Effectiveness of bank credit activity evaluation with application of economic and mathematic modeling

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Abstract. The paper presents data on the influence of the most significant factors having impact on the credit portfolio volume, as well as conducts correlation and regression analysis with the subsequent construction of the trend for a short period. Credit activity is understood as the bank activity in the formation of a credit portfolio. Considering the structure of the bank credit portfolio, it can be observed that it consists of credits granted by the bank particularly for legal entities, individuals and other banks. Herewith, it is necessary to understand that any decrease in the credit portfolio will adversely affect the financial stability and effectiveness of any commercial bank. Moreover, during crisis periods, the policy and practice of banks have been determined as quite aggressive and conducted as such with regard to interest rates. The dynamics of credit portfolio volume has been selected as an independent factor due to the reason that it can fully explain the current development situation and the effectiveness of the bank credit policy. Considering the dependent factors, their influence will be assessed by the credit portfolio volume indicator. The authors have distinguished the following ones among them: the volume of credits granted to individuals; the volume of credits granted to legal entities; the amount of overdue credits in the credit portfolio; bank investments in the securities; inflation; key rate.

1. Introduction

These days, it is necessary to apply the economic and mathematic method of multiple correlation-regression analysis for identification of relationship between the credit portfolio volume and the factors affecting this indicator. The model development required involvement of the data for the period of 2012-2016 from the publicly available information sources of Russian statistical organizations and analytical groups. In order to determine the dependence of the volume of the credit portfolio on various performance indicators of the bank, it is necessary to build a regression model and analyze the quality of these models. For calculation of the paired correlation coefficients matrix, let us use the “Correlation” program of the MicrosoftExcel “Data Analysis” menu.

Then, using the Regression program of the MicrosoftExcel Data Analysis Add-in menu, let us get the data and regression analysis coefficients. The results of the analysis and calculations of regression statistics are summarized in Table 2.

The data obtained allow one to assess primarily the reliability of the model on the basis of coefficient analysis, and also to assess the influence of each factor of the model for the immediate forecasting of each factor, respectively, and then to forecast the volume of the credit portfolio itself.
This paper presents an investigation of the influence of different factors having impact on the credit portfolio volume.

2. Materials and methods
It is necessary to consider the significance of factors for the period of 2014-2016 in monthly dynamics to offer the most accurate forecast for the development of the credit portfolio volume.

The following type of the regression model will be used to construct the multiple linear regression equation:

\[ Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n, \]  

where \( Y \) - dependent variable;  
\( x = (x_1, x_2 \ldots x_n) \) – vector of independent variables;  
\( \beta = (\beta_1, \beta_2 \ldots \beta_n) \) – vector of regression coefficients.

6 independent variables, previously identified, are used to compile the regression study.

Let us apply the methods of correlation-regression analysis for determination of the factors most closely-influencing on the development indicator of the credit portfolio volume.

Variables used in the study are as follows:
- as a dependent variable, \( Y \) - the volume of the credit portfolio;  
- as an independent variable, \( X_1 \) - the volume of credits granted to individuals;  
- as an independent variable, \( X_2 \) - the volume of credits granted to legal entities;  
- as an independent variable, \( X_3 \) - the amount of overdue credits in the credit portfolio;  
- as an independent variable, \( X_4 \) - the bank investments in securities;  
- as an independent variable, \( X_5 \) - inflation;  
- as an independent variable, \( X_6 \) - the key rate.

The requirement of the least possible correlation between the factorial characteristics included in the model shall be observed when constructing multifactor models. As a result, the variation in the input data ceases to be completely independent, and it is impossible to assess the impact of each factor separately.

3. The study of the bank credit activity with application of economic and mathematic modelling
The matrix of paired coefficients shows correlation both between the performance indicator and each of the factor indicators and between the factors themselves (Table 1).

|       | Y   | X1  | X2   | X3    | X4   | X5    | X6   |
|-------|-----|-----|------|-------|------|-------|------|
| Y     | 1   |     |      |       |      |       |      |
| X1    | 0.535411 | 1   |      |       |      |       |      |
| X2    | 0.356846 | -0.59603 | 1   |       |      |       |      |
| X3    | 0.076465 | -0.48689 | 0.623633 | 1   |      |       |      |
| X4    | 0.475553 | -0.34946 | 0.83233 | 0.522649 | 1   |       |      |
| X5    | 0.43707  | 0.216638 | 0.179237 | 0.215471 | 0.412658 | 1   |      |
| X6    | 0.423695 | -0.17852 | 0.598955 | 0.410111 | 0.752445 | 0.795297 | 1   |

According to the above-mentioned data, all the dependent factors will participate in the construction of the regression model, with the exception of \( X_3 \) (the amount of overdue debt in the credit portfolio), since the value of the \( X_3 \) indicator is below the critical level (0.25).
Table 2. Regressive analysis results

| Regression statistics | Value                  |
|-----------------------|------------------------|
| Multiple R            | 0.997862748            |
| R-square              | 0.995729524            |
| Df                    | 5                      |
| Y-crossing            | 2891039.736            |
| Variable X1           | 1.00625268             |
| Variable X2           | 0.964167638            |
| Variable X4           | 0.048220259            |
| Variable X5           | -139016.9849           |
| Variable X6           | 105439.5848            |

According to Table 2, the R-square value, also called a measure of certainty, characterizes the quality of the regression line obtained. By the results of the analysis, the value of the R-square is close to the figure of one and is 0.995729524, which means that the model constructed explains almost entire variability of the corresponding variables. Thus, the factors that make up the model explain the dependent variable by 99%.

Multiple R - the coefficient of multiple correlations expresses the dependence degree of independent variables (X) and the dependent variable (Y). Based on the results of calculations, multiple R is 0.997862748, which evidences a very high relationship between the variables. The number of freedom degree (df) is 5.

From the presented analysis, it is possible to formulate the regression equation, which will have the following form:

\[ Y = 2891039.736 + 1.00625268 \times X_1 + 0.964167638 \times X_2 + 0.048220259 \times X_4 - 139016.9849 \times X_5 + 105439.5848 \times X_6 \]

This equation shows that an increase in the volume of credits issued to individuals leads to an increase in the volume of the credit portfolio by 1.00625268 million rubles. With the increase in the volume of credits granted to legal entities, the volume of the credit portfolio is increased by 0.964167638 million rubles. With an increase in the bank investments in securities, there is an increase in the volume of the credit portfolio by 0.048220259 million rubles. With the growth of inflation, the volume of the credit portfolio is reduced by 139016.9849 million rubles. With the growth of the key rate, the volume of the credit portfolio is increased by 105439.5848 million rubles.

Let us estimate the quality of the constructed model of multiple regressions using β and Δ-elasticity coefficients.

Table 3. Calculation results of β and Δ-elasticity coefficients

|                | Y     | X1        | X2        | X4         | X5          | X6         |
|----------------|-------|-----------|-----------|------------|-------------|------------|
| average value  | 433460946 | 207897597.5 | 225337004.6 | 91437783.48 | 8.461666667 | 8.316666667 |
| elasticity     | x     | 0.482621368 | 1.045046455 | 0.019566931 | -0.012864653 | 103632.7611 |
| dispersion     | 6.44629E+14 | 8.55474E+14 | 7.13684E+14 | 3.32904E+14 | 14.80511582 | 10.84717514 |
| rmsd           | 25389544.44 | 29248487.89 | 26714859.92 | 18245669.88 | 3.847741652 | 3.293504993 |
| bi             | x     | 1.00625268 | 0.964167638 | 0.048220259 | -139016.9849 | 105439.5848 |
| βi             | x     | 1.159129493 | 1.014496476 | 0.03465249 | -0.021067784 | 0.013677512 |
| ryxi           | x     | 0.535410859 | 0.356846174 | 0.475552871 | 0.437069767 | 0.423694771 |
| Δi             | x     | 0.623306062 | 0.363571811 | 0.016549766 | -0.009247583 | 0.005819944 |
| R^2            | 0.995729524 | x         | x         | x          | x           | x          |
4. Conclusion
1. With an increase of 1% in the volume of credits granted to individuals (X1), the credit portfolio volume will increase by 0.483% (E1 = 0.483); with an increase of 1% in the volume of credits granted to legal entities (X2), the credit portfolio volume will increase by 1.045% (E2 = 1.045); with an increase of 1% in the amount invested by the bank in securities (X4), the credit portfolio volume will increase by 0.019% (E4 = 0.019); with an increase in inflation by 1% (X5), the credit portfolio volume will decrease by 0.012% (E5 = 0.012); with a 1% increase in the key rate level (X6), the credit portfolio volume will increase by 103632.7611% (E6 = 103632.7611).

2. If the number of credits granted to individuals (X1) is increased by 1 unit of RMSD, the RMSD of the credit portfolio will increase by 1.16 (β1 = 1.159192493). When the volume of credits granted to legal entities (X2) is increased by 1 unit, the RMSD of the credit portfolio volume will increase by 1.01 (β2 = 1.014496476). With an increase by 1 unit of RMSD of the amount invested by the bank in securities (X4), the RMSD of the credit portfolio volume will increase by 0.03 (β4 = 0.03465249). With an increase by 1 unit of RMSD inflation rate (X5), the RMSD of the credit portfolio volume will decrease by 0.021 (β5 = -0.021067784); with an increase in the unit level of key rate (X6) by 1 unit, the RMSD of the credit portfolio volume will increase by 0.013 (β6 = 0.013677512).

3. The specific weight of the effect of the volume of credits granted to individuals (X1) on the volume of the credit portfolio (the result) is 62.3% (Δ1 = 0.623306062); the specific impact of the volume of credits granted to legal entities (X2) on the volume of the credit portfolio is 36.3% (Δ2 = 0.363571811). The specific weight of the impact on the bank's funds invested in securities (X4) on the volume of the credit portfolio is 1.65% (Δ4 = 0.016549766). Specific influence of the inflation level (X5) on the volume of the credit portfolio will have a negative impact and be equal to -0.92% (Δ5 = -0.009247583), and the key rate level (X6) will be 0.58% (Δ6 = 0.005819944).

According to the given data, the forecast value of the volume of the credit portfolio under investigation calculated by the multiple regression equation will be in the range of 485581979.48 rubles up to 495092951.12 million rubles. This regression equation is recognized as statistically significant by the Fisher criterion and has a sufficiently high quality; therefore, the results of calculations can be considered as true and reliable.

Indeed, many experts predicted the economic recovery in 2017. In order to improve the activity of credit institutions, it is recommended that the volume of the credit portfolio be constantly monitored, which brings the greatest profit to the commercial organization, depending on various factors, such as: the volume of credits issued to individuals and legal entities, the bank investments in securities, situations in the domestic and foreign financial markets, the Central Bank key rate, the inflation rate, etc.

Application of mathematic modeling to the analysis of financial processes will allow a quick monitoring of the results of banking activity and making scientifically sound decisions in a timely manner.

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