

METHODOLOGICAL FOUNDATIONS OF DIGITALIZATION AND ECONOMETRIC MODELING OF COMMERCIAL BANKING ACTIVITIES

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Abstract. This article highlights the importance of introducing digital technologies and blockchain systems in increasing the efficiency of innovative processes in the activities of commercial banks and ensuring competitiveness. The role of modern information technologies, in particular blockchain platforms, in the process of digitizing the bank lending system, their functional capabilities, level of security and efficiency of use are analyzed. The article also details the trends in the digitalization of the economy, the spread of mobile and Internet services, the share of the ICT sector in GDP, and the development of e-commerce. The need to use economic and mathematical (econometric) models in assessing and forecasting economic processes is substantiated.

Keywords: commercial banks, digital transformation, innovative activity, blockchain technology, digitization of credit policy, fintech, econometric modeling, digital economy.

TIJORAT BANKLARI FAOLIYATINI RAQAMLASHTIRISH VA EKONOMETRIK MODELLASHTIRISHNING METODOLOGIK ASOSLARI

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Annotatsiya. Ushbu maqolada tijorat banklari faoliyatida innovatsion jarayonlarning samaradorligini oshirish va raqobatbardoshlikni ta'minlashda raqamli texnologiyalar va blockchain tizimlarini joriy etishning ahamiyati yoritilgan. Bank kreditlash tizimini raqamlashtirish jarayonida zamonaviy axborot texnologiyalarining, xususan, blokcheyn platformalarining roli, ularning funksional imkoniyatlari, xavfsizlik darajasi va foydalanish samaradorligi tahlil qilingan. Shuningdek, maqolada iqtisodiyotni raqamlashtirish tendensiyalari, mobil va internet xizmatlarining kengayishi, AKT sektorining YaIMdagi ulushi va elektron savdo rivojlanishi batafsil yoritilgan. Iqtisodiy jarayonlarni baholash va prognoz qilishda iqtisodiy-matematik (ekonometrik) modellardan foydalanish zarurligi asoslab berilgan.

Kalit so'zlar: tijorat banklari, raqamli transformatsiya, innovatsion faoliyat, blockchain texnologiyasi, kredit siyosati raqamlashtirilishi, fintex, ekonometrik modelashtirish, raqamli iqtisodiyot.

МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ЦИФРОВИЗАЦИИ И ЭКОНОМЕТРИЧЕСКОЕ МОДЕЛИРОВАНИЕ ДЕЯТЕЛЬНОСТИ КОММЕРЧЕСКИХ БАНКОВ

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Аннотация. В статье подчеркивается важность внедрения цифровых технологий и блокчейн-систем в повышении эффективности инновационных процессов в деятельности коммерческих банков и обеспечении конкурентоспособности. Анализируется роль современных информационных технологий, в частности блокчейн-платформ, в процессе цифровизации системы банковского кредитования, их функциональные возможности, уровень безопасности и эффективность использования. В статье также подробно рассматриваются тенденции цифровизации экономики, распространение мобильных и интернет-сервисов, доля сектора ИКТ в ВВП, развитие электронной коммерции. Обосновывается необходимость использования экономико-математических (эконометрических) моделей при оценке и прогнозировании экономических процессов.

Ключевые слова: коммерческие банки, цифровая трансформация, инновационная деятельность, блокчейн-технологии, цифровизация кредитной политики, финтех, эконометрическое моделирование, цифровая экономика.

Introduction.

In accordance with the rapidly changing operating conditions, any bank is forced to change itself, becoming a full-fledged participant in the market, initiating intra-organizational innovation processes. Of course, these processes should not occur spontaneously - they should be systematically carried out within the framework of a developed innovation strategy, which is part of the bank's overall development strategy. Currently, one of the main factors of successful banking is a policy of constant innovation. This conclusion follows from a number of assumptions characterizing the current state of the economy. First, the bank's relationship with clients is based on the principles of partnership. This means, in particular, that banks constantly take care not only of preserving, but also of increasing the capital of their clients, offering new services that contribute to the expansion of financial and economic activities, reducing costs, developing business activity and increasing its profitability.

Innovations are a very important factor in the stability of the functioning of banks and ensure their economic growth. The choice of any strategy, like innovation, always involves the creation of a separate organizational and economic mechanism that ensures its implementation. Its direction, features of operation and structural structure largely depend on the specifics of the innovation processes, which are determined by the typology of innovations that prevail in the process of the bank's innovative activity.

Effective management and analysis of innovative activities in commercial banks requires an accurate and scientifically based assessment of the dynamics of economic processes. In this case, many factors, such as the bank's innovation strategy, the level of technological development, and improving the quality of customer service, are interconnected and complex. Therefore, it is necessary to conduct a systematic analysis using econometric modeling to assess and optimize innovative processes in the banking sector.

The need for econometric modeling in the development of the production process of innovative products in commercial banks is reflected in the following:

- Developing reasonable forecasts for the future financial indicators, liquidity levels, and risk levels of commercial banks;
- Developing recommendations for the effective management of commercial banks, resource allocation, and optimization of credit policy;

- Developing risk models to assess the risk of customer default, financial losses, and the impact of market uncertainties on bank activities;

Literature review.

Several regulatory legal documents and scientific approaches to improving the lending process in commercial banks have been cited in the scientific literature. In particular, according to the legal framework of the banking system of the Republic of Uzbekistan, in accordance with the Regulation "On Requirements for the Credit Policy of Commercial Banks": "The credit policy of a bank is a set of measures and methods adopted by the bank's management in managing the risk arising from the lending process, as well as the bank's management and employees in order to effectively manage the credit portfolio. is a document that provides guidance on management. The credit policy must clearly indicate and define the goals of the bank's credit activities. "The description of the credit policy is determined depending on the size of the credit portfolio and the economy of the region in which the bank operates. It is noted that when forming a credit strategy and implementing a credit policy, the bank must take these factors into account.

Also, in a number of economic scientific research works, there are different opinions on describing the economic essence of a bank with state participation. That is, a bank with state participation: According to Azriliyan, it is understood as a bank that is partially or fully owned by the national capital and operates from its interests. According to Babayev, banks in which the country participates as a shareholder, according to Beloglazova, the authorized capital of which is fully or partially owned by the state A large financial institution that is affiliated with and supported by the country in various ways. Commercial banks are described as financial institutions that aim to make a profit in exchange for taking advantage of the country's privileges in certain areas. The use of the complete model of the banking system developed by Egorova and Smulov in modeling the optimal management of the lending process serves as the basis for solving this problem.

Research methodology.

In the current global economic environment, the use of accurate and scientifically based analytical methods for the effective organization and strategic management of commercial banks is becoming increasingly important. The fact that banking is a multifactorial, dynamic and sensitive system to external influences requires the introduction of scientifically based economic and mathematical models, i.e. econometric modeling, in assessing its effectiveness and sustainability, not limited to simple analytical methods.

Econometric modeling of commercial banks' activities primarily allows for an accurate and objective assessment of the banks financial stability, liquidity level, loan portfolio quality, customer base growth, and innovative activity results. Such models identify the relationships between factors affecting the activities of banks, analyze the impact of internal and external shocks, and develop sound forecasts for future development. In the econometric analysis of economic processes, it is necessary to generate statistical data, which is based on official bank reports, central bank data, and financial market statistics. The use of time series and panel data models is important in analyzing the dynamics of banking activities. At the stage of selecting the model type and technical methods, methods such as multivariate regression models, vector autoregression (VAR), vector error correction models (VECM), or logit and probit models are used. The method of mean squares (OLS), generalized mean squares (GLS), and likelihood methods (MLE) are used to estimate the model parameters. Diagnostic tests such as multicollinearity (VIF), heteroskedasticity (Breusch-Pagan test), and autocorrelation (Durbin-Watson test) are also performed to ensure the reliability and adequacy of the model.

Analysis and discussion of results.

Currently, the consistent introduction of digital technologies into economic and social spheres around the world is having a strong impact, first of all, on the financial market. Therefore, the world economy is increasingly undergoing a process of international digital transformation. This technological transformation process is called digitization. The main goal of implementing the digitization process is to achieve high economic efficiency as a result of providing customers with modern, high-quality and safe financial services. To this end, the banking system in the Republic of Uzbekistan is being improved on the basis of modern digital technologies to a high-quality level that meets the technological requirements of our national digital economy.

Digital transformation contributes to the evolutionary development of business models, the introduction of modern conceptual solutions in the banking system, from the improvement of Internet banking technologies to the maximum transformation of traditional monetary and credit operations. The introduction of digital innovative technologies into banks and financial institutions is the main mechanism for ensuring sustainable and long-term growth in their effective activities. Also, the process of digitization is one of the modern strategic priorities of banking and lending technologies in the world economy.

Therefore, the application of modern digital technologies to bank lending is the basis for providing high-quality and safe lending services. However, the lack of a clear methodology and concepts for implementing the digitization process of commercial banks' lending sectors can lead to a decrease in the efficiency and slowdown of the digitization process. For this reason, we need to pay attention to the following issues in the digitization of economic processes.

- Research into the fundamental theoretical foundations of the digitization process of commercial banks;
- Develop theoretical methodological foundations for the classification, clustering and use of scientific directions, theories, concepts, models and methods necessary for the digitalization of the lending system of commercial banks;
- Identify effective information technology tools necessary for the digitalization of the economic process based on scientific methodology. That is, to fully cover this process, identify software environments that fully implement its parameters and calculation processes, cluster them, and study methodological conceptual foundations for them;
- Develop conceptual models for the identification and use of effective information security tools for the implementation of secure financial services in commercial banks;
- Analyze modern financial technologies used to improve the efficiency of the lending process of commercial banks, and form methodological foundations for their implementation;

From the above issues, it can be understood that it is necessary to study the theoretical and methodological foundations for the implementation of the process of effective digitalization of the activities of commercial banks.

Therefore, this paragraph aims to study the theoretical, methodological and conceptual foundations necessary for the digitalization of commercial banks. To achieve this goal, it is necessary to understand the essence of the digitalization process and study the factors affecting it. The process of introducing innovative technologies and digitization in the banking and financial sectors has been widely studied by banks, financial institutions and researchers for many years and has led to significant innovative results. Therefore, it is necessary to study the main factors and developments in improving the lending systems of commercial banks and introducing digital technologies. The evolution of the digitization and introduction of innovative technologies in the commercial banking sector is presented in the table below (Table 1).

Table 1.

The evolution of digitalization of banking systems

Developmental periods	Development stage	Developmental stage classification
I-period	Production and introduction of plastic cards of commercial banks	Creates opportunities for the development of retail banking services and the improvement of the financial sector
II-period	Development and introduction of new technologies for using plastic cards of commercial banks and ATMs	It allows customers to use banking services remotely. This allows banking organizations to use these banking services in areas outside of their borders.
III-period	The emergence of electronic trading platforms, stock exchanges (NASDAQ)	The introduction of the Internet and modern network technologies has contributed to the development of financial markets and stock exchanges. This has created the opportunity for banks and financial institutions to expand their remote services.
IV-period	Benefits and implementation of Fintech technologies	Fintech (Financial technology) is an institution that introduces modern technologies to improve the financial sector and develops new financial technologies. The development of Fintech financial technologies has created opportunities for the emergence of projects that compete with traditional banking services and an increase in the volume of bank financial transactions.
V-period	Improving financial sector digitalization systems	Widespread introduction of internet technologies and digital innovations in the banking and financial sectors
VI-period	Introduction of blockchain technology	The creation and implementation of cryptocurrencies, crypto exchanges, and crypto lending technologies based on blockchain technology to improve the financial sector

In particular, if we look at the scientific research works of such world scientists as Chen and Liao, Antonopoulos, Thomas, Golovenchik, Yegorova, Smulov, Koroleva, Bukharin, we can see the approaches of various researchers to understanding the essence of digitization and innovation. Summarizing the studied approaches, it can be seen that the digitization of commercial banks' lending systems is inextricably linked to the following scientific areas (Table 2).

In the digitalization of the financial sector, integration between the scientific fields listed in Table 2 is of great importance. It is necessary to study the issues, problems, methods and algorithms necessary for the implementation of the economic digitalization process of these scientific areas. The results of the research can be used to develop theoretical methodologies and concepts for the development of the digital economy. A conceptual model for using models and methods of scientific fields in improving the digital economy. The process of digitizing the economy cannot be implemented without using the theoretical and practical achievements of mathematics, applied mathematics and computer science. Therefore, scientific research is being conducted by world scientists to improve the digitization process. From these research works, it can be understood that the role of not only economic scientific fields, but also mathematical sciences is invaluable in the digital economy.

Table 2.

Scientific fields that are inextricably linked to the digitalization of economic sectors

Scientific fields	Stage 1	Stage 2	Stage 3
Applied mathematics	Mathematical modeling of economic processes	Identifying errors in economic and mathematical models	Evaluation of economic-mathematical models
Information Technology (Informatics)	Development of financial blockchain platform architecture and creation of blockchain models	Identify and program blockchain model programming tools	Identify the technical tools required to implement blockchain software tools
Information Security (Cryptography and Cryptanalysis))	Studying methods for ensuring information security in financial software	Selecting, modifying, and creating new cryptographic methods that are resistant to cryptography	Cryptanalysis of existing cryptographic algorithms, modifications, and new methods using cryptanalysis techniques
Statistics	Collecting, analyzing, and generalizing units of a set using special methods	Statistical inference is the evaluation of predictions about the population and some other generalizations based on the information that makes up the sample.	Determining the level of confidence, i.e. the degree of uncertainty associated with a statistical conclusion
Econometrics	Identifying factors influencing the digitalization of financial processes	Conducting econometric modeling and computational experiments	Econometric model evaluation, economic analysis

Nowadays, information technologies are becoming an integral part of most sectors of society and people's lifestyles, which also affects the economic relations between them. In particular, according to the Statistics Committee of the Republic of Uzbekistan, the indicators of the provision of mobile communication devices to the population of our country were 63.4 units per 100 permanent residents in 2013, while this indicator was 89.7 units according to 2022 data (Table 3). That is, over the past ten years, the provision of mobile communication devices to the population of our republic has increased by almost 29.31 percent (Figure 4).

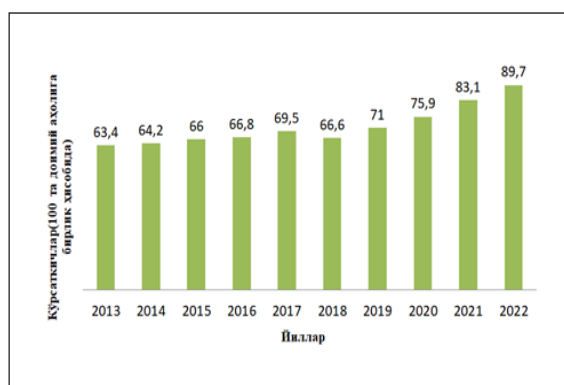


Figure 1. Indicators of mobile communication coverage of the population of the Republic of Uzbekistan (per 100 permanent population units)

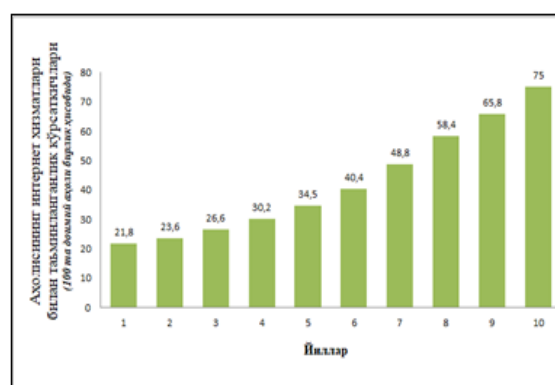


Figure 2. Internet service coverage indicators for the population of the Republic of Uzbekistan (per 100 permanent population units)

From these indicators, it should be understood that 89.7 percent of the population of our country uses mobile devices. To determine their indicators of use of mobile financial services, it is first necessary to study the level of provision of this population with Internet services. The level of provision of the population of the Republic of Uzbekistan with Internet services is presented below (Table 3).

Table 3.

Indicators of provision of mobile communication and Internet services to the population of the Republic of Uzbekistan, (per 100 permanent population units)

Years	Indicators of the population's access to mobile communication devices	Indicators of population coverage of Internet services
2013	63,4	21,8
2014	64,2	23,6
2015	66	26,6
2016	66,8	30,2
2017	69,5	34,5
2018	66,6	40,4
2019	71	48,8
2020	75,9	58,4
2021	83,1	65,8
2022	89,7	75

According to the data presented in Table 3, the rate of provision of Internet services to the population of our country was 21.8 per 100 permanent residents in 2013, and this figure reached 75 in 2022. Compared to 2013, in 2017 it increased by 36.8 percent, and by 2022 this figure reached almost 72 percent. From the data presented in the table above, it can be understood that by 2022, 75 percent of the population of our Republic will be connected to the Internet and use the services of this technology (Figure 5). In this regard, we can see in the table below that the increase in the number of mobile communication devices is inextricably linked to the provision of Internet services (Table 4).

Table 4.

The dependence of mobile communication coverage on Internet service indicators.

The relationship between the level of access to the Internet and mobile communication devices among the population	Indicators of population coverage with mobile communication devices	Indicators of the population's access to Internet services
Indicators of population coverage with mobile communication devices	1	0,9573638
Indicators of the population's access to Internet services	0,9573638	1

Table 4 shows that the correlation coefficient between the availability of mobile communication devices and the indicators of Internet services is $R=0.957363$. This indicates that the increase in mobile communication devices has a strong impact on the increase in the efficiency of Internet services. Also, currently, the gross added value of the ICT economy and e-commerce in the GDP of the Republic is increasing in our country (Table 5).

Table 5.

Share of the information economy and e-commerce sector in the GDP of the Republic of Uzbekistan (billion soums)

Information economy and e-commerce sector						
	ICT production	ICT trade	ICT services	Content sector and media	E-commerce	The size of the digital economy
2015	141,7	140,8	3 299,20	294,6	x	3876,3
2016	127,2	228	4 220,10	392,4	x	4967,7
2017	238,3	281,6	5 329,10	518,7	10,1	6377,8
2018	301,9	236,2	6 338,70	750,1	105,2	7732,1
2019	279,4	293,3	6 750,30	908,9	260	8491,9
2020	540,1	252,3	8 303,50	1 089,70	591,4	10777
2021	630,3	367,8	10 696,40	1 464,60	3 907,30	17066,4
2022	680,6	402,6	12695,5	1854,4	5425,8	20165,7

According to the data presented in Table 1.1.5, the ICT economy in our country amounted to 141.7 billion soums in 2015, and in 2022 the ICT industry increased by almost 4.8 times and amounted to 680.6 billion soums. The value of ICT trade increased by 287.5 percent compared to 2015, ICT services by 384.8 percent, and the media sector by 629.4 percent. Also, the statistics for 2015 do not provide indicators of the share of e-commerce in GDP. This is because the formation of e-commerce projects, startups and other innovative projects in our country is at an early stage. The share of e-commerce in GDP amounted to 10.1 billion soums by 2017, and this indicator increased by 542.5 times in 2022. At the same time, the share of e-commerce in GDP in our country is 0.6 percent.

We can model the impact of the digitization of the banking systems of the Republic of Uzbekistan on the size of the digital economy using multivariate linear econometric modeling as follows.

$$\hat{Y} = 439.4 + 5.33 \cdot X_1 + 6.10 \cdot X_2 + 0.36 \cdot X_3 + 2.27 \cdot X_4 + 0.92 \cdot X_5 \quad (1)$$

where, Y - The size of the digital economy, X_1 - ICT production, X_2 - ICT trade, X_3 - ICT services, X_4 - Content sector and media, X_5 - E-commerce.

In order to identify the factors affecting the growth of the digital economy in Uzbekistan and assess the level of their impact, a correlation and regression analysis was conducted based on data for the period 2015–2022. In this analysis, the “volume of the digital economy” (Y) was used as the independent variables, and the indicators of ICT production (X_1), ICT trade (X_2), ICT services (X_3), content and media (X_4) and e-commerce (X_5) were taken. The results of the analysis show that the volume of the digital economy is highly correlated with all factors. In particular, the correlation coefficient with the indicators of ICT services and e-commerce is higher than 0.95, indicating that they are decisive factors in the development of the digital economy.

The model results indicate that ICT trade and e-commerce sectors have the greatest impact on the size of the digital economy. T-statistics and p-value analyses for e-commerce confirmed that this variable is statistically significant ($p < 0.05$). Other factors also have a positive effect, but due to the limited sample size, not all of them were statistically significant. The coefficient of determination (R^2) is 0.999, which means that the model can explain 99.9 percent of the real data. This indicates that the model is of high quality and that the analyzed factors are the main drivers of the growth of the digital economy. The model was also found to be statistically significant according to the overall F-statistic ($p < 0.01$).

Residual analysis shows that there are no signs of autocorrelation and heteroscedasticity, which ensures the stability and reliability of the model.

Conclusion and suggestions.

In conclusion, the key factors in ensuring the growth of the digital economy in Uzbekistan, especially in the areas of ICT services, e-commerce and content media, are the following. Also, attracting investment to the private sector, improving the processes of lending and digitization of financial services will provide an opportunity to further develop the digital economy and increase its share in GDP.

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