Optimization Model of Credit Strategy of Commercial Bank

ABSTRACT
Economic and mathematical model of credit management of commercial banks is developed. The model allows obtaining optimal strategies of variant calculations of this kind of banking services. The procedure of quantitative solution of this problem is substantiated to help to make optimal decisions in reference to allocation of assets.

Key words: bank, deposit, credit, loan portfolio, model and optimal management.

Successful functioning of the bank depends not only on workers' skills, their knowledge and experience, but also on the optimization of the whole process of making and implementation of management decisions.

Modeling of bank financial activity is very important and difficult task, as the bank is a system in which deterministic and random processes take place simultaneously and that are interrelated by very complicated factors. Furthermore, subjective management decisions are essential in bank activity. However, a bank interacts with the financial markets in the process of functioning, which are difficult to model. All these facts point at considerable complexity of creating an analytical model of bank financial activity, which can be used in practice.

K. Scally, E. Baltensperger, H. Markowitz, M. Klein, N. Murphy, N. Egorova, A. Smulov, and others drew on the problem of modeling of optimal loan portfolio. However, one of the most important tasks of commercial bank in the field of financial activity is to balance between profitability and risk and to find optimal combination in the form of trade-offs.

Based on the classic approach of modeling of credit portfolio, we model optimal structure of commercial bank loan portfolio.

The purpose of this study is the use of existing models and the development of applied economic and mathematical model for finding profitable credit strategies of commercial banks in Ukraine and abroad.

Commercial bank may carry out credit, investment and other active operations only within available financial resources. Deposits are principal source of financial resources of the bank; they determine the scope and range of profitable operations of the bank.

The main management instrument of credit activity is economic and mathematical methods and models.

The prerequisite of building economic and mathematical model of a bank loan portfolio is the following conditions:

1) the timing of the credit arrangement;
2) the calculation of annual and monthly crediting rates;
3) the determination of the conditions for loan repayment;
4) the determination of the home equity sum that can be used for the crediting process;
5) the determination of the risk magnitude as the probability of default of all types of credits and the calculation of default risk by periods;
6) the use of current percent of credit repayments in the crediting process;
7) the determination of the period, at the beginning of which the calculation of profits is carried out;
8) Taking into account the liquidity ratios (H1, H5 and H6) that regulate the credit activity of a commercial bank.

The target function of the problem is:

\[ Z = \sum_{t=1}^{T} \sum_{m=1}^{M} r_t \]

1) Balance conditions:

\[ S_1 = x_{1,1} + \frac{x_{1,3} + x_{1,5} + x_{1,7}}{t_3 + t_5} \]

2) Balance conditions:

\[ \sum_{i=1}^{n} x_{i,2} + \sum_{j=1}^{m} z_{j,2} \]

3) Balance conditions:

\[ S_2 = x_{1,2} + 2 \cdot \left( \frac{x_{1,3} + x_{1,5} + x_{1,7}}{t_3 + t_5} \right) \]

4 Restriction:

\[ \sum_{i=1}^{n} x_{i,3} + \sum_{j=1}^{m} z_{j,2} D_{12} \]
6 Restrictions accounting the implementation of current liquidity standards by periods:

\[ \sum_{i=1}^{18} x_{i1} \geq 0.4 \sum_{j=1}^{5} D_{j1} \]
\[ \sum_{i=1}^{18} x_{i2} \geq 0.4 \sum_{j=1}^{5} D_{j2} \]
\[ \sum_{i=1}^{18} x_{i3} \geq 0.4 \sum_{j=1}^{5} D_{j3} \]

7 Restrictions for size of average risk of credit defaults:

\[ \sum_{i=1}^{n} \sum_{t=1}^{T_i} u_{it} \cdot x_{it} \leq U^* \]
\[ \sum_{i=1}^{n} \sum_{t=1}^{T_i} x_{it} \leq K_0 \]

8 Restrictions that determine the marginal sum of volume of credit:

9 Restrictions for nonnegative variables:

\[ x_{it} \geq 0, i = 1, \ldots, n; t_i = 1, \ldots, T_i \]

The given economic and mathematical model enables obtaining the optimal scheme of the crediting process, which is divided into monthly, that allows us to trace the funds movement, calculate idle balances and direct them to acquire marketable instruments, provide short-term interbank credits and deposit in another bank.

Since the model is designed for one quarter (3 months), bankers can orientate themselves in the current situation, summarize their activities per quarter, and make adjustments in the subsequent period (it may be a change of rates and credit conditions, which is important in a competitive environment and economic instability). It should be noted that the optimization model is quite flexible. Additional restrictions can be added to it, with the help of which the current situation of credit and deposit activities is modeled. For example, these may be the restrictions accounting known volume of credits at the beginning of the crediting period, the current values, and necessary reserve funds. If the desirable amount of profit is noted in the target function, then we obtain necessary scheme of credit allocation for periods and types. In addition, if necessary, you can change the amount of the deposit incomes.

We use software application package EXEL to obtain numerical solutions of constructed model.

Optimization algorithm indicates the direction of the search; conjugate gradient method is selected, which is used to solve big optimization problems. During the solving of the problem with this search method, the large number of iterations is performed; this gives the possibility to obtain accurate results.

At the end of the period (at the beginning of the first month of the next quarter) maximum profit and the scheme of credit arrangement on volume, types and periods is obtained.

Quantitative analysis of different scenarios provides a selection of profitable option for the bank, the estimate of the probability of a bad situation and makes it possible to develop an adequate plan of action. Using simulation models one can evaluate and analyze alternative scenarios of profit and risk management. In the process of optimization modeling, banks can develop their own models that meet their individual needs, thus increasing the efficiency of credit operations.