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Research Article

# Correlation and regression analysis of factors influencing the profitability of commercial banks in Uzbekistan

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## Abstract

The article analyzes the correlation-regression effects to profit in 2020-2000 of inflation, risky assets, capital, percent rate of loans in 32 commercial banks of Uzbekistan, which have their 836 branches. The impact of these factors on the bank's profit has been researched both theoretically and practically, with a connection model developed between their effect on the outcome factor (profit).

Moreover, the development trends of commercial bank assets in Uzbekistan are examined in this article. It was identified the primary elements impacting the efficiency of commercial banks and the development of asset performance indicators in commercial banks throughout the country, as well as the study findings.

## 1 Introduction

The reforms in the banking sector started in 1991 when a two-tier banking sector was established on base former Gosbank of the USSR. Despite the liberalization of monetary policy in recent years, reforms to transform banks to market principles, the state's share in the capital of commercial banks in the country remains high (87.2%). At the same time, the assets of commercial banks account for 63.1% of GDP, and credit flows – 47.7%, deposits – 19.1%, capital – 10.1%. The assets of the banking system of Uzbekistan make up 86.3% of risky assets, the ratio of net income to assets (ROA) is 2.2, and the capital ratio (ROE) is 10.3 (CBU, 2020). From the above data, it is clear that the inflow of loans does not play an important role in the formation of the profit of commercial banks in Uzbekistan, and their economic efficiency is low, despite the high proportion of risky assets in the composition of their assets. However, it is

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natural for commercial banks to pay special attention to the steady growth of profits since profits play an important role in increasing dividends and wages paid to shareholders, increasing the bank's capital and strengthening financial stability. Of course, there is an influence of local and foreign policy in favor of commercial banks, but the inflation rate, risky assets of the bank, bank capital and average annual interest rates on loans are factors that directly affect their profitability.

The Decree of the President of the Republic of Uzbekistan dated on February 7, 2017, "On the Strategy for the Further Development of the Republic of Uzbekistan" PD – 4947 emphasizes the issues of deepening and ensuring the reform of the banking system, increasing the level of capitalization and the deposit base of banks, strengthening their financial stability and reliability (Decree,2017). In recent years, regulators have increased their focus on the capital adequacy of banking institutions to enhance the financial system's stability (Rime, 2001). The main reason for this, in our opinion, stems from the global financial and economic crises, especially the COVID-19 pandemic in 2020, as well as the demands placed on commercial banks by the mega-regulator.

## 2 Materials and Methods

The author used a database based on information from the State Statistics Committee of Uzbekistan, the periodic statistical bulletin of the Central Bank. According to data, the profit of commercial banks in Uzbekistan (Y), inflation rate (X1), risky assets of the banking system (X2), regulatory capital of commercial banks (X3), average annual interest rates on bank loans (X4) data were analyzed for correlation and regression, as of condition January 1, 2000-2020.

In the correlation and regression analysis, we used simple factor analysis, statistical correlation methods of the inflation rate affecting the profit margins of commercial banks, risk-weighted bank assets, regression analysis of weighted average annual interest rates of bank capital and loans. In particular, the methods of balance and index were widely used to test functional relationships, and methods of parallel series, analytical grouping, analysis of variance, and regression and correlation analysis methods were widely used to study correlation relationships.

## 3 Results

The advantages of commercial banks are the subjects of research by many economists and experts as a topical issue. It is because several factors directly or indirectly affect the benefits of banks. One of the main ones is inflation, which negatively affects the profitability of commercial banks and their stability. Without inflation, a company's profitability is overestimated if the cost of depreciation and inventory consumed during the year is based on historical cost rather than replacement cost (Slawson, 2015). Thus, when determining the level of bank profitability in inflation conditions, the separation of inflationary income from its income structure allows us to determine the real situation in terms of its profitability.

Commercial banks' profitability is affected by the market power measured by the ratio of outstanding loans to the country's credit, the size of the bank in terms of capital structure, the nature of business as it is exposed to risks and the set limit for capital adequacy (Koba, 2018). In fact, the volume of risky assets of commercial banks, particularly a large volume of loans, leads to an increase in their level of profitability and requires an increase in the amount of bank capital.

Koba puts forward important ideas about the capital adequacy of commercial banks. According to him, like any commercial organization, banks need capital to operate and survive. However, capital plays a much more specific role in the banking sector than other industries because banks are high-level institutions. Therefore, regulatory bodies must maintain a minimum amount of capital to ensure this in any case (2015). The Central Bank of Uzbekistan seeks to further increase the volume of bank capital by raising the standards for risking the assets of commercial banks, the main goal of which is not to increase the lending rate of commercial banks.

The Central Bank of Uzbekistan is pursuing a tight monetary policy to ensure the national economy's consumer price index (CPI) stability. Of course, the Central Bank focuses on fulfilling the inflation targeting forecast to reduce the money supply in the economy. As a result, interest rates on bank loans in the country tend to grow steadily since the high demand for money in the real sector. The lack of sufficient financial resources of commercial banks to meet this demand directly leads to an increase in their lending rates.

The level of bank efficiency may affect future bank risk. In addition, a decrease in efficiency leads to an increase in the bank's risk. There should be a negative correlation between risk and efficacy when these exogenous events occur. Such events increase problem loans, risks, and in response, banks have to pay additional costs and resort to management actions. Accordingly, an increase in banking risk decreases cost-effectiveness (Moscow & Bozdo, 2016). Indeed, the current increase in risky assets in Uzbek commercial banks has a positive effect on their profits, but high inflation has led to a decline in the bulk of profits as inflationary earnings and an increase in bank capital to ensure capital adequacy.

In accordance with the banking legislation and market principles in force in the country, the Central Bank does not have the right to give direct instructions to commercial banks on setting loans and interest rates. The Central Bank has established the order of risk at the level of 150, 200 and 300 percent: risking the loan amount, the interest rates on loan exceed the limits that it satisfies. In this case, an increase in the volume of risky assets of commercial banks imposes an obligation to increase their capital.

However, according to Jean, Ying, Salwa (2014), concerning market principles, banks find it risky to lend to those who agree to take out a loan at a high-interest rate because even if the borrower agrees to take out a loan at a high-interest rate, this increases the risk of repayment. In fact, this idea finds its practical confirmation in the real sector since the process of repaying loans issued by banks is very laborious and leads to additional costs.

The increase by the central bank of the rate on risky assets of commercial banks also affects the level of profitability of their capital. It is noted by Lotto (2018), who recognizes that the size of assets at risk has a direct impact on the determination of a bank's capital adequacy while the efficiency of their capital decreases. In fact, increasing the volume of risky assets of commercial banks requires a constant increase in the size of their capital. Currently, the capital adequacy ratio of commercial banks in Uzbekistan is 13%, fixed assets – 9.5%, which is significantly higher than the requirements of international Basel III (Benjamin, Michela, 2014).

Altunbas, Carbo, Gardener and Molineux argue that there is an inextricable link between the capital, risky assets and financial stability of commercial banks while increasing the volume of their risky assets will have a positive impact on profits (2007). An excessive increase in the

volume of risky assets of the bank can lead to a problematic situation for them in fulfilling their obligations.

Among the factors influencing the profitability of commercial banks, the interest rate on a bank loan plays an important role. It is known that the interest rate on loan should be adjusted based on supply and demand in the market. However, it is impractical to conclude that a high interest rate on a bank loan guarantees its profitability since several factors affect its formation. For instance, in Uzbekistan, interest rates are directly affected by inflation and a low money supply. Evidence is an indication that bank profitability depends on several factors in which inflation is one of them. Inflation has reduced competitiveness in global markets and can negatively impact nearly all types of economic operations, particularly banking, as a virus that has infected almost all economies of the world, including emerging and industrialized ones (Oleka, Eyisi, 2014). There is no doubt that the bulk of interest on loans from commercial banks will not be real income in the form of inflationary income. In addition, banks are not very interested in attracting time deposits due to interest payments from legal entities and individuals. The share of term deposits in the deposits of commercial banks in Uzbekistan is low, and banks form risky assets at the expense of demand deposits, that is, demand deposits. It, in turn, leads to inconsistencies in their liquidity indicators.

Al-Nimer, Dr-Munther, Lina, Rania (2013) found that a decrease in the liquidity of banks not only causes problems in fulfilling their obligations but also leads to an increase in the risk level of assets of commercial banks. If the bank does not apply effective management policies in this process, it will have a negative impact on their profitability and financial stability (2013). According to Uremadu, while the capital and liquidity of commercial banks serve to ensure their financial stability, the fact that banks have excess capital and liquidity affects their profitability. Therefore, the bank liquidity and capital should be provided to such an extent that it does not lead to the formation of excess capital and liquid funds in them (2012).

Correlation coefficients are used to determine the factors affecting the profitability of commercial banks using the following formula:

$$r_{x_1x_2} = \frac{N\sum x_1x_2 - \sum x_1 \sum x_2}{\sqrt{N\sum x_1^2 - \left(\sum x_1\right)^2}\sqrt{N\sum x_2^2 - \left(\sum x_2\right)^2}} \quad (1)$$

*Table 1*

**Using the correlation package in an Excel spreadsheet, find the following correlation coefficients:**

| | *Y* | *X1* | *X2* | *X3* | *X4* | *X5* |
|---|---|---|---|---|---|---|
| Y | 1 | | | | | |
| X1 | 0,10572115 | 1 | | | | |
| X2 | 0,99241435 | 0,098039 | 1 | | | |
| X3 | 0,99560399 | 0,099902 | 0,994166 | 1 | | |
| X4 | 0,98963959 | 0,119929 | 0,977252 | 0,986213 | 1 | |
| X5 | 0,06104374 | 0,983354 | 0,036521 | 0,049846 | 0,076851 | 1 |

Multiple factors were not found among the elements. Now the linear relationship between the factors $y$ $x_1$ $x_2$ is determined.

The linear relationship between the type of connection and the factors $y$ $x_1$ $x_2$ is searched for in the following representation:

$$\tilde{y} = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + ax_4$$

Using computer calculations, we compose the following regression equation:

$$\tilde{y} = -649{,}32 - 86{,}3x_1 + 0{,}11x_2 + 0{,}027x_3 + 79{,}5x_4$$

Based on the regression coefficients, we calculate the standardized coefficients using the following formulas:

$$\beta_i = a_i \cdot \frac{\sigma_{x_i}}{\sigma_y}$$

$\sigma_{x_1} = 1{,}5$ $\sigma_{x_2} = 9892{,}04$ $\sigma_{x_3} = 3518{,}04$ $\sigma_{x4} = 7{,}6$

$\sigma_y = 5927{,}9$

$\beta_1 = 0{,}00002$ $\beta_2 = 0{,}00019$ $\beta_3 = 0{,}00002$ $\beta_4 = 0{,}00012$.

We get the equation in the standard form:

$$t_y = 0{,}000002 \cdot t_{x_1} + 0{,}00019 \cdot t_{x_2} + 0{,}000002 \cdot t_{x_3} + 0{,}000012 \cdot t_{x_4}$$

Since the standardized regression coefficients are comparable, the most significant impact on profitability is $x_2$ - the assets of the banking system, total (billion soums) and $x_3$ - risky assets of the banking system, total (billion soums), since their absolute value of the coefficients is about the same and much more. We calculate the flexible coefficients using the following formula:

$$E = a_i \frac{\bar{x}}{\bar{y}}.$$

We calculate the flexible coefficients:

$E_1$=-0,92826
$E_2$=7,569123
$E_3$=1,058989
$E_4$=0,019251

Obviously, with an increase in the total assets of the banking system by 1% (billion soums), the bank's profit will increase by 7.5%. The model is evaluated using Fisher's criterion to assess relevance and adequacy.

*Table 2*

**Analysis of variance for multivariate regression**

| Variation ***y*** | Rate of availability | Sum of squares | Average square | *F* |
|---|---|---|---|---|
| Factor | $\nu_{factor} = p$ | $SS_{factor} = \sum(\tilde{y} - \bar{y})^2$ | $MS_{factor} = \frac{SS_{factor}}{\nu_{factor}}$ | $F = \frac{MS_{factor}}{MS_{residue}}$ |
| Residue (Balance) | $\nu_{residue} = n - p - 1$ | $SS_{residue} = \sum(y - \tilde{y})^2$ | $MS_{residue} = \frac{SS_{residue}}{\nu_{residue}}$ | |
| Total | $\nu_{total} = n - 1$ | $SS_{total} = \sum(y - \bar{y})^2$ | | |

Main features of variance analysis:

$SS_{total} = SS_{factor} + SS_{residue}$.

Standard error S or residual variance $S^2$ is used to assess the adequacy of the selected models.

## 4 Discussion

Several modules and equations are used in regression and correlation analysis of factors affecting the profitability of commercial banks. It should be noted that when the factors affecting the benefits of commercial banks in the country change, it is essential to apply market principles and transparency. Because in this case, the accuracy of the generated data is ensured, which makes it possible to form effective conclusions based on correlation and regression analysis (Berkinov, 2015). To this end, Fisher's test is used to assess the density and adequacy of the model.

The following statistical hypothesis was made:

$$H_0 : a_1 = a_2 = a_3 = ... = a_n = 0$$

In other words, the factors $x_1$, $x_2$,..., $x_n$ *have almost no effect on the result* ***y***.
*The actual F–* score is calculated using the following formula:

$$F = \frac{MS_{factor}}{MS_{residue}} = \frac{R^2}{1 - R^2} \cdot \frac{n - p - 1}{p}, \quad (5)$$

where $n$ – is the number of observations; $p$ – is the number of factors involved in the model; $R^2$ – is the coefficient of determination.

The values of the factor (α, k1, k2 ) should be found from the Fisher quantum distribution table. In this case, $k_1 = p = 4$ and $k_2 = n - p - 1 = 16$ .
The actual state according to the $F_{хис}$ Fisher criterion is determined by the following formula for analysis of variance:

$$F_{comp.} = \frac{MS_{factor}}{MS_{residue}}, \; F_{comp.} = \frac{12602496,09}{9325,03} = 1351,5 .$$

If after the calculation, it turns out that $F_{comp.} > F_{tab}$. it will be possible to predict the future values of the factor $\tilde{y}$ using the regression equation.

Where $F_{comp.}$*=1351,5*> $F_{tab.}$= 3,01.

The multivariate correlation coefficient determines the density of the relationship between the factors$\mathbf{x}_1$, $\mathbf{x}_2$,..., $\mathbf{x}_p$ and the resulting index **y**. The following formula determines the multivariate correlation coefficient using analysis of variance:

$$R = \sqrt{\frac{SS_{total}}{SS_{factor}}} = \sqrt{1 - \frac{SS_{residue}}{SS_{factor}}} = 0{,}998523$$ the importance of the regression equation appears.

*For individual regressor, the t– Student's test is used. It makes it possible to create the optimal filling of the model*

. $t_{a_j} = \frac{a_j}{S_j}$ (10), where $S_j^2 = \frac{\sum (y - \tilde{y})^2}{n - p - 1}$ - is the squared residual error.

If the inequality $\left|t_{a_j}\right| \le t_{tab}(\alpha, n - p - 1)$ is true, then the hypothesis is confirmed, i.e., the regression coefficients *are equal to0, and the hypothesis $H_0$ is confirmed. That is, it determines the significance of the parameter $a_j$,* and we hypothesize that the factors $\boldsymbol{x}_j$ do not depend on the result:

$$H_0 : a_1 = a_2 = a_3 = ... = a_n = 0$$

In this case, there is no connection between the regressors $\mathbf{x}_j$ and **y**. Otherwise, hypothesis $H_0$ is not confirmed. In this case, there is a relationship between the regressors $\mathbf{x}_j$ and **y**.
It was found that there is a relationship between the regressors $\mathbf{x}_j$ and **y** from

$t_r = \left|-4{,}21695\right| = 4{,}21695$, $t_{a_1} = \left|-4{,}293\right| = 4{,}293$, $t_{a2} = 9{,}696$, $t_{a3} = 3{,}9434$, $t_{a4} = 4{,}3192$ and $t_{table} = 2{,}09$.

the strength of the relationship between the resulting and influencing factors was confirmed since a correlation coefficient is $R = \sqrt{\frac{SS_{total}}{SS_{factor}}} = 0{,}998523$

The importance of the regression equalization

$\tilde{y} = -649{,}32 - 86{,}3x_1 + 0{,}11x_2 + 0{,}027x_3 + 79{,}5x_4$ according to Fisher's criterion $F_{com.} = \frac{MS_{factor}}{MS_{residue}}$, $F_{com.} = \frac{12602496{,}09}{9325{,}03} = 1351{,}5$ the value found in the table of values is greater than $F_{table}$= 3.
Hence, there is appeared the importance of the regression equalization

$\tilde{y} = -649{,}32 - 86{,}3x_1 + 0{,}11x_2 + 0{,}027x_3 + 79{,}5x_4$

As a result of research using the t–Student's test, it was found that there is a relationship between the regressors $\mathbf{x}_j$ and **y** from $t_r = \left|-4{,}21695\right| = 4{,}21695$, $t_{a_1} = \left|-4{,}293\right| = 4{,}293$, $t_{a2} = 9{,}696$, $t_{a3} = 3{,}9434, t_{a4} = 4{,}3192$ and $t_{table} = 2{,}09$.

In short, it can be predicted using a regression equation $\tilde{y} = -649{,}32 - 86{,}3x_1 + 0{,}11x_2 + 0{,}027x_3 + 79{,}5x_4$ that Elastic Coefficients are:

$E_1$=-0,92826
$E_2$=7,569123
$E_3$=1,058989

Where $E_4$=0,019251, the change in each of the above factors can be determined.

## 5 Conclusion

We made several conclusions based on the correlation-regression analysis of factors affecting the profitability of commercial banks.

**1.** It was found that the factors affecting the $y-$ bank's profit (billion soums) in commercial banks are associated with $x_1-$ inflation (in percent), $x_2-$ risky assets of the banking system as a whole (billion soums, $x_3-$ the bank's regulatory capital (billion soums), $x_4-$ average interest rates of the bank (in percent).

**2.** The high level of inflation in the economy negatively affects the profitability of the bank, which leads to an increase in inflationary income. High inflation negatively affects the time deposits of depositors in banks, which indirectly and negatively affects their profits, naturally due to a decrease in the amount of risky assets of banks.

**3.** An increase in the volume of risky assets of commercial banks has a direct positive impact on the bank's profit. According to the results of the correlation-regression analysis, the growth of risky assets of banks increased by 7.5%, while bank's profits increased by 10.5%.

**4.** 1% in the bank's regulatory capital will increase the bank's profits by 1.05%. In contrast, the increase in interest rates on bank loans should be based on supply and demand in the economy and in an environment of high inflation, interest rates rose.

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