorithms as the core of the bank’s operational model [23].

The functional transformation of banking is accompanied by changes in approaches to the regulatory provision of the financial sector. The concept of adaptive regulation substantiates the necessity of using instruments aimed at ensuring a balance between innovation and financial stability [3]. In this context, the functional and regulatory approaches are complementary, since the former determines the directions of banking transformation, whereas the latter establishes the boundaries and mechanisms of institutional ordering of digital change.

The systematisation of fintech innovations in banking is carried out according to technological, functional, and strategic dimensions (Table 1).

Table 1

Analytical Systematisation of Fintech Innovations in Banking

Dimension	Innovation Type	Technological Base	Banking Functions	Key Risks	Regulatory Instruments	Performance Indicators
Technological	AI/ML, Cloud, API, DLT	Big Data, algorithms, cloud computing	scoring, fraud detection	model risk, cyber risk	model governance, DORA	model accuracy, cost-to-income ratio
Functional	payments, lending, compliance	API, digital ID	open banking, e-KYC	operational risk	PSD2, AML/KYC	onboarding time, SLA
Strategic	platform models, embedded finance	BaaS, digital ecosystems	service integration	concentration risk	sandbox, licensing	share of digital revenues

Source: compiled by the author based on [21; 4; 6; 14; 12; 35; 23; 3; 8; 26; 31]

The analytical systematisation of fintech innovations demonstrates that the digital transformation of banking extends beyond the implementation of individual technological solutions and encompasses changes in the functional structure of banks, risk management mechanisms, and regulatory approaches. The interrelationship between technological, functional, and strategic

dimensions confirms that the effectiveness of fintech innovations is determined not only by the level of technological development, but also by the quality of institutional coordination and the adaptability of the regulatory environment.

The implementation of fintech innovations is realised through the internal development of technological solutions, partnerships with fintech companies, corporate venturing, and the API economy [25].

Digital public infrastructure, including digital identification, payment systems, and data exchange mechanisms, plays a significant role in ensuring the scalability of innovations. Its functioning reduces transaction costs associated with access to financial services and creates preconditions for scaling remote customer service.

The generalisation of interrelationships between technological drivers, functional changes, business models, risks, and regulatory influence is presented in the proposed contour-dynamic model of fintech innovation development in banking (Figure 1).

The proposed model interprets the development of fintech innovations as the result of interaction between technological, functional, regulatory, risk, and managerial contours and extends existing approaches to the analysis of the digital transformation of banking through the integration of institutional and regulatory mechanisms into a unified conceptual system.

The technological contour forms the infrastructural basis of digital transformation; the functional contour ensures changes in processes and banking services; the regulatory contour determines the permissible boundaries of innovation; the risk contour reflects the transformation of the risk profile; and the managerial contour integrates these elements into the system of decision-making and adaptation of the bank's business model.

Unlike existing approaches to the analysis of the digital transformation of banking, the proposed contour-dynamic model combines technological, regulatory, risk, and managerial components within a unified system of interaction. This makes it possible to interpret fintech innovation development not as a set of isolated technological changes, but as a process of sequential institutional adaptation of the banking sector to the conditions of the digital economy.

The model reflects the sequence of banking transformation in which technological innovations generate new functional capabilities, transform bank business models, and create new types of risks requiring corresponding management mechanisms and regulatory support. The existence of feedback loops ensures the adaptability of the system and the cumulative nature of digital change.

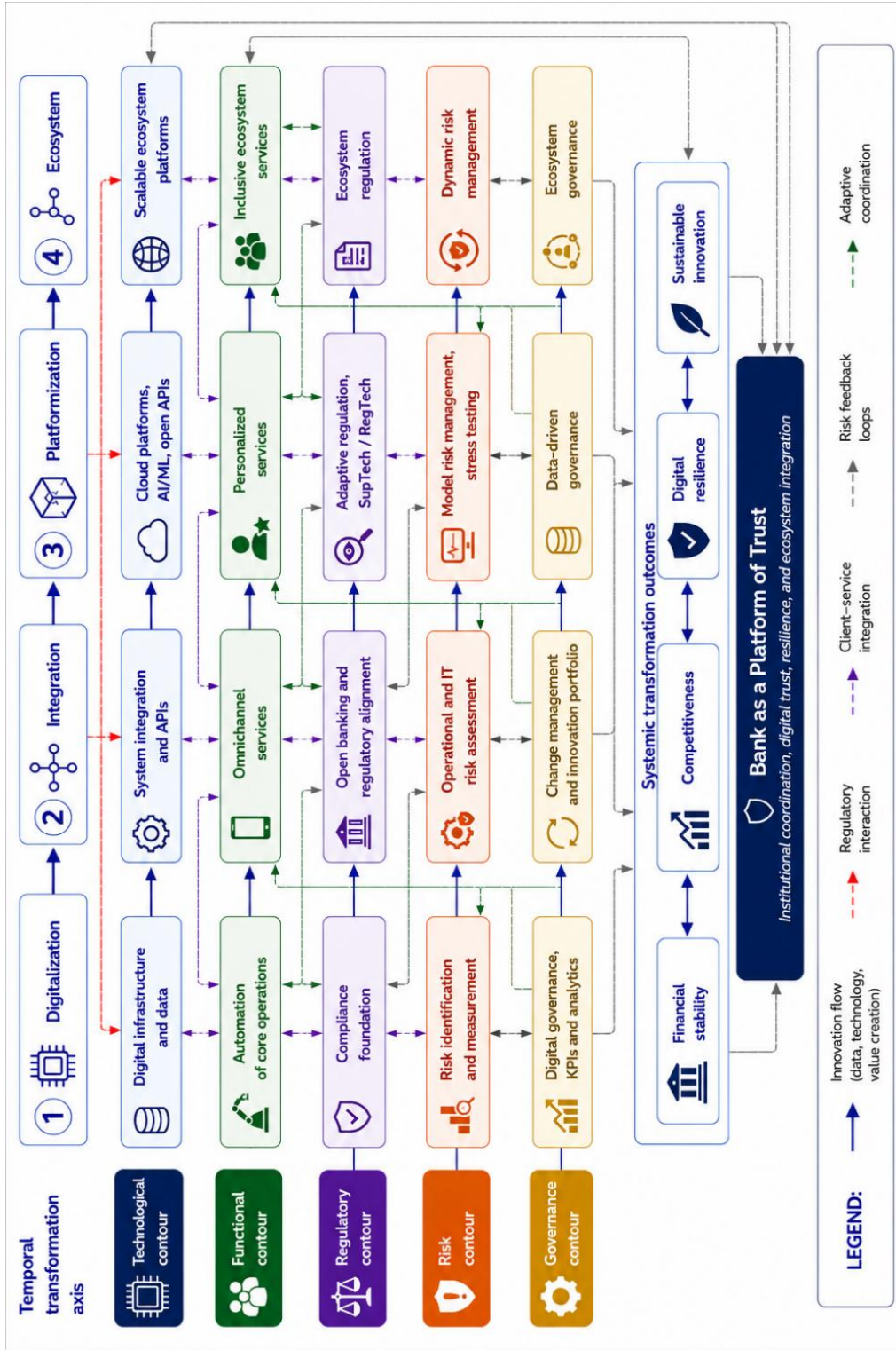


Figure 1. Proposed contour-dynamic model of fintech innovation development in banking
 Source: Developed by the author based on [21; 4; 6; 14; 12; 35; 23; 3; 8; 26; 31]

Within the systemic approach, fintech innovations form an inclusive dimension of financial system functioning, reflecting the transformation of access to financial services. Financial inclusion acquires the characteristics of a systemic feature determining the ability of the financial system to scale customer interactions without proportional growth in transaction costs.

The gradual complication of the contours leads to the transformation of the bank's role within the financial system. The transition towards ecosystem integration creates preconditions for changing the functional role of the bank from an institution conducting financial operations to an institution ensuring trust in digital financial interactions.

In this context, the bank should be regarded as a platform of trust that ensures data reliability, operational security, and compliance with regulatory requirements [14]. Trust is formed at the intersection of technological reliability, regulatory compliance, and the quality of customer experience.

The digitalisation of banking is accompanied by the transformation of the risk profile, particularly through the growth of cyber risks, third-party risks, and regulatory risks [6]. The integration of fintech solutions increases the significance of model risk, data quality, and algorithm interpretability, thereby necessitating the strengthening of model governance and bias control mechanisms.

An ESG dimension of fintech innovations is emerging, integrating the requirements of sustainable development and the responsible use of technology [12; 35]. ESG factors are gradually being incorporated into the regulatory and managerial contours of the digital transformation of banks, influencing approaches to the assessment of resilience, cybersecurity, algorithmic transparency, and the responsible use of data. Under these conditions, the evaluation of fintech innovation effectiveness is carried out on the basis of an integrated approach combining financial, customer, process, and ESG indicators.

The integration of digital, risk, and ESG components into the system for evaluating banking performance forms the basis for further empirical analysis of the interrelationships between the level of digitalisation, ESG indicators, and banking performance. In this context, fintech innovations acquire the characteristics of a measurable factor in banking sector transformation, making it possible to evaluate their impact through a system of financial, technological, and non-financial indicators.

At the same time, fintech innovation development is characterised by a high degree of technological dynamism and heterogeneity of regulatory approaches across jurisdictions, which complicates the formation of universal models of digital transformation in banking. The convergence of financial and technological services also limits the possibility of rigid classification of individual fintech solutions.

Thus, the development of fintech innovations in banking reflects the transformation of financial intermediation towards platform-based, ecosystem-oriented, and data-centric models of functioning. Within such transformation, technology, regulation, risks, and governance form an interconnected system that determines the adaptability and resilience of the banking sector under conditions of the digital economy and creates preconditions for further analysis of regulatory architectures, digital infrastructure, and the effectiveness of fintech innovations in banking practice.

2. Comparative analysis of regulatory architectures for financial technology development in the banking sectors of the European union, the United Kingdom, the United States, and Ukraine

A comparative analysis of regulatory models makes it possible to specify the parameters of the regulatory contour of fintech innovations across different jurisdictions. The evolution of financial technology regulation in the banking sector is characterised by a transition from a reactive approach towards the formation of a multi-level regulatory architecture combining instruments of experimentation, supervision, and financial stability assurance [21]. Regulatory models should be interpreted as systemic configurations differing in the level of centralisation, degree of experimental orientation, and mechanisms of coordination [23].

The methodological foundation of the study is based on the comparative institutional approach, which enables the identification of differences in the construction of regulatory architectures, coordination mechanisms, and interaction models between banks, fintech companies, and supervisory authorities. The method of analytical typologisation has been applied to systematise the models, ensuring the distinction between integrated, experimental-adaptive, fragmented, and adaptive-harmonisation regulatory models.

The regulatory contour of fintech innovations determines not only the boundaries of permissible innovation activity, but also the speed of transformation of banking business models, the level of integration of digital services, and the degree of adaptability of the financial system to technological change. In this context, differences between jurisdictions reflect different approaches to balancing innovation, competition, and financial stability.

Within the European Union, an integrated regulatory model has been established based on the combination of directly applicable legal acts and coordination mechanisms. The DLT Pilot Regime functions as an experimental framework for infrastructures based on distributed ledger technologies, whereas the MiCA Regulation establishes a unified legal framework for crypto-assets through the phased implementation of provisions relating to stablecoins. The DORA Regulation strengthens requirements concerning the operational resilience of financial institutions. Additional elements include the European

Blockchain Sandbox and the network of innovation facilitators, which ensure the coherence of national initiatives.

The integrated model of the European Union is characterised by a high level of regulatory certainty and centralisation of regulatory approaches. Its principal advantage lies in the formation of a unified regulatory environment for digital financial services, which reduces regulatory asymmetry and facilitates the scaling of fintech solutions within the common market. At the same time, the strengthening of requirements relating to ICT risk management, outsourcing, and governance increases the regulatory burden imposed on banks and fintech companies, which may constrain the speed of implementation of certain innovative solutions.

The regulatory model of the United Kingdom is characterised by an experimental-adaptive orientation. The Financial Conduct Authority institutionalised the regulatory sandbox as a mechanism for testing innovations within a controlled environment through the use of instruments such as restricted authorisation, waivers, and no-enforcement letters [20]. The further development of the model is taking place through the implementation of the Digital Securities Sandbox and specialised programmes for crypto-assets alongside the gradual institutionalisation of regulation.

Unlike the integrated model of the European Union, the British approach is oriented towards ensuring flexibility and accelerating the market testing of innovative products. Such a model creates favourable conditions for the development of the fintech ecosystem and stimulates competition between traditional financial institutions and technology companies. At the same time, the dominance of experimental mechanisms increases the dependence of system effectiveness on the quality of supervisory procedures and the speed of adaptation of regulatory instruments.

The model of the United States is fragmented in nature, with the distribution of regulatory powers between federal and state authorities. The absence of a unified sandbox is compensated for by separate supervisory initiatives, including the Novel Activities Supervision Program and the activities of the Office of Financial Technology. Experimental regimes operate at the state level. The regulation of virtual assets is implemented through the combined application of securities legislation, commodities law, and financial monitoring requirements, thereby generating an elevated level of regulatory uncertainty.

The fragmented nature of the American model results in asymmetry of regulatory requirements and complicates coordination between market participants. Under such conditions, banks are compelled to adapt models of interaction with fintech companies to different jurisdictional requirements, thereby increasing compliance and risk management costs. At the same time, intense competition between states and regulatory authorities stimulates the

emergence of new mechanisms supporting innovation and accelerates the development of segments of the fintech market.

The Ukrainian model remains at the stage of institutional completion and is characterised by an adaptive-harmonisation orientation. The National Bank of Ukraine has identified the establishment of a regulatory sandbox as a key instrument for stimulating innovation. The functioning of the sandbox within a controlled environment is complemented by the gradual expansion of the regulatory perimeter concerning virtual assets and the implementation of approaches similar to European practices. The development of the model is taking place with due regard to the EU *acquis* and the support of international institutions.

A distinctive feature of the Ukrainian model is the combination of the adaptation of international regulatory practices with the development of digital public infrastructure, including BankID, state digital services, and the concept of the *e-hryvnia*. This creates preconditions for the integration of banking services into a broader digital ecosystem and establishes the institutional foundation for the scaling of remote financial services.

The systematisation of regulatory models makes it possible to distinguish four types of regulatory architectures (Table 2). The European Union represents an integrated model characterised by a high level of regulatory certainty and coordination.

The United Kingdom implements an experimental-adaptive model focused on testing innovations in real market conditions. The United States is characterised by a fragmented model with asymmetry of regulatory requirements. Ukraine is developing an adaptive-harmonisation model oriented towards the integration of European approaches.

The analytical comparison of regulatory models demonstrates that the type of regulatory architecture directly influences the configuration of the regulatory contour of fintech innovations, the speed of integration of digital services, and the level of systemic resilience of the banking sector.

Centralised models ensure a higher degree of predictability of the regulatory environment, whereas experimental-adaptive models create more favourable conditions for the testing of innovations. Fragmented systems, by contrast, generate asymmetry of requirements and increase coordination costs between participants in the financial market.

Differences between models determine the configuration of the regulatory contour of fintech innovations. In centralised models, predictability and the reduction of regulatory risks are ensured, whereas flexible models are characterised by the dominance of experimentation, thereby increasing requirements relating to supervisory mechanisms. Fragmented models create additional risks in interactions between banks and fintech companies, particularly within bank-fintech partnerships. Consequently, a trade-off

emerges between the flexibility of the regulatory environment and the level of financial stability, determining the boundaries and pace of digital transformation within the banking sector.

Table 2

Comparative characteristics of regulatory architectures for financial technology development in the banking sector

Criterion	European Union	United Kingdom	United States	Ukraine
Type of regulatory architecture	Integrated supranational model	Experimental-adaptive model	Functionally fragmented model	Adaptive-harmonisation model
Institutional framework	MiCA, DORA, DLT Pilot Regime, EFIF, European Blockchain Sandbox	FCA Regulatory Sandbox, DSS, HM Treasury framework	CFPB, OCC, Federal Reserve, state sandboxes	NBU sandbox, Fintech Strategy, VA framework
Mechanisms of experimental regulation	Regulated experimentation	Live-market testing	State sandboxes	Controlled environment testing
Approach to virtual asset regulation	MiCA and DLT Pilot	Crypto-assets and stablecoins framework	Securities law, commodities law, BSA/AML	VA legislation aligned with the EU acquis
Implications for banking	ICT risk governance, disclosure, tokenisation	Live supervision, product testing	Compliance asymmetry, partnership risks	Digital infrastructure integration
Inclusive effect	Open banking, interoperability, digital identity	Innovation-oriented product access	Fragmented innovation access	DPI-based financial inclusion

Source: Compiled by the author based on [21; 4; 6; 14; 12; 26; 31; 18; 16; 20], and Federal Reserve System materials concerning the supervision of novel activities

The inclusive dimension of regulatory architectures is manifested in the creation of conditions for scaling access to financial services through digital channels [35]. In integrated models, inclusion is achieved through service interoperability, the development of open banking, and the unification of digital identification. In experimental-adaptive models, the inclusive effect is realised through the testing of innovative products. In fragmented models, it is asymmetrical in nature and dependent upon individual market initiatives.

Within the adaptive-harmonisation model of Ukraine, the inclusive contour is formed through the development of digital public infrastructure ensuring customer identification, the integration of state and banking platforms, and the

scaling of remote services. In this context, digital public infrastructure performs the function of an institutional catalyst for the integration of financial services into the digital economy.

At the same time, regulatory architectures remain dynamic and dependent upon the speed of technological change, geopolitical factors, and the degree of harmonisation of international standards. The strengthening of requirements relating to cyber resilience, digital identification, and data governance is gradually generating a tendency towards convergence of regulatory models; however, differences in supervisory mechanisms and institutional approaches continue to preserve a high level of jurisdictional asymmetry.

Thus, the effectiveness of fintech innovation development in the banking sector is determined by the type of regulatory architecture, which establishes the conditions for balancing innovation and financial stability. The regulatory contour constitutes one of the key mechanisms for adapting banking systems to digital transformation, whereas the inclusive dimension reflects the ability of the financial system to ensure the expansion of access to financial services without undermining systemic resilience.

3. Institutional coordination and digital state infrastructure in the formation of fintech innovations in the banking sector

The development of fintech innovations in banking under conditions of digital transformation of the economy is determined not only by the technological maturity of banks or the existence of a regulatory framework, but also by the ability of the institutional system to ensure coordinated digital interaction between the state, the regulator, banks, fintech companies, and users of financial services. In this context, the digital state functions as an integral component of the institutional architecture of fintech innovations, forming digital public infrastructure that ensures identification, data exchange, access to registers, document verification, and electronic interaction.

The methodological foundation of the study is based on the institutional-systemic approach, which makes it possible to interpret digital public infrastructure as an integrated system of interaction between state platforms, banking services, and mechanisms of digital supervision. Elements of infrastructural and comparative approaches have been applied for the analysis, ensuring the examination of interrelationships between the digital state, financial innovations, and the transformation of banking business models.

The institutional dimension of fintech innovation development presupposes that the boundaries of banking innovation are formed beyond the individual financial institution. A bank cannot ensure a complete cycle of digital trust without integration with state digital platforms, mechanisms of remote identification, verified data, and supervisory technologies. Accordingly, the

innovative capacity of a bank is determined by the level of its integration into digital public infrastructure.

In international practice, digital public infrastructure is gradually transforming into a key element in the development of financial innovations. The India Stack model ensures the integration of digital identification, payment infrastructure, and data exchange mechanisms, thereby creating a scalable environment for digital financial services. The Estonian e-governance model is oriented towards the integration of state registers and digital interaction between the public and private sectors. Within the European Union, the development of the European Digital Identity Framework is aimed at the unification of digital identification and enhancement of service interoperability. Thus, digital public infrastructure is gradually transforming into a fundamental institutional component of the development of the digital economy and financial intermediation.

The coordinating role of the National Bank of Ukraine is systemic in nature and combines the functions of regulator, supervisor, and participant in the development of financial infrastructure. Through the development of BankID, research into the e-hryvnia, implementation of RegTech and SupTech solutions, and enhancement of remote identification mechanisms, institutional conditions for the controlled implementation of fintech solutions are being established. The BankID system ensures the transmission of users' identification data between service providers and creates a standardised channel for remote identification [32].

The use of BankID transforms the functional boundaries of banking innovation, as remote identification evolves from an internal procedure into an element of interinstitutional interaction. Such transformation ensures a reduction in onboarding time, decreases dependence on the customer's physical presence, and improves the quality of primary identification. At the same time, banks retain full responsibility for compliance with regulatory and financial monitoring requirements.

The Diia State platform performs the function of an infrastructural intermediary for digital interaction. The document sharing mechanism ensures the transfer of digital copies of documents or metadata for integration into banking information systems [11]. As a result, document processing time is reduced, data quality is improved, and dependence on paper-based document circulation decreases, as illustrated in Figure 2.

Digital public infrastructure changes the nature of banking innovations by shifting them from the level of an individual product to the level of interinstitutional interaction. Innovativeness is determined by the ability to integrate banking services with state platforms, registers, and API ecosystems. As a result, the bank is gradually transformed into an integrator of digital trust between the state, the customer, and the financial system.

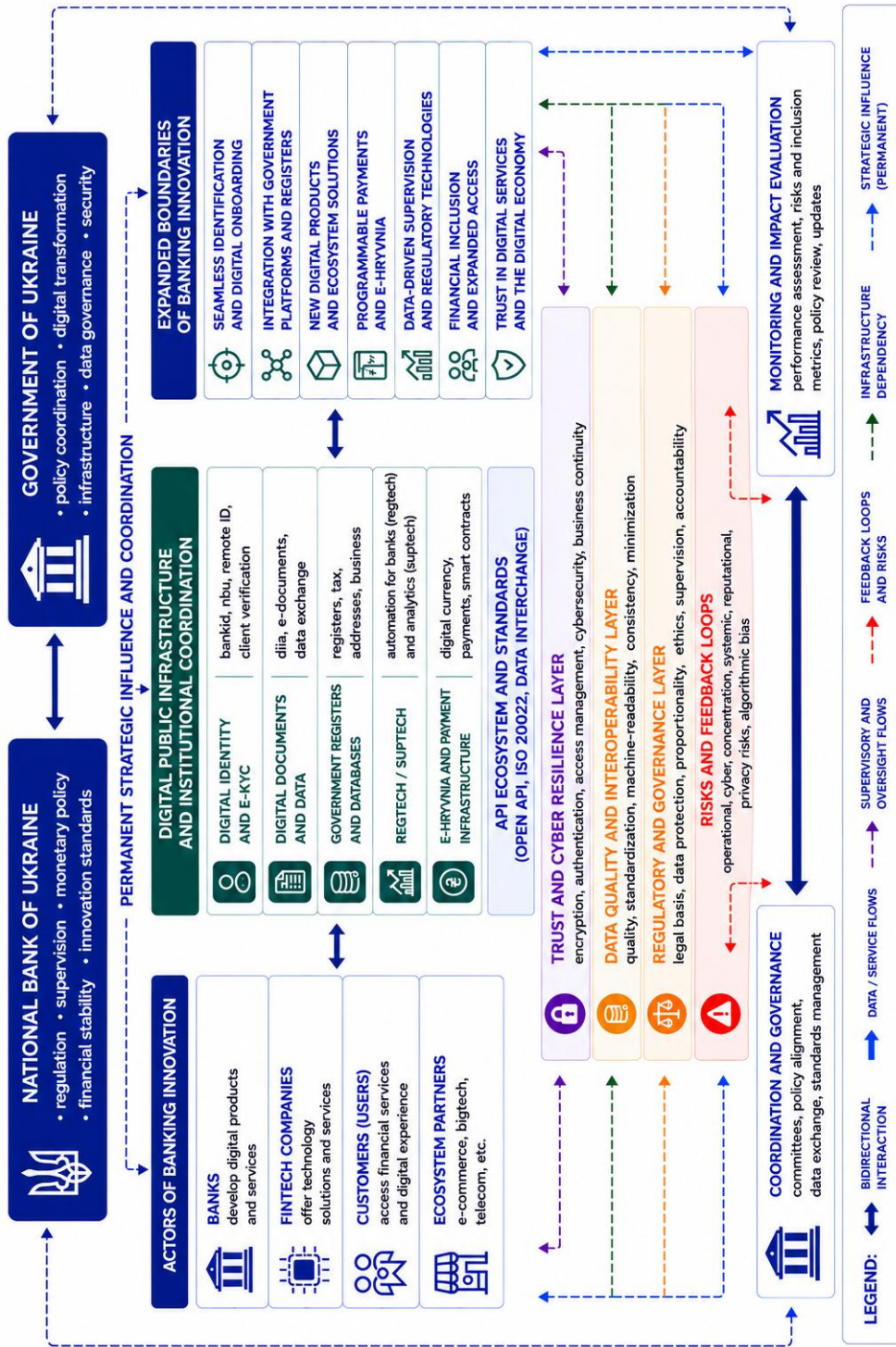


Figure 2. Institutional interaction model of digital public infrastructure in banking innovation

Source: developed by the author based on [32; 33; 11; 37; 5; 35]

Unlike traditional models of digitalisation, within which technological solutions function primarily as internal automation instruments, digital public infrastructure forms an intersectoral mechanism for coordinating data, services, and identification. This makes it possible to interpret fintech innovations as the result of integrating banking into a broader system of digital public governance.

Within this transformation, e-KYC ensures the transition from a document-oriented model of customer interaction towards a data-centric model. The combination of digital documents, register-based data, remote identification, and automated verification makes it possible to improve the accuracy of risk assessment, accelerate customer identification, and reduce transaction costs.

The development of RegTech and SupTech reflects institutional coordination between banks and the regulator. RegTech ensures the automation of compliance with regulatory requirements by financial institutions, whereas SupTech is oriented towards the use of technologies by the regulator for data collection and analysis. Such transformation contributes to the transition towards data-driven supervision, within which data quality, timeliness, and machine readability acquire decisive importance [37].

Institutional coordination between banks and the digital state forms a new level of the regulatory contour of fintech innovations, within which supervisory functions are integrated with digital platforms, automated monitoring, and data analytics. This increases the adaptability of the financial supervision system, while simultaneously strengthening the dependence of banking upon the stability of digital infrastructure and the continuity of data exchange.

The e-hryvnia represents a prospective element of institutional architecture capable of transforming payment infrastructure and expanding the possibilities of programmable payments, state transfers, and digital services [33]. Its implementation requires balancing the impact on banking liquidity, competition within the payment sector, and the risks of financial intermediation.

Within the contemporary approach to digital public governance, inclusion acquires the characteristics of an institutional feature of the financial system. Institutional coordination forms the inclusive dimension of fintech innovations through the development of remote identification, digital documents, and access to financial services. Inclusion is determined by the integration of digital identity, verified data, and regulatorily acceptable procedures.

The ESG dimension of digital public infrastructure is manifested through issues of digital inclusion, ethical data use, algorithmic transparency, and cyber resilience. Under these conditions, digital infrastructure ceases to function solely as a technological platform and is transformed into a component of the system of responsible digital governance.

At the same time, digital public infrastructure transforms the nature of risks. Dependence of banks upon the reliability of state platforms, continuity of

register operations, and security of API integrations increases. The concentration of functions within digital platforms may generate systemic risks in the event of technical failures, cyberattacks, or disruption of interoperability between state and banking systems.

The institutional concentration of data and digital services creates a trade-off between the scalability of innovations and the resilience of the financial system. On the one hand, the integration of digital platforms ensures acceleration of financial services, reduction of transaction costs, and increased accessibility of services. On the other hand, the systemic dependence of banks upon state digital infrastructure and centralised data governance mechanisms intensifies.

The effectiveness of the digital state for the banking sector is determined by the ability of the institutional system to ensure a balance between innovation, cyber resilience, data protection, inclusion, and operational continuity.

At the same time, the development of digital public infrastructure is characterised by heterogeneity in the level of digitalisation of public services, differences in interoperability standards, and uneven access to digital financial services. This limits the possibility of establishing universal models for the integration of banking into digital state infrastructure and preserves a high level of institutional asymmetry between jurisdictions.

Thus, institutional coordination and the digital state form a new level of fintech innovation development, within which the bank functions as an integrator of trust between the customer, the state, the regulator, and digital services. The innovative capacity of the bank is determined by its ability to integrate into an institutionally coordinated digital ecosystem ensuring scalability of solutions, improvement of data quality, strengthening of trust in financial interactions, and adaptability of the banking sector to the conditions of the digital economy.

4. Digital customer services and e-KYC architectures in the transformation of banking

Under contemporary conditions, banks are implementing not fragmented digitalisation of individual services, but a transformation of the operational model based on an integrated digital customer process. The development of remote identification and e-KYC enables remote onboarding by combining service interaction, compliance, data analytics, and mechanisms of digital control. Mobile and online channels are gradually transforming into the principal points of interaction between banks and customers, while document-sharing mechanisms automate data verification and reduce dependence on paper-based document circulation.

The functional transformation of customer services constitutes a component of a broader institutional restructuring of banking, within which digital public infrastructure, API interaction, and data-driven governance form a new

architecture of financial intermediation. In this context, digital customer services function as a functional manifestation of the transformation of the regulatory, managerial, and technological contours of the banking system.

The integration of digital instruments of public infrastructure and banking technologies ensures the separation of front-office and back-office functions through end-to-end digital processes. As a result, flexible digital products are formed, opportunities for remote servicing are expanded, and financial inclusion is enhanced. Simultaneously, requirements concerning transparency of terms, cyber resilience, personal data protection, and consumer protection mechanisms are becoming more stringent [34]. Banking is transitioning towards a data-centric model within which the front office, back office, and risk engine are integrated into a unified digital value-creation process.

The initial stage of such transformation is represented by remote customer identification. The use of video verification, BankID, and digital instruments makes it possible to ensure compliance with regulatory requirements in real time and corresponds to changes in customer behaviour towards the dominance of digital channels [34]. The integration of KYC with digital identification enhances the accuracy of verification, accelerates onboarding, and ensures prompt detection of risky transactions.

The implementation of e-KYC is based on the use of state registers, digital documents, biometric data, and API integrations, thereby reducing account-opening time and improving the quality of verification [28]. e-KYC simultaneously performs service and control functions by combining accelerated customer onboarding with compliance with financial monitoring requirements.

Within the framework of data-driven banking, e-KYC is transformed from an instrument of formal identification into a mechanism of operational efficiency and risk management. The combination of digital identity, automated data verification, and analytics enables banks to reduce operational costs, improve the quality of customer data, and accelerate service delivery. At the same time, the dependence of banks upon state digital infrastructure, stability of API interaction, and continuity of access to registers intensifies.

Mobile and online platforms constitute the principal channel of interaction, reflecting changes in customer behaviour and creating requirements for the continuous availability of banking services [9]. The mobile application is being transformed into a comprehensive digital front office integrating product and operational processes, risk management, compliance, and data analytics. As a result, the digitalisation of banking is implemented through the customer value-creation flow rather than through isolated digital products.

Integration with digital public platforms ensures automation of document processing and improvement of data quality. The use of digital documents and data exchange mechanisms reduces costs, decreases the duration of procedures,

and improves the accuracy of information. Document-sharing mechanisms institutionalise the transition from document-based verification towards data-driven onboarding architectures, within which digital interaction between the bank, the state, and the customer is conducted in real time.

The digital model transforms the customer journey by integrating its stages into a unified automated process. Systems based on algorithms and data analytics generate personalised offers, produce documents, and ensure contract conclusion without the direct participation of bank employees [22]. Under these conditions, the competitiveness of banks is increasingly determined by the quality of data analytics, the speed of digital interaction, and the level of service integration.

The development of open banking and the use of APIs create conditions for the formation of new fintech products, including mobile wallets, instalment payment services, embedded finance, and digital financial assistants. Data exchange between market participants stimulates innovation while simultaneously increasing requirements relating to information protection, data access management, and cybersecurity [19].

API ecosystems form a new model of interaction between banks, fintech companies, and technology providers. Within this model, banks gradually transition from the role of autonomous service providers towards the function of regulated infrastructure providers ensuring service integration, risk control, and trust in digital financial interactions.

At the same time, the expansion of digital services is accompanied by an increase in systemic risks. The significance of cyber risks, data concentration risks, platform dependency, and operational vulnerability is increasing. The integration of banking services with digital platforms intensifies dependence upon the stability of API infrastructure, continuity of digital channels, and interoperability of systems. Risks associated with algorithmic opacity are becoming particularly relevant, complicating the interpretation of automated decisions and increasing requirements relating to explainability.

The expansion of digital services is accompanied by increasing requirements for the protection of consumer rights. Ensuring transparency of conditions, personal data protection, cybersecurity, and customer control over the use of personal data is becoming a necessary condition for the functioning of the banking sector. Under these conditions, the ESG component of digital transformation extends beyond the reputational or compliance dimension and becomes integrated into mechanisms of data governance, algorithmic accountability, and responsible digital finance.

Importance is attached to ensuring digital inclusion, which presupposes access to financial services irrespective of place of residence, income level, or the physical presence of the customer. As a result, digital customer services are

gradually transforming into an element of the institutional model of financial inclusion.

At the same time, the development of digital customer services is characterised by a high degree of dependence upon the level of digital infrastructure development, regulatory coherence, and interoperability standards. Uneven digital maturity of banks, differences in technological capabilities, and asymmetry of access to innovative services limit the possibility of establishing a universal model of digital transformation within the banking sector.

Thus, digital customer services form a new configuration of banking innovation within which the integration of digital public infrastructure, API ecosystems, and data-driven banking ensures the reduction of transaction costs, enhancement of accessibility of financial services, and expansion of the boundaries of innovation. Simultaneously, requirements relating to regulatory control, compliance, cyber resilience, explainability, and consumer protection are becoming increasingly stringent, thereby determining the parameters of banking sector functioning under conditions of the digital economy.

5. ESG, digital governance, and the effectiveness of the digital transformation of banking

The digital transformation of banking changes the principles for evaluating the responsibility of banks towards customers, investors, regulators, and society. ESG, green finance, cyber resilience, the quality of data governance, and the ethical nature of algorithmic decision-making form an integrated contour of banking resilience within which financial efficiency, operational reliability, data transparency, and customer responsibility function as interconnected characteristics of the digital business model [12; 35].

Within the framework of contemporary digital transformation, ESG is gradually being integrated into systems of risk management, digital governance, and assessment of banking competitiveness. Under such conditions, bank resilience is determined not only by the volume of capital or the level of profitability, but also by the ability to ensure cyber resilience, responsible use of data, transparency of algorithmic decisions, and integration of sustainability-oriented financial practices.

The theoretical foundation of the study is based on the integration of the ESG-finance approach, the digital governance framework, and the institutional banking transformation perspective. Within this approach, digitalisation is interpreted as an infrastructural precondition for ESG integration, whereas ESG functions as a mechanism of institutional ordering of digital financial processes. Accordingly, the interrelationship between ESG, digitalisation, and banking performance is interpreted as a component of the systemic transformation of financial intermediation.

Within the European regulatory approach, ESG is interpreted not as a voluntary reputational element, but as a component of the system of risk management and prudential supervision. Taxonomy-related disclosure, the Green Asset Ratio (GAR), requirements concerning climate risks, and non-financial reporting form a regime of transparency of banking assets [13; 15]. The average level of GAR within the banking sector of the European Union remains relatively low at approximately 2–3%, reflecting the limited share of taxonomy-aligned assets and the complexity of their verification [13].

Under such an approach, green finance acquires the characteristics of a data-driven process, since it depends upon the ability of banks to collect, verify, and use financial and non-financial data for the assessment of customers, projects, and portfolios [1; 35]. Consequently, the ESG transformation of banking directly depends upon the level of digital maturity of the bank, the quality of data governance, and the integration of digital infrastructure.

The digitalisation of banks functions as an infrastructural precondition for ESG integration by ensuring automation of verification procedures, risk monitoring, and the formation of non-financial indicators. Simultaneously, new risks emerge, including cyber risks, risks of algorithmic bias, model opacity, and inadequate data quality. According to international estimates, approximately 20–25% of operational losses within the financial sector are associated with IT incidents and cyber threats, thereby increasing the significance of cyber resilience as a component of the governance dimension of ESG [6; 7].

Regulatory ethics in digital banking is formed through the combination of innovation stimulation, assurance of financial stability, and maintenance of trust in the financial system. The assessment of banking activity encompasses not only financial performance, but also parameters relating to data usage, the functioning of algorithms, explainability of automated decisions, and the impact of digital channels on customers [35]. Under these conditions, algorithmic accountability and responsible data governance are transformed into components of the governance dimension of ESG.

The ethical dimension of digital transformation also encompasses risks of algorithmic discrimination, information asymmetry, and greenwashing practices. The use of AI-based scoring systems increases requirements concerning model transparency, explainability, and control of potential customer discrimination. Simultaneously, the risk of formal ESG positioning without genuine transformation of the banking business model increases, thereby strengthening the significance of ESG data verification and taxonomy compliance.

The empirical analysis is based on a panel sample of banks from the European Union, the United Kingdom, and Ukraine covering the period 2020–2025 (30 institutions), which makes it possible to evaluate interrelationships between ESG, digitalisation, and the financial performance

of banks. Sources of information include ESG reports, annual reports of banks, Pillar 3 ESG disclosures, and regulatory materials.

For European banks, the Green Asset Ratio and taxonomy-related indicators have been applied, whereas proxy indicators have been used for Ukrainian banks due to limitations in ESG data disclosure [13; 1]. Such an approach ensures cross-jurisdictional comparison, while simultaneously preserving a high level of asymmetry in ESG disclosure between countries.

The principal parameters of the panel sample are systematised in Table 3.

As shown in Table 3, banks in the European Union and the United Kingdom demonstrate higher ESG Scores, a larger share of digital users, and lower levels of non-performing loans compared with Ukrainian banks. At the same time, the low GAR values reflect the complexity of verifying taxonomy-aligned assets and the limited extent of full ESG integration even within developed financial systems.

Table 3

Descriptive statistics of key indicators of the banking sample

Indicator	Mean (EU/UK)	SD (EU/UK)	Mean (Ukraine)	SD (Ukraine)
ESG Score	59.3	12.1	41.7	15.4
GAR, %	2.8	1.5	n/a	n/a
ROE, %	8.5	3.2	6.1	2.5
ROA, %	0.9	0.4	0.7	0.3
Cost-to-income, %	62.4	12.5	65.8	15.0
IT expenses, % total	11.2	4.8	8.0	3.6
Digital users, %	68.5	15.0	45.2	20.1
NPL ratio, %	2.3	1.1	5.6	2.2
Cyber incidents, count	1.2	1.0	0.3	0.5

Source: author's calculations

For the construction of the panel model, four blocks of variables were distinguished. The ESG block includes ESG Score, ESG disclosure status, Green Asset Ratio, and the share of green lending. The financial block includes ROE, ROA, cost-to-income ratio, total assets, and a proxy for funding costs.

The digital block has a proxy character and includes the share of IT expenditures, the share of digital customers, the existence of open banking and APIs, and investments in digital transformation. The risk block encompasses the NPL ratio, operational losses, cyber incidents, customer complaints, and fraud losses.

The baseline panel model for evaluating the association between ESG and return on equity is presented in Formula 1:

$$ROE_{it} = \alpha_i + \beta_1 ESG_{it} + \beta_2 \ln(Assets_{it}) + \gamma_t + \varepsilon_{it}, \quad (1)$$

where ROE_{it} is the return on equity of bank i in year t ; ESG_{it} denotes the normalised ESG indicator; $\ln(Assets_{it})$ is the natural logarithm of bank assets used to control for bank size; α_i denotes the individual bank effect; γ_t represents year fixed effects; and ε_{it} is the error term.

Analogous models were constructed for the cost-to-income ratio as the dependent variable, as well as for the joint impact of ESG and digital proxy indicators on financial performance.

To verify the reliability of the results, diagnostic tests of the panel models were conducted. The results of the Hausman test confirmed the appropriateness of using fixed-effects models for the baseline specifications. VIF diagnostics did not reveal critical multicollinearity between the key variables. At the same time, the results of the Breusch–Pagan and Wooldridge tests indicated the presence of heteroskedasticity and autocorrelation, which necessitated the use of robust standard errors clustered at the bank level. An additional robustness check using ROA as an alternative indicator of financial performance confirmed the preservation of the direction of the relationship between ESG indicators and banking performance (Table 4).

Table 4

Diagnostic tests of panel models

Test	Testing purpose	Value	Interpretation
Hausman test	Selection of FE or RE specification	$\chi^2 = 12.84$; $p = 0.025$	Fixed-effects model preferred
VIF	Multicollinearity	max VIF = 2.41	No critical multicollinearity detected
Breusch–Pagan test	Heteroskedasticity	$\chi^2 = 9.36$; $p = 0.041$	Evidence of heteroskedasticity detected
Wooldridge test	Autocorrelation	$F = 5.27$; $p = 0.030$	Autocorrelation detected
Robustness analysis	Selection of FE or RE specification	ROA specification instead of ROE	Preference for FE model

Source: author's calculations

The results of the correlation analysis are presented in Table 5.

According to the results of the correlation analysis, ESG Score demonstrates a positive relationship with ROE, whereas digitalisation negatively correlates with the cost-to-income ratio and the NPL ratio. The obtained results confirm that digitalisation and ESG increasingly operate as interconnected governance mechanisms rather than isolated strategic initiatives.

Table 5

Correlation matrix of key variables

Indicator	ESG Score	GAR	ROE	Cost-to-Income	Digital	NPL
ESG Score	1.00	-0.07	0.54***	-0.11	0.26***	-0.18*
GAR	-0.07	1.00	-0.03	-0.17	0.07	-0.09
ROE	0.54***	-0.03	1.00	-0.09	0.27***	-0.20*
Cost-to-Income	-0.11	-0.17	-0.09	1.00	-0.26***	0.21**
Digital	0.26***	0.07	0.27***	-0.26***	1.00	-0.86***
NPL	-0.18*	-0.09	-0.20*	0.21**	-0.86***	1.00

Source: author's calculations.

Note. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

The positive relationship between ESG and ROE may be explained by improvements in risk management quality, lower funding costs, stronger stakeholder trust, and higher levels of transparency. At the same time, the negative relationship between digitalisation and both the cost-to-income ratio and NPL ratio indicates that digital technologies improve operational efficiency and enhance the quality of credit monitoring.

At the same time, the weak relationship between GAR and certain financial indicators suggests that taxonomy-aligned assets do not yet function as an independent driver of banking profitability. This may be explained by the early stage of development of the sustainable finance ecosystem, high costs of ESG verification, and the complexity of standardising green assets.

The results of the panel regressions are summarised in Table 6.

As demonstrated in Table 6, an increase in ESG Score is associated with growth in ROE, whereas an increase in the digital index is associated with a reduction in the cost-to-income ratio. In the combined model, ESG and Digital preserve a positive relationship with ROE, indicating the complementary character of digitalisation and ESG integration.

The obtained results make it possible to interpret ESG and digitalisation as interdependent governance systems forming a new model of banking competitiveness. Within such a model, the principal sources of resilience are represented by data quality, cyber resilience, transparency, and adaptive risk management.

Simultaneously, the results indicate a gradual shift in the competitive advantages of banks from the scale of operations towards the quality of digital infrastructure, explainability of algorithms, ESG transparency, and the ability to integrate sustainability principles into the digital business model.

Table 6

Summary of panel regression results

Model	Dependent variable	Key predictor	β estimate	Std. error	p-value	R ²	Interpretation
1	ROE	ESG Score	0.12	0.04	<0.01	0.42 (FE)	Positive ESG–ROE association
2	Cost-to-income	Digital	–0.55	0.12	<0.01	0.37 (FE)	Digitalisation associated with lower C/I
3	Cost-to-income	GAR	–0.45	0.20	<0.05	0.30 (FE)	GAR associated with lower C/I
4	ROE	ESG Score; Digital	0.08; 0.05	n/a	<0.05	0.48 (RE)	ESG and Digital positively associated with ROE

Source: Author's calculations.

Note. FE = fixed-effects model; RE = random-effects model

The methodological limitations of the study are associated with the use of proxy indicators, heterogeneity of ESG metrics, and incomplete comparability of data across jurisdictions. ESG ratings of different providers differ in methodology, GAR is applicable primarily to banks in the European Union and the United Kingdom, and the digital index does not fully capture the entire content of digital transformation. In addition, the results reflect associative rather than causal relationships and may partially depend upon omitted variable bias and measurement asymmetry.

Nevertheless, despite the aforementioned limitations, the results confirm the systemic nature of the interrelationship between ESG, digitalisation, and banking performance. This makes it possible to interpret digitalisation not merely as a technological process, but as an institutional mechanism for the transformation of the governance architecture of the banking sector.

Thus, ESG, green finance, and digitalisation form an integrated model for the development of banking within which technologies provide the infrastructure for sustainable finance, risk management, and customer protection. The competitiveness of banks is increasingly determined by the ability to combine digital efficiency, taxonomy transparency, cyber resilience, explainability, and responsible use of data within a unified data-driven governance architecture.

6. Platform transformation of banks and their role in financing innovation in the digital economy

The digital transformation of the financial sector determines changes in the functional role of banks within the economy, manifested through the transition from classical financial intermediation towards a platform-based model of banking organisation. Under contemporary conditions, the bank no longer functions exclusively as a channel for transforming savings into investment but operates as a multi-level institutional structure integrating financial, technological, and information flows.

Within the traditional model, the bank primarily performed the functions of resource accumulation, assessment of borrowers' creditworthiness, and redistribution of capital between sectors of the economy. In the digital economy, this role is expanding. The bank becomes not only a creditor or investor, but also a platform coordinator of innovative interactions, since it ensures access to financing, digital channels, customer data, payment infrastructure, compliance procedures, and risk management mechanisms.

This transformation is determined by the development of fintech innovations, the expansion of open banking, the growing role of data as an economic resource, and increasing regulatory requirements relating to transparency, operational resilience, and risk management. Under these conditions, the financing of innovation acquires a systemic character. Banks provide not only lending for innovative projects, but also investments in fintech companies, support the development of RegTech solutions, finance the digital modernisation of customers, and function as infrastructural partners for green technology (Figure 3).

The figure reflects the transition of the bank from a linear model of financial intermediation towards a platform structure within which the bank combines the functions of financing, data processing, digital identification, risk management, and ensuring customer access to innovative financial services. Such an approach makes it possible to interpret the bank not as an isolated service provider, but as an institutional centre of interaction between investors, technology companies, customers, regulators, and digital platforms.

Importance is attached to the role of banks in financing innovative and green transformation. First, banks may directly provide lending or investment for innovative business models. Second, they finance customers implementing technological, energy, or environmental modernisation. Third, banks themselves function as purchasers of innovations, particularly in the areas of RegTech, cybersecurity, cloud infrastructure, AI-based scoring, data analytics, and digital onboarding. Fourth, banks perform a signalling function for the market, since their participation in financing innovative projects reduces information asymmetry and increases the confidence of other investors.

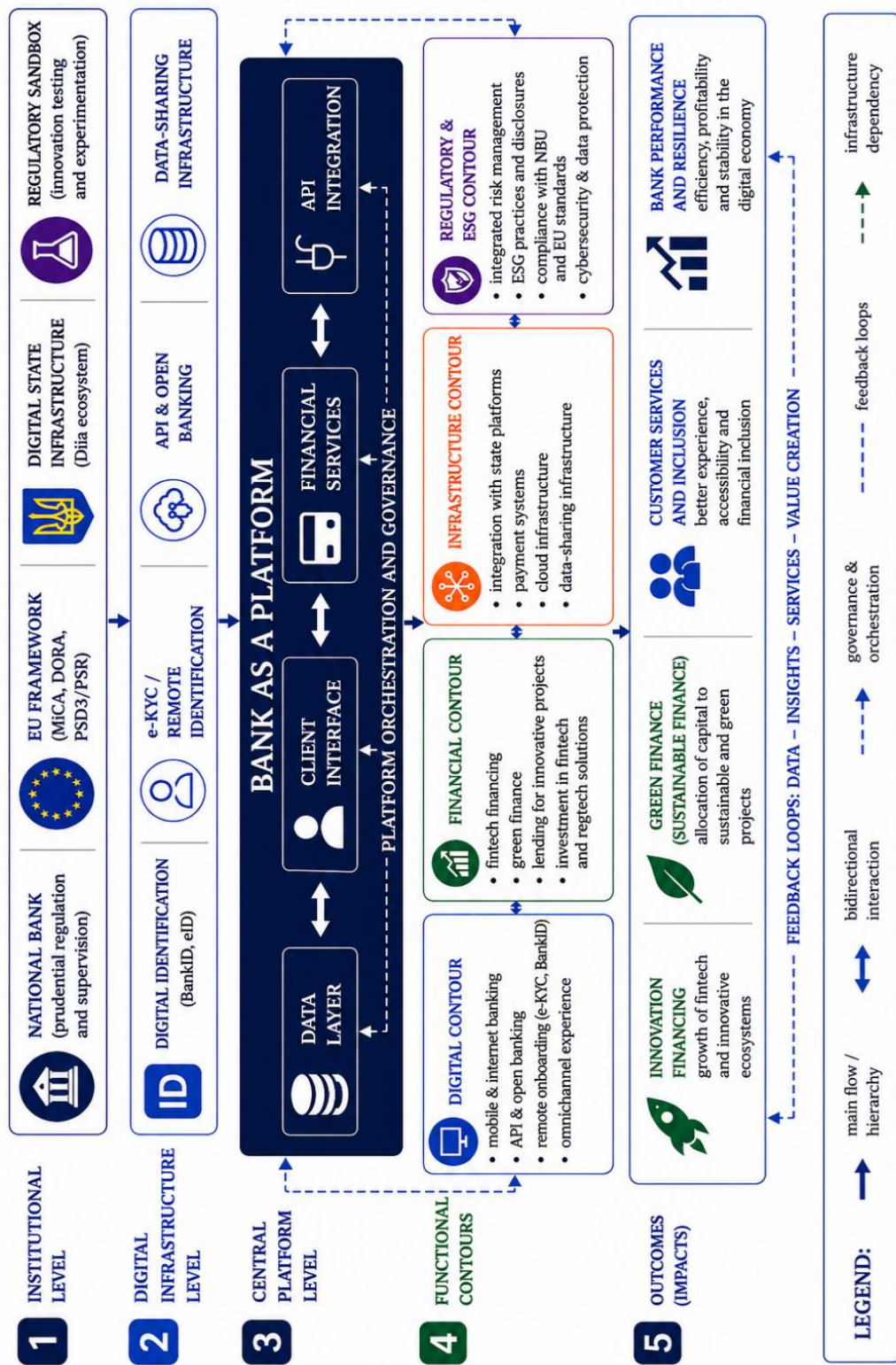


Figure 3. Bank as a platform model in the digital economy

Source: developed by the author

For the empirical verification of the role of banks in financing innovation, a panel sample of 30 banks from the European Union, the United Kingdom, and Ukraine covering the period 2020–2025 was used. The sample was formed taking into account the necessity of comparing banks with different levels of digital maturity, ESG disclosure, participation in fintech and green technology financing, and institutional integration into the digital economy. The source base of the study consists of banks’ annual reports, ESG disclosures, financial statements, open analytical databases, and regulatory materials.

To assess the digital-innovative capacity of banks, a system of variables was constructed including indicators of fintech financing, green technology financing, level of digitalisation, ESG Score, ROE, cost-to-income ratio, and bank size determined through the natural logarithm of assets. Certain indicators have a proxy character, and therefore their use requires standardisation and careful economic interpretation. The variables were normalised in order to ensure comparability between banks and jurisdictions.

Considering the latent character of bank platformisation, factor analysis using the principal component method was applied (Table 7).

Table 7

Factor loadings and statistical characteristics of the components

Indicator	Factor 1	Factor 2	Interpretation
FinTech financing	0.81	0.12	Principal driver of innovation financing
GreenTech financing	0.76	0.18	High contribution to sustainable finance
Digital Index	0.69	0.22	Reflects the level of digital integration
ESG Score	0.64	0.31	Characterises sustainability and non-financial factors
Eigenvalue	3.12	0.94	Eigenvalue of components
Explained variance	58.4%	17.6%	Share of explained variance

Source: author’s calculations

Its purpose was to determine whether the indicators of fintech financing, green technology financing, Digital Index, and ESG Score form a unified generalised characteristic of the digital-innovative capacity of the bank.

The data presented in Table 1 indicate that the first factor is characterised by an eigenvalue of $\lambda_1 = 3.12$ and explains 58.4% of the total variance. High factor loadings for the variables FinTech financing, GreenTech financing, Digital Index, and ESG Score provide grounds for interpreting it as an integrated characteristic of the digital-innovative platformisation of the bank.

The second factor possesses lower explanatory power and reflects a narrower aspect associated with selective orientation towards sustainability.

Considering the obtained results, the first factor was used as the basis for constructing the integrated index of bank platformisation. The index aggregates the influence of key variables into a unified generalised indicator and makes it possible to quantitatively compare banks according to the level of their digital-innovative capacity.

The bank platformisation index is determined by the following formula:

$$IPT_i = \sum w_j Z_{ji}, \quad (2)$$

where IPT_i is the integrated platformisation index of bank i ; w_j denotes the variable weights determined on the basis of factor loadings; and Z_{ji} represents the standardised values of the corresponding variables.

The weighting coefficients were formed on the basis of the factor loadings of the first principal component and normalised, as presented in Table 8.

Table 8

Weights used for calculating the bank platformisation index

Indicator	Factor loading of Factor 1	Normalised weight (w_j)
FinTech financing	0.81	0.28
GreenTech financing	0.76	0.26
Digital Index	0.69	0.24
ESG Score	0.64	0.22
Σ	–	1.00

Source: author's calculations

The data presented in Table 8 demonstrate that the indicators of fintech financing and green technology financing possess the largest weights within the index. This confirms their decisive role in the formation of the platform model of the bank.

At the same time, Digital Index and ESG Score are not secondary elements, since they provide the technological and non-financial basis for the participation of banks within the innovation ecosystem.

To verify the influence of platformisation on financial performance, a fixed-effects panel regression model was constructed:

$$ROE_{it} = \alpha_i + \beta_1 IPT_{it} + \beta_2 \ln(Assets_{it}) + \gamma_t + \varepsilon_{it}, \quad (3)$$

where ROE_{it} is the return on equity of bank i in period t ; α_i denotes the individual fixed effect of the bank; IPT_{it} is the bank platformisation index; $\ln(Assets_{it})$ denotes the natural logarithm of bank assets; γ_t represents time fixed effects; and ε_{it} is the error term.

The estimation results are presented in Table 9.

Table 9

**Regression model of the influence
of bank platformisation on financial performance**

Variable	Coefficient	Standard error	t-statistic	p-value
IPT	0.11	0.03	3.67	0.000***
ln(Assets)	0.04	0.02	2.10	0.036**
Constant	0.02	0.01	2.00	0.045**

Model characteristics: within $R^2 = 0.47$; number of observations = 180; number of banks = 30; study period = 2020–2025; fixed effects specification was applied.

Source: author's calculations.

Note. *** $p < 0.01$; ** $p < 0.05$

The results presented in Table 9 indicate a statistically significant positive relationship between bank platformisation and return on equity. The coefficient $\beta_1 = 0.11$ at the significance level $p < 0.01$ confirms that banks with higher levels of digital-innovative integration demonstrate a greater capacity to generate financial results. The economic explanation of this effect lies in the ability of platform banks to scale digital products more rapidly, use customer data more efficiently, expand partnership channels, reduce information asymmetry, and participate more actively in financing innovative and green-oriented projects.

The positive coefficient for ln (Assets) indicates the existence of a scale effect. Larger banks possess broader opportunities for investment in digital infrastructure, data governance, ESG analytics, and partnerships with fintech companies. At the same time, scale does not guarantee effectiveness. The decisive factor is not the size of the bank, but its ability to integrate digital, innovative, and regulatory components into a unified platform model.

Additionally, the influence of digitalisation on the operational efficiency of banks was assessed through the cost-to-income indicator:

$$CI_{it} = \alpha_i + \beta Digital_{it} + \delta \ln(Assets_{it}) + \gamma_t + \varepsilon_{it}, \quad (4)$$

where CI_{it} is the cost-to-income ratio of bank i in period t ; $Digital_{it}$ denotes the level of bank digitalisation; $\ln(Assets_{it})$ is the natural logarithm of bank assets; γ_t denotes time fixed effects; and ε_{it} is the error term.

The estimation results are systematised in Table 10.

The data presented in Table 10 indicate the existence of a statistically significant inverse relationship between the level of digitalisation and the cost intensity of banking operations. The coefficient $\beta = -0.58$ at the significance level $p < 0.01$ demonstrates that digitalisation contributes to reducing the cost-to-income ratio through automation of operations, reduction of manual data

processing, development of remote servicing, optimisation of the back office, and scaling of digital sales channels.

Table 10

**Regression model of the influence
of digitalisation on banking cost efficiency**

Variable	Coefficient	Standard error	t-statistic	p-value
Digital	-0.58	0.09	-6.44	0.000***
ln(Assets)	-0.07	0.03	-2.33	0.021**
Constant	0.68	0.12	5.67	0.000***

Model characteristics: within $R^2 = 0.47$; number of observations = 180; number of banks = 30; study period = 2020–2025; fixed effects specification was applied.

Source: Author's calculations.

*Note. *** $p < 0.01$; ** $p < 0.05$*

The obtained results confirm the existence of a dual-channel effect of digital transformation. The first channel is manifested through increased profitability resulting from platformisation, innovation financing, and the use of data. The second channel is manifested through the reduction of costs resulting from the digitalisation of the operational model of the bank. It is precisely the combination of these channels that determines the economic essence of the transition of banks towards the platform model within the digital economy.

For further specification of the results, banks were grouped according to jurisdiction, as presented in Table 11.

Table 11

Descriptive statistics of indicators by groups of banks for 2020–2025

Indicator	EU mean; 95% CI	United Kingdom mean; 95% CI	Ukraine mean; 95% CI
IPT	0.72 [0.69; 0.75]	0.68 [0.65; 0.71]	0.54 [0.50; 0.58]
Digital Index	0.75 [0.72; 0.78]	0.71 [0.68; 0.74]	0.59 [0.55; 0.63]
FinTech financing	0.78 [0.74; 0.82]	0.74 [0.70; 0.78]	0.52 [0.48; 0.56]
GreenTech financing	0.74 [0.70; 0.78]	0.69 [0.65; 0.73]	0.48 [0.44; 0.52]
ESG Score	0.77 [0.73; 0.81]	0.73 [0.69; 0.77]	0.55 [0.51; 0.59]
ROE, %	0.72 [0.69; 0.75]	0.68 [0.65; 0.71]	0.54 [0.50; 0.58]
Cost-to-income, %	0.75 [0.72; 0.78]	0.71 [0.68; 0.74]	0.59 [0.55; 0.63]

Source: author's calculations.

Note. Indicators are normalised; 95% CI denotes confidence intervals

Analysis of the data presented in Table 11 demonstrates that banks in the European Union are characterised by the highest values of the platformisation index, level of digitalisation, fintech financing, green technology financing, and ESG Score. This reflects the higher institutional maturity of the digital banking ecosystem, the development of open banking, the quality of ESG disclosure, and the systemic nature of the regulatory environment.

Banks in the United Kingdom demonstrate indicators close to those of the European Union, which is associated with the early development of open banking, flexible regulatory sandbox practices, and intense competition from fintech companies. Ukrainian banks demonstrate lower average values of IPT and ESG Score; however, they are characterised by significant growth potential owing to the development of BankID, digital services of Diia, remote identification, digital payments, and gradual convergence with European regulatory standards.

The results of regression analysis by groups of banks are presented in Table 12.

Table 12

Results of panel regression estimation by groups of banks

Indicator	EU mean; 95% CI	United Kingdom mean; 95% CI	Ukraine mean; 95% CI
IPT ROE	0.13*** [0.06; 0.20]	0.10** [0.02; 0.18]	0.08* [0.00; 0.16]
Digital CI	-0.51*** [-0.64; -0.38]	-0.55*** [-0.68; -0.42]	-0.63*** [-0.76; -0.50]
ln(Assets) ROE	0.05** [0.01; 0.09]	0.04** [0.00; 0.08]	0.03* [-0.01; 0.07]
ln(Assets) CI	-0.06** [-0.11; -0.01]	-0.07** [-0.12; -0.02]	-0.08** [-0.13; -0.03]

Model characteristics: within $R^2 = 0.45$ for the EU sample, 0.43 for the United Kingdom, and 0.39 for Ukraine. Fixed effects estimation was applied.

Source: author's calculations.

*Note. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$*

Analysis of the results presented in Table 12 demonstrates that the influence of platformisation on financial performance is most pronounced in banks within the European Union. This is associated with a higher level of integration of digital and innovative solutions into banking business models, a more developed regulatory environment, higher-quality ESG disclosure, and the maturity of digital infrastructure.

In the United Kingdom, the effect of platformisation is also statistically significant, although somewhat lower compared with the European Union. This may be explained by the more experimental character of the fintech ecosystem,

within which a significant share of digital innovations is implemented not only by banks, but also by non-bank providers. For Ukraine, the IPT coefficient is lower and statistically significant at the level of $p < 0.1$, reflecting the earlier stage of integration of the platform model into banking practice.

At the same time, it is precisely for Ukraine that the strongest inverse relationship between the Digital Index and the cost-to-income ratio has been identified. This indicates that the digitalisation of Ukrainian banks possesses substantial potential for reducing operational costs, since remote channels, process automation, digital identification, and integration with state digital platforms may replace more costly traditional servicing formats more rapidly.

To verify the reliability of the panel estimations, the Hausman test was applied to confirm the appropriateness of the fixed-effects specification, the variance inflation factor (VIF) was used to control for multicollinearity, and robust standard errors were employed taking into account potential heteroskedasticity and autocorrelation. The conducted modelling confirmed the statistical adequacy of the constructed models and demonstrated the transformation of banks into platform structures financing innovative ecosystems.

Within such a model, the bank combines financing, data processing, digital identification, ESG assessment, and risk management, whereas bank platformisation should be interpreted as an integrated characteristic of the bank's ability to participate in the digital, innovative, and green transformation of the economy.

Conclusions

The development of fintech innovations in banking represents an institutionally determined transformation of financial intermediation driven by digitalisation, platformisation, and ecosystem integration. The transition from the traditional intermediary model toward platform-based banking restructures the functional role of banks and expands their capacity to finance innovation-oriented economic development.

Fintech innovations are systematized through technological, functional, and strategic dimensions, demonstrating how digital platforms, artificial intelligence, API infrastructures, and data analytics reshape payments, lending, investment services, and customer interaction models. These transformations accelerate the integration of banks into digital financial ecosystems and redefine sources of competitive advantage within the banking sector.

A contour-dynamic model of fintech innovation development conceptualizes the interaction between technological, regulatory, risk, and managerial dimensions. The proposed framework explains the sequential transformation of banking business models and indicates that fintech effectiveness depends on

the coherence between institutional environments, technological infrastructure, and adaptive governance mechanisms.

Comparative analysis of regulatory architectures in the European Union, the United Kingdom, the United States, and Ukraine indicates that the scale and intensity of fintech development are determined by the flexibility and adaptability of regulatory environments. Regulatory sandboxes coordinated institutional frameworks, and adaptive supervisory instruments increasingly function as mechanisms for balancing financial innovation and systemic stability.

Digital public infrastructure acts as a fundamental institutional enabler of fintech development. Digital identification systems, e-KYC mechanisms, open banking infrastructures, and data-sharing platforms reduce transaction costs, improve access to financial services, and strengthen the integration of banks into digital ecosystems.

The integration of ESG factors into banking models reflects the transition toward multidimensional approaches to financial intermediation that combine sustainability, cyber resilience, ethical governance, and risk management. In this context, ESG-oriented regulation becomes an integral component of digital banking transformation rather than an external compliance mechanism.

Banks are increasingly transforming into platform-based institutional structures that combine financing, data processing, digital identification, ESG assessment, and risk management functions. In such a model, platformisation represents an integrated characteristic of a bank's capacity to participate in the digital, innovative, and green transformation of the economy.

The transformation of banks into platform-based institutional structures indicates that the future competitiveness of banking systems will increasingly depend on the ability to integrate digital infrastructure, regulatory adaptability, ESG-oriented governance, and innovation financing mechanisms within unified financial ecosystems.

References:

1. ABN AMRO. Why EU banks' Green Asset Ratios may mislead on green alignment. Available at: <https://www.abnamro.com/research/en/our-research/esg-strategist-why-eu-banks-green-asset-ratios-may-mislead-on-green> (accessed: 28.04.2026).
2. Agnese P., Giacomini E. (2023) Bank's funding costs: Do ESG factors really matter? *Finance Research Letters*, vol. 51, article 103437. DOI: <https://doi.org/10.1016/j.frl.2022.103437>
3. Anagnostopoulos I. (2018) Fintech and regtech: Impact on regulators and banks. *Journal of Economics and Business*, vol. 100, pp. 7–25. DOI: <https://doi.org/10.1016/j.jeconbus.2018.07.003>

4. Bank for International Settlements. Sound practices: Implications of fintech developments for banks and bank supervisors. 2019. Available at: <https://www.bis.org/bcbs/publ/d431.htm> (accessed: 02.05.2026).
5. Bank for International Settlements. Annual Economic Report 2023. 2023. Available at: <https://www.bis.org/publ/arpdf/ar2023e.htm> (accessed: 02.05.2026).
6. Basel Committee on Banking Supervision. Principles for operational resilience. 2021. Available at: <https://www.bis.org/bcbs/publ/d516.htm> (accessed: 02.05.2026).
7. Benthabet S. (2025) When ESG meets cybersecurity: The moderating effect of digital protection on bank performance in MENAT countries. *International Journal of Economics and Financial Issues*, vol. 15, no. 6, p. 356–370. DOI: <https://doi.org/10.32479/ijefi.21354>
8. Broby D. (2021) Financial technology and the future of banking. *Financial Innovation*, vol. 7, article 47. DOI: <https://doi.org/10.1186/s40854-021-00264-y>
9. Choi J., Dynes M., Erande Y., Rosioru D. Taking digital banking beyond customer journeys. Boston Consulting Group. 2022. Available at: <https://www.bcg.com/publications/2022/customer-value-and-banking-in-the-digital-age> (accessed: 30.04.2026).
10. Citterio A., King T., Locatelli R. (2024) Is digital transformation profitable for banks? *Finance Research Letters*, vol. 70, article 106269. DOI: <https://doi.org/10.1016/j.frl.2024.106269>
11. Diia. Document sharing. Available at: <https://integration.diia.gov.ua/en/sharing.html> (accessed: 28.04.2026).
12. European Banking Authority. Guidelines on the management of ESG risks. 2023. Available at: <https://www.eba.europa.eu/activities/single-rulebook/regulatory-activities/sustainable-finance/guidelines-management-esg-risks> (accessed: 05.05.2026).
13. European Banking Authority. The EBA publishes key indicators on climate risk in the EU/EEA banking sector. 2025. Available at: <https://www.eba.europa.eu/publications-and-media/press-releases/eba-publishes-key-indicators-climate-risk-eueea-banking-sector> (accessed: 05.05.2026).
14. European Central Bank. The digitalisation of banks and the banking sector. 2024. Available at: <https://www.ecb.europa.eu> (accessed: 05.05.2026).
15. European Commission. Commission Delegated Regulation (EU) 2021/2178 supplementing Regulation (EU) 2020/852 as regards disclosure requirements under Article 8 of the Taxonomy Regulation. 2021. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32021R2178> (accessed: 05.05.2026).
16. European Union. Regulation (EU) 2022/2554 on digital operational resilience for the financial sector (DORA). 2022. Available at: <https://eur-lex.europa.eu/eli/reg/2022/2554/oj> (accessed: 05.05.2026).
17. European Union. Regulation (EU) 2022/858 on a pilot regime for market infrastructures based on distributed ledger technology. 2022. Available at: <https://eur-lex.europa.eu/eli/reg/2022/858/oj> (accessed: 05.05.2026).

18. European Union. Regulation (EU) 2023/1114 on markets in crypto-assets (MiCA). 2023. Available at: <https://eur-lex.europa.eu/eli/reg/2023/1114/oj> (accessed: 05.05.2026).
19. Feyen E., Frost J., Gambacorta L., Natarajan H., Saal M. (2021) Fintech and the digital transformation of financial services: Implications for market structure and public policy. *BIS Papers*, no. 117. Available at: <https://www.bis.org/publ/bppdf/bispap117.pdf> (accessed: 02.05.2026).
20. Financial Conduct Authority. Regulatory sandbox. 2023. Available at: <https://www.fca.org.uk/firms/innovation/regulatory-sandbox> (accessed: 05.05.2026).
21. Financial Stability Board. Financial stability implications from fintech. 2017. Available at: <https://www.fsb.org/wp-content/uploads/R270617.pdf> (accessed: 02.05.2026).
22. FlowForma. How to automate customer onboarding in banking. Available at: <https://www.flowforma.com/demo-library/how-to-automate-customer-onboarding-in-banking-explained> (accessed: 30.04.2026).
23. Gomber P., Koch J.-A., Siering M. (2017) Digital finance and fintech: Current research and future research directions. *Journal of Business Economics*, vol. 87, p. 537–580. DOI: <https://doi.org/10.1007/s11573-017-0852-x>
24. Hamdouni A. (2025) From ESG to financial stability: Unpacking the multi-dimensional impact of AI-enabled fintech in banking. *International Journal of Financial Studies*, vol. 13, no. 4, article 234. DOI: <https://doi.org/10.3390/ijfs13040234>
25. Hornuf L., Klus M., Lohwasser T., Schwienbacher A. (2020) How do banks interact with fintech startups? *Small Business Economics*, vol. 57, p. 1505–1526. DOI: <https://doi.org/10.1007/s11187-020-00359-3>
26. International Monetary Fund. Fintech and financial services: Initial considerations. 2022. Available at: <https://www.imf.org/en/Publications> (accessed: 30.04.2026).
27. Kaur J. (2024) Digital banking as a catalyst for sustainable finance: Promoting ESG principles in India. *Journal of Risk and Financial Management*, vol. 17, no. 3, article 102. DOI: <https://doi.org/10.3390/jrfm17030102>
28. Kruhliakova V. V. (2025) Compliance-polityka bankivskoho sektoru Ukrainy: Suchasni tendentsii ta vyklyky. *Finansy i pidpriemnytstvo*, no. 2(56). DOI: [https://doi.org/10.30970/fp.2\(56\).2025.107118119](https://doi.org/10.30970/fp.2(56).2025.107118119)
29. Manu F. M. M. M., Rajendran N. (2025) Digital Banking and Sustainability: A Decade of Research Through Bibliometric Mapping. *International Journal on Science and Technology (IJSAT)*, vol. 16, no. 4, p. 811. DOI: <https://doi.org/10.71097/IJSAT.v16.i4.8688>
30. Ministry of Digital Transformation of Ukraine. Integration Diia platform. Available at: <https://integration.diia.gov.ua/index.html> (accessed: 28.04.2026).
31. National Bank of Ukraine. Strategy of fintech development in Ukraine until 2025. 2020. Available at: https://bank.gov.ua/admin_uploads/article/Strategy_finteh2025.pdf (accessed: 07.05.2026).
32. National Bank of Ukraine. BankID NBU. Available at: <https://bank.gov.ua/en/bank-id-nbu> (accessed: 07.05.2026).

33. National Bank of Ukraine. E- hryvnia. Available at: <https://bank.gov.ua/en/payments/e-hryvnia> (accessed: 07.05.2026).
34. National Bank of Ukraine. Consumer protection of financial services. Available at: <https://bank.gov.ua/ua/consumer-protection> (accessed: 07.05.2026).
35. OECD. Artificial intelligence in finance: Market developments and financial stability implications. OECD Publishing. 2021. Available at: <https://www.oecd.org/finance/artificial-intelligence-finance.htm> (accessed: 30.04.2026).
36. Philippon T. (2019) On fintech and financial inclusion. *NBER Working Paper*, no. 26330. DOI: <https://doi.org/10.3386/w26330>
37. Prenio J., Broeders D. Innovative technology in financial supervision (SupTech): The experience of early users. Bank for International Settlements. 2018. URL: <https://www.bis.org/fsi/publ/insights9.htm> (accessed: 02.05.2026).
38. Renz J., Robert N. From ESG Scores to Bank Performance: A Quantitative Study Examining the Impact of ESG Performance on Financial Outcomes: Evidence from EU Listed Banks: dissertation. 2025. URL: <https://urn.kb.se/resolve?urn=urn:nbn:se:hj:diva-68246> (accessed: 30.04.2026).
39. Rogers E. M. (2003) Diffusion of innovations. 5th ed. New York : Free Press, 576 p.
40. Tanveer M. (2026) FinTech-enabled digital transformation for sustainable performance: the strategic role of dynamic capabilities. *Frontiers in Human Dynamics*, vol. 8. DOI: <https://doi.org/10.3389/fhumd.2026.1747642>
41. Thakor A. V. (2020) Fintech and banking: What do we know? *Journal of Financial Intermediation*, vol. 41, article 100833. DOI: <https://doi.org/10.1016/j.jfi.2019.100833>
42. Zhu Y., Jin S. (2025) The impact of bank digital transformation on financial performance. *SAGE Open*, vol. 15, no. 3. DOI: <https://doi.org/10.1177/21582440251365342>