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# DEVELOPMENT OF RETAIL BANKING SERVICES IN THE CONTEXT OF DIGITAL TRANSFORMATION

## ABSTRACT

The article examines retail banking services, their importance and how they are improving in the context of digital transformation. In the article, using the data of 14 commercial banks in Uzbekistan, the number of observations is 280. The dependent variable is the deposit practice of commercial banks, the independent variables are the credit practice of commercial banks, the remote services of commercial banks and the practice of commercial banks with plastic cards, analyzed through several models.

The research shows that when we analyze 3 models based on panel data, the Random effects estimator (REE) model econometric equation of the impact of retail banking services development practices in the national economy today is  $Y=0.59x1+0.08x2+0.22x3-1.66$  is the most optimal model. Accordingly, regarding the choice between the Fixed effects estimator (FEE) model and the Random effects estimator (REE) model, the Hausman test is used to determine which model is more suitable. The test compares the estimates from two models and tests whether the difference between them is statistically significant. If the p-value of the test is greater than the significance level (usually 0.05), then the Random effects estimator (REE) model is preferred because it allows for unobserved heterogeneity not accounted for in the Fixed effects estimator (FEE) model.

In this case, the p-value of the Hausman test is equal to 0.36, which is greater than 0.05. We use the Random effects estimator (REE) model to analyze the impact of the practice of developing retail banking services in the national economy today based on panel data. We came to the conclusion that it is suitable.

**Keywords:** retail banking services, FinTech, banking products, mobile banking, plastic card, deposit, bank loans

**JEL Classification:** E2, E5, C58, G20, G21, L81

## INTRODUCTION

Globally, in recent years, the banking industry has been providing its customers with an improved digital banking experience with new technologies, products and partnerships. The banking industry is investing heavily in digital transformation opportunities and solutions to uncertain economic realities. Although the banking industry seems to understand what it takes to compete with alternative digital banking providers and meet the needs of an increasingly demanding consumer, it is wary of fully digitizing banking services. Often, traditional banks are reluctant to introduce digital banking services due to fear of risk or to reduce costs. Historically, banks have done so by expanding their branch network to expand coverage and brand strength. However, due to increased demand for contactless services during the pandemic, digital services have grown exponentially, and digital FinTech firms have risen to the top by offering convenience and security to customers and bank employees.

In line with global practice, banks have closed many branches to reduce operating costs and cope with increased pressure as consumers increasingly use online channels during the COVID-19 pandemic. Banks are constantly strategizing about smart branch networks to optimize customer relationships and costs while providing convenient access to banking services in all regions. In particular, the European Central Bank reported that

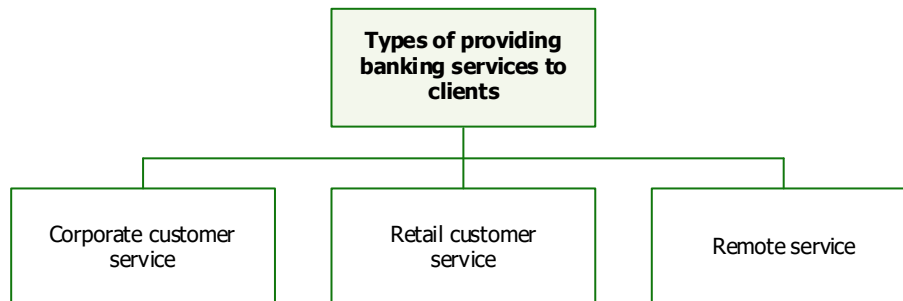
in the first half of 2022, the cost-income ratio (CIR) of European banks was higher than 60% [1]. At the same time, J.P. Morgan, Citibank, Morgan Stanley, Goldman Sachs and Wells Fargo banks of the USA also had a high CIR coefficient [2]. A lower CIR ratio indicates that banks are spending less per dollar of income. In particular, although the attitude of customers towards banking activities is changing, bank branches are still gaining actual importance. In particular, based on the results of a survey conducted by the World Retail Banking Report 2022, 75 per cent of bank customers considered bank branches to be important. In total, 64% of bank customers are interested in self-service options, 44% are interested in expanding customer interaction areas in their branch, and 31% are interested in deeper Augmented Reality (AR) and Virtual Reality (VR) experiences [3].

## LITERATURE REVIEW

Most of the bank's clients are individuals, and their number is increasing year by year. Traditional methods of providing them with fast and quality offline service are associated with high costs for today's banks. In such conditions, the need for remote organization of automated and digitized modern banking services to a large number of people is increasing, which encourages banks to make extensive use of digital technologies, to integrate the database with the database of relevant state bodies and other organizations. This creates a strong competitive environment for banks. That is, it is necessary to introduce new digital services that meet the demands of bank customers, to be among the first to introduce innovative banking services, and to introduce services based on FinTechs and automated systems.

Retail banking services are a generalized set of banking services provided to individuals directly or indirectly through a network of bank branches [4]. Customer satisfaction is considered an important attribute of establishing a customer's business relationship with a bank and is considered an effective customer-centric marketing approach in today's business environment used by many successful businesses worldwide. In order to excel in today's fiercely competitive business environment and build a loyal customer base, today's banks must model their retail banking services at a level that guarantees customer satisfaction [5].

In our opinion, it is appropriate to divide the bank services into the following types:



**Figure 1. Types of providing banking services to clients.**

In addition to the above, a number of banking products and services of banks can be distinguished under retail banking services. Among them, operations on personal accounts, lending, bank cards, various transfers, working with safe deposit boxes, working with precious metals, working with foreign currency and preferential service for communal services, can be distinguished.

Along with the development of the banking services market, digitization and remote provision of retail banking services (electronic banking) began to be introduced. Electronic banking is a high-order device consisting of several supply channels. It is worth noting that, although the general type of electronic banking in our time is online banking, in other words, internet banking, electronic banking is a bigger platform than Internet banking. The term electronic banking can be interpreted in different ways. The simplest is the provision of information and services by the bank to its customers through a computer, special television, telephone, or mobile communication device [6], for example, electronic communication between the bank and the customer for the purpose of preparation, management and control of financial transactions. Internet banking allows customers to access bank accounts and make bank transfers. The early stages of Internet banking were called transactional online banking because they included the provision of tools such as accessing accounts, transferring funds, and purchasing financial services and products [7]. Internet banking and electronic banking are cited as one concept in most literature. Nowadays, internet banking is considered one of the most important channels of electronic banking. Internet banking allows customers to use their bank and an account that represents their bank transactions.

In addition, e-banking has three different delivery methods: telephone, personal computer, and the Internet. For example, Elizabeth Daniel said that there are four different channels of electronic banking: RS banking, Internet banking, managed network and telebanking.

It should also be noted that the service based on RS banking, Home banking and the Bank client program differs from Internet banking. First, Internet banking is browser-based, while RS banking, Home banking, and Bank-client require the client to install bank-specified software on his PC. Also, since its working process is related to the banking process, it cannot create continuous operation 24 hours a day, 7 days a week, 365 days a year, it depends on the working hours of the bank. The software you install also requires that you have a computer that can work with this program and has installed RS banking, Home banking requires a software package such as Intuit, Inc.'s Quicken and Microsoft Corp.'s Money. According to Heikki Karjaluoto's interpretation, the main electronic supply channel in banking is the Internet accessible through a personal computer [8].

Today, telephone banking, telebanking, and managed networks do not play a very big role in banking activities. The transition of the supply platform from wired Internet connections to wireless mobile technologies continues. Therefore, Wah emphasized that electronic banking does not need to be on computer screens. Internet banking can be done on thin-screen mobile devices or other wireless devices [9]. Through these wireless application logs, the customer can get information about the bank account and view the history of transfers, apply to buy or sell securities, make payments, and send email messages to the bank.

Electronic banking is a modern supply channel in many developed countries and has a significant impact on the market of banking services. According to C. Nehmzow, internet banking provides an opportunity for traditional players in the financial services sector to add their many different services to low-cost supply channels [10]. In addition, it threatens the market share of traditional banks of Internet banking, because. It destroys their competitive advantage in having a network of traditional bank branches.

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Electronic banking is a modern supply channel in many developed countries and has a significant impact on the market of banking services. According to C. Nehmzow, internet banking provides an opportunity for traditional participants in the financial services sector to add their many different services to low-cost supply channels [12]. In addition, it threatens the market share of traditional banks of Internet banking, because. It destroys their competitive advantage in having a network of traditional bank branches.

The rapid growth and development of information and communication technologies (ICT) has enabled companies to create value in the digital environment [13]. Currently, the introduction and use of innovations in the organization's strategy is an important requirement for value creation. Thus, value creation in the digital age is co-created between the company and its customers [14]. The Internet and technological development have dramatically changed the way financial services are offered and used [15]. Banks and many financial institutions offer alternative innovative electronic channels to maintain a competitive edge and meet customer demands. Mobile devices and modern ICT have increasingly become means by which customers make payments for products and services through electronic banking [16]. Therefore, electronic banking is becoming increasingly important for many financial organizations and customers.

Banks and other financial institutions have enabled their customers to manage their business transactions using smartphones and mobile devices. Mobile banking is different from Internet banking because Internet banking uses Internet browser software while mobile banking uses apps. Recently, smartphones have played an important role in people's daily lives. As smartphone technologies continue to evolve, the demand for mobile banking for financial services and mobile commerce is increasing in Asian countries [17].

J. Zhang studied mobile payment, which is one of the mobile banking services. Mobile payment has transformed traditional payment methods into digital payment methods. Researchers have pointed out that there are vital factors such as the perception of interface design features [18].

Mobile Banking Prior to the introduction of mobile web services in 1999, mobile banking was primarily done via text or SMS and was known as SMS banking. Later, European banks offered mobile banking services using the mobile Internet

by supporting WAP [19].

SMS banking was the most popular mobile banking product until 2010. With the development of smartphones with iOS and Android operating systems, mobile banking (applications) began to develop. Customers can now download banking applications on their smartphones with more sophisticated interfaces, improved transaction capabilities and convenient navigation.

So why are traditional banks unable to meet the demands of their customers today? The main reason for this is that customers are dissatisfied with their banking experience. FinTech companies are stepping into this gap left by retail banks and are paying close attention to customer demand, focusing on efficient and personalized service. According to CNBC (American paid television business news channel), mobile banking has increased by 85% since the beginning of April 2020, and many experts predict that this growth will continue. Mobile banking offers many advantages to customers, the most important of which is the ease of use of the system. Instead of waiting in line at bank branches, customers can access and manage their money almost anywhere [20].

Today, in the context of the digital transformation of banks, customers also prefer digital communication in the implementation of their financial services. COVID-19 has further accelerated the process of implementing banking services through digital channels. For example, since the beginning of the pandemic, 35% of customers have started using online banking [21].

### ***Theoretical framework***

In the modern economy, the banking sector is defined as one of the most sensitive areas for the activation of innovative processes, in particular, innovative banking services and types of information and communication. Banking services with commercial banks are one of the main conditions for ensuring the competitiveness required today.

In order to effectively introduce and implement innovations in the digitalization of banking, banks should develop a long-term strategy of targeted work in this area and define specific goals and objectives. It is impossible to organize the effective operation of the system without developing a plan for the digitalization of banking activities. In order to ensure the necessary speed to introduce new innovative products to the service market, it is necessary to create partnerships with customers and ensure the formation of necessary skills in people.

One of the important areas of development of the banking sector is the development of remote banking systems. The creation and development of conditions for the provision of digital and remote services will bring commercial banks to a completely new level of service [22].

On the one hand, the rapid development of retail banking services requires cheap and effective mechanisms of client-bank interaction. On the other hand, high-quality services provide certain advantages in the highly competitive banking market.

In particular, according to foreign economist Allen N. Berger, banking is an important service in any economy, and it is very important for the success of its organization and structure [23].

According to the results of their research, the impact of commercial banking services is important for economic growth.

Economists A.D. Kurt and Ross Levin noted that the structure and organization of the banking industry have a great impact on its stability and efficiency [24].

Anil K. Kashyap, an Asian economist, has studied in his research that the organization of banking services has a significant impact on the availability and cost of credit for households and business entities [25]. According to the scientist's conclusions, a significant change in the capital regime in commercial banks, although it does not have a significant impact on the cost of credit, raises serious concerns about changes in lending methods and effects on financial stability. emphasized.

According to European scientist J. Lawrence, the organization of banking services should balance consumer needs with security and reliability requirements, taking into account the wider economic and social context [26].

Also, the factors affecting banking services were econometrically modelled and researched by several scientists.

For example, Viral Acharya used various econometric models in his research on banking and financial regulation, as well as in his work on the transmission of monetary policy through the banking system.

He used structural models of the banking sector to examine how bank capital and liquidity affect financial stability. These models involve identifying the behaviour of banks and other financial institutions and then simulating the effects of changes in policy or market conditions on the overall system [27].

Dynamic Stochastic General Equilibrium (DSGE) models-DSGE models are used to analyze interactions between various

sectors of the economy, including the banking sector. Acharya used these models to study the transmission of monetary policy through the banking system and how changes in interest rates or other policy instruments affect banks' lending and investment decisions.

Foreign economist R. Rajan used various econometric models in his research on banking and financial sector regulation, as well as in his work on the role of banks in conducting monetary policy [28]. According to him, in developing the econometric model, empirical models of financial intermediation also used empirical models to study the behaviour of banks and other financial intermediaries. These models involve estimating the relationship between various variables, such as credit supply and interest rates, using data from financial markets and institutions.

Luigi Guiso, a renowned economist, has conducted extensive research on banking and household finance using econometric models. In his research, he used a cross-country data set to study the relationship between the banking system and economic growth. They used a panel vector autoregression (VAR) model and included variables such as bank concentration, capital adequacy, and credit-to-GDP ratio as independent variables [29].

In general, Guiso used a variety of econometric models in his research, including dynamic panel data models, cross-country panel VAR models, and other models appropriate to the research question. The independent variables he uses vary depending on the specific research question but often include variables related to firm or household characteristics, financial constraints, and macroeconomic conditions.

Stefan Gerlach, a foreign economist, conducted extensive research on monetary policy, financial stability and the European banking system using econometric models. He used a panel data set of European banks to study the effects of bank capital requirements on money and credit. They used a dynamic panel data model and included variables such as equity ratio, loan growth and interest rates as independent variables [30].

In general, Gerlach used a variety of econometric models in his research, including extensive use of SVAR models, panel VAR models, and dynamic panel data models. The independent variables he uses vary depending on the specific research question but are often variables related to monetary policy, financial stability, and the banking system, such as interest rates, and exchange rates, including production volume and bank capital requirements.

## AIMS AND OBJECTIVES

The main purpose of this article is to study the influence of some factors affecting the improvement of retail banking services in the context of digital transformation using modern approaches. In addition to this general objective, the research includes a number of specific objectives: the interaction of digital loans, remote banking services (internet banking, mobile banking) and bank plastic cards on the digital attraction of deposits in commercial banks Pooled OLS estimator (POLSE) model, the econometric equation of the random effects estimator (REE) model, fixed effects estimator (measured on the basis of econometric analyzes with FEE) models.

## METHODS

In our research, we have econometrically analyzed the impact of commercial banks' practices related to retail banking services, retail credit practices, remote service systems (internet banking, mobile banking) and plastic cards, which are part of the banking services, we have developed models on the development of retail banking services in the context of digital transformation, based on panel data. The main reason for choosing these factors is the widespread use of Internet banking and mobile banking among digital banking services in the banking system of Uzbekistan. In particular, bank customers use Internet banking and mobile banking, mainly for some types of retail credit, household deposits and mobile banking based on plastic cards.

Panel data analysis allows the inclusion of time and individual-level variation in this econometric analysis, which provides a more complete picture of the processes under study [31].

According to him, one of the main advantages of panel data analysis is its ability to capture changes in data over time and at the individual level. By observing the same individual over several time periods, panel data analysis provides a more complete understanding of the underlying processes being studied. It is especially widely used in economics, where changes in individual behaviour over time can have important implications for policy and decision-making. In general, panel data analysis is important in providing a more complete picture of complex phenomena.

Panel data models require careful consideration of the potential endogeneity of variables as well as the possibility of

unobserved heterogeneity between individuals [32].

Accordingly, it highlights some of the problems that arise in the analysis of panel data, in particular, the endogeneity of variables and the potential for unobserved heterogeneity between individuals. Endogeneity occurs when a variable is correlated with an error term in the model, which can lead to biased estimates. Overall, it emphasizes the importance of careful modelling in panel data analysis to ensure accurate and reliable results.

Panel data is widely used in econometric modelling because it allows the analysis of dynamic relationships between variables while controlling for individual heterogeneity. Econometric analysis of panel data involves estimating models that account for within-unit and between-unit variation.

There are various econometric methods for analyzing panel data, including fixed effects estimator models, random effects estimators, and pooled OLS data models.

### Data analysis

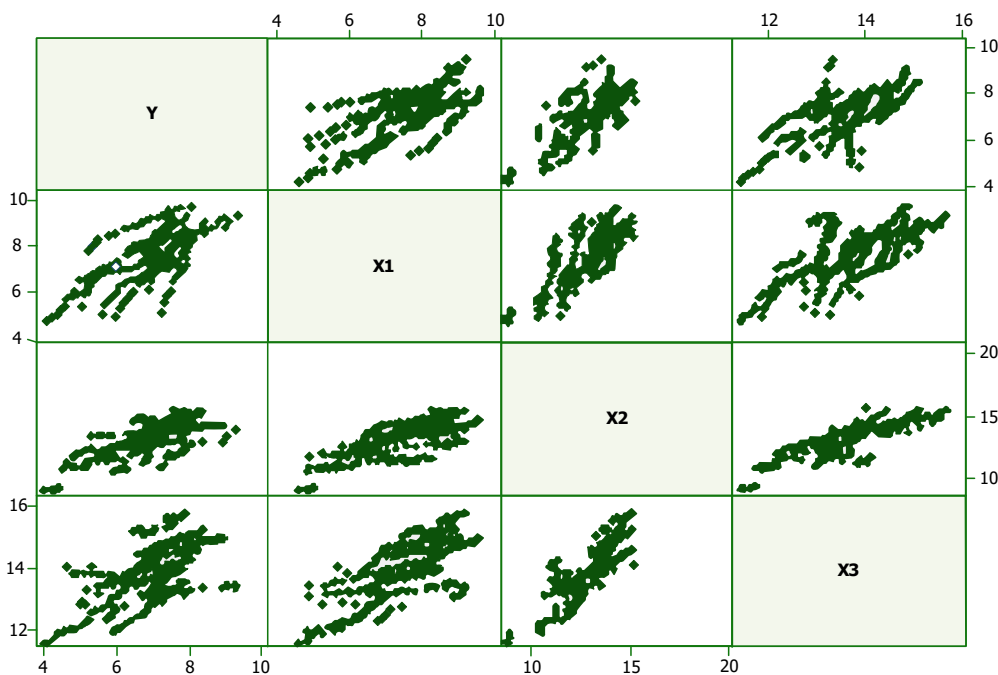
Empirical data from the Central Bank of the Republic of Uzbekistan were used for the dependent variable and independent variables according to the econometric models developed for the study.

They were expressed as follows:

- Y – the practice of attracting population deposits of banks (dependent variable);
- $x_1$  – retail lending practices of banks to individuals (independent variable);
- $x_2$  - number of users of remote banking services (internet banking, mobile banking) (independent variable);
- $x_3$  – number of bank plastic card users (independent variable).

In the banking system of Uzbekistan, remote banking services were initially used only for certain types of payments, and these systems are improving year by year. Today, it provides various services based on plastic cards, attracting public deposits, and providing retail loans to individuals through remote banking services. Therefore, in the improvement of retail services provided to individuals, it is necessary to attract deposits of residents of Y - bank (Y)  $x_1$  - the practice of retail lending of banks to individuals,  $x_2$  - the number of users of remote banking services (internet banking, mobile banking) and  $x_3$  - the number of users of bank plastic cards effect was measured.

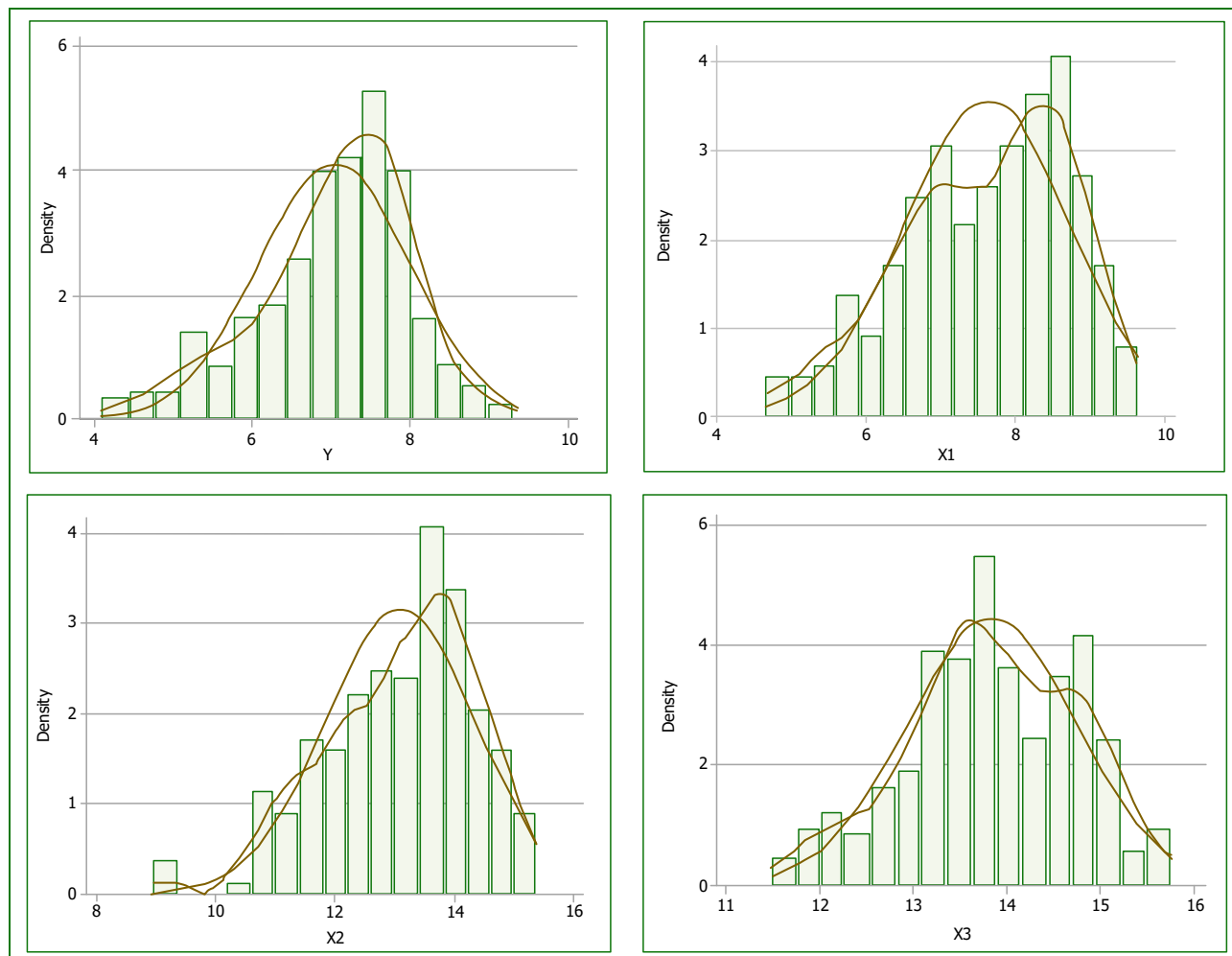
According to the study, the number of observations of 14 commercial banks in our Republic was 280, and the analytical graphic matrix of the indicators of the dependent variable and the independent variable was as follows (Figure 1).



**Figure 1. A graphical matrix of the relationship between the dependent variable and the independent variable.** (Source: developed independently by the authors based on the Stata program)

As can be seen from Figure 1, according to the graphic analysis, the practice of attracting deposits from the population of banks, the practice of retail lending to individuals, the number of users of remote banking services (internet banking, mobile banking) and the number of users of bank plastic cards according to the graphic matrix has a strong density effect, indicating that there is a relationship between the factors in this case.

Graphical histograms for the dependent variable and independent variable in the study are given below (Figure 2).



**Figure 2. A graphical histogram of the dependent variable and the independent variable.** (Source: developed independently by the authors based on the Stata program)

According to Figure 2, the histogram graph shows the practice of attracting public deposits of banks and the number of users of bank plastic cards. Also, the number of users of retail lending to individuals and remote banking services (internet banking, mobile banking) is not evenly distributed according to the histogram graph.

Using the Stata program, the dependent variable and independent variables were checked for each other and the following results were obtained (Table 1).

According to Table 1, the correlation relationship between the dependent variable and independent variables is presented. It can be seen that there is a high correlation between the practice of attracting deposits from the population of banks, the practice of retail lending to individuals, the number of users of remote banking services (internet banking, mobile banking) and the number of users of bank plastic cards.

**Table 1. Correlation matrix of relationships between the dependent variable and independent variables.** (Source: developed independently by the authors based on the Stata program)

Variables	(1)	(2)	(3)	(4)
(1) Y	1.000			
(2) X1	0.655 (0.000)	1.000		
(3) X2	0.699 (0.000)	0.725 (0.000)	1.000	
(4) X3	0.616 (0.000)	0.685 (0.000)	0.851 (0.000)	1.000

Table 1 shows the correlation between the dependent variable and independent variables. It can be seen that there is a high correlation between deposit practices of commercial banks, loan practices, remote services of commercial banks, and plastic card practices.

It also shows the presence of a high correlation between independent variables. There is no multicollinearity between influencing factors. The reliability coefficient of the research models was 0.90 per cent.

Econometric equations based on panel data on the study Pooled OLS estimator (POLSE), Fixed effects estimator (FEE), Random effects estimator (REE) main indicators, important conditions of Gauss Markov (Breusch Pagan, Durbin Watson, Shapiro Wilk) tests and Hausman test scores were generated (Table 2).

**Table 2. Indicators of econometric models based on survey panel data.** (Source: developed independently by the authors based on the Stata program)

№	Model indicators	Model 1	Model 2	Model 3
		POLSE model	FEE model	REE model
1.	Y	*	*	*
2.	X1	0.27 (0.05)	0.59 (0.03)	0.59 (0.03)
3.	X2	0.36 (0.06)	0.08 (0.03)	0.08 (0.03)
4.	X3	0.01 (0.08)	0.22 (0.05)	0.22 (0.05)
5.	F test	105.84 (0.0000)	459.90 (0.0000)	
6.	R2	0.53	0.84	0.84
7.	Chi-square			1384.31 (0.0000)
8.	Adj R2	0.52		
9.	Durbin Watson	0.14		
10.	Breusch-Pagan	0.27		
11.	Vif	3.38		
12.	Hausman			0.36

From the data in Table 2, econometric models based on panel data were analyzed for each indicator and test.

1. Pooled OLS estimator (POLSE) model analysis. The analysis of econometric equation indicators according to the Pooled OLS estimator model is presented below (Table 3).

**Table 3. Pooled OLS estimator (POLSE) model econometric equation.** Note: \*\*\*\* p<.01, \*\*\* p<.05, \*\* p<.1. (Source: developed independently by the authors based on the Stata program)

Y	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
X1	.272	.053	5.15	0	.168	.377	****
X2	.362	.065	5.60	0	.235	.489	****
X3	.01	.085	0.01	.088	-.167	.169	**
Constant	.204	.657	0.31	.756	-1.088	1.496	
<b>Mean dependent var</b>		7.039		<b>SD dependent var</b>		0.966	
<b>R-squared</b>		0.535		<b>Number of obs</b>		280	
<b>F-test</b>		105.838		<b>Prob &gt; F</b>		0.000	
<b>Akaike crit. (AIC)</b>		567.582		<b>Bayesian crit. (BIC)</b>		582.121	

According to the study, the Gauss-Markov Pooled OLS estimator included the evaluation of important assumptions for the econometric model and provided the following findings.

Observing the Gauss-Markov initial state, our research data showed that the number of characters had a factor of 4 and contained 280 observations.

In a linear regression model that conforms to Gaussian-Markov assumptions, the sum of the theoretical values is expected to match the sum of the observed values. This follows from the objective of ordinary least squares (OLS) to minimize the difference between predicted and actual values.

Based on the data in our study, it can be seen that this criterion is met.

$$Y=0.27X_1+0.36X_2+0.01X_3+0.20 \tag{1}$$

According to the study, the important conditions of Gauss Markov were checked according to the Pooled OLS estimator econometric model and the following results were obtained.

According to the first condition of Gauss Markov, it can be seen that the number of observations in the data of our research is 280 and the factors in the number of characters are 4.

In the linear regression model satisfying the Gauss-Markov assumptions, it is assumed that the sum of the theoretical values is equal to the sum of the empirical values. This is because OLS is designed to minimize the difference between predicted values and observed values.

From the data in our study, we can see that this condition is fulfilled (Table 4).

**Table 4. Gauss Markov Condition 2 on the Pooled OLS Estimator (POLSE) econometric model.** (Source: developed independently by the authors based on the Stata program)

Variable factors	The number of observations	Average value	Standard deviation	Minimum	Maximum
Model	280	7.038798	0.7062158	4.728681	8.286592
Y	280	7.038798	0.965542	4.110874	9.356084

According to the pooled OLS estimator model, the Durbin Watson, Breusch-Pagan tests were also checked based on the stata program in Gauss Markov sequence conditions. According to the results, the Durbin-Watson test had a value of 0.14, and the Breusch-Pagan test had a value of 0.27.

Based on the test values above, you are describing a hypothesis test with the null hypothesis  $H_0:y=0$  and the alternative hypothesis  $H_1:y \neq 0$   $r>0.05$ . As a result of the test df with a p-value greater than 0.05, we cannot reject the null hypothesis at the 5% significance level.

Also, the Durbin-Watson test and the Breusch-Pagan test were performed and the resulting p-values were greater than 0.05, and these tests were used to evaluate the assumptions of the linear regression model. If p-values are greater than 0.05, this indicates that the assumptions of the model are not violated and that the model fits the data. According to the study, the VIF indicator under Gauss Markov conditions is 3.38, and the model is not multicollinear. According to him, the confidence interval of this value is [1, 10].

2. Random effects estimator (REE) model analysis. The indicators of the econometric equation according to the study Fixed effects estimator (FEE) model are presented in Table 5 below.

**Table 5. The econometric equation of the random effects estimator (REE) model.** Note: \*\*\*\* p<.01, \*\*\* p<.05, \*\* p<.1. (Source: developed independently by the authors based on the Stata program)

Y	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
X1	.591	.035	17.09	0	.524	.659	****
X2	.086	.032	2.72	.007	.024	.149	****
X3	.221	.055	4.01	0	.113	.329	****
Constant	-1.665	.652	-2.55	.011	-2.943	-.388	***
Mean dependent var		7.039		SD dependent var		0.966	
Overall r-squared		0.493		Number of obs		280	
Chi-square		1384.313		Prob > chi2		0.000	
R-squared within		0.840		R-squared between		0.380	

According to Table 5, the independent variables of the Random effects estimator (REE) model were 0.59, 0.08, and 0.22, respectively, and the standard errors were 0.03, 0.03, and 0.05. The actual value in the ANOVA table is Chi=1384.31 and has a high value and R-squared=0.84.

The Random effects estimator (REE) model developed for the study is expressed as follows.

$$Y=0.59x_1+0.08x_2+0.22x_3-1.66 \tag{2}$$

Using the Random Effects Estimator (REE) econometric model as a basis, a Hausman test was performed and the test statistic was 0.36.

The Hausman test serves the purpose of comparing the performance of random effects (REE) and fixed effects estimators (FEE) within panel data models. For the Hausman test, the null hypothesis (H0) states the consistency and efficiency of the random effects estimator, while the alternative hypothesis (H1) states the consistency and efficiency of the fixed effects estimator. If the p-value falls below the chosen significance level, we reject the null hypothesis in favour of the alternative hypothesis and confirm that the Fixed Effects Estimator (FEE) is consistent and effective. If the p-value of the Hausman test exceeds the chosen significance threshold of 0.05, we fail to reject the null hypothesis and thus conclude that the Random Effects Estimator (REE) is consistent and effective.

3. The indicators for the econometric equation based on the Fixed Effects Estimator (FEE) model are presented in Table 6 below.

**Table 6. Fixed effects estimator (FEE) model analysis.** Note: \*\*\*\* p<.01, \*\*\* p<.05, \*\* p<.1. (Source: developed independently by the author based on the Stata program)

	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
<b>x1</b>	.597	.035	17.12	0	.528	.666	****
<b>x2</b>	.081	.032	2.54	.012	.018	.144	***
<b>x3</b>	.229	.056	4.08	0	.118	.339	****
<b>Constant</b>	-1.745	.635	-2.75	.006	-2.996	-.495	****
<b>Mean dependent var</b>		7.039		<b>SD dependent var</b>		0.966	
<b>R-squared</b>		0.840		<b>Number of obs</b>		280	
<b>F-test</b>		459.901		<b>Prob &gt; F</b>		0.000	
<b>Akaike crit. (AIC)</b>		-78.125		<b>Bayesian crit. (BIC)</b>		-63.586	

According to Table 6, according to the Fixed effects estimator (FEE) model, the factor values were 0.59, 0.08, and 0.22, respectively, and the standard errors were 0.03, 0.03, and 0.05.

The true value in the ANOVA table was 459.90 and produced an R-squared value of 0.84.

The Fixed effects estimator (FEE) model developed for the study has the following form.

$$Y=0.59x_1+0.08x_2+0.22x_3-1,78 \tag{3}$$

### RESEARCH HYPOTHESES

In our opinion, the increase in the practice of retail lending by banks to individuals, the increase in the number of users of remote banking services (internet banking, mobile banking) and the increase in the number of users of bank plastic cards will allow a significant increase in attracting deposits of the population of banks and attracting customers. In this regard, the following hypotheses were developed:

**Hypothesis 1.** Banks' practice of retail lending to individuals ( $x_1$ ) has a positive effect on banks' practice of attracting population deposits (Y).

**Hypothesis 2.** An increase in the number of users of remote banking services (internet banking, mobile banking) ( $x_2$ ) has a positive effect on the practice of attracting deposits from the population (Y).

**Hypothesis 3.** An increase in the number of bank plastic card users ( $x_3$ ) has a positive effect on the practice of attracting deposits from the population (Y).

These hypotheses show that banks that offer a variety of retail credit options, especially convenient remote services such as online and mobile banking, as well as user-friendly plastic cards, attract more customers when attracting public deposits and offering various retail credit options. The convenience and ease of use offered by these services can make them more attractive to customers, leading to greater customer engagement and increased bank revenue.

## RESULTS

Panel data provide information on individual behaviour and have both cross-sectional and time-series measures. In panel data, observations are usually organized in a matrix format, with each row representing a separate unit and each column representing a time period.

The symbol  $x_{it}$  represents the value of variable  $x$  for unit  $i$  at time  $t$ .

A pooled OLS model involves a dependent variable that is analyzed against a set of independent variables that are regressed in the context of an ordinary least squares (OLS) model. Here  $i = 1, 2, \dots, N$  indices represent units, and  $t = 1, 2, \dots, T$  represent time points.

$$y_{it} = \alpha_0 + \alpha_1 x_{it} + \varepsilon_{it} \quad (4)$$

Here,  $\alpha_0$  and  $\alpha_1$  represent the intercept and slope coefficients, respectively, and they represent the error term in the regression equation.

The pooled OLS model does not assume individual or time-specific effects, meaning that the coefficients are the same for all individuals and time periods. This can be called the assumption of homogeneity of coefficients across individuals and time periods [33].

In solving this problem, alternatives to Fixed effects estimator and Random effects estimator models can be used, respectively, individual effects estimator and time-specific effects estimator models [34].

The fixed effects estimator model, also known as the nested estimator, is a technique used to estimate the coefficients in a linear regression model using panel data. This estimator accounts for individual effects by including non-individual variables in the regression equation. By controlling for individual characteristics that are constant over time, a fixed effects estimator allows us to determine the causal relationship between the independent variables and the dependent variable. This method is particularly useful in panel data analysis because it solves the problem of unobserved heterogeneity and provides consistent and efficient estimates [35].

In the fixed effects estimation system, the model includes the regression of the dependent variable  $y_{it}$  dependent variable  $y_{it}$  on a group of independent variables, as well as a number of fixed effects specific to each individual, together with a set of fixed effects is regressed with  $a_i$ , where  $i = 1, 2, \dots, N$  is the unit index and  $t = 1, 2, \dots, T$  is the time index. Regression equation:

$$y_{it} = \gamma_0 + \gamma_1 x_{it} + a_i + \varepsilon_{it} \quad (5)$$

where  $\gamma_0$  and  $\gamma_1$  are the relevant terms intercept and slope coefficients, the equivalent term  $a_i$  is the individual-specific fixed effects and  $\varepsilon_{it}$  represents the error term.

By including individual-specific fixed effects in the regression equation, the fixed-effects estimator controls for all unobserved time-invariant factors affecting the dependent variable. This means that the fixed effects estimator takes into account the unique characteristics of each individual in the analysis and allows for the control of any unobserved factors that are constant over time [36].

A random effects estimator model is an alternative to fixed effects models that can control for time-varying individual factors. They provide individual and time-specific effects that allow for more extensive data analysis [37].

A random effects estimator model is also known as a mixed effects model or a hierarchical linear model [38].

A random effects estimator model is used to account for unobserved heterogeneity between individuals by including individual and time-specific random effects in the regression equation. These models are particularly useful when there are multiple sources of random variation and there is a need to address endogeneity issues. They allow for modelling heterogeneity and inefficiency that may change over time [39].

The random effects estimator has the following appearance.

$$y_{it} - \delta \bar{y}_I = \alpha_0 + \alpha_1(x_{1it} - \delta \bar{x}_{1i}) + \alpha_2(x_{2it} - \delta \bar{x}_{2i}) + (\alpha_i - \delta \bar{\alpha}_i) + (u_{it} + \delta \bar{u}_i) \quad (6)$$

The assumption that the individual and time-specific random effects are uncorrelated with the independent variables is equivalent to the assumption that there is no correlation between the random effects and the explanatory variables. If this assumption is violated, it can lead to incorrect estimates when using a random effects model [40].

The Hausman test can be used to compare the results of a random effects estimator with a fixed effects estimator that does not make this assumption. This is an application of generalized least squares and the basic idea is to weight the inverse variance [41].

In our study, we constructed econometric equations using Pooled Effects Estimator (POLSE), Fixed Effects Estimator (FEE) and Random Effects Estimator (REE) models with panel data of 14 commercial banks in the national economy over 20 quarters.

Based on the aforementioned econometric models, we evaluated key assumptions such as Gauss-Markov conditionals and conducted tests such as Durbin-Watson, Shapiro-Wilk, Breusch-Pagan, and Hausman. In addition, the VIF test was used to examine potential multicollinearity between factors.

Also, in the process of developing econometric equations, we created graphic tables and determined the direction of connection and density of indicators.

As a result of the analysis and conclusions of the study, the following proposal and conclusions were made on the study of the interaction of the number of users of remote banking services (internet banking, mobile banking) on the practice of attracting deposits of the population, the practice of retail lending to individuals, recommendations were developed.

1. Pooled OLS estimator (POLSE) model based on panel data according to the econometric equation  $Y=0.27x_1+0.36x_2+0.01x_3+0.20$ :
  - a 1% increase in the practice of retail lending to individuals requires a 0.27% increase in the practice of attracting population deposits of banks;
  - a 1% increase in the number of users of remote banking services (internet banking, mobile banking) leads to a 0.36% increase in the practice of attracting deposits from the population of banks. Also, a 1% increase in the number of bank plastic card users leads to a 0.01% increase in the practice of attracting deposits from the population of banks.

It should be noted that these interpretations show that the model is correct and all assumptions of the Pooled OLS estimator are met.

2. Based on panel data, the Random effects estimator (REE) model is based on the econometric equation  $Y=0.59x_1+0.08x_2+0.22x_3-1.66$ :
  - Y represents the dependent variable, which is the practice of banks to attract public deposits. Then,  $x_1$ ,  $x_2$  and  $x_3$  are independent variables, which are, respectively, the practice of retail lending to individuals, the number of users of remote banking services (internet banking, mobile banking) and the number of users of bank plastic cards.

Interpretation of the coefficients shows that a 1% increase in each independent variable leads to the following changes in the dependent variable:

- A 1% increase in retail lending to individuals leads to a 0.59% increase in banks' practice of attracting population deposits. An increase in the number of users of remote banking services (internet banking, mobile banking) by 1% leads to an increase in the practice of attracting deposits of the population by 0.08%. In addition, a 1% increase in the number of bank plastic card users leads to a 0.22% increase in the practice of attracting deposits from the population.
- In addition, it was noted that the model was correctly specified and that all assumptions of the random effects estimator were met. In general, the presented data show that this model can be used to analyze the relationship between independent and dependent variables and to forecast the impact of changes in these variables on the practice of attracting deposits from the population.

3. Based on panel data, the Fixed effects estimator (FEE) model is based on the econometric equation  $Y=0.59x_1+0.08x_2+0.22x_3-1.78$ :

- for every 1% increase in the practice of retail lending to individuals, keeping the influence of other variables constant, the practice of attracting deposits from the population of banks increases by 0.59%. For every 1% increase in the number of users of remote banking services (internet banking, mobile banking), keeping the influence of other variables constant, there is a 0.08% increase in the practice of attracting deposits from the population of banks. Also, for every 1% increase in the number of bank plastic card users, keeping the effects of other variables constant, the practice of attracting deposits from the population of banks increases by 0.22%.

These coefficients represent the average effect of the respective independent variables on the dependent variable in the population of interest.

4. When we analyzed the above 3 models based on the panel data of our research, the econometric equation of the Random effects estimator (REE) model on the impact of retail banking services development practices in the banking system of Uzbekistan today is  $Y=0.59x_1+0.08x_2+0.22x_3-1.66$  is the most optimal model. Accordingly, regarding the choice between the Fixed effects estimator (FEE) model and the Random effects estimator (REE) model, the Hausman test is used to determine which model is more suitable. The test compares the estimates from two models and tests whether the difference between them is statistically significant. If the p-value of the test is greater than the significance level (usually 0.05), then the Random effects estimator (REE) model is preferred because it allows for unobserved heterogeneity not accounted for in the Fixed effects estimator (FEE) model.

In this case, considering that the Hausman test has a p-value of 0.36, which is greater than 0.05, we came to the conclusion that the Random effects estimator (REE) model is suitable today for analyzing the impact of the practice of developing retail banking services in the national economy based on panel data [42].

## DISCUSSION

Today, it is necessary for banks to fully satisfy the needs of their customers in order to deepen the loyalty of their customers. This competitive advantage can only be achieved by banks that have invested financially and intellectually and must develop a customer-centric approach to directly meet their diverse needs across all digital channels.

Retail banking refers to services offered by commercial banks to individuals. These services include savings, deposits, bank plastic cards, ATMs, terminals, info kiosks, mortgage loans and other types of loans. Nowadays, commercial banks provide a wide range of retail banking services and various banking products to cover their customer base.

Banks in Uzbekistan should pay attention to the involvement of advanced digital technologies in the transformation of their activities in accordance with foreign experience and standards, establishing cooperation with international financial institutions or foreign FinTech companies.

The emergence of new technologies and Fintechs has led to a radical change in financial services, as a result of which the current generation of consumers prefers fast, transparent, reliable, convenient platforms and applications without physically visiting a bank office. As long as traditional (classical) banks do not change their outdated development strategies, do not abandon outdated technologies, and do not close branches to optimize costs, they will face various problems in the digital transformation of the banking system and the introduction of innovations [43].

If traditional banks do not digitize and automate their operations based on financial technologies, they will lose in competition with digital banks that operate at low costs. In addition, it is important to increase the attractiveness of loan products and types offered to individuals by banks and fully explain their conditions to the population. In particular, it is necessary to provide information about the interest rate of the loan, its repayment schedule and schedule.

## CONCLUSIONS

Most of the bank's clients are individuals, and their number is increasing year by year. Traditional methods of providing them with fast and quality offline service are associated with high costs for today's banks. In such conditions, the need for remote organization of automated and digitized modern banking services to a large number of people is increasing, which encourages banks to make extensive use of digital technologies, to integrate the database with the database of relevant state bodies and other organizations. This creates a strong competitive environment for banks. That is, it is necessary to introduce new digital services that meet the demands of bank customers, to be among the first to introduce innovative

banking services, to introduce services based on FinTechs and automated systems. Based on the above, the following conclusions were drawn during the analysis of ways to develop retail banking services in the context of digital transformation:

- banks in Uzbekistan should pay attention to the involvement of advanced digital technologies in the transformation of their activities in accordance with foreign experience and standards, establishing cooperation with international financial institutions or foreign FinTech companies;
- it is necessary to reduce banking costs through digitalization and automation of retail banking services based on modern financial technologies, and to establish a system that provides fast, high-quality and transparent service to customers;
- if traditional banks do not digitize and automate their activities based on financial technologies, they will lose in competition with low-cost digital banks;
- increase the attractiveness of loan products and types offered to individuals by banks and fully explain their conditions to the population. In particular, it is necessary to provide information about the interest rate of the loan, its payment schedule and schedule;
- it is necessary to implement retail crediting practice with the full use of assessment models based on artificial intelligence. Today, in the process of retail lending, the creditworthiness scoring system is widely used. Organization of scoring evaluation on the basis of artificial intelligence allows to provide quick loans to customers while reducing the human factor;
- it is necessary to take measures to increase the financial literacy of potential customers and employees so that bank employees and customers know perfectly how to use retail banking services based on modern financial technologies and innovative banking technologies;
- in economic literature, lending to individuals is mainly used with two terms. That is, it is presented with the concepts of "consumer credit" and "retail lending". Although there are common aspects of these concepts, some economists used these concepts as synonyms, while others explained them differently. This causes inaccuracies in the implementation of scientific research, statistical and analytical processes regarding the assessment of commercial banks' lending practices to individuals.

Also today, the impact of various models of artificial intelligence on the economy is immeasurable. At this point, it is necessary to implement retail lending practices with the full use of assessment models based on artificial intelligence. Today, in the process of retail lending, the creditworthiness scoring system is widely used. Organization of scoring evaluation based on artificial intelligence allows to provision of quick loans to customers while reducing the human factor. It is necessary to take measures to increase the financial literacy of potential customers and employees so that both bank employees and customers know perfectly how to use retail banking services based on modern financial technologies and innovative banking technologies.

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## ADDITIONAL INFORMATION

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**Formal Analysis:** *Zokir Mamadiyarov*

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## CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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## **АНАЛІЗ ФАКТОРІВ, ЩО ВПЛИВАЮТЬ НА РОЗВИТОК РОЗДРІБНИХ БАНКІВСЬКИХ ПОСЛУГ В УМОВАХ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ**

У статті розглянуто роздрібні банківські послуги, їхню важливість і те, як вони вдосконалюються в контексті цифрової трансформації. Використані дані 14 комерційних банків Узбекистану, кількість спостережень становить 280. Залежною змінною є депозитна практика комерційних банків, незалежними змінними є кредитна практика комерційних банків, дистанційні послуги комерційних банків і практика комерційних банків із пластиковими картками. Дані проаналізовано за допомогою кількох моделей.

Дослідження показує, що коли ми аналізуємо 3 моделі на основі панельних даних, економетричне рівняння моделі оцінювача випадкових ефектів (REE) впливу практик розвитку роздрібних банківських послуг на національну економіку сьогодні становить  $Y=0,59x_1+0,08x_2+0,22x_3 - 1.66$ ; це найоптимальніша модель. Відповідно, щодо вибору між моделлю оцінювача фіксованих ефектів (FEE) і моделлю оцінювача випадкових ефектів (REE) тест Хаусмана використовується для визначення того, яка модель є більш прийнятною. Тест порівнює оцінки двох моделей і перевіряє, чи є різниця між ними статистично значущою. Якщо р-значення тесту перевищує рівень значущості (зазвичай 0,05), то перевага віддається моделі оцінювача випадкових ефектів (REE), оскільки вона допускає неспостережувану неоднорідність, яка не враховується в моделі оцінювача фіксованих ефектів (FEE).

У цьому випадку р-значення критерію Хаусмана дорівнює 0,36, що більше за 0,05. Ми використовуємо модель Random effects estimator (REE) для аналізу впливу практики розвитку роздрібних банківських послуг на національну економіку сьогодні на основі панельних даних, і ми дійшли висновку, що це підходить.

**Ключові слова:** роздрібні банківські послуги, FinTech, банківські продукти, мобільний банкінг, пластикова картка, депозит, банківські кредити

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