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BANKS FINANCIAL PERFORMANCE OPTIMIZATION PROBLEM IN THE CONTEXT OF THEIR FINANCIAL DEVELOPMENT

Abstract. In the paper the mathematical model of optimization tasks of the bank activity financial indicators is built with the purpose of increase of their values to «standard» and with the purpose increase of concrete bank rating in general rating at comparison with banks-competitors. The tasks are set as the classic tasks of the nonlinear programming with nonlinear functionals and possible nonlinear constraints.

Keywords: bank, financial indicators, financial development management, rating number, reference bank, modeling, nonlinear programming task, optimization, functional, limitations

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JEL Classification: G 21, G 24

Introduction. In recent years, in period of social and economic changes, the task of sustainable development of the CIS countries, including Ukraine, banking systems ensuring, in general, and the problem of the individual bank financial development in particular, acquire relevance due to the fact that the banking system financial activity was accompanied by a display of all sorts of crisis events.

Today, analyzing a situation in which Ukrainian banks are functioning, we can talk about the imperfection of the bank development financial management system, imperfection of the optimal planning system of banks financial development, the imperfection of the prediction and prevention crisis events system. These and other facts are the reason that the part of the Ukrainian banks face with a problem of bankruptcy.

In modern conditions banks financial resources management optimization and flexible approaches to managing their financial development problem with a view to prompt and adequate response to both internal and external factors that affect the bank financial performance and the bank development in a whole are very important. Actual problems are preventing the situation of the bank financial condition deterioration, finding ways of optimal resources allocation through the bank's financial performance optimization and as a result achieving effective process for the bank financial development.

Based on the above, the relevant problem is the control formation that can ensure efficient financial development of the bank and the bank's adequate response to the destabilizing influences of external and internal environment.

Literature review and the problem statement. A significant contribution to the development of the management in the banks theory and practice have such well-known Ukrainian scientists as V. Mishchenko, A. Kalinichenko, I. Karpova, S. Kozmenko, F. Shpyga, I. Voloshko, S. Lapteva, O. Lyubunya, P. Matvienko, I. Salo, T. Smovzhenko, A. Trided, A. Pushkar and others; and Russian scientists such as O. Lavrushin, V. Platonov, N. Kunitsin,

L. Ushvitsky, M. Bor, V. Pyatenko, Y. Maslenchenkov and others.

However, the focus of many scholars and practitioners has been given to the development and implementation of techniques and recommendations for the strategic bank management as a whole.

At the same time methodological aspects of financial indicators optimization process in the context of its financial development management are considered insufficiently. Require further development problems of the banks financial development optimal planning and the formation of the banks financial performance adequate criteria using regular methods of optimization - Hook-Jeeves method, Nelder-Mead method, Rosenbrock method, Powell method, Cauchy method, Newton method and others [Bandi 1988; Dźwigoł 2015; Dźwigoł 2010; Dźwigoł 2009; Dźwigoł 2004; Dźwigoł 2003a; Himmelblau 1975; Kirgat, Surde 2014; Kvilinskyi 2012; Lavrushin 2009; Long, Wu 2014; Gao, Han 2010]. Search of using of the classical optimization methods (including specified) in banking in the scientific literature, libraries and the Internet does not provide positive results. The conclusion is that in the modern banking use of such effective and powerful mathematical formalism as the optimization techniques is not enough.

The aim of the study is to pose the problem of banking financial performance optimization in order to increase their value to the "standard" and the problem of the banks financial performance optimization in order to improve the position of a particular bank in the overall ranking compared to competitor banks.

Research results. Optimum decisions that are taken, and plans are being developed in the preparation of action, as well as efficient using of resources is impossible without the correct mathematical modeling of financial condition and prognosis of the situation, without comparing and evaluating possible options for using the mathematical apparatus and the latest information technology.

In general, the problem of mathematical programming or optimization problem is formulated in the following way [Bandi 1988; Heygeman, Young 1986; Himmelblau 1975].

Find function extremum

$$f(x) = f\left(x_1, x_2, ..., x_N\right), \quad (1)$$

n-dimensional vector argument $x = \left(x_1, x_2, ..., x_N\right)$ with restrictions

$$h_k\left(x\right) = 0,\ k = \overline{1,K}; \quad (2)$$

$$G_r\left(x\right) \geq 0, r = 1, R; \quad (3)$$

$$x_{\theta min} \leq x_\theta \leq x_{\theta max},\ \theta = \overline{1, N}. \quad (4)$$

In (1)-(4) $x_1, x_2, ..., x_N$ – varying variables or controlled parameters; equality constraints (2) of the amount K; inequality constraints (3), the number of which is R; restrictions on the varying variables (4).

It should be noted that some of the variables $x_\theta, (\theta = \overline{1, N})$ in the N-dimensional vector argument x can be equal to zero, that is, not to take part in the mathematical description of equality constraints (2) and inequalities (3). In addition, varying variables themselves in the sense of a particular banking tasks also vary within their respective possible minimax values (4).

The values of financial indicators of banks constitute a certain matrix P (i-th column vector of the matrix elements - a list of values of i-dimensional index

for each of the banks b and s-th row vector elements - a list of diverse values for the s-parameters of the bank ($i=\overline{1,n}$; n – the number of indicators being considered, or are involved in a particular procedure; $s=\overline{1,b}$; b – the number of banks, which are investigated).

The normalized values of the bank's activities are defined as the elements of the matrix [Samorodov 2011; Samorodov 2012]:

$$p'_{s,i}=\frac{p_{s,i}}{\sqrt{\sum_{s=1}^{b}p_{s,i}^2}}, \quad (5)$$

where $p_{s,i}$ – the numerical value of the i-th index ($i=\overline{1,n}$) in the s-th bank ($s=\overline{1,b}$).

For the formation of a "standard" bank [Samorodov 2011], to the indicators which ideally should approach the performance of all other banks, the optimal values are determined i-th normalized indicators for all banks. Under optimal understood respectively maximum or minimum value depending on the direction of the resulting impact on the sign. Selected normalized optimal values form a matrix row [Samorodov 2011]:

$$Pet_i=\left(\begin{bmatrix}\max\limits_s\{p'_{s,1}\}\\ \min\limits_s\{p'_{s,1}\}\end{bmatrix}\ \ldots\ \begin{bmatrix}\max\limits_s\{p'_{s,i}\}\\ \min\limits_s\{p'_{s,i}\}\end{bmatrix}\ \ldots\ \begin{bmatrix}\max\limits_s\{p'_{s,n}\}\\ \min\limits_s\{p'_{s,n}\}\end{bmatrix}\right), \quad (6)$$

where $\begin{bmatrix}\max\limits_s\{p'_{s,i}\}\\ \min\limits_s\{p'_{s,i}\}\end{bmatrix}$ – determination of the maximum or minimum value of the normalized i-th index, depending on the direction of the resulting impact on the sign.

For comparing the values of investigated banks i-th parameters with their "standard" values is used the ratio to determine the distance D_s between the s-parameters of the bank and the "standard", according to the expression [Bubenko, Vladimirova 2009; Samorodov 2011]:

$$D_s=\sqrt{\sum_{s=1}^{b}\left(p'_{s,i}-p_{eti}\right)^2}, \quad (7)$$

where $p'_{s,i}$ – normalized values of the activity of banks; p_{eti} – values of "standard" of the bank - the elements of row (6) ($s=\overline{1,b}$; $i=\overline{1,n}$).

On the basis of (7) we construct the functional optimization of variable parameters $x_\theta,(\theta=\overline{1,N})$, from which in turn depend on a particular bank financial performance $p_{s,i}=p_{s,i}(x)$ and, accordingly, their normalized values $p'_{s,i}=p'_{s,i}(x)$. There should be again focus on the fact that, in general, not all

the variables $x_\theta,(\theta=\overline{1,N})$ of N-dimensional vector argument x may be involved in the description of functions $p_{s,i}=p_{s,i}(x)$ and $p'_{s,i}=p'_{s,i}(x)$, and also in the mathematical description of equality constraints (2) and inequalities (3).

Thus, the functional, a minimum of which should be found in order to maximize the specific approach of the j-bank to the "standard" bank, will be:

$$D_j(x)=\sqrt{\sum_{i=1}^{n}\left(\frac{p'_{j,i}(x)}{\sqrt{p'^2_{j,i}(x)+\sum\limits_{\substack{s=1\\ s\neq j}}^{b}p'^2_{s,i}}}-p_{eti}\right)^2},\ j=\overline{1,b}. \qquad (8)$$

In functional (8) normalized values of the banks financial performance are not functions of varying variables $x_\theta,(\theta=\overline{1,N})$ if $s\neq j$. In case, if $s=j$ that is $p'_{s,i}(x)=p'_{j,i}(x)$ for the j-th bank functional $D_j(x)$ depends on varying variables vector $x_\theta,(\theta=\overline{1,N})$ and is an analogue of the target function (1).

Thus, the task is the banking financial performance optimizing in order to increase their value to the "standard".

In the next phase of the study it is proposed to set the task of the banks financial performance optimization in the context of the problem of a particular bank position improving in the overall ranking, which is determined by comparing the financial performance of the group of banks.

Let us assume that it had been built rating of b banks. In general, the ratings chart is shown in Figure 1. It is necessary to boost the ranking of a particular j-th bank in the appropriate percentage using the optimization of the bank's financial performance, which is built on the basis of rating, in order to improve its position in the overall ranking of b banks. Graphically, this task is shown in Figure 1.

The idea presented in Figure 1, is that management of the bank №1, which has a rating number R_1 = 0.50061, seeks to improve its ranking by 10% in order to advance bank №b, which rating number R_b = 0.52866. This can be achieved using the powerful apparatus of the optimization theory.

Banks ratings are determined on the basis of (7) – the less the distance D_s is, the higher the rating of the bank is. However, for ease of subsequent analysis of banks ratings, and for more adequate data granularity in graphical form it is suggested to use a ratio that characterizes the total rating number R_s for each of the banks:

$$R_s=1-\frac{D_s}{\sqrt{\sum_{s=1}^{b}D_s^2}}. \qquad (9)$$

In this case, the higher value of the total rating number R_s is, the higher

the bank rating is.

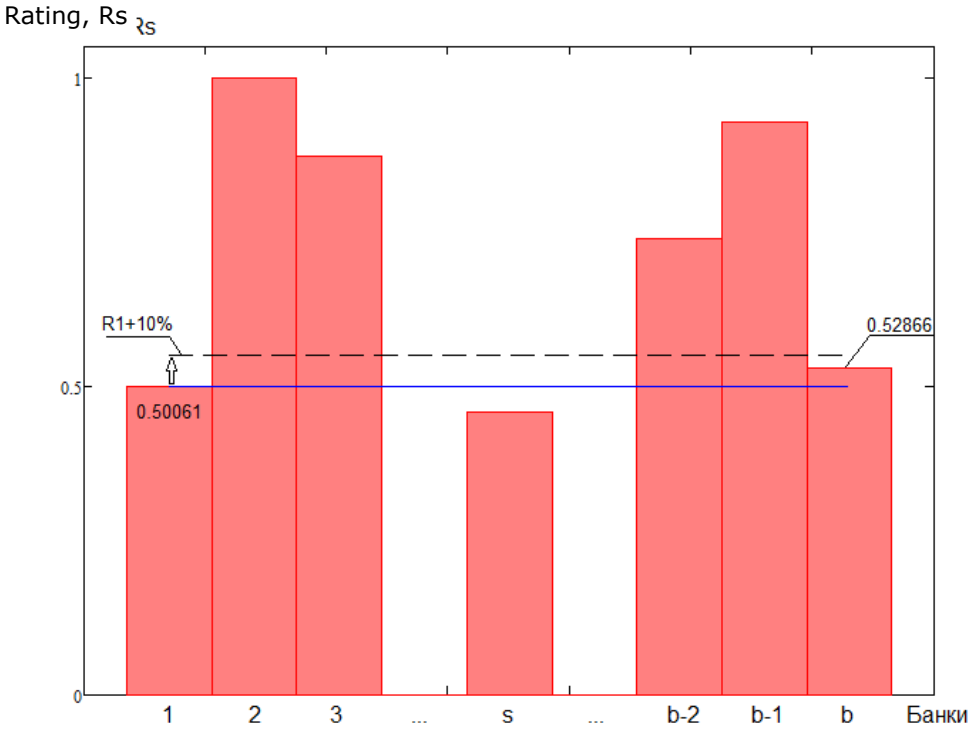

Figure1 – Formulation of the bank's rating increasing problem
Sourse: own development

If in this case (Figure 1), the task is to increase the rating of the s-bank, for example, by 10%, the corresponding functional which is minimized has the following form:

$$F = \left[1 - \frac{R_s}{R_s^{>10\%}}\right]^2 = \left[1 - \left(1 - \frac{D_s}{\sqrt{\sum_{s=1}^{b} D_s^2}}\right) / R_s^{>10\%}\right]^2, \qquad (10)$$

where $R_s^{>10\%} = \text{const} = R_s + R_s \cdot 0.1$ – s-order bank rating number value, which increased by 10%.

On the basis of the relation (10) let's construct the functional for variable parameters $x_\theta, (\theta = \overline{1, N})$ optimization, from which in turn depend on the financial performance $p_{s,i} = p_{s,i}(x)$ of a particular bank and, accordingly, their normalized values $p'_{s,i} = p'_{s,i}(x)$. As in the previous case, it should be noted that in the general case not all variables $x_\theta, (\theta = \overline{1, N})$ of N-dimensional vector argument x can take part in the description of $p_{s,i} = p_{s,i}(x)$ and $p'_{s,i} = p'_{s,i}(x)$ functions and in the mathematical description of equality constraints (2) and inequalities (3).

Thus, the functional, a minimum of which have to be found in order to improve of a particular j-th bank rating in a certain amount of interest (in this

case 10%, see. Fig. 1), will be:

$$F = \left[1 - \frac{R_j(x)}{R_j^{>10\%}}\right]^2 = \left[1 - \left(1 - \frac{D_j(x)}{\sqrt{\sum_{s=1}^{b} D_s^2}}\right) / R_j^{>10\%}\right]^2, \quad (11)$$

where $D_j(x)$ is determined according to (8).

In equations (8) and (11) j - is index, introduced for convenience ($j = s = \overline{1,b}$) which is denoted the number of a particular bank, which rating is improved in the optimization process (in this particular example, j = 1. See Figure 1); $D_j(x)$, $R_j(x)$ - are defined by the formulas (7) and (9) respectively.

Especially for the j-th particular bank the financial performance of its operations is optimized, which depend on variable parameters $x_\theta, (\theta = \overline{1,N})$. The values of the financial performance of all other banks in the group ($s \neq j$), their rating numbers R_s $(s \neq j)$ and indicators of "standard" of the bank remain unchanged.

In the functional (8) and (11) normalized values $p'_{s,i}$ of the banks financial performance are not functions of varying variables $x_\theta, (\theta = \overline{1,N})$ if $s \neq j$. In case, if $s = j$ that is $p'_{s,i}(x) = p'_{j,i}(x)$, for the j-th bank functional F (11) depends on the varying variables $x_\theta, (\theta = \overline{1,N})$ vector and is analogous to the target function (1).

Zero-order approximation [Bandi 1988; Heygeman, Young 1986; Himmelblau 1975] for the variable parameters $x_\theta, (\theta = \overline{1,N})$ is a vector $x_\theta^{(0)}, (\theta = \overline{1,N})$ of which depend on a particular bank financial performance values $p_{j,i} = p_{j,i}\left(x^{(0)}\right)$ and, accordingly, their normalized values $p'_{j,i} = p'_{j,i}\left(x^{(0)}\right)$. While using regular methods of optimization the solution of the problem is a vector $x_\theta^*, (\theta = \overline{1,N})$ that provides the minimum of the functional (11).

With regard to the constraints of the bank financial performance optimization problem (2) - (4), their mathematical description depends on their particular set, which is built on the basis of the banks current rating. It should be noted that the decision maker can either set the constraints (2) - (4) on varying variables, or fix some of them, in order to build an adequate mathematical model of the banks financial performance optimization problem.

For example conditionally, if the size of the bank's №1 capital is 200 million UAH, and for the bank №b this value equals 4 billion UAH., it is obvious that vary this index either pointless, because in this case the optimization will be carried out by other indicators, which can be obtained by varying the bank №1 best rating, or it must be installed the appropriate limits for this value, for example in the form of restrictions (4).

It should be noted that when certain variables $x_\theta, (\theta = \overline{1,N})$ are fixed, the

dimensionality of the optimization problem is reduced, i.e. varying variables number is reduced. And with the increase in the number of indicators and the varying variables which are described them – the optimization problem dimension increases.

Conclusions. The author of the article supplied two tasks: the task of banking financial performance optimization in order to increase correspondent values to the "standard" and the task of the banks financial performance optimization in order to improve the position of a particular bank in the overall ranking compared to competitor banks.

These tasks are the nonlinear programming problems with nonlinear functionality and nonlinear constraints. Determination of the variables optimal values that affect the banks financial performance can be done using the regular classical optimization methods.

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