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Econometric Estimation of Debt on Legal Entities Loans

Estimación econométrica de la deuda de préstamos a entidades jurídicas

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ABSTRACT

This study aims to assess the connection between macroeconomic indicators and banking sector economy indicators, with the share of overdue loans to legal entities on the example of the Russian economy, based on a multiple regression linear model. Linear correlation, linear regression, classical least squares method and graphical method were used. The obtained models predict positive opportunities for the corporate sector lending development in the future. In the course of the analysis based on Russian quarterly data for 2013-2019, the relationship between the share of legal entities overdue loans, macro indicators and banking sector development indicators were measured.

Keywords: Bank lending, inflation rate, linear regression model, overdue loans, volume of bank deposits of legal entities.

RESUMEN

Este estudio tiene como objetivo evaluar la conexión entre los indicadores macroeconómicos y los indicadores de la economía del sector bancario, con la proporción de préstamos vencidos a entidades legales en el ejemplo de la economía rusa, basado en un modelo lineal de regresión múltiple. Se utilizó la correlación lineal, regresión lineal, método clásico de mínimos cuadrados y el método gráfico. Los modelos obtenidos predicen oportunidades positivas para el desarrollo del crédito al sector empresarial en el futuro. En el curso del análisis basado en datos trimestrales de Rusia para 2013-2019, se midió la relación entre la proporción de entidades legales con préstamos vencidos, indicadores macroeconómicos e indicadores de desarrollo del sector bancario.

Palabras clave: Modelo de regresión lineal, préstamos bancarios, préstamos vencidos, tasa de inflación, volumen de depósitos bancarios de personas jurídicas.

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INTRODUCTION

In the context of the modern economy development, one of the most important roles is played by lending operations to manufacturing enterprises, the effectiveness of which depends on the state support conditions for various economy sectors, using the credit mechanism (Hamilton: 1994; Khasawneh&Dasouqi: 2017; Sewpersadh: 2019). Lending to the corporate sector in the Russian Federation is becoming increasingly important, as it reveals the natural economic process that covers the interests of many economic entities (Bulatova et al.: 2019; Sikochi: 2020). In order to reduce credit risks and the share of overdue debt in the total volume of loans issued, a set of measures based on the analysis of the creditworthiness and financial condition of borrowers is necessary (Grydaki&Bezemer: 2013, pp.4615-4626; Chernyshova et al.: 2015; Nasir et al.: 2020). According to the Central Bank, in 2019, the growth rate of the loan portfolio of corporate clients slowed down to 4-5%, which is explained by the increase in the tax burden and the reduction of rates on the debt market to the minimum level of 2013.

The possibility of increasing the volume of corporate lending directly depends on the macroeconomic, political and social factors of the country's development (Bulatova et al.: 2016, pp.185-190; Kudrenko: 2017; Almaghribi et al.: 2020). An increase in the tax burden, as well as a fall in the purchasing power of the ruble, can significantly change the direction of lending to legal entities, which will lead to a decrease in GDP growth (Britton et al.: 2019; Shaidullin et al.: 2019).

To identify the factors that determine the amount of overdue debt on loans granted to legal entities, we used linear multiple regression models in the study. To build models, we use statistical data that characterize the banking system and the Russian economy over the past 7 years in quarterly terms - from the 1st quarter of 2013 to the 1st quarter of 2020. The least squares method is used to evaluate model parameters, and the traditional formal Student and Fisher tests are used to verify statistical significance. The choice of factors influencing the observed indicator was made on the basis of qualitative and quantitative analysis of the studied phenomena.

The main purpose of the research is to detect and evaluate the factors that determine the share of overdue loans issued to legal entities.

Based on the analysis of literary sources, two main research questions were formulated (Cumming et al.: 2020, pp.95-120):

1. What macroeconomic indicators correlate with the share of overdue debt on loans to legal entities?
2. What indicators of the economy banking sector contribute to the change in the share of overdue loans to legal entities?

The following results were obtained during the study:

- There was no statistically significant correlation between the share of overdue debt and the level of inflation, gross domestic product, key rate, revenue of medium and large enterprises, the coefficient of organizations autonomy, balances on current accounts of legal entities, weighted average interest rates on loans and deposits of legal entities, as well as the volume of loans to legal entities;
- Statistically significant inverse relationship was defined between the share of overdue loans from legal entities, the US dollar exchange rate and the number of operating credit institutions. This corresponds to theoretical concepts by Brooks (Brooks: 2008);
- Direct correlation between the share of legal entities overdue loans and legal entities deposits was confirmed, which can predict the problem of debt load in the future.

METHODOLOGY

Correlation analysis allows one to determine whether there is a statistical connection between two indicators in the same sample, or between two different samples, and if this connection exists, whether the increase in one indicator is accompanied by an increase or decrease in the other. The correlation analysis reveals not only the strength of the connection between the influencing variables and the dependent variable, but also the link between the influencing factors. If the connection between influencing factors is ≥ 0.7 , then these factors are called multicollinear.

The correlation coefficient shows the tightness of the linear relationship and changes in the range from -1 to 1. Minus one means a complete linear inverse connection. The unit is a complete linear positive connection. Zero – no linear correlation. When there is a positive correlation, an increase in one factor leads to an increase in another, and when there is a negative correlation, the growth of one indicator leads to a decrease in the other.

Regression analysis allows one to identify the statistical significance of factors and the difference between the correlation coefficient and zero using a formal Student test.

To build a linear model of multiple regression, quarterly statistical data for 7 years from 01.01.2013 to 01.01.2020 were used (Table 1, Table 2).

Variables	Data type	Source	Internet Link
Variables of the banking economy sector			
Yt – the share of overdue debt on loans to legal persons	percent.	CBR	https://cbr.ru/
X ₁₈ - the deposits of legal entities	millionrubles.	CBR	https://cbr.ru/
X ₁₉ - the balances on current accounts of legal entities	thousandrubles.	CBR	https://cbr.ru/
X ₁₁₀ - the weighted average interest rates on loans granted by credit organizations to legal entities for more than 1 year	percent.	CBR	https://cbr.ru/
X ₁₁₁ – the volume of loans granted to legal entities	Million rubles.	CBR	https://cbr.ru/
X ₁₁₂ - the weighted average interest rates on deposits of legal entities over 1 year	percent.	CBR	https://cbr.ru/
Variables – macroeconomic indicators			
X ₁₁ - rate of inflation	percent.	ROSSTAT	https://www.gks.ru/
X ₁₂ – Gross domestic product	Billion rubles.	ROSSTAT	https://www.gks.ru/
X ₁₃ - USD exchange rate	RUB / USD.	CBR	https://cbr.ru/
X ₁₄ – the key rate	percent.	CBR	https://cbr.ru/
X ₁₅ – the revenue of medium and large enterprises	Billion rubles.	ROSSTAT	https://www.gks.ru/
X ₁₆ - number of credit organizations	units.	ROSSTAT	https://www.gks.ru/
X ₁₇ – the coefficient of organizations' autonomy	percent.	ROSSTAT	https://www.gks.ru/

Table 1. Data sources

Variables	Mean	Median	Standard Deviation	Variation	Minimum	Maximum
Y_t	3,062	3,200	0,683	0,466	2,100	5,600
X_{t1}	1,625	1,320	1,482	2,195	-0,620	7,440
X_{t2}	22473,820	22163,100	3681,428	13552915,187	16375,300	30685,900
X_{t3}	55,885	59,090	13,583	184,507	31,080	77,730
X_{t4}	8,241	7,750	3,404	11,587	0,000	17,000
X_{t5}	38569,572	36390,200	8562,151	73310429,486	24669,800	54961,500
X_{t6}	680,103	649,000	177,569	31530,882	436,000	958,000
X_{t7}	47,902	49,240	6,111	37,347	33,690	56,980
X_{t8}	17373,172	17536,600	4730,833	22380778,520	9144,000	29166,800
X_{t9}	8577,559	9027,700	1524,923	2325391,080	5882,800	10953,000
X_{t10}	11,214	11,200	2,123	4,506	8,260	16,450
X_{t11}	29420,172	30180,700	4320,468	18666443,468	20002,700	34153,800
X_{t12}	8,515	8,100	2,088	4,362	5,760	13,460

Table 2. Descriptive statistics of variables

As a dependent variable we use the share of legal entities overdue loans in Russian banks, % – Y_t .

In the econometric literature, the use of time series reference levels to study statistical relationships is discouraged due to the possible false regression (Cowpertwait & Andrew: 2009; Brockwell et al.: 2016; Neusser: 2016). False regression is a situation when there is no causal connection between the explanatory variable and the dependent variable, but the correlation coefficient between them is close to one in module, and the equation describing their connection corresponds to the data with high accuracy. This situation usually occurs when working with time series, which are characterized by the trend, deterministic or random. To avoid false regression, one needs to eliminate trends from the original time series levels using absolute increments of time series levels:

$$\Delta Y_t = \beta_0 + \beta_1 \Delta X_{t1} + \beta_2 \Delta X_{t2} + \beta_3 \Delta X_{t3} + \dots + \beta_{10} \Delta X_{t10} + \varepsilon_t, \quad (1)$$

where: β_0 – free coefficient,

$\beta_1 \dots \beta_{10}$ – regression coefficient,

ε_t – random variation (regression error).

To evaluate the model, we use the usual least squares method (Wooldridge: 2013). Previously, we applied the matrix of pair correlation linear coefficients to test the regressors for multicollinearity. Multicollinearity is the linear connection between the explanatory variables of the model, which distorts estimates of regression parameters. If the modal value of the pair correlation linear coefficient is greater than 0.7, then such a pair of regressors is considered collinear, and one of the regressors is excluded from the linear model of multiple regression. The final regression model is also freed from statistically insignificant (redundant) regressors.

The adequacy of the regression model is estimated by the determination coefficient R^2 :

$$R^2 = \frac{\sum (\Delta \hat{Y}_{tx} - \Delta \bar{Y}_t)^2}{\sum (\Delta Y_t - \Delta \bar{Y}_t)^2} = 1 - \frac{\sum (\Delta Y_t - \Delta \hat{Y}_{tx})^2}{\sum (\Delta Y_t - \Delta \bar{Y}_t)^2}, \quad (2)$$

Where: $\Delta \hat{Y}_{tx}$ – growth value of the dependent variable predicted by the regression equation;

$\Delta \bar{Y}$ – Average growth value of the dependent variable.

To predict the share of legal entities overdue loans in Russian banks, based on a linear trend, the forecast values of each regressor absolute growth in the final model are determined, then the growth of the dependent variable is determined, which is added to the last known time series initial level of the volume of mortgage loans granted.

RESULTS

The matrix of pair correlation linear coefficients, constructed from the initial levels of time series, defined multicollinearity. After switching to absolute increments of variables, the matrix of pair correlation linear coefficients showed a practical absence of collinear regressors. It remained between the factors ΔX_{12} and ΔX_{15} , as well as between ΔX_{14} and ΔX_{112} . We decided to exclude the X_{12} and X_{14} factors. The strength of the connection between the dependent and factor variables ranges from weak to moderate

	ΔY_t	ΔX_{t1}	ΔX_{t2}	ΔX_{t3}	ΔX_{t4}	ΔX_{t5}	ΔX_{t6}	ΔX_{t7}	ΔX_{t8}	ΔX_{t9}	ΔX_{t10}	ΔX_{t11}	ΔX_{t12}
ΔY_t	1												
ΔX_{t1}	-0,20	1											
ΔX_{t2}	0,32	-0,18	1										
ΔX_{t3}	-0,54	0,48	0,02	1									
ΔX_{t4}	-0,17	0,35	0,13	0,42	1								
ΔX_{t5}	0,01	0,08	0,85	0,30	0,19	1							
ΔX_{t6}	-0,09	0,13	-0,13	-0,09	-0,08	-0,02	1						
ΔX_{t7}	-0,06	0,04	0,00	-0,05	0,11	-0,03	-0,19	1					
ΔX_{t8}	0,17	0,58	0,21	0,49	0,26	0,36	0,28	-0,03	1				
ΔX_{t9}	-0,15	0,54	-0,64	0,20	0,04	-0,44	0,02	-0,03	0,23	1			
ΔX_{t10}	-0,08	0,38	-0,45	0,07	0,09	-0,41	0,25	0,04	0,18	0,50	1		
ΔX_{t11}	-0,08	0,48	0,07	0,54	0,38	0,14	-0,00	0,05	0,55	0,44	0,38	1	
ΔX_{t12}	-0,22	0,33	0,20	0,48	0,71	0,23	-0,1	0,13	0,24	-0,09	0,29	0,33	1

Table 3. The correlation matrix

The results of evaluating linear multiple regression models are summarized in table 4. In the regression model (1), three regressors were statistically significant: ΔX_{15} – increase in the US dollar exchange rate, ΔX_{16} – increase in the number of operating credit institutions, and ΔX_{18} – increase in deposits of legal entities. In other words, linear statistical connection with the increase in the share of overdue loans to legal entities was confirmed only for the increments of these variables. In model (2), the multiple correlation coefficient takes the value of 0.82 and indicates a fairly close joint connection between the growth of the dependent variable ΔY_t (the

share of overdue loans to legal entities) and the increase in the US dollar exchange rate (ΔX_{13}), the increase in the number of operating credit institutions (ΔX_{16}), the increase in deposits of legal entities (ΔX_{18}).

Dependent variable: The share of overdue debt on loans to legal persons in the Russian banks in total amount		
Regressor	(1)	(2)
Intercept	-0,669 (0,226)	-0,610 (0,199)
ΔX_{11}	-0,046987495 ()	
ΔX_{12}	-0,102887444*** ()	0,104947882** (0,015226827)
ΔX_{13}	-1,57698E-05 ()	
ΔX_{14}	-0,032238698*** ()	-0,029171318*** (0,009139786)
ΔX_{15}	-0,031056123 ()	
ΔX_{16}	0,000429474*** ()	0,000380213*** (7,23597E-05)
ΔX_{17}	-0,000170961 ()	
ΔX_{18}	0,004431549 ()	
ΔX_{19}	4,85634E-05 ()	
ΔX_{110}	-0,000988071 ()	
Standard Error (Se)	0,390	0,369
R ²	0,747	0,682
N	28	28

Table 4. The results of the regression assessment of the volume of mortgage loans

For model (2), the coefficient of determination R^2 has a value equal to 0.68, which indicates that this model explains 68% of the variation in the share increase of overdue loans to legal entities in Russian banks. The remaining 32% of the growth variation may be due to the influence of other factors that are not taken into account in this model. The indicator of 68% indicates that the model (2) has a good predictive ability, the regressors ΔX_{13} , ΔX_{16} , and ΔX_{18} in this case are interconnected with the dependent variable ΔY_t .

According to the evaluation results, the linear multiple regression model (2) has the following form:

$$\Delta Y_t = -0,610220985 - 0,104947882 \cdot \Delta X_{13} - 0,029171318 \cdot \Delta X_{16} + 0,000380213 \cdot \Delta X_{18} + \varepsilon_t$$

The signs of coefficients in the regression equation correspond to economic intuition, which is confirmed by economic interpretation. An increase in the US dollar exchange rate by 1 point, other things being equal, reduces the share increase of overdue loans to legal entities by an average of 0.105%. This can be explained as follows: when the US dollar exchange rate increases, the level of currency risks for non-financial organizations increases sharply. An increase in the number of operating credit institutions, other things being equal, reduces the increase of overdue loans to legal entities by an average of 0.029%. This can be explained

by the concentration of the loan portfolio and the growth of credit risks in a smaller number of credit institutions. An increase in deposits of legal entities by 1 mln rub, other things being equal, increases the share of overdue loans of legal entities by an average of 0.0004%. This indicates that the real sector of the economy is in the process of dividing large enterprises into two groups. Some have a significant amount of working capital, which increases deposits in the amount of more than 1 mln rub, and others have financial difficulties in servicing their accounts payable.

The forecast of changes in the share of overdue loans to legal entities obtained using the model (2) is presented in Table 5.

Date	Y_t – the share of overdue debt on loans to legal persons in the Russian banks in total amount	X_{1t} - USD exchangerate	X_{2t} - number of credit organizations	X_{3t} - the deposits of legal entities
Forecast of absolute growth of variables				
01.04.2020	0,113556	1,325397	-14,9127	1125,295
01.07.2020	0,119417	1,301902	-14,6604	1153,585
01.10.2020	0,125278	1,278407	-14,4080	1181,874
01.01.2021	0,131139	1,254912	-14,1557	1210,163
01.04.2021	0,137000	1,231418	-13,9034	1238,453
01.07.2021	0,142861	1,207923	-13,6511	1266,742
01.10.2021	0,148722	1,184428	-13,3987	1295,031
01.01.2022	0,154583	1,160933	-13,1464	1323,321
01.04.2022	0,160444	1,137438	-12,8941	1351,610
01.07.2022	0,166305	1,113944	-12,6418	1379,899
01.10.2022	0,172166	1,090449	-12,3894	1408,189
Time series levelforecast				
01.04.2020	3,413556	79,05540	421,0873	30292,100
01.07.2020	3,532973	80,35730	406,4269	31445,680
01.10.2020	3,658251	81,63571	392,0189	32627,550
01.01.2021	3,789390	82,89062	377,8632	33837,72
01.04.2021	3,926390	84,12204	363,9598	35076,17
01.07.2021	4,069251	85,32996	350,3087	36342,91
01.10.2021	4,217972	86,51439	336,9100	37637,94
01.01.2022	4,372555	87,67532	323,7635	38961,26
01.04.2022	4,532999	88,81276	310,8695	40312,87
01.07.2022	4,699304	89,92670	298,2277	41692,77
01.10.2022	4,871470	91,01715	285,8383	43100,96

Table 5. The forecast of the volume of mortgage loans

DISCUSSION

Figures 1-4 show the forecast of statistically significant predictors and the possible share of overdue debt in 2020-2022.

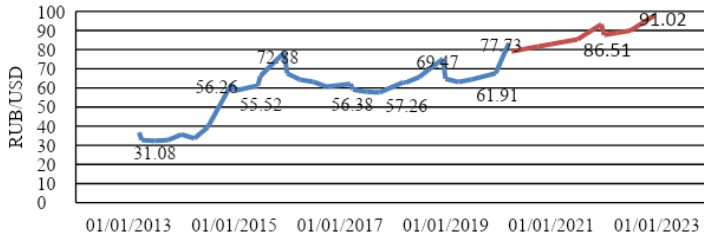


Figure 1.The forecast of the USD exchange rate in 2020-2022, RUB / USD.

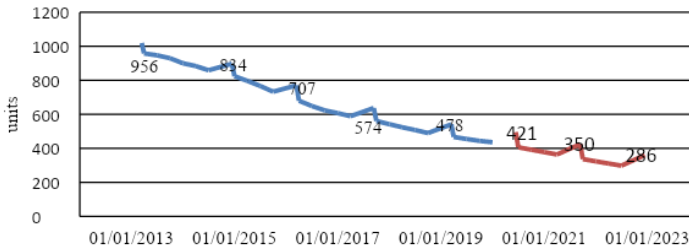


Figure 2.The forecast of the number of credit organizations for 2020-2022, units.

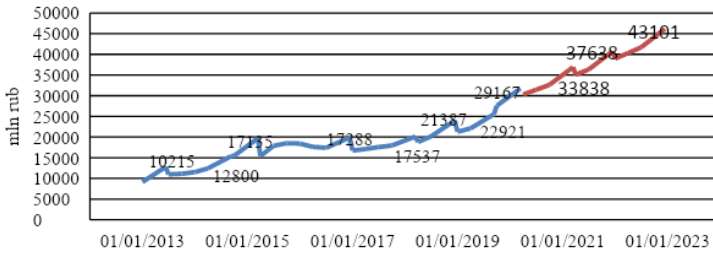


Figure 3.The forecast of the deposits of legal entities for 2020-2022, million rubles.

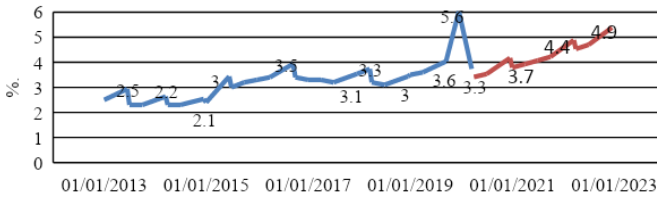


Figure 4. The forecast of the share of overdue debt on loans to legal persons in the Russian banks in total amount for 2020-2022, %.

Model (2) predicts an increase in the share of legal entities overdue loans in Russian banks. This means that in the future, the corporate lending market will continue to develop actively and will need effective methods for defined connections allow one to formulate two main conclusions. First, the lack of correlation between overdue loans from legal entities and most macro-indicators indicates possible positive trends in the development of Bank corporate lending. Second, the direct connection between the share of overdue debt and the volume of legal entities deposits may indicate a problem in asset management in the banking sector, as well as the lack of Deposit insurance for legal entities in the Russian Federation.

CONCLUSION

The article is devoted to the factor's regression analysis of overdue loans to legal entities share in Russian banks. We proceeded from empirically proven theoretical arguments in favor of the influence of macroeconomic indicators and indicators of the banking sector. The paper uses quarterly Russian statistical data for 2013 and partially for 2020. The study applied practical recommendations (Neusser: 2016) on a methodological approach to analyzing the connection of non-stationary time series. The approach presented in the study to modeling the share of overdue debt regressors has a number of advantages due to the ability to assess the contribution of each of the considered model factors to the variation of the overdue debt share and to predict changes in the found dependencies in the future (Jordi: 2008). In particular, it allows one performing a better selection of predictors of overdue loans to legal entities and preserve the possibility of meaningful interpretation of modeling results for making practical decisions in the banking sector.

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