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CURRENT CHALLENGES AND PROSPECTS OF MANAGEMENT OF LOAN PORTFOLIO QUALITY IN WARTIME: THE CASE OF UKRAINE

The purpose of the study is to develop effective ways to solve the problems of managing the quality of the loan portfolio of the Ukrainian banking sector in the context of the financial crisis caused by the russian-Ukrainian war. In the course of the study, such scientific methods as fundamental provisions of the credit portfolio theory, multifactor regression analysis, extrapolation, trend analysis, mathematical programming, etc. have been used.

A methodical approach to the study of contemporary problems and prospects of loan portfolio quality management under martial law, consisting in modelling the profitability of the Ukrainian banking sector, taking into account the quality of the loan portfolio, has been proposed. This approach is implemented by constructing a two-factor power regression equation; forecasting with the establishment of confidence intervals and the development of 3 forecast scenarios (realistic, pessimistic and optimistic); solving the target function to maximize the profit of the banking sector, taking into account the restrictions formed on the basis of forecasting results.

It has been determined that an increase in the volume of the bank loan portfolio by 1% leads to an increase in bank revenue by 3.1%, while an increase in the volume of non-performing loans by 1% leads to a 0.28% reduction in revenues of the banking sector of Ukraine. According to the results of medium-term forecasting and optimization, it has been proved that the maximum growth of bank revenues by 60.4%, compared to 2022, is possible with an increase in the loan portfolio by 18.9%, a reduction of non-performing loans by 26% and a reduction of their share in the loan portfolio by 13.9%. It

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has been justified that the key condition for maximising bank revenues is the soonest termination of the russian-Ukrainian war and further expansion of effective government concessional lending programs.

Keywords: loan portfolio, quality, non-performing loan, income, banking sector, maximisation
JEL classification: ***C61, E51, G21***

Основна мета дослідження полягає у розробці ефективних шляхів вирішення проблем управління якістю кредитного портфеля банківського сектору України в умовах фінансової кризи, спричиненої російсько-українською війною. У ході дослідження використано такі наукові методи, як фундаментальні положення теорії кредитного портфеля, мультифакторний регресійний аналіз, екстраполяцію, трендовий аналіз, математичне програмування тощо.

Запропоновано методичний підхід до дослідження сучасних проблем та перспектив менеджменту якості кредитного портфеля в умовах воєнного стану, який полягає в моделюванні доходності банківського сектору України з урахуванням якості кредитного портфеля шляхом побудови двофакторного степеневого рівняння регресії; середньостроковому прогнозуванні з установленням довірчих інтервалів та розробки 3 прогнозних сценаріїв (реалістичного, песимістичного та оптимістичного); розв'язанні цільової функції максимізації доходу банківського сектору з урахуванням обмежень по факторах, утворених за результатами прогнозування.

Визначено, що зростання обсягу банківського кредитного портфеля на 1% спричиняє збільшення банківських доходів на 3,1%, а збільшення обсягу непрацюючих кредитів на 1% призводить до зменшення доходів банківського сектору України на 0,28%.

За результатами прогнозування і оптимізації доведено, що максимальне зростання банківських доходів на 60,4%, порівняно з рівнем 2022 р., можливе за умови збільшення обсягу кредитного портфеля на 18,9%, скорочення обсягу непрацюючих кредитів на 26% та зниження їх частки в кредитному портфелі на 13,9%. Обґрунтовано, що ключовою умовою максимізації банківських доходів є якнайшвидше завершення російсько-української війни та подальше розширення ефективних державних програм пільгового кредитування.

Ключові слова: кредитний портфель, якість, непрацюючий кредит, дохід, банківський сектор, максимізація
JEL classification: ***C61, E51, G21***

Introduction. In modern conditions in Ukraine, tendencies have been formed for the development of a socially oriented market economy. In this regard, there is an increase in the number and scale of activities of such financial institutions that are able to accumulate financial resources and then, transform them into credit, to meet the temporary needs of individuals and businesses for additional funds. First of all, such institutions in the financial market of Ukraine are banks, whose primary function is the mobilization of free funds and the subsequent redistribution of funds raised through bank loans.

Despite the development of financial services and the expansion of their range, lending remains a priority active banking operation, generating a significant part of banks' revenues. Credit operations not only generate income for the bank but are also a source of risk. When granting a loan, the bank assesses the risk and decides whether the risk is acceptable or not. However, the bank cannot be sure that the borrower's financial situation will not deteriorate, that their cash flow will not decrease, or that other circumstances will not arise that will make the debt non-performing. The increase in lending as a result of the aggressive lending policy of Ukrainian banks led to the deterioration of their loan portfolios. In such conditions, the management of problem loans by banks, whose effectiveness directly affects the quality of the loan portfolio, profitability and financial stability of a banking institution, is of particular relevance.

The banking sector of Ukraine is currently operating in an unstable and challenging environment. During the coronavirus crisis of 2020 and the large-scale phase of the Russia-Ukraine war which unfolded February 24, 2022, the quality of the bank loan portfolio has been deteriorating and the share of bad debts has been growing and remains

high to date, posing a direct threat to the solvency and liquidity of the banking sector of Ukraine. At the micro level, an increase in the volume of bad debts leads to additional costs for the bank associated with the servicing of non-performing loans, often turning into absolute losses (direct losses) due to loan defaults. That is why the effectiveness of managing the quality of the loan portfolio is the basis for ensuring that banking risks, in particular profitability and stability of the banking sector, are counteracted.

Literature review and problem statement. The methodological foundations of the theory of the quality of a bank loan portfolio were laid in a series of studies. P. Bennett proposed the parameters of the quality of the loan portfolio based on a quantitative assessment of the trade-off between risk and return [1]. D. Lucas, & R. McDonald proved that the cost of low-quality loans is the asymmetry of information arising from different awareness of creditors and shareholders [2]. J. Madura, & E. Zarruk substantiated that the increase in provisions for losses associated with non-performing real estate loans caused a negative reaction in the share prices of other banks [3], and 5 years later their results were confirmed by S. Docking, M. Hirschey, & E. Jones [4]. W. Bessler, & T. Nohel studied the impact of asymmetric information on the quality of the loan portfolio and stock returns [5].

The theory of the quality of the bank loan portfolio formed the basis of the research of modern authors. H. Tchakoute-Tcbuigoua, & I. Soumare studied the impact of decentralisation of loan approval on the quality of the loan portfolio [6]. G. Afrifa, E. Gyapong, & A. Zalata substantiated that the quality of the loan portfolio mitigates the negative impact of buffer capital on the Money flow index [7]. V. Fiador, & E. Sarpong-Kumankoma proved that corporate governance is a key factor influencing the quality of the loan portfolio [8]. D. Cucinelli, L. Gai, F. Ielasi, & A. Patarnello, studied the impact of lending policy, bank capitalisation, poor management, and procyclical lending policy on the quality of the loan portfolio [9]. K. Semenova, & N. Tarasevych applied regression analysis when modelling bank revenues, assessing the impact of the number of payment cards, the volume of deposits, and the loan portfolio of the bank [10].

Considering the above studies of the quality of the bank loan portfolio, it should be noted that the methodological support for managing the profitability of the banking sector of the economy, taking into account the impact of the quality of the loan portfolio, has not been sufficiently developed, and therefore needs to be improved and tested in the realities of martial law, in the context of the financial crisis caused by the Russian-Ukrainian war.

The aim and objectives of the study. The main purpose of the study is to develop effective ways to solve the problems of managing the quality of the loan portfolio of the banking sector of Ukraine.

The study materials and methods. The methodology for studying current problems and prospects of the management of the quality of a loan portfolio under martial law is based on a two-stage modelling of the profitability of the banking sector of Ukraine, taking into account the quality of the loan portfolio and predicting indicators of the quality of the loan portfolio.

At the first stage, the individual impact of the volume of loan portfolios of banks and non-performing loans (independent variables) on the income of the banking sector of Ukraine (dependent variable) is studied using automated statistical data processing tools.

Excel functionality is used to study the individual influence of the independent variable on the dependent variable. Thus, a scatter plot is constructed, where the x-axis represents the data set of the factor trait, and the y-axis represents the data set of the resulting trait. Further, trend lines with equations and R^2 approximation levels are added [11]. It should be noted that Excel provides 5 types of trends: exponential, linear, logarithmic, polynomial, and power. When modelling the individual impact of indicators of the loan portfolio and revenues of the banking sector of Ukraine we will construct all possible lines, and choose for analysis the one that has

the highest level of approximation (R^2), i.e., according to the criterion:

$$R^2 \to \max. \quad (1)$$

Formula (1) shows that the model for formalising the individual impact of loan portfolio indicators on the income of the banking sector of Ukraine is chosen at the highest level of approximation. Also, an approximation level $R^2 > 0.3$ will indicate a stochastic relationship of average density between loan portfolio indicators and the income of the banking sector of Ukraine.

The second stage of the study involves building a two-factor model of the power function. The use of the power function in financial research using economic and mathematical modelling is popular because it formalises nonlinear processes that prevail in financial and economic phenomena, such as production function [12], Laffer Curve [13], supply and demand curves in financial markets [14], financial risk curve [15], Lorenz Curve [16], Phillips Curve [17], utility function [18], Kuznets Curve [19], production possibility curve [20], indifference curve [21], IS-LM model [22], AD-AS model [23].

The equation of a two-factor power function is as follows:

$$BR = \alpha_0 \cdot LP^{\alpha_1} \cdot NPL^{\alpha_2}, \quad (2)$$

where *BR* is the revenue of the banking sector of Ukraine (dependent variable), UAH billion;

LP is loan portfolio of Ukrainian banks (independent variable), UAH billion;

α_1 is a parameter of the equation or the coefficient of elasticity of the profitability of banks on the loan portfolio, which shows how much the income of the Ukrainian banking sector changes with a 1% increase in their loan portfolio;

NPL is non-performing loans of Ukrainian banks (independent variable), UAH billion;

α_2 is a parameter of the equation or the coefficient of elasticity of the profitability of banks on NPLs, which shows by how much the income of the Ukrainian banking sector changes with a 1% increase in NPLs;

α_0 is a constant (the value of the resultant indicator when all factor indicators are equal to 1).

The data are formalised by logarithmising formula (2):

$$\ln BR = \ln \alpha_0 + \alpha_1 \ln LP + \alpha_2 \ln NPL, \quad (3)$$

where ln is the natural logarithm.

Let us take a closer look at the process of forecasting the indicators of the quality of a loan portfolio of the banking sector of Ukraine. Forecasting is a popular tool for studying the dynamics of financial and economic phenomena. Usually, in scientific research, specific indicators are forecasted in order to obtain the most accurate forecast values for future research periods, on the basis of which plans are developed. The accuracy of the forecast can be determined by comparing the deviations of the actual values of the indicator from the forecast values. It should be noted that the main goal in the context of our study is not to achieve the maximum forecast accuracy for the quality of the loan portfolio of the Ukrainian banking sector, but to extrapolate the trends of economic dynamics. Extrapolation will be considered as forecasting method, which consists in transferring the actual trend of a dynamic series, formalised by a trend equation, to future periods.

Extrapolation as a forecasting method is based on trend analysis, a mathematical formalisation of the existing trend of a time series or a series of dynamics (a set of numerical values of an indicator for the same time intervals are called levels of a dynamic series formed over a certain period, the so-called length of a dynamic series), the sequence of terms of which can be written as follows:

$$y_1, y_2, ..., y_t, \quad (4)$$

where t – is the ordinal number of the level of the dynamic series, and $t = \overline{1;n}$, n is the number of members of the dynamic series [24, p. 400].

Then the trend function in general will look like this:

$$\hat{y}_t = f\left(t_1, t_2, ..., t_n\right). \quad (5)$$

Another important component of the trend analysis is the establishment of confidence intervals as an effective means of protecting the forecast from unreliability. In this case, the maximum range of variation of the forecast indicator is determined, taking into account the trend equation and the fluctuations in the observed values of the dynamic series. To calculate the limits of fluctuation of the observed forecast value from the trend, the standard error of the forecast value of the trend function (S_e) is calculated:

$$S_e = \sqrt{\frac{\sum_{t=1}^{n}\left(y_t - \hat{y}_t\right)^2}{n-2}}, \quad (6)$$

where y_t and $\hat{y}_t$ are, respectively, the values of the actual and calculated by the trend equation members of the dynamic series;

n – is the number of members of the dynamic series [11, p. 403].

In trend analysis, confidence intervals are set based on the double standard error of the relevant forecast value. The lower confidence interval of the respective forecast value of the indicator under study is calculated using the formula:

$$\hat{y}_{t+L} - 2S_e. \quad (7)$$

where $\hat{y}_{t+L}$ is the forecast value of the indicator calculated by the trend equation in each of the L forecast periods;

L is the serial number of the forecast year, where $L = \overline{n+1; n+m}$, m – is the number of members of the forecast period.

The upper confidence interval of the forecast is calculated using the formula:

$$\hat{y}_{t+L} + 2S_e. \quad (8)$$

Then it can be argued that the predicted value of the indicator with a probability of 95% will be within the confidence interval:

$$\hat{y}_{t+L} \in \left[\hat{y}_{t+L} - 2S_e; \hat{y}_{t+L} + 2S_e\right]. \quad (9)$$

The implementation of the last stage of the study is to maximise bank income by means of optimisation. The maximisation procedure is carried out by constructing the target maximisation function based on formula (2) as follows:

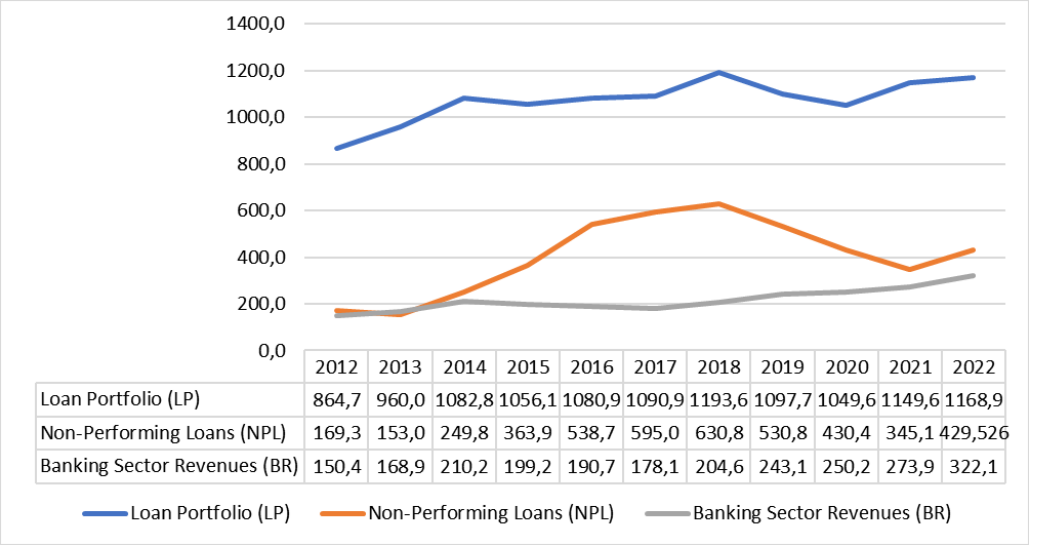
$$BR = \alpha_0 \cdot LP^{\alpha_1} \cdot NPL^{\alpha_2} \xrightarrow[LP,NPL]{} \max, \quad (10)$$

where $\xrightarrow[LP,NPL]{}$ means that the profitability maximisation of the Ukrainian banking sector occurs after changes in the factor attributes LP and NPL.

The target function is solved using the "Solver" function in Excel. It is also an important condition for optimisation to set limits for an acceptable range of factor values, taking into account the prediction results obtained from formula (9).

Results and Discussion. Having outlined the basic methodological principles, let us move on to the implementation of modelling the profitability of the Ukrainian banking sector, taking into account the quality of the loan portfolio. Credit operations are the most risky and profitable operations of the bank, so they tend to have a direct impact on bank income and loss prevention of banking activities. However, there is reason to believe that an increase in the volume of non-performing loans in the loan portfolio leads to a reduction in the bank's profitability. Therefore, the system of measures taken by the bank to prevent non-performing loans must be constantly reviewed and improved. Taking into account the current operating environment of banks and the peculiarities of their loan portfolios, appropriate monitoring procedures and measures to prevent problem loans need to be put in place.

Given the need to improve the quality of the loan portfolio management of Ukrainian banks, modelling the impact of the quality of the loan portfolio on banking sector revenues is an important area of formation of prerequisites for improving the efficiency of banking activity. Let us first conduct a comparative analysis of the dynamics of the volume of the loan portfolio, non-performing loans, and revenues of the banking sector of Ukraine for 2012–2022 (Figure 1).



	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Loan Portfolio (LP)	864,7	960,0	1082,8	1056,1	1080,9	1090,9	1193,6	1097,7	1049,6	1149,6	1168,9
Non-Performing Loans (NPL)	169,3	153,0	249,8	363,9	538,7	595,0	630,8	530,8	430,4	345,1	429,526
Banking Sector Revenues (BR)	150,4	168,9	210,2	199,2	190,7	178,1	204,6	243,1	250,2	273,9	322,1

Note: Data for 2022 as of 01.12.2022.

Fig. 1. Comparative dynamics of the loan portfolio, non-performing loans, and revenues of the Ukrainian banking sector in 2012–2022, UAH billion

Source: NBU [25; 26].

The data presented in Fig. 1 shows that in 2012–2022, the loan portfolio of Ukrainian banks increased by 35.2% with an average annual growth rate of +3.1%, and the volume of non-performing loans increased by 153.7% with an average annual growth rate of +9.8%. This led to an increase in the share of non-performing loans in 2022 by 17.2 percentage points (from 19.6% to 36.8%) compared to 2012.

Also, after the beginning of the Russian-Ukrainian war in 2014, a rapid increase in the volume of non-performing loans began, which continued until 2018. During this period, the volume of non-performing loans increased 4.1 times, reaching a maximum of 630.8 billion UAH at the end of 2018, and the maximum share of non-performing loans in the loan portfolio was 54.5% in 2017. This reflects the crisis processes in the bank lending market during 2014–2018, as evidenced by a 15.3% drop in banking sector revenues in 2017 compared to 2014. Instead, the share of non-performing loans in the loan portfolio reached a minimum level of 15.9% in 2013. From 2018 to 2021, the volume of non-performing loans decreased by 45.3% while the revenues of the banking sector increased by 53.8%, which indicates that the situation in the bank loan market stabilised during that period.

Since the dynamics of the loan portfolio, non-performing loans, and banking sector revenues were multidirectional (Figure 1), it is necessary to examine the individual impact of each indicator of the quality of the loan portfolio on the revenues of banks in Ukraine. The individual impact of the size of the loan portfolio on the banking sector revenues is illustrated in Fig. 2.

Based on the data shown in Figure 2, we can see that there is a direct stochastic relationship of average density ($0.437 < R^2 < 0.443$) between the volume of the loan portfolio of Ukrainian banks and their revenues, and it is the highest in the quadratic and power model. Also, with more than 44% confidence it can be stated that the growth of the loan portfolio volume by 1 billion UAH is accompanied by the growth of the bank income by 358.5 million UAH (linear model). A 1% growth in the loan portfolio is accompanied by a 1.7% growth in the bank's income (power model).

The individual impact of non-performing loans on banking sector revenues is illustrated in Fig. 3.

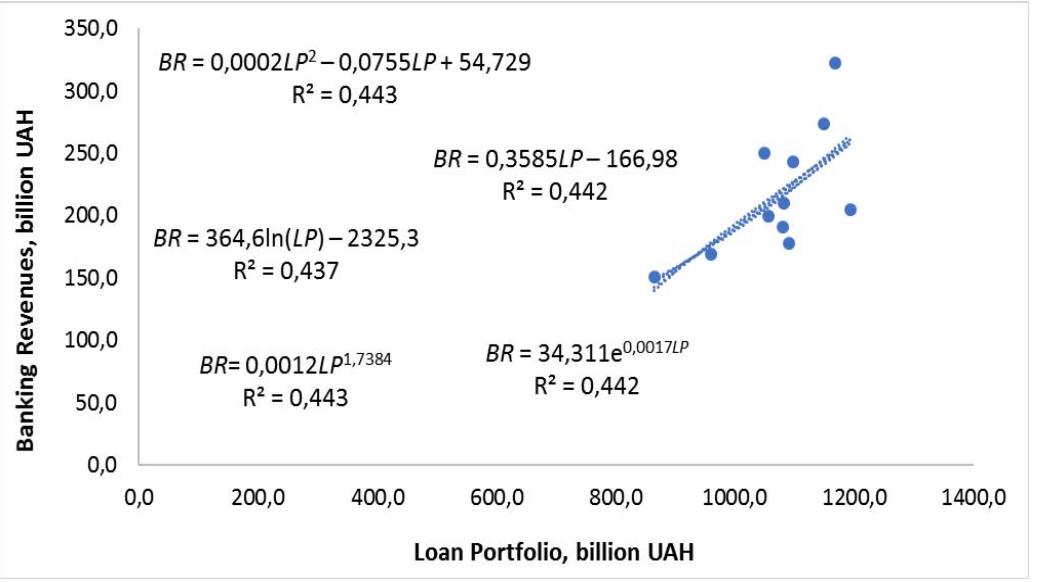


Fig. 2. Formalisation of the impact of the size of a loan portfolio on the revenues of Ukrainian banks
Source: NBU [25; 26].

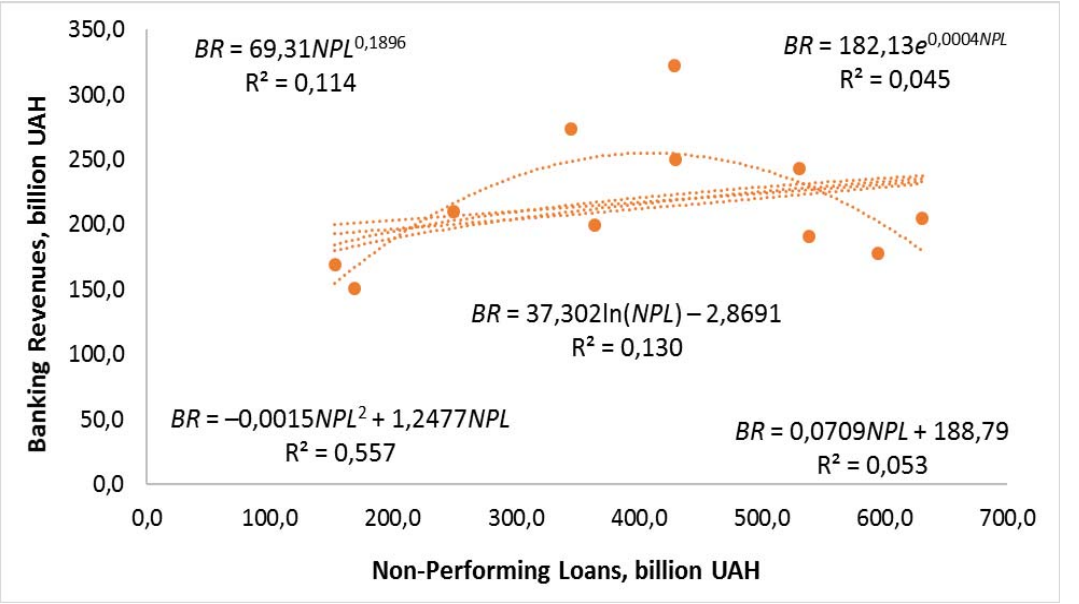


Fig. 3. Formalisation of the impact of non-performing loans on the revenues of Ukrainian banks
Source: NBU [25; 26].

Based on the data shown in Figure 3 we can suggest that formalization of the impact of the volume of non-performing loans on the revenues of the Ukrainian banking sector is possible only by the polynomial model, as the level of approximation of the linear, exponential, logarithmic, and power models $R^2 < 0.13$, indicating a very weak relationship. In the case of a polynomial model (quadratic function), the relationship between the indicators is dense, allowing formalisation. Figure 3 shows that the graph of the quadratic function has a maximum point with coordinates (415.9; 259.5), i.e., the growth of non-performing loans to 415.9 billion UAH was accompanied by growth of banking revenues to 259.5 billion UAH (direct stochastic relationship between the indicators), a further increase in non-performing loans led to a decrease in banking revenues (reverse stochastic relationship between the indicators).

Comprehensive modelling of the impact of loan portfolio quality on the profitability of the banking sector is carried out using a two-factor power model according to formula (2). For this purpose, the natural logarithms of the indicators are first calculated (Table 1).

The data in Table 1 are entered into the model construct using the Excel function "Data ð Data Analysis ð Regression". The results of the simulation are shown in Fig. 4.

From the analysis of the data presented in Fig. 4, it can be seen that, in general, the power regression equation of the impact of the loan portfolio and non-performing loans on Ukrainian banking sector income is characterized by a high-density stochastic relationship (multiple correlation coefficient R = 0.7318), which is confirmed by sufficient F-test ($F_{act} = 4.6132 > F_{norm} = 4.4590$) and t-test ($t_{act} = 3.0375 > t_{norm} = 2.3060$) levels. The value of the multiple determination coefficient $R^2 = 0.5356$ means that a 53.56% change in bank income is explained by changes in the size of the loan portfolio and non-performing loans.

From the data in Fig. 4, a multiple regression equation can be constructed in logarithmic form:

$$\ln BR = \ln(-14.874) + 3.143 \ln LP - 0.282 \ln NLP. \quad (11)$$

After the necessary transformations, the power multiple regression equation of Ukrainian banking sector revenues takes this final form:

$$BR = 3.470 \cdot 10^{-7} \cdot LP^{3.143} \cdot NPL^{-0.282}. \quad (12)$$

Consequently, the following can be seen from formula (12):

- during 2012–2022, a 1% increase in the bank loan portfolio was accompanied by a 3.143% increase in banking revenues;

Table 1

Natural logarithms of Ukraine's loan portfolio, NPLs, and banking sector revenues

Year	ln*LP*	ln*NPL*	ln*BR*
2012	6.76236	5.13164	5.01362
2013	6.86690	5.03040	5.12924
2014	6.98726	5.52048	5.34806
2015	6.96238	5.89687	5.29427
2016	6.98552	6.28918	5.25065
2017	6.99477	6.38856	5.18209
2018	7.08469	6.44694	5.32083
2019	7.00096	6.27435	5.49348
2020	6.95614	6.06465	5.52214
2021	7.04714	5.84392	5.61263
2022	7.06384	5.86161	5.77472

Source: NBU [25; 26].

- while NPL volume increased by 1%, Ukrainian banking sector revenues decreased by 0.282%;

- with a simultaneous increase in the volume of loan portfolio and NPLs by 1% the incomes of the Ukrainian banking sector grew by 2.861%.

Let us move on to predicting the quality indicators of the loan portfolio of the Ukrainian banking sector based on trend analysis and extrapolation. Forecasting methods are widely used in planning at both micro and macro levels, as planning is an important function of management together with organization, motivation, and control [27]. This is why the planning function is also relevant in loan portfolio quality management.

Using formulas (4)–(9), we extrapolate the series of loan portfolio dynamics (Fig. 5) and the volume of non-performing loans (Fig. 6) to 2023–2025. As under martial law and deep recession, projections for a longer period would be unreliable.

SUMMARY OUTPUT

Regression statistics	
Multiple R	0.731844485
R Square	0.53559635
Adjusted R Square	0.419495438
Standard Error	0.21789955
Observations	11

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*	*t*
Regression	2	0.438071134	0.219035567	4.61319674	0.046513872	3.03750
Residual	8	0.379841709	0.047480214			
Total	10	0.817912843				

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	–14.8738283	6.867319431	–2.165885605	0.06221617	–30.7098953	0.962238703
LP	3.143151332	1.106754261	2.839972197	0.0218129	0.590971428	5.695331235
NPL	–0.28225332	0.209076773	–1.34999843	0.21396718	–0.76438522	0.199878588

Fig. 4. Modelling results of the impact of the quality of a loan portfolio on the revenues of Ukrainian banks

Source: Data given in Table 1, Excel calculations.

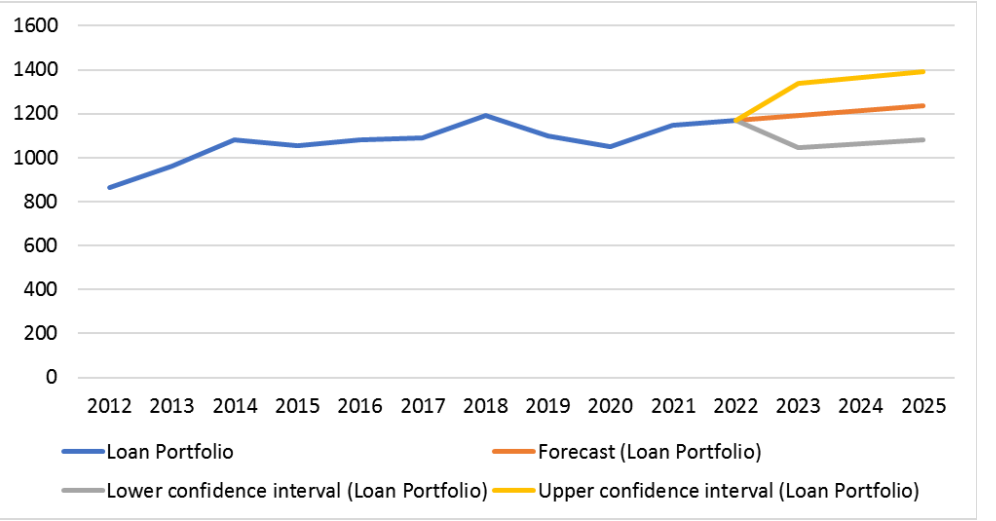


Fig. 5. Extrapolation of the series of dynamics of the loan portfolio volume of Ukrainian banks in 2023–2025

Source: NBU [25].

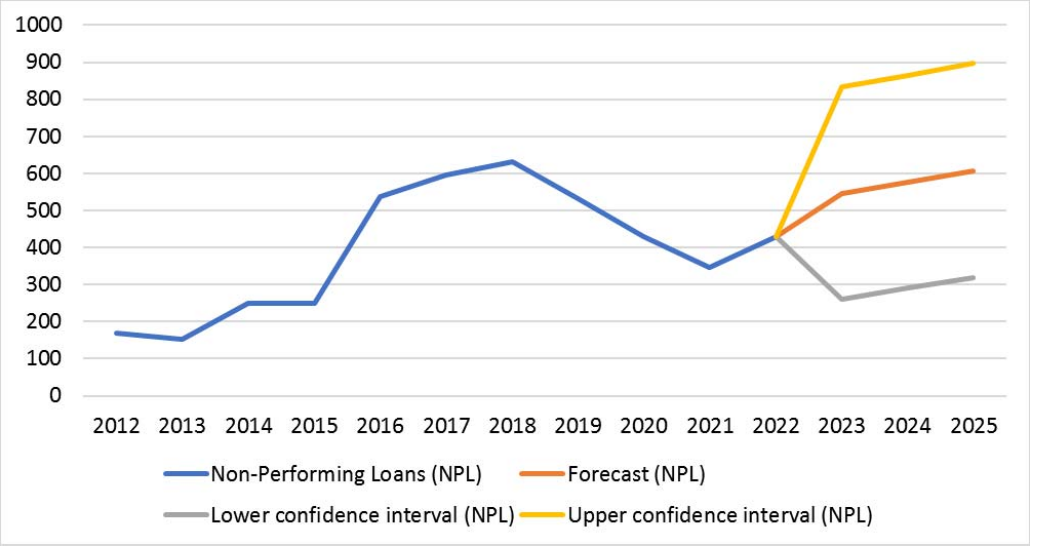


Fig. 6. Extrapolation of the dynamics series of Ukraine's NPLs from 2023 to 2025
Source: NBU [25].

Based on the data in Figures 5 and 6, it can be seen that the following trends of change are projected for the period 2023–2025:

1. The loan portfolio of the Ukrainian banking sector is likely (realistic scenario) to grow by UAH 66 billion (+5.7%). However, if there is a need for an increase in the Ukrainian financial market as a result of the Russian-Ukrainian war and its extension (pessimistic scenario), the loan portfolio may decrease by UAH 88 billion (-92.5%). If the war ends and the Ukrainian economy recovers, the bank's loan portfolio could increase by UAH 221 billion (+18.9%).

2. Under a realistic scenario, the banks' NPLs may increase by 178 billion UAH (+41.4%), under a pessimistic scenario by 467 billion UAH (+108.7%), and under an optimistic scenario by 111 UAH billion (–25.9%).

Let us carry out revenue maximisation of the Ukrainian banking sector by means of optimisation based on formula (10) and formula (12) using "Solver" in Excel. Let us construct the target function of maximising the revenues of the banking sector of Ukraine:

$$BR = 3.470 \cdot 10^{-7} \cdot LP^{3.143} \cdot NPL^{-0.282} \xrightarrow[LP,NPL]{} \quad (13)$$

де $1{,}081 < LP < 1390$;

$318 < NPL < 896$;

$0.159 < \frac{NPL}{LP} < 0.545.$

The results of the maximisation of banking sector revenues are illustrated in Table 2.

The data presented in Table 2 shows that in order to increase the revenues of the Ukrainian banking sector by 60.4% compared to 2022 it is necessary to increase the loan portfolio by 18.9%, reduce non-performing loans by 26% and reach their share in the loan portfolio of 22.9% (13.9% less than in 2022). Obviously, these changes can only be secured under an optimistic scenario where the Russian-Ukrainian war ends with a Ukrainian victory as soon as possible and national economic recovery begins.

However, throughout the large-scale invasion, the state programme for business support "Affordable Loans 5–7–9%" has been actively implemented, contributing

Table 2

Ukrainian banking sector revenue maximisation results

Indicator name	Value 2022	Optimum value	Changes (+ / –)	
			Units of measure	%
1. Loan portfolio, UAH billion	1,168.9	1,390.0	+221.1	+18.9
2. Non-performing loans, UAH billion	429.5	318.0	–111.5	–26.0
3. Share of non-performing loans in loan portfolio, %	36.8	22.9	–13.9	–13.9
4. Banking sector revenues, UAH billion	322.1* 275.2**	516.5	+194.4 +241.3	+60.4 +87.7

* Actual value.

** Theoretical value calculated from formula (12).

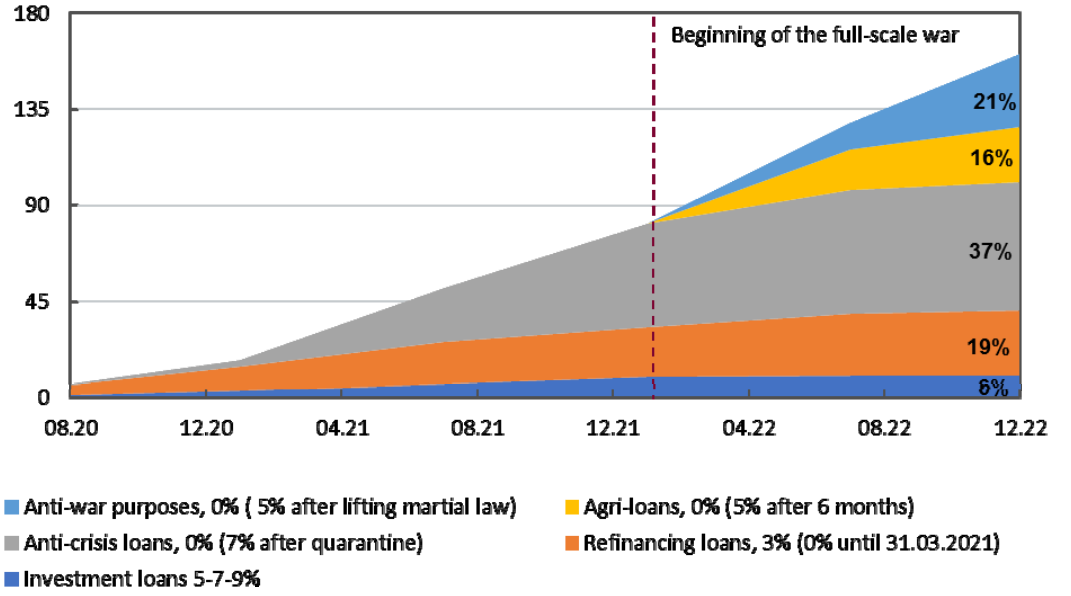
Source: Calculated from data in Figures 5 and 6 using formula (13) and "Solver" in Excel.

19% to the loan portfolio in 2022. The state programme "Affordable Loans 5–7–9%" was started in 2020 as a stimulus for investment lending [28]. However, from the outset, the programme's targeted content shifted towards anti-crisis business support: first as a result of the COVID–19 pandemic and later as a result of the Russia-Ukraine war. During the crisis, government support also played a crucial role in lending and supporting the banking sector. Therefore, to increase the size of the loan portfolio of the Ukrainian banking sector and its profitability in 2023, an expansion of the state programme "Affordable Loans 5–7–9%" should be ensured.

The state programme "Affordable Credit 5–7–9%" was launched in February 2020 [28]. At first, it had the sole purpose of facilitating the access of individual entrepreneurs, and small and micro-enterprises to bank loans for the implementation of investment projects. The programme is based on a mechanism of partial compensation of interest rates. The interest rate on a loan, which a bank receives, is determined by market conditions: a spread is added to the cost of deposits, expressed by the Ukrainian index of 3-month UIRD deposit rates [29], to cover operating costs, credit risks and profitability. Banks are essentially compensated at a floating rate that is reviewed quarterly depending on changes in UIRD. At the start of the programme, the lending rate was 17–19% per annum. However, the debtor was only paying a fixed low rate of 5 to 9%. The bank's difference is compensated by the Entrepreneurship Development Fund with budgetary funds (Fig. 7).

The programme was slow to start due to subdued demand for investment loans and a small maximum loan amount of UAH 1.5 million. In addition, the COVID–19 pandemic and the introduction of quarantine made business conditions difficult. As of April 2020, the conditions of the programme changed. Two new directions were added: anti-crisis loans (at 3%, in December 2020 at 0%) and loans to refinance existing debt (at 0% until the end of March 2021, then at 3%). Also, for the first time, the maximum loan amount was increased to 3 million UAH (this amount was revised several times in the future). This gave an impetus to the development of the programme.

Since March 2022, the programme has been expanded to include two new types of loans: support for the sowing campaign; and overcoming the effects of aggression. Initially, loans were granted at 0%. The size limits for enterprises participating in the programme were then lifted. In October 2022, loans at 9% per annum were added to rehabilitate production facilities destroyed by the fighting. Forty-five banks are involved in the programme, of which 40% are state-owned and an equal number are foreign-owned. In December 2022, a total of 52,000 loan agreements were approved for a total of UAH 161 billion, of which about 95 billion UAH are active.



Note: The shares of the different ways of support in the total amount of contracts are indicated in %, as of December 19, 2022.

Fig. 7. Total amount of signed contracts under different ways of support, UAH billions

Source: Entrepreneurship Development Fund [30], Ministry of Finance of Ukraine [31].

Conclusions. In the process of developing ways to solve the problems of managing the quality of the loan portfolio of the banking sector of Ukraine during the financial crisis caused by the Russian-Ukrainian war, the following important results were obtained.

Firstly, a methodological support for improving prospects for managing the quality of a loan portfolio under martial law has been proposed, which provides for modeling the profitability of the banking sector of Ukraine, taking into account the quality of the loan portfolio, forecasting the quality indicators of the loan portfolio of Ukrainian banks and maximization of the bank's income through optimization based on the solution of the objective function with restrictions made based on the results of forecasting.

Secondly, a model of the power dependence of Ukrainian banking sector revenues on the loan portfolio volume and non-performing loans has been constructed. It has been proved that, during 2012–2022, the increase in the volume of the bank loan portfolio by 1% was accompanied by an increase in banking revenues by 3.1%; with an increase in the volume of non-performing loans by 1%, the income of the Ukrainian banking sector decreased by 0.28%; with a simultaneous increase in the loan portfolio and non-performing loans by 1%, the income of the Ukrainian banking sector grew by 2.9%.

Thirdly, the optimization task of maximizing the revenues of the Ukrainian banking sector has been set and solved considering the results of forecasting loan portfolio quality indicators. It has been proved that in order to expand the revenues of banks by 60.4% it is necessary to increase the volume of the loan portfolio by 18.9% while reducing the amount of non-performing loans by 26% and reducing their share in the bank loan portfolio by 13.9% compared to the level of 2022. It has been justified that the maximization of bank income can be achieved only with the soonest termination of the Russian-Ukrainian war and the expansion of practical state programs for preferential lending to legal entities and individuals.

Bibliography

1. Bennett P. Applying portfolio theory to global bank lending. *Journal of Banking and Finance*. 1984. Vol. 8. No. 2. P. 153–169. URL: https://doi.org/10.1016/0378-4266(84)90002-5 (Accessed 10.02.2023).

2. Lucas D., McDonald R. L. Bank portfolio choice with private information about loan quality: Theory and implications for regulation. *Journal of Banking & Finance*. 1987. Vol. 11. No. 3. P. 473–497. URL: https://doi.org/10.1016/0378-4266(87)90044-6 (Accessed 10.02.2023).

3. Madura J., Zarruk E. R. Information effects of loan portfolio quality on bank value. *Journal of Economics and Finance*. 1992. Vol. 16. No. 1. P. 27–40. URL: https://doi.org/10.1007/BF02919791 (Accessed 10.02.2023).

4. Docking D. S., Hirschey M., Jones E. Information and contagion effects of bank loan-loss reserve announcements. *Journal of Financial Economics*. 1997. Vol. 43. No. 2. P. 219–239. URL: https://doi.org/10.1016/S0304-405X(96)00895-1 (Accessed 10.02.2023).

5. Bessler W., Nohel T. Asymmetric information, dividend reductions, and contagion effects in bank stock returns. *Journal of Banking and Finance*. 2000. Vol. 24. No. 11. P. 1831–1848. URL: https://doi.org/10.1016/S0378-4266(99)00097-7 (Accessed 10.02.2023).

6. Tchakoute-Tcbuigoua H., Soumare I. The effect of loan approval decentralization on microfinance institutions' outreach and loan portfolio quality. *Journal of Business Research*. 2019. Vol. 94. P. 1–17. URL: https://doi.org/10.1016/j.jbusres.2018.09.021 (Accessed 10.02.2023).

7. Afrifa G. A., Gyapong E., Zalata A. M. Buffer capital, loan portfolio quality and the performance of microfinance institutions: A global analysis. *Journal of Financial Stability*. 2019. Vol. 44. No. 100691. URL: https://doi.org/10.1016/j.jfs.2019.100691 (Accessed 10.02.2023).

8. Fiador V., Sarpong-Kumankoma E. Does corporate governance explain the quality of bank loan portfolios? Evidence from an emerging economy. *Journal of Financial Economic Policy*. 2021. Vol. 13. No. 1. P. 31–44. URL: https://doi.org/10.1108/JFEP-06-2019-0130 (Accessed 10.02.2023).

9. Cucinelli D., Gai L., Ielasi F., Patarnello A. Preventing the deterioration of bank loan portfolio quality: A focus on unlikely-to-pay loans. *The European Journal of Finance*. 2021. Vol. 27. No. 7. P. 613–634. URL: https://doi.org/10.1080/1351847X.2020.1830143 (Accessed 10.02.2023).

10. Семенова К. Д., Тарасевич Н. В. Моделювання впливу факторів клієнтського капіталу на доходи банківських установ. *Академічний огляд*. 2020. № 2(53). С. 39–45. URL: https://doi.org/10.32342/2074-5354-2020-2-53-4 (Accessed 10.02.2023).

11. Moore J. H., Weatherford L. R. Decision modeling with Microsoft Excel. 6th Edition. Hoboken: Prentice Hall, 2001. 693 c.

12. Cobb C. W., Douglas P. H. A theory of production. *The American Economic Review*. 1928. Vol. 18. No. 1. P. 139–165.

13. Laffer A. B. The Laffer Curve: Past, present, and future. *Backgrounder*. 2004. No. 1765. P. 1–16. URL: http://s3.amazonaws.com/thf_media/2004/pdf/bg1765.pdf (Accessed 10.02.2023).

14. Madura J. Financial markets and institutions. 10th Edition. Stamford: Thomson, 2014, 784 p.

15. Geiger F. The Yield Curve and financial risk premia: Implications for monetary policy. Berlin : Springer Science & Business Media, 2011, 260 p.

16. Sitthiyot T., Holasut K. A simple method for estimating the Lorenz curve. *Humanities and Social Sciences Communications*. 2021. Vol. 8. No. 268. URL: https://doi.org/10.1057/s41599-021-00948-x (Accessed 10.02.2023).

17. Hazell J., Herreño J., Nakamura E., Steinsson J. The slope of the Phillips Curve: Evidence from U.S. States. *The Quarterly Journal of Economics*. 2022. Vol. 137. No. 3. P. 1299–1344. URL: https://doi.org/10.1093/qje/qjac010 (Accessed 10.02.2023).

18. Shen J., Zhu T., Sun F. A study on the mechanism and pricing of drainage rights trading based on the bilateral call auction model and wealth utility function. *Water*. 2022. Vol. 14. No. 2269. URL: https://doi.org/10.3390/w14142269 (Accessed 10.02.2023).

19. Bibi F., Jamil M. Testing environment Kuznets curve (EKC) hypothesis in different regions. *Environmental Science and Pollution Research*. 2021. No. 28. P. 13581–13594.

20. Mankiw N. G. Macroeconomics. 7th edition. New York: Worth Publishers, 2010. XXXVIII+603 p.

21. Mankiw N. G., Taylor M. P., Ashwin A. Business economics. 3d edition. Hampshire : Cengage Learning EMEA, 2019, 544 p.

22. Rajpal A., Bhatia S. K., Hiremath K. R. Inspecting the stability of non-linear IS-LM model with dual time delay. *Chaos, Solitons & Fractals*. Vol. 165. Part 2. No. 112821. URL: https://doi.org/10.1016/j.chaos.2022.112821 (Accessed 10.02.2023).

23. Dutt A. K. Aggregate demand, aggregate supply and economic growth. *International Review of Applied Economics*. 2006. Vol. 20. No. 3. P. 319–336.

24. Наконечний С. І., Терещенко Т. О., Романюк Т. П. Економетрія: підручник. Вид. 3-тє, доп. та перероб. К. : КНЕУ, 2004. 520 с.

25. Рівень непрацюючих кредитів (NPL): Національний банк України. URL: https://bank.gov.ua/ua/stability/npl (Accessed 10.12.2022).

26. Основні показники діяльності банків України: Національний банк України. URL: https://bank.gov.ua/files/stat/Indicators_Banks_2023-03-01.xlsx (Accessed 10.12.2022).

27. Mescon M. H., Albert M., Khedouri F. Management. 3d edition. New York: HarperCollins Publishers, 1988. XXVIII+777 p.

28. Про надання фінансової державної підтримки : Постанова Кабінету Міністрів України від 24.01.2020 р. № 28. URL: https://zakon.rada.gov.ua/laws/show/28-2020-%D0%BF#n129 (Accessed 10.02.2023).

29. Український індекс ставок за депозитами фізичних осіб : за даними агентства “Thomson Reuters”. URL: https://bank.gov.ua/files/UIRD.xls (Accessed 10.02.2023).

30. Інформація про результати державної програми доступні кредити 5–7–9 : Фонд розвитку підприємництва. URL: https://bdf.gov.ua/uk/informaciya-pro-rezultati-derzhavnoji-programi-dostupni-krediti-5-7-9 (Accessed 10.02.2023).

31. Доступні кредити 5–7–9% : Міністерство Фінансів України. URL: http://surl.li/egzcd (Accessed 10.02.2023).

References

1. Bennett, P. (1984). Applying portfolio theory to global bank lending. *Journal of Banking and Finance*, vol. 8, no. 2, pp. 153–169. https://doi.org/10.1016/0378-4266(84)90002-5

2. Lucas, D., McDonald, R. L. (1987). Bank portfolio choice with private information about loan quality: Theory and implications for regulation. *Journal of Banking & Finance*, vol. 11, no. 3, pp. 473–497. https://doi.org/10.1016/0378-4266(87)90044-6

3. Madura, J., Zarruk, E. R. (1992). Information effects of loan portfolio quality on bank value. *Journal of Economics and Finance*, vol. 16, no. 1, pp. 27–40. https://doi.org/10.1007/BF02919791

4. Docking, D. S., Hirschey, M., Jones, E. (1997). Information and contagion effects of bank loan-loss reserve announcements. *Journal of Financial Economics*, vol. 43, no. 2, pp. 219–239. https://doi.org/10.1016/S0304-405X(96)00895-1

5. Bessler, W., Nohel, T. (2000). Asymmetric information, dividend reductions, and contagion effects in bank stock returns. *Journal of Banking and Finance*, vol. 24, no. 11, pp. 1831–1848. https://doi.org/10.1016/S0378-4266(99)00097-7

6. Tchakoute-Tcbuigoua, H., Soumare, I. (2019). The effect of loan approval decentralization on microfinance institutions' outreach and loan portfolio quality. *Journal of Business Research*, vol. 94, pp. 1–17. https://doi.org/10.1016/j.jbusres.2018.09.021

7. Afrifa, G. A., Gyapong, E., Zalata, A. M. (2019). Buffer capital, loan portfolio quality and the performance of microfinance institutions: A global analysis. *Journal of Financial Stability*, vol. 44, no. 100691. https://doi.org/10.1016/j.jfs.2019.100691

8. Fiador, V., Sarpong-Kumankoma, E. (2021). Does corporate governance explain the quality of bank loan portfolios? Evidence from an emerging economy. *Journal of Financial Economic Policy*, vol. 13, no. 1, pp. 31–44. https://doi.org/10.1108/JFEP-06-2019-0130

9. Cucinelli, D., Gai, L., Ielasi, F., Patarnello, A. (2021). Preventing the deterioration of bank loan portfolio quality: A focus on unlikely-to-pay loans. *The European Journal of Finance*, vol. 27, no. 7, pp. 613–634. https://doi.org/10.1080/1351847X.2020.1830143

10. Semenova, K. D., Tarasevych, N. V. (2020). Modeliuvannia vplyvu faktoriv kliientskoho kapitalu na dokhody bankivskykh ustanov [Modeling of the influence of client capital factors on income of banking institutions]. *Academy Review*, no. 2(53), pp. 39–45. https://doi.org/10.32342/2074-5354-2020-2-53-4 (in Ukrainian)

11. Moore, J. H., Weatherford, L. R. (2001). *Decision Modeling With Microsoft Excel*. 6th Edition. Hoboken: Prentice Hall, 693 p.

12. Cobb, C. W., Douglas, P. H. (1928). A theory of production. *The American Economic Review*, vol. 18, no. 1, pp. 139–165.

13. Laffer, A. B. (2004). The Laffer Curve: Past, present, and future. *Backgrounder*, no. 1765, pp. 1–16. available at: http://s3.amazonaws.com/thf_media/2004/pdf/bg1765.pdf (Accessed 20 February 2023).

14. Madura, J. (2014). *Financial markets and institutions*. 10th Edition. Stamford: Thomson, 784 p.

15. Geiger, F. (2011). *The Yield Curve and financial risk premia: Implications for monetary policy*. Berlin: Springer Science & Business Media, 260 p.

16. Sitthiyot, T., Holasut, K. (2021). A simple method for estimating the Lorenz curve. *Humanities and Social Sciences Communications*, vol. 8, no. 268. https://doi.org/10.1057/s41599-021-00948-x

17. Hazell, J., Herreño, J., Nakamura, E., Steinsson, J. (2022). The slope of the Phillips Curve: Evidence from U.S. States. *The Quarterly Journal of Economics*. vol. 137, no. 3, pp. 1299–1344. https://doi.org/10.1093/qje/qjac010

18. Shen, J., Zhu, T., Sun, F. (2022). A study on the mechanism and pricing of drainage rights trading based on the bilateral call auction model and wealth utility function. *Water*, vol. 14., no. 2269. https://doi.org/10.3390/w14142269

19. Bibi, F., Jamil, M. (2021). Testing environment Kuznets curve (EKC) hypothesis in different regions. *Environmental Science and Pollution Research*, no. 28, pp. 13581–13594.

20. Mankiw, N. G. (2010). *Macroeconomics*. 7th edition. New York: Worth Publishers, XXXVIII+603 p.

21. Mankiw, N. G., Taylor, M. P., Ashwin, A. (2019). *Business economics*. 3d edition. Hampshire: Cengage Learning EMEA, 544 p.

22. Rajpal, A., Bhatia, S. K., Hiremath, K. R. Inspecting the stability of non-linear IS-LM model with dual time delay. *Chaos, Solitons & Fractals*, vol. 165, part 2, no. 112821. https://doi.org/10.1016/j.chaos.2022.112821

23. Dutt, A. K. (2006). Aggregate demand, aggregate supply and economic growth. *International Review of Applied Economics*, vol. 20, no. 3, pp. 319–336.

24. Nakonechnyi, S. I., Tereshchenko, T. O., Romaniuk, T. P. (2004). *Ekonometriia* [Econometrics]. 3d edition. Kyiv: KNEU, 520 p. (in Ukrainian).

25. National Bank of Ukraine (2023). Riven nepratsiuiuchykh kredytiv (NPL) [Level of non-performing loans (NPL)]. available at: https://bank.gov.ua/ua/stability/npl (Accessed 20 February 2023) (in Ukrainian).

26. National Bank of Ukraine (2023). Osnovni pokaznyky diialnosti bankiv Ukrainy [Main performance indicators of Ukrainian banks]. available at: https://bank.gov.ua/files/stat/Indicators_Banks_2023-03-01.xlsx (Accessed 20 February 2023) (in Ukrainian).

27. Mescon, M. H., Albert, M., Khedouri, F. (1988). *Management*. 3d edition. New York: HarperCollins Publishers, XXVIII+777 p.

28. Cabinet of Ministers of Ukraine (2020). Pro nadannia finansovoi derzhavnoi pidtrymky [On providing financial state support]: Resolution of the Cabinet of Ministers of Ukraine dated January 24, 2020, no. 28. available at: https://zakon.rada.gov.ua/laws/show/28-2020-%D0%BF#n129 (Accessed 20 February 2023) (in Ukrainian).

29. National Bank of Ukraine (2023). Ukrainskyi indeks stavok za depozytamy fizychnykh osib: za danymy ahentstva "Thomson Reuters" [Ukrainian index of rates on deposits of individuals: according to the agency "Thomson Reuters"]. available at: https://bank.gov.ua/files/UIRD.xls (Accessed 20 February 2023) (in Ukrainian).

30. Entrepreneurship Development Fund (2023). Informatsiia pro rezultaty derzhavnoi prohramy dostupni kredyty 5–7–9 [Information on the results of the state program is available credits 5–7–9]. available at: https://bdf.gov.ua/uk/informaciya-pro-rezultati-derzhavnoji-programi-dostupni-krediti-5-7-9 (Accessed 20 February 2023) (in Ukrainian).

31. Ministry of Finance of Ukraine (2022). Dostupni kredyty 5–7–9% [Available loans 5–7–9%]. http://surl.li/egzcd (Accessed 20 February 2023) (in Ukrainian).

CURRENT CHALLENGES AND PROSPECTS OF LOAN PORTFOLIO QUALITY MANAGEMENT IN WARTIME: THE CASE OF UKRAINE

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The purpose of the study is to develop effective ways to solve the problems of managing the quality of the loan portfolio of the Ukrainian banking sector in the context of the financial crisis caused by the russian-Ukrainian war. In the course of the study, such scientific methods as fundamental provisions of the credit portfolio theory, multifactor regression analysis, extrapolation, trend analysis, mathematical programming, etc. have been used.

A methodical approach to the study of contemporary problems and prospects of loan portfolio quality management under martial law, consisting in modelling the profitability of the Ukrainian banking sector, taking into account the quality of the loan portfolio, has been proposed. This approach is implemented by constructing a two-factor power regression equation; forecasting with the establishment of confidence intervals and the development of 3 forecast scenarios (realistic, pessimistic and optimistic); solving the target function to maximize the profit of the banking sector, taking into account the restrictions formed on the basis of forecasting results.

A power model of dependence of Ukrainian banking sector profitability on the volume of loan portfolio and non-performing loans has been built and its statistical significance has been established on the basis of official statistics for 2012–2022. It has been determined that an increase in the volume of the bank loan portfolio by 1% leads to an increase in bank income by 3.1%, while an increase in the volume of non-performing loans by 1% leads to a 0.28% reduction in revenues of the banking sector of Ukraine. The loan portfolio and NPL series have been extrapolated to 2023–2025, which is consistent with the medium-term, as long-term projections would be unreliable under martial law and deep recession.

According to the results of medium-term forecasting and optimization, it has been proved that the maximum growth of bank revenues by 60.4%, compared to 2022, is possible with an increase in the loan portfolio by 18.9%, a reduction of non-performing loans by 26% and a reduction of their share in the loan portfolio by 13.9%. It has been justified that the key condition for maximising bank revenues is the soonest termination of the russian-Ukrainian war and further expansion of effective government concessional lending programs. In particular, the effectiveness of the state program "Affordable Loans 5–7–9%", which provided 19% of the bank loan portfolio in Ukraine and became a key mechanism of anti-crisis business support both during the COVID-19 pandemic and during the large-scale invasion from 2022 during the russian-Ukrainian war, has been substantiated.

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