

Article

Ecometric Analysis Of Bank Assets Profitability

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Abstract: This article conducts an econometric analysis using a multivariate linear regression equation to identify significant factors affecting the return on assets of commercial banks in Uzbekistan, in particular, JSC Aloqabank. Also, based on the influencing factors, a forecast for 2024-2026 was developed.

Keywords: Bank, Asset, Return on assets, Credit, Interest and non-interest income, Stability of the national banking system.

1. Introduction

The relevance of the topic is determined by the fact that the formation of the income base of commercial banks is one of the priority areas for reforming the country's banking system in the Decrees of the President of the Republic of Uzbekistan No. PD-60 dated January 28, 2022 "On the New Development Strategy of Uzbekistan for 2022-2026" and No. PD-5992 dated May 12, 2020 "On Reform of the Banking System of the Republic of Uzbekistan for 2020-2025", which set a number of tasks related to strengthening the income base of commercial banks, including improving the quality of credit portfolio and risk management, ensuring stable growth in the volume of loans of commercial banks, strengthening the resource base of banks, improving corporate governance in banks, and the existence of urgent problems related to the formation and improvement of the management of the income base of commercial banks of Uzbekistan.[1,2]

Today, there are the following pressing problems related to the formation and management of the income base of commercial banks:

1. The low level of profitability of assets in commercial banks;
2. Problems associated with improving the quality of the loan portfolio of commercial banks;
3. The low level of development of investment operations carried out by commercial banks with securities
4. The relatively high level of reserve allocations intended to cover losses on loans
5. The actual level of net interest spread and net interest margin indicators in banks is lower than the normative levels of these indicators.

The return on assets of commercial banks is one of the most important indicators in assessing the financial performance of a bank. It shows how much income can be generated from the bank's assets.

2. Materials and Methods

The results of a study conducted by Lando and Skodberg based on a sample of seven thousand companies showed that the evaluation of transition matrices between ratings (migration matrices) and extrapolations based on them allows for an accurate assessment

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of the transition to default status for high-rated credit portfolios, including low-default credit portfolios [4].

According to D. Tasche's conclusion, if the standard method of selecting the upper bounds of the confidence interval is used to estimate the probability of default in conditions of small correlation of assets (18%), then the optimal adjustment corresponds to a significance level of 50-75%, and in conditions of large correlation ($R=24\%$) - to a significance level of 75-90%.[5] This is an important conclusion for practical modeling of LDP. The reason for this is that if LDP is a retail product (in which the correlation is usually small), then the conservative significance level is 75%. If LDP is not a retail segment product, then the conservative significance level should be 90%.

According to the conclusion of professor J. Isakov, an average increase in the average annual interest rate on loans allocated by commercial banks to the services sector by one percentage point leads to an increase in the profitability of loans granted by 0.8 percentage points, and an increase in the volume of loans granted by one percentage point leads to a decrease in the profitability of loans by 1.8 percentage points [6].

It should be noted that the role of commercial banks in the development of the national economy in any country is determined by the volume and scale of loans they provide. Therefore, scientific studies devoted to the study of the role of commercial banks as financial intermediaries pay special attention to the lending activities of banks [7]

3. Results

We used a multi-factor linear regression equation to determine the significant factors affecting the profitability of Aloqabank's assets.(table 1)

Thus, we set the goal of developing an econometric expression (econometric model) that determines the dependence of "y" - "Alokabank's return on assets" on factors x1, x2, ..., xk using the "least squares" method.

Table 1. Factors included in the econometric analysis sample [11]

Result indicator			
Y	Return on assets, %		
Influencing factors			
x1	Total assets, billion soums	X7	Interest expenses, bln. soum
x2	Loans, billion soum	X8	Non-interest expenses, bln. soum
x3	Securities - assets, bln. soum	X9	Operating expenses, bln. soum
x4	Cash assets, billion soum	x10	Average annual interest rate of loans in national currency, %
x5	Interest income, bln. soum	x11	The main rate of the Central Bank, %
x6	Non-interest income, bln. soum		

Table 2. Indicators affecting profitability of bank assets [9,10]

Indicators	2015	2016	2017	2018	2019	2020	2021	2022	2023
Return on assets, %	17,1	15,9	12,8	13,1	18,3	18,3	12,9	14,5	21,1
Total assets, billion soums	1217,8	1574,2	2792,2	5846,6	7342,0	8 108,2	12 638,5	16 083,6	16 044,7
Loans, billion soum	934,8	1094,6	1626,5	4 743,2	5601,8	5 705,9	7 754,3	9 161,9	10 293,9
Securities - assets, bln. soum	12,2	13,6	10,7	24,1	38,7	41,2	98,3	95,8	156,1
Cash assets, billion soum	181,0	379,8	988,7	563,1	743,2	628,9	1514,6	2104,9	1261,5
Interest income, bln. soum	150,8	178,4	218,1	619,8	1152,2	1185,9	1206,7	1499,5	1862,0
Non-interest income, bln. soum	57,7	73,1	140,7	147,2	192,8	294,5	427,2	836,1	1530,2

Interest expenses, bln. soum	92,7	105,1	127,9	355,6	776,7	819,3	798,3	993,8	1340,4
Non-interest expenses, bln. soum	7,9	9,8	23,4	47,5	68,2	170,1	211,9	399,0	571,1
Operating expenses, bln. soum	68,3	87,7	113,2	187,4	244,5	264,5	362,6	488,5	608,9
Average annual interest rate of loans in national currency, %	11,4	11,5	18,5	20,5	24,2	22,3	20,8	21,9	22,7
The main rate of the Central Bank, %	9,0	9,0	14,0	16,0	16,0	14,0	14,0	15,0	14,0

We used a multi-factor linear regression equation to determine the significant factors affecting the profitability of Aloqabank's assets. The following model is considered in multivariate regression theory[8]:

$$y = \hat{y}(x) + \varepsilon, \quad \hat{y}(x) = a_0 + \sum_{i=1}^k a_i x_i, \quad (1)$$

where: y is a variable that depends on the factors; ε is a random variable; $a_0, a_1, a_2, \dots, a_k$ are the unknown regression coefficients, estimated on a sample basis; k is the number of factors affecting the outcome; n is the number of observations.

In the analysis, the method of "least squares" proposed by the German scientist K.F. Gauss (1794-95) and the French mathematician A. Legendre (1805) was used to determine the unknown parameters $a_0, a_1, a_2, \dots, a_k$ of the regression equation. The study of multivariate regression is carried out in the same way as univariate regression, that is, the

method of least squares is used.: $Q^2 = \sum_{j=1}^n (y_j - a_0 - \sum_{i=1}^k a_i x_{ji})^2 \rightarrow \min, \quad (2)$

First we find the critical points:

$$\frac{\partial Q^2}{\partial a_0} = -2 \sum_{j=1}^n (y_j - a_0 - \sum_{i=1}^k a_i x_{ji}) = 0, \quad (3)$$

$$\frac{\partial Q^2}{\partial a_\ell} = -2 \sum_{j=1}^n (y_j - a_0 - \sum_{i=1}^k a_i x_{ji}) x_{j\ell} = 0, \quad \ell = 1, 2, \dots, k, \quad (4)$$

Thus, a normal equation was constructed to find the regression parameter estimates:

$$n \tilde{a}_0 + \sum_{i=1}^k (\sum_{j=1}^n x_{ji}) \tilde{a}_i = \sum_{j=1}^n y_j, \quad (5)$$

$$(\sum_{j=1}^n x_{ji}) \tilde{a}_0 + \sum_{i=1}^k (\sum_{j=1}^n x_{ji} x_{j\ell}) \tilde{a}_i = \sum_{j=1}^n y_j x_{j\ell}, \quad \ell = 1, 2, \dots, k, \quad (6)$$

If we insert into the equations found from the first equation \tilde{a}_0 , we arrive at a system

$\tilde{a}_0 = \bar{y} - \sum_{i=1}^k \tilde{a}_i \bar{x}_i$ consisting of the following equations k for the parameters k :

$$\sum_{i=1}^k \left(\sum_{j=1}^n (x_{ji} - \bar{x}_i)(x_{j\ell} - \bar{x}_\ell) \right) \tilde{a}_i = \sum_{j=1}^n y_j (x_{j\ell} - \bar{x}_\ell), \ell = 1, 2, \dots, k, \quad (7)$$

Solving this system of equations, we find $\tilde{a}_1, \tilde{a}_2, \dots, \tilde{a}_k$ and generate

$$\bar{y}(x) = \tilde{a}_0 + \sum_{i=1}^k \tilde{a}_i x_i. \text{ Found } \tilde{a}_0, \tilde{a}_1, \tilde{a}_2, \dots, \tilde{a}_k \text{ grades } a_0, a_1, a_2, \dots, a_k \text{ there will}$$

be reasonable estimates for the regression coefficients.

We determine the pairwise correlation coefficients between the factors using the following formula:

$$r_{ij} = \frac{(\sum x_i x_j - \sum x_i \times \sum x_j / n)}{\sqrt{(\sum x_i^2 - (\sum x_i)^2 / n)(\sum x_j^2 - (\sum x_j)^2 / n)}}, \quad i, j = \overline{1, k} \quad (8)$$

It can be seen that $r_{ii} = 1$ for all $i = \overline{1, k}$.

Here, r_{ij} is the pairwise correlation coefficient between factors x_i and x_j . If the absolute value of the pairwise correlation coefficient (r_{ij}) of two factors is greater than its critical value (r_{kr}) ($r_{ij} > r_{kr}$), then the linear correlation between these factors is considered strong. Usually, its critical value $r_{kr} = 0.7$ is taken as a strong correlation.

It is known that in a multivariate regression equation, factors that are strongly linearly correlated should not be included simultaneously. Because they overlap to a certain extent and cause distortion of the parameters of the regression equation.

Analyzing the data presented in the appendix, we can see the presence of strongly correlated factors x_2 and x_3 , x_4 and x_5 , x_6 , which are greater than the critical value (r_{kr}). Therefore, we considered it appropriate to exclude these factors from the regression equation.

The most important stage in the analysis of socio-economic development using the correlation-regression analysis method is the selection of an econometric expression that describes the dependence of the resulting indicator on the selected factors. The quality, significance and reliability of the constructed econometric expression are assessed based on the following criteria: the overall quality of the econometric model is assessed using the multifactor correlation coefficient and the coefficient of determination; the significance of econometric models is assessed using the Fisher criterion and the approximation error; the significance of the econometric model parameters is assessed using the Student criterion.

The coefficient of determination (R^2) is used to determine the overall quality of the identified regression equation, and this indicator is calculated using the following formula:

$$R^2 = 1 - \frac{\sum_{i=1}^n (y_i - \hat{y}_i)^2}{\sum_{i=1}^n (y_i - \bar{y})^2}, \quad (9)$$

In this case: y_i - observed quantities of the outcome measure; \bar{y} - arithmetic average value of the resulting indicator; \hat{y}_i - determined, predicted, and smoothed values of the outcome indicator; n - number of observations.

The coefficient of determination shows the proportion of the variance of the outcome variable that is explained by the specified model, that is, the influence of the factors under consideration. This indicator takes values between "0" and "1". The closer its value is to

the value "1", the more the factors included in the regression equation explain the movements of the outcome indicator.

Analysis of the significance of the determined model is carried out by testing the "null hypothesis". "Null hypothesis" $H_0 : \beta_1 = \beta_2 = \dots = \beta_k = 0$ is reflected in the form and represents the general significance of the regression coefficient. If the results of the analysis do not reject the "null hypothesis", then: " X_1, X_2, \dots, X_k " the effect of the factors on the resulting indicator "y" is insignificant, and the overall quality of the regression equation is low," it is concluded. Testing the "Null hypothesis" is performed using the analysis of variance and is expressed as the "Null hypothesis" $H_0: D_{fact} = D_{leftover}$ versus the alternative hypothesis $H_1: D_{fact} > D_{leftover}$. The Fisher F-test is used to test these hypotheses.

In this case, the actual value of the criterion is determined by the following

$$F = \frac{\sum_{i=1}^n (\hat{y}_i - \bar{y})^2 / k}{\sum_{i=1}^n (y_i - \hat{y}_i)^2 / (n - k - 1)} = \frac{R^2}{1 - R^2} \times \frac{(n - k - 1)}{k}$$

formula: , (10)

In this case: $\sum_{i=1}^n (\hat{y}_i - \bar{y})^2 / k$ - factor variance corresponding to one degree of freedom

(number of degrees of freedom $\gamma_1 = k$); $\sum_{i=1}^n (y_i - \hat{y}_i)^2 / (n - k - 1)$ - residual variance

corresponding to one degree of freedom (number of degrees of freedom $\gamma_2 = n - k - 1$); n - number of observations; k - the number of factors (parameters) in the multivariate regression equation. The true value of the F-Fisher test (F_{real}) is compared with the critical value of the test ($F_{table}(\alpha; k; n - k - 1)$). If $F_{real} > F_{table}$, then the identified model is considered significant.

In the model developed through the analysis of factors affecting the profitability of Alokabank assets (presented in the table), the true value of the F-Fisher criterion is $F_{real} = 8.005$, and the number of degrees of freedom is $\gamma_1 = 17$ in the numerator and $\gamma_2 = 16$ in the denominator, and the tabular value of the Fisher criterion (at the significance level $p = 0.95$) is $F_{table} = 22.38$. Thus, our derived multifactor regression equation is significant.

Another criterion used to test the "null hypothesis" is the "P-value." If the "P-value" is less than the specified "0.05" value, it is concluded that "the null hypothesis can be rejected," and the identified model is considered significant.

Table 3. Descriptive statistics[11]

Modifiers	Number of observations	Average	Standard deviation	Minimum value	Maximum value
Return on assets, %	9	16	2,922	12.8	21.1
Total assets, billion soums	9	7960.867	5820.823	1217.8	16083.6
Loans, billion soum	9	5212.989	3475.082	934.8	10293.9
Securities - assets, bln. Soum	9	54.522	50.84	10.7	156.1
Cash assets, billion soum	9	929.522	608.212	181	2104.9
Interest income, bln. Soum	9	897.044	627.463	150.8	1862
Non-interest income, bln. Soum	9	411.056	484.305	57.7	1530.2
Interest expenses, bln. Soum	9	601.089	448.161	92.7	1340.4
Non-interest expenses, bln. soum	9	167.656	198.062	7.9	571.1
Operating expenses, bln. soum	9	269.511	186.136	68.3	608.9

Average annual interest rate of loans in national currency, %	9	19.311	4.729	11.4	24.2
The main rate of the Central Bank, %	9	13.444	2.651	9	16

This table presents the financial indicators of an enterprise or organization with statistical data. For each indicator, the average value, minimum and maximum values, as well as the distribution of values, are given. This information is used for financial analysis and decision-making.

When we analyzed the correlation coefficients between the factors, all factors, except for x4 (cash assets) and x11 (central bank interest rate), were strongly correlated, and therefore were not included in the regression equation.

Table 4. Correlation matrix[11]

Modifiers	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Return on assets, %	1.000										
(2) Total assets, billion soums	0.986	1.000									
(3) Loans, billion soum	0.932	0.919	1.000								
(4) Securities - assets, bln. soum	0.850	0.770	0.718	1.000							
(5) Cash assets, billion soum	0.950	0.976	0.892	0.685	1.000						
(6) Interest income, bln. soum	0.851	0.836	0.942	0.631	0.829	1.000					
(7) Non-interest income, bln. soum	0.938	0.964	0.901	0.660	0.998	0.849	1.000				
(8) Interest expenses, bln. soum	0.921	0.898	0.958	0.717	0.887	0.981	0.899	1.000			
(9) Non-interest expenses, bln. soum	0.977	0.971	0.969	0.775	0.953	0.939	0.954	0.975	1.000		
(10) Operating expenses, bln. soum	0.716	0.783	0.547	0.563	0.806	0.483	0.785	0.537	0.676	1.000	
(11) Average annual interest rate of loans in national currency, %	0.553	0.621	0.339	0.509	0.592	0.284	0.555	0.329	0.486	0.931	1.000

Below, the impact of factors x4 and x11 on Y is estimated.

Table 5. The results of the regression equation[11]

Return on assets	Coefficients	Standard error	t- value	p- value	[95% Conf	Interval]
Cash assets (x4)	-0.001	.002	-3.41	0.01	-4.006	.005
Average annual interest rate of loans in national currency (x11)	-0.031	.512	-3.06	0.01	-4.282	1.221
Constant	17.258	6.19	3.79	0.01	1.113	32.403
Mean dependent var	16.000		SD dependent var		2.922	
R-squared	0.942		Number of obs		9	
F-test	26.132		Prob > F		0.000	
Akaike crit. (AIC)	149.396		Bayesian crit. (BIC)		149.988	

The data presented in the above tables can be written as follows:

$$Y = 17.26 - 0.001x_4 - 0.03x_{11}$$

That is, this equation can be explained as follows: an increase in cash assets by 1 billion soums reduces the profitability of Aloqabank's assets by 0.001% unit. It was determined that an increase in the interest rate of the Central Bank by 1% unit will reduce the return on assets of Aloqabank by 0.03% unit. In this model, the factors x_4 and x_{11} explain 94.2% of the Y variable (R^2 squared).

At the same time, a forecast of Aloqabank's return on assets indicators was developed. The forecast indicators for 2024, 2025 and 2026 were calculated using the trend line $Y=0.2867*t-562.78$, where t is the time.

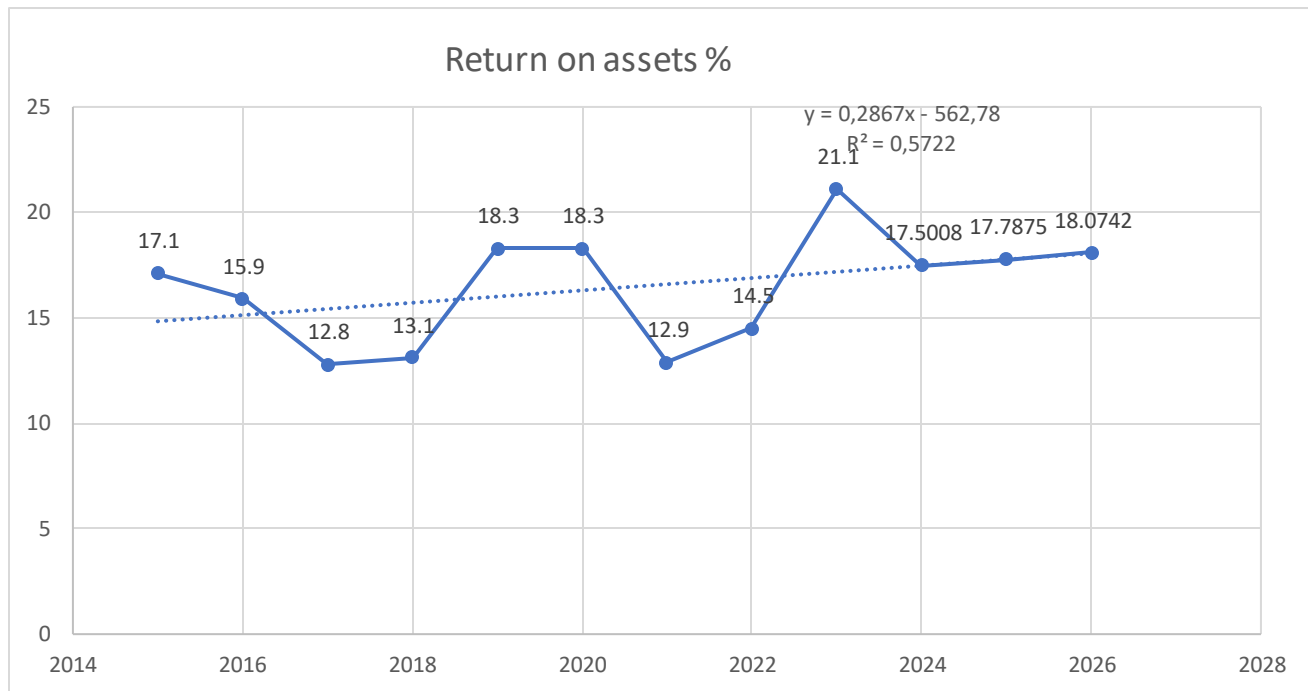


Figure 1. Forecast of Aloqabank's return on assets for 2024-2026[11]

According to the forecast, Aloqabank's return on assets will be 17.5 points in 2024, 17.79 points in 2025, and 18.07 points in 2026.

8. Discussion

The results of the study indicate that Aloqabank's return on assets (ROA) is significantly influenced by cash assets (x_4) and the average annual interest rate of loans in national currency (x_{11}). The regression model, $Y=17.26-0.001x_4-0.03x_{11}$, demonstrates that an increase in cash assets by 1 billion soums leads to a decrease in ROA by 0.001 percentage points, while an increase in the Central Bank's interest rate by 1 percentage point reduces ROA by 0.03 percentage points. This suggests that liquidity management and interest rate fluctuations play a crucial role in determining bank profitability.

The high R^2 value of 94.2% signifies that these two factors explain a substantial portion of the variance in ROA, reinforcing their relevance in financial decision-making. The significance of the regression model is confirmed by the F-test result (26.132, $p < 0.01$), indicating the robustness of the model. The exclusion of highly correlated factors ensures the reliability of the model by mitigating multicollinearity issues.

Furthermore, the trend analysis predicts an upward trajectory for ROA, with an estimated value of 17.5% in 2024. This suggests that despite fluctuations in interest rates and cash assets, the bank's profitability is expected to remain stable or improve. However,

external economic conditions, monetary policies, and bank-specific strategies must be continuously monitored to validate and adjust the forecast. Future research should incorporate additional macroeconomic variables, such as inflation and exchange rate fluctuations, to enhance the predictive accuracy of the model.

9. Conclusion

As a result of econometric analyses conducted using a multivariate linear regression equation on the profitability of commercial banks' assets, the following conclusions were drawn:

From 2015 to 2018, Aloqabank's return on assets decreased, then increased again in 2019, then sharply decreased again in 2021 and increased until 2023. In our opinion, Aloqabank's return on assets will continue to fluctuate, although the average rate of return will grow, albeit slowly. The reason for this may be the growing trend of consumer spending in the country and the stability of the national banking system.

The increase of cash assets by 1 billion soums reduces the profitability of Aloqabank's assets by 0.001% unit. It was determined that an increase in the interest rate of the Central Bank by 1% unit will reduce the return on assets of Aloqabank by 0.03% unit.

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