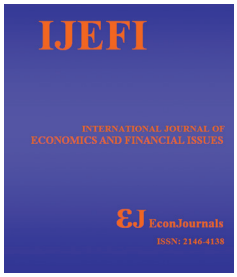

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Econometric Analysis of Factors Influencing the Efficiency of Banking Services

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ABSTRACT

As a result of increasing the efficiency of banking services, the possibility of increasing competitiveness, full satisfaction of customer needs and profitability increases. This article examines various strategies and effects that can be used to optimize banking services. In addition, the article analyzes factors that affect the increase in interest income of Agrobank JSCB, such as the volume of Agrobank JSCB's assets, the volume of remote banking services provided by Agrobank JSCB, the inflation rate, the ROE coefficient of Agrobank JSCB, and ways to reduce operating costs. As a result, a 1% increase in the volume of assets of Agrobank JSCB will increase the bank's profit margin by 0.50%, a 1% increase in remote banking services of Agrobank JSCB will increase the bank's profit margin by 1.25%, and a 1% increase in the inflation rate will reduce the bank's profit margin by 0.98%. Also, a 1% increase in the return on equity (ROE) of Agrobank JSCB will increase the bank's profit margin by 0.50%. It should be noted that banks that invest in these areas can achieve a significant increase in operational efficiency and overall financial indicators in providing services. In the study, the multiple linear regression (LS) model demonstrates that the fusion of factors such as the asset volume of "Agrobank" JSCB, the volume of remote banking services, the return on equity (ROE) coefficient, and the inflation rate has a positive relationship with the bank's total interest income. The integrated impact of these variables contributes significantly to the improvement of the bank's financial performance indicators.

Keywords: Remote Banking Services, FinTech in banking, Inflation Rate, ROE, Volume of Assets
JEL Classifications: G21, C13, L11, O47

1. INTRODUCTION

Today, in the activities of any bank, it is important to find rational solutions to issues such as how to provide services to clients or to whom to extend credit, and to improve service delivery processes. Therefore, we need to establish a higher level of communication with the client in our private bank, expand the type of service, and establish a partnership with a global bank. It is important to determine and improve the direction of formation. The reason for this is that modern competition is not only about finding a target market, but also about identifying potential customers, satisfying their needs and desires, and optimizing the shape and scale of the market.

In the current conditions, the range of banking services is constantly expanding, new types of banking products and services are appearing on the market. This factor leads to an even greater competition between credit institutions for each client. The banking services market constantly imposes new requirements on the work of credit institutions, and thus forces banks to master new operations that are of interest to the client. However, despite this, the policy of banks should be based on the level of permissible risks and maximum profitability. One of the key elements of such a mechanism is the development of competitive positions aimed at ensuring non-competitiveness in services, assessing the dynamics of the development of non-competitive factors and the level of competition. The evolution of the theory of banking services has gone through several stages of development. At the initial stage of the development of the theory of banking services, the banking services market and its banking service segment were studied. The second stage studied the specific features of the functioning of the credit and financial systems of individual countries and the possible consequences of the globalization and centralization of bank capital on the banking services market. At the third stage, the idea of "Financial supermarket" and financial boutique, as well as the inclusion of banks specializing in a narrow direction in the ranks of universal banks, became relevant. Services in the loan capital market, electronic services became widespread, and cases of mergers and acquisitions of banks increased. In recent years, banks have made significant investments in technological advancements and digital transformation, leading to a dramatic transformation in banking services. In particular, in the Indian banking sector, the integration of mobile banking, online banking, ATMs, and other digital financial services (DFS) has significantly improved the efficiency of banks (Peringanam Veluthedan and Kiran, 2023). Strategic cooperation between banks and FinTech has also had an impact on reducing costs and increasing revenues, especially in Chinese commercial banks (Fang et al., 2022). Another reason is that banks' adoption of artificial intelligence and big data analytics will further improve operational efficiency in banking services (Khanh, 2024). Improving the legal framework for digital services in banks and stabilizing the economic environment, strengthening public supervision, and strengthening the capital market are considered to be related to improving the efficiency of banking activities. The FinTech revolution has accelerated since the COVID-19 pandemic, and banks need to study customer demand, digitize banking services, and manage the risks associated with them in order not to be left behind (Toshtemirovich et al., 2021; Cahyani et al., 2025).

In recent years, the increase in the volume of retail services has often led to difficulties in large banks in maintaining high levels of efficiency, especially difficulties in resource allocation (Almanidis, 2013). Optimizing the share of non-performing assets in the assets structure, the share of preferential loans in the loan portfolio, the ratio of loans to deposits, and the ratio of loans to total bank assets have a positive effect on bank efficiency, while increasing provisions for problem loans and increasing problem loans in the loan portfolio have a negative effect on bank stability (Xiang et al., 2011).

The main economic and financial factors affecting deposits in commercial banks, in particular, the impact of indicators such as inflation, interest rates, unemployment rate, and gross domestic product (GDP) on the volume of population deposits was analyzed based on econometric models, and the conclusions were drawn that flexible interest rate policy and economic stability contribute to an increase in deposits, while factors such as inflation or unemployment growth lead to a decrease in the volume of deposits (Mamadiyarov et al., 2025). One of the most profitable services of banks is lending, and digitization of these services will create even greater convenience for customers. To do this, it is necessary to take measures to automate lending processes through financial technologies and minimize the risks associated with them (Litamahuputty et al., 2025; Makhmudov et al., 2025). Banking services are aimed at attracting customers by offering new services and improving their qualitative characteristics. Banking services contribute to the optimal implementation of banking operations, and the developed and provided banking services, together with banking operations, create a banking product. The efficiency of banking services is influenced by many factors, which can be analyzed using a fusion econometric approach. In particular, the analysis of the operational costs and profit efficiency of banking services by combining different econometric models and methodologies provides greater accuracy. The factors influencing the efficiency of banking activities are diverse, and technological progress, digital transformation, regulatory framework and other macroeconomic conditions are of particular importance. Analyzing these factors using various econometric models leads to the study of various aspects of the assessment of the efficiency of banking activities.

Factors such as the size of bank assets, the volume of remote banking services, the inflation rate, and the ROE coefficient affect the increase in interest income of banks. Therefore, the impact of factors such as the size of assets of Agrobank JSCB, the volume of remote banking services of Agrobank JSCB, the inflation rate, and the ROE coefficient of Agrobank JSCB on the increase in interest income of Agrobank JSCB is analyzed in this work. To this end, the linear equation model is employed.

2. LITERATURE REVIEW

Improving the efficiency of commercial banking services, ensuring economic growth and further increasing the scale of financial institutions remain a priority task. Reducing costs in financial institutions and commercial banks, strengthening profitability indicators and balancing the distribution of financial resources play an important role in supporting economic activity. The importance of improving the efficiency of banking services and its assessment has been confirmed by scientific developments, theoretical studies conducted by foreign economists and hypotheses developed based on econometric models. In particular, as Effective banking systems in commercial banks have a strong impact on stimulating economic growth by directing resources to efficient use (Abdullah et al., 2025; Mensah et al., 2012). The authors noted that, according to the results of their scientific work, the efficiency of the banking system under the influence of economic growth has enabled commercial banks in African regions to save up to 31% of their costs through efficient operation. Ćurak et al., 2009 developed econometric equations based on panel data of commercial banks in 15 Central

and Eastern European countries for the period from 1992 to 2006 and supported the hypothesis that the banking industry makes a positive contribution to economic growth.

Gómez-Ortega et al. (2024) analyses changes in the regulatory framework for improving banking efficiency in Spain. They find a positive impact on profitability and cost efficiency, depending on the size of financial institutions. According to Wu et al. (2015) commercial banks that have improved their efficiency in a competitive financial services market will gain a competitive advantage. According to the authors' research, an optimistic response by commercial banks to market challenges will allow them to increase their competitiveness. According to Piracha et al. (2022), openness policies in the banking sector lead to an increase in financial services and a reduction in the financial costs of financial intermediaries, which ultimately leads to capital accumulation and economic growth. Factors such as capital adequacy, leverage, and monetary conditions significantly affect the efficiency of commercial banks' services. In particular, the authors' analysis showed that while monetary conditions, economic growth, price stability, and exchange rate stability had a positive impact on bank efficiency in the G7 and E7 countries, operating and investment efficiency showed significant differences (Nasim et al., 2024).

3. DATA AND METHODOLOGY

3.1. Data

To assess the factors affecting the efficiency of banking services, quarterly economic indicators with a total number of observations covering 2016-2024, consisting of data sources from the Statistical Agency under the President of the Republic of Uzbekistan (Stat, 2025), the Central Bank of the Republic of Uzbekistan (Cbu, 2025), the Unified Corporate Information Portal of the National Agency for Prospective Projects of the Republic of Uzbekistan (https://new.openinfo.uz), and Agrobank JSCB (Agrobank, 2025), were used.

Since the data are formed on the basis of multivariate time series in the development of the econometric model, we used the multivariate linear equations (LS) model. "Multivariate linear models rely on several key assumptions, in particular linearity, independence, homoscedasticity, and normality of residuals, which are important for the validity of the model's conclusions and predictions" (Osemeke et al., 2024). According to the authors, these assumptions imply that the linearity assumption of the model implies that the relationship between the independent and dependent variables is linear. "Parameters of a multivariate linear regression model are assessed using linearity plots with trend lines and residual plots" (Thrane, 2019). Schutzenmeister, A et al. state that "multivariate regression homoscedasticity means that the residuals are constant across all levels of the independent variables" (Schützenmeister et al., 2012). According to the authors' research, if the assumption of homoscedasticity is violated, it is called heteroscedasticity, which leads to inefficient calculations. According to Osbourne et al., "the normality assumption of a multivariate linear regression model indicates that the residuals are normally distributed and is important for testing hypotheses and constructing confidence intervals." According to the authors, although the normality of the residuals is often considered a reliable assumption, it can be assessed using statistical tests such as simple probability plots or the Shapiro-Wilk test. According to econometric research, the "multivariate linear (LS) model" (Fox and Weisberg, 2011) Gauss-Markov conditions were checked and several confidence tests, including "Durbin-Watson" (Tillman, 1975), "Shapiro-Wilk (González-Estrada and Cosmes, 2019)" and "Breusch-Pagan" (Abdul-Hameed and Matanmi, 2021) the level of statistical significance of the econometric model was evaluated based on the tests. Furthermore, the diagnosis of multicollinearity in the econometric model was assessed based on the "VIF" (Tsagris and Pandis, 2021) test.

3.2. Methodology

The article formulates a multivariate linear equation (LS) model as an econometric model. The formula for the multivariate linear equation (LS) model is given below.

$$Y_i = {}_0 + {}_{1i} + {}_2 c_{2i} + {}_3 c_{3i} \cdots + {}_{ik} c_{ik} + {}_i \quad (1)$$

Here, t is the dependent variable for the y_i-observation, which is the dependent variable in the model,

c_t, c_{2t}, c_{3t} ..., c_{ik} - represent the independent variables (influencing factors).

$\beta_1, \beta_2, \beta_3, \ldots \beta_i$ - represent the regression coefficients (the influence of each factor) and ϵ_t - residual (error) value.

All variables in the econometric model are natural logarithmized. All variables in the econometric model are expressed below (Table 1).

The main (H_0) and alternative (H_1) hypotheses were reflected in the development of the econometric study.

The structure of the hypothesis in the combined model:
The main hypothesis (H_0): The volume of assets of "Agrobank" JSCB, the volume of remote banking services of "Agrobank" JSCB, the inflation rate and the ROE coefficient of return on equity of "Agrobank" JSCB do not significantly affect the volume of total interest income of "Agrobank" JSCB and have no correlation effect.

Table 1: Classification of dependent and independent variables according to the econometric model

S. No.	Variable name	Classification	Logarithmic value
1	Total interest income of Agrobank JSCB	Dependent variable	Loginter_ incoome
2	Volume of assets of Agrobank JSCB	Independent variable	Logasset_ volume
3	Volume of remote banking services of Agrobank JSCB	Independent variable	Logfin_tech
4	Inflation rate	Independent variable	Loginf._rate
5	ROE coefficient of return on equity of Agrobank JSCB	Independent variable	logROE

Source: The authors

Alternative hypothesis (H_1): The volume of assets of "Agrobank" JSCB, the volume of remote banking services (fintech) of "Agrobank" JSCB, the inflation rate and the ROE coefficient of return on equity of "Agrobank" JSCB have a significant effect on the volume of total interest income of "Agrobank" JSCB and have a strong correlation effect.

4. EMPIRICAL RESULTS

At the first stage of the econometric study, descriptive statistical values were expressed for the volume of total interest income of Agrobank JSCB and the factors affecting it (Table 1).

Based on Table 2 above, the volume of total interest income of Agrobank JSCB and the independent variables descriptive statistical indicators formed an average distribution of the main economic values of the selected variables according to the model. All variables selected according to descriptive statistical values consist of 31 observations and the value indicators show consistency. Also, the average values according to the table showed a distribution close to the norm with high kurtosis indicators for indicators of stable financial profitability.

According to the study, a graphical representation of the volume of total interest income of Agrobank JSCB and the factors affecting it over time was developed (Figure 1). According to the analytical graph, the dynamics of the total interest income and the factors influencing it are shown in the time series diagram, which expresses the evolutionary nature of Agrobank JSCB over time. The analytical period is from the 3rd quarter of 2016 to the 3rd quarter of 2024, based on quarterly data, the periodic movement of four potentially influencing variables in terms of financial indicators is expressed.

According to the graph, the strong growth trend of interest income of Agrobank JSCB in each quarter was observed as a result of the stable growth of interest income, increased activity of lending operations, increased interest rates and growth of the asset base. The volume of the asset base of Agrobank JSCB formed a sharp growth trend from 2016 to 2022, causing some fluctuations in the subsequent periods. Also, during the analyzed period, the interest rate level represented a high peak around 2019-2020, but in subsequent periods it showed a downward and stable trend.

The next stage of the article presents a graphical matrix and scatter plots of the total interest income of Agrobank JSCB and the factors affecting it (Figures 2 and 3).

Based on Figures 2 and 3 above, a strong density correlation effect has been observed between the volume of total interest income of Agrobank JSCB and the variables affecting it, and the plots show a strong clustering, which indicates a strong correlation effect between the selected factors. The graphical images show that Agrobank JSCB is influencing the operational efficiency and profitability of the bank through its financial indicators, in particular, through a strong growth in total interest income. The scatter plot and the graphical matrix reflect the interaction of total interest income and the variables for each plot and a positive relationship with the bank's financial results. The graphical images show that Agrobank JSCB demonstrates the ability of the bank to convert the growth of its trending strategic assets into profitable lending and investment activities by expanding its total assets, while simultaneously increasing its income-generating opportunities. Also, the distribution schemes demonstrate the positive impact of the return on equity (ROE) of Agrobank JSCB on the high values of the total interest income. According to them, this financial relationship is an important factor in increasing the bank's net income, strengthening investor confidence and financial stability, especially the effective use of equity capital.

The next step is to present a graphical representation of the analytical relationship (dotplot) between the total interest income of Agrobank JSCB and the factors affecting it (Figure 4).

According to Figure 4, the density distribution dependence diagram provides a clear and structured visual dynamics of the volume of Agrobank's total interest income and the factors affecting it. Distribution graphs, dotplot line images, represent the change in the density of variables by values, the volume of Agrobank's total interest income and the factors affecting it, which allows for systematic analysis and forecasting. According to the graphic image, the volume of Agrobank's total interest income, the inflation rate and the shocks to the ROE indicators in the banking system showed chaotic dynamics of change and were closely linked in stabilization and created the basis for consistent growth in the upward trend. According to the research, a correlation matrix of the total interest income of Agrobank JSCB and the variables affecting it was developed (Table 3).

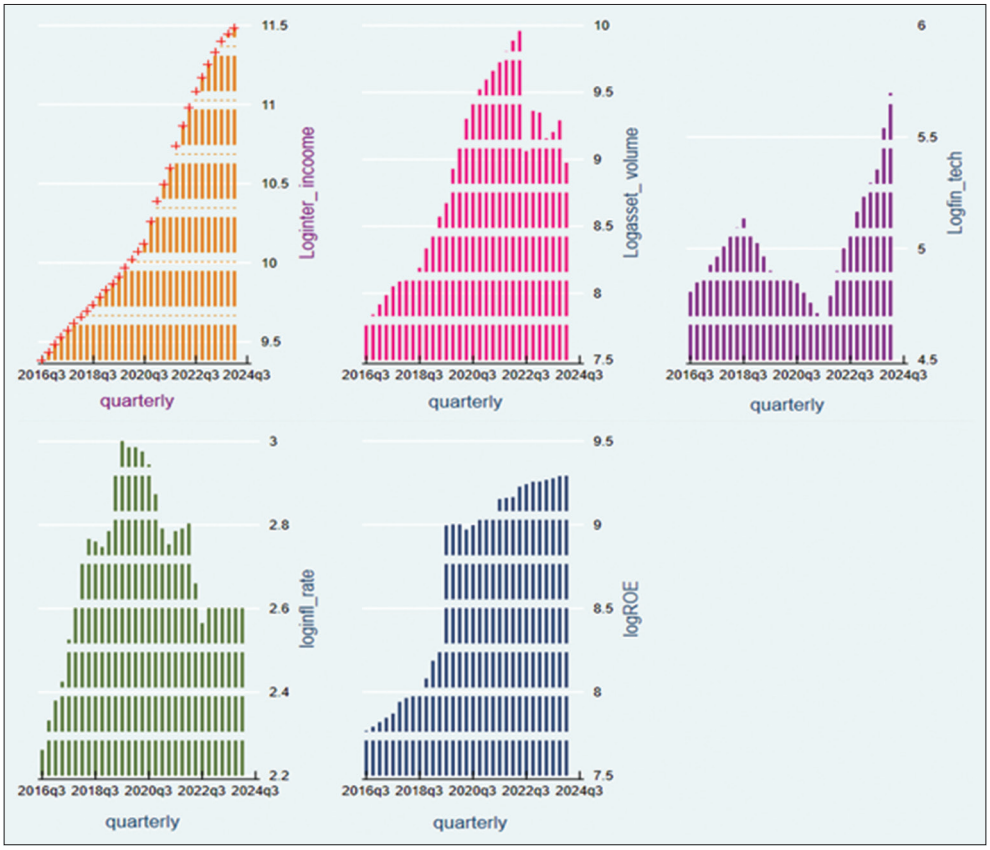
According to Table 3, Agrobank JSCB demonstrates a strong, inverse, and significant correlation between the volume of total interest income and the variables affecting it.

Table 2: Descriptive statistical values for the volume of total interest income of Agrobank JSCB and the factors affecting it

	Loginter_ incoome	Logasset_ volume	Logfin_tech	Loginf._rate	logROE
Mean	10.29533	8.887444	5.004601	2.70374	8.686386
Maximum	11.485	9.958789	5.696253	3.00072	3.00072
Minimum	9.384353	7.760041	4.661115	2.261763	7.769548
Standard Deviation	0.6929241	0.689436	0.2332148	0.1952132	0.6003862
Standard Error	0.1244529	0.1238265	0.0418866	0.0350613	0.1078326
Skewness	0.4214256	−0.158723	1.185323	−0.3720907	−0.4575366
Kurtosis	1.736595	1.652411	4.307889	2.596824	1.401961
Observation	31	31	31	31	31

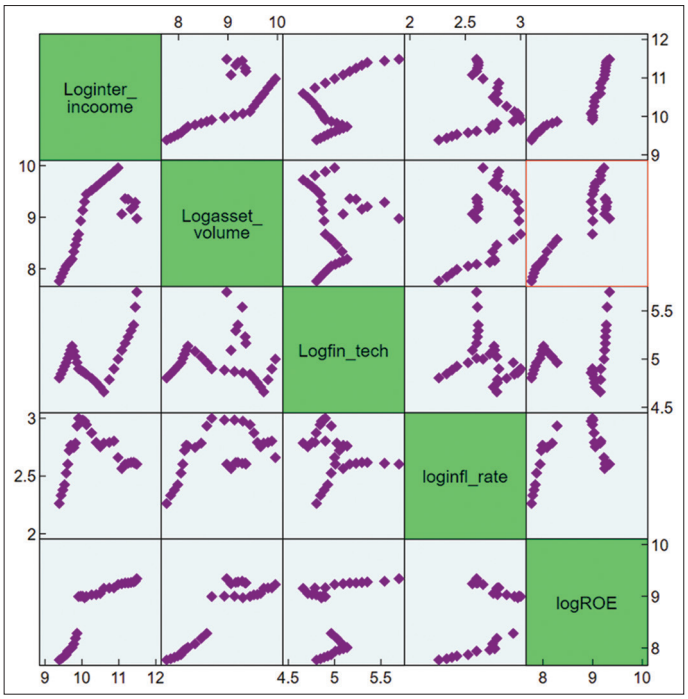
Source: The authors

Figure 1: Analytical graphic representation of the volume of total interest income of Agrobank JSCB and the factors affecting it over time



Source: The authors

Figure 2: Graphic matrix representation of the volume of total interest income of Agrobank JSCB and the factors affecting it



Source: The authors

Positive correlation across all variables has a direct impact on the total interest income of Agrobank JSCB. Also, the table shows that the P-value is <0.05, which indicates that the condition for the correlation coefficient is met. In the next stage of the study, a regression model of the total interest income of Agrobank JSCB and the factors affecting it was developed using a multivariate linear (LS) model (Table 4).

The formula coefficients of the multivariate linear (LS) model are given below.

$$log(inter\_income) = \beta_0+\beta_1 log(asset\_volume)+\beta_2 log(fin\_tech)+\beta_3 log(infl\_rate)+\beta_4 log(ROE)+\varepsilon \quad (2)$$

The formula coefficients of the multivariate linear (LS) model are given below.

$$log(inter\_income) = -2.17+0.50log(asset\_volume)+1.25log(fin\_tech)-0.98log(infl\_rate)+0.50log(ROE)+\varepsilon \quad (3)$$

General description of the multivariate linear (LS) model.

The P-value of the total interest income of Agrobank JSCB and the variable affecting it is <0.05, which indicates a statistically significant forecast of the resulting factor at a 5% significance level. The R-squared value is 0.9771, which provides a positive forecast of the quality of the model with 97.71% of the factors affecting the total interest income of Agrobank JSCB. The formation of a high R-squared value indicates that the econometric model has a strong effect on the observed data. When testing the hypothesis of the regression equation according

Table 3: Correlation matrix of the total interest income of Agrobank JSCB and the factors affecting it

Variables	(1)	(2)	(3)	(4)	(5)	Significant
(1) Loginter_ income	1.000					
(2) Logasset_ volume	0.7432	1.000				
	(0.0000)					***
(3) Logfin_tech	0.5560	−0.5410	1.000			
	(0.0012)	(0.0077)				***
(4) Loginf._rate	0.8212	0.4743	−0.5271	1.000		
	(0.0423)	(0.0070)	(0.0219)			**
(5) logROE	0.8726	0.8085	0.5222	0.4092	1.000	
	(0.0000)	(0.0000)	(0.0096)	(0.0223)		***

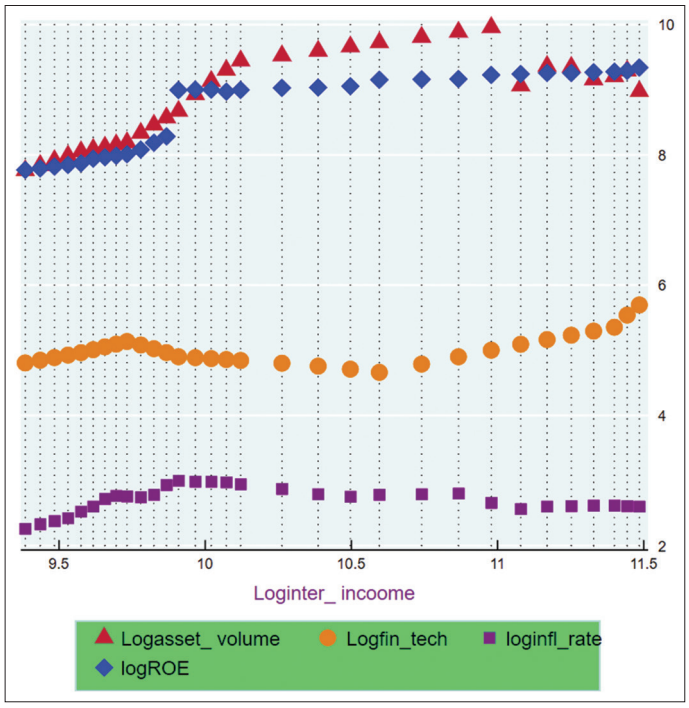
Source: It was developed by the authors based on Stata software

Table 4: Regression equation indicators based on a multivariate linear (LS) model of the total interest income of Agrobank JSCB and the factors affecting it

Loginter_income	Coefficient	Standard error	t-value	P-value	[95% Confidence	Interval]	Significant
Logasset_volume	0.501	0.092	5.46	0	0.313	0.69	***
Logfin_tech	1.255	0.12	10.45	0	1.008	1.501	***
loginfl_rate	−0.987	0.124	−7.98	0	−1.242	−0.733	***
logROE	0.507	0.109	4.67	0	0.284	0.73	***
Constant	−2.174	0.653	−3.33	0.003	−3.516	−0.832	***
Mean dependent var		10.295		SD dependent var		0.693	
R-squared		0.977		Number of obs		31	
F-test		277.880		Prob>F		0.000	
Akaike crit. (AIC)		−42.920		Bayesian crit. (BIC)		−35.750	

***P<0.01, **P<0.05, *P<0.1
Source: The authors

Figure 3: Scatter plot of the total interest income of Agrobank JSCB and the factors affecting it

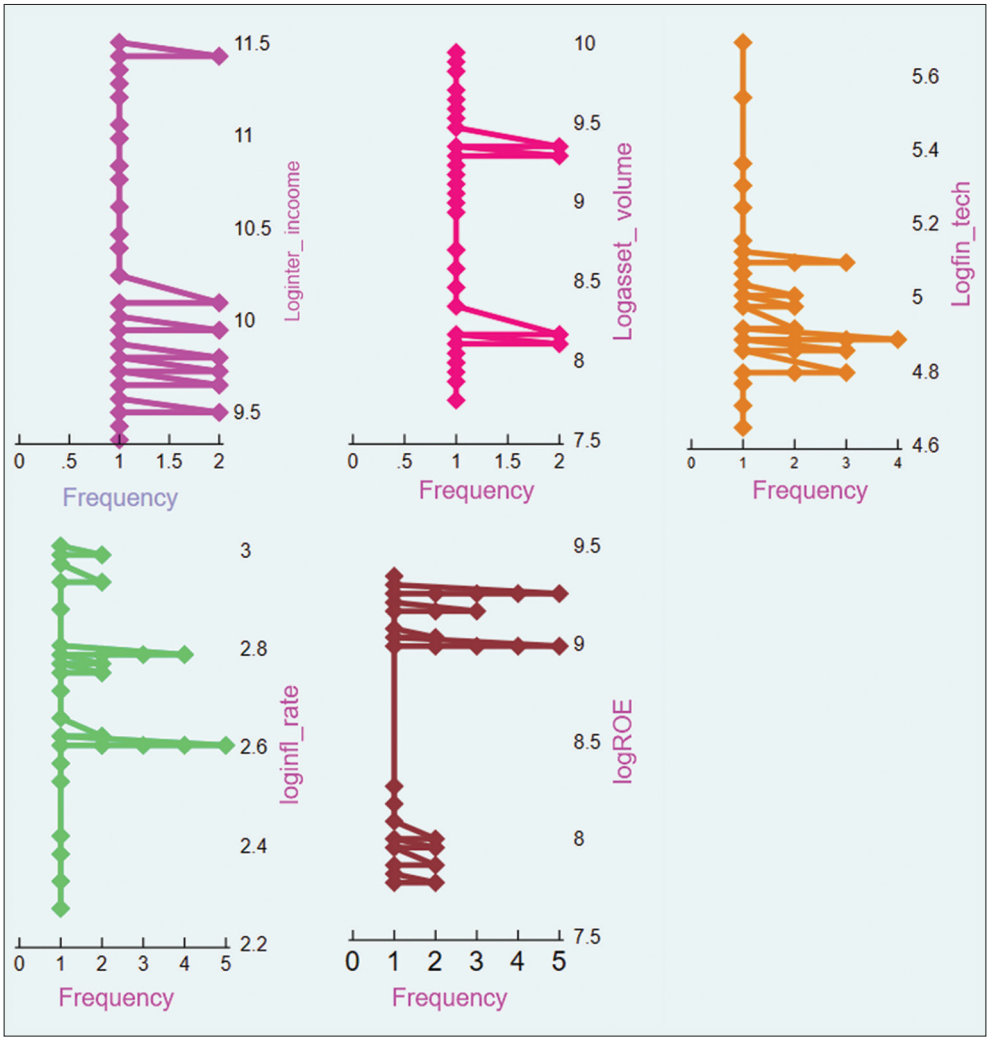


Source: The authors

to the multivariate linear (LS) model, it is clear that the null hypothesis (H_0:y = 0) is rejected when F < 0.05 and t < 0.05, which means that the main hypothesis (H_0:y = 0) is statistically insignificant. Accordingly, the main hypothesis is rejected in favor of accepting the statistically significant alternative hypothesis (H_1: y ≠ 0). A 1% increase in the volume of bank assets of Agrobank JSCB will lead to an increase in the total bank interest income of Agrobank JSCB by 0.50%. A 1% increase in the number of remote banking services of Agrobank JSCB will lead to an increase in the total bank interest income of Agrobank JSCB by 1.25%. A 1% increase in the inflation rate will lead to a decrease in the total bank interest income of Agrobank JSCB by 0.98%. Also, a 1% increase in the ROE coefficient of Agrobank JSCB will lead to an increase in the total bank interest income of Agrobank JSCB by 0.50%.

According to the econometric model, the Durbin-Watson test for the multivariate linear (LS) model regression equation recorded a value of 1.14. Also, the Shapiro-Wilk W test value was 0.58 and the Breusch-Pagan test value was 0.12. According to the primary hypothesis, H_0: y = 0 and H_1: y ≠ 0, P > 0.05 significance level test was performed. According to the results of the Durbin-Watson and Shapiro-Wilk tests on the regression equation of the multivariate linear (LS) model, the null hypothesis was accepted. According to it, the P > 0.05 threshold, error conditions and Gauss-Markov conditions confirming the absence of a relationship between the independent variables included in the analysis of the study. In this case, the Gauss-Markov basic conditions for the econometric model were met. When checking the multicollinearity of the multivariate linear (LS) model, the VIF test was used to check the multicollinearity of the regression model, its value was 5.70, indicating that there is no multicollinearity in the econometric model, and the confidence interval for this value is [1, 10].

Figure 4: Graphical representation of the volume of total interest income of Agrobank JSCB and the factors affecting it (dotplot)



Source: The authors

5. CONCLUSION AND POLICY IMPLICATIONS

The results of the multivariate linear (LS) equation model of the econometric study showed that the volume of total interest income of Agrobank JSCB showed a strong and positive relationship between the volume of assets of Agrobank JSCB, the volume of remote banking services (fintech), the inflation rate and the ROE coefficient of Agrobank JSCB, which significantly contributes to the stimulation of the financial performance of this bank. Estimating the impact of the volume of bank assets. An increase in the volume of bank assets of Agrobank JSCB by 1% leads to an increase in total interest income by 0.50%. According to this result, it is shown that Agrobank JSCB is effectively using its assets to increase interest income. Agrobank JSCB represents a proportional increase in income as its balance sheet grows through lending, investment and other interest-bearing assets. This emphasizes the proper management of assets and the significant income-generating activities of the bank.

Assessment of the positive impact of remote banking services. A 1% increase in the number of remote banking services of Agrobank JSCB is achieved by a 1.25% increase in total interest income. According to this result, digital transformation practices and remote banking services significantly increase profitability. Remote banking services, by increasing the accessibility of bank customers, activate the volume of transactions and increase financial expectations, ultimately all this allows the bank to increase interest income. According to him, Agrobank is well positioned to benefit from the adoption of technology and creates the basis for further increasing net profit through investment in digital infrastructure. The significance of the inflation impact. A 1% increase in inflation leads to a 0.98% decrease in the interest income of Agrobank JSCB. According to this result, the absence of a negative impact reflects the sensitivity of the inflation indicator to the importance of Agrobank's protection from macroeconomic risks. This relationship increases the need for proactive interest rate management and inflation hedging strategies. This sensitivity allows for a better forecast of possible financial losses of the bank's interest income during inflation.

The significance of assessing the ROE indicator. A one percent increase in the return on equity (ROE) of Agrobank JSCB leads to an increase in total interest income by 0.50%. According to

this econometric result, Agrobank's profitability and shareholder returns are closely related to its ability to generate basic income. By optimizing the bank's ROE indicator, cost control, asset utilization, and leverage ratio, as well as an increase in the bank's interest income, are achieved.

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